University of Alberta

Housing and Health in Alberta First Nations Communities: Examining the Relationship between Enteric Disease and Environmental Factors

by

Joan Emma Elson Yee ©

A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science
in
Population Health

Department of Public Health Sciences

Edmonton, Alberta
Fall, 2007

Your file Votre référence
ISBN: 978-0-494-33238-2
Our file Notre référence
ISBN: 978-0-494-33238-2

Abstract

This study examines the relationship between components of housing and the incidence of enteric disease in Alberta First Nation communities. Statistically significant relationships were established between household occupancy density, open discharge sewage systems and the occurrence of one or more sewage back-ups. Disease specific rates (1998-2004) in First Nations communities are generally not higher than the provincial rates, with two exceptions: giardiasis and shigellosis. Both populations have been experiencing a downward trend in enteric disease for the study period, despite a growth in population. While the best available data were used to complete the analysis, there were many limitations regarding the level of analysis of available data sets, survey design, and data verification issues that restricted the data analysis. Future surveys must be designed and completed in a collaborative manner based on clear research objectives and sound survey design, data collection and data analysis principles.

Acknowledgements

I would like to thank a number of people who supported me through this research:

My husband, Brian and daughter, Emma for their understanding, and love; for our baby-to-be for patiently accompanying me on the final stage of this journey.

My parents, John and Pearl Elson, who instilled in me the importance of education and encouraged the importance of dedicating oneself to the task at hand.

My sister, Kathleen Elson, for her support and assistance with editing and researching this document.

My many friends and family who have stood by me throughout the completion of this thesis, especially the Yee family and Darren and Amy Hudson for their support and encouragement.

My colleagues at Health Canada and in Alberta First Nations communities, for their on-going support and dedication to address environmental health issues on reserve in Alberta, especially Skattar Sandhu.

To my advisory committee, Dr. Lory Laing, Dr. Victoria Edge, Dr. Duncan Saunders, and Dr. Daniel Smith for sharing their area of expertise with me and giving me the opportunity to learn from them.

Table of Contents

List of Tables

List of Figures

Introduction

This thesis examines the relationship between enteric diseases and community infrastructure and the concept of crowding in present-day Canadian society. Enteric diseases are acute infections of the gastrointestinal tract with diarrhea being the most common manifestation (Sherris, 1990). The severity of these types of diseases can range from self-limiting to fatal and include illness such as salmonellosis, shigellosis and campylobacteriosis. These types of diseases tend to affect infants and children more than adults because they are more prone to fecal-oral contact and their immune systems are not as developed. Enteric diseases can be spread in the home environment, whether by direct (person-to-person) contact or indirect contact, with sources being humans, water, wastewater systems, food or pets. Water supply and wastewater disposal systems will be the components of community infrastructure used in the research. Crowding will be defined as density or the number of people per unit space, which also influences the spread of enteric diseases.

In order to establish a foundation to improve health, the Ottawa Charter for Health Promotion (1986) lists shelter as a prerequisite, along with peace, education, food, income, a stable eco-system, sustainable resources, social justice and equity. Shelter or housing provides protection from the elements, but it also provides a meaningful place in which individuals interact with each other and their environment. There are components of housing, that if lacking or deficient, directly affect the environment in which individuals and families live and may potentially affect the health of the residents. While the importance of sanitary and hygienic design and

conditions of houses in the avoidance of illness is established, healthy housing is also about providing a living environment for the betterment of health (Ranson, 1991).

While it is established that the immediate environment of the home can influence health, it is also important to consider the context in which the dwelling exists. The physical environment of the home and the social, economic, and cultural conditions of the community are both crucial to understanding the relationship between housing and health. (Young, Bruce, Elias, O'Neil, & Yassie, A. 1991.)

The development of healthy housing standards is not a new issue. In countries such as Great Britain during the Industrial Revolution, there was a large shift in population from rural to urban communities. This population migration was related to the search for employment associated with a shift from a primarily agrarian economy to an industrial economy. As the urban centers were not prepared for the rapid influx of people, communities were faced with a severe lack of suitable, adequate and affordable housing. Communities experienced many epidemics and high rates of mortality from diseases such as tuberculosis, cholera, and typhus. Factors contributing to the management (or lack there of) of these diseases included debate on the causation of different diseases (e.g., miasma versus specific disease agents) by medical practitioners; the role of central governments (passing legislation to establish public health service, use of quarantine); actions of local governments (sanitary reforms to improve living environments such as housing, construction of community infrastructure through water and sewer systems); and the dimension of class (Brunton, 2004). It has been argued that the key factor to controlling these diseases during this time was the actions of local governments through sanitary

reform (Brunton, 2004). These improvements were not achieved uniformly across populations and usually those that needed it the most were the last to achieve it.

This study attempts to determine whether a relationship exists between components of housing (as measured by community infrastructure and crowding) and the incidence of enteric disease in First Nations communities using existing data sources. The purpose of this research project is to address this question using population, enteric disease data, and community infrastructure data from six Alberta First Nations communities. This study will assist band administrations and federal government departments on how to improve the collection, examination and application of housing, health and population data on a community level.

Background

This section provides background information on the general relationship between housing and health, research issues, groups vulnerable to substandard housing, and a summary of health status and housing issues in Canadian First Nations communities.

Housing, Health and Epidemiological Evidence

Disease can result from the interaction of a host, agent and the environment (and sometimes through interaction with a vector). This is known as the epidemiologic triad of disease, and is most often used in describing infectious diseases (Gordis, 2000). Manifestations of different types of disease in humans depend on the interactions of the factors (Gordis, 2000):

- host characteristics (examples include age, sex, race, occupation, genetic profile, previous diseases, immune status)

- types of agents and dose (examples include biologic, chemical, physical, nutritional)
- environmental factors (temperature, humidity, crowding, housing, neighbourhood, food, water)

In relation to housing, there are a number of environmental health and safety issues that may result in disease. For example, poor construction, improper maintenance of heating/ventilation systems, and prolonged state of disrepair can result in damp conditions in homes. This type of condition can be conducive to the growth of microorganisms and may cause upper respiratory symptoms and allergic reactions in sensitive or immunocompromised individuals.

The transmission of enteric diseases is most commonly by the fecal-oral route by direct or indirect contact with the agent by the host. A host may be exposed to an agent of enteric disease by indirect contact due to plumbing disrepair or a contaminated water supply. Alternatively, a host may be exposed to an enteric disease by person-to-person contact (direct) due to conditions of overcrowding.

Defining Healthy Housing

The European Office of the World Health Organization has a definition of healthy housing (Appendix A) that outlines components necessary to promote the health and safety of the residential environment. The definition, while not as inclusive as other documents that exist[1], does provide a general description of healthy housing that is sufficient for the purposes of this paper. This definition includes the following components:

[1] The American Public Health Association's document *Basic Health Principles of Housing and Its Environment* outlines in great detail specifications for the "Living Unit and Structure" and "Residential Environment"

- potable water supply;
- collection, storage, disposal of liquid and solid wastes;
- weatherproof, waterproof, windproof, and protection from the elements;
- free from injury hazards;
- sufficient space for all normal household activities;
- protection from insects and vermin;
- facilities for personal and household hygiene and cleanliness;
- natural and artificial means of illumination;
- protection from exterior and interior sources of noise;
- access to health, welfare, social, education, cultural and protective community services.

The definition addresses the structures of the house and the contextual conditions that create an environment that may protect and promote residents' health.

Housing and Health in the Community Context

Meeting physical housing standards and having access to the services outlined in the WHO definition will not guarantee an illness-free health status. The concepts of housing and community are linked to the identities of individuals and to emotional well-being. Housing and the community context become more than a place where one lives and keeps warm, dry, and safe (Young et al., 1991). Lindheim and Syme (as cited in Young et al., 1991) list three risk factors for poor health from a social perspective:

1. lack of meaningful social relationships: the interruption of supportive ties between individuals;

2. low hierarchical positions: low self-esteem, lack of control over one's lives, absence of meaningful participation;
3. disconnection from biological and cultural heritage.

The state of housing and its community context can have an impact on and be impacted by the three risk factors. Therefore, it is important to consider social, economic and cultural dimensions in the planning and design of housing and communities in order to promote better health. Poor planning can have implications on the physical, social, and psychological health of the affected population (Young et al., 1991). Housing that meets health standards and addresses social interactions through its environment will both contribute to improvements in quality of life and health. This relationship is summarized by a quote from the World Health Organization Expert Committee on the Public Health Aspects of Housing:

> Since the residential environment consists of many elements of the overall environment, with each element capable of exerting individual detrimental effects upon health and well-being, it can be deduced that the effect of the residential environment upon health is the sum of the individual factors (as cited in Ranson, 1993).

Research Challenges

Given the multiple aspects of the relationship between housing and health, it is very difficult to investigate the causal relationships between specific aspects of housing and subsequent health status indicators. Some of the issues to consider when conducting research in this area are:

- In the past, measures of mortality (infant mortality, infectious disease mortality) were used to measure health status. Decreases in infant mortality and infectious disease mortality have occurred and these measures are not as suitable to measure health status. Morbidity measures

are now used, but great care needs to be taken to ensure the chosen measure is suitable. (Young et al., 1991.)

- Socioeconomic status (SES) can be a confounder when studying the health effects of poor housing. SES can be separately associated with housing and with health. Methods to help control for confounders include restriction, matching stratification and multivariate statistical analysis. In the scientific stream, it may be important to determine true risk factors. However, in an applied sense, it may not be as necessary since housing improvements should occur concurrently with social and economic strategies. (Young et al., 1991.)
- The direction of a cause and effect relationship between a housing factor and disease outcome can be unclear. That is, if a housing factor is known to be associated with a disease, it does not definitively mean that the housing factor caused the illness. An example would be that respiratory illnesses could be caused by damp conditions or environmental tobacco smoke or both. (Ranson, 1993.)
- "Indices for measuring health and the hygienic quality of housing are often too insensitive, inappropriate, and/or lack universal acceptability"(Ranson, 1993) For example, operationalizing concepts such as overcrowding (i.e., how to define overcrowding) in direct relation to health can be problematic. (Young et al., 1991.)
- There is a lack of epidemiologic studies relating to the effect of particular housing factors on health.

The challenges outlined above have also been discussed in a paper by Blum (1983).

Addressing the above-mentioned challenges through research in this field is necessary to help us to better understand the human relationship between physical, social, and emotional health and the built environment.

Despite the intuitiveness of the benefits of a healthy house, substandard housing still continues to exist. A substandard housing stock can exist when the demand for quality, affordable housing exceeds the supply. In times when there is rapid population growth, high population density and/or a young and poor population, as examples, the health of the population becomes vulnerable (Ineichen, 1993). Mixing this with a housing stock that does not meet health standards creates conditions that place an already vulnerable population at further risks of poor health.

Vulnerable Groups in the Population

Certain groups are more vulnerable to substandard housing. These groups include the physically disabled, mentally ill, mentally handicapped, terminally ill, and elderly (Ineichen, 1993). Housing issues related to these groups range from the availability of suitable housing, limited healthcare resulting in earlier discharge, ability to afford suitable housing and having the ability to live an independent life. First Nations people in Canada are considered a group vulnerable to housing deficiencies both on and off reserve.

First Nations people are those who occupied the land in Canada before the appearance of explorers, trappers and settlers from Europe. As the land was taken over by the settlers, this put pressure on the First Nations peoples and their generally nomadic way of life. By the late 1800s the government of Canada had started to sign

treaties with the Tribes and eventually the *Indian Act* was passed. In the *Indian Act*, "reserves" or specific tracts of land are set aside in Canada for the exclusive use of Status (Registered) aboriginal peoples (Shin, 1997). More recently, housing has become a very serious concern in Canadian First Nation communities. The Assembly of First Nations, a national political lobby group, in their 2003 pre-budget submission to the Federal Department of Finance stated, "First Nation citizens have consistently identified addressing the shortage of quality housing as a top priority" (Barnsley, 2003).

Those First Nations people who live off reserve face issues of affordability and housing discrimination that have the potential to limit options and can result in ghettoization in the inner city or neighbourhoods that may expose individuals to despair related to poverty, discrimination, and exposure to addictions, violence and crime (Dunn, 2002). First Nations people who live on reserve are also challenged by housing issues specific to their own situation. This is discussed in the following sections.

Health Status of Canadian First Nations

First Nations people have greater risks of developing illnesses and earlier death in general than the Canadian population. A gap not only exists for health, but also for the determinants of health in general, including income, education, literacy, socioeconomic status, and the physical environment including access to safe, affordable and healthy housing. (FPTACPH,[2] 1999.)

---

[2]Federal, Provincial, and Territorial Advisory Committee on Population Health for the Meeting of Ministers of Health, Charlottetown, Prince Edward Island, September, 1999

Despite experiencing an increase in life expectancy by 13.1% and 12.6% for males (68.9 years) and females (76.6 years), respectively, between 1980 and 2000, this segment of the population continues to experience proportionately more health problems than the rest of the Canadian population (FNIHB, 2003).

The common causes of age specific deaths in 1999 parallel the Canadian population as a whole (younger populations were more susceptible to unintentional and intentional injuries, while older age groups succumbed to circulatory diseases). However, First Nations populations also experienced disproportionately higher rates of infectious diseases, such as pertussis, chlamydia, Hepatitis A, shigellosis, tuberculosis in 1999 (FNIHB, 2003). Additionally First Nations people continue to have an increased risk of death from chronic diseases such as diabetes compared to Canadians nationally (First Nations and Inuit Regional Health Survey, 1999). This makes addressing health issues in the Canadian First Nations population difficult and complicated because there are many health issues within a relatively small population and there are many factors that affect health.

Historical Perspectives on Health Services for First Nations Communities

The treaties play an important role in the relationship First Nations have with the federal government, which affects the way housing issues are approached in the communities. As the land in Canada began to be explored and eventually settled by Europeans, all aspects of life in native populations were affected. Treaties were signed between the "Queen" and the different tribes starting in 1871. In Alberta, there are a total of three treaty areas (6, 7, and 8). Each treaty is different as the terms were negotiated separately. The only Alberta area treaty that specifically refers to

health is Treaty 6 with the "medicine chest" provision (Waldram, 1995). To this day, the meaning of the "medicine chest" provision is still debated. According to Waldram (1995), the federal government has provided medical services to First Nations people as a matter of policy – not legal obligation. In contrast, native organizations believe that medical services are a part of the "spirit and intent" of the treaties. Furthermore, the *Constitution Act, 1867* provides a legal framework for the division of law-making powers between federal and provincial governments. While "Indians and Lands Reserved for Indians" is a federal jurisdiction (s. 91(24)), health is a provincial jurisdiction (s. 92(7)). Therefore, public health legislation, including housing and health, is a provincial jurisdiction which further complicates the issue of health services delivery in First Nations communities.

Housing and Health Issues in Canadian First Nations Communities

The Canadian First Nations population is expected to increase by 3% between 1998 and 2008, with an expected aging trend as the 19 and under age group declines and the working age group (20 to 64 years) increases in size. However, the 1999 First Nations birth rate was twice the Canadian rate at 23.0 birth per 1000 population. The population structure indicates that the working age population has a greater burden of caring for children and the aged. (FNIHB, 2003).

As First Nations communities grow, increased pressure is put on the community infrastructure and services and ultimately the housing supply. In addition to supply, construction and maintenance issues are also important. In Alberta, each First Nation is responsible for funding and/or administering funds to meet the housing needs of the community. Many Band administrations report not having enough

money to adequately provide housing to their members. On reserve housing programs funded by Indian and Northern Affairs Canada (INAC) or Canada Mortgage and Housing Corporation (CMHC) generally require new or renovated homes to be inspected, usually by the First Nations and Inuit Health Branch for health requirements and by a housing inspector for building code requirements. Alternatively, inspections may occur at the request of the band administration for projects that are locally funded. Unfortunately, this approval process is not without its flaws and is very dependent on the communication between the stakeholders or the ability (human and financial resources) of a given community to access funding programs. When homes are built without the financial assistance of federal money, monitoring agencies, such as Health Canada, are often not notified or involved in the construction process to ensure homes are constructed to public health standards. In 2003, the Auditor General's report on housing identified that dwellings inspected by band level or CMHC-trained housing inspectors were only evaluated for progress of the project and not evaluated as to if the construction meets the national building code. This is a crucial point as homes that are not properly constructed in the first place are prone to have problems later on.

Once a home is constructed, as a monitoring agency, Health Canada will inspect homes for public health issues at the request of either the band administration or band members and will provide a report to the band for follow-up action.

First Nation communities are plagued with issues such as housing quality, affordability, supply, sanitation (plumbing and sewage) and housing maintenance issues (Dunn, 2002). Issues of administration include how to deploy resources

efficaciously, address the inadequacy of the housing stock (Dunn, 2002) and stakeholder responsibilities. Furthermore, the rules governing housing tenure, ownership and responsibilities impedes progress in improving housing conditions (Auditor General of Canada, 2003). The roles of the INAC, CMHC, Health Canada, Band administrations *and* the Band members (house occupant) are not agreed upon nor are they legally defined, making it unclear where responsibilities lie.

Chapter six of the April 2003 Report of the Auditor General of Canada (Federal Government Support to First Nations – Housing on Reserves) summarizes the depth of the problem of housing on reserve:

- there are 612 First Nations across Canada, with the majority having fewer than 500 residents. In 2001, there were about 423 000 people living on reserves;
- in 2001, INAC estimated there were about 89 000 housing units on reserves to accommodate about 97 500 households. Of the 89 000 housing units, approximately 44% required renovations;
- a critical shortage in adequate on reserve housing exists for a young and growing population;
- numerous studies over the last 20 years have noted that poor housing conditions negatively affect the health, education and overall social conditions of individuals and communities on reserves;
- current First Nations demographic trends predict about 4500 new households to be formed every year for at least the next 10 years;

- at current (2003) levels, federal support for on-reserve housing is expected to provide funding for the construction of about 2 600 new housing units per year and the renovation of about 3 300 existing housing units per year;
- the federal government has not clearly defined what its assistance ($3.8 billion over that last 10 years) is intended to achieve;
- Federal program funding mechanisms are complex and need to be streamlined.

The 2003 Auditor General's Report states "if current demographic trends persist and federal assistance remains unchanged, high levels of overcrowding and substandard housing are expected to persist, given a combination of factors that include a growing population, rising construction and maintenance costs, limited access to non-government resources and growing debt levels.

This is further complicated by public health being a provincial jurisdiction in Canada with each province having its own public health act and supporting housing and health regulations and standards. The provincial public health acts cover provincial lands specifically, calling into question the protection of public health in relation to housing on federal lands, such as First Nations communities.

This thesis examines the complexity of housing issues in First Nations communities by studying the relationship between environmental factors (as measured by community infrastructure and crowding) and incidence of enteric disease in selected Alberta First Nations communities.

Purpose of Research

Upon synthesizing background information on the topic of housing and health in Canadian First Nations communities, the following research objectives were developed:

1. To gain a better understanding of how to measure housing components (water and wastewater infrastructure) and population variables in relation to enteric disease in Alberta First Nations communities.
2. To gain a better understanding of the strengths and weaknesses of housing, health and population data relevant to Alberta First Nations communities.
3. To assist First Nations organizations and government agencies in better using available data to address current issues and on-going problems regarding housing and enteric disease in First Nations communities.
4. To assist First Nations and government agencies in better understanding the relationship between environmental factors and the occurrence of enteric disease.

This type of research is important to First Nations communities and government agencies as it will help provide information on housing and enteric disease in communities. Establishing baseline information provides First Nations organizations with the means to measure progress and aid in the understanding and planning around these complex issues. Engaging in this type of research, specifically if a relationship exists between the housing environment and enteric disease, will help cultivate a better understanding of these complicated issues.

Research Goal and Objectives

The research goal was to investigate aspects of environmental factors, including crowding, and enteric illness in Alberta First Nations communities. Enteric illness was used as an indicator of general health. Four research objectives were defined:

1. To compare enteric disease rates in First Nations communities and the general Alberta population.
2. To develop and apply a method to characterize the state of household water and sewer infrastructure.
3. To examine the relationship between household density and enteric disease.
4. To examine factors associated with private (on-site) sewage systems and environmental variables that are indicators of the possible risk of illness.

The results and recommendations from this study are intended to assist band administrations and federal government departments on how to improve the collection, examination, and use of housing, health and population data on a community level.

Review of Literature Related to Enteric Disease, Housing and First Nations

Many articles, publications, and documents were found when reviewing the literature examining the transmission of disease and the relationship between housing and health. It is well established that environmental factors such as housing conditions have an effect on human health. As this topic is broad and not all publications can be discussed, the focus of this research will be on enteric disease as an indicator of the relationship between housing and health for this literature review.

The Medline database was searched for the time period 1966 to present in an attempt to find articles related to housing, enteric disease, and First Nations. "Housing" was used initially as a keyword for the subsequent searches described below and resulted in 21,574 articles. A separate search on "communicable diseases" was then completed and the search revealed 10,739 articles. Lastly, a search was done with the following keywords, "Indian, North American" or "First Nation". This resulted in 7,674 articles found in the Medline database.

The "housing" and "communicable disease" searches were combined, resulting in 61 articles. However, when reviewing the titles and abstracts of these articles, it was found that many were not pertinent to the research topic and were excluded from the review. These articles included subjects on hygiene practices (1 article), history of public health (4), disease transmission in battered women shelters (1), veterinary issues (20), international health topics (17 articles on topics such as health policy, nutrition, vectorborne disease, non-communicable disease, health of refugees/immigrants), immunization (1), immunology (1), urban issues (4), female reproductive health (1), prisoners (1), foodborne illness (1), pest control (1) and

tuberculosis (2), published in a language other than English (1). Two articles on infectious disease transmission in the home were reviewed. It is important to note these articles were not regarding First Nations communities in Canada or other aboriginal communities internationally.

The "housing" and "First Nations" searches were combined resulting in 31 articles. The articles in this search included the five previously mentioned articles from the combined "housing" and "First Nations" searches. The titles and abstracts of the 31 articles were reviewed. Twenty-seven articles were removed, as their subject matter was not related directly to the literature review. These articles included the following subjects cranimetric variation (1), HIV/AIDS (2), asthma/COPD (2), vector-borne disease (1), lead exposure/poisoning (2), mould and moisture (1), arthritis (2), radiation exposure (1), sudden infant death syndrome (1), nutrition (1), gastric cancer (2), tuberculosis (2), respiratory illness (4), otitis media (3), breast-feeding (1), trachoma (1). The four remaining articles addressed topics such as health disparities in aboriginal Canada, shigellosis and rotaviral infections.

The University of Alberta Library catalogue was searched for publications related to the research topic. A variety of publications were found that describe the health of the First Nations population. In addition to the Medline database and library catalogue searches, through my employment with the First Nations and Inuit Health Branch of Health Canada and through professional contacts in the public health field, a number of articles and publications were accessed.

Appendix B illustrates the Medline search strategy and lists the articles reviewed resulting from the literature search strategies discussed. The reviewed articles were categorized into the following topics:

1. The Relationship between Health and Environmental Factors
2. The Burden of Enteric Disease in Canadian First Nations Communities
3. The Accuracy of the Reporting of Enteric Disease in Canada
4. Existing Research on Risk Factors for Enteric Disease with Regard to Housing in Canadian First Nations

The following is a discussion of the literature that addresses issues related to the research topic.

The Relationship between Health and Environmental Factors

Schliessmann, Atchley, Wilcomb, and Welch (1958) completed a study examining the relationship between environmental factors and enteric disease in an area of eastern Kentucky because of its generally higher rates of diarrheal illness but with variation of the rates between the communities in the study area. Demographic/socioeconomic data, self-reported information on diarrheal illness were collected from households in the study area. Information was collected on the prevalence of enteric infections and intestinal parasites through rectal swabs and stool samples, respectively. Environmental factors surveyed included fly abundance, household water supply and sewage disposal systems. This study found that

1. More than half of the total cases were reported in the 0 to 4 age group.
2. Housefly abundance was not significantly correlated with morbidity from diarrheal illness.

3. There were no instances where water quality could be implicated in outbreaks or seasonal variations in morbidity, despite many of the water sources used by the study populations being subject to fecal contamination.
4. Lowest rates of diarrhea were observed in the communities served by complete sanitary facilities.
5. While socioeconomic factors, such as crowding, family size and education of the housewife appeared to be related to diarrheal illness rates, the effect was not as great as access to adequate sanitary facilities.

The paper concluded by stating that the occurrence of "diarrheal disease may be reduced significantly through selective modification of specific environmental factors within communities without regard to etiological or sociologic differences." The research discussed in the "Background" section of this thesis on First Nations housing in Canada does not share this view. While it would be difficult to replicate this study today due to some of the research methods used, it is a testament to the relationship between environmental factors and the occurrence of diarrheal illness.

Michael (1987) completed a study that examined links between municipal services, housing and disease and investigated if improvements in water supply and sanitation resulted in health improvements. Study outcomes suggested that improvements in housing, sanitation and educational programs will have a greater impact on decreasing certain types of illnesses compared to increased investment in medical treatment programs.

The study used two methods: central study and field study. The central study used existing government data. It involved comparing two similar communities (with one of the communities lacking the service) and compared their health records to assess the effect of a certain municipal service on public health. The field study analysed data collected on housing and municipal services for four Northwest Territories communities. Those data were compared with nursing station health records (including demographics, housing characteristics, and gastro-intestinal and skin disease).

The study concluded that disease rates have declined in the Northwest Territories due to improvement in medical treatment, municipal services, housing, education, economic and social development. The study showed improvements in municipal services lead to improvements in public health, but cause and effect could not be established due to other factors besides municipal services affecting disease rates.

The study demonstrated that having adequate quantities of water for washing and personal hygiene was the most significant contributing factor to the decline in disease within communities. Communities with a piped water supply have lower disease attack rates compared to those with a combination of trucked and piped or trucked water supplies only.

With regards to sewage disposal systems, the study found that households on pump-out (holding tank) sewage systems have a lower water related disease rate compared to those with honeybag systems and there was no substantial difference in disease rates between those using pumpout systems versus those that were piped.

The study concluded that housing type, overcrowding, distance separation between houses, home ownership, and overcrowding appeared to have an effect on the disease attack rates. Municipal services improvements were not sufficient to impact public health on their own, but should be coupled with the proper operation and utilization of these services in a systematic manner in order to protect public health.

There is some research that examines contamination by pathogens in the home and how it is related to the transmission of infectious diseases. Kagan, Aiello, and Larson (2002) did a literature review for the time period 1980-2000 that assesses the microbiology of rooms in the home environment that are known to harbour pathogens, and how hygiene and cleanliness practices affect the transmission of infectious diseases. This article falls out of the scope of this research thesis, as basic infrastructure (water supply and wastewater disposal) is not discussed.

Dennehy (2000) writes that rates of rotavirus-infected children are similar in industrialized and less developed countries, "indicating that further improvements in water supply and hygiene are unlikely to decrease the incidence". It is important to note that while rotavirus is an enteric illness, it is mainly transmitted by fecal-oral contact and potentially through contact with contaminated surfaces (Dennehy, 2000), not from the water supply or wastewater system directly. However, adequate access to these two components in the home environment is important because cleanliness and hygiene are promoted through their use. This, in turn, will limit the transmission of rotavirus in the home environment.

