NOTE TO USERS

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ENVIRONMENTAL CONTAMINATION (EC) IN A FIRST NATION COMMUNITY: CAN EC BE USED AS AN INDICATOR FOR HUMAN HEALTH AND IS THERE A HUMAN HEALTH CONCERN?

By

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GLOSSARY OF TERMS

Absorption factor
The percent or fraction of a contaminant within an organism that becomes absorbed into the receptor.

Acceptable Risk
A risk level that is considered by society or regulatory agencies as tolerable.

Aliphatic hydrocarbon
Hydrocarbons in which the carbon-hydrogen groupings are arranged in open chains which may be branched. The term includes paraffins and olefins and provides a distinction from aromatics and naphthenes, which have at least some of their carbon atoms arranged in closed chains or rings.

Alkanes
Hydrocarbons that contain only single bonds. The chemical name indicates the number of carbon atoms and ends with the suffix "-ane".

Alkenes
Hydrocarbons that contain carbon-carbon double bonds. The chemical name indicates the number of carbon atoms and ends with the suffix "-ene".

Alkyl groups
A group of carbon and hydrogen atoms that branch from the main carbon chain or ring in a hydrocarbon molecule. The simplest alykl group, a methyl group, is a carbon atom attached to three hydrogen atoms.

Aromatic
A compound containing one or more conjugated rings that also may contain sulfur, nitrogen, and oxygen.

Alluvial Fan
A fan or cone-shaped mass of material, usually of sand and gravel deposited by a stream where it emerges from the constriction of a narrow valley at a mountain front and debouches on to a plain or into a wide trunk valley. The apex of the fan points upstream and this marks the thickest part of the mass (i.e. at the point of origin). The fan deposits become thinner as they are traced outwards and downwards and as the stream breaks up into a number of distributaries.

Alluvial soils
One of the subgroups of the azonal soils, comprising those immature soils which form on recent alluvial deposits.

Anthropogenic
Of human origin.

ASTM
American Society for Testing and Materials, responsible for many of the standard methods used in industry.

Azonal soil
A soil which lacks a B-horizon because it is too immature for the soil-forming processes to have had time to create one. Thus, the A-horizon lies immediately above the C- horizon of weathered parent material. This is the entisol of the Seventh Approximation soil classification. It is commonplace on volcanic soils, newly deposited glacial drift, windblown sand, cliff-foot screes, marine mudflats, and river alluvium freshly laid down. Azonal soils are subdivided into lithosol, regosol, and alluvial soils.

Biodegradation
The process by which organic substances are broken down by bacteria into elements and compounds. Most organic wastes are biodegradable; e.g. certain organisms can consume marine oil spillages.

Boiling point
A characteristic physical property of a liquid at which the vapour pressure is equal to that of the atmosphere and the liquid is converted to gas.

Cobble
A rounded to sub-rounded rock fragment between 64 and 256 mm in diameter. It is smaller than a boulder but larger than a pebble. Particle size, Wentworth scale.

Contamination
Contact with an admixture of an unnatural agent, with the implication that the amount is measurable. The deposition of unwanted material on the surfaces of structures, areas, objects, or people. It may also be airborne, external, or internal (inside components or people).

Cycloalkane
A class of alkanes that are in the form of a ring.

Dermal exposure
Exposure of an organism or receptor through skin absorption.

Diesel fuel
That portion of crude that distills out within the temperature range approximately 200 to 370^0 C. A general term covering oils used as fuel in diesel and other compression ignition engines.

Dose
The amount of a contaminant taken in by potential receptors on exposure; it is a measure of the amount of contaminant received by the receptor, as a result of exposure, expressed as an amount of exposure (mg) per unit body weight of the receptor (kg) (mg/kg).

Environment
Air, water, land and all plants and humans and other animals living therein, and the interrelationships which exist among them.

Environmental Justice
Environmental justice asserts the fair treatment of people in the development of environmental laws, regulations and policies; irrespective of race, culture or socio-economic status.

Environmental Site Assessment (ESA)
The process of determining whether there is contamination present at a site, the source and extent of that contamination, and the potential pathways of exposure to the public and the environment.

Epidemiology
The study of the distribution and dynamics of diseases and injuries in human populations. Specifically, the investigation of the possible causes of a disease and its transmission.

Ethnobotany
The scientific description of plants, and all kinds of vegetation associated (culturally) with a particular ethnic group.

Exposure
Contact of an organism with a contaminant. Exposure is quantified as the amount of contaminant available at the exchange boundaries of the organism (e.g. skin, lungs, gut) and available for absorption.

Exposure Assessment
The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration and route of exposure.

Exposure Limit
The maximum recommended daily exposure to a chemical (ADI, RfD, RsD, TDI).

Exposure Pathway
The course a chemical takes from a source to an exposed population or organism; it describes a unique mechanism by which an individual or population is exposed to chemicals originating from a site.

Extract
In solvent extraction, the portion of a sample preferentially dissolved by the solvent and recovered by physically separating the solvent.

Fluvial
Terms pertaining to rivers and river action, (river flow and erosive activity) respectively.

Fuel oil
A general term applied to oil used for the production of power or heat. In a more restricted sense, it is applied to any petroleum product that is used as boiler fuel or in industrial furnaces. These oils are normally residues, but blends of distillates and residues are also used as fuel oil. The wider term, 'liquid fuel', is sometimes used, but the term 'fuel oil' is preferred.

Gasoline (petrol)
Refined petroleum distillate, normally boiling within the limits of 30 to 220^0 C, which, combined with certain additives, is used as fuel for spark-ignition engines. By extension, the term is also applied to other products that boil within this range.

Geomorphology
The scientific study of the origin of landforms based on a cause-and-effect relationship. It comprises two complementary approaches: an earlier one based on inductive reasoning, that studied existing landforms, from which their evolutionary processes were inferred (denudation chronology); and a later one based on deductive reasoning, which depended largely on the measurement of currently operating geomorphological processes and inferred their influence on the landforms upon which they are acting. These processes comprise the physical and chemical interactions between the Earth's surface and the natural forces acting upon it to produce landforms (gravity, ice, river, waves, wind).

Glacial
Strictly, the term refers only to a glacier.

Glaciofluvial
A term referring to the processes and the landforms related to the action of glacial meltwater. The fluvial transport of material and the associated mechanisms of erosion and deposition are similar to those of a river when the action is occurring beyond the edge of the glacier or ice-sheet. But when the processes occur within or beneath the ice body they are subject to increased pressure and velocity, which allow the processes to operate more rapidly and with greater capability.

Grab Sample
A single sample collected at a particular time and place that represents the composition of the water only at that time and place.

Hazard
The inherent adverse effect that a chemical poses.

Heating oil
Gas oil or fuel oil used for firing the boilers of central heating systems.

Human Health Risk
The likelihood (or probability) that a given exposure or a series of exposures to a hazardous contaminant will cause adverse health impacts on individual receptors experiencing the exposures.

Humic layer, humose layer
A layer of highly decomposed organic soil in which only a little fibrous material has survived.

Humus
A black or dark-brown organic substance produced by the processes of mineralization and humification within the soil. Micro-organisms in the soil. moder, mor, mull.

Hydrocarbons
Molecules that consist only of hydrogen and carbon atoms.

Ingestion
An exposure type whereby contaminants enter the body through the mouth and into the gastrointestinal system.

Inhalation
The intake of a contaminant by receptors through the respiratory tract system.

Intake
The amount of material inhaled, ingest, or dermally absorbed during a specified time period. It is a measure of exposure, expressed in mg/kg/day.

Lacustrine plain
A low-lying tract of land formed from the sediment deposited in a lake, which has been completely infilled. The former lake floor is usually marshy and can only be used for farming if artificially drained.

Leachate
A liquid resulting from precipitation percolating through landfills containing water, decomposed waste, and bacteria. In sanitary landfills leachate is collected and treated to prevent contamination of water supplies.

Lowest-Observed-Adverse-Effect-level (LOAEL)
In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.

Methodology
The principles, practises of orderly thought or procedure applied to a particular branch of learning and arrived at by systematic analysis and application of the techniques of logic.

Naphthene
Petroleum industry term for a cycloparaffin (cycloalkane).

Olefin
Synonymous with alkene.

Oxygenated gasolines
Gasolines with added ethers or alcohols, formulated according to the Federal Clean Air Act to reduce carbon monoxide emissions during winter months.

Partitioning
In chromatography, the physical act of a solute having different affinities for the stationary and mobile phases. Partition ratios, K, are defined as the ratio of total analytical concentration of a solute in the stationary phase, C_s, to its concentration in the mobile phase, C_M.

Pathway
Any specific route by which a potential receptor or individual may be exposed to an environmental hazard, such as the release of a chemical material.

Photodegradable
A process whereby the sun's ultraviolet radiation attacks the link in the polymer chain of plastic. The breaking of this causes the plastic chain to fragment into smaller pieces, losing its strength and ability to flex and stretch. As the photodegradable plastic is subjected to the effects of the natural environment, the material is flexed, stretched, and disintegrated into plastic dust.
Polycyclic Aromatic Hydrocarbons (PAHs)
PAHs consist of a suite of compounds comprised of two or more aromatic rings. PAHs are found in many petroleum mixtures, and they are predominantly introduced to the environment through natural and anthropogenic combustion processes.

Probability
The likelihood of an event occurring.

Receptor
Refers to members of a potentially exposed population, e.g., persons or organisms that are potentially exposed to concentrations of a particular chemical compound.

Recycling
A resource recovery method involving the collection and treatment of a waste product for use as raw material in the manufacture of the same or another produce (e.g., ground glass in the manufacture of new glass).

Reference dose
Maximum amount of a chemical that the human body can absorb without experiencing chronic health effects. It is expressed in mg/kg body weight/day. It is the estimate of lifetime daily exposure of a non-carcinogenic substance for the general human population which appears to be without am appreciable risk of deleterious effects; used interchangeably with acceptable daily dose and Tolerable Daily Intake (TDI).

Remediation
Process of managing contaminants to the degree necessary to accommodate a specified land use.

Risk
Probability or likelihood of an adverse consequence from a hazard, or the potential for the realization of undesirable adverse consequences from impending events.

Risk Assessment
The process of identifying and documenting actual and perceived risks to human health or the environment, to allow further evaluation and appropriate responses.

Risk Characterization
This last step in the risk assessment process characterizes the potential for adverse health effects and evaluates the uncertainty involved.

Risk Estimate
A description of the probability that organisms exposed to a specific dose of a chemical or other pollutant will develop an adverse response (e.g. cancer).

Risk Management
The steps and process taken to reduce, or eliminate the risk that has been revealed by a risk assessment. It is an activity concerned with decisions about whether an assessed risk is sufficiently high to present a public health concern and about the appropriate means for controlling the risks judged to be significant.

Risk Perception
The magnitude of the risk as an individual or society perceives it.

Sanitary landfill
A method of disposing of refuse on land without creating nuisances or hazards to public health or safety. Careful preparation of the fill area, including the use of clay and/or synthetic liners and control of water drainage are required to ensure proper landfilling. To confine the refuse to the smallest practical area and reduce it to the smallest practical volume, heavy equipment is used to spread, compact, and cover the waste daily with at least 15 cm of compacted soil. After the area has been completely filled and covered with a final 1 m layer of soil and seeded with grass, the reclaimed land may be turned into a recreational area such as a park. Sanitary landfills have leachate collection systems, methane gas controls, and environmental monitoring systems.

Seismology
The scientific study of earthquakes and of elastic properties of the Earth.

Stakeholders
Stakeholders are persons or groups who are affected by or can affect the outcome of a project. These can include affected communities, local organizations, and NGOs and government authorities. Stakeholders can also include politicians, commercial and industrial enterprises, labour unions, academics, religious groups, national social and environmental public sector agencies and the media.

Stratigraphy
The branch of geology which deals with the composition, sequence, spatial distribution, classification and correlation of stratified rocks (sedimentary rocks, volcanic rocks) Stratigraphic cross section pertains to a visual cross section of an area in terms of geology.

Surficial
Pertaining to the surface of the ground.

Sustainability
The ongoing process of achieving development or redevelopment that does not undermine its physical or social systems of support.

Sustainable Development
A process of change in which the resources consumed (both social and ecological) are not depleted to the extent that they cannot be replicated. The concept also emphasizes that the creation of wealth within the community considers the well-being of both the human and natural environments, and is focused on the more complex processes of development rather than on simple growth or accumulation.

Synergistic
Joint effects of two or more agents, such as drugs that increase each other's effectiveness when taken together.

Teacherage
Dwelling dedicated to housing teachers who relocate to teach in the school system of a First Nations community.

Threshold
The lowest dose or exposure of a chemical at which a specified measurable effect is observed and below which such effect is not observed.

Tolerable Daily Intake (TDI)
The maximum amount of a chemical that the human body can absorb without experiencing chronic health effects; it is expressed in mg/kg body weight/day. It is the estimate of lifetime daily exposure of a non-carcinogenic substance for the general human population that appears to be without an appreciable risk of deleterious effects used interchangeably with acceptable daily dose and Reference Dose (RfD).

Topography
The surface features of the earth's surface, including the relief, the terrain, the vegetation, the soils and all the features created in the landscape by human endeavour. It is not synonymous merely with relief.

Toxicity
The harmful effects produced by a chemical substance. It is the quality or degree of being poisonous or harmful to human or ecological receptors.

Toxicity Assessment
Evaluation of the toxicity of a chemical based on available human and animal data. It is the characterization of the toxicological properties and effects of a chemical substance, with special emphasis on the establishment of dose-response characteristics.

Trace Metals
Metals normally found in trace amounts due to their insolubility or to their relative lack of abundance in the crust of the earth.

Transform-fault
A type of massive tear-fault on a continental scale in which the fault terminates sharply at a place where the movement is transformed into a structure of another type. The term was introduced in 1965 by J. T. Wilson to explain the transformation of strike-faults into mid-oceanic ridges, island arcs or fold-mountain belts.

Uncertainty Factor (UF)
Refers to a factor that is used to provide a margin of error when extrapolating from experimental animals to estimate human health risks.

Underground Storage Tanks (USTs)
A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals.

Volatile compounds
"Volatile" is relative. It may mean (1) any compound which will purge, (2) any compound which will elute before the solvent peake (usually those < C_6) or (3) any compound which will not evaporate during a solvent removal step.

Workshop
A structured forum where people are invited to work together in a group(s) on a common problem or task.

ACRONYMS

AST	Aboveground storage tank
ASTM	American Standard for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BGS	Below ground surface
BTEX	Benzene, Toluene, Ethylbezene, Xylene
CACAR	Canadian Arctic Contaminants Assessment Report
CBC	Canadian Broadcasting Corporation
CCME	Canadian Council of Ministers of the Environment
COI	Chemical of Interest
CSR	Contaminated Sites Regulation
CWS-PHC	Canada Wide Standards for Petroleum Hydrocarbon Compounds
DIAND	Department of Indian and Northern Development
EC	Environmental Contaminants
EHO	Environmental Health Officer
EHS	Environmental Health Services
EMS	Environmental Management System
ESA	Environmental Site Assessment
EPH	Extractable Petroleum Hydrocarbon
FN	First Nations
FNC	First Nation Community
FNESS	First Nations Emergency Services Society
FNIHB	First Nations Inuit Health Branch
GGC	Gitksan Government Commission
GCDWQ	Guidelines for Canadian Drinking Water Quality
HC	Health Canada
HEPH	Heavy Extractable Petroleum Hydrocarbons
INAC	Indian and Northern Affairs Canada
LOEL	Lowest Observed Effect Level
LOEAL	Lowest Observed Adverse Effect Level
LEPH	Light Extractable Petroleum Hydrocarbons
MAC	Maximum Acceptable Concentration
NAPL	Non-Aqueous Phase Liquids
NCSCS	National Classification Systems for Contaminated Sites
NWBC	North West British Columbia
PAH	Polycyclic Aromatic Hydrocarbon
PHC	Petroleum Hydrocarbon
PPM	Parts Per Million
PDP	Physical Development Plan
PSI	Preliminary Site Investigation
RfD	Reference Dose
SD	Sustainable Development
TDI	Tolerable Daily Intake
TEK	Traditional Ecological Knowledge
USEPA	United States Environmental Protection Agency

UST	Underground Storage Tank
VOC	Volatile Organic Compound
VPH	Volatile Petroleum Hydrocarbons

ABSTRACT

This research develops a process to investigate an environmental contaminant in an Aboriginal community. Through the use of this investigative approach a balance between the scientific evidence and quantitative perception of environmental contamination is presented. Conventional and action research methodologies are employed to collect as must evidence as possible of (a) the physical environmental contaminants (EC) and their impact on human health, and (b) the perception of the presence and subsequent human health implications of those ECs.

One deliverable of this research is a specific protocol or step-by-step approach that, when called upon, any Environmental Health Officer could use in response to a complaint from Aboriginal community members.

Aboriginal communities in BC tend to be located in remote areas without access to diverse means of development. In the past, many rural areas have had environmental problems associated with petroleum storage, which continues to be a source of concern for the members of these communities as well as local and federal governments.

This research demonstrates how from the initial complaint to project completion, an investigation may be conducted using the science of risk management. This approach integrates both human health and environmental risk determinations.

In order to achieve an effective measure of Aboriginal health, environmental influences must be factored into the equations. A generic framework that reflects appropriate measures of health and that could be applied to any Aboriginal community, regardless of the contaminant, must include as a minimum protocol the following three steps:

- verification of contaminant of concern (Preliminary Site Investigation);

- risk audit and risk assessment; and
- Environmental Management System (EMS) developed by the community for the community

The three steps support decision-making for sustainable development of the Aboriginal community, and in particular, remediation of environmental contaminants. The most current guidelines and standards are used to determine the nature of and measure the impacts of the contaminant (petroleum) on both the environment and human health, in addition, reviewing the most applicable decision-making matrices ensures a more holistic or integrative approach to Aboriginal health, thereby developing a more robust measure of Aboriginal health.

1.0 INTRODUCTION

Aboriginal peoples in Canada have the poorest health of any people living in BC and Canada as a whole (The Report of the Royal Commission on Aboriginal Peoples, 1996, as cited in The Report of the Auditor General of Canada, 2000). The report stated that the average life expectancy is 12 years less for status Indians than for British Columbians or other Canadians. Chronic diseases, respiratory system diseases such as pneumonia and influenza, are twice as prevalent in Aboriginal populations, and the incidence of digestive system diseases are three times higher compared to other Canadians. According to a recent report entitled Plans and Priorities, Health Canada has designated Healthy First Nations and Inuit communities as a high priority. As well, the report stated that there is an urgent need to improve the health status of Aboriginal populations.

Health status is measured by using health indicators. Current indicators of health status for all Canadians include life expectancy, incidence of disease, demographics, population size, degree-of-isolation, lifestyle, level of education, level of employment and vital statistics.

1.1 Definition of Problem

The 1999 edition of the Regional Health Authorities Handbook on Aboriginal Health stated that current health indicators are inadequate. To more fully determine the measure of Aboriginal health, parameters such as health and safety practices at home and throughout the communities must be included as health indicators, and

environmental determinants. Environmental influences in the home and community setting can be measured through the use of tools such as environmental audits, risk assessment and risk perception.

A study to determine whether or not Aboriginal health is negatively affected by environmental influences and the perception of risk associated with those environmental influences on their health was conducted. In particular, the study looked at petroleum contamination as a specific environmental contaminant in the community of Kispiox.

Chapter one examines the practical approach to the investigation describing why and how the study was conducted. Chapter two provides background on the case study community including climatic, geologic, seismologic and ethno-botanical information. Chapter three describes the research methodology, where and how to obtain the necessary information to support the hypothesis. Chapter four features the specific contaminant of environmental concern to the community. Chapter five describes the findings and analysis of the study. Chapter six focuses on the existing infrastructure for sustainable development in First Nation (FN) communities using Health Canada's SD strategy for FN communities. Chapter seven identifies ways and means to communicate the research results and respond to community members' concerns. Chapter eight suggests recommendations to improve the well-being of the community.

1.2 Research Focus

To accurately assess the number of environmental contaminants (EC) that pose a risk to the community of Kispiox a study was conducted with a focus on human health risk relevant to the contamination found.

As part of this research the study consisted of two phases. Phase one involved a literature search of the most up to date scientific information on petroleum contamination including pathways to humans and subsequent health risk, and included a field investigation report to qualify and quantify the petroleum contamination present in the community.

Phase two, complemented phase one as it brought the human dimension into the problem formulation stage. It included a survey wherein one hundred community members actively participated in sharing their knowledge and beliefs regarding EC in their community.

1.3 Research Methodology

Phase one of this thesis outlines the approach used to assess risk associated with EC in one FN community. The case study used to investigate the human health effects of exposure to petroleum contamination was the FN community of Kispiox, BC. Kispiox was identified as the most contaminated out of five communities selected to receive a preliminary site investigation. The findings were ranked for risk to human health using the National Classification System for Contaminated Sites (NSCSC) (Appendix A, A-1). This ranking system takes into account contaminant

characteristics, exposure pathways (e.g., direct contact, contamination of groundwater used for drinking water, and surface water contamination) and receptors (human and ecological). The emphasis of this study was on human health concerns. The second guideline used in the study was the Guidelines for Canadian Drinking Water Quality. This guideline defines the maximum acceptable concentration (MAC) of parameters based on human health risk or aesthetic objective (AO).

Phase two consisted of a survey using a questionnaire designed to collect data on five aspects of Aboriginal life, including perceived health status, perceived risk associated with petroleum contamination, percentage of sustenance activity (hunting and gathering), attitudinal perception to individuals contaminating the local environment, and perception of future of the community. One hundred Aboriginal people were surveyed. The objective of the survey was to determine the level of knowledge and attitude concerning petroleum contamination, relative to the five aspects of Aboriginal life as they relate to health risks, subsistence activity and the future of the community.

1.4 Research Goal

The research goal of this thesis is to create a more robust measure of Aboriginal health. More indicators that reflect the whole person must be developed and included in the definition of health. This will further implementing the mission statement of Health Canada – **Our mission is to help the people of Canada maintain and improve their health.** The research was concerning environmental

contamination in a FN community which uncovered the complex interactions between food, culture and the environment. The research suggests that the presence of environmental contaminants can have profound effects on the way of life of Aboriginal communities beyond physical health risks posed by the contaminants themselves (Federal, Provincial and Territorial Advisory Committee on Population Health, Health Canada, 1999). Therefore, it is necessary to develop health indicators that better reflect life in FN communities. Health indicators unique to Aboriginal people would entail a high degree of investigation into the social fabric of Aboriginal society and would therefore take considerable time to define. To include environmental influences such as contamination of home and community as health indicators would provide a more accurate and immediate, though not complete measurement, of Aboriginal health.

The Environmental Health Program under the auspices of Health Canada serving the needs of First Nations and Inuit peoples has drafted a proposal relative to environmental health indicators that would serve to measure steps leading to a positive health outcome in the Aboriginal/Inuit community. **The goal: To assess the risk of environmental contaminants (EC) to First Nations/Inuit people (exposure, types, etc) and to manage and communicate that risk effectively.** The Environmental Health Indicators were based on the World Health Organization (WHO) principles of Measuring Health System Performance Table 1-1 (R. Lawrence, personal communication, July 25, 2000).

Table 1.1. Environmental Health Indicators

Activities 1. To support, investigate and consult with FN regarding their concerns about environmental contaminants including lease land issues. 2. Establish linkages with relevant organizations and government departments. 3. Participate in environmental assessment review process. 4. Participate in remedial programs and risk communication.
Outputs 1. Number of concerns fielded. 2. Number of communications delivered to FN communities. 3. Number of research projects.
Health outcomes 1. Reduction in anxiety through appropriate treatment, risk management and risk communication. 2. Improvements in health outcomes through eliminating/decreasing exposure to hazardous contaminants.
Indicators 1. Number of communities with EC that pose a risk to the community. 2. Community's awareness and understanding of environmental contaminants. 3. Number of advisories issued on health risk to communities. 4. Number of risk management strategies underway.

