

# Health Impact Assessment (HIA) of Mining Activities near Keno City, Yukon

PREPARED FOR THE YUKON DEPARTMENT OF HEALTH AND  
SOCIAL SERVICES

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Prepared by:

Habitat Health Impact Consulting  
Calgary, Alberta



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## Acronyms

AML	Acid metal leaching
COPC	Constituents of particular concern
dba	Decibels
EIA	Environmental impact assessment
GI	Gastro-intestinal
HHRA	Human Health Risk Assessment
HIA	Health Impact Assessment
HSS	Yukon Department of Health and Social Services
KCC	Keno Community Club
LQO	Lucky Queen & Onek
NNDFN	First Nation of Na-Cho Nyak Dun
P-AML	Potential acid metal leaching
PM	Particulate Matter
SIA	Social impact assessment
STI	Sexually transmitted infection
TB	Tuberculosis
TSP	Total suspended particulates
YESAB	Yukon Environmental and Socio-Economic Assessment Board



## Section 1. Introduction

### Purpose of this report

This report was commissioned by the Yukon Department of Health and Social Services (HSS) in response to public concerns over mining activities near Keno City. The purpose of this report is to disclose the potential beneficial and adverse health impacts for Keno City residents that could arise from current and proposed mining operations. Specifically this report will:

- a) Identify health issues that are likely to be associated with the current and proposed mine developments
- b) Summarize and characterize potential health impacts for issues on which there is sufficient data and, where possible, suggest mitigations or enhancements that may reduce adverse health impacts
- c) Identify areas of concern for which data gaps limit understanding of the overall health impact of the activity

The report was prepared by Habitat Health Impact Consulting, and presented to the HSS in August, 2012.

### What is Health Impact Assessment?

Health Impact Assessment is a process used to identify how a project, policy or program might influence the health of a population. The types of projects examined in HIA are generally not designed to influence health — for example, natural resource projects, economic policies, or land-use proposals.

Like environmental impact assessment (EIA) and socio-economic impact assessment (SIA), HIA systematically assesses potential impacts, and recommends strategies to mitigate harmful effects and enhance benefits. HIA, EIA and SIA differ in where they look for effects. EIA examines effects on the environment, SIA on the social and economic well-being of affected communities, and HIA on the physical, mental and social health of human populations.

HIA uses an unbiased and systematic approach to understanding health impacts. The approach and methods used depend on the nature of the project being examined, the make-up of the communities affected, and the likely health effects that may be associated. Several key documents provide guidance to ensure a high standard of HIA practice, and this HIA has adhered to these recommendations. Key guidance documents include:

- *The Canadian Handbook on Health Impact Assessment* (Environmental Health Assessment Services 2004)
- *Good Practice Guidance for Health Impact Assessment* (International Council on Mining and Metals 2010).
- *Minimum Elements and Practice Standards for Health Impact Assessment* (Bhatia et al. 2010)

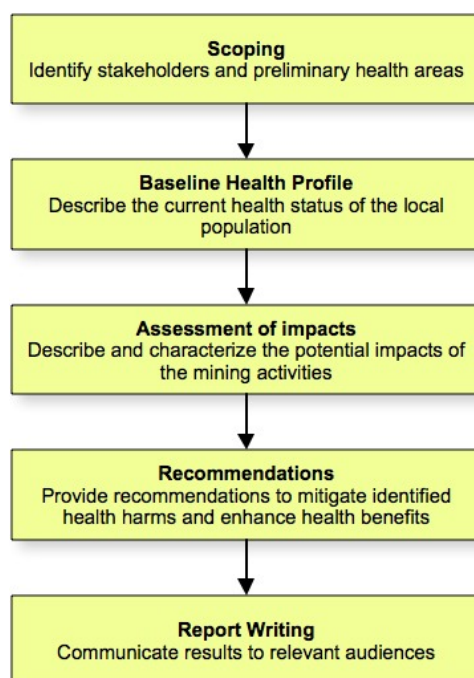
## Section 2. HIA Methodology

### Overview of the methodology

The HIA followed the standard steps of HIA: scoping, developing a baseline health profile, assessing impacts, developing recommendations, and communicating the results. An overview of this process is shown in Figure 1. Stakeholder consultation and guidance from the Yukon Department of Health and Social Services informed the HIA throughout the process.

Evaluation and monitoring are steps that are often taken after the completion of the HIA. Monitoring is discussed as part of the recommendations; evaluation of the effectiveness or usefulness of the HIA may be conducted by the DHSS in the future.

**Figure 1: Steps used in HIA**



### Study area

Because of the proximity of current and proposed mining activities to Keno City, the primary study area is Keno City and its residents. In addition, because of the potential for some project impacts to extend regionally, the community of Mayo is included in the study area for certain health pathways.