The Burden of Enteric Disease in Canadian First Nations Communities

It has been well established that Canada's First Nations people are at higher risk for poor health, despite strides that have been made to address this issue (Health Canada, 1999). Health disparities are manifested in society in specific populations, such as Canada's First Nations, by the disproportionate burden of disease they experience compared to the rest of the population (Adelson, 2005).

This burden of disease applies specifically to enteric diseases. In the publication, *A Statistical Profile on the Health of First Nations in Canada*, 2003, rates of giardiasis, Hepatitis A infection, shigellosis and verotoxigenic *Escherichia coli* for the overall First Nations population were reported to be higher than the remainder of the Canadian population. In 1999, the reported incidence of Hepatitis A was 12 times higher among First Nations children aged 0 to 14 than for the comparable age group in the remainder of the population. The rate of shigellosis in the First Nations populations was found to be 20 times higher in 1999 than that of the overall population, with this rate being primarily driven by a shigellosis outbreak at that time. (FNIHB, 2003.)

The Accuracy of the Reporting of Enteric Disease in Canada

There are a number of reasons why enteric diseases are underreported, for instance, not all patients visit a medical doctor as their symptoms may be mild; those who do visit a health care provider may not submit a stool sample for biological analysis or be required to do so (Flint, Dore, Majowicz, Edge, & Sockett, 2004). Additional factors that may contribute to the underreporting of enteric disease are asymptomatic infection due to immunity to organism, parents tend to take children to

the medical doctor but adults are not as likely to seek care, it may not be culturally acceptable to provide stool samples, or those who are ill may seek alternate means of treatment. A case is only recorded officially in the health system if a pathogen is positively identified in the submitted stool sample and the results are forwarded from the laboratory to the appropriate public health agency (Flint, et al., 2004). While the clinical significance of enteric disease may be of limited value because cases are usually self-limited and managed adequately without a definite diagnosis, their identification is important from the perspectives of prevention and control (Flint, et al., 2004). It is estimated that the cases of acute gastrointestinal illness submitting stool samples represent approximately 4.5% of all cases if international figures apply (Flint, et al., 2004). The same study found that 5% of stool specimens submitted test positive for bacterial pathogens, a rate that is consistent with the international literature. These authors included recommendations to improve the reporting of acute gastrointestinal illness: non-infectious acute gastrointestinal illness needs to be more accurately identified, harmonize laboratory testing and reporting policies and protocols, conduct periodic community etiology studies to validate that pathogens are routinely tested for are in fact of a high priority, enhance surveillance of pathogens not routinely tested for and/or conduct syndromic surveillance.

Existing Research on Risk Factors for Enteric Disease with Regard to Housing in Canadian First Nations Communities

A limited pool of research exists on this topic. In total, three articles were found. The initial publication reviewed was a Master's thesis completed by Brocklehurst (1985) entitled, "The Effect of Water Supply and Sanitation on Health

on Indian Reserves in Manitoba". The health data (categorized as "intestinal infections" and digestive diseases from hospital/nursing station visits) were collected from the Medical Services Branch of Health and Welfare Canada (now Health Canada) and the Manitoba Health Services Commission. The water supply and sanitation facilities data were collected from Indian and Northern Affairs personnel, Health and Welfare Canada personnel, band council representatives, and a household questionnaire. This paper compared the large variation in health levels between reserves and the water supply and sanitation systems in those communities. One aspect of the study was to compare servicing levels to the health data. Daily per capita water consumption and a servicing score[3] were used to measure the infrastructure. The author found a relationship between the score and water consumption that was almost linear; the lower the score (or more substandard the water supply), the lower the water consumption was for that community. This is an important relationship as access to a safe and clean water supply promotes hygiene and cleanliness and will limit the spread of enteric diseases. Two other studies in a similar vein to this one (discussed below), did not "score" the water and wastewater systems, but characterized a community by what type of water system served the majority of houses, the type of wastewater disposal system that served the majority of houses and to which functional category (substandard or satisfactory) each of these services belonged (Jin & Martin, 2003; Rosenberg, Kendall, Blanchard, Martel, Wakelin, & Fast, 1997).

[3] Each community's level of service was calculated by assigning a score to each type of water system (e.g., trucked to barrel, trucked to cistern, private well, piped, etc.) and then weighted each scored according to the proportion of residents using that system.

While the initial article discussed used "intestinal infectious diseases" and digestive diseases from hospitalizations and nursing station visits, the articles by Jin and Martin (2003) and Rosenberg, et al. (1997) analyzed Hepatitis A and shigellosis, respectively, on Canadian Indian Reserves. "Hepatitis A Among Residents of First Nations Reserves in British Columbia, 1991-1996" (Jin and Martin, 2003) discussed risk factors (community water supply, sewage disposal and mean population per housing unit) that predispose British Columbian First Nations to Hepatitis A infection. A higher incidence of Hepatitis A was associated with conditions of crowding and with the presence of community water supply problems.

Rosenberg, et al. (1997) found that the incidence and hospitalization rates of shigellosis in First Nations communities were considerably higher than the remainder of the Manitoba population. A significant association between the elevated rates of shigellosis on reserve and type of water delivery was found, but there was not a significant relationship with sewer and household density (crowding). The authors indicate that the variables are highly correlated with each other and they were not able to test for interactions. They conclude that one intervention will likely not be the most cost-effective way of reducing diarrheal illness in the communities.

It is generally agreed that steps to prevent enteric disease are dependent on many factors, not just improving the water supply and wastewater disposal system infrastructure. Brocklehurst (1985) acknowledges that there are a number of factors, such as water supply and wastewater disposal system infrastructure, consumption of water, reliability of service, and attitude of community members, impact the presence of infectious diseases. Addressing the infrastructure component alone will not

adequately address water supply and sanitation (sewage disposal) problems. Jin and Martin (2003) argue for an ecologic, multi-factorial approach to disease prevention and they note that "upgrading of housing, water supply and sewage disposal systems will...be an important part of a program of primary prevention" but community infrastructure was not independent of other prevention measures. The paper concludes by stating complacency toward basic public health and housing measures was unacceptable as they do impact population health. Schliessmann et al. (1958) concluded that improvement in environmental factors alone will result in a lower incidence of enteric disease. Finally, Rosenberg et al. (1997) acknowledged that the ecological design of their study made it difficult to infer cause and effect and the "association between environmental infrastructure and disease rates may really be a marker for other risk factors present in the study population", however, the findings of the study are still consistent with the fecal-oral transmission of enteric infections in populations.

In other literature pertaining to North American Indians, Engleberg, Holburt, Barrett, Gary, Trujillo, Feldman, & Hughes, (1982) found that the transmission of rotaviral infections in the home environment on the San Carlos Apache Reservation, Arizona was significantly associated with the presence of a household contact under the age of two years and dog ownership. While no literature relevant to Canadian First Nations communities identified those risk factors specifically, it is likely they may play a role in the transmission of enteric disease in general.

The Health Effects of Housing and Community Infrastructure on Canadian Indian Reserves (Young et al, 1991) examined methodologies for studying the

relationship between health and housing. This publication emphasized that the physical environment of the home and the social, economic, and cultural conditions of the community are both crucial to understanding the relationship between housing and health. Poor planning can have implications on the physical, social, and psychological health of the affected population (Young et al., 1991). Housing that meets health standards and addresses social interactions through its environment will both contribute to improvements in quality of life and health.

Included in the document is a review of study designs on the health effects of poor housing that include strengths, weaknesses, and suitability of this type of research. The report includes summaries of international literature on housing conditions and health (1941 to 1990) and the health effects of water supply and sanitation (1953-1985). Study designs reviewed include ecologic studies, cross-sectional surveys, randomized control trials, and cohort studies. Even though the report was published in 1991, many of the issues documented remain relevant today.

Young, et al. (1991) concluded that a large gap existed between the situation in First Nations communities and the larger Canadian community in terms of adequacy and quality of housing and community infrastructure and health status with many challenges linking health status to substandard housing and environmental conditions, including difficulty in collecting "exposure" data and defining outcome measures. Furthermore, the issue was complicated by other determinants of health that can act as confounders, such as socio-economic status, accessibility to health services, nutritional status, and social stress, thus making it difficult to establish an independent role for housing and related infrastructure.

Traditional health problems associated with poor housing (e.g., gastrointestinal illness) are not a major cause of mortality in First Nations communities per se; injuries are recognised a greater contributor to mortality rates. However, because of the longer term and additive impacts on health and well-being due to events such as infectious illnesses, it is necessary to understand and develop strategies to address the predisposing factors related to the host, agent, physical and social environment in the home and community that affect the occurrence of these health events. Housing standards in Canadian First Nations communities should afford community members the same level of health protection as the remainder of the population, recognising that they need to be adapted due to the special circumstances on reserve.

Study Design

The overall design of the study is an observational, retrospective analysis that investigates potential associations between variables describing housing infrastructure, enteric disease, and population structure in Alberta First Nations communities. The data analysis has been divided into four sections, each with a slightly different focus using methodologies appropriate to the type of data: a) Enteric Disease in Alberta First Nations; b) Household Density and Enteric Disease; c) Alberta Housing First Nations Survey; and d) Alberta First Nations Private Sewage Systems Survey.

Enteric disease data for Alberta provincial and First Nations populations were from 1998-2004. Data used to calculate household density were from 2001. The housing survey data for the Alberta First Nations Private Sewage Systems Survey and Alberta First Nations Housing Survey were from 1999 and 2000, respectively.

Data Sources

Population Data

Population data sets for the year 2001 were used since 2001 was the mid-point for the enteric disease study period (1998-2004). The Alberta Health Care Insurance Program registration files as of June 30, 2001 were used for estimates of the Alberta population; these account for approximately 99% of Albertans (K. Morrison, Alberta Health and Wellness, personal communication, July 13, 2006). For the 2001 First Nations population on reserve, the Indian and Northern Affairs Canada's Indian Registry System population numbers were used, which are updated annually as of December 31 and are available publicly (INAC First Nations and Northern Statistics Section, Corporate Information Management Directorate).

Enteric Disease Data

The enteric disease data were accessed for the province of Alberta and Alberta Region First Nations communities. The provincial enteric disease data were retrieved in aggregate form (total and by age/gender) by reviewing hard copies of the Alberta Annual Notifiable Disease Incidence Reports (Alberta Health and Wellness). The Alberta First Nations enteric disease data stored in the Alberta Region First Nations and Inuit Health Branch (FNIHB) notifiable disease database were accessed through permission granted by the FNIHB Health Protection Directorate.

The Notifiable Disease Reports account for cases of specific diseases as required by law to be reported to the Medical Officer of Health (Part 3 of the *Alberta Public Health Act* and *Communicable Diseases Regulation 238/1985).* The "Protocol for Reporting Notifiable Disease Involving Health Canada First Nations and Inuit

Health Branch Clients" (October 2000) outlines the flow of information for response and follow up to a notifiable disease (Alberta Health and Wellness, 2005) in this population. In general, the laboratory reporting the disease notifies the provincial regional health authority. If the notifiable disease case is determined to be a First Nation resident, the report is then forwarded to the appropriate First Nations Community Health Centre and the regional Medical Officer of Health for the First Nations and Inuit Health Branch. Once the First Nations community health centre receives the positive laboratory report and the follow-up with the patient is complete, it is usually the community health nurse that fills out the notifiable disease report (NDR) and forwards it to the regional Medical Officer of Health of the First Nations and Inuit Health Branch. The NDR is reviewed and tracked at the regional office of the FNIHB in the notifiable disease database and then forwarded to Alberta Health and Wellness. As a result, when Alberta Health and Wellness reports on notifiable diseases, their summaries include those First Nations on reserve cases reported to them by FNIHB.

As this thesis focuses on the relationship between components of housing and enteric disease, the Alberta Case Definitions Manual (Alberta Health and Wellness, 2003) enteric disease definition were used to define the enteric diseases of interest for this study. The Alberta Case Definitions Manual includes the following enteric diseases in its classification:

- Amoebiasis
- Botulism
- Calicivirus infection
- Campylobacteriosis
- Cholera
- Cryptospiridiosis

- Cyclosporiasis
- Enterohaemorrhagic *Escherichia coli* (EHEC) O157:H7
- Enterovirus infection
- Giardiasis
- Hepatitis A and E
- Listeriosis
- Paratyphoid fever
- Rotavirus
- Salmonellosis
- Staphylococcal intoxication
- Shigellosis
- Trichinosis
- Typhoid Fever
- *Vibrio cholerae* NON-O1, NON-O139
- *Vibrio parahaemolyticus*
- Yersiniosis

Enteric disease description parameters from the FNIHB notifiable disease database included community, disease organism, date of onset, date of birth, laboratory confirmation, gender and NDR number for on-reserve cases. The Health Protection Directorate of the First Nations and Inuit Health Branch granted permission to access enteric disease data for 1998-2004 for the purposes of this study (Appendix C). Personal identifying information, such as names and healthcare numbers were not utilized.

Housing Data

Alberta First Nations Housing Survey (2000). The housing survey was completed in 2000 in five First Nation communities by a First Nations organization with funding and survey question contributions from Indian and Northern Affairs Canada (INAC) and Health Canada's First Nations and Inuit Health Branch (FNIHB). The 14 page survey assessed 3,512 dwellings and had three sections: tombstone information (basic house characteristics such as number of bedrooms, water supply type), housing infrastructure assessment including repair/replacement needs (INAC)

and data on environmental health conditions (FNIHB). The FNIHB portion comprised of 7 sections (Figure 1) and 83 questions relating to water and sewer infrastructure. A copy of the survey questionnaire is included in Appendix D. The data collected included individual identifiers (occupant name, house number, GPS coordinates) that were not included in the analysis. The First Nations organization that coordinated the data collection and data storage has given written permission to use the survey data for the purpose of this research (Appendix C).

Figure 1 Alberta First Nations Housing Survey FNIHB Section Headings

1. Water Supply: Cistern
2. Water Supply: Well
3. Sewage Disposal System: General
4. Sewage Disposal System: Pump Dependent Septic Tank
5. Sewage Disposal System: Subsurface Disposal/Chamber Field
6. Sewage Disposal System: Open Discharge
7. Sewage Disposal System: Private Lagoon

Housing and Infrastructure Asset Reports. Every year, First Nation band administrations in Canada are required to provide Indian and Northern Affairs Canada (INAC) with their community's information on housing and infrastructure. These are called "Housing and Infrastructure Asset Reports" and include information on housing activity and water/sewer infrastructure. This publicly available information is stored at the First Nations and Northern Statistics Section, Corporate Information Management Directorate of Indian and Northern Affairs Canada. Housing activity information accessed included, for the reporting year, the number of houses and water and sewer infrastructure components (type of water supply, water quality/quantity components, sewage system type and sewage effluent quality).

Alberta First Nations Private Sewage System Survey. A private sewage system survey was completed for a group of central Alberta First Nations located in close proximity to one another between November 1998 and November 1999 by the First Nation health centre with funding from FNIHB. The purpose of the survey was to collect data on private sewage disposal systems and solid waste disposal. FNIHB designed the survey and the First Nations health centre organized the data collection. The data collected include individual identifiers (house numbers, occupant name) that were not included in the analysis. A letter of permission from the First Nation health centre was provided to use the survey data for the purpose of this research (Appendix C). A copy of the questions used in the survey is included in Appendix D.

Limitations

As the study design is ecological, this poses a limitation as cause and effect cannot be established. The sources of data that were used in this study are considered the best available information; however, there are a number of limitations associated with them. The context for collecting information regarding First Nations can be complicated by issues of privacy and infrastructure, health information not necessarily collected consistently, and aboriginal status not always identified. This may create gaps in sources of data that are discussed below.

Population Data

For the Alberta provincial population, 2001 Census of Canada was considered. However, upon researching this data source, it was determined that these data are considered incomplete because data collection on some Indian Reserves was either interrupted or not permitted, or the quality of the enumeration was not considered adequate (Statistics Canada, 2002). The most accurate representation of the provincial population was the Alberta Health and Wellness provincial population counts based on Alberta Health Care registrants. This is because the majority of Albertans accessing the healthcare system requires an Alberta Health Care number, including Alberta First Nations residents. It is important to note that not all Albertans have an Alberta Health Care Insurance Plan number (usually those with the means to pay for private care), so the numbers from this system are slightly underestimated.

In order to calculate disease rates, population counts for the Alberta First Nation communities were needed. Since the 2001 Census of Canada data for First Nations in Alberta has missing data or incomplete data for at least one of the Alberta

First Nations, population counts from the Federal Indian Register System were used. The federal government has a system in place to account for those who are considered to have official Indian status (on reserve, crown land or off reserve). The system is updated every year as of December 31 and classifies registrants as " on reserve/crown land" or "off reserve". A number of limitations with the Indian Registry System (IRS) have been identified (INAC, 2005): Non-Registered individuals living on reserve or crown land are not accounted for in the IRS, the data do not account for any individuals registered to other bands who may be living on reserve or crown lands, late reporting of births or deaths are not adjusted for, and residency codes (on reserve, crown land or off reserve) are only updated when a life event (such as a birth or death) is reported to the First Nations Indian Registry Administrator. Despite these limitations, these counts are the best available information to estimate the on reserve First Nations regional and community populations.

Enteric Disease Data

The first major limitation with the enteric disease data is the issue of underreporting at the healthcare provider/patient interaction level. It has been well established that enteric diseases are underreported in the general population. This occurs for a number of reasons, including that not all persons who experience diarrheal or enteric symptoms seek medical care and for those that do, healthcare providers do not always order stool samples. As well, the manner in which enteric disease is reported may contribute to the issue of underreporting. It is not known if the degree of underreporting in First Nations communities is the same, less or more compared to the general population and whether or not any diseases in particular are

more likely to be non-differentially underreported in the province and in First Nation communities.

The notifiable disease database where the Alberta Region FNIHB stores notifiable disease report information was relatively new and gaps in the reporting were expected, especially with the data before 2002. Ideally, any data stored at FNIHB should be easily cross-referenced with what is stored provincially as all on-reserve cases are required to be reported to the provincial health ministry (AHW).

Therefore, due to the combination of underreporting and the potential gaps in reporting, it is possible that on-reserve cases were missed in the analysis of the data available for this study.

Housing Data

The housing surveys that were carried out in the study communities have some limitations due to their design and the amount of data that were collected. Upon reviewing the data sets, there were many fields for which data were not collected and there appeared to have been no means to check the quality of the records. Therefore, it was difficult to assess the accuracy of the information resulting in potentially incomplete or inaccurate data that were difficult to verify after the fact.

The information supplied from the Housing and Infrastructure Asset Reports from INAC and the housing surveys are considered the best available information, but the information is not without its limitations. This information is self-reported by the Bands and there appears to be no method of verification to confirm the reported data.

Analytic Methods

Enteric Disease in Alberta First Nations

This portion of the study included all Alberta enteric disease cases reported by Notifiable Disease Report (NDR) if their reported date of onset was between January 1,1998 and December 31, 2004. Cases occurring in Alberta First Nation communities were identified, collected and stored by Alberta Region FNIHB, Health Canada; these were used as the primary source for the counts of on-reserve cases of reported enteric disease. The case information collected by and stored at Alberta Region First Nations and Inuit Health Branch, Health Canada is reported to AHW and included in their notifiable disease database. If date of onset, date of birth or gender information were missing, the cases were excluded from analyses as appropriate (e.g., age could not be calculated). Enteric disease data for the general Alberta population that were reported by NDR were reviewed in aggregate form overall and by age/gender from Alberta Health and Wellness data. AHW Healthcare Statistics were used for provincial population counts (as of June 30, 2001) and the Federal Indian Registration Statistics were used for First Nations population counts (as of December 31, 2001) for the seven-year study period.

As discussed in "Data Limitations" First Nations community enteric disease cases and population numbers were not identified within the AHW dataset, therefore direct comparisons between the general and First Nations community data cannot be made. However, general trends for the two datasets over time, gender, and age can be reviewed on a preliminary level.

Microsoft Excel 2003 and SPSS version 13.0 were used to complete the data analysis.

Alberta First Nations Housing Survey (2000)

The Alberta First Nations Housing Survey had assessed 3,512 dwellings. After the data were reviewed, 995 records were removed due to incompleteness or conflicting information, as will be discussed. As a result, this data analysis included 2,517 records. In preparing and reviewing the FNIHB portion of the survey (environmental health data) for data analysis, and it was determined that many records were not complete. For example, the sewage system type may not have been indicated in the appropriate field, but if other data in the record were available that indicated sewage system type, the record could still be classified. If sufficient data were not available to determine sewage system type, the record was removed from the dataset. In the event of conflicting information (i.e., more than one type of sewage system was identified in a record), the record was removed from data analysis.

The FNIHB portion of the survey only included two options for characterizing water supply type (private wells or cisterns) and did not include an option for community water distribution system connections.

Using these survey data, a method to characterize the state of water and sewer infrastructure at the community level was developed. Previous research by Jin and Martin (2003) has done this by characterizing the predominant type (serves 50% or more of homes) of water supply or sewage disposal system at the community level. A servicing score developed by Brocklehurst (1985) assigned a score for each

community based on available data for types of water supplies, reliability and the proportion of homes using that specific type of system (Table 1). The score was assigned by multiplying the water supply servicing score by the proportion of dwelling serviced by that type of system. The scores for each type of water supply were totaled, resulting in an overall community score.

Table 1 Servicing Score System (Brocklehurst, 1985)

Water Supply System	Score
Trucked delivery to cisterns (2300 to 4500 litres)	10
Trucked delivery to small tanks, pails, barrels (<900 litres)	4
Trucked delivery to sealed small tanks	5
Piped water	10
Self haul from well	4
Well connected to household plumbing	9
Self haul from lake	1
Self haul from standpipe	4
Self haul from nursing station, treatment plant	4

For this survey, data were collected at the household level and were categorical. As a result, a score was calculated for each dwelling, which could be aggregated to the community level if determined necessary. The scores were based on household level responses relating to the questions about each of six possible categories: septic tank, subsurface disposal/chamber field, open discharge, private lagoon, private well, and private cistern. Questions within each category were assessed by their impact on health, environment or installation/maintenance using public health engineering and environmental health practice principles, such as the *Alberta Private Sewage System Standard of Practice (1999),* that contributed to the score:

1. *Health.* Direct exposure may result in an adverse health event (e.g., exposure to an enteric disease agent) if the condition measured was or was not present. These variables are rated out of five. A rating of zero indicates that occupants are not protected from the exposure and a rating of five indicates that the measured variable provides protection of health. An example is a subsurface sewage field that has malfunctioned because this indicates the private sewage system is not working and there is a potential that people may come into direct/indirect contact with sewage. This would score zero out of a possible five.
2. *Environment.* The identified condition has a potential environmental impact and is indirectly related to health. These variables are rated out of three. A rating of zero indicates the condition has a potential environmental impact, while a rating of three indicates that the measured variable is in place to provide protection of environment. An example is a private lagoon that is installed less than 90 metres from a water course (lake, creek) would score zero out of a possible three.
3. *Installation/Maintenance.* The identified condition (usually an installation/maintenance standard) if met optimizes system operation/maintenance and indirectly protects occupant health and safety. The rating scale is zero to one. A rating of zero indicates the installation/maintenance standard was not met, while a rating of one indicates the standard was met. An example is a subsurface sewage system where the vegetation over the field was not maintained. This would score zero out of a possible one.

Details on the ranking criteria for each survey question (variable) evaluated are in Appendix E. Once a variable was classified, a score based on a binary scale was

assigned to the survey question response on a dwelling-by-dwelling basis. The scores for each variable were totalled to give a score by category for each dwelling. For any given dwelling, if a response was missing for a variable that dwelling was not assigned a score for that category/variable.

While Brocklehurst's classification was ranked based on water supply reliability, for this research a survey variable was ranked based on its potentials to impact health. All three classifications have a direct or indirect potential affect on health, with those variables that are more likely to expose an occupant to disease have the highest rating and therefore a greater weight to those variables has been assigned. In each of the category descriptions, the variables scored are listed.

SPSS version 13.0 was used to complete the data analysis for the Alberta First Nations Housing Survey (2000).

Household Density and Enteric Disease

For this section, the ratio between a community's population (using data from the INAC Indian Registration System (December 31, 2001)) and the number of houses in a given community (using data from the INAC Housing and Infrastructure Assets Inventory (2001)) was calculated to derive an estimate of household density or number of persons/house in a given community. Enteric disease cases occurring in Alberta First Nation communities between 1998 to 2004 were accessed with permission from the Alberta Region First Nations and Inuit Health Branch, Health Canada and are the same data used in the *Enteric Disease* section. When the data on the 43 available First Nations[4] were compiled, 8 First Nation communities were

[4] Two First Nations were not included because complete information was not available to calculate density.

joined to form 3 communities. This was done because in some cases, either enteric disease or housing statistics were reported at a multi-community level. An example of this is First Nation communities in close proximity access the same health centre resulting in the enteric disease reported by health centre name, not band name. Individual communities were not identified.

These data were grouped into density categories and analyzed using rate ratios and confidence intervals. Microsoft Excel 2003 was used for all household density and enteric disease calculations.

Alberta First Nations Private Sewage System Survey (1999)

A private sewage system is an on-site (or on property) means for the treatment and/or disposal of sewage (Safety Codes Council, 2000) with approximately 73% of homes in Alberta First Nation communities serviced by this type of system (Indian and Northern Affairs Canada, 2005). Of interest is the potential association between factors associated with sewage and the occurrence of enteric illness. Previous studies have examined this topic using a variety of study designs with the unit of analysis at the household level (Chambers, et al., 1989; Borchardt, Chyou, Devries, & Belongia, 2003). In this survey private sewage system data were available at the household level, but enteric illness data were not. As a result, environmental variables that could be used as a proxy or indicator of the possible risk of illness were identified due to their potential to expose/protect occupants from pathogens associated with sewage and/or to optimize the operation of private sewage systems thereby protecting health. A descriptive analysis of identified key environmental variables that may play a role in the spread of enteric disease is presented. These variables are:

- number of occupants in the home at the time of the survey;
- sewage system disposal type at the time of the survey;
- the accumulation of effluent around the open discharge at the time of the survey;
- the distance of the open discharge to the dwelling;
- the distance of the open discharge to the drinking water supply;
- evidence of sewage overflowing from septic tank;
- field malfunctioning;
- open discharge pipe in a low lying area;
- septic tank cleaning frequency.

Descriptive statistics were completed for these variables. The survey design included open-ended, numerical and categorical responses to questions. In order to analyze the data, they were recoded into categories based on public health or sewage system installation standards (Appendix F). This survey focused on rural dwellings (serviced by individual water and sewage systems). The total number of houses surveyed was 1,180. The identified survey variables were reviewed for completeness (Table 2).