1.5 Organization of Study

This study was organized with the intent to be adaptable to any EC query that an Environmental Health Officer, may encounter during the execution of his or her duties. The study contains two phases; one a literature search and field report generated as a result of physical inspection and sample analysis of the mediums selected for consideration (drinking water and soil) and two, a stakeholder participation activity (in the form of a questionnaire) that involved local community members to voluntarily contribute to the data gathering exercise (Appendix B). The approach taken to the organization of the study was to define the problem: Is there an adverse health effect between environmental contaminants in Aboriginal communities and Aboriginal health? The research was organized into the following steps:

- determine a frame of reference for the community's physical infrastructure and profile;
- ascertain areas of possible concern, relative to historical practises concerning spillage of home heating fuel, heavy equipment lubricants and motor oils and other petroleum products found in a remote community setting;
- following data collection, develop a strategy to examine the findings in light of the appropriate guidelines and standards for the sample mediums selected;
- identify a risk management and risk communication protocol in keeping with the Sustainable Development strategy for FN communities as outlined by Health Canada;
- examine possible avenues of communication that would enlighten the Kispiox community; and

- compile the physical and management recommendations for consideration by the stakeholders (Kispiox, Health Canada, and the Scientific community)

This particular organizational approach provides a precise yet generic set of steps that can be followed for any contamination or perceived threat of contamination in any FN community across Canada. The principle applied to develop a series of steps that an EHO can employ was taken from the Adaptive Management as defined by the BC Forest Service. Table 1-2.

Table 1.2. Steps to an Investigation

Step 1 Verify Complaint	**Obtain exact location of suspected contamination site.** **Complainant's name date and time of call.** **Collect as much information as possible during interview of complainant.** • Kind, quantity, structure from which contamination is emitting. • Local weather conditions, wind speed and direction. **Visual/Physical inspection.** **Record all data.** **Measure staining area.** **Take photographs with date and time recorded on each photograph.** **Contact Emergency Services FNESS, CANUTEC, MOE.** **Request all information collected from other sources be sent to EHS office.**
Step 2 Notification of Senior EHO	**Contact Senior EHO and submit information obtained from Step 1.** **Provide an estimated time of arrival to the site and a contact number.**
Step 3 File report to Senior EHO, Chief and Council	**Details to Senior EHO, Chief and Council.**
Step 4 Recommend Appropriate Action	**Draft a Contribution Agreement between Health Canada and the FN community to investigate further.**
Step 5 Conduct a Screening Level Evaluation	**Environmental consultants should be included in the evaluation of risk.** **Create a work plan to include the following:** • Review and integrate available information (local topography, population, hydro geological data, location of schools, institutes in or around spill site). • Complete a preliminary evaluation of available information. • Rank the risk (using an accredited risk ranking protocol).
Step 6 Conduct A Survey	**Query the general population of the community – as to awareness of contamination.**
Step 7 Provide Ongoing Consultation To Chief And Council	• Determine a contact and protocol for information sharing. • Schedule public meetings in community. • Record concerns from public. • Respond to concerns using the best available knowledge.
Step 8 Prepare General	**Provide to FN community and any adjacent communities using various means of media.**

Statement	
Step 9 Engage FN Community	**Members in remediation plan must be informed of all options in order to make responsible decision.**
Step 10 Integrate Final Report	**Final report must be an integration of data from all sources:** • Environment Canada • FNESS • CANUTEC • PEP
Step 11 Develop A Strategic Plan	**Plan of action for decision-making must include:** • FN community mission and vision statements for their community growth and development • Establish methods of clean up, prevention and protection using current guidelines
Step 12 Generate Final Report	**With recommendations and submit to:** • Health Canada • Chief and Council
Step 14 Record Feedback From Community	**Environmental Management Systems require detailed feedback:** • Evaluate the public response relative to scientific uncertainty • Adjust to the feedback, information and data collected
Step 15	**Respond to step 14 in a timely manner.**

2.0 BACKGROUND – THE COMMUNITY OF KISPIOX

2.1 Background

In general, information regarding Aboriginal people is sketchy at best (Kendall, 2000). Aboriginal people view human health within a model that embodies physical, emotional, intellectual and spiritual well-being (Federal, Provincial and Territorial Advisory Committee on Population Health, 1999). A further challenge to the determination of Aboriginal health is the knowledge gaps associated with the "value of health indicators to Aboriginal People" (Mussell et al, 1999).

Pathways that have the most relevance to FNCs and Aboriginal health status are vegetation (berries and alder trees), animals and fish (moose and salmon), drinking water and soil (Appendix T, T-5 and T-6). The effects of each pathway demonstrate ways and means of understanding the interactions between human (anthropogenic) activity and the biosphere as they relate to environmental pollution, land use and ecosystem health.

Western scientific knowledge systems, which include the design and application of health indicators, cite formal employment as one of their criteria but have omitted a critical aspect of Aboriginal employment (time spent hunting, gathering and fishing for food - subsistence activity). As a result, these tools of measurement for health fall short of Aboriginal reality as demonstrated in the Canadian Arctic Contaminants Report (CACAR) (INAC, 1997). Should this omission not be addressed, the fallout will result in a continued poor health status for the individual Aboriginal person.

2.2 Location of Community

The Gitksan territory is located in the Pacific northwest of BC and consists of five communities; Gitanmaax, Kispiox, Sik-E-Dahk, Gitanyow and Gitwangak. Kispiox is located at the confluence of the Kispiox and Skeena Rivers, and is located sixteen kilometres north of the District of New Hazelton, as shown in (Appendix C, C-1 and C-2, 3). The Kispiox Band has an allocation of ten separate land reserves situated along or near the Skeena River. The community of Kispiox resides in the area known as Kispiox Indian Reserve No. 1 (IR) immediately north of the confluence of the Skeena and Kispiox Rivers (Figure 1), (Golder, 2002). The remaining nine reserves are used as traditional fishing grounds. Kispiox IR No. 1 is the most populated of the ten reserves (Golder, 2002). This study was conducted in the Kispiox IR No.1, as it appeared to have the most significant number of potential areas of concern (Smith, 1997).

Highway 49 crosses the community from the south boundary to the north boundary. The Skeena and Kispiox Rivers enter the community along the northern boundary, the Kispiox River flows into the Skeena in the southern portion of the community and the Skeena exits the community in the central portion of the southern boundary. The majority of the band members live immediately north of the confluence of the two Rivers (Appendix C, Figure 1), (Golder, 2002).

2.3 Demographics

Population statistics provided by the GGC indicated that, as of December 31, 2001, there were 638 Kispiox band members, 90 members of other bands and 30 non-registered people residing in Kispiox for a total population of 758 (Golder, 2002).

2.4 Geomorphology

Geomorphology is critical to risk assessment especially in the Problem Formulation stage wherein the frame of reference for the environmental risk is established. To illustrate, knowing the subsurface adds to the information sources from which to draw conclusions as to migration of contaminants, or possible directional flow and chemical weathering.

The geomorphological setting of Kispiox is located in the Skeena River valley and is flat to gently sloping. West of the Kispiox River, the land slopes steeply to the west. Soil in the river valley consists of Pleistocene boulder clay overlain by recent river alluvium comprised of silt, sand and gravel.

The rivers that make up the watershed region and impact on the life of the Gitksan people are the Nass (northwest), Kispiox (north) and Babine (northeast), (Smith, 1997). The Skeena River is the predominant drainage system for the area. The mountain range influences are the Hazelton Mountains to the west and the Skeena Mountains to the east.

The following description illustrates the soil profile, which is common in the Kispiox area. The Geological Survey of Canada (GSC) map 1557A (Clague, 1984 as cited in Golder, 2002) depicts Kispiox as being located in a river terrace escarpment that

consists of surficial deposits of gravel and sands greater than 2 m in thickness, with generally one to several metres of sand overlying gravel. A stratigraphic cross section taken approximately 4 km from Kispiox and east of the confluence of the Shegunia and Skeena Rivers found the same river terrace material with a similar description of the soil profile - 25 m of glaciofluvial and fluvial gravel in the top (and 5 m of glacioalacustrine clay, silt sand and yet another 25 m of glaciofluvial and fluvial gravel) finally, a 20 m layer of ice-contact gravel (Golder, 2002).

The results of a preliminary soil investigation by R. E. Graham Engineering Ltd. (as cited by Golder, 2002) indicated the following soil characteristics and that the general subsurface profile in the region south of the active landfill and north of the community consisted of topsoil over medium dense sand and cobbled gravel. A layer of silt was found at a depth of 1.3 m. Groundwater was not encountered. The percolation rate was estimated to be less than 5 min/25 mm in the sand and gravel layer. This percolation is typical of sand and gravel deposits and bespeaks the rate of migration for contaminants in this kind of subsurface material.

2.5 Hydrogeology

The community of Kispiox is situated immediately north of the confluence of the Skeena and Kispiox Rivers. Although a detailed hydrological assessment has not been conducted, the presumption of groundwater flow direction is variable and is inferred to be toward the west (Kispiox River) or southeast (Skeena River).
The geotechnical and hydrogeological assessment of the active landfill reported that during the period of high recharge (freshet) a perched water table is likely to exist over the thin layer located above the bedrock surface. Outside peak recharge

events, the water table is likely situated beneath the bedrock surface. The bedrock surface was observed between six and eight meters below ground surface. Groundwater flow direction at the landfill is presumed to be in the southeast toward the Skeena River.

2.6 Climatology

Climatology is important to the risk assessment as weathering and vegetative growth influence the behaviour of contaminants discharged into the environment. The climate zone in which Kispiox is located is dominated by easterly moving air masses that produce cool, wet winters and warm dry summers. The regions closest to Kispiox that collect climatic data are Smithers and Terrace. Table 2-1 summarizes the relevant climatic statistics for these communities compiled by Environment Canada from climatic data from 1942 to 1990 (as cited by Golder, 2002). The table features the highest/lowest daily maximum temperature (H/LDMT) recorded in degrees Celsius, the highest/lowest monthly precipitation (H/LMP) recorded in millimetres, Total annual precipitation (TAP) recorded in millimetres and annual snowfall (AS) recorded in centimetres.

Table 2.1 Climatic Data 1942-1990

Community	Smithers	Terrace
HDMT (^{0}C)	21.4 July	21.3 July
LDMT (^{0}C)	-5.2 January	-2.4 January
HMP (mm)	62.3 October	200.8 October
LMP (mm)	18.0 April	44.1 June
TAP (mm)	509.5	1295.3
AS (cm)	216.4	389

This area is known today as the Hazeltons, and is comprised of boreal forest and seven of the fourteen biogeoclimatic zones of BC. Kispiox is situated within the Interior Cedar-Hemlock (ICM) biogeoclimatic zone BC Ministry of Forests (as cited in

Golder, 2002). Of the fourteen biogeoclimatic zones in BC, the ICH zone is the most productive and has the greatest diversity of tree species. Western red cedar and western hemlock dominate the mature forests in the zone (Golder, 2002).

2.7 Seismology

The plate tectonic theory is used to explain the development and activity of the western limit of Canada. The region is still geologically lively, with frequent earthquakes, bubbling hot springs and recent volcanic activity (Monger, 1965). The Pacific plate is sliding eastward at a rate of six centimetres per year relative to the North American plate. The boundary between these two giant plates is the Queen Charlotte-Fairweather fault – Canada's equivalent to the San Andreas fault. This boundary is in fact a transform fault.

Canada's largest historical earthquake measured at a magnitude of 8.1 on the Richter scale had occurred on August 22, 1949 (Natural Resources Canada, October, 2001). Since then, there have been numerous events including the recent one of Thursday evening October 11, 2001 registering a magnitude of 5.8 (CBC news, October 12, 2001). This is a concern with regard to petroleum USTs. Kispiox is inland from the fault area but neighbouring communities have contaminants in volume exceeding 80,000 gallons located in the subsurface between a clay lens and the water table (Golder, 2001). Seismic hazard is constantly being monitored according to J.Cassidy, seismologist with Geological Survey of Canada in Sydney, BC (personal communication, November 12, 2001).

2.8 Ethnobotany

The principles of Traditional Ecological Knowledge (TEK) and individual health are closely intertwined, given the community's reliance on subsistence activities and hunting. In his book Ethnobotany of the Gitksan Indians of BC, Harlan Smith recorded information about 112 botanical species and their traditional cultural roles among the Gitksan (Smith, 1997).

2.9 Aboriginal Culture

Local implications of the stressor (EC) can be felt in Aboriginal cultural expression due to the significant build-up of fuel oils and toluene in plants and animals (ATSDR, September 1996). Subsistence activity includes the traditional gathering of indigenous berries and edible plants, as well as hunting bear, caribou, mountain sheep and moose that could impact on the Aboriginal population by ingestion of foods grown locally or by reducing the species as a result of contamination.

The differences between Western Scientific Knowledge and Traditional Ecological Knowledge which exposes the paradigms of each culture is summed up in a statement made by an unidentified First Nations Elder of the West Coast as quoted by Dr. William Rees, in a lecture given at Royal Roads University, March, 2000: **'" When are you people going to start acting like you're going to stay?"'** Dr. Rees mentioned that there are cultures remaining on Earth today that have no words to mean the environment; the implication is that peoples of these cultures do not treat or regard it differently from but rather, in and of themselves.

3.0 RESEARCH METHODOLOGY

3.1 Conventional Research

3.1.1 Literature Search

Conventional research included a literature search regarding the chemistry of petroleum and petroleum contamination with regard to its behaviour in the environment, exposure pathways and human health effects. The literature search also included a review of existing information in the form of historical aerial photographs (Appendix D, D-1, D-2), geographical and geological data, geotechnical and hydrogeological data. Additionally, a summary of previous environmental reports, and finally, a series of drinking water samples and soil samples were taken for analysis and interpretation.

To grasp an understanding of the environmental issues in Kispiox, an inventory of possible contamination sources was completed.

The media through which petroleum by-product contamination can impact on human health status includes soil, groundwater, food and air. For the purpose of this study and for reasons associated with time and budget, only soil and groundwater were considered. The obvious subsequent step to this study would be to examine food and air.

3.1.2 Risk Assessment Framework

The risk assessment framework approach had been selected as the more appropriate method of assessment of the environmental contaminants in the community. The risk based approach allowed for full consideration of land use, presence/absence of receptors and the presence/absence of operable exposure pathways in determining what if any remediation is required.

The three general conditions required for risk to be present at a contaminated site are:

- contaminant(s) present at hazardous concentrations;
- receptor present; and
- exposure pathway by which receptor comes into contact with the environmental contaminant (Appendix E, E-1, Figure 1)

It is important to note that if any one of these three conditions is absent, no risks to human health or ecological health would be expected (Hoover and Zapf-Gilje, 1998).

To determine whether these conditions are present at a site, a series of three analytical stages are carried out:

1. Problem formulation
    - Preliminary Considerations
    - Chemical Screening Process
    - Receptor Screening
    - Exposure Pathway Screening
    - Conceptual Exposure Model
2. Exposure and toxicity assessment

3. Risk characterization

The above is the framework for risk assessment that is typically used in Canada (Appendix F, F-1).

Problem Formulation

The problem formulation stage ensures that everyone agrees that the narrowing of the scope and simplification of the problem at hand is justifiable and in their best interests before everyone begins to pre-suppose the outcome of various detailed risk analyses. However, the abuse or omission of the problem formulation stage in environmental risk assessment is one of the most frequent errors by practitioners. There are no technical fixes for an ill-conceived conceptualization of the possible problem. Yet, many managers are scared or cynical about inviting stakeholder participation and empowerment in the process, D. Bright (personal communication, May 4, 2000).

To acquire a more holistic profile of Aboriginal life and the challenges to everyday living as well as the need to practise cultural expression, it is vital that the underpinnings of the study be integral to the concerns of those people. Therefore, it is for this reason that problem formulation was the focus of this study.

Problem formulation is the first stage in risk assessment. During this phase a focused understanding of the contaminated site is developed. By defining the goals of the risk assessment and describing conceptually how the receptors, contaminants, exposure and toxicity interact, a determination of associated health

risks can follow. The primary objectives of the problem formulation step in the risk assessment approach are:

- identify contaminants of concern;
- identify human and ecological receptors that may be present on the site currently or in the future; and
- evaluate how the receptors may come into contact with the contamination (Hoover and Zapf-Gilje, 1998).

Preliminary Considerations

In the risk assessment framework, preliminary considerations are a pivotal step to the process of accurately defining the risk(s) to human health. The framework is comprised of a screening level evaluation involving three steps:

1 Review and integration of available information

2 Preliminary evaluation of risk

3 Risk ranking

Step 1

Review and integration of available information

The first step in the field study was the collection and review of all relevant information pertaining to Kispiox. This included a review of existing reports and historical data. The primary objective was to identify former and current operations that may have resulted in soil and/or groundwater contamination. The presence/absence of contamination was based on observations, historical information and soil sampling.

Using the above information, an inventory of soil and groundwater contamination issues was identified. The issues included drinking water quality, solid waste disposal and residential fuel storage.

Step 2

Preliminary evaluation of risk

Health risk is calculated based on a number of factors including:

- type and amount of contamination;
- types of receptors present (some receptors are more sensitive than others);
- duration of exposure to the receptors;
- types of land use; and
- site activities carried out in the community.

To determine whether the above conditions are present at a given site and to quantify the risks, a series of analytical steps was carried out. The framework for evaluating risk in this study involved three stages:

1. a screening stage – problem formulation;
2. a detailed assessment stage for calculating the likely exposure dose and the toxicity of the contaminant; and
3. a risk characterization stage that describes the likely adverse health effects.

This study focused on the screening stage (stage 1), which is primarily qualitative. The quantitative methods (stages 2 and 3) would be recommended only if the problem formulation stage indicates the necessity (Appendix F, F- 1).

During the screening stage it was necessary to identify the contaminants of interest (COI), the potential human receptors and the exposure pathways that were relevant

for each issue of concern. The COIs were selected based on type of contamination known or suspected regarding the issue of concern. Potential human receptors were selected based on land use (residential, industrial) and the type of activity carried out in the area. The potential exposure pathways were selected by identifying the means by which a contaminant came into contact with a receptor.

The focus of this stage of the investigation was on pathways directly impacting human health. Indigenous plant and animal life forms a critical aspect of the lifestyle of Aboriginal people. The Gitksan enthnobotany is regarded as a historical treasure (Smith, 1929). Plant remedies are still sought after throughout the seasons, and continue to be a source of food, a subsidy to income and a resource for ceremonial purposes and aesthetics, thus playing an important factor in the health and well being of the individual First Nation resident.

Step 3

Risk ranking

Ranking the issues that were identified as a potential concern for residents was carried out using the National Classification Systems for Contaminated Sites (NCSCS); Canadian Council of Ministers of the Environment [CCME] 1992). The NCSCS is a ranking system that classifies contaminated sites into general categories of concern (Class 1,2,3, or N) in a systematic and rationale manner, according to their current or future potential for adverse impact on human health or the environment. Although the system is used in contaminated sites that far exceed the level of contamination found in Kispiox it still had direct application to this study. The application was specific to environmental issues identified in the soil and ground

water of Kispiox. A primary reason for its use was that it is an established and accepted risk based ranking system, which can be updated and used by other qualified individuals. In addition, the NCSCS also considers the potential risk to wildlife, and the final ranking for each issue found did include consideration of ecological issues (Golder, 2002). However, the application of NCSCS to Kispiox focused on human health risks and did not include ecological risks.

Using the NCSCS ranking system, each site within the community was classified regarding individual characteristics found at that site (Class 1,2,3, or N) according to priority of action. Sites requiring more information before a schedule of classification could be applied, were assigned a Class I, thereby designating them the highest priority and in need of immediate action. Class N sites are considered sites where there is not likely a need for action. The rationale for assigning a score to a site can been viewed in the NCSCS User's Guide (Appendix A, A-1-11).

3.1.3 NCSCS Definition of Classes

Table 3.1

Class 1 A class 1 rating (score 70 to 100) is interpreted as " the available information indicates that action (e.g. further site characterization, risk management, remediation, etc.) is required to address existing concerns. Typically, Class I sites show a propensity to high concern for several factors, and measure or observed impacts have been documented."
Class 2 A class 2 rating (score 50 to 69.9) is interpreted as "there is currently a high potential for adverse off-site impacts, although the threat to human health and the environment is generally not imminent. There is probably no indication of off-site contamination; however, the potential for this was rated high and therefore some action is likely required."
CLASS 3 A class 3 rating (score 37 to 49.9) is interpreted as "there is currently not a high concern. However, additional investigation may be carried out to confirm the site classification, and some degree of action may be required."
Class N A class N rating (score < 37) is interpreted as "there is probably no significant environmental impact or human health threats. There is likely no need for action unless new information becomes available indicating greater concerns, in which

case the Site should be re-examined."

Class I

A class I rating (Estimated Score > 15) is interpreted as "there is insufficient Information to classify the site. In this event, additional information is required to address the data gaps."

The screening methods typically used to identify contaminants, receptors and exposure pathways are described below.

Chemical Screening Process

For each chemical of interest (COI), appropriate CSR standards based on current and anticipated future land use are compared to the maximum detected concentration. Depending on the quality of data available at a site, an evaluation of the contamination using a statistical measure (the upper 95th confidence limit on the mean or the upper 90th percentile rather than the maximum concentration) (Hoover and Zapt-Gilje, 1998).

Receptor Screening

Human receptors are generally identified by considering the current and anticipated use of the land on or nearby the site. Onsite human receptors may include trespassers, workers (at an industrial/commercial site), recreational users (at a park) and residents. Off site receptors may include individuals who receive exposure via consumption of contaminated groundwater originating from the site or being influenced by the site (Hoover and Zapt-Gilje, 1998).

Ecological receptors can be identified through a site visit or assumed based on proximity of the site to a stream for example. Common ecological receptors include plants, other soil-dependent receptors such as soil invertebrates, mammals, birds and aquatic organisms (Hoover and Zapf-Gilje, 1998).

Exposure Pathway Screening

Once the sources and identity of the contamination as well as the relevant receptors are identified, the likely means of exposure can be determined (Hoover and Zapf-Gilje, 1998). The major pathways that are screened include air, soil and groundwater. To start the investigation of exposure pathway screening knowledge of how and into which environmental media the chemical was released. To illustrate, a scenario involving air in a dwelling as the environmental media would require consideration of how volatile contaminants present in the earth below that dwelling could volatilize from soil into indoor air, thereby becoming a potential exposure pathway through inhalation of the indoor air by the occupants.

Conceptual Exposure Model

The results of the problem formulation are summarized in a conceptual exposure model, which illustrates the pathway of the contamination through the relevant environmental media and the receptors of concern (Appendix G, G-1 and G-2). The conceptual model focuses on the subsequent quantitative aspects of risk assessment on only those pathways of potential concern (Hoover and Zapf-Gilje, 1998).

Exposure and Toxicity Assessment

Although this study focused on Problem Formulation, it is necessary to explain the two subsequent steps in the Risk Assessment Framework in order to emphasize the importance of step one (Problem Formulation) and its relativity to accurately measuring the risk.

Stage two in risk assessment is to quantify the exposure of the receptors and the toxicity of the contaminants. The exposure assessment involves estimating the dose of the contaminant received by the human or ecological receptors for each pathway identified in the problem formulation. Dose to humans is expressed as an amount of chemical per kilogram of body weight per day, while exposure to aquatic receptors is described by the concentration of chemical present in their habitat (Hoover and Zapf-Gilje, 1998). Site-specific data are used to characterize contaminant source concentrations (e.g. soil concentrations) and exposure media concentrations (e.g. groundwater concentrations) and conservative assumptions are employed to describe potential contact with the contamination. Hoover and Zapf-Gilje continue the protocol for exposure and toxicity assessment by identifying toxicity reference values for each contaminant of concern. The definition of a toxicity reference value is described as an acceptable dose or concentration of a contaminant that can be received by a receptor without experiencing adverse health effects. Both the type of health effect (e.g. cancer) and the pathway by which the chemical is received (e.g. inhalation) are considered when choosing appropriate toxicity reference values.

Risk Characterization

Risk characterization is the final step in the quantitative risk assessment and involves numerical estimation of the human and ecological risks. This step must be completed for all contaminants, receptors and exposure scenarios of concern (Hoover and Zapf-Gilje, 1998). Risks are calculated by combining the results of the exposure and toxicity analyses. To illustrate, comparison is made of the dose of a metal received by a person via soil ingestion to a reference dose for that metal. Hoover and Zapf-Gilje continue by explaining that if the amount of dose received is ultimately less than the reference dose, no adverse health effects are expected. Finally, the numerical scheme of presentation for the results of the characterization allows for definitive discussion of the significance of the predicted risks as well as any associated uncertainties.

3.2 Action Search – Questionnaire – Interviews

3.2.1 Questionnaire

The second stage of the study, action research, involved a questionnaire (Appendix B). Among the tools of measurement used to complement the conventional research method was a statistically valid questionnaire to survey one hundred people from Kispiox. The questionnaire was designed to solicit information regarding five aspects of Aboriginal life, including perceived health status, perceived risk associated with petroleum contamination, percentage of sustenance activity (hunting and gathering), attitudinal perception to individuals contaminating the local environment, and perception of future of the community.