It is important to note that only people who are resident in the project area for at least part of the year are considered in the assessment of impacts. Seasonal tourists and campers are excluded because of the short exposure time in the project area.

## Stakeholder engagement

Stakeholder engagement with local residents and various stakeholders took place in May and June of 2012. Stakeholders were identified by the Yukon Department of Health and Social Services as well as through a stakeholder analysis that identified relevant local service providers for each assessment area.

Stakeholder meetings took place via telephone interview, one-on-one interview, email correspondence and group meetings. All stakeholder engagement activities are listed in Table 1.

**Table 1. Summary of Stakeholder Meetings**

Date	Number of people or name of individual
June 12-15	Fourteen residents of Keno city (one-on-one meetings)
June 12	Dr. Brendan Hanley, Chief Medical Officer of Health, Yukon Department of Health and Social Services
June 12	Benton Foster, Manager of Environmental Health Services, Yukon Department of Health and Social Services
June 13	Scott Davidson, Access Consulting Group
June 13	Paula Shemley, Alexco Resource Corporation
June 15	Linda Heasley, Nurse in Charge, Mayo Health Clinic
June 15	Darlene Hutton, Mayo Ambulance
June 30	Jim Harrington, President, Alexco Environmental Group / Alexco Keno Hill Mining Corporation

In addition, all comment submissions for the Bellekeno, Lucky Queen and Onek mine proposals were reviewed to ensure all documented community and stakeholder concerns were captured.

## Scoping

Scoping enabled the identification of health issues to be carried forward for analysis in the HIA. Based on a review of public comments, community and stakeholder interviews, and literature summarizing health effects observed in other mining contexts the health pathways listed below were selected for inclusion in this HIA. The process that was used in identifying and selecting these specific issues is discussed more extensively in Section 5 of this report.

- Air- and soil-related health effects
- Water-related health effects
- Noise-related health effects
- Infectious disease
- Stress and mental well-being
- Injury
- Emergency medical response

## Assessment methodology

The assessment for each of the seven health pathways is organized into five sections. The contents of each section are outlined below.

*Background:* Summarizes the research literature linking mining and resource development activity to the health outcome.

*Pathways between mining activities and health effects:* Provides information on the potential linkages between mining activities relevant to the study area and the health outcomes.

*Current knowledge of project impacts:* Describes what is currently known about impacts to health for current and proposed mining activities.

*Summary of the potential effect:* Characterizes the health impact based on selected parameters: direction, severity, duration and likelihood. The definitions used for effect characterization are shown in Table 2.

*Recommended additional mitigation measures:* Provides recommendations to minimize or mitigate potential health harms and, where possible, enhance health benefits.

**Table 2: Definitions Used for Effect Characterization**

<b>DIRECTION</b>	
<b>Beneficial</b>	A beneficial or desirable change.
<b>Adverse</b>	An adverse or undesirable change.
<b>SEVERITY</b>	
<b>Low</b>	Has the potential to cause acute, short-term effects with limited and reversible effects on function, health or well-being.
<b>Medium</b>	Has the potential to cause acute, chronic, or permanent effects that substantially affect function, health or well-being.
<b>High</b>	Has the potential to cause acute, chronic, or permanent effects that are potentially disabling or life threatening.
<b>DURATION</b>	
<b>Transient</b>	Is likely to last for only a short period of time.
<b>Persistent</b>	Has the potential to last for the duration of mining activity.
<b>Permanent</b>	Has the potential to result in irreversible change.
<b>LIKELIHOOD</b>	
<b>Unlikely</b>	There is little evidence that effects will occur in with resource development activity in this setting.
<b>Possible</b>	Evidence suggests that effects do occur, but are infrequent in this setting.
<b>Probable</b>	Evidence suggests that effects commonly occur with resource development activity in similar settings.
<b>Certain</b>	Effects are already being reported in the study area.

## Section 3. Community Profiles

### Keno City

#### History

Keno City, located in the Keno Hill Silver District, began as a stopping point for miners along a haul road in 1919 and rapidly grew into a centre for recreation and supplies. With prosperity dependent upon the nearby silver and gold mines, Keno City has experienced a number of booms and busts throughout its history. In 1947, United Keno City Hill Mines Ltd., the primary mining company in the area, was the second largest silver producer in North America and fourth largest in the world. However, by 1989 falling silver prices caused United Keno Hill to close down its operations. At its peak in 1980, Keno City, along with the neighbouring company town of Elsa, had a population of over 600. Currently, Keno City has less than 30 full-time residents. Those who live in Keno City today are predominately miners (both retired and active), outdoor enthusiasts, artists and others drawn to the unique local environment (Yukon Development Corporation 2004).