On First Nations lands (reserves) in Alberta, provincial regulations and related documents are used as guidelines for private sewage systems due to gaps in the federal legislation. The provincial regulations and related documents have been developed to provide minimum design, installation, operation and maintenance standards with the intention of protecting public health and safety. Based on the

Table 2
Alberta First Nations Private Sewage System Survey Review
(total number of records: 1,180)

	Potential Number of Records	Number of Valid Records	Number Missing
Sewage System Type	1,180	1,065	115
Number of Occupants	1,180	1,100	80
Sewage Back-Ups	1,180	898	282
Distance from Open Discharge to Dwelling	522	503	19
Distance from Open Discharge to Drinking Water Supply	522	426	96
Effluent Accumulation on Ground around Open Discharge	522	518	4
Septic Tank Cleaning Occurrence	1,180	808	372
Septic Overflow	1,180	1,120	60
Field Malfunction	543	438	105
Open Discharge Lowlying	522	520	2

provincial guidelines, the selected variables in this analysis have been chosen because of their potential to affect (protect/compromise) public health. For example sewage effluent[5] discharged to the land surface provides potential direct and indirect exposure routes to untreated fecal wastes (Borchardt et al., 2003). This would also apply to sewage discharged into the physical confines of a dwelling via a sewage back-up. If private sewage disposal guidelines for installation and maintenance are not followed the sewage system operation may be compromised and a system malfunction may occur. This creates a potential route of transmission for enteric pathogens.

SPSS version 13.0 was used for all graphs and statistical calculations for the private sewage system survey.

[5] Sewage means human excreta or the water-carried wastes from drinking, bathing, laundering or food processing (Safety Codes Council, 2000)

Ethical Considerations

The First Nations organizations that were the custodians of the various data sources were consulted and permission to conduct these data analyses was granted by them before proceeding with this study's analysis. The First Nations and Inuit Health Branch also provided a letter of permission granting access to enteric disease notifiable disease reports for on reserve cases between 1998 and 2004. For these data sources, the issue of confidentiality was paramount and it was ensured that the privacy of individuals and communities whose data were analyzed was respected and upheld.

In December, 2005 an application to the University of Alberta Health Research Ethics Board was submitted, reviewed and approved to conduct this study.

Findings

Enteric Disease

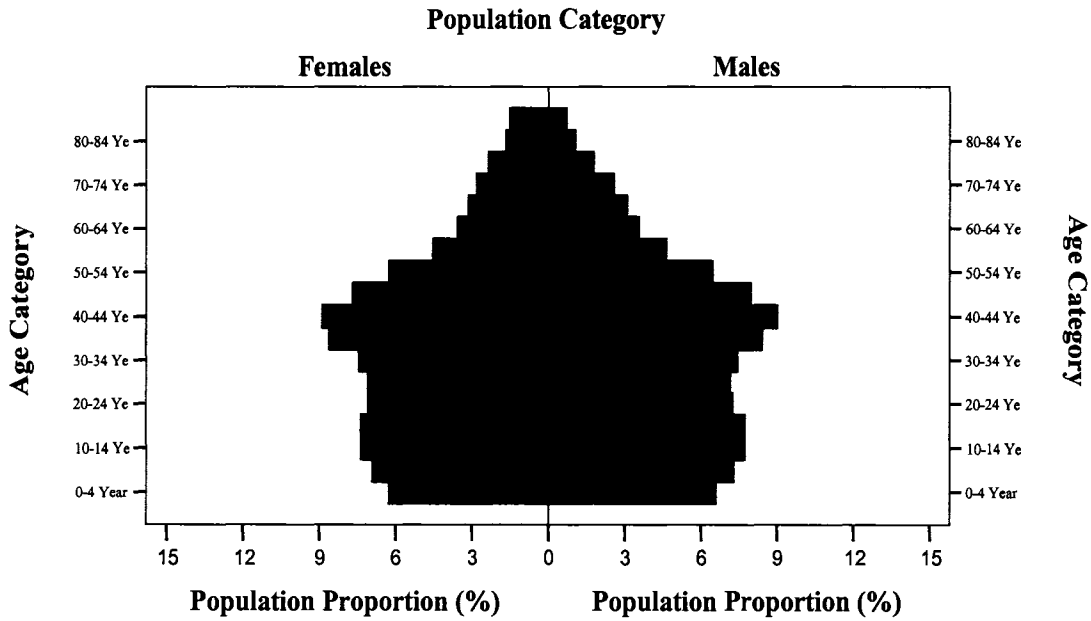
Enteric diseases are acute infections of the gastrointestinal tract, with diarrhea being the most common manifestation (Sherris, 1990). Commonly encountered enteric diseases include amoebiasis, botulism, campylobacteriosis, cholera, cryptospiridiosis, cyclosporiasis, salmonellosis, listeriosis, shigellosis, trichinosis, yersiniosis and typhoid fever, and infections caused by *E. coli*, enterovirus, Giardia, Hepatitis A, paratyphoid, Norovirus (Norwalk-like virus, calicivirus, small round enteric virus) and Rotavirus. The following is a description of the occurrence of enteric disease in Alberta and in Alberta First Nations communities in the 1998 to 2004 time period.

Enteric Disease in Alberta (1998-2004)

Age statistics for the Alberta population were reviewed to examine its general size, age and gender structures. A population pyramid is a simple, graphical way to do this (Figure 2); Alberta's population in 2001 was 3,002,891 and illustrates the largest proportion of the population in the 35 to 45 year age range. The structure of the population is stationary showing little variation from the lower age group through to the middle, tapering off at the older age categories (Statistics Canada, 2007). This structure is fairly typical of industrialized countries with families having fewer children and the middle age and older age categories making up an increasingly greater proportion of the population.

There has been a downward trend in the numbers of reported enteric disease cases in the Alberta population from 1998 to 2004 (Table 3). In that time period,

Figure 2 Province of Alberta Population Distribution (2001)



Source: Alberta Health and Wellness Alberta Healthcare Statistics (as of June 30, 2001)

1998 had the greatest number of cases and 2004 had the lowest number of cases, despite the population demonstrating steady growth in that time period (growth of over 300,000 people). Because of this increase in the population, the decline in enteric disease at the provincial level is even more pronounced in the rate per 100,000 calculation with 145.4 in 1998 compared to 87.6 in 2004.

Table 3
Alberta Annual Enteric Disease Statistics
1998 to 2004

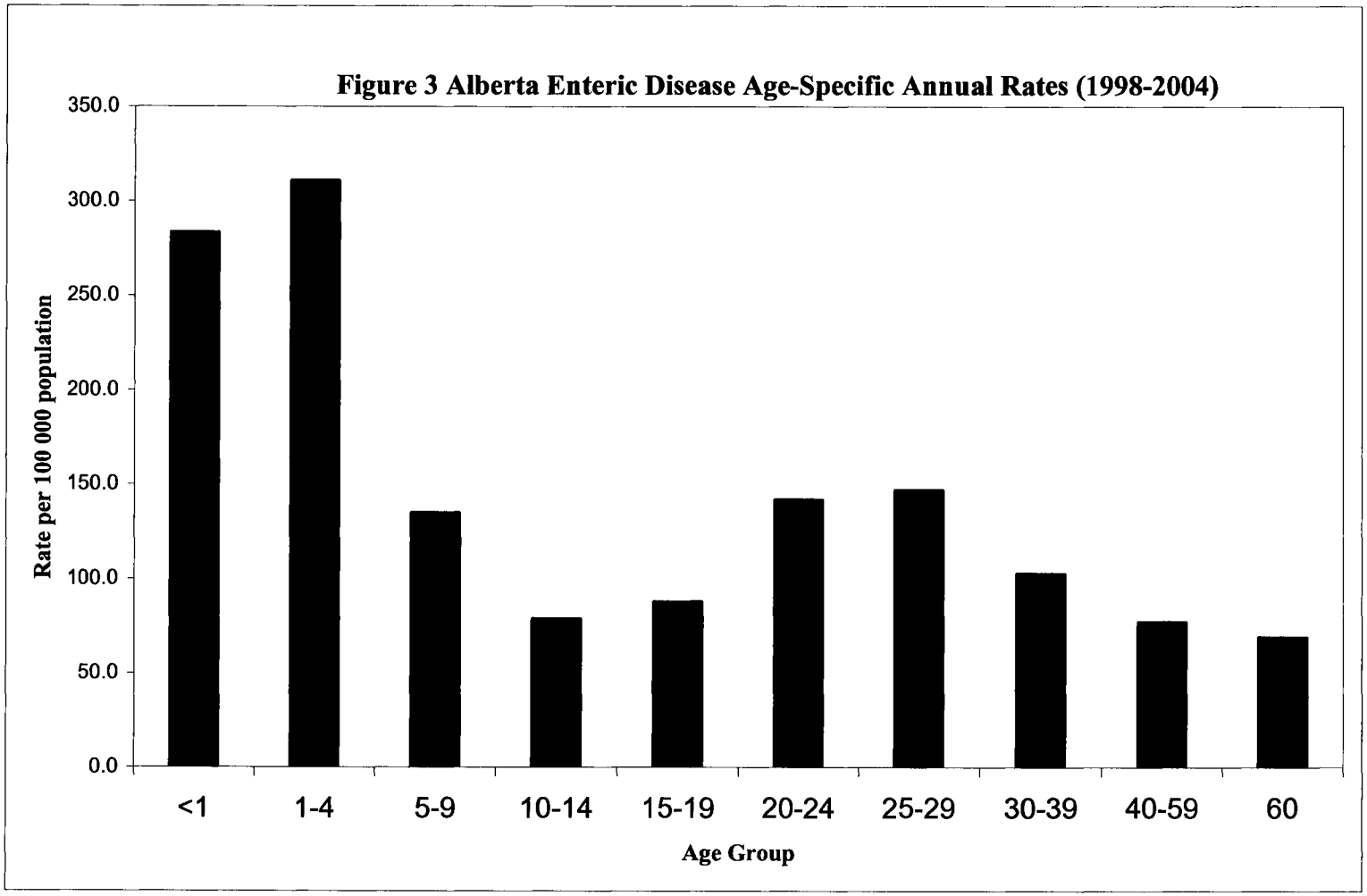
1998	4,148	2,852,932	145.4
1999	3,125	2,923,639	106.9
2000	3,256	2,968,536	109.7
2001	3,690	3,022,891	122.1
2002	3,406	3,086,646	110.3
2003	2,886	3,134,337	92.1
2004	2,785	3,179,036	87.6
Total	23,296		110.09*

§number of cases include reports from Alberta First Nations
*number of cases per 100,000 population per year, based on 2001 population figures

The total number of reported enteric disease cases for the 1998 to 2004 period was 23,296. Of these, male casess accounted for 12,020 (113.7 per 100,000) and in females cases were 11,024 (104.1 per 100,000)[6]. Gender was not reported for 252 cases. The crude incidence rate for 1998-2004 was 110.09 per 100,000.

Examining enteric disease by age gives insight into how population groups are affected by these illnesses. AHW has reported enteric disease data using the following age groups: <1 year of age, 1 to 4 years, 5 to 9, 10 to 14, 15 to 19, 20 to 24, 25 to 29, 30 to 39, 40 to 59, and 60 years and over. Since the sizes of the age groups are not equal, direct comparisons of counts by age groups are inappropriate. Instead, when age group comparisons are discussed, rates per 100,000 population are used. Figure 3 illustrates the variations in annual rates between age groups for the study period. The age-specific annual rates were calculated using the following formula:

[6] Annual gender-specific rates were calculated for the 1998-2004 time period using the 2001 population numbers (mid-point): 1 510 057 males and 1 512 834 females.



Age-specific annual rate =
number of cases in specified age group (1998 to 2004) /
mid period age group population /
number of years in study period (7) * 100,000

For example, the <1 year age group with 735 reported cases and a mid period population of 37,031, had an age-specific annual rate of 283.5 per 100,000.

The age groups of < 1 year (283.5 per 100,000) and 1 to 4 years (311.0 per 100,000) had rates that were each twice as high as any other age group. This indicates that a much higher proportion of individuals less than 5 years of age have reported cases of enteric disease than found in other age groups. It is also of interest that the rates in the 20 to 24 (142.0 per 100,000) and 25 to 29 (147.2 per 100,000) age groups are elevated compared to all age groups 10 years and over. The rates in these two categories are similar to the 5 to 9 age group (135.1 per 100,000).

Campylobacteriosis cases accounted for 36.13% of all enteric disease cases reported in Alberta in the study period, followed by salmonellosis (24.09%), giardiasis (15.11%), *E. coli* infections (8.17%), cryptosporidiosis (4.5%), shigellosis (4.32%) and yersiniosis (2.12%) (Table 4). These seven etiologic agents made up 94.4% of all reported enteric diseases.

Table 4
Alberta Enteric Disease Distribution by Etiologic Agent
1998-2004

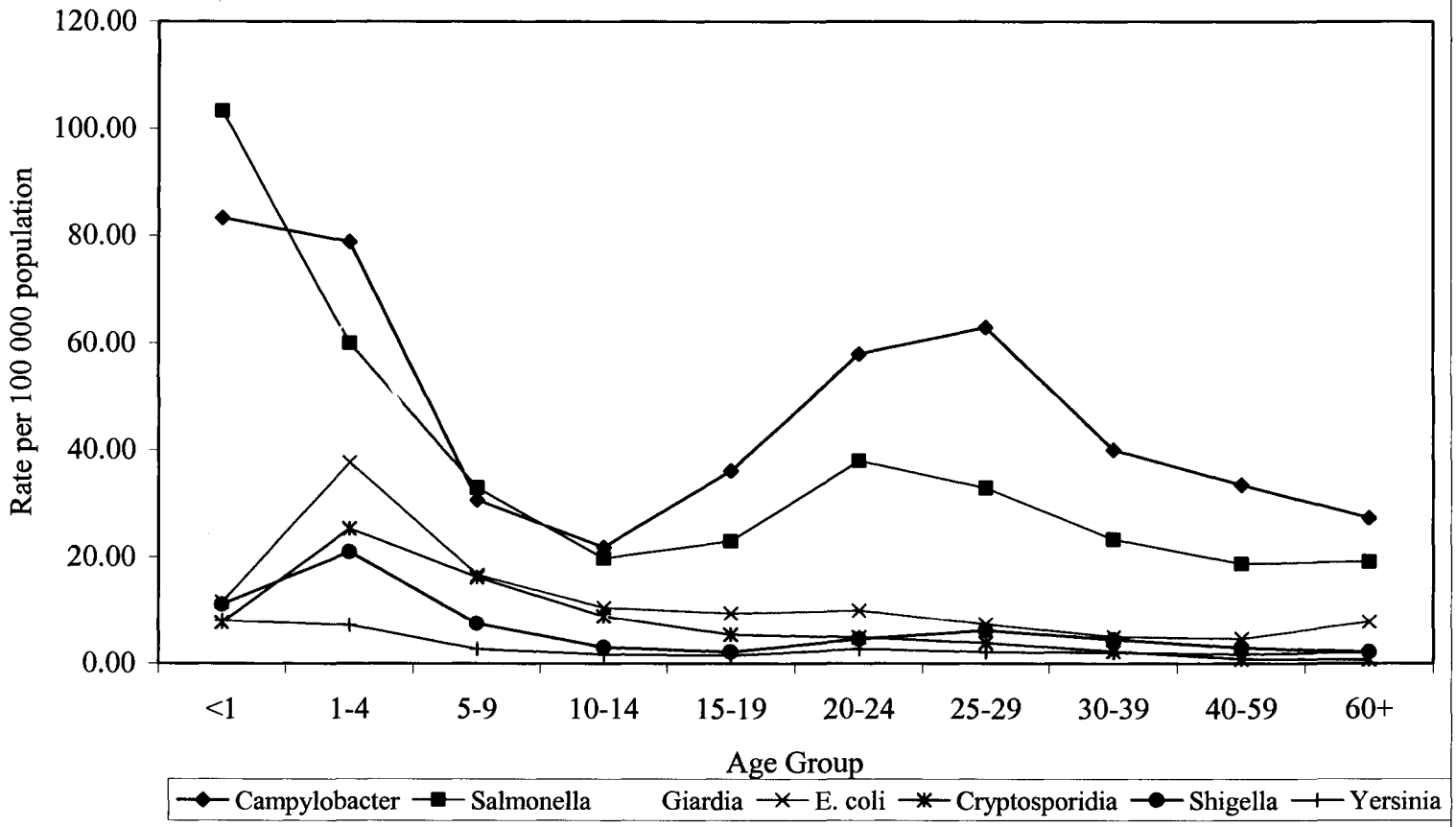
Campylobacteriosis	8,417	36.13	39.78
Salmonellosis	5,613	24.09	26.53
Giardiasis	3,520	15.11	16.63
E. coli infection	1,947	8.17	9.2
Cryptosporidiosis	1,048	4.50	4.95
Shigellosis	1,007	4.32	4.76
Yersiniosis	493	2.12	2.33
HAV	430	1.85	2.03
Amoebiasis	365	1.57	1.72
Rotavirus infection	197	0.85	0.93
Cyclosporiasis	102	0.44	0.48
Typhoid	54	0.23	0.26
Listeriosis	46	0.20	0.22
Paratyphoid	33	0.14	0.16
Vibrio cholerae parahaemolyticus	10	0.04	0.05
Bacillus cereus	7	0.03	0.03
Cholera	5	0.02	0.02
Botulism	2	0.01	0.01
Total	**23,296**		

◇number of cases per 100,000 population per year based on 2001 AHW Healthcare numbers

The seven enteric diseases that constitute the highest number of cases for the study period are bacteriological and parasitic in origin. Figure 4 shows the age-specific rates per 100,000 population for these seven diseases. The age group trends in the chart are fairly similar to the trends in Figure 3 with the following observations:

- The rate of salmonellosis (103.39 per 100,000) is higher than the rate of campylobacteriosis (83.33 per 100,000) in the <1 age group.
- All diseases illustrated have a higher rate in the 1 to 4 age group compared to the <1 year age group, with the exception of salmonellosis and campylobacteriosis.

Figure 4 Alberta Enteric Disease Agent-Specific Distribution by Age Group (1998-2004)



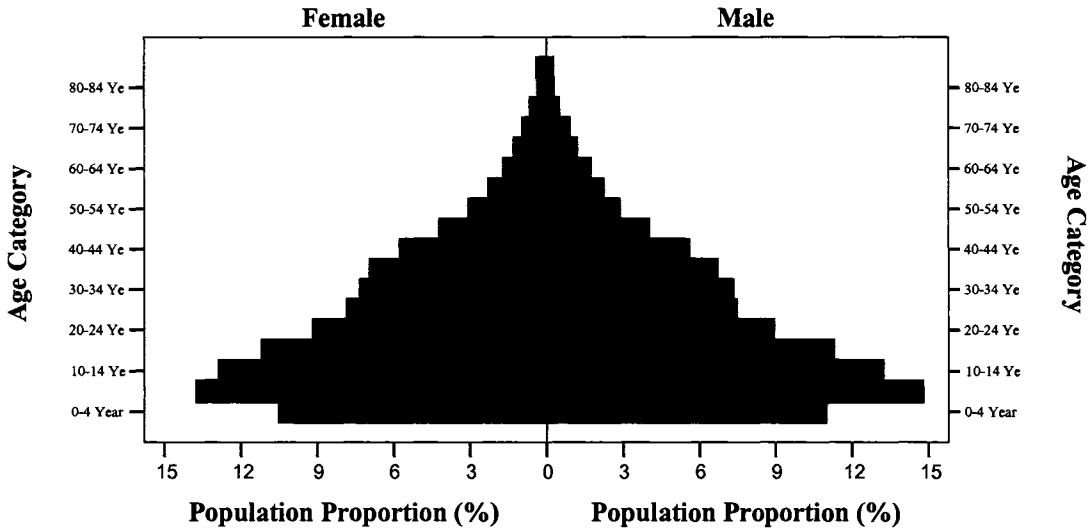
- The rates per 100,000 of campylobacteriosis in the 20 to 29 and 25 to 29 (57.91 and 62.91, respectively) are much higher than that in the 5 to 9 age group (30.65); these three groups appear to have a similar age specific rates when all reported enteric diseases are considered (Figure 3).
- The age group rate trends for campylobacteriosis, salmonellosis, and giardiasis appear to decline during later childhood, with the lowest rates in the 10 to 14 age group. An increasing trend is observed for ages 15 to 29, after which the rates start to decline again.
- *E. coli* infections and cryptosporidiosis decrease with age after age 5 with an increase in those >60; shigellosis, and yersiniosis decline from childhood years (until 19 years of age) until adults years.

Enteric Disease in Alberta First Nations (1998-2004)

The population structure of Alberta First Nations[7] (Figure 5) is considered "expansive" and has a broad base indicating a high proportion of children, a rapid rate of population growth, and a low proportion of older people (Statistics Canada, 2007). This structure is very different from the general Alberta population as illustrated in Figure 2.

[7] Alberta First Nations population structure was described using numbers from the federal Indian Registration system on-reserve and crown lands as of December 31, 2001.

Figure 5 Alberta First Nations Population Distribution (2001)



Source: Indian and Northern Affairs Canada, 2001 Registered Indian Population

Table 5 shows the occurrence of enteric diseases in Alberta First Nations communities by gender and age. Enteric disease occurrence was approximately evenly distributed between males and females. Rates were highest in the 0 to 4 age group[8] (635.58 per 100,000) which is as much as 15 times higher than other age groups. The lowest rate was observed in the 30 to 39 age group (27.91). These results show that there is generally a declining trend in the overall enteric disease rates by age group from the childhood years to adult years, however, the rates increase in the 40 and above age groups. The crude incidence rate[9] was 126.75 cases per 100,000 population, which is higher than the provincial rate of 110.09 for the same time period (Table 3).

[8] Population data from the INAC population file were available for the 0-4 age group only.
[9] Crude incidence was calculated for the 1998-2004 time range as an annual rate (divided by seven years).

Table 5 Enteric Disease Cases in Alberta First Nation Communities (1998 to 2004)

	Alberta First Nations Population*	Alberta First Nations Cases◊		Alberta First Nations Rate☼	Provincial Rate^
		No.	%		
Total	58,046	515	100	126.75	110.09
Gender╪					
Male	29,441	251	49.22	121.79	113.7
Female	28,605	259	50.78	129.35	104.1
Age in yearsΔ					
0-4	6,226	277	57.35	635.58	305.71
5-9	8,276	71	14.70	122.56	135.1
10-14	7,566	29	6.00	54.76	79.0
15-19	6,511	19	3.93	41.69	88.1
20-24	5,244	13	2.69	35.41	142.0
25-29	4,428	13	2.69	41.94	147.2
30-39	8,191	16	3.31	27.91	102.9
40-59	8,694	29	6.00	47.65	77.6
60 and over	2,910	15	3.11	73.64	69.3

* **on-reserve** Status Indian population, December 31, 2001, INAC population file. Population data are not available specifically for the <1 year age group.
◊ cases reported to Alberta Region, First Nations and Inuit Health Branch (94.6% of cases laboratory confirmed)
☼number of cases per 100,000 population per year based on INAC population file 2001 on reserve status Indian population
╪ not included: 6 cases of unknown gender
Δ not included: 30 cases of unknown age
^Provincial rates includes Alberta First Nations cases

Of further interest, there was a large outbreak of shigellosis in an Alberta First Nation community during the study period (April 1998 with a projected end date in 1999). According to the FNIHB database, 130 shigellosis cases occurred in this community during that time period. When these outbreak numbers are removed from the analysis, the crude incidence rate is 94.75 cases per 100,000 population for Alberta First Nations, while the general population rate is calculated at 109.48.

Adjusting the Alberta First Nations enteric disease rate for age by using the Canadian First Nations population as the standard population, shows a lower crude incidence enteric disease rate of 110.43 per 100 000, that is similar to the Alberta general population crude incidence rate.

The distribution of the specific enteric disease agents in First Nations communities is quite different from the provincial distribution. Gender specific rates indicate that there are more cases in males than females provincially, while the opposite is true in First Nation communities. In Alberta First Nations communities for 1998 to 2004, the enteric disease with the highest case specific rates were shigellosis (56.36 per 100,000), followed by giardiasis (25.35), salmonellosis (17.72), and campylobacteriosis (13.29) (Table 6). The on-reserve rates of shigellosis and giardia are the only rates that are higher than the provincial rates. When the rate of shigellosis is calculated excluding the cases from the community that experienced a shigellosis outbreak, the rate is 24.36 per 100,000, which is still almost five times the provincial crude incidence rate for this disease.

Table 6 Alberta First Nation Enteric Disease Distribution by Etiologic Agent 1998-2004

Etiologic Agent	Number of Cases*	Proportion of Total (%)	Rate per 100,000◇
Shigellosis	229	44.5	56.36
Giardiasis	103	20.0	25.35
Salmonellosis	72	14.0	17.72
Campylobacteriosis	54	10.5	13.29
Cryptosporidiosis	19	3.7	4.68
Hepatitis A Virus	18	3.5	4.43
E. coli infection	17	3.3	4.18
* Diseases with less than five cases are not reported. ◇ number of cases per 100,000 population per year based on INAC population file 2001 on reserve status Indian population of 58,046			

The high rates of giardiasis and shigellosis in the 1 to 4 year age group contribute to the elevated overall rate of enteric disease in First Nations communities for the 1998-2004 time period. In general, age specific rates for specific diseases in First Nations communities are generally not higher than the provincial rates, with the exception of the following: all age groups for shigellosis (56.36 FN, 4.76 AB), 0 to 4 year age group giardiasis (174.38 FN, 58.35 AB), 60 years and over salmonellosis (34.36 FN, 19.16 AB), 60 years and over *E. coli* (9.82 FN, 7.9 AB).

When examining the Alberta First Nations enteric disease data by month of onset, the number of cases generally do not fluctuate more then plus/minus five cases on a month to month basis over the span of a year (Figure 7). Campylobacteriosis, salmonellosis, and shigellosis are the exceptions. Campylobacteriosis indicates a higher trend in the summer months; salmonellosis shows an increasing trend in the summer months and peaks in October. Shigellosis shows an increasing trend during the spring months, fluctuating elevated levels in the summer and a peak number of cases in October.