3.2.2 Interviews

Action research also included community reconnaissance by Golder Associates representatives and the author. Interviews of local community members and others serving the community in a professional capacity included, Mr. Tony Siebert, P. Eng., for the Gitksan Government Commission, Ms. Brenda Stewart, CHN and Mr. Jim Angus, Kispiox School Administrator and Hereditary Chief.

The objective was to acquire as much information as possible to construct a frame of reference for the community profile in terms of historical practises that may impact on where and how to conduct the preliminary site investigation (soil and water sampling). The issues included contamination of drinking water, solid waste disposal, and residential fuel storage.

In the case of Mr. Angus, as Hereditary Chief his comments were appreciated for his insight into Traditional Ecological Knowledge. Below is the essence of the interview with Mr. Jim Angus:

Mr. Angus is a heretary chief in the Gitksan Nation, is very well known throughout the Aboriginal community of BC and has had the privilege of meeting with several Statesmen of this country. When asked about the meaning of Traditional Ecological Knowledge, he replied by saying that the Gitksan believe they are part of the earth and as such spirituality is built right in. This belief system is based on four values; (1) honesty, (2) trust, (3) respect and (4) humour. Mr. Angus continued by stating that without the value of humour one cannot heal in addition, humour gives balance. Also, he advised that it is time to wear our Blankets as the Blanket symbolizes our values. Tradition has taught the Gitksan that sustainability is key to the way we live. Mr. Angus used an example from his childhood to illustrate that point; his

grandmother instructed him to hunt for three rabbits, he brought back four rabbits instead, his grandmother responded by telling him "'be thoughtful that we are part of the earth and all that's on it, take only what you need"'. Mr. Angus reflected on the value of human beings that come into one's life to offer something leading one to a heightened awareness of oneself, admonishing that these people should be regarded as gifts. Furthermore, he commented on the concern his own father demonstrated respecting the vulnerability of the great rivers that pass through their community and their lives; "When we came here there was no pollution, today there are fewer fish." At the time Mr. Angus' father made the statement, Mr Angus, being a child, could not appreciate its significance, today however, Mr. Angus has allowed the TEK and the words of his elders to flow through him as demonstrated by his closing remark: "Always remember to say thank you to the Creator for the moose and the salmon" (Agus, January 14, 2002: Personal Interview).

3.2.3 Case Study – Kispiox

Kispiox was selected as the case study as it was determined to be the most contaminated out of the five communities considered. The case study provided a practical application of conventional and action research, which facilitated the development of a data baseline. That baseline included an inventory of chemicals of concern and of the human dynamics relative to petroleum contamination and health issues in the community.

4.0 CONTAMINANT OF CONCERN – PETROLEUM

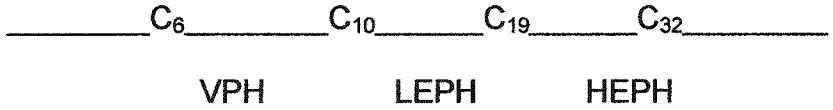
4.1 Chemistry of Petroleum

Some of the by-products of resource use of petroleum are crude oil and its derivatives containing hydrocarbon components, e.g. gasoline and diesel fuel. Some of the constituents of gasoline are benzene, ethylbenzene, toluene and xylene (BETX), all of which can be found in water as a result of pollution from oil spills or leakage from USTs and/or ASTs (Sawyer et al, 1994, p. 632). 1,2-dichloroethane and (prior to the 1990's) lead are also considered constituents of gasoline.

The damage done to aquifers is mostly irreversible or at best can take years before groundwater pollution reveals itself, and it is not known how chemicals react synergistically (Brown et al, 2001, p. 37).

The chemical nature of lighter as opposed to heavier hydrocarbons permits greater solubility in water. An example of a lighter hydrocarbon is commercial gasoline, which has solubility of 20-80 milligrams per litre (mg/l) and can be detected by taste and odour at concentrations less than 0.005 mg/l Figure 4.1, illustrates the concept of the demarcation by number of Carbons; lighter equal fewer Carbons whereas, heavier equates to more Carbons.

Figure 4.1 Hydrocarbon Weights



Minister of Supply and Services Canada, 1996, states that the only means for petroleum contamination in drinking water is a spill or leaking storage tank. The Guidelines continue, stating that exposure to petroleum contamination including gasoline in drinking water is not likely to occur, as taste and odour can be readily detected at concentrations well below the harmful effects level, therefore, people would not drink it. However, maximum acceptable concentrations (MAC) have been developed for constituents of gasoline. These constituents of gasoline are toluene, ethylbenzene and the xylenes (there are three possible xylene isomers) all belonging to a group of organic compounds known as alkyl benzenes. These chemicals have been used as gasoline additives. Alkyl benzenes are recognized primarily as atmospheric pollutants because of their high volatility, but small amounts can enter aquatic and terrestrial ecosystems (e.g. gasoline spills and leaking storage tanks) (Minister of Supply and Services Canada, 1996). The US EPA has set the maximum permissible level at 0.005 mg/l. Further, lighter hydrocarbons pose a greater threat to groundwater due to solubility resulting in greater migration along groundwater flow paths (Freeze and Cherry, 1979). The resulting implication of petroleum product discharge into the environment (ecosystem of soil, water and vegetation) is contamination. Water-soluble organic chemicals such as oil and gasoline threaten human health and harm fish and other aquatic life (Buchholz, 1998).

The toxicology of toluene, ethylbenzene and the xylenes suggest that the exposures or doses related to the induction of central nervous system, respiratory or irritant effects exceed, by several orders of magnitude, the levels known to elicit

organoleptic effects (Minister of Supply and Services Canada, 1996). Because of the chemical nature of petroleum products, their behaviour (low solubility), once released into the environment is referred to as non-aqueous phase liquids (NAPL). However, these NAPL's are "slightly" soluble and these solubilities tend to be in orders of magnitude higher than the regulatory standards.

Toluene is found in petroleum products including heating fuel. Relative to this study, the PSI involved a review of historical data to quantify the number of buildings and homes that used this type of heating source. This data was reflected in the evaluation of the community in terms of risk assessment for present or potential hazard according to the NCSCS.

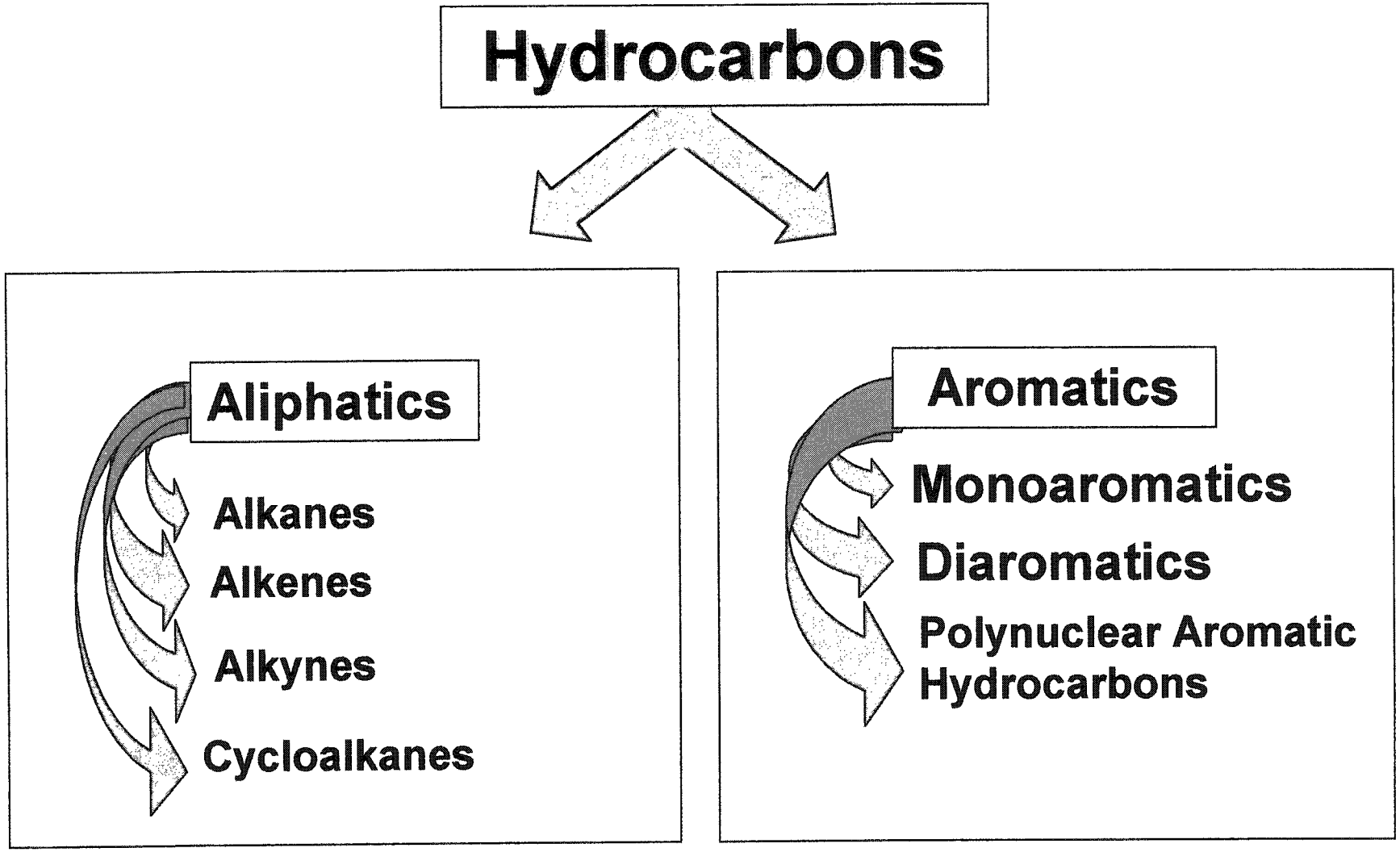
The chemical composition of petroleum products is complex and may change over time following release into the environment. In an effort to assist site managers, risk assessors, regulators and community members in understanding the complexities of total hydrocarbon characterization in soil and water at petroleum contaminated sites and implement health risk-based decisions at these sites the chemical composition and technical information was examined.

The following is a clear definition of the chemistry of petroleum.

> Crude oil, the source of nearly all petroleum products contain, a variety of elements combined in various forms. The principle constituents are carbon and hydrogen atoms, which are arranged in varying structural configurations to form hydrocarbons. Hydrocarbons are divided into two families, aliphatics (fatty) and aromatics (fragrant). Aliphatics are further divided into three main classes, alkanes, alkenes and cycloalkanes (Potter and Simmons, 1998, p.2).

Figure 4.2 on the following page illustrates hydrocarbon structural relationships.

Figure 4.2 Hydrocarbons



On a molecular level, aliphatic and aromatic compounds differ by the patterns of bonding between adjacent carbon atoms. Aromatic molecules have ring structures, are flat and symmetric with clouds of electrons above and below the plane of the molecule. Aromatic carbon-carbon bonds are termed resonance bonds because electrons are shared between multiple carbon atoms. This makes the electrons "delocalized" (participating in several bonds). This imparts chemical stability. Whereas, aliphatic structures contain highly directional bonds in which carbon atoms share electrons only with adjacent carbons. The molecules are free to rotate around these bonds therefore the aliphatic structures can have many conformations (Weisman, 1998).

The bonding pattern of aromatic structures contributes to their moderate polarity. The electron clouds surrounding the molecules can be deformed by the charge on the adjacent molecules. This results in partial positive and negative charge sites on the molecule. However, aliphatics are nonpolar or only slightly polar. Their bonding pattern does not result in non-uniform distribution of charge on the molecule. This pattern of polarity of hydrocarbon structures governs the degree of interaction among molecules and with water. As polarity increases so does water solubility and boiling points. Aromatics are more water soluble and less volatile than alkanes with a corresponding number of carbons (Weisman, 1998).

The hierarchy of hydrocarbons not only include family, sub-family but homologous series. Each member of a series is termed a homolog, and can differ by the repeating of a unit such as CH_2 group. Within a homologous series, physical

properties of compounds change with the number of carbon atoms. To explain, there is an increase of 20^0 C for every carbon atom added to an n-alkane chain. The persistence of petroleum hydrocarbon compounds in the environment increases as the compound's boiling point increases (Weisman, 1998).

Because data for all components of petroleum hydrocarbons is not available, characterization by way of typical physical-chemical properties for subsets of an entire mixture (called fractions) was devised (Weisman, 1997). Fractions are determined based on a range of physical-chemical properties and simple partitioning models. Hydrocarbon mixtures separate and partition based on the make-up of the individual chemicals. Some chemicals degrade, some persist, some are mobile, and some adhere tightly to soil particles (Weisman, 1997). Chemicals similar in nature and boiling point (e.g. aliphatic and aromatic) behave similarly.

Petroleum hydrocarbons have large numbers of isomers. Isomers are compounds that have the same elemental formula but have different structural configurations. Proportionally as the number of carbon atoms increase so do the number of isomers. An alkane with six carbon atoms has five possible isomers. Increasing the number of isomers to ten would increase the number of isomers to seventy-five. The large number of isomers account for the complexity of petroleum mixtures, to illustrate, the higher the boiling point, the higher the number of carbon atoms and the higher the number of isomers therefore, the greater the chemical complexity.

4.1.1 Alkanes

Alkanes contain single carbon-carbon bonds. The simplest alkane is methane (CH_4), which is comprised of a single carbon atom and four hydrogen atoms. Methane is the single carbon homolog (member of structural series) and ethane is the two-carbon homolog in the straight chain alkane family. Ethane (C_2H_6) consists of two carbon atoms, each of which participates in directional bonds with three hydrogen atoms and the remaining carbon atom. The homologous series of straight-chain alkanes continues on from methane to tetracontane ($C_{40}H_{82}$), see Table 4.1 - Alkane Nomenclature and Chemical Formulae.

Table 4.1 Alkane Nomenclature and Chemical Formulae

Name	Formula	Name	Formula
methane	CH_4	heneicosane	$C_{21}H_{44}$
ethane	C_2H_6	docosane	$C_{22}H_{46}$
propane	C_3H_8	triosane	$C_{23}H_{48}$
butane	C_4H_{10}	tetracosane	$C_{24}H_{50}$
pentane	C_5H_{12}	pentacosane	$C_{25}H_{25}$
hexane	C_6H_{14}	hexacosane	$C_{26}H_{54}$
heptane	C_7H_{16}	heptacosane	$C_{27}H_{56}$
octane	C_8H_{18}	octacosane	$C_{28}H_{58}$
nonane	C_9H_{20}	nonacosane	$C_{29}H_{60}$
decane	$C_{10}H_{22}$	triacontane	$C_{30}H_{62}$
undecane	$C_{11}H_{24}$	hentricontane	$C_{31}H_{64}$
dodecane	$C_{12}H_{26}$	otriacontane	$C_{32}H_{66}$
tridecane	$C_{13}H_{28}$	tritriacontane	$C_{33}H_{68}$
tetradecane	$C_{14}H_{30}$	tetratriacontane	$C_{34}H_{70}$
pentadecane	$C_{15}H_{32}$	pentatriacontane	$C_{36}H_{72}$
hexadecane	$C_{16}H_{34}$	hexatiacontane	$C_{37}H_{74}$
heptadecane	$C_{17}H_{36}$	heptatriacontane	$C_{38}H_{76}$
octadecane	$C_{18}H_{38}$	octatriacontane	$C_{39}H_{78}$
nonadecane	$C_{19}H_{40}$	nonatricontane	$C_{39}H_{80}$
eiosane	$C_{20}H_{42}$	tetracontane	$C_{40}H_{28}$

Alkane groups that are substituted onto hydrocarbon structures have their carbon numbers described by the same prefixes (Table 4.1- Alkane Nomenclature and Chemical Formulae) and complete nomenclature has a –yl suffix. An example of a single-carbon alkyl substituent is methyl-, in addition a two-carbon substituent is ethyl-, a three-carbon substituent is propyl- and so on.

Structural isomers are compounds that share the same formula but have distinct chemical structures or configurations of the formula. To explain, n-Heptane, 3,3-dimethylpentane and isoheptane are all described by the following formula C_7H_{16} (Appendix H, H-1, Figure 4.3) for the three varying structures.

4.1.2 Alkenes

Alkenes are hydrocarbons that contain less hydrogen, carbon for carbon than the corresponding alkane group. This is due to the occurrence of one or more double bond between the carbon atoms in the alkene structure. An alkene is the unsaturated form of the corresponding saturated alkane. Butane for example, is described by the chemical formula C_4H_{10}. Alkenes are named by replacing the ending – ane of the corresponding alkane name with – ene refer to Table 4.1. The alkene name is preceded by a number (or numbers in the case of multiple double bonds), which indicates the position of the first double-bonded carbon in the chain. For example 2-Pentene describes a hydrocarbon that has a five-membered chain with a double bond between the second and third carbons. Alkenes that contain two double bonds are termed dienes. When the two double bonds are separated by a single bond, they become conjugated dienes. These dienes have increased stability due to the fact that the electrons are delocalised across the two double bonds and the single bond between them (Weisman, 1998).

The electron pair of any double bond is distributed around the entire diene group resulting in the carbon-to-carbon bonds being thought of as partially single and partially double bonds. The carbon atom involved in a double bond lies at the

centre of a flat triangle, with three bonds being directed toward the triangle corners. The two carbon atoms of a double bond and the four groups attached to them all lie within the same plane. The structural configuration of the double bond gives rise to geometric isomers (Weisman, 1998).

4.1.3 Cycloalkanes

Cyloalkanes are alkanes where carbon atoms form cyclic structures. The naming of cycloalkanes is the same as the naming of alkanes (Table 4.1) with the addition of a cyclo – prefix. For example a five-carbon alkane ring is cyclopentane. Cycloalkane compounds can exhibit configurational isomerism in that attached groups can differ in their positions relative to the ring (Weisman, 1998).

4.1.4 Aromatics

Aromatic hydrocarbons have one or more benzene rings as structural components. Benzene is a six-membered carbon ring with the chemical formula C_6H_6. There are three carbon-to-carbon single bonds that alternate with three carbon-to-carbon double bonds. The bonds of benzene have electron pairs that are delocalised across the entire six-membered ring. This gives benzene more polar characteristics than alkanes or alkenes, electron clouds being more easily deformed by opposite charges on other molecules (Weisman, 1998).

A monoaromatic compound has one benzene ring with either six hydrogen groups, or a combination of alkyl and hydrogen groups, attached to that six-

carbon aromatic ring. A diaromatic compound has two fused benzene rings as its basis with eight hydrogen or alkyl groups attached to the rings (Weisman, 1998). The electron pairs of the five double bonds are delocalised across both rings of the diaromatics. Polynuclear aromatic hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic, and their structural stability results from the concomitant electron pair delocalisation. PAHs have various alkyl groups and hydrogens attached to the mulit-ringed structure. In general, alkyl-substituted PAHs predominate in petroleum. For example, there are much higher concentrations of methylphenanthrene and dimenthylphenanthrene in diesel fuel than phenanthrene (Weisman, 1998).

[Structures of a Monoaromatic, an Alkyl-monoaromatic, a Diaromatic and Polynuclear Aromatic Hydrocarbons (Appendix H, H-2, Figure 4.4]).

4.1.5 Other Petroleum Fuel Mixture Components

Organic compounds containing sulfur, nitrogen and oxygen can be found in crude oil and some heavier fuels such as No. 6 fuel oil.

Metals are also found in petroleum fuel mixtures in the form of salts of carboxylic acids, or as porphyrin chelates. Vanadium and nickel are found in high concentrations in crude oil and residential fuel oils.

4.1.6 Petroleum Fuel Mixture Specifications

Petroleum fuel mixtures have general characteristics such as average density (g/mL), approximate carbon number range (of the predominate) n-alkanes,

distillate characteristics, hydrocarbon compound structural classes, and typical end uses. Low-end through to high-end distillates are the fractions collected from a specific boiling temperature range, low-end fractions from 40^0 C to 200^0 C, middle-end fractions from 200^0 C to 300^0 C and high-end from 300^0 C to 600^0 C.

4.1.7 Weathering On Petroleum Product Composition

Weathering occurs when petroleum products are released into the environment. The changes in composition of the petroleum is dependent upon the medium in which the petroleum is released. The main weathering processes are dissolution in water, volatilization, biodegradation and photodegradation. Each process of weathering affects the various hydrocarbon families differently. To explain, aromatics tend to be more water soluble than aliphatics, whereas, aliphatics tend to be more volatile. Therefore when petroleum is released into the environment the aromatics will be the principle water contaminants, while aliphatics will be the principle air contaminants. Solubility and volatility decrease with an increase in molecular weight of the compound. The more soluble and volatile compounds are lost most rapidly from contaminated soil, due to the low molecular weight of the compound (Weisman, 1998).

The rates of weathering by dissolution in water or volatilization of individual petroleum compounds are retarded by the being in a mixture. For example the solubility of pure benzene in water is approximately 1800mg/L. The equilibrium concentration of benzene in water in contact with gasoline containing one percent benzene is approximately 20 mg/L. Solubility and volatility of individual

compounds in petroleum hydrocarbon mixtures are proportional to the solubility or volatility of the compound in its pure state and its concentration in the mixture (Weisman, 1998).

The effects of leaching and depletion of benzene, toluene, ethylbenzene and xylene (BTEX) from gasoline in soil have been evaluated in laboratory studies. Benzene is the most soluble member of this homologous series whereas ethylbenzene and xylenes are the least soluble. Benzene will deplete rapidly from the gasoline-saturated soil, while ethylbenzene and xylenes tend to increase in concentration. Leaching rates are directly proportional to their pure-state water solubilities.

The lower molecular homologs within each series would be depleted first through the weathering process (volatilization) due to their lighter molecular weight, the greater a compound's volatility the more rapid its loss from a hydrocarbon mixture (Weisman, 1998).

4.2 Pathways of Petroleum

Identification of the type of petroleum product on the site and trace history of petroleum use at the site, along with a visual assessment of the soils or sediment should be completed in order to determine the pathway. Further, a collection of information pertaining to current and future uses of site, the presence of water bodies at or near the site, topography at the site, and surrounding land use should be compiled for examination of the transport potential of the petroleum

product. Information should include current physical data collection and historical data from previous investigations. Following the identification of sources of contamination, a description of potential transport pathways on and off site must be created (Vorhees, 1999). This study is based on the Problem Formulation phase. Therefore, the screening level evaluation must be as detailed and comprehensive as scientifically possible. Table 4.2 depicts a complete exposure pathway (Vorhees, 1999, p. 17).

Table 4.2 – Complete Exposure Pathway

Complete Exposure Pathway
A complete exposure pathway has a source of contamination, a transport pathway by which the contaminant travels from the source to a person, and a person who may be exposed to the contaminant (USEPH, 1992 as cited by Vorhees, 1999 p. 17). • **Source:** Fuel leaking onto the ground from an AST. • **Pathway:** Direct contact or incidental ingestion of contaminated soil, inhalation of compounds volatilizing from contaminated soil, ingestion of contaminants leaching to groundwater. • **Humans exposed:** Construction worker, Resident, Trespasser, depiction of complete exposure pathway (Appendix G).

4.3 Human Health Effects

Gustafson, Tell and Orem (1997) stated that "human health risk as related to petroleum contamination is directly linked to the exposure potential of the particular petroleum product. The fate and transport of a chemical or mixture defines the exposure route in conjunction with receptor properties and concentrations at receptors" (p. vii). Fate and transport must be considered to fully assess the human health risk, establish clean-up protocol and develop regulatory guidelines.

The method used to delineate Total Petroleum Hydrocarbons (TPHs) into equivalent carbon number fractions is based on the fate and transport considerations (Gustafson et al, 1997, p. viii). This construction method includes the composition data of the fuel and petroleum product. Once fractions are defined, fraction-specific values of relevant physical-chemical properties are calculated based on the correlation to boiling point (Gustafson et al, 1997 p. 2). From this point in the analysis of the particular petroleum product, a toxicity criteria (TC) can be developed, however; this is beyond the scope of this study as the focus is the Problem Formulation Stage.

When evaluating the human health risk associated with petroleum products a combination of chemical properties, site properties and information on how individuals or species (receptors) are potentially placed in contact with the chemical this defines the Exposure Scenario. A route of exposure is defined which describes the way receptor to chemical contact could occur (e.g. inhalation, ingestion).