#### Physical setting

Keno City sits at the base of Keno Hill in the mountains of central Yukon. The community is located in the Yukon Plateau-North ecoregion to the northwest of the Tintina Trench. A number of large rivers, such as the Pelly, Ross, Macmillan, Stewart, Hess, McQuesten and Klondike, drain the plateau and empty into the Yukon River (Yukon Development Corporation 2004).

**Figure 2. Map of Keno and Mayo.**



Source: <http://suethomas.ca/SilverTrail.html>

#### Demographics

In 2011, the population of Keno City was 28 people, up from 15 people in 2006, and 20 people in 2001. In total, there are 20 private and permanent dwellings in the settlement (Statistics Canada 2012). A community site visit in June 2012 indicated that there were presently no children living within the community year-round although

children may visit or camp in the area in the summer. The permanent population is comprised of only adults, with the majority of community residents being 35 years of age and older.

### Political, economic, and social context

Keno City is an unincorporated community and therefore does not have an official political body or local governance structure. The Keno Community Club (KCC) has acted in many ways as an unofficial 'governing' body in Keno City.

Today, Keno City's economy is primarily driven by a small but steady tourism industry based on the recreational use of the area and interest in the mining history, including the local mining museum. In addition there are also a number of active placer mines in the area, a commercial herb farm and assorted other small ventures.

Community residents tend to be divided into two social groups: the 'cottagers' (those who do not live in Keno City year-round, but live there seasonally or temporarily) and the permanent residents. Within the community there are divergent views on current mining activity, including Alexco's operations and recent proposals. However, whether in support or opposed to mining operations, most residents appear to agree that the current situation within the community regarding mining developments is strained and causing stress.

### Services and infrastructure

The services of Keno City are limited and tourist-based. Keno City has a pizza and snack bar, a café and tavern (Sourdough Café and Tavern), a mining museum, an alpine interpretive centre, a campground, a number of rental cabins and accommodations, nearby hiking trails, and a few artist studios (Travel Yukon 2012). Keno City draws drinking water from the Fire Hall Well (Well E) and delivers it via truck to community residents. A waste transfer station is located at the town dump immediately to the west of the community. The Village of Mayo is the backup source in case there are problems with obtaining potable water from the Firehall Well.

### Health services and trends

The Yukon Health Act defines health as 'the physical, emotional, social, mental and spiritual well-being of residents of Yukon in harmony with their physical, social, economic and cultural environments' (Yukon Health and Social Services 2009). Information on the health status of the population of Keno City is unavailable due to issues of confidentiality given the very small population size. Recent data on a number of important health indicators, however, is available at the territorial level (Table 3) and can be used as a proxy.

**Table 3. Health Data: Keno City, Mayo, and Yukon Territory**

Health Indicators	Keno City	Mayo	Yukon Territory			Canada
			Male	Female	Total	
Perceived health, 2009/10						
Perceived health as very good or excellent (%)	n/a	n/a	57.3	58.6	58.0	60.3
Perceived mental health as very good or excellent (%)	n/a	n/a	72.3	73.9	73.1	73.9
Perceived life stress (%)			17.5	21.0	19.2	23.4
Health Conditions, 2009/10						
Overweight or obese (%)	n/a	n/a	56.9	48.9	53.0	52.0
Diabetes (%)	n/a	n/a	5.2	4.5	4.8	6.2
High blood pressure (%)	n/a	n/a	12.3	12.6	12.5	17.0
Injury hospitalization (per 100,000 population)	n/a	n/a	1,417	1,006	1,216	514
Health Behaviours, 2009/10						
Current smoker, daily (%)	n/a	n/a	27.1	22.1	24.6	15.6
Heavy drinking (%)	n/a	n/a	35.6	18.8	27.3	17.3