Figure 6 Distribution of Specific Enteric Diseases in Alberta First Nation Communities (1998-2004)

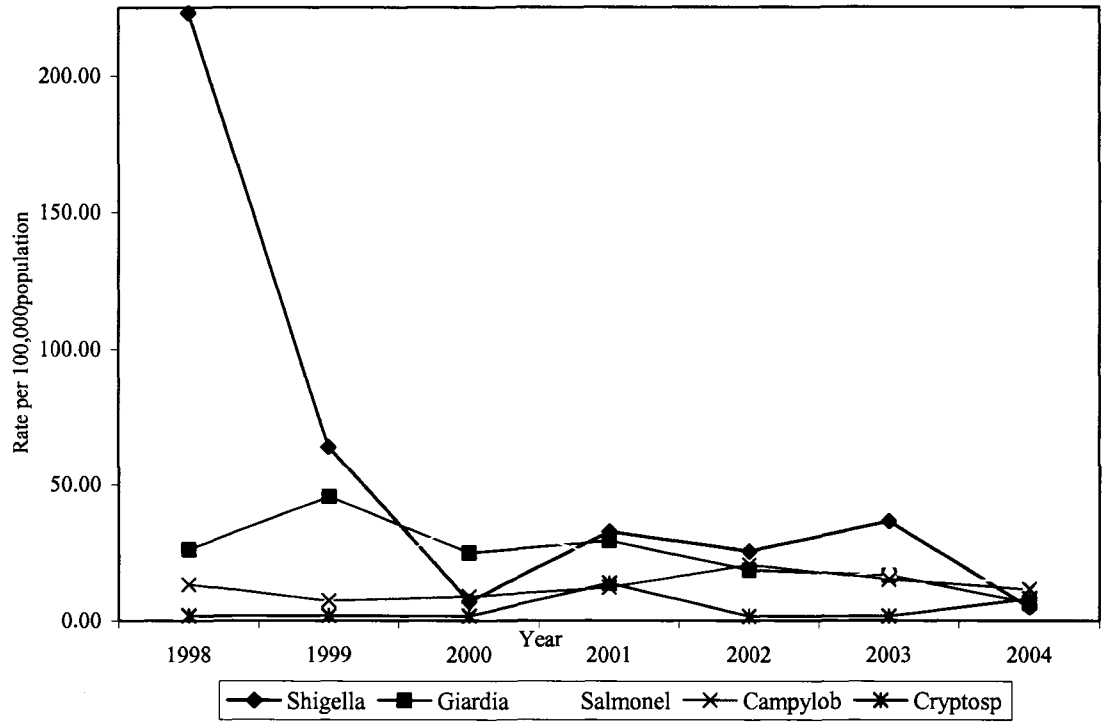
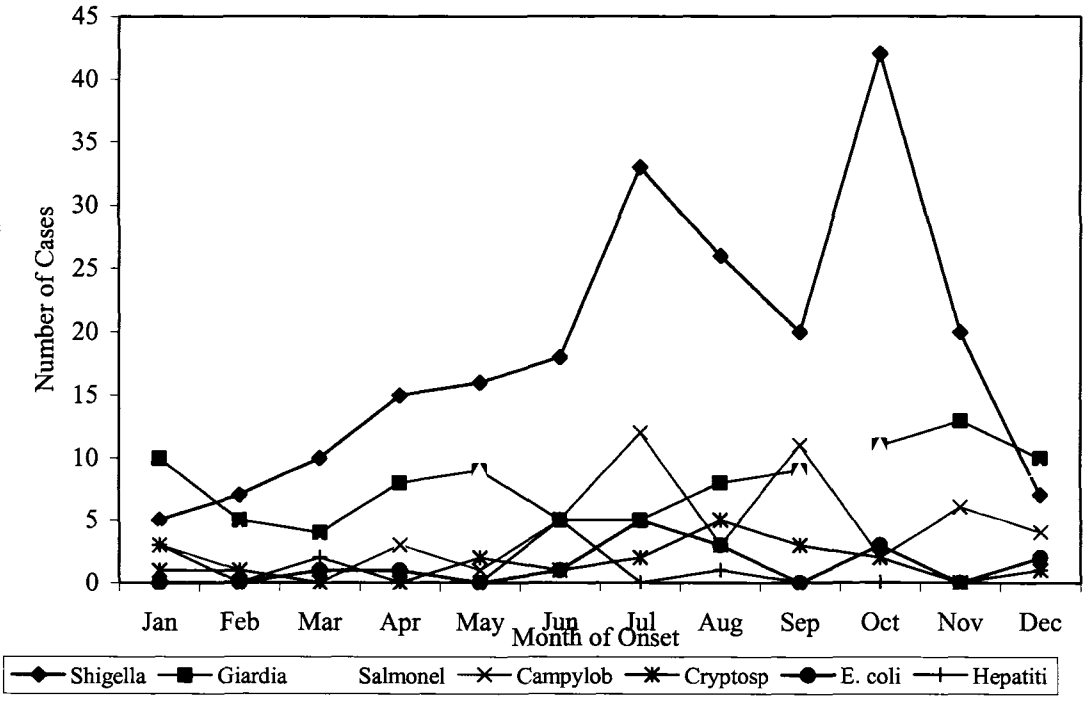


Figure 7 Distribution of Specific Enteric Diseases by Month of Onset (1998-2004)



Alberta First Nations Housing Survey (2000)

The following describes the findings for the six categories in the Alberta First Nations Housing Survey: septic tank, subsurface disposal/chamber field, open discharge, private lagoon, private well, and private cistern

Sewage Disposal Systems

General. Of the 2,517 dwellings included in the analysis, the majority were serviced by a subsurface disposal field (69.1%, n=1,740) or community sewage system (piped) (25.9%, n=653) as the final treatment stage. The remaining sewage system types included private lagoon, open discharge, holding tank or no service (5.0%, n=124). (Table 7).

Table 7 Sewage System Types (n=2517)

	Frequency	Percent	Valid Percent	Cumulative Percent
No Service/Malfunctioned	10	0.4	0.4	0.4
Holding Tank	14	0.6	0.6	1.0
Open Discharge	48	1.9	1.9	2.9
Private Lagoon	52	2.1	2.1	5.0
Piped	653	25.9	25.9	30.9
Subsurface Disposal Field	1,740	69.1	69.1	100.0
Total	2,517	100.0	100.0	

Septic tank. A septic tank is a digestion chamber in which sewage is received, retained, the solids are settled to the bottom of the tank and from which the effluent is discharged to the final treatment component (Safety Codes Council, 2000). Of the 1,854 dwellings surveyed serviced by private sewage disposal systems (subsurface disposal field, private lagoon, open discharge, holding tanks), 92% (n=1,711) had concrete septic tanks and 67% (n=1,242) had two-chamber septic tanks. Septic tanks

generally provide effluent to the treatment area by use of a pump or gravity, which constituted 31.5% (n=584) and 61.2% (1,136) of homes, respectively[10].

Ten variables were used to assess a dwelling's septic tank score. Of the 10 variables, 2 were classified as health, 1 as environment, and 7 as installation/maintenance with a total possible score of 20 (Table 8). Of the variables reviewed:

- Dwellings generally met the standard of the classification, with the exception of the septic tank cover being level. This indicates at the time of the survey, the septic tank was not level (either due to installation method or settling over time).
- Evidence of sewage overflowing from the septic tank is a health concern due to the potential for occupants to be directly/indirectly exposed to sewage effluent. This was the case for 4.5% (77 of 1,687) of septic tanks surveyed.

Of the 1854 private sewage systems, 1,354 or 73% had complete information (all survey questions answered) on septic tanks. While the scores ranged from 5 to 20, the majority of homes scored 18 or 19 (1,156 or 85.6%) with a mean of 18.31, median of 19 and mode of 19. Twenty-one homes had the maximum possible score of 20. These results indicate that from the variables measured, septic tanks generally met installation/maintenance standards that optimized operation while protecting the environment and occupant health and safety.

[10] Of the 1,855 dwelling on private sewage systems that were surveyed, 7.3% (n=135) did not indicate a method uses to discharge sewage effluent from the septic tank.

Table 8 Alberta First Nations Housing Survey Septic Tank Variables Score Results

Variable (Survey Question)	Classification	Maximum Points Possible*	Summary of variable scores by number of dwellings			
			No Points	Maximum Points	Missing Response (not scored)	Total
Is any portion of the building sewer/drain exposed?	Installation/ maintenance	1	106	1,699	49	1,854
Condition of access/manhole opening cover	Installation/ maintenance	1	159	1,572	123	1,854
The access cover is child proof by mean of	Installation/ maintenance	1	63	1,663	128	1,854
Condition of the access/manhole opening extension	Installation/ maintenance	1	249	1,469	136	1,854
Is the access cover level?	Installation/ maintenance	1	1,576	95	183	1,854
What are the ground conditions around the access/manhole?	Installation/ maintenance	1	434	1,292	128	1,854
Is there evidence of sewage overflowing or overflowed from the septic tank/holding tank?	Health	5	77	1,610	167	1,854
Distance from septic tank to house.	Installation/ maintenance	1	9	1,579	266	1,854
Distance from septic tank to water course.	Environment	3	8	1,554	292	1,854
Distance from septic tank to drinking water source.	Health	5	10	1,638	206	1,854
Total Possible Score	20					
Mean Score: 18.39 Median Score: 19 Standard Deviation: 1.44						

*Classification criteria identified in Appendix E.

Subsurface disposal field. A subsurface disposal field is a system of sewage effluent treatment and disposal distributing sewage effluent that has been discharged from a septic tank within trenches containing void spaces that are covered with soil and includes conventional field (pipe and gravel) and chamber field designs (Safety Codes Council, 2000). Of the surveyed dwellings that met the data analysis criteria, 1,740 or 69.1% were serviced by this type of sewage system.

Seven variables were used to calculate the score for dwellings serviced by subsurface disposal fields. Of the seven variables, three were classified as health, one as environment, and three as installation/maintenance with a total possible score of 19 (Table 9). Of the variables reviewed:

- Fifty-four percent (933 of 1,729) of subsurface disposal fields with complete responses were located in a low-lying area. This was classified as an "environment" classification because low lying areas are potentially more closely situated to the groundwater table, thus primarily creating an environmental concern.
- Ninety-three percent (1,589 of 1,718) of the subsurface disposal fields with complete responses did not have maintained vegetation. Vegetation not maintained over a subsurface disposal field can promote the growth of shrubs and trees whose root systems can interfere with the operation of the field.
- Five percent (82 of 1,720) of the subsurface disposal fields with complete responses noted evidence that the field had malfunctioned (ponding/leaking sewage).

Table 9 Alberta First Nations Housing Survey Subsurface Disposal Field Variables Score Results

Variable (Survey Question)	Classification	Maximum Points Possible*	Summary of variable scores by number of dwellings			
			No Points	Maximum Points	Missing Response (not scored)	Total
Where is the disposal field located (level, low-lying or elevated area)?	Environment	3	933	796	11	1,740
Is the vegetation maintained (cut/trimmed)?	Installation/ maintenance	1	1,589	129	22	1,740
Indications that the disposal field is malfunctioning (ponding/leaking sewage or temporary surface discharge)?	Health	5	82	1,638	20	1,740
Is any part of the sewage disposal field uncovered?	Installation/ maintenance	1	35	1,653	52	1,740
Distance from subsurface disposal field to septic tank.	Installation/ maintenance	1	5	1,533	202	1,740
Distance from subsurface disposal field to water course.	Environment	3	13	1,534	193	1,740
Distance from subsurface disposal field to drinking water supply.	Health	5	10	1,640	90	1,740
Total Possible Score	19					
Mean score: 16.21 Median score: 15 Standard deviation: 1.95						

*Classification criteria identified in Appendix E.

Of the 1,740 homes serviced by a subsurface disposal field, 1,472 had complete responses to the variables used to calculate a score for this category. Out of a possible score of 19, scores ranged from 0 to 19 with a mean of 16.21, median of 15 and mode of 15. The majority of dwellings scored 15 or 18 points (668 and 616 dwellings respectively). When reviewing the summary in Table 9, the clustering around those two point totals is due to the majority of homes having its subsurface disposal field located in a low lying area and/or not maintaining the vegetations over the subsurface disposal field.

Open discharge. Open discharge systems are designed to discharge sewage effluent that has been discharged from a septic tank to the ground surface to accomplish evaporation and absorption of the effluent into the soil as a method of disposal (Safety Codes Council, 2000). Of the surveyed dwellings that met the data analysis criteria, this type of sewage system serviced 48 homes or 1.9%.

Six variables were used to calculate the score for dwellings serviced by open discharge systems. Of the six variables, one was classified as health, and five as installation/maintenance with a total possible score of 10 (Table 10). Unfortunately, setback distances were not collected for the open discharge category and would have been an important part of calculating the score as this type of system has the potential for directly and indirectly exposing occupants to sewage effluent and health hazards associated with it. Of the variables reviewed:

- a fence around the sewage effluent discharge area was not present for 82.0% of systems (28 of 34 responses);

Table 10 Alberta First Nations Housing Survey Open Discharge Variables Score Results

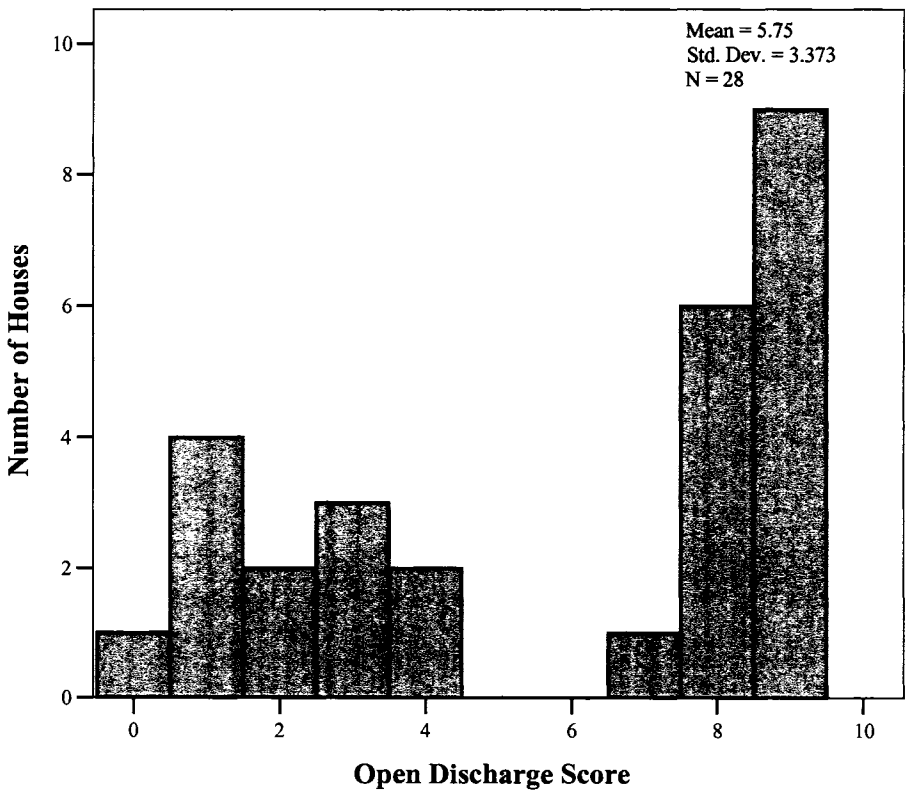
Variable (Survey Question)	Classification	Maximum Possible Points*	Summary of variable scores by number of dwellings			
			No Points	Maximum Points	Missing Response (not scored)	Total
Is the effluent line uncovered?	Installation/ maintenance	1	7	28	13	48
Is the effluent discharge area fenced off?	Installation/ maintenance	1	28	6	14	48
Is the effluent discharge pipe damaged or broken?	Installation/ maintenance	1	3	26	19	48
Is the ground around the effluent discharge pipe mounded?	Installation/ maintenance	1	12	17	19	48
Is effluent accumulating around the discharge area?	Health	5	16	16	16	48
Is there a frost protection pipe with cap around the effluent discharge line?	Installation/ maintenance	1	17	14	17	48
Total Possible Score	10					
Mean score: 5.75 Median score: 8 Standard deviation: 3.37						

*Classification criteria identfied in Appendix E.

- the majority of systems with available responses (80.0%, 28 of 35 dwellings) had the sewage effluent line covered and in satisfactory condition;
- systems with available responses were generally spilt between having a mounded area around the discharge pipe or not, having frost protection or not, and having sewage accumulating around the discharge area or not.

Of the 48 open discharge systems surveyed, 27 or 56.0% had complete responses (all surveyed questions answered). From the 28 responses, the mean score was 5.75, median was 8 and mode was 9. Figure 8 shows the distribution of the

Figure 8 Distribution of Open Discharge Scores



scores and illustrates that the data are not normally distributed with the small sample size likely being a contributing factor. Approximately half of those dwellings surveyed had a score of seven or less indicating a lack of adherence to installation and maintenance measured in the score calculation. Unfortunately, the number of variables scored was less compared to the other categories and setback distances were not measured (which is important for this type of system that discharges sewage effluent directly to the ground surface), which gives limited information about the installation and operation components of the system and how they may impact health.

Private lagoon. A lagoon is a shallow artificial pond for the disposal of sewage effluent either discharged from a septic tank or flow directly to a lagoon with no prior treatment. Of the surveyed dwellings that met the data analysis criteria, this type of system serviced 52 or 2.1%.

Eleven variables were used to calculate the score for dwellings serviced by private lagoons. Of the 11 variables, 2 were classified as health, 3 as environment, and 6 as installation/maintenance with a total possible score of 25 (Table 11). A summary of the variables used to calculate the score follows:

- The majority of private lagoons were bermed (44/47 or 93.6%) and satisfactorily contained sewage effluent within the bermed area (43/44 or 97.7%)
- Fifty-eight percent (29/50) were fenced, but the condition/type of fencing was not known (barbed wire, chain link, etc).
- Of the 37 dwellings that had a response regarding the continuous discharge of sewage effluent from the lagoon, none had indicated that this was occurring.

- Setback distances from the private lagoon to house, water course, and drinking water supply met the standards outlined in the *1999 Alberta Private Sewage System Standard of Practice.*

Of the 52 dwellings serviced by a private lagoon, only 13 or 25.0% had complete responses to the measured variables. Of the six categories, this was the lowest proportional response. Out of a possible maximum of 25 points, the scores ranged from 18 to 23 with a mean of 20.77, median of 21 and mode of 21. A score of less than 20 indicates that at least one variable classified as health, or a combination of variables that totals the same amount affected the score.

Table 11 Alberta First Nations Housing Survey Private Lagoon Variables Score Results

Variable (Survey Question)	Classification	Maximum Possible Points*	Summary of variable scores by number of dwellings			
			No Points	Maximum Points	Missing Response (not scored)	Total
Is the lagoon fenced?	Installation/ maintenance	1	21	29	2	52
Was the gate locked?	Installation/ maintenance	1	13	18	21	52
Is the lagoon bermed?	Environment	3	3	44	5	52
Is the berm vegetation maintained? (ie. mowed)	Installation/ maintenance	1	36	7	9	52
Is effluent overflowing the lagoon berm?	Health	5	1	43	8	52
Is the discharge point on the opposite side from where the sewage enters the lagoon?	Installation/ maintenance	1	18	14	20	52
Is there sewage discharging from the lagoon on a continuous basis?	Environment	3	0	37	15	52
Is there aquatic weeds and vegetation growing within the lagoon?	Installation/ maintenance	1	27	16	9	52
Distance from private lagoon to house	Installation/ maintenance	1	0	45	7	52
Distance from private lagoon to water course	Environment	3	0	44	8	52
Distance from private lagoon to drinking water supply	Health	5	0	46	6	52
Total Possible Score	25					
Mean score: 20.77 Median score: 21 Standard deviation: 1.54						

*Classification criteria identified in Appendix E.

Water Supplies

General. This section focused on private drinking water wells and private cisterns (trucked) water supplies. The variables were given a more stringent classification as compared to the sewage disposal systems because the same variable will have stronger implications for health because of the risk of directly affecting the drinking water supply.

Wells. A drinking water well is a bored, drilled, driven or dug excavation utilized for the purpose of extracting groundwater from an aquifer (Municipality of Anchorage Alaska, 2007). Of the 1,199 dwelling serviced by a private drinking water well (47.6% of all dwellings surveyed), 1,074 had complete responses to the variables used to calculate a score for this category.

Four variables were used to calculate the score for dwellings serviced by private drinking water wells, with three variables classified as health and one as installation/maintenance for a total of 16 points(Table 12). For each variable a range between 3.1% and 15.9% of responses by dwelling did not receive any points, therefore did not adequately protect health or were not properly installed or maintained. An appropriate well casing height of 200 mm was met in 96.9% of the water wells assessed, while 84.1% of assessed drinking water wells had ground area that sloped away from the well head.

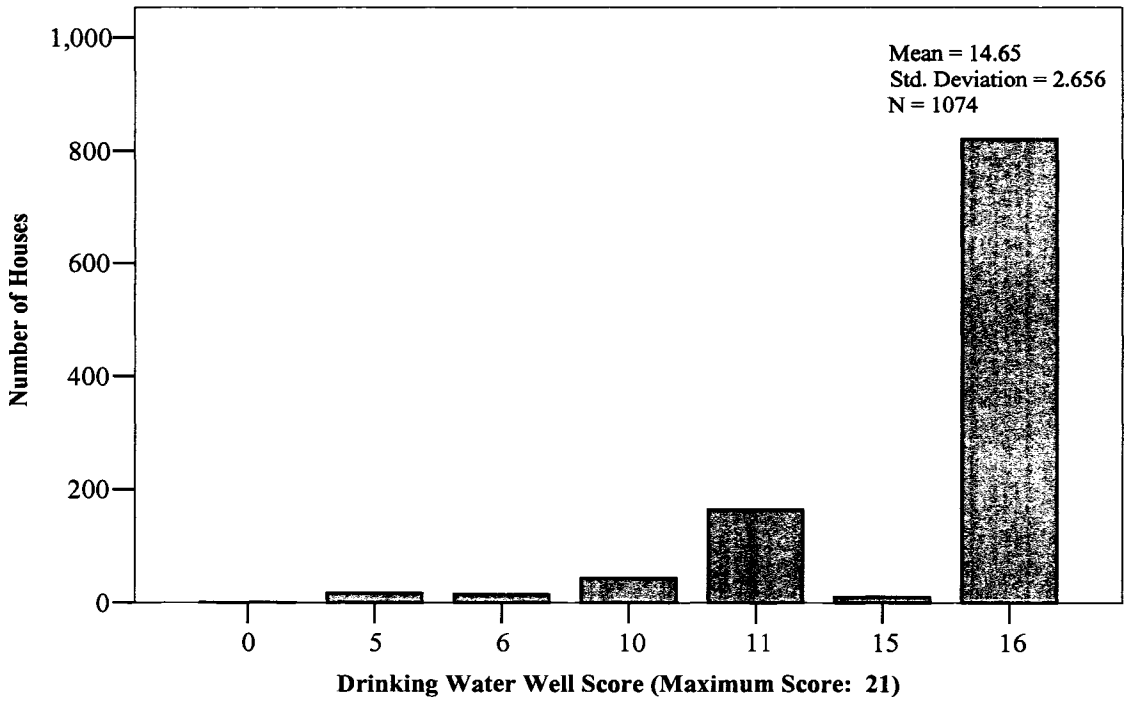
Table 12 Alberta First Nations Housing Survey Well Variables Score Results

Variable (Survey Question)	Classification	Maximum Possible Points*	Summary of variable scores by number of dwellings			
			No Points	Maximum Points	Missing Response (not scored)	Total
Does the well casing have a proper secured cap?	Health	5	135	1,022	42	1,199
What is the well cap condition?	Installation/ maintenance	1	83	1,041	75	1,199
What are the ground conditions around the well?	Health	5	159	9,98	42	1,199
The top of the well casing is (less than or equal to/greater than) 200 mm/8inches.	Health	5	35	1,121	43	1,199
Total Points	16					
Mean score: 14.65 Median score: 16 Standard deviation: 2.66						

*Classification criteria identified in Appendix E.

Out of a possible maximum of 16 points, the scores ranged from 0 to 16 with a mean of 14.65, median of 16 and mode of 16. Almost 69.0% of dwellings scored 16 and 14% scored 11 points (Figure 9). This indicates that 83.0% of the dwellings with complete survey responses adequately met the variables measured.

Figure 9 Distribution of Drinking Water Well Scores



Cisterns. Five cisterns were characterized as having the access/manhole opening to the cistern below ground level. These dwellings were removed from the analysis because the variables analyzed require a visual assessment of the access/manhole or extension. As a result, 402 dwellings served by cisterns (16.0% of all dwellings surveyed) were included in the analysis.

Of the seven variables assessed, four were classified as health and three as installation/maintenance, for a possible total point score of 23 (Table 13). Of the variables reviewed:

- that majority (75.4%) of cisterns were not vented. A cistern vent assists in the exchange of air, especially as a cistern is being re-filled;
- thirty-five percent of cisterns did not have a childproof lid (lids were not padlocked and/or did not weigh more than 29.5 kilograms. This indicates a health and safety concern because items that could contaminate drinking water may enter the cistern and pose an entrapment hazard for children;
- twenty-one percent of dwellings had ground conditions that sloped toward the cistern, which increased the likelihood of run-off water entering the cistern and contaminating the drinking water;
- over one quarter (28.6%) of cisterns assessed had manhole opening covers in an unsatisfactory condition (cracked/damaged/missing), thus allowing a pathway for contamination of the drinking water.

Of the 402 cisterns included in the survey, 143 (35.1%) had complete responses for each of the seven variables. Out of a possible maximum of 23 points, the scores ranged from 0 to 18 with a mean of 14.59, median of 16 and mode of 18. Sixty-six percent of the dwellings scored between 16 and 18 points, inclusive. The highest score was 18, which indicates that all cisterns did not meet at least one of the conditions necessary to protect health.

Table 13 Alberta First Nations Housing Survey Cistern Variables Score Results

Variable (Survey Question)	Classification	Maximum Possible Points*	Summary of variable scores by number of dwellings			
			No Points	Maximum Points	Missing Response (not scored)	Total
What is the condition of the cistern access/manhole opening cover?	Health	5	113	282	7	402
What are the ground conditions around the cistern?	Health	5	76	300	26	402
Is the access cover childproof?	Health	5	130	240	32	402
What is the condition of the access/manhole opening extension?	Health	5	88	292	22	402
Is the cistern vented?	Installation/ maintenance	1	292	95	15	402
What is the condition of the cistern vent?	Installation/ maintenance	1	94	66	242	402
Is the cistern lid level?	Installation/ maintenance	1	42	332	28	402
Total Points	23					
Mean score: 14.63 Median score: 16 Standard deviation: 4.32						

*Classification criteria identified in Appendix E.

Sewage System Profile by Community

Descriptive statistics were completed for the categories based on community and compared with the data from the whole survey. A summary of the descriptive statistics for the survey and each community is included in Tables 14, 15, and 16.

Septic tank. Of the five surveyed communities, the median and mode were the same for each community and for the overall survey. The means for each of the communities were plus/minus 0.5 point of the overall survey mean. This indicates that the variations between specific community survey results were minimal.

Subsurface disposal field. The mean survey score for this category (all communities) was 16.21, with two communities lower than that number. The community-by-community median range was 15 to 18, with the median for all communities at 15. The mode for all communities was either 15 or 18. These results are consistent with the findings discussed above for this survey category.

Open discharge and private lagoon. The sample size for both categories with complete responses was small (28 open discharge, 13 private lagoon) for the whole survey and revealed variation in the descriptive statistics between communities due to the small sample sizes.

Private well. The maximum possible score for this category was 16. The median and mode were the same (16, 16, respectively) for all communities. Community C had the highest mean score and the narrowest range of scores (10 to 16) indicating less variation in the assessed variables.

Cistern. The maximum possible score for this category was 23. One community had two cisterns that were not scored, therefore was not included as a

community in the descriptive analysis. The number of cistern scores ranged from 8 to 82 dwellings by community. The community with the greatest number of cisterns had the lowest mean, median and mode (13.82, 16, 16, respectively).