5.0 FINDINGS

5.1 Findings

The findings are based on the field investigation PSI and community survey conducted over several months by Golder Associates and the author.

5.1.1 Existing Land Use

The estimated area of Kispiox First Nation Community is approximately 1,150 hectares. Surrounding the community, the majority of land is undeveloped and forested. Development within consists primarily of residential dwellings. At the time of the 1999 Physical Development Plan (PDP) for Kispiox, there were 184 occupied dwellings and 12 unoccupied dwellings (six were under construction and six were required replacement) in the community. Additional facilities within the community include the band office, healing centre, fire hall, community hall, elementary school, teacherages, nursery school, two churches, and a cemetery. Commercial ventures within the community include a service station and a fish hatchery. Highway 49 is paved however; most roads are bare earth surfaced (Appendix C, Figures 1,2 and 2-1).

5.1.2 Inventory of Environmental Contamination Issues

The following section summarizes the observations regarding the environmental issues that have the potential to impact on human health issues that have the potential to impact on human health.

5.1.2.1 Fuel Storage – Aboveground Storage Tanks (Asts) And Underground Storage Tanks (Usts)

Golder approximated the number of ASTs to be twenty-eight and that of USTs to be six within the community. This compared to thirty-four ASTs and eight USTs observed by Pottinger Gaherty Limited (PGL), (1998) (as cited in Golder, 2002), (Appendix I, I-1 and I-2).

Four of the ASTs observed were located at one residence (Appendix J, J-1-photograph # 1). The yard around the residence is used for refuelling heavy commercial equipment (excavators, skidders, and other vehicles). The ASTs observed had no secondary containment and ranged in size from 1,000 L to 2300 L. Also observed were several pails (20 L) of hydraulic oil, motor oil and five batteries. There was a strong hydrocarbon-like odour and surficial soil stains in the yard. A diesel spill had occurred, although the volume was not documented. Access to this property is not restricted in any way and children and dogs were observed playing in the area.

The remaining ASTs in use are located at other residential dwellings or community buildings, such as the Pentecostal and United churches. Most of the residential ASTs contain heating oil or diesel having a 1,100 L capacity and do not have secondary containment. Prior to 1957 there was no electricity into the community, so the only petroleum source of heating was in the form of heating oil or diesel. Today older dwellings and sites where older dwellings were replaced have evidence of surficial staining. The United Church AST is located in the basement of the

church access was not permitted during the time of the field inspection. Surficial stains on the ground were observed outside the church and where the filler pipe is located.

The six USTs identified by Golder were located at the nursery school, teacherage, community hall (2 USTs) and former fuel station (2USTs). The USTs at the nursery school, teacherage and community hall are still in use. A strong odour and surficial soil staining surrounding the fill pipes of the USTs at the nursery school, the teacherage and the community hall were observed (Appendix J, J-2, photograph # 2). An area resident stated that the UST at the northeast corner of the community hall is rusting through and likely leaking and the other UST at the southwest corner is in similar condition. The two USTs at the former fuel station have not been removed but are no longer in use. The fuel station closed down approximately twenty years ago and the USTs were never emptied or removed. These two USTs are reportedly thirty-five years old and had a capacity of 3,700 L. The top of one tank is exposed at ground surface. Given that these tanks are greater than 20 years old they are not double walled tanks, therefore, leaks are more likely to occur.

According to FNESS, there were two USTs at the elementary school, which were removed in 1998 and no soil contamination was found at that time. However, at the Pentecostal church a UST was recently removed and soil contamination was observed around the tank.

Prior to 1957, electricity was not available in the community making oil, diesel or wood the primary sources of heat. The majority of the homes in the area would have had residential heating oil/diesel tanks. The potential concern associated with the use of ASTs and USTs is the risk of leaks and spills of the fuel resulting in contamination of the surface soil (ASTs only) and underlying soil and groundwater (ASTs and USTs) (Golder, 2002).

5.1.2.2 New Fuel Station

A new fuel station was completed five years ago and is situated at the intersection of Highway 49 and Gunanoot Street. The station has two large double walled ASTs for diesel and gasoline having a total holding capacity of 4000 to 5000 L. The area around the tanks is not paved and there are no sump pumps or drains to collect spills or leaks, which could occur during refuelling (Golder, 2002).

5.1.2.3 Solid Waste Disposal

Solid waste generated within the community is collected once per week and disposed of at the Kispiox landfill. However, according to an area resident, the majority of band members choose not to use the collection service. Rather they dispose of refuse at the landfill personally. The landfill is located off Highway 49, approximately 500 m north of the community (Appendix C, C-3, Figure 2-1). The landfill is approximately 0.28 hectares in size and is not lined. The waste thickness is estimated to be about 4 m (Piteau, 2000), (as cited in Golder, 2002). Access to the landfill is not restricted nor is any monitoring taking place (Appendix J, J-3, photograph # 4). Incineration takes place without restriction. The school is within close proximity to the landfill and children have been seen playing at the site.

The landfill has been in operation since the 1980's, and is covered with imported soil periodically. The former landfill site (now decommissioned) is located approximately 65 m South of the active landfill and was approximately 0.16 hectares in size with a refuse thickness of 5 m (Piteau, 2000), (as cited in Golder, 2002).
The Kispiox band council intends to close the landfill site and ship all refuse to the New Hazelton landfill site.

A limited hydrogeological and geotechnical assessment for the closure plan was conducted. As part of that assessment three monitoring wells were installed in the vicinity of the active landfill. No monitoring wells were installed at the former landfill. The chemical analysis of groundwater indicated elevated chloride concentrations and conductance in one of the down-gradient wells and metal levels (aluminium, chromium, copper, iron, manganese and selenium) exceeding the CDWQG were observed in the other downgradient well (Golder, 2002). In the up-gradient well, manganese was the only compound elevated above the MAC in the guidelines.

Materials observed at the active landfill during the inspection included abandoned vehicles, refrigeration units, discarded ASTs and USTs and miscellaneous household waste (Appendix J, J-3, 4 photograph # 4, 5, 6). Golder also observed an unregulated vehicle dump site off Highway 49 behind the new service station, (Appendix J, J-4, photograph 6). There were two excavated USTs discarded at this unregulated dumpsite as well.

5.1.2.4 Drinking Water

Prior to 1987 a surface water source namely Dale Creek served as the community drinking water supply. Since 1987, the drinking water source has been two wells each approximately 36 m deep located south of the fish hatchery (Appendix C, C-1, Figure 2). The wells are located downgradient of the community and the water supply is not treated. The community drinking water is pumped from the wells and stored in a 502,800 L closed reservoir north of the community.stored in a 502,800 L closed reservoir north of the community.

5.1.2.5 Fuel Storage

During inspection one test pit was excavated in the band maintenance yard located behind the band office in an area where two diesel ASTs were formerly situated. The test pit was excavated using a backhoe. According to band members when the ASTs were removed, some of the hydrocarbon-contaminated soil was also removed. Some surfical soil staining was still present and a strong hydrocarbon-like odour was detected in the remaining surficial soil in the test pit. Organic vapour monitor (OVM) readings in surficial soils ranged from 26.8 ppm to 34.6 ppm and in deeper soil (0.5 m) a reading of 3.7 ppm was observed. The test pit soil profile measured to a depth of 0.5 m. The test pit consisted of two distinct layers of material, the first layer being primarily fine silt-like sand and the underlying layer being composed of medium to coarse sand and gravel mixture. Two soil samples and one field duplicate were collected from the test pit at depths of 0 to 0.1 m and 0.5 m. Both samples were submitted for LEPH, HEPH and PAH analyses (Appendix K, K-1, Table 5.1).

The surficial sample that was analysed had evidence of staining, odours and an elevated OVM reading. The analytical results indicated that concentrations of LEPH and HEPH were elevated above the CSR standards and CCME guidelines for residential land use (RL). The CSR standards are generic as are the CCME guidelines, however the CCME guideline for LEPH was based on the protection of aquatic life and the protection of human health via the inhalation pathway. The HEPH standard was based on the protection of soil invertebrates and plants. Furthermore, at the concentrations observed, LEPH also exceeded the CCME guideline protective of soil ingestion by humans, soil contact by ecological receptors and the guideline protective of groundwater used for drinking water.

At the depth the second sample was collected (0.5 m) there was no observable odour or staining and the OMV reading was considered to be low at 3.7 ppm. A field duplicate sample was collected at the same depth (0.5 m) for quality assurance/quality control purposes (QA/QC). One duplicate sample exceeded the CCME guideline for LEPH and the other exceeded the CCME guideline for LEPH, HEPH and PAHs.

In the context of this investigation, the above results indicate that areas that show obvious signs of surficial staining and odours are likely to have elevated concentrations of hydrocarbons. At the concentrations observed, LEPH exceeded the human health standards for soil ingestion, indoor inhalation of vapours and groundwater used for drinking water. In addition, considering that the highest

concentrations were observed at the surface, the direct contact pathways (ingestion, dermal contact and inhalation of dust) for humans would be operable (Appendix G, G-1, 2).

5.1.2.6 Kispiox Landfill

Golder conducted a limited subsurface sampling program at the active Kispiox landfill. Samples were collected at two separate locations immediately downgradient of the landfill site using a hand auger (Appendix J, J-4, photograph # 7).
The soil profile of the first auger hole was that of sand, silt and trace organics. There was no observable odour or staining in the sample collected. The depth of sample collection was 0.9 m. The second sample collected was at a depth of 0.6 m using a shovel. The soil profile was similar to the first sample site with the exception of humic material at depths less than 0.15 m with overlying sand, gravel and cobble. Samples were analyzed for LEPH, HEPH, PAH and metals, the results being summarized in (Appendix K, K-1, 2, Tables 5.1 and 5.2). Each of the parameters analyzed were found to be below the CSR standards and CCME guidelines (Golder, 2002).

Soil samples were not collected inside the landfill area proper where contamination would have been identified. The main issue with unlined landfills is leaching of contaminants into groundwater. Numerous investigations in North America and Europe have shown that in nonarid regions, infiltration of water through refuse causes water table mounding within or below the landfill. The water table mounding causes leachate to flow downward and outward from the landfill (Appendix L, L-1,

Figure 5.1). The Pottinger-Gaherty Environmental Consultants Ltd. (PGL) hydrogeological investigation (as cited in Golder, 2002) concluded that leachate impacts on groundwater were not expected to be significant due to the low rate of infiltration and low rate of refuse generated by this small population. However, PGL did find elevated levels of chloride and conductance (indicators of leachate) in one of the downgradient wells. The potential for leachate to reach groundwater is evident but the impact on the community drinking water supply is not a concern as the source is located 5 km away in a cross gradient direction (Golder, 2002).

5.2 Discussion of Findings – Kispiox

5.2.1 Soil Sampling

5.2.1.1 Regulatory Framework

Soil sampling was conducted in the band maintenance yard, the sewage overflow ditch and the active Kispiox landfill. The soil sample results were compared to the applicable federal and provincial environmental quality guidelines and standards. The provincial (BC Contaminated Sites Regulation [CSR]) and the federal guidelines (Canadian Council of Ministers of the Environment [CCME]) provide numerical concentrations of chemicals for the evaluation of soil. These guidelines/standards are:

- CSR, B.C. Reg. 375/96, April 1997, includes amendments up to B.C. Reg. 244/99, updated November 12, 1999;
- CCME, 1999. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment; and
- CCME, 2001. Canada Wide Standards for Petroleum Hydrocarbon Compounds in Soil (CWS-PHC). Canadian Council of Ministers of the Environment

The CSR and CCME soil standards are divided into categories based on land use (residential, agricultural, industrial). For the site sampled residential land use (RL) was applied. CSR and CCME have derived matrix numerical soil standards. The matrix numerical soil standards are risk-based and are available for specific human

and/or ecological exposure pathways; for example soil ingestion by humans, ground water flow to surface water used by aquatic life and designated land uses namely, residential (Golder, 2002).

The following matrix standards were used to screen soil chemistry data:

- human health protection associated with ingestion of contaminated soil;
- environmental protection associated with toxicity to soil invertebrates and plants;
- environmental protection associated with groundwater flow to surface water used by aquatic life; and
- human health protection of groundwater used for drinking water

The lowest applicable matrix was applied. Generic standards were applied if matrix standards were not available (Golder, 2002).

The CSR has derived generic soil standards for extractable petroleum hydrocarbons EPH. The two categories are light extractable petroleum hydrocarbons (LEPH) and heavy extractable petroleum hydrocarbons (HEPH), and are considered protective of all exposure pathways and receptors (Golder, 2002). The assumption here includes all the PAHs between (C_9 and C_{32}) leaving off the ($C_1 - C_9$). To illustrate, the CSR standard for LEPH was applied to EPH ($C_{10} - C_{19}$) and the standard for HEPH was applied to EPH ($C_{19} - C_{32}$), (Golder, 2002).

In addition to the CSR generic standards, the CCME has just recently released for review the "Canada-Wide Standards for Petroleum Hydrocarbon Compounds in Soil (CWS-PHC)" (CCME, 2001). The CWS are risk based and are available for specific human and/or ecological exposure pathways (soil ingestion by humans, groundwater flow to surface water used by aquatic life, vapour inhalation), and designated land uses (residential). The standards were developed for residential and commercial sites and assume that buildings are present on-site, and consider inhalation of vapours migrating into indoor air. The residential standards were considered directly applicable for the site (Golder, 2002). The LEPH and EPH (C_{10} - C_{19}) concentrations measured at the site were compared to Canada-Wide Standards reported for the (C_{10} - C_{16}) fraction (F2) and HEPH and EPH (C_{19} - C_{32}) concentrations were compared to standards reported for the (C_{16}-C_{34}) fraction (F3). The CWS were applied for comparison purposes to show the potentially applicable federal soil standards for hydrocarbons.

5.2.1.2 Methods of soil sample collection

Soil samples were collected using either a hand auger, shovel or backhoe machine (Appendix J, J-4, photograph # 7). Each sample consisted of aliquots of soil placed in a stainless steel mixing bowl then homogenized to form one composite sample. Each sample was visually examined and logged on a chain of custody sheet for record (Appendix M, M-1 to M-28). Discussion of the interpretation is found in relevant sections below.

To limit cross-contamination between samples, all equipment used in sampling was washed with distilled water or wiped clean with single use paper towelling. All soil

samples were then placed in the prescribed glass jars labelled and then placed into an ice-pack cooler for shipment to laboratory. The soil samples were submitted for metals, petroleum hydrocarbons or PAH analysis. The analytical reports are included in the chain of custody sheets (Appendix M, M-1to M-28).

5.2.2 Preliminary Evaluation of Potential Health Risk

5.2.2.1 Receptors and Exposure Pathways

Kispiox is primarily a residential area. For that reason adults and children living in the community were identified as the primary receptors of concern (Golder, 2002). The exposure pathways that were considered relevant for human receptors included ingestion of soil, dermal contact with soil, inhalation of air borne soil particles (dust), and inhalation of vapours from soil and groundwater. Inhalation of soil/dust can occur when wind and vehicle erosion from unpaved road surfaces generate fugitive dust concentrations in the air (Appendix N, N-1, 2, 3, Table 5.2).

The community water supply is obtained from two wells located downgradient of the community and from a depth of approximately 36 m below ground surface (bgs). Based on the existing regional geologic information, the inference is that the wells are installed deep into the bedrock at 6 to 8 m bgs. The wells located downgradient of the community could mean a negative impact on the drinking water quality, should some environmental contamination occur within the community proper. Therefore, the groundwater used for the drinking water supply was evaluated as a potential pathway for human receptors.

In general, chemical and bacteriological testing of the community drinking water supply does not indicate that drinking water has been impacted by activities in the community. Further, there was no record of complaints by band members regarding the drinking water quality.

The sewage lift station frequently malfunctions resulting in a discharge of raw sewage into an overflow ditch, which is situated approximately 100 m east of the drinking water wells.

5.2.2.2 Potential Sources of Contamination

A brief description of the issues of concern and the relevant chemicals of interest (COIs), receptors and exposure pathways is provided for each issue that was identified as a potential source of contamination.

5.2.2.3 Residential Fuel Storage – ASTs

Given that diesel or heating oil was the primary source of heat prior to 1957, most if not all of the homes would have historically had residential fuel ASTs. Currently, many of the older homes in the community continue to use heating oil or diesel. Golder observed 28 heating oil ASTs within the community. The residential ASTs have a capacity of 1100 L and do not have any form of secondary containment. The concern associated with the use of diesel and heating oil in residential ASTs is related to the potential for spills and leaks to contaminate surficial soil and the underlying soil and groundwater.

COIs in both diesel and heating oil consist of light and heavy extractable petroleum hydrocarbons (LEPH and HEPH) and PAHs. In surficial soil, adults and children could come into direct contact with contamination via soil ingestion, dermal contact, and inhalation of dust. The inhalation of volatiles is also considered a potential exposure pathway, as diesel and heating oil are both composed of light end hydrocarbons that are susceptible to inhalation.

Although most newer buildings in the community do not have ASTs, some of these newer buildings are referred to as replacement homes and are erected on an original site, where in the past each of the residences would likely have had an AST, therefore, it would not be imprudent to consider the soil on these sites as having been possibly contaminated. In general, the overall risk to human health associated with contamination originating from residential ASTs is considered to be low, as leaks and spills are visible and are usually noticed before the problem gets too big. As part of the FNESS program, all unused ASTs will be removed and disposed of and any active AST will be replaced or updated to meet the current standards and guidelines for environmental protection.

Based on the above, the potential for soil and groundwater contamination associated with residential ASTs was considered moderate.

5.2.2.4 Fuel Storage – USTs

Six USTs were identified within the community during the investigation. The USTs were located at the nursery school, teacherage, two each at the community hall and at the former fuel station. The USTs at the former fuel station had a capacity of 37,000 L each. The capacity of the remaining USTs mentioned is not known. It is not likely that these USTs had any form of secondary containment (double walled), as they were more than twenty years old. Age and construction factors would increase the likelihood of contamination by leaks. Surficial staining and odours were observed around the fill pipes of the USTs located at the nursery school, teacherage and community hall, which are currently in use. Furthermore, it has been noted that the USTs at the community hall are in questionable condition (rusting through) in terms of prevention of leakage (Golder, 2002).

In addition to the six USTs Golder observed, the PGL (1998) reported (as cited in Golder, 2002) that two USTs at the elementary school and one UST, at the Pentecostal Church were recently removed. According to information provided by FNESS soil contamination was not identified during the removal of the USTs at the elementary school; however, an area resident indicated that during the removal of the church UST, the soil surrounding it appeared contaminated with either diesel or heating oil.

Given that the tanks are below ground it is difficult to determine whether there have been leaks or spills. Based on the age of the USTs and anecdotal information, it did

not appear that any of the USTs were doubled walled. A number of USTs had evidence of rust damage and there were visible signs of staining at the surface, it is likely that there have been leaks. Furthermore, overall risk to human health associated with contamination originating from USTs is considered to be higher for USTs relative to ASTs, as leaks and spills can go undetected (Golder, 2002).

COIs in heating oil consist of LEPH, HEPH and PAHs. Given that the USTs are below ground, direct contact with potentially contaminated soil would not occur. However, the inhalation of volatiles is considered a potential exposure pathway, as diesel and heating oil are composed of light end hydrocarbons that are respirable. Surficial contamination was documented around fill pipes of active USTs. Residents could come into direct contact with contamination at the surface via ingestion, dermal contact and inhalation of fugitive dust particles. Based on the above, former and active USTs were identified as a moderate to high potential source of contamination for soil and groundwater (Golder, 2002).

5.2.2.5 Site Residence (Yard)

Four ASTs ranging in size from 1000 to 2300 L were stored in the front yard of a residence. The ASTs were actively used and did not have any secondary containment (Golder, 2002). Several containers with a capacity of 20 L of hydraulic oil and motor oil and five batteries were also observed in this yard. At the time of the investigation there was a strong hydrocarbon-like odour and significant surficial soil staining. Access to this yard is not restricted (Golder, 2002).

COIs in diesel and motor oil include LEPH, HEPH and PAHs. COIs associated with batteries include metals and acid. Potential exposure pathways include soil ingestion, dermal contact and inhalation of dust. Based on the above, the residence (yard) was identified as having a moderate to high potential for contamination of soil and groundwater.

5.2.2.6 New Service Station

The new service (fuelling) station is five years old with ASTs double walled from installation, it is unlikely that there have been any substantial leaks or spills that would impacted soil and groundwater in the vicinity of the tanks (Golder, 2002). However, there is potential for smaller spills occurring during refuelling. The escaped fuel could infiltrate into soil as the ground surface is not paved and there are no sumps or drains to collect spills (Golder, 2002).

COIs in diesel and gasoline include LEPH, HEPH, VPH, BTEX and PAHs. Potential exposure pathways would include soil ingestion, dermal contact, inhalation of dust and inhalation or volatiles. Based on the above, the new service station was considered to pose a low potential for soil and groundwater contamination (Golder, 2002).

5.2.2.7 Solid Waste Disposal

The solid waste generated in Kispiox is collected and disposed of in the Kispiox landfill located 500 m north of the community. The landfill has been in operation since the 1980's. Access to the landfill is not restricted and currently there are no controls on the types of refuse discarded there. Open burning is permitted at the

landfill. The band and several community members have concerns regarding the proximity of the landfill to the new school as children have been seen playing at the site. Piteau Associates (as cited in Golder, 2002) concluded that leachate impacts at the active landfill site was not anticipated to be significant, although elevated levels of chloride, conductance and metals were observed in the monitoring wells downgradient of the landfill (Golder, 2002).

Soil sampling was not conducted inside the landfill area, where contamination existed.

However, the two soil samples collected immediately downgradient of the landfill at depths of 0.6 m and 0.9 m did not have elevated levels of metals or hydrocarbons. The main issue associated with unlined landfills is the leaching of contaminants into groundwater. Although it is unlikely that leachate from the landfill would impact on drinking water, it is possible that it could reach the Skeena River and have a potential impact on aquatic receptors. Based on the Piteau results (as cited in Golder, 2002) there may be potential for landfill leachate to impact on groundwater but it is unlikely that it would impact on drinking water given that the drinking water source is located at least 5 km away in a cross gradient direction.

Prior to the current active landfill, refuse generated in the community was disposed of at a former landfill site approximately 65 m south of the current landfill site. An investigation conducted by Piteau Associates at the former landfill site concluded

that the landfill leachate impacts were not anticipated to be of any significance (as cited by Golder, 2002).

In addition to the active and former landfill sites, Golder observed an unregulated dumpsite consisting of vehicles in the community adjacent to the new service (fuelling) station.

Considering that there is one active landfill site, one inactive landfill site and one unregulated dumpsite within the community, solid waste disposal was identified as having a moderate potential for contamination of soil and groundwater (Golder, 2002).

5.2.3 Risk Ranking

The NCSCS evaluation form for the different areas/issues of concern is attached (Appendix O, O-1 to O-6, Table 5.3). Based on a review of the chemical results for drinking water, there does not appear to be a problem with drinking water quality (Golder, 2002).

Based on the available data collected to date, the issues identified as a potential concern were ranked as follows:

5.2.3.1 Residential ASTs – 51 (+/- 3.25) or Class 2

Kispiox had a large number of active and inactive ASTs. The current risks estimated for residential ASTs considered the potential contamination associated with historical and current use. Some contamination is expected to have occurred given the historical use of the ASTs and the lack of secondary containment. Although leaks and spills are visible and are usually noticed before the problem escalates, the overall risk to human health associated with contamination originating from residential ASTs is considered to be moderate (Golder, 2002).

5.2.3.2 Fuel Tanks USTs – 63 (+/- 3.25) or Class 2

The risk ranking considered the potential for soil contamination related to USTs to be moderate to high, given the historical use of the USTs, the lack of secondary containment, the observation of staining and odours and the anecdotal information regarding the poor condition of some of the USTs. Typically, potential contamination associated with USTs is limited to the subsurface, however, surficial staining and odours were observed at four of six USTs observed. Based on the above, the risk of soil contamination and the potential exposure to humans was considered moderate to high (Golder, 2002).

5.2.3.3 New Service Station – 32 (+/- 3.25) or Class N

The new service station was ranked as a Class N (action not likely required). The low concern for human health risks was directly related to the use of secondary containment around each of the ASTs (double walled tanks) reducing the likelihood for contamination. The service station, which has only been in operation

approximately five years, has always had double walled tanks (Golder, 2002). The function of the double walled tanks is to prevent spillage of gasoline or diesel that subsequently would impact the soil and groundwater. Small spills or leaks associated with refuelling have the potential to infiltrate the soil as the ground surface is not paved and there are no sump pumps to collect spills (Golder, 2002).