Deaths per 100,000 population, 2009/10						
Total, all causes of death	n/a	n/a	882.7	582.4	736.7	542.3
All cancers, deaths	n/a	n/a	287.4	196.1	244.1	166.4
Circulatory diseases, death	n/a	n/a	229.3	142.4	189.2	157.3
Respiratory diseases, deaths	n/a	n/a	61.8	48.2	52.8	45.0
Unintentional injuries, deaths	n/a	n/a	49.3	40.1	43.2	25.1
Sense of Belonging to Local Community, 2009/10						
Sense of belonging (%)	n/a	n/a	77.4	76.9	77.2	65.4
Crime and Violence, 2006 (per 100,000 population)						
Criminal code crime rate (excluding traffic)	n/a	n/a	n/a	n/a	20,593	7,518
Food Security, 2003						
Yukoners who said that they 'often' or 'sometimes' did not have enough food to eat (%)	n/a	n/a	n/a	n/a	11%	n/a
Age-Standardized Mortality Rate per 100,000 population, 2000-2004						
Colorectal cancer	n/a	n/a	20.5	19.6	20.3	17.9
Lung cancer	n/a	n/a	104.5	43.3	74.6	45.4
Acute myocardial infarction	n/a	n/a	50.4	27.2	39.6	37.1a (2006)
Cerebrovascular diseases	n/a	n/a	51.7	46.0	47.9	30.8 (2005/7)
Standardized Mortality Rate: Age-Standardized Mortality Rate per 100,000 population, 1992-2001						Male/ Female
Diabetes	n/a	n/a	10.85	18.81	n/a	21.1/14.9
Pneumonia	n/a	n/a	29.60	16.52	n/a	26.6/16.8
Chronic Obstructive Lung Disease	n/a	n/a	56.46	19.73	n/a	42.3/17.7
Asthma	n/a	n/a	--	--	n/a	1.26/1.35
Motor Vehicle Accidents	n/a	n/a	39.65	17.37	n/a	14.8/6.2
Communicable Diseases: Disease transmitted by direct contact and respiratory routes, per 100,000 population, 2006						
Invasive Group A streptococcal disease	n/a	n/a	n/a	n/a	0	n/a
Invasive pneumococcal disease	n/a	n/a	n/a	n/a	22.1	n/a
Influenza (laboratory confirmed)	n/a	n/a	n/a	n/a	202.5	n/a
Tuberculosis	n/a	n/a	n/a	n/a	9.5	n/a
Communicable Diseases: Enteric, food and waterborne disease, rate per 100,000 population, 2006						
Campylobacteriosis	n/a	n/a	n/a	n/a	19	n/a
Cryptosporidiosis	n/a	n/a	n/a	n/a	3.2	n/a
Giardiasis	n/a	n/a	n/a	n/a	28.5	n/a
Hepatitis A	n/a	n/a	n/a	n/a	3.2	n/a
Salmonellosis	n/a	n/a	n/a	n/a	12.7	n/a
Shigellosis	n/a	n/a	n/a	n/a	0	n/a
Verotoxigenic E. coli	n/a	n/a	n/a	n/a	0	n/a
Laboratory-confirmed sexually transmitted and blood borne infections, incidence rate per 100,000 population, 2006						
Chlamydia	n/a	n/a	n/a	n/a	556.4	258.5 (2009)
Gonorrhea	n/a	n/a	n/a	n/a	36.2	33.1 (2009)
Syphilis	n/a	n/a	n/a	n/a	0	5.0 (2009)
HIV	n/a	n/a	n/a	n/a	6.58	n/a
Hepatitis C	n/a	n/a	n/a	n/a	125.1	33.7 (2009)

Sources: Canadian Community Health Survey, 2003 and 2009/2010; Statistics Canada, CANSIM Table 102-0126 as of October 9, 2008; Yukon Communicable Disease Control, Government of Yukon; Healthy Canadians-A Federal Report on Comparable Health Indicators, 2010; Public Health Agency of Canada. Reported cases and rates of hepatitis C by age group and sex, 2008-2009; Public Health Agency of Canada. Executive Summary - Report on Sexually Transmitted Infections in Canada: 2009.

As is common for a community of its size, no health services are available within Keno City itself. Health services are located in the neighbouring community of Mayo, 61 kilometers west of Keno City on the Silver Trail/Highway 11. Mayo's health services include a physician and two nurses servicing the community health centre, and Emergency Medical Services staffed with volunteer Emergency Medical Respondents.

## Mayo

The Village of Mayo, originally called Mayo Landing, was first established in 1903 and operated mainly as a dock and receiving area for riverboats hauling supplies to the mines in the region. The discovery of silver deposits on Keno Hill in 1919 sparked an economic boom in the area that lasted 20 years; a second mining boom occurred after World War II and helped to fuel the local and territorial economy for roughly 30 years (Yukon Department of Tourism and Culture 2012).

### Physical setting

The community of Mayo sits at the confluence of the Mayo and Stewart Rivers and is located approximately 400 km north of Whitehorse, and 61 kilometers west of Keno City.

### Demographics

In 2011, the population of the Village of Mayo was 226 people, down from 248 people in 2006 and 267 people in 2001. In 2006 (which is the most recent year available for detailed demographic data), the population was roughly composed of an equal number of males and females with the median age being 40.3 (Statistics Canada 2011). Statistics Canada reports that within Mayo, 52% are Aboriginal and 48% are non-Aboriginal; comparatively, within the Yukon Territory as a whole, 25% are Aboriginal and 75% are non-Aboriginal.