Table 14 Sewage System Category Scores by Community[11]

All Communities Cateogory Score Statistics

		Sewer_ HealthSurvey	Septic Tank Score	Subsurface Disposal Field Score	Open Discharge Score	Private Lagoon Score
N	Valid	2,517	1,354	1,472	28	13
	Missing	0	1,163	1,045	2,489	2,504
Mean			18.31	16.21	5.75	20.7692
Median			19.00	15.00	8.00	21.0000
Mode			19	15	9	21.00
Minimum			5	0	0	18.00
Maximum			20	19	9	23.00

Community A Cateogory Score Statistics

		Sewer_ HealthSurvey	Septic Tank Score	Subsurface Disposal Field Score	Open Discharge Score	Private Lagoon Score
N	Valid	822	400	436	10	0
	Missing	0	422	386	812	822
Mean			18.15	16.41	5.30	
Median			19.00	18.00	6.00	
Mode			19	18	8	
Minimum			8	9	0	
Maximum			20	19	9	

Community B Cateogory Score Statistics

		Sewer_ HealthSurvey	Septic Tank Score	Subsurface Disposal Field Score	Open Discharge Score	Private Lagoon Score
N	Valid	400	182	224	13	0
	Missing	0	218	176	387	400
Mean			17.89	16.29	6.69	
Median			19.00	16.00	9.00	
Mode			19	18	9	
Minimum			5	7	1	
Maximum			19	19	9	

[11] The "Missing" row label indicates the number of records for the whole dataset for which no score was calculated. Included in "Missing" are dwellings that were not categorized as being serviced by that type of system and dwellings that did not have complete responses to all variables used to compute the score.

Table 14 Sewage System Category Scores by Community (continued)

Community C Cateogory Score Statistics

		Sewer_ HealthSurvey	Septic Tank Score	Subsurface Disposal Field Score	Open Discharge Score	Private Lagoon Score
N	Valid	615	239	248	0	13
	Missing	0	376	367	615	602
Mean			18.37	16.75		20.7692
Median			19.00	18.00		21.0000
Mode			19	18		21.00
Minimum			11	7		18.00
Maximum			20	19		23.00

Community D Cateogory Score Statistics

		Sewer_ HealthSurvey	Septic Tank Score	Subsurface Disposal Field Score	Open Discharge Score	Private Lagoon Score
N	Valid	499	403	426	4	0
	Missing	0	96	73	495	499
Mean			18.57	15.89	3.25	
Median			19.00	15.00	2.00	
Mode			19	15	1	
Minimum			8	0	1	
Maximum			20	19	8	

Community E Cateogory Score Statistics

		Sewer_ HealthSurvey	Septic Tank Score	Subsurface Disposal Field Score	Open Discharge Score	Private Lagoon Score
N	Valid	181	130	138	1	0
	Missing	0	51	43	180	181
Mean			18.50	15.49	8.00	
Median			19.00	15.00	8.00	
Mode			19	15	8	
Minimum			12	9	8	
Maximum			20	19	8	

Table 15 Private Well Category Scores by Community

Community A Well Score Statistics

Well Score

N	Valid	205
	Missing	28
Mean		14.05
Median		16.00
Mode		16
Minimum		0
Maximum		16

Community B Well Score Statistics

Well Score

N	Valid	156
	Missing	15
Mean		13.97
Median		16.00
Mode		16
Minimum		5
Maximum		16

Community C Well Score Statistics

Well Score

N	Valid	254
	Missing	30
Mean		15.59
Median		16.00
Mode		16
Minimum		10
Maximum		16

Community D Well Score Statistics

Well Score

N	Valid	328
	Missing	38
Mean		14.53
Median		16.00
Mode		16
Minimum		5
Maximum		16

Community E Well Score Statistics

Well Score

N	Valid	131
	Missing	14
Mean		14.86
Median		16.00
Mode		16
Minimum		5
Maximum		16

Table 16 Private Cistern Category Scores by Community

Community A Cistern Score Statistics

Cistern Score

N	Valid	82
	Missing	204
Mean		13.82
Median		16.00
Mode		16
Minimum		1
Maximum		18

Community B Cistern Score Statistics

Cistern Score

N	Valid	21
	Missing	14
Mean		14.19
Median		18.00
Mode		18
Minimum		0
Maximum		18

Community D Cistern Score Statistics

Cistern Score

N	Valid	30
	Missing	39
Mean		16.33
Median		18.00
Mode		18
Minimum		7
Maximum		18

Community E Cistern Score Statistics

Cistern Score

N	Valid	8
	Missing	3
Mean		16.88
Median		17.50
Mode		18
Minimum		13
Maximum		18

Household Density and Enteric Disease

Household density for any given community was calculated by the total registered Indian on reserve population divided by the number of houses[12]. Community density calculations ranged from 2.35 to 6.82, with a mean of 4.21 and median of 4.02. Based on this information, 38 Alberta First Nations communities were categorized in two ways:

- Communities with densities 1 to 3 persons per house and 4 or more persons per house, with the former being the referent variable.
- Communities with densities of 6 or more persons per house, 4 to 5 persons per house and 1 to 3 persons per house (referent variable).

Table 17 summarizes the data in the two categories by number of communities in each category, reserves with cases, reserve population, number of enteric disease cases, enteric disease rates and the rate ratios (95% confidence intervals).

The rate ratio for enteric disease was 3.243 (95% CI = 2.358, 4.461) where the average household density was 4 or more persons per house compared to communities with an average of 1 to 3 persons per house. When the household categories were broken down further, the rate ratios for enteric disease were 0.989 (95% CI = 0.649, 1.510) where the average household density was 6 or more persons per house and 4.287 (95% CI = 3.113, 5.904) where the average household density was 4 to 5 persons per house compared to communities with an average of 1 to 3 persons per house.

[12] Household density was calculated assuming similar house size.

Table 17 Household Density Rate Ratios for Enteric Disease in Alberta First Nations (1998-2004)

Household Density (persons per house)	No. of Communities	Reserves with Cases		Population ^	Enteric Disease Cases (n=515)*		Enteric Disease Rate (per 100,000)	Rate Ratio (95% Confidence Interval)
		No	%		No.	%		
4 or more	19	19	100	45,014	466	90.00	147.9	3.243 (2.358, 4.461)
1 to 3	19	9	47.37	12,846	41	7.96	45.6	1.0
6+	3	3	100	14,249	45	8.74	45.1	0.989 (0.649, 1.510)
4 to 5	16	16	100	30,765	421	81.75	195.5	4.287 (3.113, 5.904)
1 to 3	19	9	47.37	12,846	41	7.96	45.6	1.0

^ Alberta First Nations population structure was described using numbers from the federal Indian Registration system on-reserve and crown lands as of December 31, 2001.
*Of the 515 total enteric disease cases reported, 8 did not report a community of origin

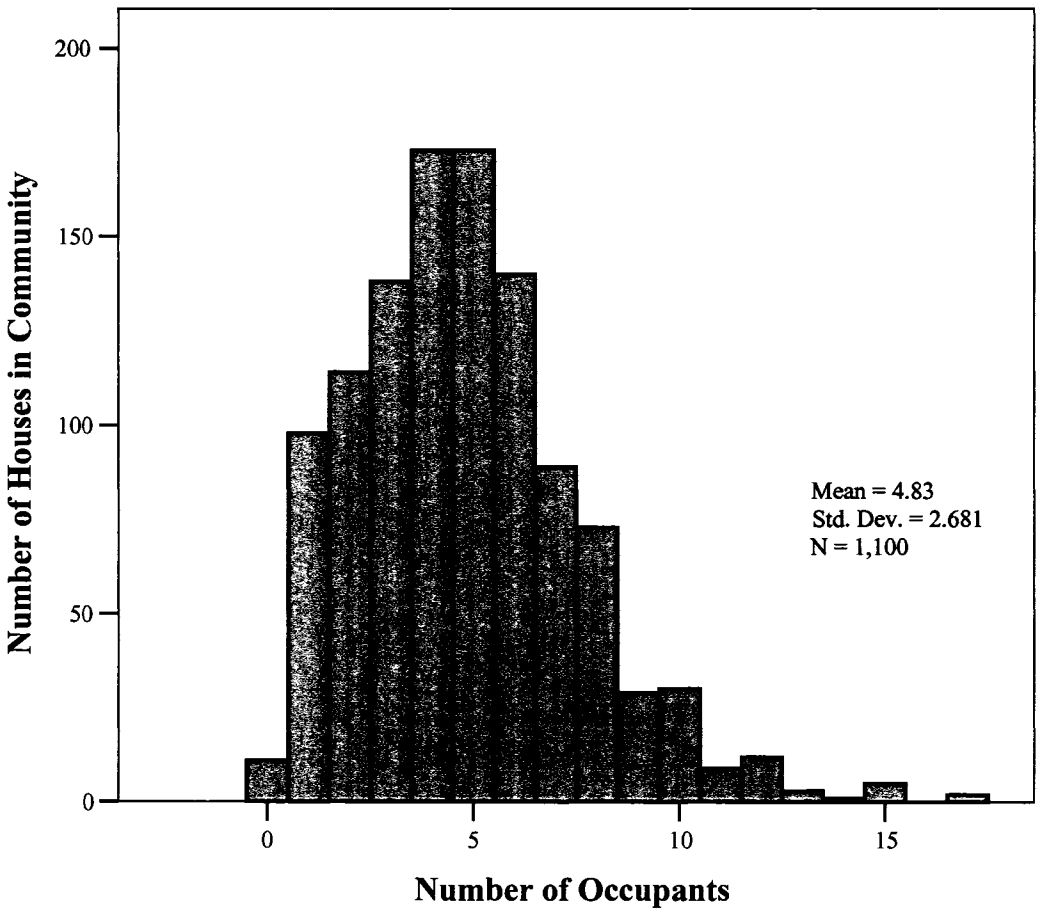
Descriptive statistics, including cross tabulations in some cases, are presented for the nine private sewage disposal system variables identified in the *Analytic Methods* section. Cross tabulations have been constructed for outcome variables that may result from design, installation, operation and maintenance guidelines that are compromised. For example, a sewage system may fail and cause sewage back-up into a dwelling (outcome) due to an unexpected increase in the daily sewage flow that the system was not designed to handle. The following describes the private sewage system components and related factors.

Number of Occupants

Data on the number of occupants per dwelling were available for 1,100 (93.2%) records. The number of occupants per dwelling ranged from zero to 17, with the mean number per home of 4.83 (Figure 10). The number of occupants residing in a dwelling affects the amount of wastewater that is created on a daily basis; the higher number of occupants, the greater amount of wastewater created. Thus, if a sewage system is not designed (design should be based on number of occupants or bedrooms) to handle the increased demand due to overuse, sewage back-up may result.

A cross tabulation of the number of occupants in relation to the occurrence of sewage back-ups are presented in Table 18. Of those dwellings that had one or more sewage back-ups (n=344), 60.8% were homes with five or more occupants, compared to 39.2% of home with four or less occupants. The odds ratio was 1.862 (95% CI 1.415-2.449, $p<0.001$) indicating that the odds of a dwelling with five or more occupants to

Figure 10 Distribution of Number of Occupants per House



experience a sewage back-up is almost twice the odds of a sewage back-up in those homes with four occupants or less.

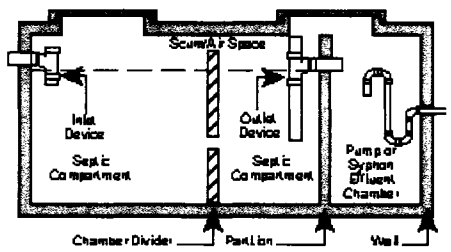
Table 18 Sewage Back-Up Occurrence by Crowding Crosstabulation

			Sewage Back-up Occurrence		
			One or More Sewage Back Ups	No Sewage Back Ups	Total
Crowding	5 or more occupants	Count	209	247	456
		% within Crowding	45.8%	54.2%	100.0%
		% within Sewage Back-up Occurrence	60.8%	45.4%	51.4%
	4 or less occupants	Count	135	297	432
		% within Crowding	31.3%	68.8%	100.0%
		% within Sewage Back-up Occurrence	39.2%	54.6%	48.6%
Total		Count	344	544	888
		% within Crowding	38.7%	61.3%	100.0%
		% within Sewage Back-up Occurrence	100.0%	100.0%	100.0%

Septic Tank

A common design of private sewage systems is to have a septic tank receive sewage effluent from a dwelling via the building drain. The septic tank receives and retains the effluent and settles the solids before the liquid is discharged for final treatment that is usually a soil absorption system. Single chamber septic tanks are available, but the dwellings surveyed are normally serviced by a two-compartment septic tank. In the latter type of septic tank (Figure 11), there is a working chamber and an effluent dosing chamber. The working chamber is the section that first receives and retains the effluent. As part of

Figure 11 Septic Tank Design Cross Section



Source: Safety Codes Council, 2000

the anaerobic process to break down the sewage, the solids settle out and scum floats. Once the sewage has had adequate settling time it will flow to the effluent dosing chamber as per the design of the tank.

Cleaning

Septic tank cleaning is the removal of sludge layer from the working chamber of the septic tank. If a septic tank is not cleaned periodically (timing depends on the amount it is used), this layer can build up and reduce the amount of effluent received by the tank (reduced storage capacity) and affect the amount of settling time the sewage has. If a septic tank is not cleaned, suspended solids and organic material will not settle out, potentially resulting in these materials plugging the soil that normally receives the sewage effluent in the final treatment phase and causing the final treatment component system to fail.

Occupants were asked when the last time their septic tank was cleaned. The responses were categorized by the septic tank cleaning occurrence happening less than one year ago, more than one year ago or never (Table 19). Of the total number of records, data were available for 690 dwellings. Of those dwellings, 38.8% reported having their septic tank cleaned less than one year ago, 61.4% reported the cleaning more than one year ago and 9.7% never have had their septic tank cleaned.

Table 19 Septic Cleaning Occurrence By Sewage Back-up Occurrence Crosstabulation

			Sewage Back-up Occurrence		
			One or More Sewage Back Ups	No Sewage Back Ups	Total
Septic Cleaning Occurrence	Never	Count	13	54	67
		% within Septic Cleaning Occurrence	19.4%	80.6%	100.0%
		% within Sewage Back-up Occurrence	4.7%	13.0%	9.7%
	More than One Year Ago	Count	121	234	355
		% within Septic Cleaning Occurrence	34.1%	65.9%	100.0%
		% within Sewage Back-up Occurrence	43.8%	56.5%	51.4%
	Less than One Year Ago	Count	142	126	268
		% within Septic Cleaning Occurrence	53.0%	47.0%	100.0%
		% within Sewage Back-up Occurrence	51.4%	30.4%	38.8%
Total		Count	276	414	690
		% within Septic Cleaning Occurrence	40.0%	60.0%	100.0%
		% within Sewage Back-up Occurrence	100.0%	100.0%	100.0%

In relation to the occurrence of sewage back-ups, 19.4% of dwellings that never had their septic tank cleaned out had experienced one or more sewage back-ups, while 80.6% of all dwellings that never had their septic tank cleaned out and never experienced a sewage back-up. Of the homes that did not report a sewage back up, 30.4% (n=126) were dwellings that had their septic tanks cleaned out less than one year ago, while 69.5% (n=288) were homes that did not have their septic tanks cleaned out for more than a year or never had the septic tank cleaned out. Additional information is needed to assist with this data analysis, such as age of septic tank and occurrence of sewage back-up in relation to septic tank cleaning (which occurred first). Without this information the relationship between the occurrence of septic tank cleaning and sewage back-up occurrence cannot be tested. The survey did not collection information on the type of sewage back-up and soil types in the absorption

field. Types of back-ups include pipe blockage and septic tank filled to or greater than capacity due to absorption field failure (field may flood due to inappropriate soil quality or precipitation.

Septic Tank Overflow

A septic tank overflowing is an obvious visual indicator that there are issues with the functioning of the sewage system. A septic tank overflowing can be caused by a number of factors including effluent pump malfunction or the septic tank becoming plugged with household items (towels, diapers, etc.). Of the 870 dwelling that had data available on septic tank overflow (at the time of data collection) and the occurrence of sewage back-up(s), only 2.2% (19) reported septic tank overflow and one or more sewage back-ups.

After the sewage effluent has been retained and settled in the septic tank, it is discharged to the disposal area. While there are many types of systems used in a disposal area, the homes surveyed were generally serviced by open discharge system or subsurface field systems. Without analyzing any data, it would be expected that different sewage disposal systems should comparatively function the same (i.e., not predisposed to malfunction) if the appropriate design, installation, operation and maintenance guidelines were followed.

Private Sewage Disposal System Type

Of the homes surveyed, 543 (46.0%) had a subsurface disposal system, while 522 (44.2%) were serviced by an open discharge system, with no data available for 113 (9.6%). Data were available for both private sewage system disposal type and sewage back-up occurrence parameters for 822 records. In reviewing the occurrence of sewage back-up by sewage disposal system type, it was found that 49% (n=178) of homes with open discharge systems had experienced at least one sewage back-up in the past year, compared to 30.7% of homes serviced by a subsurface disposal field (n=141) and having at least one sewage back-up (Table 20). The odds ratio of 2.17 (95% CI 1.631, 2.888, $p<0.001$) indicates that the odds of experiencing a sewage back-up are twice that if the dwelling was serviced by an open discharge system compared to other private sewage system types. This may be because installation guidelines were not followed causing the system to not function properly, especially in inclement weather.

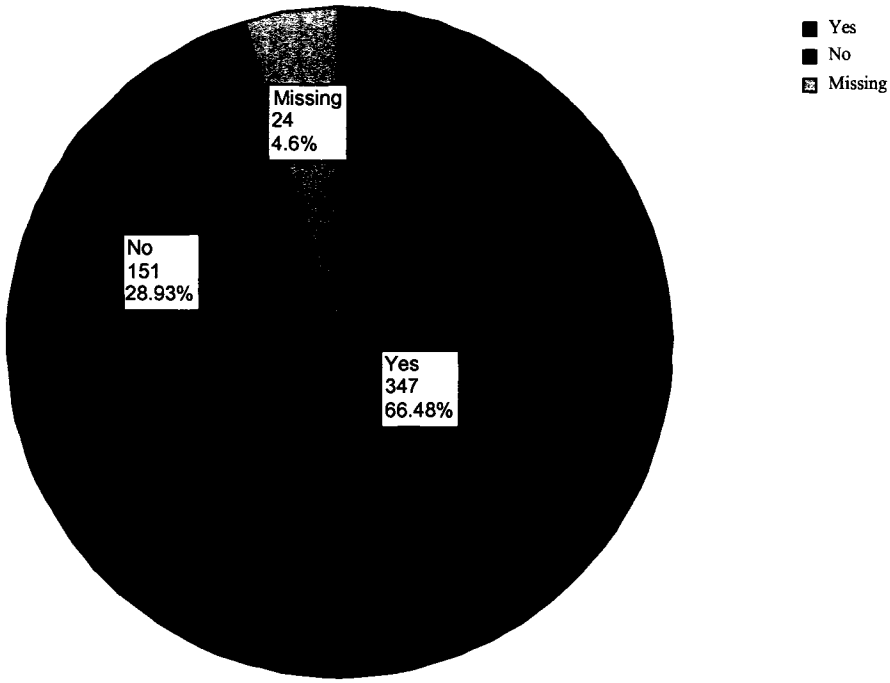
Table 20 Private Sewage System Type By Sewage Back-up Occurrence Crosstabulation

			Sewage Back-up Occurrence		
			One or More Sewage Back Ups	No Sewage Back Ups	Total
Private Sewage System Type	Open Discharge	Count	178	185	363
		% within Private Sewage System Type	49.0%	51.0%	100.0%
		% within Sewage Back-up Occurrence	55.8%	36.8%	44.2%
	Subsurface Disposal Field	Count	141	318	459
		% within Private Sewage System Type	30.7%	69.3%	100.0%
		% within Sewage Back-up Occurrence	44.2%	63.2%	55.8%
Total		Count	319	503	822
		% within Private Sewage System Type	38.8%	61.2%	100.0%
		% within Sewage Back-up Occurrence	100.0%	100.0%	100.0%

The open discharge system poses public health concerns because it operates by pumping sewage effluent onto the ground surface, thus providing means to transmit enteric disease. The transmission of enteric disease in this scenario may occur directly (humans directly exposed to sewage) or indirectly (pets, livestock, toys and other vectors having contact with sewage). The effect of this is amplified when proper installation standards, such as setback distances, are not followed (discussed below).

The survey collected data regarding the pooling of sewage effluent around the open discharge pipe on the ground surface. Data were available for 498 of 522 system reported to have open discharge systems. The accumulation of sewage effluent occurred in 66.5% of dwelling with open discharge (Figure 12). The accumulation of sewage effluent around an open discharge pipe provides an exposure route for occupants to pathogens directly or indirectly. It may also indicate that either

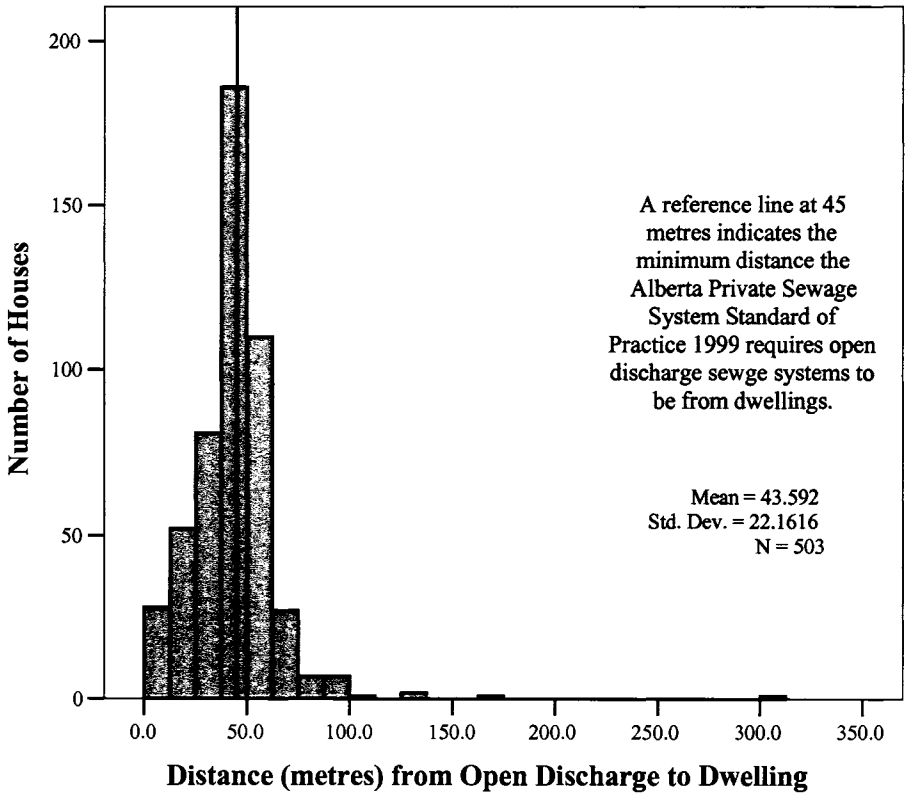
Figure 12 Presence of Sewage Effluent Accumulation around Discharge Systems



the soil conditions are not appropriate for this type of system and/or there is a very high volume of sewage generated daily at the dwelling. It is related to the soil conditions around the open discharge and is not directly related to the occurrence of sewage back-up.

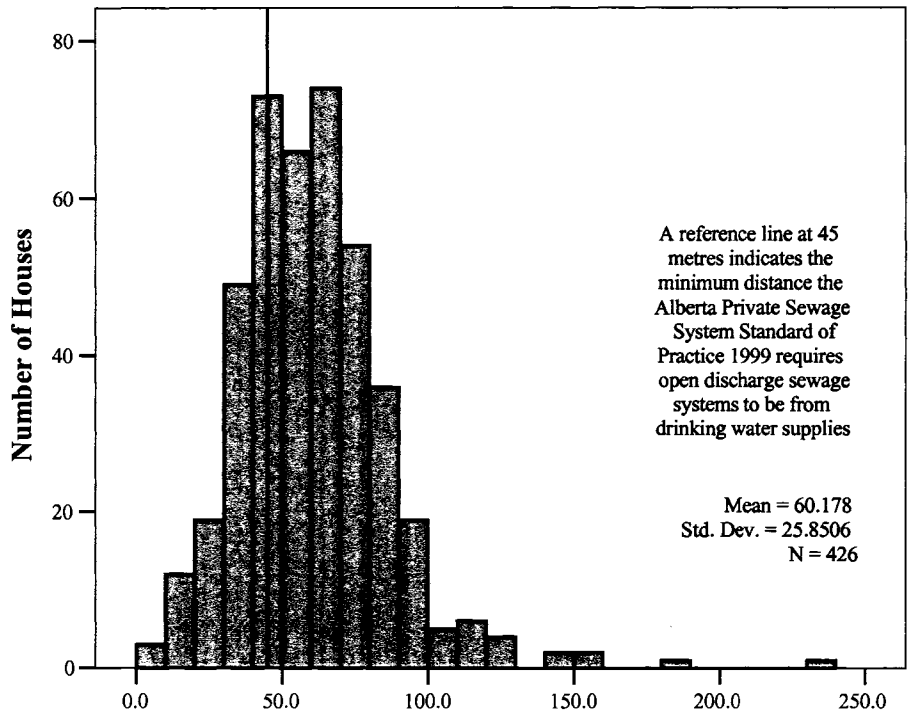
The Alberta Private Sewage System Standard of Practice 1999 outlines minimum setback distances for private sewage systems from site facilities or characteristics. For this survey, the data collected provided measurements in Imperial units (feet), but were converted to metric for analysis. In the initial review of the data, house to open discharge distance measurements were available for 503 of the 522 dwellings. The mean distance was 43.6 metres. The setback requirement of 45 metres was not met for 270 dwelling (53.7% of dwellings with this data available). Figure 13 shows the frequency distribution of these distances.

Figure 13 Distribution of Distances from Open Discharge to Dwelling



Data regarding the distance from the open discharge to the drinking water supply were available for 426 of the 522 dwellings serviced by an open discharge. The mean distance of the drinking water supply (usually a drilled well) was 60.2 metres. The setback requirement of 45 metres or greater was met for 306 dwellings (71.8% of dwellings with available data). Figure 14 shows the frequency distribution of the distances from the open discharge sewage system to the drinking water well. For drinking water supplies, adequate separation distance from on-site sewage treatment systems is important because microorganisms can be transported quickly through the soil profile and contaminates groundwater, where they can move horizontally and survive for long periods of time (Borchardt, et al., 2003).

Figure 14 Distribution of Distances from Open Discharge to Drinking Water Supply



Additionally, if an open discharge pipe is in a low-lying area, this may attribute to sewage effluent accumulation and also may be an indicator of the operation of the system. The effluent line must be installed to ensure that effluent does not freeze in the line. Positioning a discharge riser in a low-lying area without properly installing it may predispose the line to freezing. If the open discharge is in a low lying area, and the effluent in the line cannot freely drain back into the effluent-dosing chamber of the septic tank, it may negatively affect the system operation. When reviewing the occurrence of sewage back-up and the placement of the open discharge in a low lying area (n=363), it was found that of those open discharge systems located in low lying areas, 45.5% (66) systems had one or more sewage back-ups. In this case, the odds ratio of 1.336 was not significant (95% CI 0.877, 2.037, p=0.177) thus indicating that the odds of experiencing at least one sewage back-up is the same regardless of the location of the open discharge in a low lying area or not (Table 21).