5.2.3.4 Site Residence (yard) – 62 (+/- 3.25) or Class 2

The risk ranking considered the potential for soil contamination related to fuel storage in ASTs at the residence (yard) to be moderate to high. Large quantities of fuel and oil were stored at the residence and evidence of soil contamination (odour, stains) was observed during site inspection (Golder, 2002). Furthermore, access to the ASTs was not restricted and children were observed playing in the vicinity. Based on the above, the residence was considered a moderate to high risk to human health (Golder, 2002).

5.2.3.5 Solid Waste Disposal – 69 (+/- 3.25) or Class 2

The risk ranking associated with solid waste disposal was considered moderate to high. Given that the active landfill is located within 500 m of the community, access is not restricted, the landfill is not lined and the disposal of waste is unrestricted, it was considered a moderate concern for human health. In addition to the active landfill, Kispiox also has a former landfill and one unregulated dumpsite within the community (Golder, 2002). Based on the above, solid waste disposal was considered to be a moderate to high concern for human health and the potential for soil and groundwater contamination was considered high (Golder, 2002).

5.2.3.6 Uncertainty of Risk Evaluation

In the problem formulation phase of any study the uncertainty of available data and the site conditions upon specific investigation dates raises the uncertainty of risk evaluation. Assumptions were made based on observations at the time of inspection and limited sampling information, therefore uncertainty surrounding the estimates of risk is unavoidable. However, the risk rankings are considered to be reasonable given the above statement. Further information that would have proved beneficial to the risk ranking exercise by reducing the uncertainty factor would include:

- detailed information regarding the groundwater flow and chemistry;
- detailed information on the soil and groundwater quality in the community, especially in areas that historically have had ASTs and USTs.
- a log of the soil conditions where ASTs and USTs are removed should be kept for future reference;
- comprehensive anecdotal information, which would include dates and times of incidents relative to environmental contamination; and
- precise rates of exposure through the ascribed pathways

A synthesis of the main points and conclusions of the risk evaluation have been provided below in (Appendix P, P-1, 2, Table 1), (Golder, 2002). The table lists the issues from the highest to lowest priority for further action and provides a brief description of the issue.

5.3 Discussion of Stakeholder Input – Questionnaire

In the BC First Nations Regional Health Survey, health was described by the participants as having three aspects; physical, mental and spiritual and is still perceived holistically or multi-dimensionally (Atleo, 2000).

Stakeholder input was critical to this study in order to demonstrate to the Kispiox community members that risk management communication can serve as the underpinnings for Sustainable Development objectives. By this approach to the investigation, a mechanism that would facilitate the recognition, collection and interpretation of information regarding two aspects of humans, the physical and the intangible relative to the environment was actively demonstrated. The physical can be examined by the use of health indicator tools of measure, as outlined in the introduction to this study, however this is only a portion of the whole. In addition, a mechanism that identifies the intangible in terms of measuring health and well-being was created (questionnaire) to elucidate the intangible aspect of humans. While hard science pertains to the calculable physical properties of matter in this case human matter, soft science pertains to the incalculable qualities of the intangible entity that is within human matter. Human health can only be measured by considering both aspects of human manifestation.

Dialogue with Aboriginal people is critical to their well-being. Through dialogue their thoughts, feelings and perceptions are acknowledged. Scientists and managers must take into consideration the way of and reasons for the intangible qualities when determining the well-being or the influences to well-being of Aboriginal people.

Gitksan Hereditary Chief Angus reiterated the four values as honesty, trust, respect and humour.

5.3.1 Design and intent of questionnaire

5.3.1.1 Design

The questionnaire was designed using 27 questions, relating to five aspects of human life in a remote FN community in NWBC. Some questions had subjective style responses, which were categorized into equivalent remarks suitable for statistical analysis. One hundred people were surveyed. The surveyor was a Gitksan FN individual holding a Teaching degree. The criteria for selection of the surveyor was based on (1) an ability to demonstrate cultural sensitivity (2) ensuring care and diligence would be taken to collect the information as scientifically as possible. The survey was conducted over several days and took the form of house-to-house coverage, visits to places of employment, the band office, local school, and included a community event – Feast.

To address its external validity, the sample draw was from every area within the community (Appendix C, C-2, 3, Figures 2 and 2-1). The internal validity was addressed by having a representative sample surveyed. Upon completion of the questionnaire each participant signed and dated it for validation purposes. Each participant was left with an information sheet explaining the purpose of the study and how it would benefit the Kispiox community, as well as a note of appreciation (Appendix Q, Q-1).

5.3.1.2 Intent

The intent was:

- to respectfully invite participation in the sharing of information about their lives as Aboriginal people living on traditional grounds versus living outside their community; and
- to solicit their comments on the belief and value systems held, as it relates to the way they live today including their traditional lives (sustenance activities); and
- to request input regarding their view of the future of their community and how environmental influences can impact their way of life.

Finally, the questionnaire was used as a means of recording statistically the intangible aspect of the human so as to further the interests of the Aboriginal person in terms of health and well-being as described by the stakeholders of Kispiox.

5.3.2 Findings Of Questionnaire

5.3.2.1 Discussion of Results

Appendix B contains a copy of the questionnaire. Appendix R contains the captions for each question. The Appendix S contains the summary tables for each question (variable). The title of each table corresponds with the theme of each question (variable) (i.e. Variable 1 – Self-rated Health Status). Also, each table contains total response, and/or an age, gender distribution.

Appendix T contains the graphic treatment of each variable from the tabular data found in Appendix S. To illustrate, reference to tabular data will precede

corresponding graphic treatment and will appear throughout the text as follows (e.g. Appendices S, S-1 to S-27, and T, T-1 to T-26).

The statistical analysis illustrated that of the one hundred people surveyed out of a possible seven hundred and fifty eight, Kispiox reflected a typical FN community in BC today, having a large young population as compared to the rest of the community population (Appendices S–26, T-26).

5.3.2.2 Perceived Health Status

The results regarding the five aspects of Aboriginal life are discussed individually: Of the people surveyed 66 percent perceive their general health be in the range of good to excellent (Appendices S-1, T-1).

5.3.2.3 Diet And Traditional Food

There appears to be a significant difference in the consumption of locally grown fruits and vegetables and traditional foods (berries, fish and wild game). Of the total population surveyed 44 percent indicated they do not consume locally grown fruits and vegetables, while 99 percent indicated they consume local fish and wild game (Appendices S-3, 4, T-3, 4). In addition, 59 percent of the population surveyed consume between three and twelve or more traditional meals per week (Appendices S-5, T-5). Finally, 40 percent of cases report that they consume at least two traditional meals per week (Appendices S-5, T-5).

Drinking water quality is an important issue to the people of Kispiox as indicated in the consumption patterns as 44 percent stated they do not drink the tap water while 85 percent stipulated they consume bottled water at least some of the time (Appendices S-6, 7), T-6, 7).

5.3.2.4 Perceived Risk Associated With Petroleum Contamination

Perception is born of the senses therefore life experience will impact the aspect from which things may be perceived. The questionnaire attempted to broach the subject area of perception of risk associated with petroleum contamination by obtaining a profile of time spent within the community, local employment, behavourial patterns concerning use and disposal of petroleum products, the possession of a recreational vehicle (motorboat, all-terrain-vehicle or skidoo, and presence of a lawn on property) and day-to-day life in a remote setting. The analytical interpretation of this portion of the questionnaire is described as follows: 75 percent of participants lived a range from eleven to more than thirty years in the community, while 56 percent of respondents work locally, 21 percent own a recreational vehicle, 32 percent change oil on their own property, 3 percent deposit used motor oil on their own property, 16 percent deposit used oil on the roadway in front of their homes, 38 percent do not perceive disposal of used motor oil practises to be a problem finally, 1 percent indicated a problem associated with petroleum (S- 9, 10, 11, 12, 17, 18, 19, and T-9, 10, 11, 12, 17, 18, 19, 23).

When queried on the perception of a contaminant problem in the community regarding what contaminant problem would be a threat, whether or not there exists a significant contaminant problem, what the source of the contamination is) 50 percent of the population surveyed indicated that the threat is relative to environmental health and aesthetics, (contamination from air – 80 percent, water – 11 percent, petroleum – 1 percent) respectively. Further, 61 percent believe that there is a

significant contaminant problem in the community, but only 1 percent stated petroleum contamination to be a problem in the community (S-20, 21, and T-21, 22, 23).

5.3.2.5 Perception Of Remedial Measures To Be Taken In The Community

Of the one hundred respondents 63 percent indicated that the corrective action should be with regard to remediation of the problem versus 15 percent in favour of education while 5 percent favoured an environmental task force to address the issue of contamination. Respecting suggested programs to be initiated in the community 70 percent were in favour of a collection vehicle to pick up used petroleum products while 26 percent identified recycling as the most appropriate program (T-24, 25, 26).

5.3.3 Limitations Of Conventional Research

The limitations to conventional research are as follows:

- limited soil sampling;
- limited water sampling;
- information regarding ESA based on condition of property at time of inspection; and
- limited local historical data

Suggestions for future conventional research in the area:

- more soil sampling throughout community especially in areas designated for PDPs;
- more chemical water sampling;
- site visits for ESA increased to four over a one year period to collect a seasonal description; and
- more time and larger budget to spend on archival retrieving exercises to facilitate comprehensive local historical data

5.3.4 Limitations Of Action Research

The limitations to action research were as follows:

- phrasing of questions in the questionnaire;
- small population limits the absolute spread of responses;
- not many elders were represented;
- length of questionnaire;
- statistical validity of questionnaire; and
- FN people are tired of surveys and studies (questionnaire fatigue).

Suggestions for future questionnaires and data collection are as follows:

5.3.4.1 Phrasing

- include a FN individual to phrase the questions;
- meet with Chief and Council regarding phrasing of questions; and
- meet with elders and ask for their input as to what and how to articulate the questions to best meet the purpose of the questionnaire

5.3.4.2 Population Size

- Include a diversity of communities, for example, the five communities that are in the region and under the governance of the GGC. This will increase the population in this case to approximately 2700 people from which to draw.

5.3.4.3 Elder Representation

- Invite elders to a tea (tea and the sharing of tea is part of the FN and Inuit cultures of Canada (Marianno Aupilarjuk, Inuit elder, personal interview, August, 1997) to share their perceptions of the community past, present and future.

- Inclusion of elders can have a direct correlation with an increased number of participants.
- Request elder to bless the study efforts (Council meetings in FN and Inuit cultures are opened with a prayer, (Vince Shea, Micmac elder, May, 2000 and Marianno Aupilarjuk, Inuit elder, October, 1997, witnessed at opening ceremony for meetings held in Vancouver, BC and Rankin Inlet, NU). This activity stirs the Aboriginal peoples to action thereby participation.

5.3.4.4 Length Of Questionnaire

- The questionnaire may be too lengthy causing some to loose interest near the end, as the responses seemed uncharacteristically varied as compared to the responses at the beginning and toward the middle.

5.3.4.5 Statistical Validity

- The statistical validity may not be as strong due to only using frequency analysis.

5.3.4.6 FN People Are Tired Of Studies

- FN population has become somewhat resistant to being the subject of study (personal experience as an Environmental Health Officer for both the Inuit and BC FN population).

6.0 SUSTAINABLE DEVELOPMENT (SD)

The report on British Columbia's Progress toward Sustainability encompasses all ten Bellagio Principles and features four aspects of assessing progress toward sustainability (Hodge, and Prescott-Allen, 1997). The approach of looking at a province and its progress toward SD provides a template to assess the Health Canada's Sustainable Development Strategy and the follow-up document, Report on Progress for 1999 – 2000.

A strategy is indicative of how to proceed with a comprehensive, highly organized approach to achieving some goal or objective (Hodge, and Prescott-Allen, 1997). Upon examination of the Report on Progress for 1999 – 2000 for Health Canada's Sustainable Development Strategy it was evident that the approach taken was similar to that outlined in the report on British Columbia's Progress Toward Sustainability. To illustrate, themes, objectives and targets were drafted to set a precise method of obtaining information that would provide scientific information on the health and well-being of FN people in particular, moving toward developing a starting point (Hodge, and Prescott-Allen, 1997).

Health Canada's SD strategy – 2000 has four themes. Among these themes is Strengthening Partnerships on Health, Environment and Sustainable Development; wherein emphasis was placed on responding to the concept of SD by addressing the health inequalities that First Nations and Inuit people face. An example regarding targets that involve FN people is Target 2.3.5 to Incorporate SD as a component of

First Nations and Inuit Health Branch planning, budgeting and reporting by March 2002.

This study in Kispiox demonstrates that FNIHB is moving in the desired direction of the target.

6.1 Environmental Contaminants

Sustainable Development (SD) deals with interrelationships and linkages. Which means looking at decisions in a holistic way where there is a parallel care and respect for people and for the enveloping ecosystem of which everyone is a part (Hodge et al, 1995).

Using interrelationships and linkages provides a more holistic approach to collecting and gathering information from FN communities and moving this information into the decision makers' realm to effect changes toward SD. Further, the admonition to create initiatives within Health Canada's steering committee to link health with the environment is reflected in the Sustainable Development Strategy – Report on Progress for 1999 – 2000 (Hodge et al, 1995). This report reveals that Health Canada's Strategic Theme 3 responds to the concept of SD by addressing the health inequalities that First Nations and Inuit people face. In addition, the threat of environmental contamination by ASTs and USTs is addressed by way of an update and assessment of the fuel storage tank remediation action plans to review twelve sites and the fuel storage systems.

While these responses are encouraging more is needed to include all internal agencies and branches of federal government, and to reach individual communities especially in remote northern areas.

6.2 Health Canada's Sustainable Development Strategy – Environmental Risks to Health

Health Canada's SD strategy connecting environmental risks to health resulted in raising awareness of the interdisciplinary approach that must be taken in order to achieve a reasonable inventory of potential contaminants for each FN community and follow through on risk management framework to determine a best practises approach to SD. This study of Kispiox FN community exemplifies the necessity of this approach.

6.3 Health Canada's Sustainability Development Strategy – 2000 Information Discussion Session: Representatives of FN organizations

Health Canada's first SD strategy tabled in 1997 as indicated under "key achievements", stated that progress has been made to work more to improve health of FN people. With respect to Kispiox, Health Canada has supported this study discussing the health impacts of environmental petroleum contamination. The information collected and presented will add to the baseline inventory of potential contaminants of concern and FN community health. However, Aboriginal

consultation took place by way of a mail-out questionnaire that solicited voluntary feedback from such organizations as the Congress of Aboriginal Peoples, the Metis National Council, the Native Women's Association of Canada and the National Association of Friendship Centres requesting representatives of each organization to distribute the questionnaires for comment.

The method of surveying the FN organizations through a voluntary response protocol used by the Information Discussion Session has yet to prove its success, as there is no feedback from these organizations to date.

6.4 Decision matrix for future FN community Sustainable Development Strategy

Decision-making is a process that must be representative of all facets of society within a community regardless of the size of the community. Also the terms of reference for decision-making should reflect the values of that society. Moreover value-focused thinking is a more precise method of arriving at what constitutes the quality of life for a particular community or individual (Keeney, 1992). In addition, value-focused decision-making factors in the currency of the past and that of the future hence will reflect a precise description of the beholder. This is congruent with the Traditional Ecological Knowledge of the Kispiox community.

The value of the study is found in the interconnectedness of the information obtained (through the physical data collection), the sharing of beliefs and values (through the use of the Questionnaire), the practical experience for those investigating, and the

information sharing of the community members who participated in the study. The stakeholders, the people of Kispiox, Health Canada and the scientific community is better equipped to move toward achieving SD.

Through the use of this information, better decisions for public development planning can be made. The community now has an official study completed that can be used to garner support for requesting funding for further study in areas where a need has been identified. A report could also be submitted to Health Canada SD strategy to add to the big picture on the progress toward SD (Hodge and Prescott-Allen, 1997).

Any matrix for decision-making must reflect the value of both commonalities and differences. Emergent relations (as in the case of Aboriginal people) and processes can come only from the synergy of complementary differences, not from the preservation of traditional separations (Dale, 2001). In addition, it behooves the FN and Inuit peoples, in their pursuit of self-determination, to contemplate their relationships to modern Canadian society and to consider how best they can contribute to SD, by bringing traditional ecological knowledge, aboriginal diversity and values to decision-making.

As First Nations and Inuit move toward self-determination, frameworks such as the institutional characteristics that support sustainable development can be employed to best meet that objective and complement their TEK. The nature of these characteristics are reconciliation, flexible and responsive, long-term and responsive and open and inclusive (Dale, 2001).

This illustrative description of the institutional characteristics that support the implementation of sustainable development shows how sustainable development can be accomplished in a world with multiple realities, pluralities and diverse values (Dale, 2001).

7.0 RISK COMMUNICATION

Risk communication involves risk assessment, risk management and dialogue. The three components serve to facilitate an exchange of information in a framework that is positively structured. We live in a world with multiple realities and pluralities, and we need to value both commonalities and differences (Dale, 2001). Dr. Dale's admonition to value diversity can be expressed through communication, albeit this discussion is with regard to risk or perceived risk associated with environmental contaminants and human health. Risk communication is a founding factor in understanding the values and perceptions of FN people in this regard.

7.1 Dialogue with Aboriginal People

Risk assessment and risk management can lead to better standards development and policy decisions. Risk assessment is the factual scientific base that is used to define and quantify the issue under investigation (Salvato, 1992). As stated earlier, a clear understanding of the problem formulation step is critical to acquiring the most accurate risk assessment possible. The value of risk management must be balanced against the accuracy and reliability of the data used (Ibid, 1992). Risk management integrates and evaluates the results of risk assessment in the light of social, economic and political concerns to reach policy or regulating decisions (Ibid, 1992). Through the use of the questionnaire, a substantive portion of the total community population was surveyed (100 persons out of 758 total population). This approach brought the risk assessment function (data) and the risk management

function (questionnaire) together, to provide a more holistic examination of the contaminant concerns in Kispiox, thereby, providing a better quality health indicator.

Dialogue was a key factor in the management framework for this study. Dialogue involved acknowledging the views, perceptions and attitudes toward human health and environmental influences. In this study, stakeholder involvement was sought at the outset and encouraged throughout the duration of the study, culminating in the written acknowledgement of the five aspects of Aboriginal life in Kispiox.

7.2 Concerns Recorded

The questionnaire provided an open invitation to each participant for the purpose of recording their thoughts, fears and aspirations concerning the health and well-being of both the people and the physical environment of Kispiox.

7.3 Information Presented

Future goals for SD in Kispiox must involve a precise strategy that includes the members of the community. This study laid the foundation by emphasizing that inclusion begins with informing. The following are ways that were used throughout the duration of the study to inform the community:

- site visits (conversing with locals);
- progress report presentation to Band council, personal interview (Chief Councillor, Kispiox, Bill Star, October, 2001);
- active involvement on the part of the CHRs (house to house surveying);
- an information letter left at the home of every participant, including contact information for further discussion of the study; and

- interface with GGC board of governors respecting the furtherance of study into the scientific community and how that would benefit the FN community

7.4 Building A Mission Statement

The people of Kispiox could benefit by building a mission statement for their own environmental health objectives that reflect their cultural and ethical values for the ecology of the community. The mission statement could include the global principles of Aboriginal life, which reflect both the ancestral and futuristic beliefs and ideologies of the Gitksan nation. At this juncture, it would be presumptuous of me as only the researcher to make any suggestion. However, it is my duty as a researcher of conventional and action research to put forth the terms of reference would contribute to an effective vision.

7.5 Building A Vision Statement

To build a vision statement for Kispiox it must come from the people of Kispiox. As the researcher for this study I can offer one approach to the mechanics of constructing a vision, which includes characteristics of an effective vision (Kotter, 1996). An effective vision involves the relationship of the vision to strategies, plans and budgets. In addition, leadership and management facilitate the actualization of strategies, plans and budgets by the creation of a sensible and appealing picture of the future (vision) (Ibid, 1996). For example, a vision of Kispiox free of petroleum contamination and the logic for how the vision is achieved (strategy) such as alternate home heating source as one option. Through application of management, specific steps and timetables a strategy could be implemented, (i.e. by the year 2012 all homes to have an alternate heating source), also management through the

utilization budgets could convert plans into financial projections and goals that meet the objective (Ibid, 1996).

7.6 Limitations

The purpose of this research was to identify the Problem Formulation stage of an environmental contaminants investigation. The limitations of the Problem Formulation stage are subject to the following:

Conventional Research

- Limited hydrogeological data;
- Limited information on soil properties and characteristics (chemistry, texture);
- Limited groundwater and soil information where ASTs and USTs were located and removed;
- Bacteriological water quality skewing the classification of risk by inclusion which had no bearing on petroleum contamination;
- Budgetary considerations as to frequency and location of sample protocol;
- Timelines as to field investigation and partnering for inspection of sites with CHRs;
- Insufficient chemical water analysis and data; and
- Jurisdictional differences in the application of regulations, standards and guidelines (Federal – fraction 1 equivalent to Provincial - [C_6 – C_{10}]) etc.

Action Research

- human perception and subsequent error in relating anecdotal information regarding human activities in the community relative to petroleum contamination;
- external validity of the questionnaire relative to the un-surveyed population of the community;

- quality of feedback relative to Traditional Diet and Cultural activities (hunting and gathering practises); and
- cross cultural differences in perception of health and well-being translating into indicators that are inconclusive for Aboriginal people

8.0 RECOMMENDATIONS

8.1 Physical

The physical recommendations relative to the environmental issues for Kispiox were evaluated and prioritized based on knowledge about source contamination, the potential exposure pathways and the use of the Site and adjacent areas by humans and wildlife. The research focus on human health, risks to wildlife (e.g. terrestrial and aquatic organisms) were considered in the risk evaluation process.

The specific sites under investigation were then categorized into four different classes (1, 2, 3 or N) based on the current and future potential for risk (Golder, 2002).

One recommendation is to use the information collected and interpreted to develop a strategy to identify methods of improving the environment in Kispiox. As the research links the issue of SD to health, it is recommended that this information be considered when developing Physical Development Plans (PDPs) for land use planning (Reidar Zapf-Gilje, President of Golder Associates, February 4, 2002 - Personal Interview).

The environmental issues identified for Kispiox according to the risk classification as defined by the NCSCS are listed in a table which outlines the level of action

recommended for each class and provides some general recommendations to address these issues (Appendix P, P-1, P-2, Table 1).

8.1.1 Educational

A recommendation to use the Anspayaxw School Society system to articulate a regular and disciplined schedule of exposure and constructive thought processing to raise awareness in Kispiox's youth regarding the value to themselves and the community of integrated solutions. The integration of ecological, social and economic imperatives requires changes in attitudes, structures and behaviour at both societal and personal levels (Dale, 2001).

It is critical that education be used to shift the paradigm of the youth in Kispiox. Through a presentation of this thesis to the Anspayaxw students, a dialogue with the youth of Kispiox could begin.

8.1.2 Governmental Levels

Levels of government are still operating from the mindset inherited from the days of Colonialism and it continues to permeate the Canadian governmental system. This is evident by the fact that Canada has primarily a resource-based economy. Moreover, Colonialism had as its underpinnings to explore, exploit and conquer the natural and social capital of new land. To illustrate that ideology the encyclopedia Encarta (1999) states, "To many Native Americans, the Europeans appeared to be oblivious to the rhythms and spirit of nature" (section XXII). This egocentric view of humanity's particular niche relative to the rest of nature is incongruent with the

necessary ecocentric approach that must be taken in order to fully understand the health and well being of the people under all levels of governance in Canada. Further, this research combined conventional and action research to demonstrate how the first step can be taken toward the removal of any vestige of Colonialism. The paradigm shift on the part of all levels of government must be toward a change in values. The TEK is fabricated out of the values held sacred by the Gitksan people of Kispiox, and are complementary to Einstein's postulation regarding "matter" and "energy". According to Daly and Cobb Jr., (1994) Einstein recognized that "matter-energy" using the conversion technique of $E = MC^2$ could propagate a more realistic attitude regarding the depletion of a unit of energy versus a unit of matter in the minds of people, (p. 193). Here it is evident that ecocentric ideals exist in both the Aboriginal and traditional scientific communities. The challenge is to bring both communities together in order to balance the spirit of the land with the spirit of humanity, S. Freeze, (personal communication, April 1, 2002).