### First Nation of Na-Cho Nyak Dun

The First Nation of Na-Cho Nyak Dun (NNDFN), also known as the Big River People, represents the most northerly community of the Northern Tutchone culture and language group. The traditional territory of the NNDFN covers 162,456 square kilometers (with 131,599 square kilometers located in the Yukon and 30,857 kilometers in the Northwest Territories). The total membership of the NNDFN is 602 persons. The NNDFN, together with the Northern Tutchone people of the Pelly Selkirk, and Carmacks Little Salmon First Nation, form the Northern Tutchone Tribal Council (First Nation of Na-Cho Nyak Dun 2012). With the signing of land claims and self-government agreements in 1993, the NNDFN became self-governing peoples. The NNDFN also established the Nacho Nyak Dun Development Corporation in 1996, which works to develop economic and employment opportunities for its people (First Nation of Na-Cho Nyak Dun 2012).

### Political, economic, and social context

The Village of Mayo was established in 1903 and incorporated in 1984. The local government is comprised of a Mayor, a Chief Administrative Officer and four Councilors.

Mayo acts a distribution service centre for the people of Mayo and the surrounding area. Mayo is also a growing tourist hub, providing accommodations, food services, retail, as well as guiding and outfitting services for wilderness tourism (camping, canoeing, hiking, big-game hunting, and fly-in fishing); and mining tourism (the community has a mining museum and interpretive centre). In addition, Mayo serves as the administrative centre for the NNDFN. The Nacho Nyak Dun Development Corporation is establishing a number of training, work, and apprenticeship programs in the community; they currently employ approximately 60 people. Roughly one-third of the jobs in the community are related to government administration. Placer mining and mineral exploration also contribute to the economic base of the community (Keno Hill Mining Corporation 2009).

### **Services and infrastructure**

The services and infrastructure within Mayo include:

- NNDNFN main administrative offices, including NNDNFN lands/environment office
- An elementary- to post-secondary level school
- A Health Centre
- RCMP detachment
- Community social services (Government of Yukon Health and Social Services, Yukon Housing Corporation, Yukon Family Services (Dawson City), NNDNFN social services)
- Community and municipal services (volunteer firefighting services, recreation and leisure services, etc.)
- Ambulance services (provided by community volunteers in partnership with the Government of Yukon)
- An airport
- Government of Yukon Department of Environment office; Energy, Mines and Resources office; and a Mining Recorder's office
- Tourist services (two motels, three campgrounds, two restaurants, two service stations, a store, businesses catering to wilderness tours and fishing)
- Helicopter, float-plane and taxi services

Mayo's drinking water comes from a piped distribution system, with a shallow well source. This system is the source for bulk water delivery to the NNDNFN. (Yukon Health and Social Services 2009).

### **Health services and trends**

The health services for the Village of Mayo comprises a physician and two nurses servicing the community health centre, and Emergency Medical Services staffed with volunteer Emergency Medical Respondents.

Due to its small size, Mayo-specific health information is unavailable. Recent data on health indicators is available at the territorial level and can be used as a proxy to reflect the likely state of health of Mayo residents. See Table 3 for these health indicators.

## Section 4. Description of Keno Area Mining Projects

### Project area history

The Keno Hill Silver District is one of the world's highest-grade silver districts and is located 330 kilometers north of Whitehorse in the Yukon Territory, in the traditional territory of the First Nation of Na-Cho Nyak Dun. The Keno Hill Silver District is 233.5 square kilometers in size and contains more than 35 historic mine sites (Alexco Resource Corporation 2012b). Silver was first discovered in the area in 1901; from 1901 to the beginning of World War I, mostly small-scale silver mining was undertaken. Between 1921 and 1988, a number of larger silver mines were active in the area, and the Keno Hill district produced more than 217 million ounces of silver (Alexco Resource Corporation 2008). In 1989, due to falling silver prices, the mines closed. Following the bankruptcy of the former mine owner, United Keno Hill Mines Ltd., the abandoned mines and lands were transferred to the federal government.

In June 2005, due to rising silver prices and 'jurisdictional safety' of the Yukon, Alexco Resources Corporation bought both the reclamation and mineral extraction rights for the mining claims previously owned by United Keno Hill Mines Ltd. Elsa Reclamation and Development Company Ltd. and Alexco Keno Hill Mining Corp are both subsidiary companies of Alexco Resources Corporation and are respectively responsible for reclamation and mineral extraction.

### Current project: Bellekeno Mine

Alexco Keno Hill Mining Corp. was granted a Quartz Mining License (QML-009) on November 17, 2009 for the Bellekeno Silver Mine (Bellekeno). Bellekeno is located approximately 3 kilometers east of Keno City, 45 kilometers northeast of Mayo, and 354 kilometers north of Whitehorse, Yukon. It also lies within the traditional territory of the First Nation of the Na-cho Nyak Dun (Alexco Keno Hill Mining Corp. 2009).