Table 21 Open Discharge in a Low Lying Area By Sewage Back-up Occurrence Crosstabulation

			Sewage Back-up Occurrence		
			One or More Sewage Back Ups	No Sewage Back Ups	Total
Open Discharge Low Lying	Yes	Count	66	79	145
		% within Open Discharge Low Lying	45.5%	54.5%	100.0%
		% within Sewage Back-up Occurrence	36.5%	43.4%	39.9%
	No	Count	115	103	218
		% within Open Discharge Low Lying	52.8%	47.2%	100.0%
		% within Sewage Back-up Occurrence	63.5%	56.6%	60.1%
Total		Count	181	182	363
		% within Open Discharge Low Lying	49.9%	50.1%	100.0%
		% within Sewage Back-up Occurrence	100.0%	100.0%	100.0%

A subsurface disposal field may be used in the disposal area of a private sewage system. These systems provide a means to treat and dispose of sewage effluent discharged from a septic tank within trenches containing void spaces that are covered with soil (Safety Codes Council, 2000). Forty-six per cent of the homes surveyed reported having a subsurface disposal field.

A subsurface field may malfunction for a variety of reasons, including unsuitable soil conditions to receive effluent or improper maintenance. Of the dwellings that are serviced by a subsurface field and had data available on the functioning of the field and sewage back-up occurrence (n=475), 30.7% reported one or more sewage back-ups (Table 22). Interestingly, only 25.4% (16) of dwellings with a subsurface field reported to be malfunctioning had reported one or more sewage back-ups. The likelihood of sewage back-up occurring due to a subsurface field malfunction was tested. The odds of one or more sewage back-up occurring is not significantly different in those homes that had a field malfunction compared to

Table 22 Field Malfunction By Sewage Back-up Occurrence Crosstabulation

			Sewage Back-up Occurrence		
			One or More Sewage Back Ups	No Sewage Back Ups	Total
Field Malfunctior	Yes	Count	16	47	63
		% within Field Malfunction	25.4%	74.6%	100.0%
		% within Sewage Back-up Occurrenc	11.0%	14.3%	13.3%
	No	Count	130	282	412
		% within Field Malfunction	31.6%	68.4%	100.0%
		% within Sewage Back-up Occurrenc	89.0%	85.7%	86.7%
Total		Count	146	329	475
		% within Field Malfunction	30.7%	69.3%	100.0%
		% within Sewage Back-up Occurrenc	100.0%	100.0%	100.0%

those dwellings that did not have a field malfunction as the odds ratio of 1.354 was not significant as indicated by the 95% confidence interval (0.740, 2.478, p=0.324), which includes the value of one.

It was hypothesized that a subsurface system may also malfunction if it receives more sewage effluent than it was designed for. A cross tabulation was constructed to examine the relationship between crowding and field malfunction (n=549). Of those dwellings reporting a field malfunction, 60.6% of dwellings (n=40) had five or more occupants compared to 39.4% of dwelling that had 4 or fewer occupants (Table 23). An odds ratio of 1.458 (95% CI 0.862, 2.464, p=0.158) was non-significant, indicating that the odds of a field malfunction are the same regardless of the number of people living in the home.

Table 23 Crowding By Subsurface Sewage Field Malfunction Crosstabulation

			Field Malfunction		
			Yes	No	Total
Crowding	5 or more occupants	Count	40	248	288
		% within Crowding	13.9%	86.1%	100.0%
		% within Field Malfunction	60.6%	51.3%	52.5%
	4 or less occupants	Count	26	235	261
		% within Crowding	10.0%	90.0%	100.0%
		% within Field Malfunction	39.4%	48.7%	47.5%
Total		Count	66	483	549
		% within Crowding	12.0%	88.0%	100.0%
		% within Field Malfunction	100.0%	100.0%	100.0%

A summary of the calculated odds ratios is presented below from the private sewage system survey data (Table 24).

Table 24 Summary of Odds Ratios for Select Private Sewage System Variables

Sewage System Variable	Sewage Back-up Occurrence		
	Odds Ratio	***p* Value**	**95% Confidence Interval**
Crowding (5 or more/4 or less occupants)	1.862	<0.001	1.415, 2.449
Sewage system type (open discharge/all other types)	2.170	<0.001	1.631, 2.888
Open Discharge in a low lying area (yes/no)	1.336	=0.177	0.877, 2.037
Subsurface field malfunction	1.354	=0.324	0.740, 2.478
Sewage System Variable	**Field Malfunction**		
	Odds Ratio	***p* Value**	**95% Confidence Interval**
Crowding (5 or more/4 or less occupants)	1.458	=0.158	0.862, 2.464

The odds of experiencing at least one sewage back-up is 2:1 for those with five or more occupants in the home, compared with those homes with four or less occupants (OR=1.862 95% CI 1.415, 2.449). The odds of experiencing at least one sewage back-up is 2:1 for those homes serviced by an open discharge system compared to those homes serviced by other types of on-site sewage systems (OR=2.170, 95% CI 1.631, 2.888).

The open discharge in a low-lying area and subsurface field malfunction variables have 95% confidence intervals for the odds ratios that include one, indicating that there is an equal chance of experiencing a sewage back-up regardless of the presence or absence of these variables. The value of one is also included in the odds ratio 95% confidence interval for crowding and field malfunction indicating that there is an equal chance of experiencing a field malfunction regardless of the number of people in the home.

Discussion and Conclusion

Discussion

The research objective, to investigate aspects of environmental factors, including crowding, and enteric illness in Alberta First Nations communities could not be addressed in its entirety due to limitations with the data. Despite a variety of challenges researching the relationship between components of housing and the incidence of enteric disease in First Nations communities using existing data sources, the data analysis revealed some interesting findings that provide the impetus to conduct future investigations into housing and health in First Nations communities.

Enteric Disease

The descriptive analysis of enteric disease in Alberta for the general population and First Nation communities (1998-2004) revealed a declining trend in enteric disease rates despite a growth in population. Disease specific rates in First Nations communities were generally not higher than the provincial rates, with two exceptions: giardiasis and shigellosis. The rates of these two diseases appear to be over-represented in the 0 to 4 age group compared to the rates in the adult age groups.

In this study, it was not prudent to do a direct comparision between Alberta First Nations and the general provincial population as the First Nations enteric disease data utilized did not exist as a direct subset of the general population. While the data utilized give a preliminary idea of the trends over time, gender, and age in the general and First Nations Alberta populations, the limitations of the disease reporting need to be recognized and addressed if any data analyses are to occur; mainly the ability to identify on-reserve populations in a given disease dataset from the general population

and if there are different patterns of occurrence of enteric disease in First Nation communities (e.g., are outbreak of enteric disease more likely in First Nation communities?).

As a result, lower incidence of enteric disease in First Nations communities needs to be verified, including establishing if enteric diseases are differentially underreported in First Nations communities compared to the general population. Factors such as First Nations community members not able to access healthcare (too far to travel, medical treatment not available), not accessing healthcare (complacency or acceptance of current situation, not trusting healthcare system) and potential gaps in identifying First Nations cases of disease in disease databases may be contributing to the gaps in reporting thus amplifying the effect of underreporting and needs to be considered in any research. Additionally, the data should also be compared to people with a more simlar life style such as those in rural Alberta versus those in urban Alberta. As Smylie and Anderson (2006) wrote, data "quality challenges principally spring from the use of substandard data sources, substandard methods or both". Therefore, if the data sources and methods are not of adequate quality there will be difficulty in identifying the severity of an issue or if it even exists which can be detrimental to prevention and treatment program development and delivery in First Nations communities.

Alberta First Nations Housing Survey (2000)

For the variables assessed, it was found that septic tanks generally met standards classified as health and installation/maintenance with some minor exceptions. Subsurface disposal fields serviced the majority of homes (69.1%) in the Alberta First

Nations Housing Survey. Approximately 54% of dwellings had a subsurface disposal field located in a low-lying area which can potentially compromise groundwater quality and system operation as low-lying areas generally have higher groundwater tables and are more prone to the collection of surface run-off. In general, setback for private sewage systems to areas of concern (such as drinking water supplies) met the appropriate standards. However, due to the design of the survey this information was not captured for all water and sewer infrastructure types.

All drinking water cisterns that had complete enough information to calculate a score had at least one variable that did not meet the health classifications. This indicates that private trucked water supplies in the study communities were susceptible to contamination of the drinking water supplies from an infrastructure perspective. Of the drinking water well variables that were included in the assessment, the majority met the standards reviewed. It is important to consider that the assessments were visual in nature and did not include components that could not easily be assessed (e.g., presence of well seals).

Household Density and Enteric Disease

Household density has the potential to affect the transmission of a variety of diseases and for that reason is an important topic to explore. However, this topic is challenging to characterize if household level data are not available, as illustrated by the rate ratio results. While a statistically significant rate ratio was calculated when there were two density categories (1 to 3 persons or 4 or more persons per house), a rate ratio of 0.989 (95% CI = 0.649, 1.510) where the average household density was 6 or more persons per house was not expected as this indicated enteric disease rates

were lower at this density compared to the referent variable of 1 to 3 person per house. It was possible that the number of houses in the INAC information was an underestimate for at least one of the three communities in the 6 or more persons per house category, thus made it appear that household density was greater than it actually was. The calculation used in this section was crude because it pooled community-level data into household density categories and the community level relationship between crowding and disease was not captured, but it does provide a starting point for examining the relationship between crowding and disease. A better test of this relationship would involve the use of density and disease data at the household level.

Alberta First Nations Private Sewage System Survey

Of the private sewage system variables, significant relationships were found between crowding and the occurrence of sewage back-up and open discharge systems and the occurrence of sewage back-up. Higher numbers of individuals residing in a residence will increase the daily sewage flow potentially beyond the capacity that the system was designed to receive, thus putting the system at higher risk of sewage back-up occurrence. Intuitively, it would be expected that open discharge systems would experience less sewage back-ups than other systems, as this type of system's capacity to discharge is greater than a subsurface disposal field. However, it was found that dwellings serviced by open discharge systems were twice as likely to experience one or more sewage back-ups compared to other types of systems. However, the causes of the sewage back-ups were not documented. The overall

contributing factor to this finding is poor likely installation of the effluent discharge line, including poor slope, making these systems prone to freezing.

The presence or absence of data verification has a potential impact on the analyses outcomes. The housing and private sewage system survey data were not verified at the time of collection to the best of the author's knowledge. The data may be incomplete, which can contribute to insufficient data to demonstrate a relationship that may actually exist.

Recommendations

While it is expected that any given dataset will have its limitations, it is recommended that preliminary work before data analysis must be completed to ensure the effects of the limitations are minimized. This includes using a collaborative approach to this type of research and ensuring the survey design, data collection, data verification and analysis procedures are appropriate to result in the best available information. This was not possible in this study as secondary data sources were used. The following are recommendations for future studies and are outlined by enteric disease and housing infrastructure data components.

Enteric disease. Where possible, household level disease information should be used in data analysis. The enteric disease data could be notifiable disease reports or occupant-reported, as both have their limitations. However, current systems have difficulty establishing enteric disease rates in Alberta First Nations communities compared to the general provincial population. It is recommended that inter-agency collaboration be employed to optimally use existing data sources. For example, specific business rules need to be used to query the Alberta Health and Wellness

notifiable disease database to determine on reserve cases. In fact, cross checks between the two datasets should be done on a scheduled basis to ensure First Nations cases of notifiable diseases are as accurately represented in each data set as possible. Sample business rules for this type of query are found in Appendix G. This type of query would also provide a valuable check on the First Nations-specific notifiable disease databases.

Further research into whether or not enteric diseases are differentially underreported in Alberta First Nations communities is warranted, as the data presented appear to over-represent the 0 to 4 age group for giardiasis and shigellosis compared to adults. Investigating this finding would potentially provide insight into reporting discrepancies between age groups and disease types in First Nations communities.

Housing Infrastructure. The survey had major design issues including question interpretation by the surveyor. For example, the question, "where is the field located" is open to interpretation as it was not clear if responses were in absolute or relative terms. Surveys must be designed based on the study objectives and analytic methods. Questions must allow for clear, concise, and objective responses by surveyors. Additionally, each survey question must serve its own objective and survey question responses should not overlap with the purpose of streamlining data analyses.

Future housing surveys should include a component where the occupant provides information, as was done with the Private Sewage System Survey, as the occupant can give valuable information that provides insight into the operation of their dwelling's water and sewage disposal systems. Sample questions include how

many occupants currently reside in the dwelling, number of sewage back-ups in a given time period, and frequency of septic tank cleaning.

Ideally, studying the relationship between housing water supply and sewage disposal system infrastructure (design, installation, operation and maintenance components) and health outcomes requires in-depth surveys on these components and enteric disease information at the household level. This study was limited to separate descriptive analyses of housing infrastructure variables and enteric disease, but still provides insight into the operation and maintenance characteristics of housing infrastructure components that could potentially affect health. Any future studies need to have a collaborative approach and include a thorough survey design, data verification steps during and after data collection. Those with knowledge of environmental health and survey design should complete the primary survey design. A collaborative approach during the entire process must be maintained with research objectives and methods being clear and agreed upon by all stakeholders. These steps must be addressed in future studies regarding housing and health in First Nation communities.

Conclusion

The use of secondary data sources highlighted gaps in the process of conducting research in First Nations communities. When the data were reviewed before the data analyses, challenges of completeness and accuracy were identified with all data sets used, despite the source. For example, the housing surveys were likely conducted with the intention of providing First Nation governments with information on the state of current housing inventory and if the inventory met minimum housing and

health standards in terms of sewage or water infrastructure. However, once the data were collected, it appears verification or analyses were not completed, to the best of the author's knowledge. Therefore, this research is overdue. Based on a review of the literature and the author's knowledge, this is the first attempt to analyze this type of housing and health data in Alberta First Nations in this manner.

This type of research is important to First Nations communities and government agencies, as it will help provide information on housing and enteric disease in communities. The success of this type of research depends on the commitment of time, funds, and expertise to ensure the initial goals are met. Establishing baseline information provides First Nations organizations with the means to measure progress and aid in the understanding and planning around these complex issues. As First Nations and government health agencies strive to address issues of housing and health status on reserve, engaging in this type of proposed research will help cultivate a better understanding of these complex issues.

A collaborative approach as previously discussed is necessary for success. This type of approach to research utilizes comprehensive and reliable health assessment measures that reflect the needs, priorities and understandings of health in their specific geographic context, including locally relevant and customized First Nations indicators and universally recognized public health indicators (Smylie and Anderson, 2006).

There needs to be an appropriate amount of resources dedicated to the design and implementation of a survey in order to ensure accuracy/integrity of the data and include the utilization of current technologies, such as geographic information

systems for information management or artificial neural networks for predictive modelling, to analyze data. This is important because the data analysis process is affected by the quality of the data. This has implications for those agencies using this data to assess issues, base decision or request funding for infrastructure improvement or program delivery.

Further to Young (1994), basic demography and epidemiological analyses involving First Nations populations are complicated and difficult. Results from this type of analyses are basic to understanding issues that are impacting the health of community members. Currently for First Nations there appears to be a dichotomy: make inferences based on flawed or incomplete data or do not study the issue at all (Young, 1994). Perhaps the best recommendation is to do small scale, disease specific studies of local populations, as this would provide a more accurate view and provide better estimates of denominators and numerators. However, this must be done with a collaborative approach including all stakeholders, especially the affected First Nation community to ensure the survey design, data collection, data verification and analyses result in the generation of information/research for empowerment and action of that First Nation to promote understanding of their own health issues and design the best solutions to address them.

Bibliography

Alberta Health and Wellness. *Annual Notifiable Disease Reports (1998-2004).* Disease Control and Prevention Branch, Alberta Health and Wellness.

Alberta Health and Wellness (March 2005). *Notifiable Disease Report (NDR) Manual (2nd Edition).* Disease Control and Prevention Branch, Alberta Health and Wellness.

Alberta Health and Wellness (July 2003). *Alberta Case Definitions Manual.* Disease Control and Prevention Branch, Alberta Health and Wellness.

Adelson, N. (2005). "The embodiment of inequity: health disparities in aboriginal Canada." *Canadian Journal of Public Health, 96 Suppl 2,* S45-61.

Auditor General Report to the Standing Committee on Public Accounts. (April 2003). *Federal Government Support to First Nations – Housing on Reserves.* November 1, 2004 on the Government of Canada website: www.parl.gc.ca/CommitteePublication.aspx?SourceID=61840.

Barnsley, P. (2003, December 13). The legacy of inadequate housing. *Windspeaker, 21(9),* 9

Borchardt, M.A., Chyou, P.H., Devries, E.O., & Belongia, E.O. (2003). Septic system density and infectious diarrhea in a defined population of children. *Environmental Health Perspectives, 111(5),* 742-748.

Brocklehurst, C. (1985). The Effect of Water Supply and Sanitation on Health on Indian Reserves in Manitoba (Masters Thesis, Department of Civil Engineering, University of Toronto, 1985).

Brunton, D. (Ed.). (2004). *Medicine Transformed: Health, Disease and Society in Europe 1800-1930.* Manchester: Manchester University Press.

Canada Mortgage and Housing Corporation. (1996, August). *The Housing Conditions of Aboriginal People in Canada.* (Issue 27). Canada.

Chambers, L.W., Shimoda, F., Walter, S.D., Pickard, L., Hunter, B., Ford, J., et al. (1989). Estimating the burden of illness in an Ontario community with untreated drinking water and sewage disposal problems. *Canadian Journal of Public Health, 80,* 142-148.

Dunn, J.D. (2002). *The population health approach to housing: a framework for research.* Ottawa, Canada: Canada Mortgage and Housing Corporation.

Dennehy, P.H. (2000). Transmission of rotavirus and other enteric pathogens in the home. *Pediatric Infectious Disease Journal, 19(10)*, S103-5.

Engleberg, N.C., Holburt, E.N., Barrett, T.J., Gary, G.W. Jr., Trujillo, M.H., Feldman, R.A., & Hughes, J.M. (1982). Epidemiology of diarrhea due to rotavirus on an Indian reservation: risk factors in the home environment. *Journal of Infectious Diseases, 145(6)*, 894-898.

Federal, Provincial, and Territorial Advisory Committee on Population Health (1999). *Toward a Healthy Future: Second Report on the Health of Canadians.* Prepared for the Meeting of Ministers of Health, Charlottetown, Prince Edward Island, September 1999.

First Nations and Inuit Health Branch. (2003). *A Statistical Profile on the Health of First Nations in Canada.* Ottawa, Canada: Author.

First Nations and Inuit Regional Health Survey National Steering Committee. (1999). *First Nations and Inuit Regional Health Survey National Report 1999.* Ottawa, Canada: Author.

Flint, J.A., Dore, K., Majowicz, S.E., Edge, V.L., & Sockett, P. (2004.) From Stool to Statistics: Reporting of Acute Gastrointestinal Illnesses in Canada. *Canadian Journal of Public Health, 95(4)*, 309-313.

Gordis, L. (2000). *Epidemiology* (2nd ed.). Philadelphia: W.B. Saunders Company.

Health and Welfare Canada. (1986). *Ottawa Charter for Health Promotion.* Ottawa, Canada.

Health Canada. (1999). *Toward a Healthy Future: Second Report on the Health of Canadians.* Ottawa, Canada.

Indian and Northern Affairs Canada. (2005). E-mail correspondence (September 1, 2005) with First Nations and Northern Statistics Section, Corporate Information Management Directorate (Ottawa).

Ineichen, B. (1993). *Homes and Health: How Housing and Health Interact.* London: E & F.N Spon.

Jin, A. & Martin, J.D. (2003). Hepatitis A among residents of First Nations reserves in British Columbia, 1991-1996. *Canadian Journal of Public Health, 94(3)*, 176-179.

Kagan, L.J., Aiello, A.E., & Larson, E. (2002). The role of the home environment in the transmission of infectious diseases. *Journal of Community Health, 27(4)*, 247-267.

Michael, M. (1987). Effects of Municipal Services and Housing on Public Health in the Northwest Territories. In D.W. Smith and T. Tilsworth (Eds.), *Cold Regions Environmental Engineering Proceedings of the Second International Conference* (1-18). Kitchener: Tektran International.

Municipality of Anchorage, Alaska. (n.d.). *Development Services webpage.* Retrieved March 24, 2007, from http://www.muni.org/onsite/glossary1.cfm.

Province of Alberta. (2005). *Alberta Public Health Act,* Chapter P-37. Alberta: Queen's Printer.

Province of Alberta. (1992). *Communicable Diseases Regulation 357/88.* Alberta: Queen's Printer.

Ranson, R. (1991). *Healthy Housing: A Practical Guide.* London: E & F.N Spon.

Rosenberg, T., Kendall, O., Blanchard, J., Martel, S., Wakelin, C., & Fast, M. (1997). Shigellosis on Indian reserves in Manitoba, Canada: its relationship to crowded housing, lack of running water, and inadequate sewage disposal. *American Journal of Public Health, 87(9)*, 1547-51.

Safety Codes Council. (2000). *Alberta Private Sewage Systems Standard of Practice – 1999 Handbook.* Edmonton, Alberta.

Schliessmann, D.J., Atchley, F.O., & Wilcomb Jr., M.J., & Welch, S.F. (1958). Relation of environmental factors to the occurrence of enteric diseases in areas of eastern Kentucky. *Public Health Monograph, 54.*

Sherris, John, (Ed.). (1990). *Medical Microbiology: an introduction to infectious diseases.* New York: Elsevier Science Publishing Co., Inc.

Shin, I. (1997). *The annotated Indian Act : including related treaties, statutes and regulations*. Scarborough: Carswell, Thompson Professional Publishing.

Smylie, J. and Anderson, M. (2006). Understanding the health of Indigenous peoples in Canada: Key methodological and conceptual challenges. *Canadian Medical Association Journal, 175(6)*, 602-605.

Statistics Canada. (2002). *A national overview: 2001 Census of Canada* (Catalogue number 93-360-XPB). Ottawa: Industry Canada.

Statistics Canada. (n.d.). *Population Pyramids.* Retrieved January 15, 2007, from http://www.statcan.ca/english/kits/animat/pyone.htm.

Waldram, J.B.; Herring, A; & Young, T.K. (1995). *Aboriginal health in Canada: Historical, cultural, epidemiological perspectives.* Toronto: University of Toronto Press:

Young, T.K. (1994). *The Health of Native Americans Toward a Biocultural Epidemiology.* New York: Oxford University Press.

Young, T.K., Bruce, L., Elias, J., O'Neil, J., & Yassie, A. (1991). *The Health Effects of Housing and Community Infrastructure on Canadian Indian Reserves.* Ottawa: Indian and Northern Affairs, Finance and Professional Services.

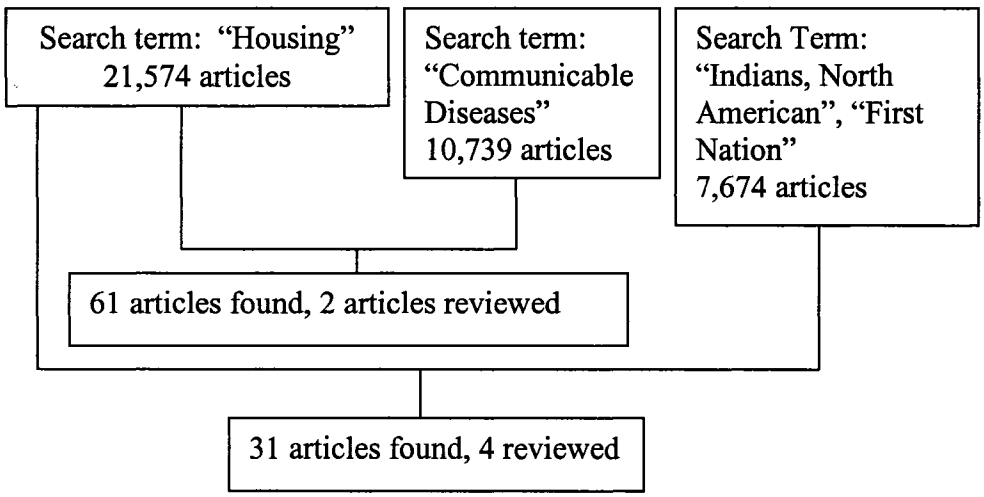
Appendix A

Healthy housing as defined by the World Health Organization Regional Office for Europe

A human habitation that is structurally sound and relatively free from accidental injury hazards, provides sufficient space for all normal household activities for all members of the family, has readily and easily available an adequate supply of potable and palatable water, as a sanitary means of collection, storage and disposal of all liquid and solid wastes, is provided with appropriate installed facilities for personal and household hygiene and cleanliness, is sufficiently weatherproof and water tight, provides proper protection from the elements, especially for those persons who may be particularly susceptible, for physical and/or physiological reasons to these potentially adverse environmental conditions, provides a hygrothermal indoor environment which is healthful and comfortable, is free from excessive noise from both interior and exterior sources of the structure, has natural and artificial means of illumination that are safe and adequate in quality and quantity for the fulfillment of all normal household activities and functions, is free from toxic and/or noxious odours, chemicals and other air contaminants, or pollutants, has adequate but not excessive microbial and thermal characteristics, provides sufficient but not excessive solar radiation, provides adequate protection from insects and rodents which may be reservoirs and/or vectors of disease agents, and is served by the necessary and/or desirable health, welfare, social, educational, cultural and protective community services and facilities.

Appendix B

Diagram of Medline Search Strategy



Listing of Articles Reviewed by Search Type

Search Type	Articles Reviewed
Medline database using "housing" and "communicable disease" search terms	Kagan, L.J., Aiello, A.E., & Larson, E. (2002). The role of the home environment in the transmission of infectious diseases. *Journal of Community Health, 27(4)*, 247-267. Dennehy, P.H. (2000). Transmission of rotavirus and other enteric pathogens in the home. *Pediatric Infectious Disease Journal, 19(10)*, S103-5.
Medline database using "housing" and First Nations search terms	Jin, A. & Martin, J.D. (2003). Hepatitis A among residents of First Nations reserves in British Columbia, 1991-1996. *Canadian Journal of Public Health, 94(3)*, 176-179. Rosenberg, T., Kendall, O., Blanchard, J., Martel, S., Wakelin, C., & Fast, M. (1997). Shigellosis on Indian reserves in Manitoba, Canada: its relationship to crowded housing, lack of running water, and inadequate sewage disposal. *American Journal of Public Health, 87(9)*, 1547-51. Engleberg, N.C., Holburt, E.N., Barrett, T.J., Gary, G.W. Jr., Trujillo, M.H., Feldman, R.A., & Hughes, J.M. (1982). Epidemiology of diarrhea due to rotavirus on an Indian reservation: risk factors in the home environment. *Journal of Infectious Diseases, 145(6)*, 894-898. Adelson, N. (2005). "The embodiment of inequity: health disparities in aboriginal Canada." *Canadian Journal of Public Health, 96 Suppl 2*, S45-61.
University of Alberta catalogue search	Young, T.K., Bruce, L., Elias, J., O'Neil, J., & Yassie, A. (1991). *The Health Effects of Housing and Community Infrastructure on Canadian Indian Reserves.* Ottawa: Indian and Northern Affairs, Finance and Professional Services.
Author's professional and academic contacts in the public health field	Schliessmann, D.J., Atchley, F.O., & Wilcomb Jr., M.J., & Welch, S.F. (1958). Relation of environmental factors to the occurrence of enteric diseases in areas of eastern Kentucky. *Public Health Monograph, 54.* Michael, M. (1987). Effects of Municipal Services and Housing on Public Health in the Northwest Territories. In D.W. Smith and T. Tilsworth (Eds.), *Cold Regions Environmental Engineering Proceedings of the Second International Conference* (1-18). Kitchener: Tektran International. First Nations and Inuit Health Branch. (2003). *A Statistical Profile on the Health of First Nations in Canada.* Ottawa, Canada: Author. Flint, J.A., Dore, K., Majowicz, S.E., Edge, V.L., & Sockett, P. (2004.) From Stool to Statistics: Reporting of Acute Gastrointestinal Illnesses in Canada. *Canadian Journal of Public Health, 95(4)*, 309-313. Brocklehurst, C. (1985). The Effect of Water Supply and Sanitation on Health on Indian Reserves in Manitoba (Masters Thesis, Department of Civil Engineering, University of Toronto, 1985).