8.1.3 Accountability

Accountability is one of the underpinnings of the federal government toward the FN community of Kispiox, as it is for any community. Assuming the responsibility for accountability and its impacts has been a problem for large bureaucracies that can be illustrated over a forty-year period. Accounting is divisive by nature, how does one elect and how is one elected to membership in a community, scientific or not? What does the group collectively see as its goals; what deviations, individual or collective, will it tolerate; how does it control the impermissible aberration? (Kuhn,

1962). In the past accountability has been shrouded in the culture of the federal government, namely the public service arena. The culture among the echelons of management in the public sector is one of vertical solitudes (Zussman, 1989). Problem formulation is only beneficial if accountability has a specific direction and target. Accountability must oscillate between federal government, FN government and the environment. The research findings indicate that the environment has been impacted upon and therefore is in need of a settling of accounts. These circumstances are exacerbated by the fact that governments and non-government groups are not in agreement regarding what constitutes an environmental problem (Hessing and Howlett, 1997). Further, large bureaucracies (eg. public service sector) exhibit inertia and tendencies towards incremental change (as demonstrated by its systemic, pervasive and multifaceted) resistance toward change (Dale, 2001). In an effort to traverse the accountability highway between Kispox and Ottawa, and to effect a reconciliation of aboriginal values and knowledge, a paradigm shift toward interconnectedness must occur.

8.2 Management Recommendations

8.2.1 Perception Of EC And Human Health Implications

Responsible management dictates that considerable energy must be directed toward addressing the issue of a perception of the presence of EC in the community, as 47 percent of the participants surveyed indicated that they believe there is reason for concern. As the researcher, it would be prudent to arrange for public

consultation to share the findings and invite the appropriate persons to share in dialogue regarding the community's perceptions. Leading change includes assuring that stakeholder participation will be on terms and grounds that meet their needs. This is building trust in the mechanics of leadership and responsible information/knowledge management. An action plan designed to address perceptions and advance toward SD in Kispiox is an application of living the principles of knowledge management and responsible leadership (Appendix U, U-1).

8.2.2 More study

More study is required to progress through stages two and three (Exposure and Toxicity Analysis and Risk Characterization) of the Risk Assessment Framework (Appendix F, F-1).

8.2.3 Co-management of study

A team of two should lead the next stages of the study, one from the Environmental Health Program of Health Canada, FNIHB and one from the Kispiox community. This would provide for a more in-depth analysis of the issues surrounding petroleum contamination and aboriginal health concerns. The obvious benefit would be to the stakeholders, as they would feel more in control of what is occurring at the community level.

8.2.4 Traditional Food study

Before the actual collection and analysis of food occurs a definite catalogue of traditional foods should be created. This catalogue should then be examined by the elders of the community as to authenticity and seasonal collection (for bioaccumulation potential) in the plants and wildlife.

Innovative partnerships should be sought to bring together a team that would complement the health indicators constructed a list of partnerships are below:

- The Technical Committee on Contaminants in Northwest BC (NWBC) ecosystems and Aboriginal Diet – chaired by DIAND and is responsible for policy and research priorities and allocation of funds. Its members are from the technical and academic institutions; and
- the Science Manager's Committee on Contaminants in NWBC ecosystems and Aboriginal Diet - chaired by DIAND and is a multidisciplinary committee comprising of Environment, Fisheries and Oceans, Health Canada and DIAND representatives

8.2.5 Traditional Hunting and Gathering study

The recommendation to have an Aboriginal manager select suitable delegates from Kispiox to identify traditional hunting and gathering geographic locations as well as ancient trap lines adds to the empowerment of the local people in data collection which then builds on their improved sense of self. Further, applying statistical evidence to traditional activities legitimizes the TEK along with the traditional scientific community.

Wearing the Blankets as Mr. Angus stated is the Gitksan way of redirecting society's resources to invest in the social capital of Kispiox.

8.2.6 Water Monitoring – Public Health Safety

The failure to market the safety of the in-house analytical testing and interpretation of water quality results is currently a failure of public health, therefore, it is recommended that more energy is spent in educating the people of Kispiox regarding water quality issues and inform them of the application of the Guidelines for Canadian Drinking Water Quality, (Minister of Supply and Services Canada, 1996).

8.3 Conclusion

Regarding the research goals, it cannot be concluded that aboriginal health is negatively impacted by the environmental contaminant of concern (petroleum). Although physical and chemical baseline data has been collected and interpreted, it is not possible to conclude that other environmental contaminants of concern exist and could pose an even greater risk to public health and safety. Further, Aboriginal perception to personal health is directly related to whatever is found in the environment. Strategies and environmental management systems options are excellent methods of engagement for all interested community members and should be developed (Appendix V, V-1). Finally, this research can provide a much- needed platform for the federal government representatives, scientists, FN community members and all interested parties to engage in meaningful dialogue leading to SD for the Gitksan people of Kispiox.

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NOTE TO USERS

Apx A

APPENDIX B

Kispiox 2002 Questionnaire

QUESTIONNAIRE KISPIOX - 2002

General health and smoking habits

The following questions ask about your general health (and smoking habits).

1. In general, would you say your health is: (choose one of the following):

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor
f) Not applicable

2. At present time do you smoke cigarettes daily, occasionally or not at all?

a) Daily
b) Occasionally
c) Not at all
d) Not applicable
e) Don't know
f) Refusal

Diet and Traditional foods

The following questions pertain to your diet.

3. Do you consume fruits and vegetables raised in a local garden?

a) Yes
b) No

4. Do you consume berries, wild game and fish gathered from the traditional fishing, gathering or hunting areas?

a) Yes
b) No

5. Overall, what portion of your diet comes from traditional foods (berries, game meat, game birds, fish)? The quantities below refer to traditional foods forming some part of a meal and not necessarily the whole meal?

a) None
b) Very little (less than or equal to 2 meals per week)
c) A little (3 or 4 meals per week)
d) A fair bit (more than quarter, up to half; or 5 to 7 meals per week)

e) Most of the time (more than 75%; traditional foods are part of twelve or more meals per week)

6. Do you drink tap water?
- a) Yes
- b) No

7. Do you drink bottled water?
- a) Yes
- b) No

Work and residence:

Following questions pertain to your work and residence location and duration in the community.

8. Do you work locally?
- a) Yes
- b) No

9. How much time do you spend working at your job?
- a) Part time = less than 23 hours per week
- b) More than part time but not full time = 24 to 36 hours per week
- c) Full time = 37.5 hours per week
- d) Seasonal work
- e) Other? Please indicate _____

10. Have you lived all your life in this community?
- a) Yes
- b) No

11. If you ever lived outside of this community, how many years have you lived in this community?
- a) 0 – 10 years
- b) 11 – 20 years
- c) 21 – 30 years
- d) More than 30 years

Following questions pertain to the environment in and around your home:

12. Do you have grass cover (lawn) around your home?
- a) Yes
- b) No

13. Do you use herbicides or pesticides (weed killer or ant killer)?

a) Yes
b) No

14. Do you own a motorboat (1), all terrain vehicle (2), skidoo (3)?

a) Yes (1), (2), (3)
b) No

15. Do you change the motor oil in your vehicles in your yard?

a) Yes
b) No

16. Where do you discard the used motor oil?

a) Local landfill site
b) Local deposit for motor oils, paints and other chemicals
c) On your own property
d) On the road in front of your home

17. Do you perceive a problem with such practises?

a) Yes
b) No

18. If yes, what do you perceive the problem to be? Please outline below

_____

_____

_____

a) Health related
b) Environmental aesthetics
c) Environmental health
d) Traditional life style threat
e) Other _____

19. Do you think there are significant environmental contaminants in your community?

a) Yes
b) No

20. What do you think the sources of contamination are in your community?

a) _____
b) _____
c) _____

Surveyor: Please check off appropriate category below

a) Air
b) Water

c) Food
d) Petroleum
e) Noise

21. What would you like to see done to correct the matter?

_____

_____

a) Remediation
b) Education/Awareness
c) Proper analysis of contamination
d) Environmental task committee to build information data bank for community

23. What types of programs can you anticipate to correct the current circumstance of your community?

a) Recycling deposit
b) Collection vehicle for used petroleum products and other substances
c) Other_____

The following questions pertain to age and gender.

24. To what age group do you belong?

a) 16 to 25
b) 26 to 35
c) 36 to 45
d) 46 to 55
e) 56 to 65
f) 66 or over

25. To which gender do you belong?

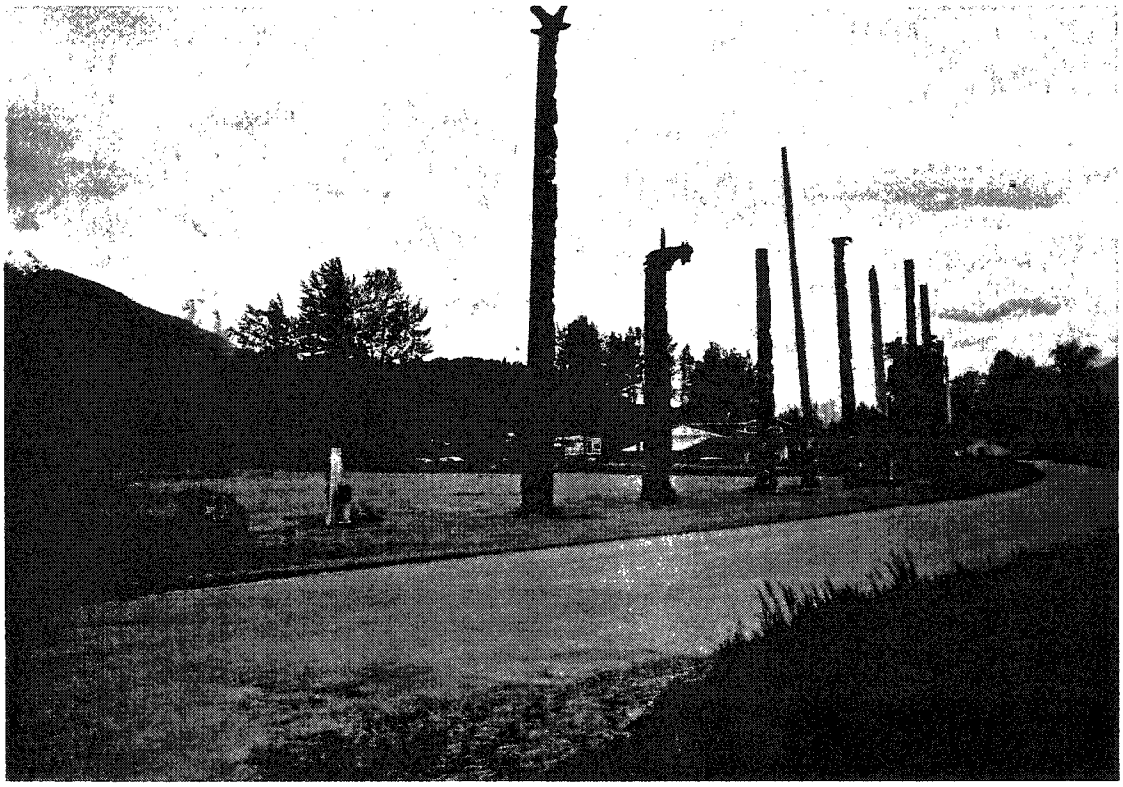
a) Female
b) Male

NOTE TO USERS

Apx C-I

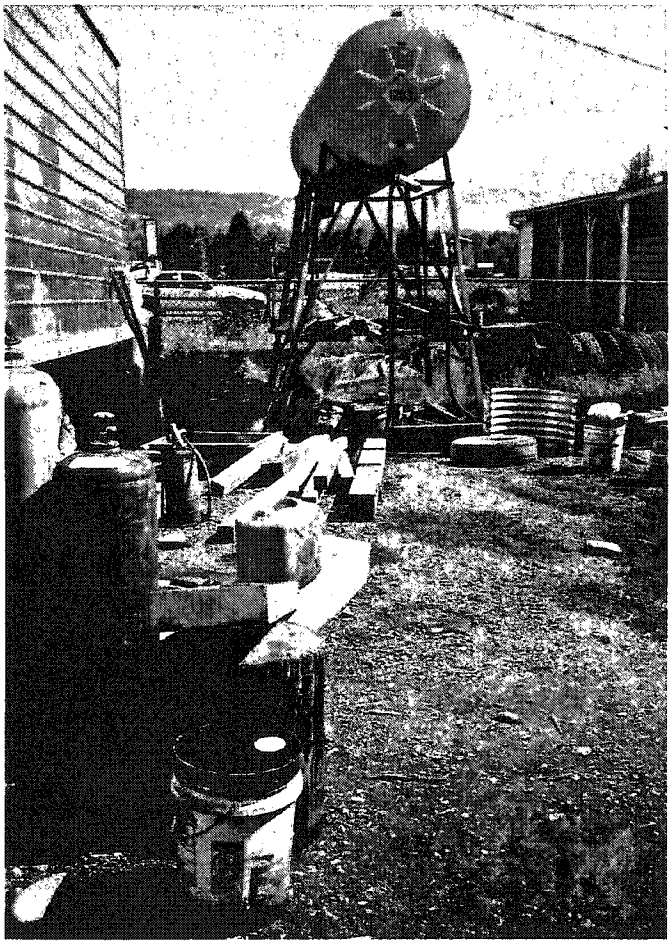
APPENDIX J

Photographs - Kispiox



PHOTOGRAPH 23 – GITWANGAK

A diesel generator building was reportedly present in the 1950s and 1960s along the north bank of the Skeena River near the totem poles. No evidence of the building was observed.



PHOTOGRAPH 1 – KISPIOX

Fuel storage at the residence of George Muldoe. Significant soil staining was observed in this lot, which is located in a residential neighborhood.

PHOTOGRAPH 2 - KISPIOX

Soil stains and stressed vegetation at the base of the filler pipe for one of the community center USTs. Staining was observed near the vent and filler pipes of many USTs in the community.

PHOTOGRAPH 3 - KISPIOX

One of two sewage treatment lagoons. Note the thick algal growth on a large portion of the lagoon which does not appear to be efficiently aerated.

PHOTOGRAPH 4 - KISPIOX

View of a portion of the Kispiox landfill. Note the open burning of refuse.

PHOTOGRAPH 5 - KISPIOX

A section of the Kispiox landfill contained a large number of old abandoned vehicles and fridges.

PHOTOGRAPH 6 - KISPIOX

Unregulated dump site observed behind the new gas bar. The dump site is in the main community and access is unrestricted.

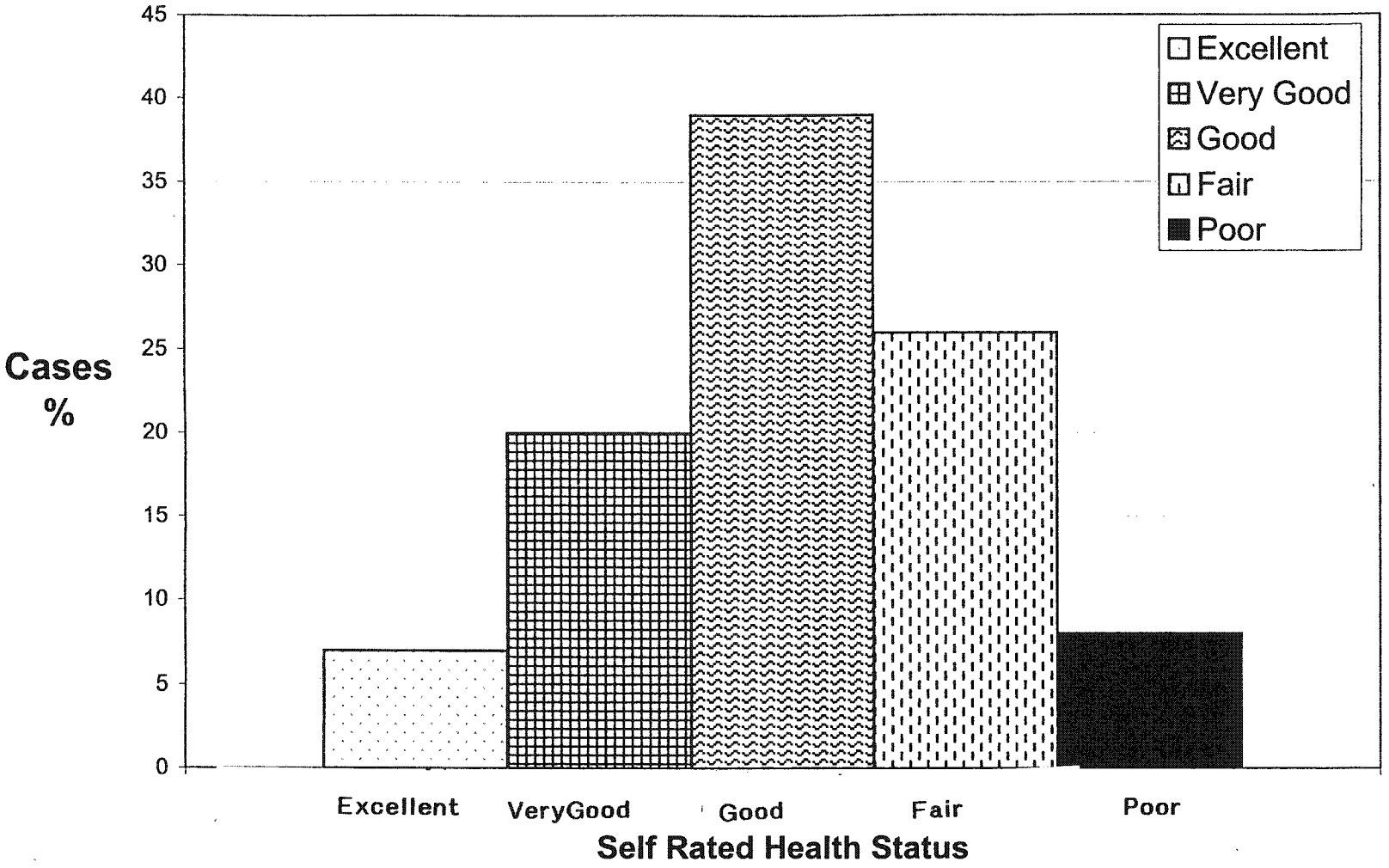
PHOTOGRAPH 7 - KISPIOX

Photo of first sampling location at the Kispiox landfill. The sample was collected using a hand auger.

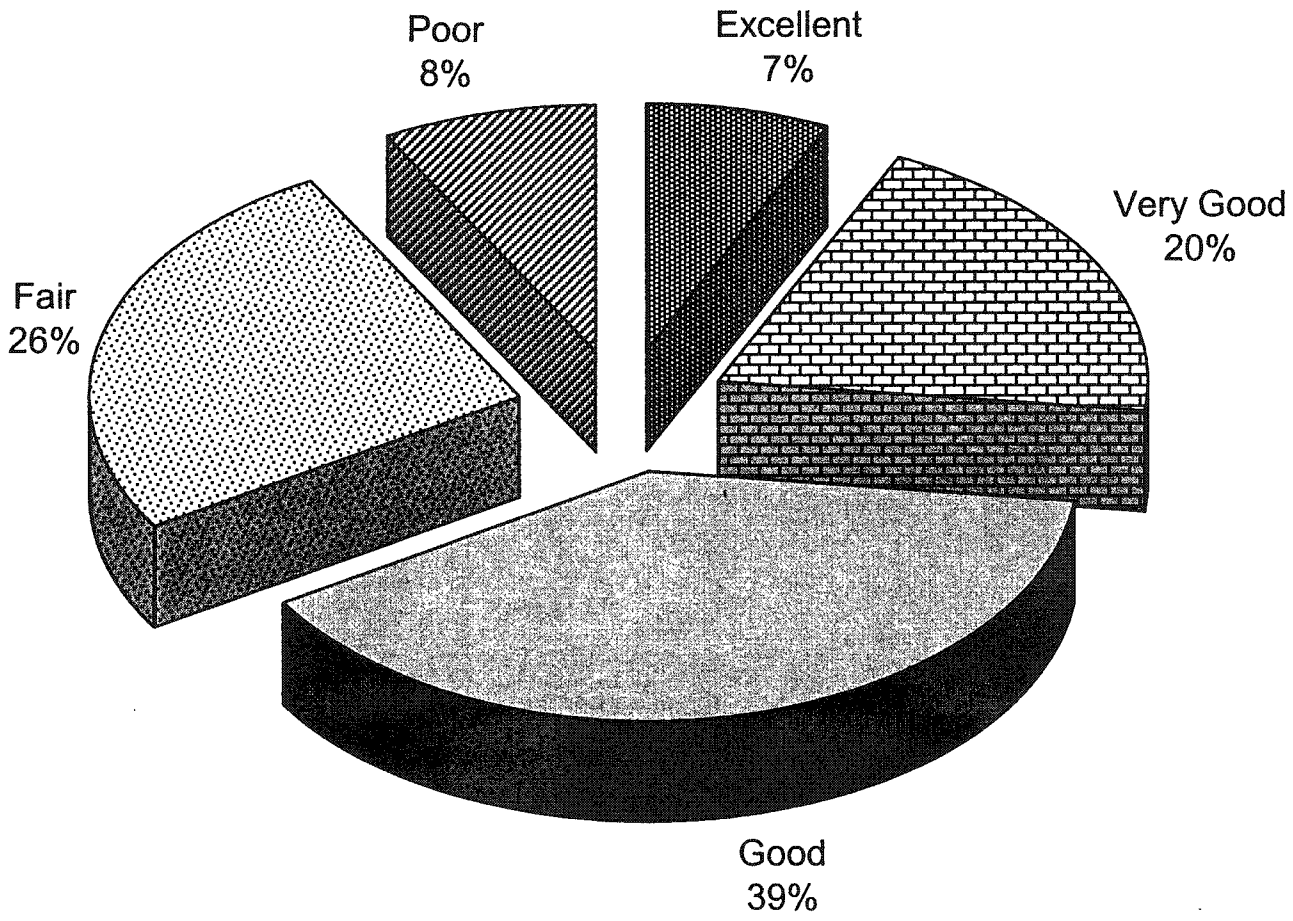
APPENDIX T

Graphic Treatment for each Question

Self Rated Health
All Age Groups and Genders



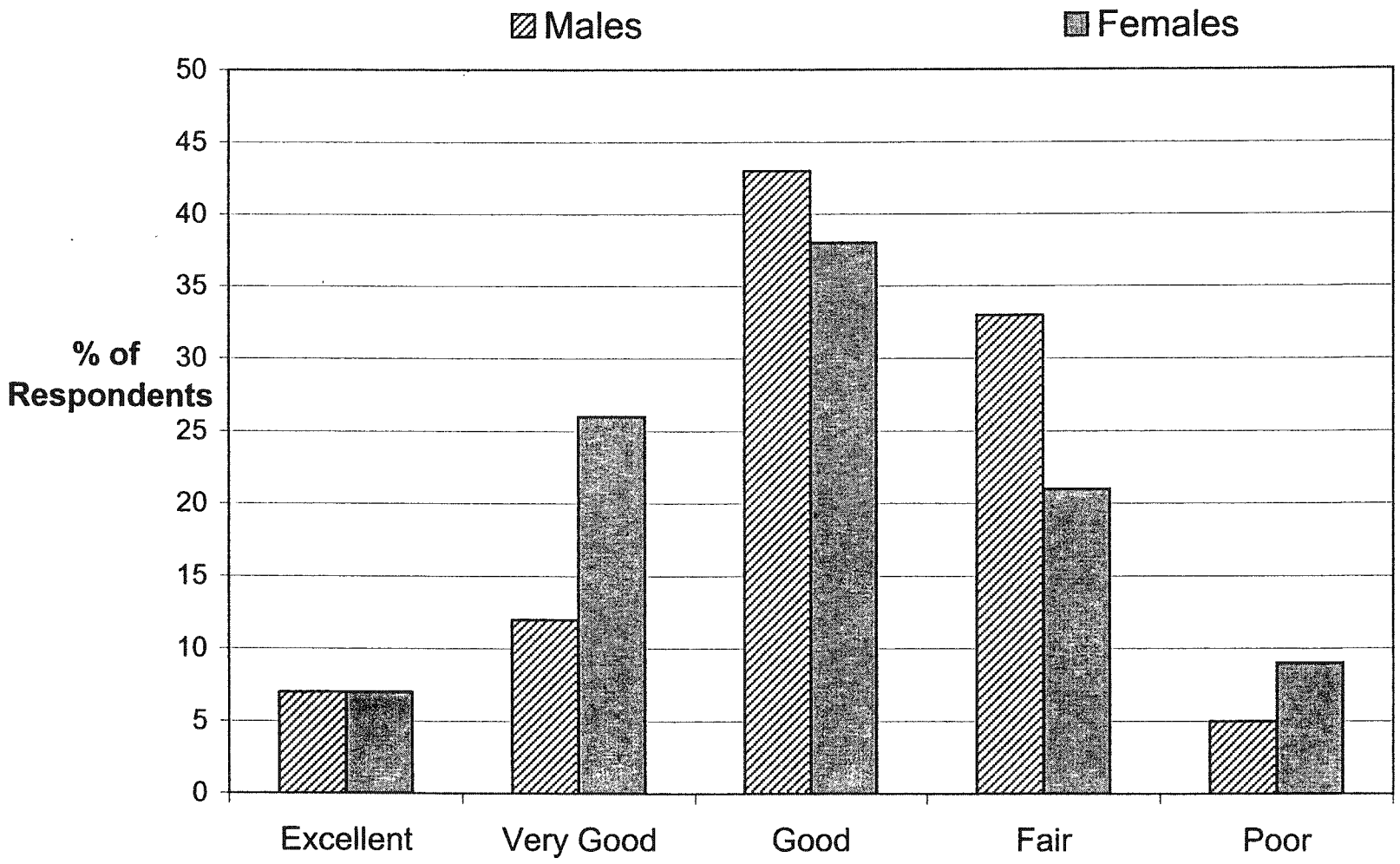
Kispiox 2002 Survey Respondents
Self Rated Health Status