The construction of the mine and mill complex was completed in the fall of 2010. In January 2011, Bellekeno – Canada's only operating primary silver mine – commenced commercial production. The life of the mine is projected to be 15 years (0-6 years construction and mine operation; 7–15 years decommissioning, reclamation and closure). The mine is expected to yield 8.6 million ounces of silver, 65.2 million pounds of lead, and 35.2 million pounds of zinc in its lifetime, with the ore production rate of 250 tonnes per day in year 1 and 400 tonnes per day for years 3-5 (Alexco Resource Corporation 2012a, Alexco Keno Hill Mining Corp. 2009).

A detailed list of the principal and accessory activities, as well as details on project personnel and a map outlining the Bellekeno Mine area is provided below.

#### Principal Activities:

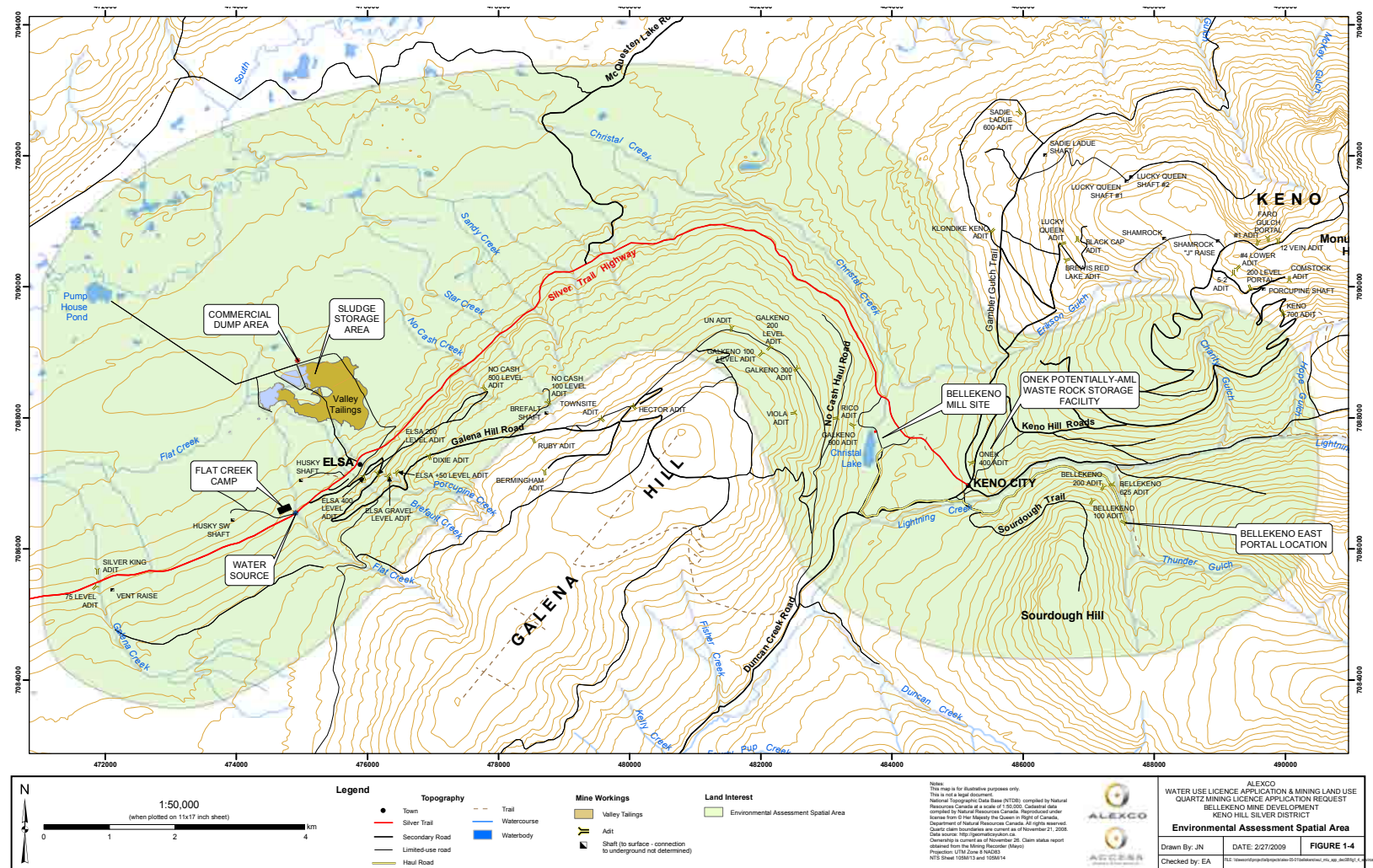
- Underground development and mining involving the movement of approximately 500,000 tonnes of waste rock and 600,000 tonnes of ore to the surface
- Construction of a series of narrow waste rock disposal areas
- Construction of a conventional flotation mill at the Flame and Moth site upstream of Christal Lake for processing ore and producing concentrate
- 250 tonnes per day mining operation, increasing to 400 tonnes per day for years three and five
- Use of mill chemicals
- Temporary storage of mill tailings and mineralized rock in stock piles
- Storage and disposal of mill tailings in a dry-stack tailings facility
- Placement of pyritic tailings below water level in the Bellekeno Mine
- Haulage of ore to the mill and haulage of potentially acid-metal leaching (AML) waste rock to the Bellekeno Waste Rock Storage Facility (BWSF); dry tailings will be hauled to a dry stack tailing facility and also back to the Bellekeno Mine for use underground
- Construction of surface infrastructure to support the mill including: coarse ore stockpile; plant services; fuel storage area and settling ponds.