Appendix C

Letters of Consent

HOBBEMA INDIAN HEALTH SERVICES

Box 100 Hobbema, Alberta T0C 1N0
Telephone (780) 585-3830 Fax (780) 585-3303

June 3, 2005

Dear Sir/Madame:

Hobbema Indian Health Services conducted a PSDS survey that was funded by Health Canada in 1999. As well, Hobbema Indian Health Services has a strong commitment to monitoring private, public and community water supplies and ensuring the data is properly stored (via Watertrax Database).

I have met with Joan Yee and she has asked for permission to analyse the above-mentioned information under the guidance of the University of Alberta's Department of Public Health Sciences and the support of the First Nations and Inuit Health Branch's Environmental Health Services, Health Canada. The findings/data will be used to

1. Examine the relationship between housing (water and sewer infrastructure) and health
2. Provide baseline information for Hobbema Indian Health Services on both water/sewer infrastructure in the communities and enteric (diarrheal) disease information.

All findings will be shared with Hobbema Indian Health Services and the communities with the potential to be used for planning purposes (measuring changes/improvements in services/infrastructure) or as Hobbema Indian Health Services deems appropriate. The findings from this study will be used as part of a Masters of Science in Public Health Sciences thesis. The results of this study may be published in a scientific journal in the future. If these data are published later, no reference will be made to any community by name. Individuals will not be identified.

Hobbema Indian Health Services grants permission for the referenced information to be used for the purposes as outlined above, providing that:

1. Confidentiality of the information is ensured. The individual identifiers (names, house numbers) will be removed and community identifiers will be replaced with the letters of the alphabet (e.g., Community A, Community B, etc.).
2. The findings of the report will be shared with Hobbema Indian Health Services.

Darrell Strongman, Health Director
Hobbema Indian Health Services

Joan Yee, EHO
Graduate Student, U of A

June 3, 2005

4 August 2005

Dear Sir/Madame:

Treaty Seven Housing Centre conducted a housing survey that was funded in part by Health Canada in 1999.

Joan Yee has asked for permission from the Treaty Seven Housing Centre to analyse the information under the guidance of the University of Alberta's Department of Public Health Sciences and the support of the First Nations and Inuit Health Branch's Environmental Health Services, Health Canada. From the survey, she will access the Health Canada-funded portion of the survey and some select fields (water supply and sewage system type) from outside the Health Canada portion for cross—referencing purposes. The findings/data will be used to

1. Examine the relationship between housing (water and sewer infrastructure) and health
2. Enhance the baseline information Treaty Seven Housing Centre has on water/sewer infrastructure.

All findings will be shared with Treaty Seven Housing Centre with the potential to be used for planning purposes (measuring changes/improvements in services/infrastructure) or as Treaty Seven Housing Centre deems appropriate. The findings from this study will be used as part of a Masters of Science in Public Health Sciences thesis. The results of this study may be published in a scientific journal in the future. If these data are published later, no reference will be made to any community by name. Individuals will not be identified.

The Treaty Seven Housing Centre grants permission for the above referenced information to be used, providing that:

1. Confidentiality of the information is ensured. The individual identifiers (names, house numbers) will be removed and community identifiers will be replaced with the letters of the alphabet (e.g., Community A, Community B, etc.).
2. The findings of the report will be shared with Treaty Seven Housing Centre.

Arnold Jerry , Director
Treaty Seven Housing Centre

Joan Yee, EHO
Graduate Student, U of A

Health Canada / Santé Canada

Health Protection Directorate
First Nations and Inuit Health Branch
Health Canada
Suite 730, 9700 Jasper Avenue
Edmonton, AB T5J 4C3

November 14, 2006

To Whom It May Concern:

Re: Letter of Support – Joan Yee, Graduate Student

I am writing this letter in support of Joan Yee's completion of her master's thesis entitled "Housing and Health in Alberta First Nations Communities: Examining the Relationship between Enteric Disease and Environmental Factors". Joan is a graduate student in the Department of Public Health Sciences at the University of Alberta and an Environmental Health Officer with the Alberta Region First Nations and Inuit Health Branch (FNIHB).

This investigation proposes to identify and examine factors that may have contributed to an increased incidence of enteric disease on reserve in Alberta (study period 1998-2004). Though the study is retrospective and might not necessarily reflect current enteric disease rates or environmental risk factors, the undertaking has the following objectives:

1. To gain a better understanding of how to measure environmental components (water and wastewater infrastructure) and population variables in relation to enteric disease in Alberta First Nations communities, including an evaluation of the strengths and weaknesses of available housing, health and population data relevant to Alberta First Nations communities.
2. To assist First Nations and public health agencies in better understanding the relationship between environmental factors and the occurrence of enteric disease.
3. To assist First Nations organizations and public health agencies in better usage of available data to address current issues and on-going problems regarding housing and enteric disease in First Nations communities.

As director of Health Protection, I have granted Joan permission to access information that will contribute to the knowledge pool in the area of housing and health in First Nations communities; this includes access to enteric disease notifiable disease reports (FNIHB electronic and hard copy and Alberta Health and Wellness records), and community specific environmental health records. Joan has also received letters granting her permission from the appropriate First Nations agencies (tribal council or health centre) that coordinated data collection of housing variables.

When the data are analysed, there will be no reference made to community names or individual names. Further, for confidentiality reasons, data will be reported in a fashion that does not allow community identification. The main focus of this work is on identifying '*what* factors influence the occurrence of enteric diseases' in Alberta First Nations .The key desired outcome is to provide recommendations to the First Nations and FNIHB on the utility of environmental data, and in particular, its linkage to health outcomes, notably the protection of the First Nations communities' public health.

Sincerely,

Dr. Wadieh Yacoub, Director, Health Protection, First Nations and Inuit Health Branch

Canada

Appendix D

Housing Surveys

Private Sewage Disposal System Survey

A. HOUSE/TRAILER INFORMATION

Community Name:

Community Site Code:

Is the House/ Trailer occupied:

Survey #:

House/ Trailer Owner's Name:

Length of Occupancy:

Previous Owner:

Legal Description of Property:

Site Code of the House/Trailer:

Type of Private Sewage Disposal System:

B. QUESTIONS TO ASK HOUSE/TRAILER OWNER

How many bedrooms are in the house/trailer?

How many people live in the house/trailer?

Where is the septic tank/holding tank

Where is the disposal field or open discharge

When was the last time the septic tank/holding tank was pumped out?

When was the last time you experienced a sewage backup

How many times within the last year have you had a sewage back up?

C. BUILDING DRAIN

Is the building drain properly covered?

D. SEPTIC TANK/HOLDING TANK

Is the septic tank/holding tank, including the man hole completely covered?

If YES, please do not answer the following blue highlighted questions in this section.

Type of septic tank/holding tank:

Tank material:

Tank size/capacity (If known):

Is the septic tank/holding tank accessible for maintenance?

The access opening/man hole is:

Condition of access opening/man hole cover:

Is the man hole cover child proof?

Condition of the access opening/man hole extension:

Is the man hole cover level?

The ground around the access opening/man hole is:

The ground around the access opening/man hole is:

Where is the effluent pump located?

Is the effluent pump in operation?

Condition of the effluent pump electrical cord:

Is there evidence of sewage overflowing from the septic

The sewage system is:

E. SUBSURFACE DISPOSAL FIELD

Where is the disposal field located?

What type of vegetation is on top of the disposal field?

Is the vegetation maintained (cut or trimmed)?

What is located over the disposal field?

Is the disposal field malfunctioning

Is any part of the sewage system uncovered?

F. OPEN DISCHARGE

Is the effluent line uncovered?

Where is the sewage discharge point located?

Is the effluent discharge area fenced off?

How high above the ground is the effluent discharge pipe? (inches)

Is the effluent discharge pipe damaged or broken?

Is the ground around the effluent discharge pipe mounded?

If YES, what is the height of the mound? inches

If YES, what type of mound material is used?

Is the effluent discharge point located in a low lying area?

Is effluent accumulating around the effluent discharge area?

Is there a frost protection pipe around the effluent discharge line?

	Septic Tank/ Holding Tank to (ft):	Disposal Field to (ft):	Open Discharge Point to (ft):
Property Line/ Boundary Line (if known)			
House/ Trailer With Basement			
Septic Tank/ Holding Tank			
Drinking Water Supply (well/cistern)			
Water Bodies (Lake, River, Stream)			
Neighbouring House/ Trailer			
Neighbouring Open Discharge Point			

Comments:

Date: Completed By:

How is the garbage stored outside the house/trailer?

Is the sewage Disposal system located on the same side of house as water system?

Is the stored garbage accessible to animals and children?

How is the garbage disposed of?

TREATY 7 HOUSING CENTRE

INSPECTION FORM

First Nation:	**Inspector:**
Owner/Occupant:	**Date:**
Address:	**GPS Coordinates:**
Telephone:	**Other Contact Number:**

House Number:	**Band Community:**	**Legal Land Description**

Funding Source:
Band Funds _____ **CMHC** _____ **CMHC Ref.** _____

Year House Built:	**Size of House:** **(Square Feet)**

HOUSE TYPE

Stick-Built	Modular	Mobile	Other
Bungalow	Bi-Level	Split Level	2-Storey
Slab on Grade	Crawl Space	Partial Basement	Full Basement

List Number of Bedrooms	Main Floor:	Basement:
List Number of Bathrooms	Main Floor: ☐Full ☐ Half ☐ ¾	Basement: ☐Full ☐ Half ☐ ¾

Foundation Construction: ☐ Concrete ☐ Preserved Wood	**Basement Development:** ☐Undeveloped ☐Partially ☐ Fully
Exterior Finish ❑ Stucco ❑ Wood Siding ❑ Vinyl Siding ❑ Other	**Roof Finish** ❑ Asphalt ❑ Wood shakes ❑ Metal ❑ Other - Specify_____
Window Material ❑ Vinyl ❑ Wood ❑ Metal ❑ Other	**Heating System** ❑ Natural Gas ❑ Propane ❑ Wood ❑ Oil ❑ Hot Water
Water Supply ❑ Piped ❑ Community Well ❑ Individual Well ❑ Trucked ❑ Other ❑ No Service ❑ Other Date Tested:_____	**Sewer System** ❑ Piped ❑ Septic Tank & Field ❑ Septic Tank & Surface Discharge ❑ Holding Tank & Septic Truck ❑ Other ❑ No Service
Fire Extinguishers ☐ Yes ☐ No	**Date Last Checked:**
Distance from Fire Department: _____Miles/Kilometres	**Special Purpose Type of Dwelling:** (i.e. Women's Shelter)

NAME: _____ INSPECTOR: _____ DATE: _____

- Year: When should repair or replacement be done (1 means this year, 2 next year etc,)

EXTERIOR AND SITE				YR*		NOTES/ DESCRIPTIONS	COST
1.	Grading ▪ OK ▪ Negative Grade ▪ Ground Sinking ▪ Other	OK	REPAIR		REPLACE		
2.	Foundation (above ground) ▪ OK ▪ Requires Parging ▪ Wall Cracked ▪ Wall Deflecting in ▪ Other	OK	REPAIR		REPLACE	Engineer Report Yes No	
3.	Walks/Driveways ▪ OK ▪ No Sidewalk ▪ Concrete Broken ▪ NO Driveway ▪ Other	OK	REPAIR		REPLACE		
4.	Roof Surface ▪ OK ▪ Shingles Missing ▪ Shingles Cupping ▪ Shingles Lifting ▪ Other	OK	REPAIR		REPLACE	Lo-Slope __ Flat Roof ___	
5.	Chimney & Roof Vents ▪ OK ▪ No Chimney/vents ▪ Chimney too Short ▪ Cap Missing ▪ Other	OK	REPAIR		REPLACE		
6.	Roof Flashing ▪ OK ▪ No Flashing ▪ Flashing Lifting ▪ Other	OK	REPAIR		REPLACE		
7.	Eavestrough/Downspouts ▪ OK ▪ No Eavestrough/Spouts ▪ No Down spouts/Extentions ▪ Broken Eavestrough ▪ Other	OK	REPAIR		REPLACE		
8.	Soffit/Facia ▪ OK ▪ Broken/Cracked ▪ Missing ▪ Requires Painting ▪ Other	OK	REPAIR		REPLACE		
9.	Exterior Wall Finish ▪ OK ▪ Missing Pieces ▪ Cracked or Broken ▪ Requires Painting ▪ Other	OK	REPAIR		REPLACE		
10.	Flashing(window/doors/siding) ▪ OK ▪ Missing ▪ Broken ▪ Other	OK	REPAIR		REPLACE		
11.	Windows/Window wells ▪ OK ▪ Windows Broken ▪ Rotted ▪ Requires Window Well ▪ Other	OK	REPAIR		REPLACE		
12.	Screens ▪ OK ▪ Missing ▪ Damaged	OK	REPAIR		REPLACE		

13.	Exterior Doors ▪ OK ▪ Damaged ▪ Rotted Frame ▪ Requires Door Sweep ▪ Needs Adjusting ▪ Other ___	OK	REPAIR		REPLACE		
14.	Storm Doors ▪ OK ▪ Damaged ▪ Missing ▪ Other _____	OK	REPAIR		REPLACE		
15.	Porch ▪ OK ▪ Needs doors/windows ▪ Needs repair	OK	REPAIR		REPLACE		
16.	Caulking(Windows/Doors/Siding) ▪ OK ▪ Cracked ▪ Missing	OK	REPAIR				
17.	Steps and Landings ▪ OK ▪ Requires Anchoring ▪ Needs Repair	OK	REPAIR		REPLACE		
18.	Hand & Guard Rails ▪ OK ▪ Missing ▪ Too Low ▪ Other	OK	REPAIR		REPLACE		
19.	Potable Water ▪ OK ▪ Testing Rrequired	OK	REPAIR		REPLACE	Certificate Required Yes No	
20.	Septic Tank/Sewage ▪ OK ▪ Cracked Cover ▪ Missing Cover ▪ Other _____	OK	REPAIR		REPLACE	Certificate Required Yes No	

CRAWLSPACE/BASEMENT		YR				NOTES/ DESCRIPTIONS	COST
1.	Stairs & Handrails ▪ OK ▪ Missing ▪ Needs anchoring ▪ Other _____	OK	REPAIR		REPLACE		
2.	Foundation Walls ▪ OK ▪ Cracked ▪ Deflecting ▪ Other _____	OK	REPAIR		REPLACE	Engineer Report Yes No	
3.	Perimeter Insulation/VB ▪ OK ▪ Missing ▪ VB Torn ▪ Other ___	OK	REPAIR		REPLACE		
4.	Columns ▪ OK ▪ Missing ▪ Require Adjusting ▪ Other	OK	REPAIR		REPLACE		
5.	Beams ▪ OK ▪ Over spanned ▪ Deflecting ▪ Other	OK	REPAIR		REPLACE		
6.	Joists ▪ OK ▪ Cracked or Broken ▪ Require Bracing ▪ Other	OK	REPAIR		REPLACE		

7.	Ventilation ▪ OK ▪ Requires venting ▪ Other __	OK	REPAIR		REPLACE	Crawlspace	
8.	Crawlspace Groundcover ▪ OK ▪ Vegitation Growth ▪ Requires Dampproofing ▪ Other __	OK	REPAIR		REPLACE		
9.	Windows ▪ OK ▪ Windows too small ▪ Requires Cranks ▪ Other	OK	REPAIR		REPLACE		

HEATING AND VENTILATION						NOTES/ DESCRIPTIONS	COST
1.	Primary Heat Source ▪ OK ▪ Requires Filter ▪ Cracked Heat Exchanger ▪ Other	OK	REPAIR		REPLACE	Certificate Required Yes No	
2.	Date Last Inspected	DATE:_____					
3.	Chimney & Accessories ▪ OK ▪ Other	OK	REPAIR		REPLACE		
4.	Grills & Registers ▪ OK ▪ Missing ▪ Other	OK	REPAIR		REPLACE		
5.	Motors & Controls ▪ OK ▪ Require Servicing	OK	REPAIR		REPLACE		
6.	Ductwork ▪ OK ▪ Missing ▪ Loose/Hanging ▪ Other	OK	REPAIR		REPLACE		
7.	Fresh Air supply ▪ OK ▪ Missing ▪ Requires Insulation ▪ Other	OK	REPAIR		REPLACE		
8.	Combustion Air supply ▪ OK ▪ Missing ▪ Requires Insulation ▪ Other	OK	REPAIR		REPLACE		
9.	Air Exchanger ▪ OK ▪ Missing ▪ Other	OK	REPAIR		REPLACE		
10.	Humidifier ▪ OK ▪ Not working ▪ Other	OK	REPAIR		REPLACE		
11.	CO2 Detector ▪ OK ▪ One required	OK	REPAIR		REPLACE		
12.	Clearances to Combustibles ▪ OK ▪ Not enough Clearance ▪ Other	OK	REPAIR		REPLACE		

PLUMBING						NOTES/ DESCRIPTIONS Plumbing Certificate Required Y__ N__	COST
1.	Sump Pump and Pit ▪ Ok ▪ Requires Servicing ▪ Other	OK	REPAIR		REPLACE		
2.	Water Pump/Pressure Tank ▪ OK ▪ Leaking ▪ Poor Pressure	OK	REPAIR		REPLACE		
3.	Sewer Pump ▪ OK ▪ Not Working ▪ Wiring Problem	OK	REPAIR		REPLACE		
4.	Hot Water Tank ▪ OK ▪ Backdrafting ▪ No Drain ▪ No Flame Shield	OK	REPAIR		REPLACE		
5.	Drain Lines ▪ OK ▪ Leaks ▪ Need Cleaning	OK	REPAIR		REPLACE		
6.	Supply Lines ▪ OK ▪ No shut off Valve ▪ Leaking	OK	REPAIR		REPLACE		
7.	Floor Drain ▪ OK ▪ Cover Missing ▪ Needs Cleaning ▪ Poor Slope	OK	REPAIR		REPLACE		

ELECTRICAL						NOTES/ DESCRIPTIONS Certificate Required Yes __ No__	COST
1.	Fixtures Main Floor ▪ Broken	OK	REPAIR		REPLACE		
	Basement ▪ Missing	OK	REPAIR		REPLACE		
2.	Switches & Receptacles ▪ OK ▪ Covers Missing/Broken ▪ Broken Receptacles ▪ Broken Switches	OK	REPAIR		REPLACE		
3.	GFCI Exterior ▪ OK ▪ Missing ▪ Not Working	OK	REPAIR		REPLACE		
	GFI Bathroom ▪ OK ▪ Missing ▪ Not Working	OK	REPAIR		REPLACE		
4.	Smoke Detector, Main Flr. ▪ OK ▪ Missing ▪ Not Working	OK	REPAIR		REPLACE		
	Smoke Detector Basement ▪ OK ▪ Missing ▪ Not Working	OK	REPAIR		REPLACE		

KITCHEN						NOTES/ DESCRIPTIONS	COST
1.	Cabinets ▪ OK ▪ Broken Doors or Frames ▪ Missing Doors ▪ Other	OK	REPAIR		REPLACE		
2.	Countertops/Backsplash ▪ OK ▪ Cracked OR Chipped ▪ Requires Caulking ▪ Other	OK	REPAIR		REPLACE		
3.	Sink/Faucets/Stoppers ▪ OK ▪ Chipped ▪ Leaking Faucettes ▪ Other	OK	REPAIR		REPLACE		
4.	Fridge ▪ OK ▪ Door requires Fixing ▪ Other	OK	REPAIR		REPLACE		
5.	Stove ▪ OK ▪ Burners not working ▪ Oven not working ▪ Other	OK	REPAIR		REPLACE		
6.	Rangehood ▪ OK ▪ Requires Venting ▪ Not Vented Pre-95	OK	REPAIR		REPLACE	Vented Yes No	

BATHROOMS						NOTES/ DESCRIPTIONS	COST
1.	Vanity ▪ OK ▪ Broken Door ▪ Other	OK	REPAIR		REPLACE		
2.	Medicine Cabinet ▪ OK ▪ Broken Glass ▪ Other	OK	REPAIR		REPLACE		
3.	Sink/Faucets/Stopper ▪ OK ▪ Chipped ▪ Leaking Faucettes ▪ Other	OK	REPAIR		REPLACE		
4.	Water Closet ▪ OK ▪ Seal Broken ▪ Chipped ▪ Other	OK	REPAIR		REPLACE		
5.	Tub ▪ OK ▪ Chipped ▪ Broken ▪ Other	OK	REPAIR		REPLACE		
6.	Tub/Shower Faucets ▪ OK ▪ Chipped ▪ Leaking Faucettes ▪ Other	OK	REPAIR		REPLACE		

7.	Tub Surround/Enclosure ▪ OK ▪ Cracked ▪ Requires Caulking ▪ Other	OK	REPAIR		REPLACE		
8.	Towel Bar/ T.P. Dispenser ▪ OK ▪ Broken ▪ Missing	OK	REPAIR		REPLACE		
9.	Exhaust Fan ▪ OK ▪ Requires Venting ▪ Not Working ▪ Other	OK	REPAIR		REPLACE	Window: Y___ N___	
10.	Flooring ▪ OK ▪ Lifting ▪ Requires Sealing ▪ Carpet (Replace) ▪ Other	OK	REPAIR		REPLACE		

INTERIOR OF UNIT (GENERAL)						NOTES/ DESCRIPTIONS	COST
1.	Ceiling Finish ▪ OK ▪ Requires Painting ▪ Requires Texturing ▪ Water Stains ▪ Other	OK	REPAIR		REPLACE		
2.	Wall Finish ▪ OK ▪ Holes in the walls ▪ Other	OK	REPAIR		REPLACE		
3.	Painting ▪ OK ▪ Requires Touchup ▪ Requires Complete Painting ▪ Other	OK	REPAIR		REPLACE		
4.	Carpet ▪ OK ▪ Worn out ▪ Seams coming apart ▪ Other	OK	REPAIR		REPLACE		
5.	Linoleum/Tiles ▪ OK ▪ Worn out ▪ Lifting ▪ Holes in Floor ▪ Other	OK	REPAIR		REPLACE		
6.	Windows ▪ OK ▪ Requires Casing ▪ Requires Insulating ▪ Broken Seals ▪ Other	OK	REPAIR		REPLACE		
7.	Interior Doors ▪ OK ▪ Doors Missing (Bathroom) ▪ Broken Doors ▪ Requires Adjusting ▪ Other	OK	REPAIR		REPLACE		
8.	Baseboard Trim ▪ OK ▪ Pieces Missing ▪ Requires Refinishing ▪ Other	OK	REPAIR		REPLACE		

9.	Closet Doors ▪ OK ▪ Missing ▪ Broken ▪ Require Adjusting ▪ Other	OK	REPAIR		REPLACE		
10.	Hardware ▪ OK ▪ Broken ▪ Missing ▪ Other	OK	REPAIR		REPLACE		
11.	Stair/Handrails ▪ OK ▪ Needs Adjusting ▪ Other	OK	REPAIR		REPLACE		
12.	Attic Access ▪ OK ▪ Needs Weatherstripping ▪ Needs Insulating	OK	REPAIR		REPLACE		
13.	Principal Exhaust ▪ OK ▪ None ▪ Does not Work ▪ Other	OK	REPAIR		REPLACE		
14.	Fireplace/Woodstove ▪ OK ▪ Needs more Clearance ▪ Needs Hearth ▪ Other	OK	REPAIR		REPLACE		
15.	Dryer Vent ▪ OK ▪ None ▪ Requires Venting	OK	REPAIR		REPLACE		

MOULD (Evidence of)		YES	NO	DESCRIPTION	
1.	Basement				
2.	Crawlspace				
3.	B athrooms				
4.	Kitchen				
5.	Other				

MOISTURE RELATED CONCERNS

1. The Windows are:
   ☐ Single Pane ☐ Double Pane ☐ Triple Pane

2. Is there condensation on windows?
   ☐ YES ☐ NO If yes, which windows:_____

WATER SUPPLY

Cisterns ☐ Water not supplied by barrel/cistern, go to question 15, Wells.

1. The cistern/barrel is located:
   ☐ in the dwelling in the basement ☐ in the dwelling on the main floor
   ☐ outside in a low lying area ☐ outside in a level area
   ☐ outside in an elevated area ☐ outside - above ground in shed
   ☐ water not supplied by barrel/cistern ☐ other_____

2. The access/manhole opening to the cistern is:

   ☐ Above ground level (_____mm or _____inches above grade).
   ☐ Below ground level (Buried).
   ☐ At ground level.
   ☐ Water not supplied by cistern.

3. The condition of cistern access/manhole opening cover:

   ☐ Satisfactory (intact and tight fitting).
   ☐ Improper Lid (not tight-fitting, wooden, etc)
   ☐ Missing
   ☐ Damaged
   ☐ Water not supplied by cistern

4. The ground around the access/manhole opening is:

   ☐ Sloping away from the cistern opening.
   ☐ Level with the cistern opening.
   ☐ Sloping towards the cistern opening.
   ☐ Water not supplied by cistern.

5. The access cover is child proof by means of:

   ☐ A padlock ☐ Removal only with tools
   ☐ Is at least 29.5 kg (65 pounds) ☐ Other_____
   ☐ Access cover is not child proof ☐ Water not supplied by cistern.

6. Condition of the access/manhole opening extension:
   ☐ Satisfactory with water tight joints ☐ Cracked/damaged
   ☐ Not properly sealed ☐ Other_____
   ☐ Water not supplied by cistern.

7. The ground around the cistern access/manhole opening is:
   ☐ Loose ☐ Compacted ☐ Water not supplied by cistern

8. Does the cistern have a filler pipe?
   ☐ Yes ☐ No ☐ Water not supplied by cistern.

9. Condition of cistern filler pipe:
   ☐ Satisfactory with cap ☐ Cracked/damaged
   ☐ Not properly sealed ☐ Cap missing
   ☐ Water not supplied by cistern.

10. Does the cistern vent?
- ❑ Yes ☐ No ☐ Water not supplied by a cistern.

11. Condition cistern vent:
- ❑ Satisfactory with screen ☐ Cracked/damaged
- ❑ Not properly screened ☐ Cap Missing
- ❑ Water not supplied by a cistern

12. Is the cistern lid level?
- ❑ Yes ☐ No ☐ Water not supplied by cistern.

Wells ☐ Water not supplied by well, go to Sewage Disposal System Section.