Question 1 - Totals

Data Source: Kispiox Questionnaire 2002- Health Canada-FNIHB

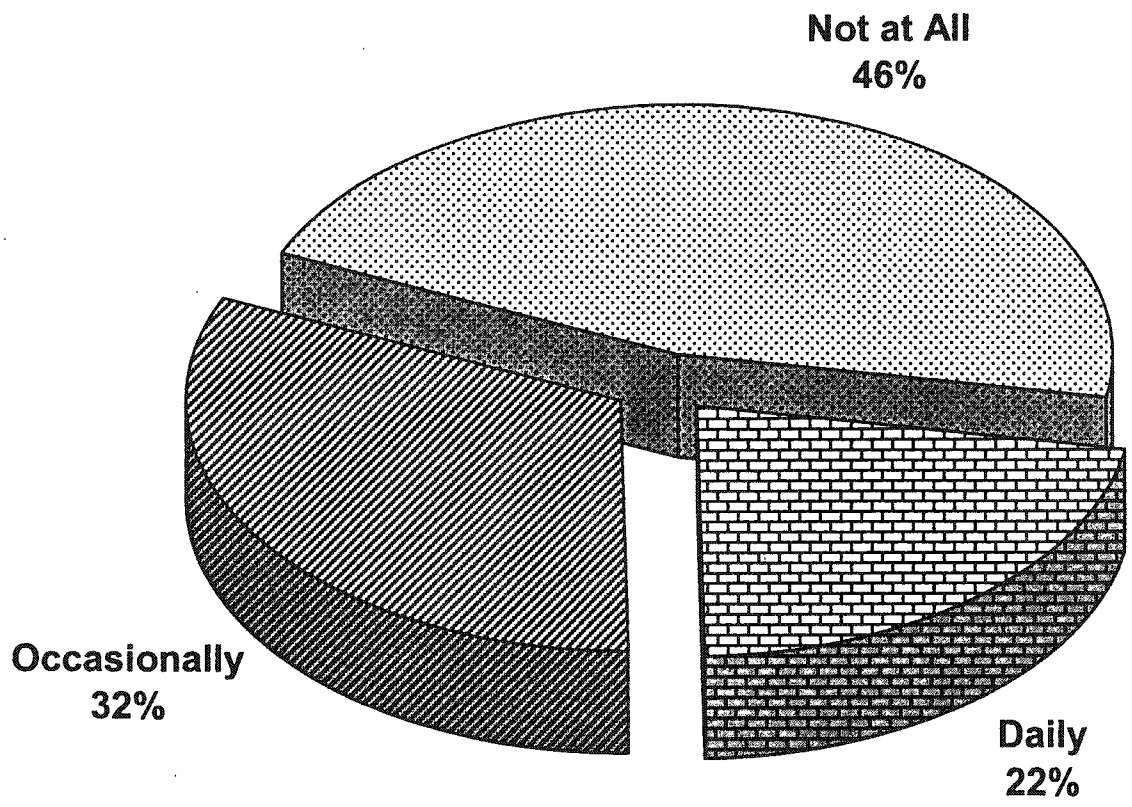
Kispiox 2002 Survey Respondents
Self Rated Health Status



Question 1 - AgeGroups

Data Source: Kispiox Questionnaire 2002- Health Canada-FNIHB

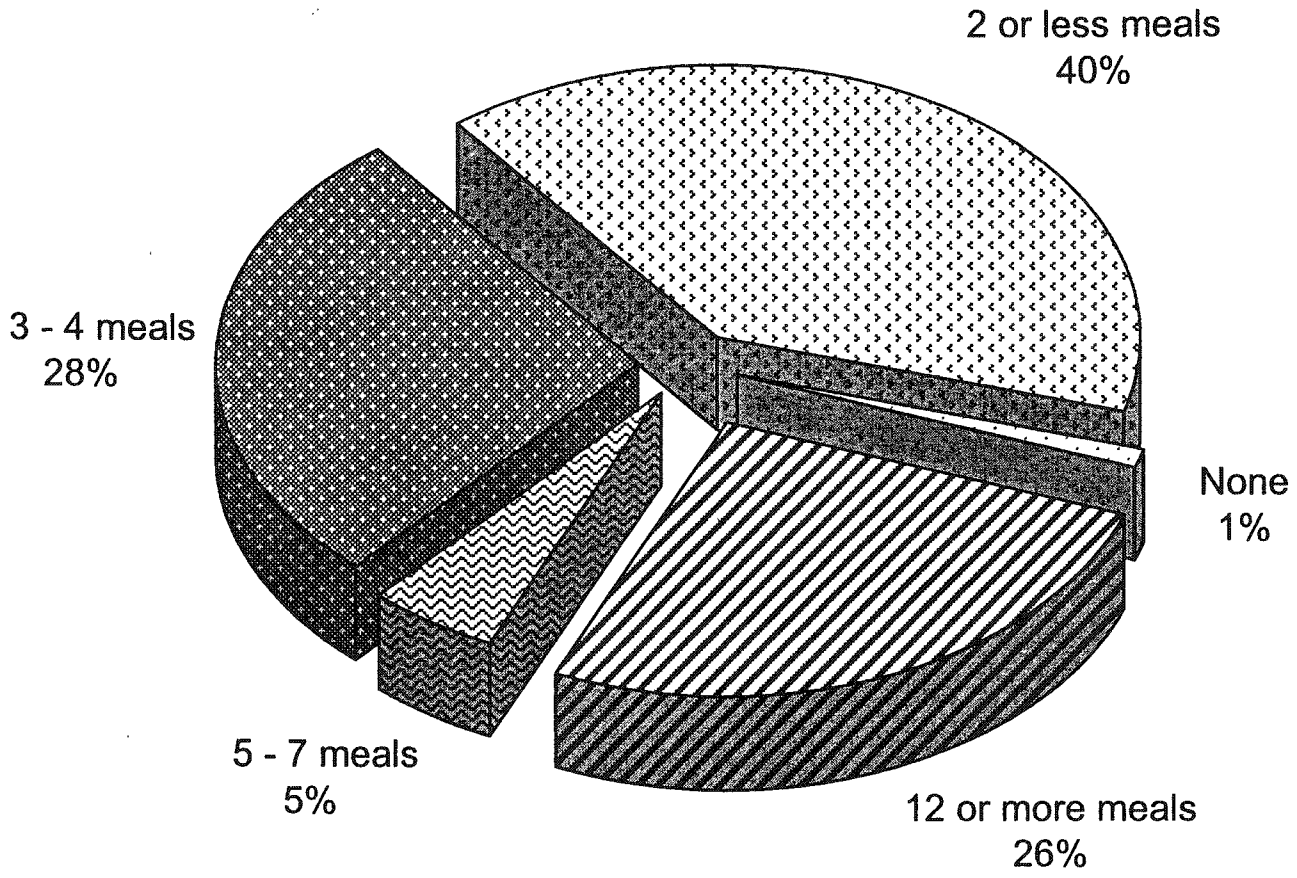
Kispiox 2002 Survey
Respondents Self-Rated Smoking Habits



Question 2 - Totals

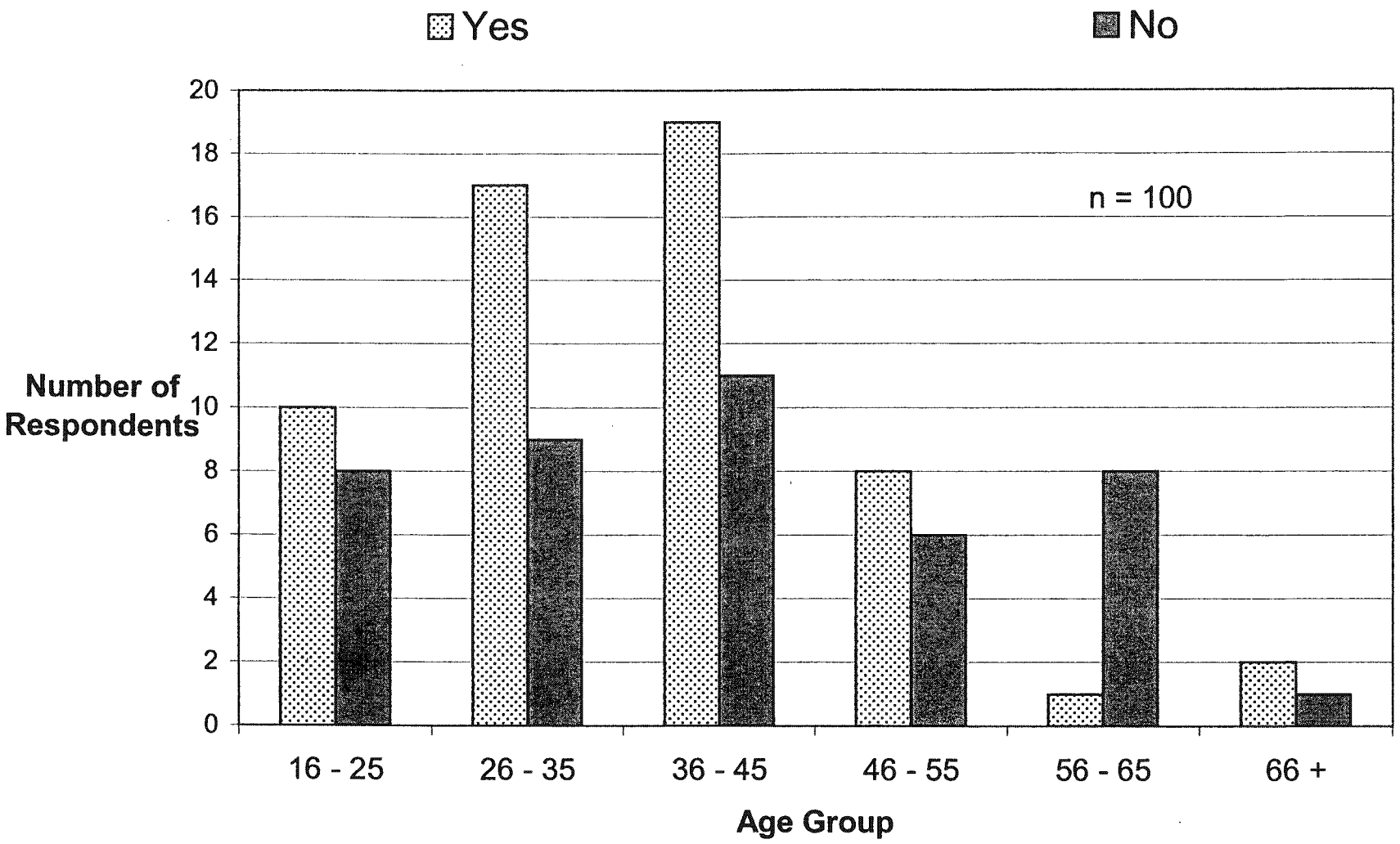
Data Source: Kispiox 2002 Questionnaire - Health Canada - FNIHB

Kispiox 2002 Survey
Portion of Weekly Diet Obtained from Traditional foods



Data Source: Kispiox Questionnaire 2002- Health Canada-FNIHB

Kispiox 2002 Survey
Consumption of Tap-water



Question 6 - AgeGroups

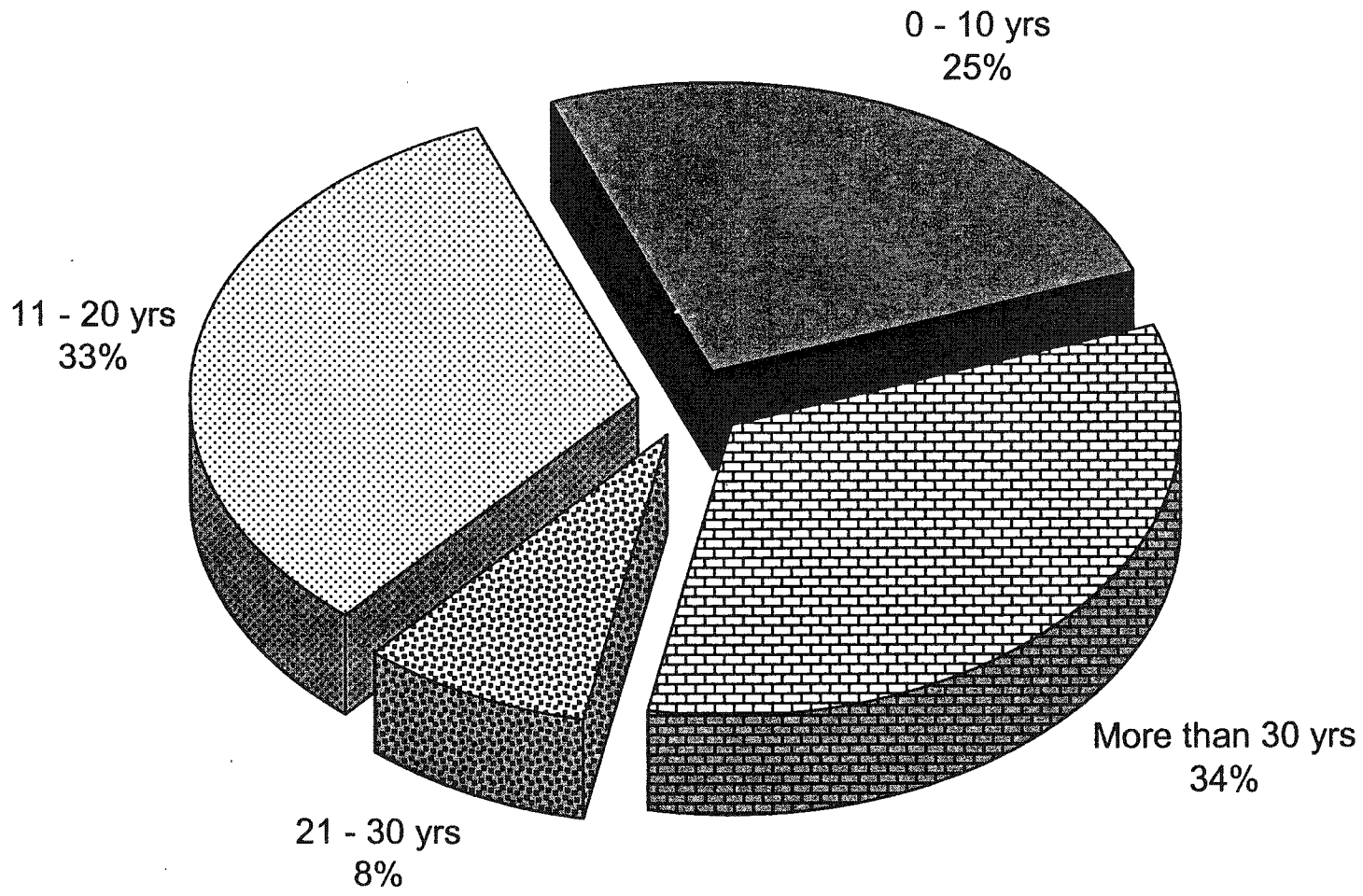
Data Source: Kispiox Questionnaire 2002- Health Canada-FNIHB

Kispiox 2002 Survey
Respondents Working Locally

Question 8 - AgeGroups

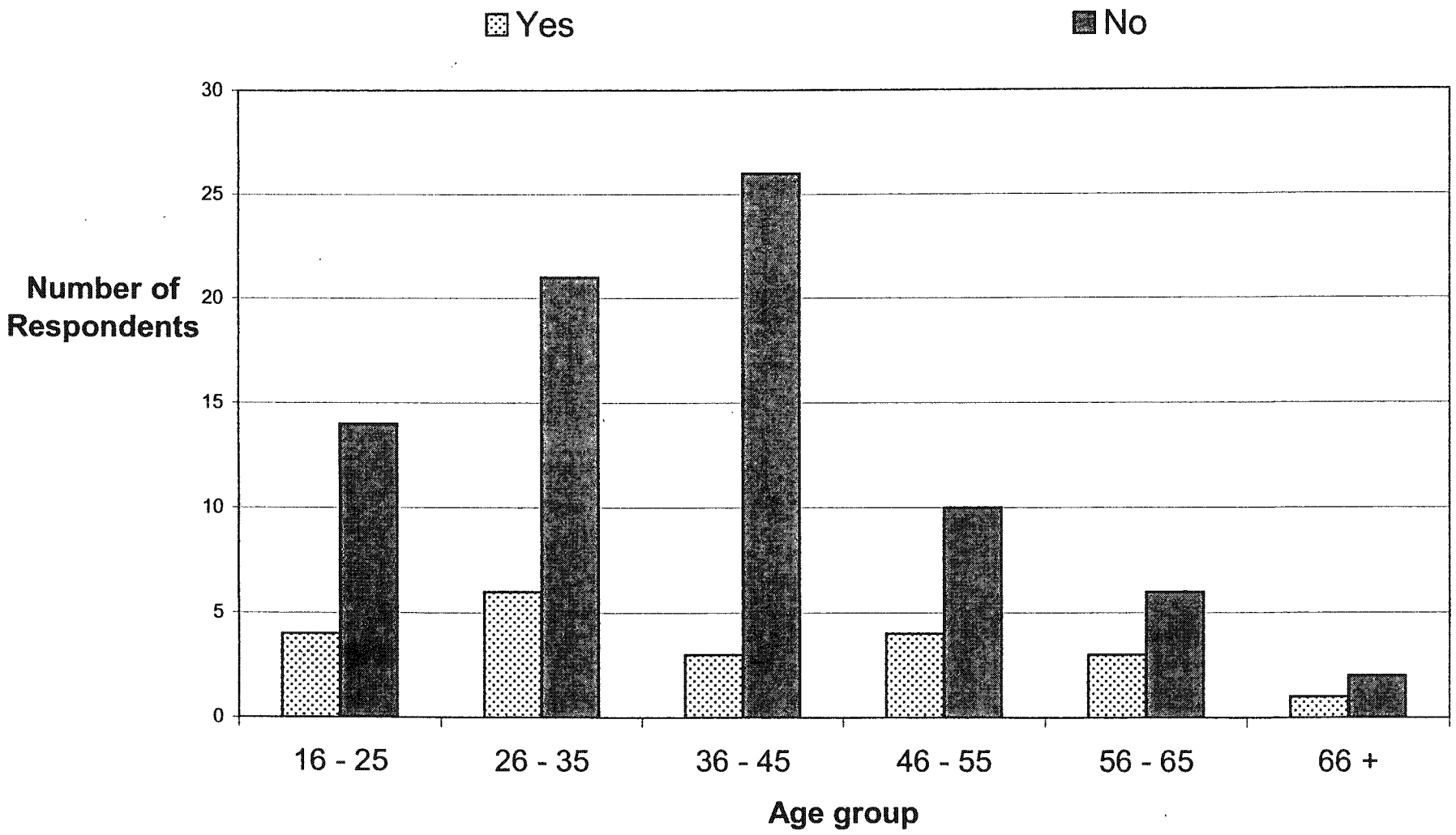
Data Source: Kispiox 2002 Questionnaire - Health Canada - FNIHB

Kispiox 2002 Survey
Survey Respondents Years of Community Residency



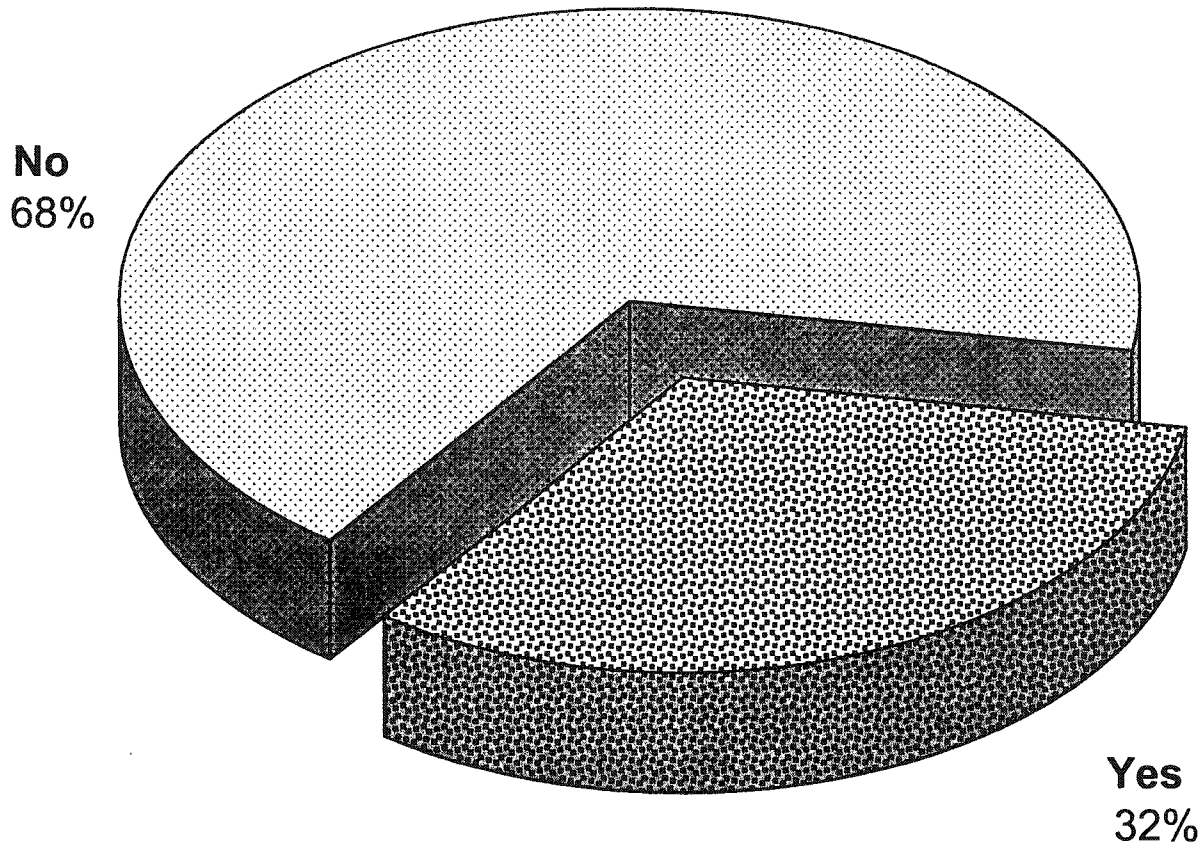
Data Source: Kispiox Questionnaire 2002, Health Canada - FNIHB