Accessory Activities:

- Expansion of Flat Creek Camp from a capacity of 100 to approx. 150 people
- Reconstruction/upgrading of the existing Bellekeno Mine power line haul road and the existing Christal Lake haul road from Duncan Creek road to the Mill site
- Construction of a segment of a new haul road around Keno City, including a new bridge across Lightning Creek for hauling ore and filtered tailings between the mine and mill
- Installation of electrical power distribution system to service the mill and ancillary buildings
- Construction of water treatment facility to treat mill waste water
- Use of water for mill operations from three potential sources: Dry stack tailings facility/mill pad runoff collection pond, Christal Lake, and local groundwater wells.
- Use of water for dust suppression, cooling and dry tailing rehydration from Lightning Creek or Thunder Gulch
- Depositing Bellekeno mine waste water using existing water treatment facilities at Bellekeno 625. Treated waste water from Flame and Moth mill will be deposited to Christal Creek.
- Inspection and maintenance of water treatment infrastructure to ensure discharge standards are achieved
- Shipping mill concentrate to various smelters
- Environmental monitoring and sampling programs

(Yukon Government 2009)

### Figure 3: Bellekeno Project Area



**Project personnel**

The original proposal by Alexco for Bellekeno indicated that approximately 135 workers would be needed during production and ongoing exploration. The 2011 proposal for expansion of mining operations indicated that 70 Yukoners and 15 Mayo residents and FNNND citizens are currently employed onsite. The total number of workers currently onsite and in the Flat Creek Camp was not provided, but includes not only those working on mine operations but also those employed in exploration and reclamation work.

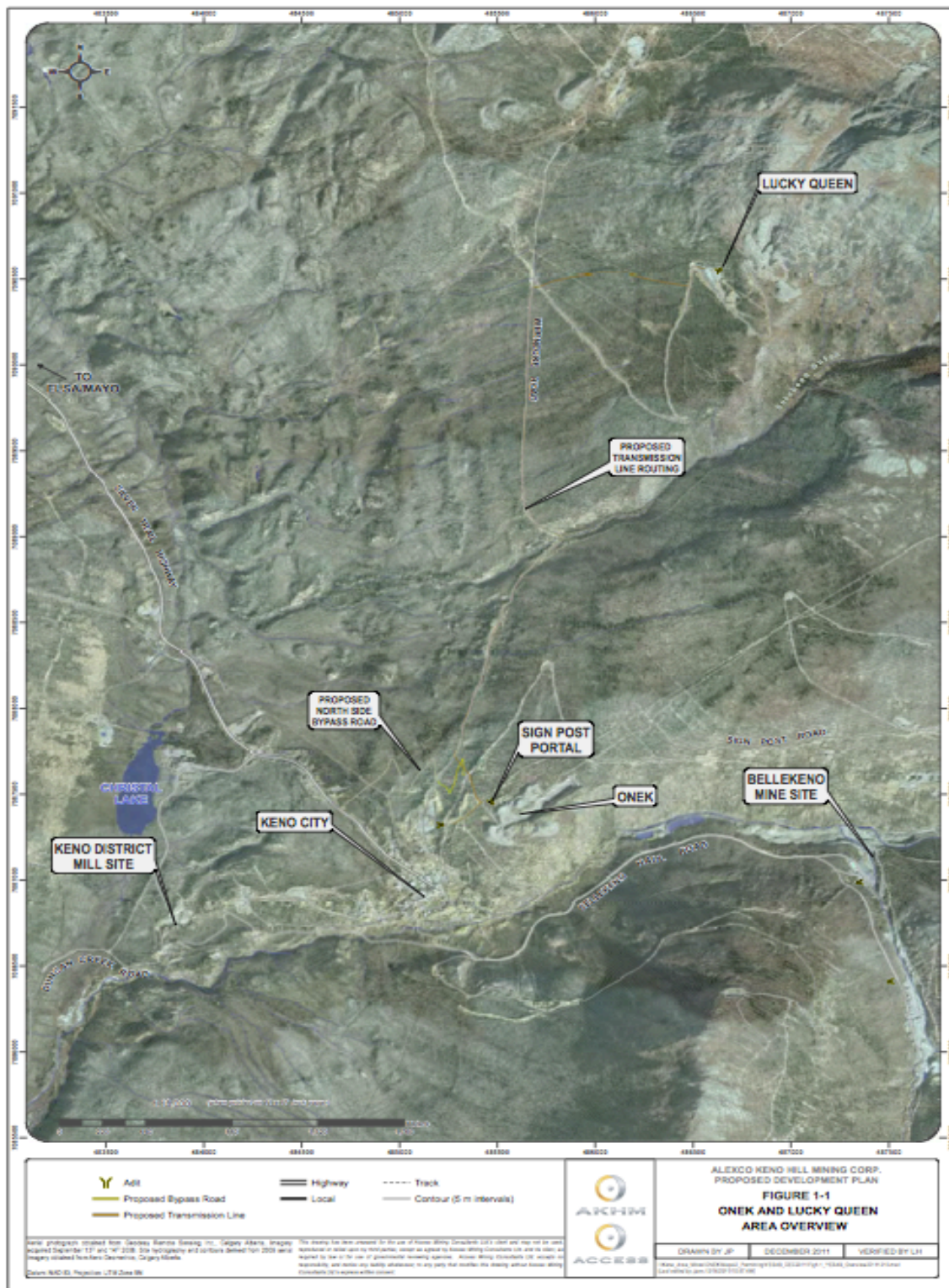
The Bellekeno labour workforce works on various rotation schedules, primarily a 4 weeks in, 2 weeks out rotation schedule. Every fifth day, a charter aircraft flies personnel living in Whitehorse, southern Yukon, and out-of-territory into Mayo (approximately a 70-minute flight, one-way). To reduce traffic, personnel are then transported in company vehicles (buses) to/from Elsa (roughly a 45-minute drive). In the winter season or poor weather conditions, personnel are transported in company vehicles between Elsa and Whitehorse (approximately a 5-hour drive) (Alexco Keno Hill Mining Corp. 2009).