13. The well is located:
- ❑ In the dwelling in the basement ☐ Outside in a low lying area
- ❑ Outside in a level area ☐ Outside in an elevated area
- ❑ Location (West etc) : _____☐ Water not supplied by well

14. Does the well casing have a proper secured cap?
- ❑ Yes ☐ No ☐ Water not supplied by well.

15. Condition of well cap?
- ❑ Satisfactory ☐ Cracked/Damaged and in need of repairs.
- ❑ Water not supplied by well.

16. The ground around the well casing is:
- ❑ Sloping away from well
- ❑ Level around the well
- ❑ Sloping towards the well
- ❑ Water not supplied by well

17. The ground around the well casing is:
- ❑ Loose ☐ Compacted ☐ Water not supplied by well.

18. The top of the well casing is:
- ❑ Less than or ☐ Equal or Greater than 200 mm(8 in) from ground surface.
- ❑ Water not supplied by private well.

SEWAGE DISPOSAL SYSTEM

❑ **Dwelling is connected to a Community sewage system. If so, omit section.**

1. Building Sewer/Drain
Is any portion of the building sewer/drain exposed?
- ❑ Yes ☐ No

2. Septic Tank/Holding Tank
a. Method of sewage collection:
- ❑ Septic Tank ☐ Holding Tank
- ❑ Outhouse ☐ Directly to private lagoon
- ❑ None

b. Is the septic tank/holding tank, including access/manhole opening completely buried?
- ❑ Yes ☐ No If YES, go to question 3.

c. Tank materials:
- ❑ Concrete ☐ Fibreglass ☐ Plastic ☐ Polyethylene ☐ Steel

d. Type of septic tank/holding tank:
- ❑ One chamber ☐ Two Chambers
- ❑ 2 – One chamber Tanks ☐ Other_____

e. The sewage system is: ☐ Bell and Siphon (gravity) dependent ☐ Pump dependent

f. Is the septic tank/holding tank accessible for maintenance?
❑ Yes ☐ No If no, why_____

g. The access/manhole opening is:
❑ Above ground level (_____mm or _____inches above grade).
❑ Below ground level (Buried).
❑ At ground level

h. Condition of access/manhole opening cover:
❑ Satisfactory (intact & tight fitting) ☐ Missing ☐ Other: _____
❑ Improper Lid (not tight fitting, wood, etc) ☐ Damaged

i. The access cover is child proof by mean of:
❑ A padlock ☐ Removal only with tools
❑ Is at least 29.5kg (65lbs) ☐ Other _____
❑ Access cover is not child proof

j. Condition of the access/manhole opening extension:
❑ Satisfactory ☐ Cracked/damaged
❑ Not properly sealed ☐ Missing ☐ Other _____

k. Is the access cover level? ☐ Yes ☐ No

l.The ground around the access/manhole opening is:
❑ Sloping away from the tank opening
❑ Level with the tank opening
❑ Sloping towards the tank opening

m. The ground around the access/manhole opening is:
❑ Loose ☐ Compacted

n. Is there evidence of sewage overflowing or overflowed from the septic tank/holding tank?
❑ Yes ☐ No

o. The septic tank is located:
❑ Less than or ☐ Equal or Greater than 1m (3.25 ft) from a building
❑ Less than or ☐ Equal or Greater than 9m (30ft) from a water course
❑ Less than or ☐ Equal or Greater than 9m (30 ft) from a drinking water source

3. Pump Dependent Septic Tank

❑ **Not applicable, septic tank is bell and siphon (gravity) dependent.**

a. Where is the effluent pump located?
❑ In the septic tank ☐ In the dwelling/trailer

b. Is the effluent pump operational?
❑ Yes ☐ No

c. Condition of the effluent pump electrical cord:
❑ Satisfactory ☐ Damaged

d. Condition of the electrical box/socket:
❑ Satisfactory ☐ Damaged

4. Sewage Disposal Method

a. Type of Sewage Disposal Method:
❑ Open discharge ☐ Subsurface Disposal Field
❑ Private Lagoon ☐ Mound ☐ Chamber Field
❑ Outhouse ☐ Community Sewage System
❑ Other_____

Complete one of the following sections depending on type of sewage disposal system.

b. SUBSURFACE DISPOSAL/CHAMBER FIELD

❑ **Not applicable, go to section c.**

i. How many homes are serviced by this system?

❑ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 or more

ii. Where is the disposal field located?

❑ In a level area ☐ In a low lying area ☐ in an elevated area Location

iii. What type of vegetation is growing in the disposal field?

❑ Grass ☐ Trees ☐ Dirt/Bare ☐ Shrubs ☐ Other_____

iv. Is the vegetation maintained (cut/trimmed)?

☐ Yes ☐ No

v. hat is located over the disposal field?

❑ Nothing ☐ Driveway ☐ Buildings ☐ livestock

❑ Parking Area ☐ Visible signs of vehicle traffic ☐ Other_____

vi. Are there any indication that the disposal field is malfunctioning (ponding/leaking sewage or temporary surface discharge).

❑ Yes ☐ No

vii. Is any part of the sewage disposal field uncovered?

❑ Yes ☐ No

viii. The disposal field is located:

❑ Less than or ☐ equal to or greater to 1 m (3.25 ft) from a building that does not have a basement or crawl space.

☐ Less than or ☐ equal to or greater to 9 m (30 ft) from a building that has a basement or crawl space.

❑ Less than or ☐ equal to or greater to 1 m(3.25 ft) from a septic tank

❑ Less than or ☐ equal to or greater to 15 m (50 ft) from a water course

❑ Less than or ☐ equal to or greater to 15 m (50 ft) from a drinking water source

c. OPEN DISCHARGE (Shoots out, ejectors, etc.).

❑ **Not applicable, go to section d.**

i. Is the effluent line uncovered?

☐ Yes ☐ No

ii. Where is the sewage discharge point located?

❑ In the trees ☐ In the tank/thick vegetation ☐ In an open area

❑ In the garden ☐ Location (W Of House etc.)_____

iii. Is the effluent discharge area fenced off?

☐ Yes ☐ No

iv. How high above the ground in the effluent discharge pipe?

_____mm or _____inches

v. Is the effluent discharge pipe damaged or broken?

☐ Yes ☐ No

vi. Is the ground around the effluent discharge pipe mounded?

☐ Yes ☐ No

If yes, what is the height of the mound? _____mm or _____inches

If yes, what type of erosion control material is used at discharge point?
☐ Field Stone ☐ Gravel ☐ Dirt ☐ Other

vii. Is the effluent discharge point located in a low-lying area?
☐ Yes ☐ No

viii. Is effluent accumulating around the discharge area?
☐ Yes ☐ No

ix. Is there a frost protection pipe with cap around the effluent discharge line?
☐ Yes ☐ No

x. Does the sewage effluent flow back towards the dwelling or water course?
☐ Yes ☐ No

d. PRIVATE LAGOON
☐ **Not applicable, form complete.**

i. How many homes are serviced by this system?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 or more

ii. Sewage effluent flows to the lagoon via:
☐ Gravity ☐ Pump

iii. Is the lagoon fenced?
☐ Yes and in good condition
☐ Yes but in need of repairs ☐ No

If yes, type of fence: _____

If yes, height of fence is: ☐ less than 1 m (3ft) ☐ more than 1 m (3ft)

iv. Is there a gate? ☐ Yes ☐ No

v. Was the gate found locked? ☐ Yes ☐ No

vi. Is the lagoon bermed? ☐ Yes ☐ No

vii. Is the berm vegetation maintained? (ie. Mowed): ☐ Yes ☐ No

viii. The sewage enters the lagoon on what side? ☐N ☐ S ☐ E ☐ W

ix. Is effluent overflowing the lagoon berm? ☐ Yes ☐ No

x. Is there indication of sewage seeping from the lagoon? ☐ Yes ☐ No

xi. Does the lagoon have a discharge point? ☐ Yes ☐ No

xii. Is the discharge point on the opposite side from where the sewage enters the lagoon?
☐ Yes ☐ No

xiii. Is yes, which side of the lagoon? ☐N ☐ S ☐ E ☐ W

xiv. Is there sewage discharging from the lagoon on a continuous basis?
☐ Yes ☐ No

xv. Is there any indication of burrowing animals in the lagoon?
☐ Yes ☐ No

xvi. Is there aquatic weeds and vegetation growing within the lagoon?

☐ Yes ☐ No

xvii. Is there any indication of berm erosion?
☐ Yes ☐ No

xviii. Is there any indication of a truck discharging directly into lagoon?
☐ Yes ☐ No

xix. The lagoon is located:
- ☐ Less than or ☐ equal to or greater than 45m (150ft) from a dwelling
- ☐ Less than or ☐ equal to or greater than 90m (300ft) from a water source
- ☐ Less than or ☐ equal to or greater than 90m (300ft) from a drinking water source.

ADDITIONAL COMMENTS:

NOTE:
This Inspection Report has been prepared solely for Treaty Seven Tribal Council and Treaty Seven First Nations' internal purposes. It does not constitute a representation or warranty as to the condition or value of the subject property, or that the subject property is in conformity with any building or property standards and is not construed as such. Treaty Seven Tribal Council, Treaty Seven First Nations nor the Inspector, who prepared this report, do not assume any responsibility for any loss or damage to the present and subsequent owner of the subject property as a result of the preparation of this report.

_____ _____
(INSPECTOR) **(DATE)**

Appendix E
Alberta First Nations Housing Survey Question (Variable Ranking Criteria)

Septic Tank			
Variable (Survey Question)	Classification		
	Type	Max. Pts.	
Is any portion of the building sewer/drain exposed?	Installation/ maintenance	1	If the building sewer/drain is exposed to the elements or other conditions for which it is not designed could compromise the operation of the system, thus potentially compromising the operation of the sewage system. Rating: Maximum points if no part of the building sewer/drain is exposed, no point is any part of it is exposed.
Condition of access/manhole opening cover	Installation/ maintenance	1	The condition of the access/manhole opening cover should be intact and tight fitting. If not, surface water, run-off, or other substances and wastewater may be introduced into the system for which it is not designed. Rating: Maximum points if the access/manhole opening cover was intact and tight fitting, no points if otherwise.
The access cover is child proof by mean of	Installation/ maintenance	1	A secure lid or access cover is necessary to prevent unintentional or unauthorized entry of people or items into the septic tank that may effect the operation and maintenance of the system. Rating: Maximum points if the access cover was secure, no points if survey response indicated otherwise.
Condition of the access/manhole opening extension	Installation/ maintenance	1	The condition of the access/manhole opening extension should be intact and tight fitting. If not, surface water, run-off, or other substances and wastewater may be introduced into the system for which it is not designed. Rating: Maximum points if the access/manhole opening extension was intact and tight fitting, no points if no points if survey response indicated otherwise.

Is the access cover level?	Installation/ maintenance	1	A cover that is not level is an indicator that the tank may not be level. A tank that is not level indicates that its base may not be stable and it may have settled, shifted and/or cracked after installation. Rating: Maximum points if the cover was level, no points if the cover was not level.
What are the ground conditions around the access/manhole?	Installation/ maintenance	1	Ground conditions where the area slopes toward the access/manhole have a greater potential for surface water, run-off, or other substances and wastewater to be introduced into the system for which it is not designed. Rating: Maximum points if the conditions around the access/manhole were sloping away or level with the tank opening, no points if the ground was sloping toward the access/manhole.
Is there evidence of sewage overflowing or overflowed from the septic tank/holding tank?	Health	5	Sewage overflow from a septic tank provides a means for occupants or their pets to become directly exposed to an enteric disease agent. It also indicates that the entire sewage system operation may be compromised. Rating: Maximum points if no sewage was overflowing from the septic tank, no points if sewage was overflowing from the septic tank.
Distance from septic tank to house.	Installation/ maintenance	1	The septic tank should not be installed too close to a building or its foundation due to the potential of the septic tank to settle, crack or leak. The required distance is at least 1 metre. Rating: Maximum points if septic tank was 1 metre or greater from the dwelling, no points if the septic tank was less than 1 metre from the dwelling.
Distance from septic tank to water course.	Environment	3	A septic tank should be at least 9 metres from a water course for protection of any surface water features from sewage effluent contamination. Rating: Maximum points if the septic tank was 9 or more metres from the water course, no points if less than 9 metres.

Distance from septic tank to drinking water source.	Health	5	Locating a septic tank at least 9 metres from a drinking water source provides a degree of protection of the potable water supply, taking into consideration that a septic tanks different components may not be water tight due to settling or other reasons. Rating: Maximum points if the septic tank was 9 or more metres from the water source, no points if less than 9 metres.
Subsurface Disposal Field			
Where is the disposal field located (level, low-lying or elevated area)?	Environment	3	Locating a subsurface disposal field in a low-lying area poses two potential problems: a) low-lying areas are more prone to receiving surface water run-off or flood and b) low-lying areas are more likely to be located closer to the top of the water table. Location of the disposal field has a potential environmental impact if the site is not properly selected. Rating: Maximum points if the disposal field was located in a level or elevated area, no points if located in a low-lying area.
Is the vegetation maintained (cut/trimmed)?	Installation/ maintenance	1	If vegetation above the subsurface disposal field is not maintained, there is the potential for the growth of trees, shrubs and other types of vegetation that have root systems that may compromise the operation of the disposal field Rating: Maximum points if vegetation was maintained, no points if not maintained.
Indications that the disposal field is malfunctioning (ponding/leaking sewage or temporary surface discharge)?	Health	5	Ponding/leaking sewage or temporary surface discharge provides a means for occupants or their pets to become directly exposed to an enteric disease agent. It also indicates that the entire sewage system operation may be compromised. Rating: Maximum points if no ponding/leaking sewage or temporary surface discharge, no points if any evidence of ponding/leaking sewage or temporary surface discharge

Is any part of the sewage disposal field uncovered?	Installation/ maintenance	1	If any part of the sewage disposal field is uncovered and exposed to the elements or other conditions for which it is not designed the operation of the system could be compromised, thus potentially affecting the operation of the sewage system. Rating: Maximum points if all parts of sewage disposal field were covered, no points if any part of the sewage disposal field is uncovered.
Distance from subsurface disposal field to septic tank.	Installation/ maintenance	1	Inlet and outlet piping for the septic tank require suitable support as the settling of an improperly supported septic tank may cause disconnection of the inlet/outlet piping. Therefore, a separation distance of at least 1 metre from the subsurface disposal field will give the required clearance for the proper support area needed for the outlet piping. Rating: Maximum points if subsurface disposal field was 1 metre or greater from the septic tank, no points if the septic tank was less than 1 metre from the septic tank.
Distance from subsurface disposal field to watercourse.	Environment	3	A subsurface disposal field should be at least 15 metres away from a water course for protection of any surface water features from sewage effluent contamination as sewage effluent can move laterally and contaminate surface water features before treatment is complete. Rating: Maximum points if subsurface disposal field was at least 15 metres away from a water course, no points if less than 15 metres away.
Distance from subsurface disposal field to drinking water supply.	Health	5	A subsurface disposal field should be at least 15 metres from a water source to protect potable water supplies in the event of a system failure as sewage effluent can move laterally and contaminate drinking water supplies before treatment in the soil layers is complete. Rating: Maximum points if subsurface disposal field was at least 15 metres away from a water source, no points if less than 15 metres away.
Open Discharge			

Is the effluent line uncovered?	Installation/ maintenance	1	If any part of the effluent line from the septic tank to the open discharge is uncovered and exposed to the elements or other conditions for which it is not designed the operation of the system could be compromised, thus potentially affecting the operation of the sewage system. Rating: Maximum points if the effluent line was covered, no points if any part of the effluent line was not covered.
Is the effluent discharge area fenced off?	Installation/ maintenance	1	A fence provides a means of protection from children, pets/animals (depending on the type of fence) from coming into contact with the sewage effluent that is discharged. Rating: Maximum points if fenced, no points if not fenced.
Is the effluent discharge pipe damaged or broken?	Installation/ maintenance	1	A damaged or broken effluent discharge pipe may pose a risk to the operation of the system, as sewage effluent may not be properly discharged from the pipe. Indicates the system is note being maintained and its operation could be compromised. Rating: Maximum points if effluent discharge piped was in satisfactory condition, no points if damaged or broken.
Is the ground around the effluent discharge pipe mounded?	Installation/ maintenance	1	The area around the discharge pipe should minimize effluent pooling. Mounding of the area around the discharge pipe will help facilitate this and allow for the quick evaporation and absorption of the effluent. Rating: Maximum points if area around discharge piped was mounded, no points if not mounded.
Is effluent accumulating around the discharge area?	Health	5	Sewage overflow from a septic tank provides a means for occupants or their pets to become directly exposed to an enteric disease agent. Open discharge systems should be designed to minimize the pooling of sewage effluent. Rating: Maximum points if no effluent was accumulating around the discharge area, no points if effluent was accumulating around the discharge area.

Is there a frost protection pipe with cap around the effluent discharge line?	Installation/ maintenance	1	A frost protection pipe with cap will assist in protecting the system from freezing, thereby optimizing operation of the open discharge system. Rating: Maximum points if frost protection pipe with cap was present, no points if not present.
Private Lagoon			
Is the lagoon fenced?	Installation/ maintenance	1	A fence provides a means of protection from children, pets or wild animals (depending on the type of fence) from coming into contact with the sewage effluent that is held for treatment in the lagoon. Rating: Maximum points if fenced, no points if not fenced.
Was the gate locked?	Installation/ maintenance	1	Keeping the lagoon fence gate locked is measure designed to prevent unintentional or unauthorized entry of people or items into the septic tank that may effect the operation and maintenance of the system. Rating: Maximum points if locked, not points if not locked.
Is the lagoon bermed?	Environment	3	A berm is a raised area around the permitted of the lagoon that should be constructed out of compacted clay to minimize seepage. If constructed properly. a berm assists in containing the sewage effluent within the lagoon, directs surface run off away from the lagoon and allows for a larger liquid surface area which aids in treatment. A properly designed, constructed, and maintained lagoon berm aids in environmental protection for these reasons. Rating: Maximum points if bermed, no points if not bermed.
Is the berm vegetation maintained? (ie. mowed)	Installation/ maintenance	1	If vegetation on the lagoon berm is not maintained, there is the potential for the growth of trees, shrubs and other types of vegetation that have root systems that may compromise the integrity of the berm. Rating: Maximum points if vegetation maintained, no points if not maintained.

Is effluent overflowing the lagoon berm?	Health	5	If sewage is overflowing from the lagoon berm, this provides a means for occupants or their pets to become directly exposed to an enteric disease agent. It also indicates that the entire sewage system operation may be compromised. Rating: Maximum point if sewage was not overflowing the lagoon berm, no points if sewage effluent was overflowing the berm.
Is the discharge point on the opposite side from where the sewage enters the lagoon?	Installation/ maintenance	1	Private lagoons are not normally intended to be drained and should be designed to retain sewage effluent for evaporation. However, in the event that there is a discharge point, it should be the furthest possible point from the inlet to ensure maximum retention time before discharge. Rating: Maximum points if discharge point on opposite side of inlet, no points if positioned otherwise.
Is there sewage discharging from the lagoon on a continuous basis?	Environment	3	Continuous discharge indicates that the actual daily sewage flow is more than what the lagoon was designed to handle, resulting in the likelihood of sewage effluent being discharged into the environment before it has had adequate retention time. Rating: Maximum points if sewage effluent was not continuously being discharged, no points if continuous discharge was taking place.
Is there aquatic weeds and vegetation growing within the lagoon?	Installation/ maintenance	1	The lagoon bottom must be constructed of compacted clay or lined to minimize seepage. If aquatic weeds or vegetation are able to grow within the berm, this indicates that the lagoon bottom may be compromised in some way and seepage may be occurring. Rating: Maximum points if the lagoon was clear of any growth of aquatic weeds, no points if aquatic weeds or vegetation were growing within the lagoon.
Distance from private lagoon to house	Installation/ maintenance	1	A distance of 45 metres is required from a private lagoon to a dwelling to ensure adequate separation of the lagoon from the occupants/children. Rating: Maximum points if the lagoon was located at least 45 metres away from the dwelling, no points if located less than 45 metres.

Distance from private lagoon to water course	Environment	3	A distance of 90 metres is required from a private lagoon to a water course for protection of any surface water features from sewage effluent contamination as sewage effluent can move laterally and contaminate surface water features before treatment is complete. Rating: Maximum points if the lagoon was located at least 90 metres away from a water course, no points if located less than 90 metres.
Distance from private lagoon to drinking water supply	Health	5	A private lagoon should be at least 90 metres from a water source to protect potable water supplies in the event of a system failure as sewage effluent may seep from the private lagoon. Rating: Maximum points if the lagoon was located at least 90 metres away from a water source, no points if located less than 90 metres.
Drinking Water Well			
Does the well casing have a proper secured cap?	Health	5	A well casing cap that is not secure can compromise the integrity of the potable water supply by providing a means for contamination, rodents, pests and foreign objects to enter the drinking water supply. Not having a properly secured cap provides a pathway for contamination to enter a drinking water well. Rating: Maximum points if a proper secured cap was in place, no points if otherwise.
What is the well cap condition?	Installation/ maintenance	1	A well cap should be in satisfactory condition, and not cracked or otherwise damaged. A well cap in poor condition indicates that drinking water well is not being properly maintained. Rating: Maximum points if the well cap was in satisfactory condition, no points if otherwise.
What are the ground conditions around the well?	Health	5	The ground conditions around a drinking water well should not slope toward the well casing as this provides a pathway for over land water flow in the event of a flood or surface run off to be directed towards the well, thus providing a pathway for contamination of the drinking water. Rating: Maximum points if ground surface around the well casing was level or sloped away, no points if the ground surface sloped toward the well.

The top of the well casing is (less than or equal to/greater than) 200 mm/8inches.	Health	5	A well casing that is low to the ground does not adequately protect the groundwater from. Not having an appropriate well casing height provides a pathway for contamination of the drinking water well. Rating: Maximum points if the well casing was at least 200 mm above the ground surface, no points if the top of the well casing was less than 200 mm above the ground surface.
Drinking Water Cistern			
What is the condition of the cistern access/manhole opening cover?	Health	5	The condition of the cistern access/manhole opening cover should be intact and tight fitting. If not, surface water, run-off, or other substances and wastewater may be introduced and directly contaminate the potable water supply. Rating: Maximum points if the cistern access/manhole opening cover was intact and tight fitting, no points if otherwise.
What are the ground conditions around the cistern?	Health	5	Ground conditions where the area slopes toward the cistern access/manhole have a greater potential for surface water, run-off, or other substances and wastewater to be introduced into the cistern and directly contaminate the potable water supply. Rating: Maximum points if the conditions around the cistern access/manhole were sloping away or level with the tank opening, no points if the ground was sloping toward the access/manhole.
Is the access cover childproof?	Health	5	A secure lid or access cover is necessary to prevent unintentional or unauthorized entry of people or items into the cistern and directly contaminating the potable water supply. Rating: Maximum points if the access cover was secure, no points if survey response indicated otherwise.

What is the condition of the access/manhole opening extension?	Health	5	The condition of the access/manhole opening extension should be intact and tight fitting. If not, surface water, run-off, or other substances and wastewater may be introduced into the cistern and directly contaminate the drinking water supply. Rating: Maximum points if the cistern access/manhole opening extension was intact and tight fitting, no points if no points if survey response indicated otherwise.
Is the cistern vented?	Installation/ maintenance	1	A cistern vent assists in the exchange of air, and this is important when a cistern is being filled with potable water. The presence of a cistern vent is important in the proper operation of the cistern. Rating: Maximum points if the cistern was vented, no points if not vented.
What is the condition of the cistern vent?	Installation/ maintenance	1	A cistern vent in poor condition (not screened/cracked/damaged) indicates poor cistern maintenance and may provide a pathway for contamination of the drinking water. Rating: Maximum points if the cistern vent was in satisfactory condition, no points if otherwise.
Is the cistern lid level?	Installation/ maintenance	1	A cover that is not level is an indicator that the cistern may not be level. A cistern that is not level indicates that its base may not be stable and it may have settled, shifted and/or cracked after installation. Rating: Maximum points if the cover was level, no points if the cover was not level.

Appendix F
Alberta First Nations Private Sewage Survey Variable Recodes

The following lists how variables were recoded.

Sewage Disposal System
- No system: 5
- Open discharge: 4
- Holding tank: 3
- Private Lagoon: 2
- Treatment Mound/subsurface disposal: 1
- Community sewage: 0

Number of Occupants
- Numeric value will match the actual number of occupants
- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10+

AND
- Crowding was defined as 5 or more people in a household (based on the mean and median of ~5)
- 4 or less occupants: 0
- 5 or more occupants: 1

Effluent Accumulating Around discharge pipe
- Yes: 1
- No: 0

Number of sewage back ups in last year
- 4 or more: 4
- 3: 3
- 2: 2
- 1: 1
- 0: 0

AND
- The data were categorized into the occurrence of sewage back ups in the last year
- No back ups reported: 0
- One or more back ups reported: 1

Distance of open discharge to dwelling with a basement
- 45m (150 feet) or less: 1
- Greater than 45 m (150 feet): 0
- (I based this on the Alberta Private Sewage System Standard of Practice 1999)

Distance of open discharge to drinking water supply

- 45m (150 feet) or less: 1
- Greater than 45 m (150 feet): 0
- (I based this on the Alberta Private Sewage System Standard of Practice 1999)

The occurrence of septic tank cleaning
- Less than one year ago: 0
- More than one year ago: 1
- Never: 2

Operation of the sewage effluent pump
- Is in working operation: 0
- Is not in working operation: 1

Septic tank overflowing
- No: 0
- Yes: 1

Subsurface sewage field malfunctioning
- No: 0
- Yes; 1

Open discharge is located in a low lying area
- No: 0
- Yes: 0
-

Appendix G

Business Rules for Querying the Alberta Health and Wellness Database for First Nations Enteric Disease Cases (on reserve)

The following data are requested for the 1998-2004 time period: ICD classification (enteric diseases only*), date of birth, date of onset, male/female, community, laboratory confirmation (yes/no), NDR#, name of person filing NDR and phone number of person filing NDR.

*Chapter 3 of the Alberta Case Definitions Manual: Amoebiasis,botulism, calicivirus infection, campylobacteriosis, cholera, cryptosporidiosis, cyclosporiasis, enterovirus infections, enterohaemmorrhagic *E. coli* O157:H7, giardiasis, hepatitis A, Hepatitis E, Listeriosis, paratyhpoid fever, rotavirus, salmonellosis, shigellosis, staphylococcal intoxication, trichinosis, typhoid fever, vibrio cholerae, NON-01, NONO139, vibrio parahaemolyticus, yersiniosis.

Query will be done based on the following fields:

- RHA reporting
- Public health staffing reporting to AHW
- Public health staff phone number
- Town
- Postal Code

Does the RHA reporting field identify the First Nations and Inuit Health Branch (FNIHB) or one of the First Nations Health Unit names on the attached list?

- If either of these fields has First Nations related information as identified below, check the town and/or postal code.
    - If the town and postal code match the below-identified First Nations communities include case.
    - If the town and postal code do not match the below-identified First Nations communities, do not include the case
- If the reporting RHA field is not identified as FNIHB or one of the First Nations Health Unit names on the attached list or is left blank, check the submitting name. Does the name appear on the attached list? Is there a phone number identifying a First Nations Health Centre (as listed in the attached)?
    - If yes is answered to either question, confirm town and/or postal code match the identified First Nations communities on the attached list.
        - If the town and/or postal code match the identified First Nations communities include case.
        - If not, do not include the case.

One scenario not captured is a nurse that works part time on reserve and part time off reserve, fills out an NDR while working off reserve for a band member residing on reserve that became ill off reserve.