Kispiox 2002 Survey
Ownership of Motorized Craft



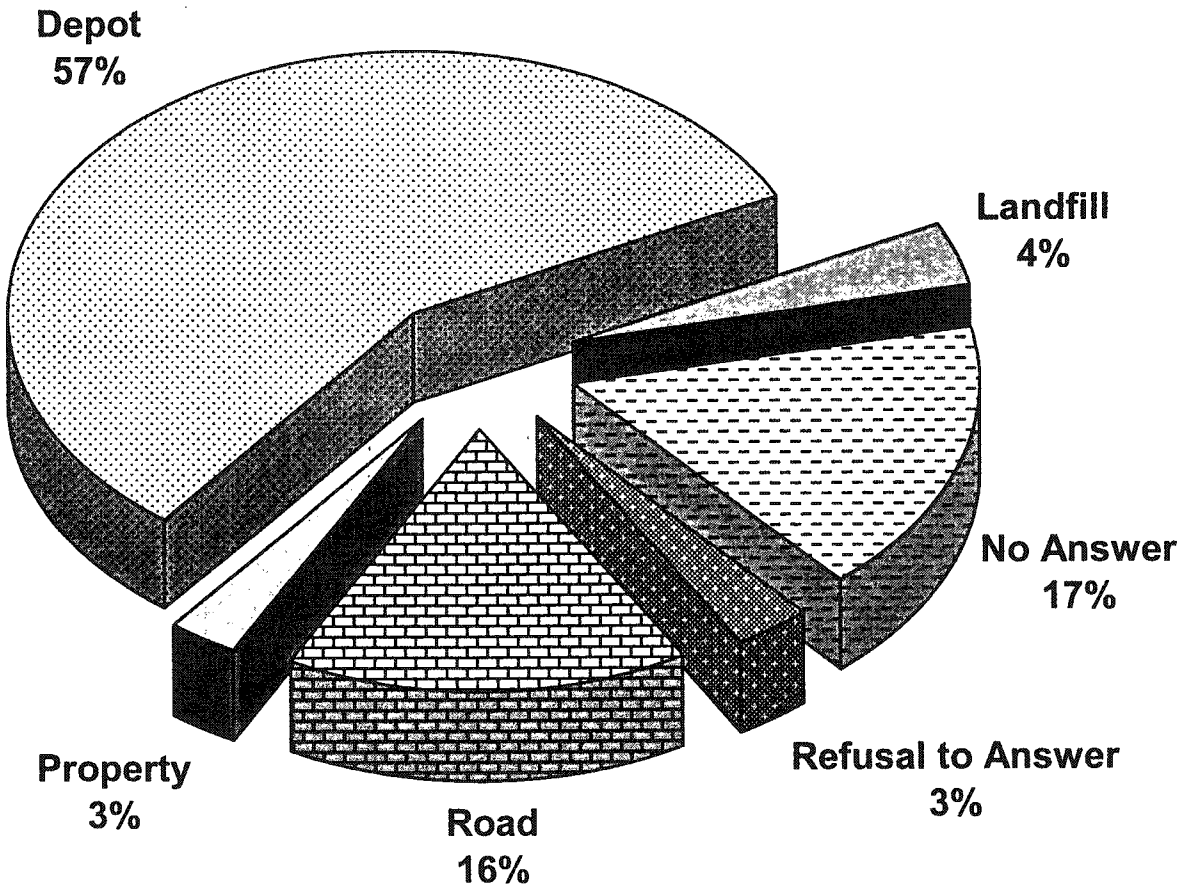
Data Source: Kispiox 2002 Questionnaire, Health Canada - FNIHB

Kispiox 2002 Survey
Respondents indicating Oil Changes Occuring in Own Yard



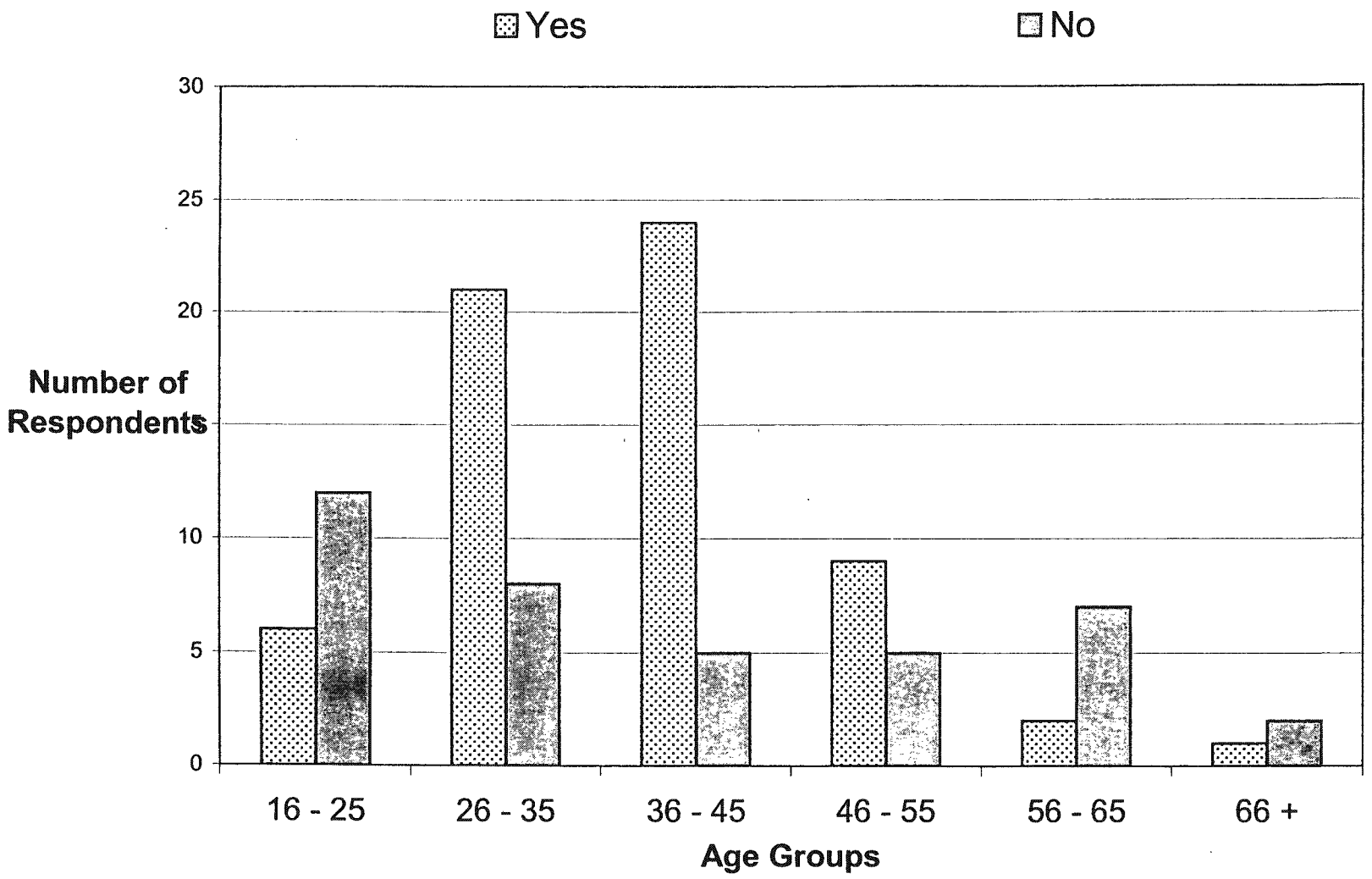
Data Source: Kispiox 2002 Questionnaire, Health Canada - FNIHB

Kispiox 2002 Survey
Disposition of Used Motor Oil



Data Source: Kispiox 2002 Questionnaire - Health Canada - FNIHB

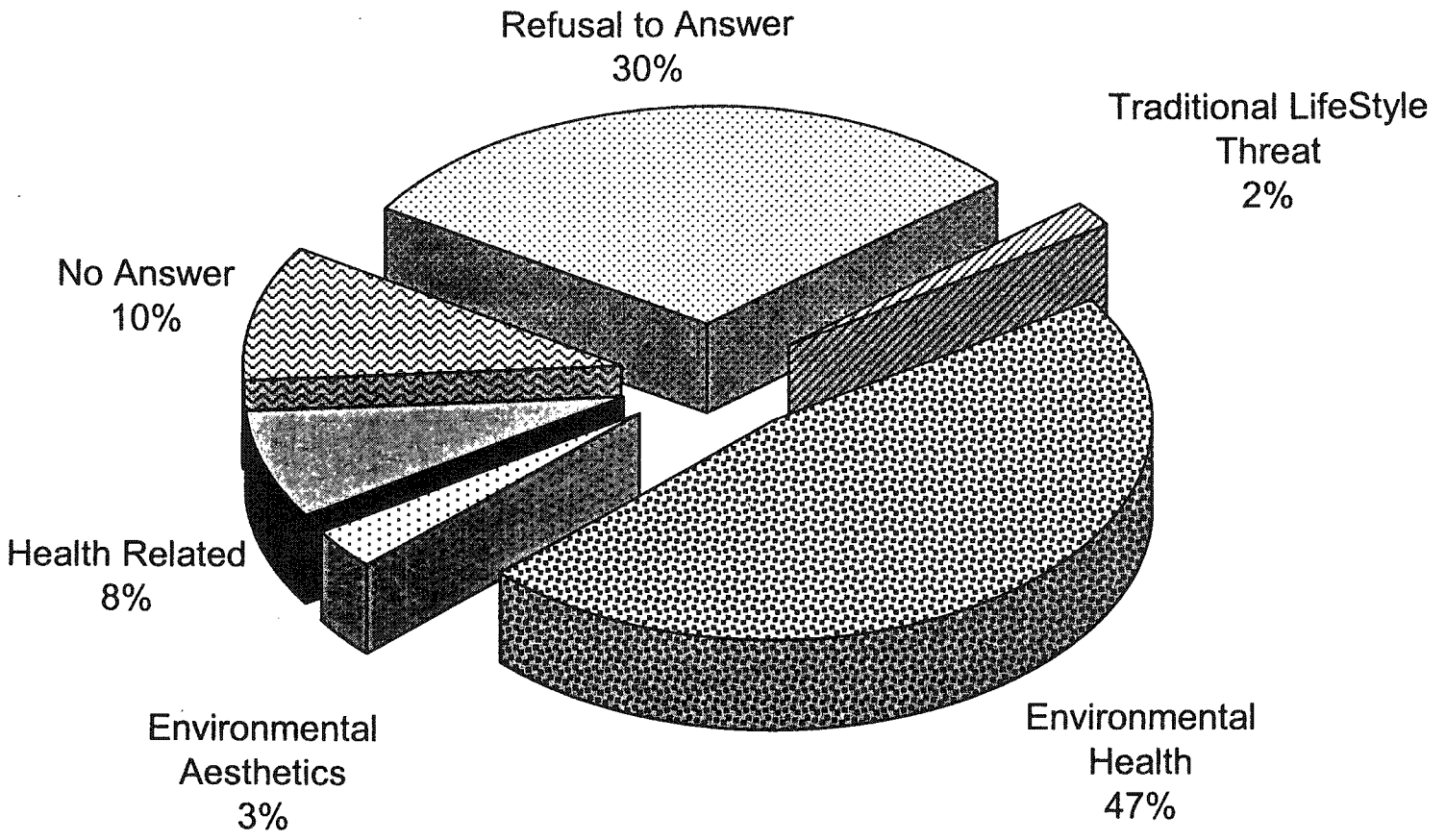
Kispiox 2002 Survey
Perception of Problems with Current Motor-oil Disposal Methods



Question 20-AgeGroups

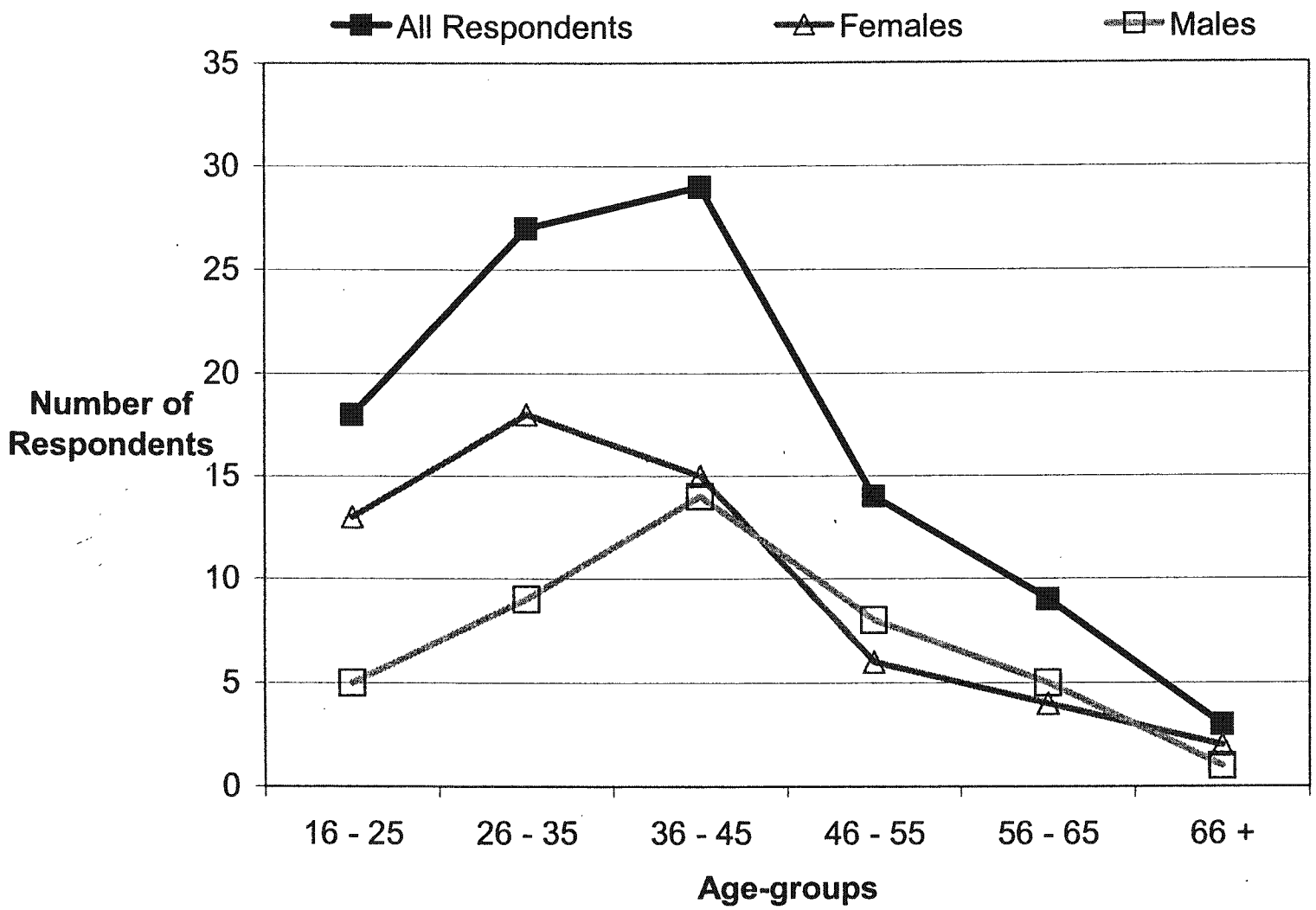
Data Source: Kispiox 2002 Questionnaire, Health Canada - FNIHB

Kispiox 2002 Survey
Perception of Contamination Problem



Data Source: Kispiox 2002 Questionnaire, Health Canada - FNIHB

Kispiox 2002 Survey
Profile of Respondents



APPENDIX U

Leadership Action Plan
for
Thesis Implementation

Meenakshi Dawar, MD, MHSc, CCFP, FRCPC
Community Medicine Specialist
First Nations and Inuit Health Programs
540 757 West Hastings Street
Vancouver, BC V6C 3E6

March 15, 2002

Dear Dr. Dawar

It is with great pleasure that I write to keep you informed of my progress in the Master of Science degree for Environment and Management (MEM) at Royal Roads University. As we discussed ten months ago, when you had agreed to be the thesis sponsor, it was decided that I would be responsible for sharing my learning experience for the purpose of program enhancement, leading to organizational advancement toward sustainable development within Health Canada.

First, I would like to take this opportunity to thank you for your interest and the energy you so generously expressed toward my thesis.

Now to begin, I shall outline for you key points and processes related to sustainable development, leadership, strategic planning and environmental management tools and how these can be applied to enhance the performance of First Nations and Inuit Health Branch (FNIHB).

'Human Imperative' - Sustainable Development

Dale (2001) described the current mindset permeating all of human society including First Nations and Inuit communities as:

> We are living with dissatisfaction, a kind of quiet despair over the old solutions that no longer seem to be working quite so effectively in the face of the crisis that are occurring everywhere. Human societies are obviously in tremendous states of flux, and current decision-making contexts are complex, plural, and paradoxical (p.28).

Sustainable development is the "human imperative of the 21st century" (Dale, 2001, p. 28), and the imperatives of sustainable development are social, economic and ecological. This truth illustrates how the system within systems approach must be considered in order to be successful in gathering information, assimilating information to bring it to knowledge and finally, to internalize the knowledge so that it is then expressed as wisdom, (Dr. David Bell, Senior Associate of RRU, March 7, 2002). Dr. Bell continued his dialogue by stating that we must envision we are "in transition toward sustainability" and in so doing implement the principle of "Is it wise?" before we embark on any new action.

These remarks bespeak the serious state the planet is currently in, and holds out hope that if we realize we need to change our mindset and begin to act in congruence with the directive "is it wise?", we can one and all play a part in establishing sustainable

development as the inextricable link between all fibres of the ecological web in the universe.

Three Imperatives of Sustainable Development

The three imperatives of sustainable development are: ecological, social and economic. Constituents of each are as follows:

Ecological

- nested systems of ecological communities within the greater universal ecosystem
- cycles, nature or the natural world exists relative to cyclic actions and reactions
- dynamic balance, limits, fluctuations, diversity

Among these constituents of the ecological imperative are found rhythms of expression to complement the health and well being of the community. To illustrate, a firestorm clears away the forest undergrowth and allows the opening of cone bearing seeds to have their turn at manifestation on the planet, contributing to the aggregate of energy in the universe and ultimately ecological capital.

Social

- trust is a keystone attribute and prerequisite to building a socially sustainable global community wherein individualism and communalism have occupancy and standing
- reciprocity is an earmark of social balance. When expressed, the residual on the face of human society can be compared to the illustrious coat of a well loved and healthy animal. Reciprocity is embedded in a fine balance with mutuality and interdependence
- communication is said to be one of the tools that can facilitate co-existence, paradoxically, it also negates peaceful co-existence. Attention must be given as to how all objects express their manifestation of existence now, and in the future. Questions like; how will the space I occupy presently be communicated in the future? as individuals attempt to recap how I personally expressed myself. That goes for all other things/energies of the universe
- time is tantamount to the great story of the universe, both time and the story of the universe transcend alpha and omega. Time is critical for building social capital, in turn, if time is allotted, social capital can positively contribute to the energies that constitute the universal story

Once we establish the mindset of trust, reciprocity, responsible communication and time the natural fallout will be social capital.

Economic

- creativity and innovation can be employed to develop the economic imperative
- diversity is congruent with sustainable development and is key to ensuring a healthy expression amongst all participants in the universe
- dynamic balance must be the description of governance at all levels
- technological clusters must demonstrate co-operation for the good of all, rather than be exploitive, as if we exist in an open system
- natural strategies must be the paint brush for all economic endeavour

All these characteristics lead to economic capital.

All three imperatives become capital because of the putting into, rather than depletion of each. This manoeuvring is demonstrative of a "transitioning toward sustainability" (Dr.

Bell, March 7, 2002). This transitioning cannot happen without understanding the "process of reconciliation between the three imperatives of sustainable development, human systems (governance) and natural systems", A. Dale, (personal communication, March, 2002).

Leadership

The information is just part of the learning at RRU, as you can imagine Dr. Dawar, the imparting of knowledge is just the beginning of understanding and so the MEM program is designed to have each learner live the learning, so we lived leading change regarding how we could lead change through implementation of our theses recommendations by means of a presentation to a panel of Senior Associates of RRU. But first, a clinical definition of leadership must be examined.

Leadership is defined as the "capacity of an individual or groups of individuals in organizations to influence others to work for a common goal"(lecture, A. Schultz, February, 2002). It is necessary to know who among us are the leaders, and how those individuals go about leading. In addition, time and circumstance will dictate the type and amount of leadership demonstrated. At this time, in our organization we are being asked by Ottawa to become evermore cognizant of accountability. Now is the time to consider leadership by examining goals and objectives of FNIHB in light of our mission statement regarding sustainable development and accountability in first nation communities.

Leadership is also about knowing who to consult with for a successful launch of initiatives that facilitate our reaching our desired goals for our branch. In order for the organization to move toward achieving our goals we must be aware of the varying vantage points taken by leaders, for example, some leaders station themselves in front, while others choose to lead from behind, and still others from elsewhere within the organization. It is advantageous to recognize who leads and from where. A full complement of leader types is needed to bring our goals and objectives to fruition.

Leadership is about communication and communication is about listening. Dr. Joseph Schaeffer demonstrated how to listen with a heartfelt desire to begin to understand, not accept but understand. His delivery was impressive; he asked, "I am fascinated that you believe abortion is a right, would you tell me more about that?" This well illustrated how to lead by example, and take the lead by actively learning through non-judgemental approaches (workshop, March 8, 2002). Finally, leadership is about vulnerability and nothing illustrates vulnerability like love. Senge (1999) wrote, "At its deepest level, mentoring provides the energy of love". He continued by stating, "my definition of love is: helping others to complete themselves."(p.133). What more need be said to describe a true leader than that he/she loved.

Strategic Business Planning

The premise for this aspect of my learning experience is based on the following statement: "Today's planning really is tomorrow's future!" (N. Cowell, Royal Roads University, unpublished data, 2002). This portion of the MEM program addressed making decisions for capital projects and, as is our focus in a government organization,

service delivery. The principles espoused were to teach us how to become effective change agents by leading and managing a strategic business planning process using a systematic and integrated approach. To say the least, this course was based on the natural dynamics found in the universe and so, it was easy to grasp the intent relative to sustainable development in a federal organization such as FNIHB.

In our organization, it behooves us to be aware of the change in how business is done. Today as never before, more accountability is required. Therefore, we must take a business approach to reshaping our program delivery. To accomplish this goal we must build a brand. Our brand will become how we frame each activity and what we aspire to, in short, it becomes how we "live our brand" (Kim Moller, lecture, March, 2002).

Decisions regarding core competencies such as our degree of knowledge, ability to communicate, technological skill and aptitude for motivating others to a desired course of action should reflect our commitment to our brand and demonstrate that to our clients (First Nations and Inuit communities).

In conclusion, strategic business planning for service delivery must integrate all aspects of a business plan, as well as developing and sustaining innovation that can be accomplished through a culture and climate for innovation and creativity (Charter and Polonsky, 1999, p.146).

Environmental Management Tools

"Environmental management systems (EMS) are not about managing the environment, they are about managing people", (Boydell, lecture, February, 2002). EMS can provide opportunity for people to observe the inter-play of the three imperatives of sustainable development. This observation can be measured, assessed and interpreted leading to improved actions on the part of the participants, relative to sustainable development. EMS can offer an appropriate vehicle for defining, designing, implementing and promoting sustainable development. EMS is a tool that incorporates feedback loops through regular monitoring which, in turn, enables people to make timely changes to ensure compliance with policies and objectives of the organization.

Synthesis

In this discussion it is obvious that sustainable development can happen only if a multi-disciplinary approach is taken. In our organization, it is critical that each member has access to leaders, are encouraged to become leaders, and provided with the resources to become a full participant in the integration of these principles into our corporate service delivery plan. In her lecture on the ten principles of sustainable development, F. Edwards extolled the merits of consensus processes, which included; participant driven, self design, equal opportunity, respect for diverse interests, accountability, time lines and implementation, all features of a true and sustainable approach to the direction of our organization.

It has been my pleasure to recall just a few of the gems I experienced during my residency at RRU. I am confident that with my learning experience and your authority

we can move to improve the performance of our organization regarding sustainable development.
I have included an action plan using my thesis as a framework to implement my thesis recommendations. This can be used as an action plan to begin to develop an integrated approach for our organization to move toward designing and implementing strategies for sustainable development.

Action Plan

Current State: 1. Management not aware of environmental contamination (EC) in FN community 2. Problem formulation phase completed	**Strategy # 1** Create environment that allows management access to information	**Action # 1** Present Thesis to stakeholders FNIHB and FN community **Action # 2** Live my brand as a proponent of sustainable development as it relates to EC in FN communities	**Desired State:** 1. Management informed and decisions are being considered 2. Completion of phases 2 and 3 (Exposure/Toxicity Analysis and Risk Characterization)
	Strategy # 2 Encourage a learning "camp" to understand thesis findings	**Action # 1** Use one Flex day (my day off) to provide cracker barrel to pique interest in thesis **Action # 2** Invite Elder from FN community (involved in thesis study) to participate in workshop for the benefit of internal management and colleagues	

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APPENDIX V

Integrated Environmental Management Process

INTEGRATED ENVIRONMENTAL MANAGEMENT PROCESS

Stakeholders:

FirstNations,CommunityMembers,HealthCanada,Scientists