The worker accommodations and services are comprised of: two trailer camps (a 36-person trailer camp and a 41-person trailer camp) at Flat Creek, which is located roughly one kilometer southwest of Elsa; a kitchen and dining facility at Flat Creek camp (which is able to seat 35 persons at a time); four five-bedroom houses located in Elsa; and a small fitness facility/health center in Elsa. The total housing capacity is 105. The consumption of alcohol and 'recreational' drugs is not permitted on site by employees (Alexco Keno Hill Mining Corp. 2009).

**Additional proposed projects by Alexco Keno Hill Mining Corp.**

Alexco Keno Hill Mining Corp. plans to further expand its silver mining operations in the Keno Hill Silver District through the mining of newly discovered extensions of two previously mined ore bodies: Lucky Queen and Onek. The proposal for Lucky Queen and Onek mines was submitted in December 2011 to the Yukon Environmental and Socio-economic Assessment Board (YESAB) for review. Each of these developments is described below. Figure 4 illustrates the locations of the two projects.

Figure 4: Location of Lucky Queen and Onek Mines



Source: Alexco Keno Hill Mining Corp., April 2012, p. 3. YESAB document: 2011-0315-032 REVISED Project Proposal\_Part 1. Apr. 2, 2012.

### **Lucky Queen and Onek deposits**

The Lucky Queen deposit is located approximately 4 km northeast of Keno City. It is situated on the upper limit of the subalpine and is covered with sparse soil, grasses, willows, and a few spruce. The original Lucky Queen mine was initially mined by Treadwell Yukon Limited from 1927 to 1932, at which point the ores were exhausted.

In August 2011, after new exploration activities, Alexco estimated the Lucky Queen property to have 4.9 million indicated and 2.8 million inferred ounces of silver. The rehabilitation and redevelopment of the historic underground mine commenced in April 2011 and, pending necessary approval and regulatory requirements, Alexco plans to initiate silver production of the mine by the end of 2012.

The Onek deposit is located roughly 500 m northeast of Keno City. The original Onek site is comprised of a 400 level adit at the lower area and two large joined pits above the main mine workings. There exists a number of large pit dumps of waste rock and a smaller amount of adit waste rock adjacent to the adit. Onek's main open pit area is located on a flat plateau above Keno City and is cut perpendicularly into the hillside. The Onek deposit was accessed from 1950 to 1952, from 1960 to 1965, and again in the late 1980s.

In August 2011, Alexco estimated the Onek property to have 3.6 million indicated and 1.5 million inferred ounces of silver, as well as zinc deposits. Currently, Alexco is working on getting permits to conduct exploration drilling.

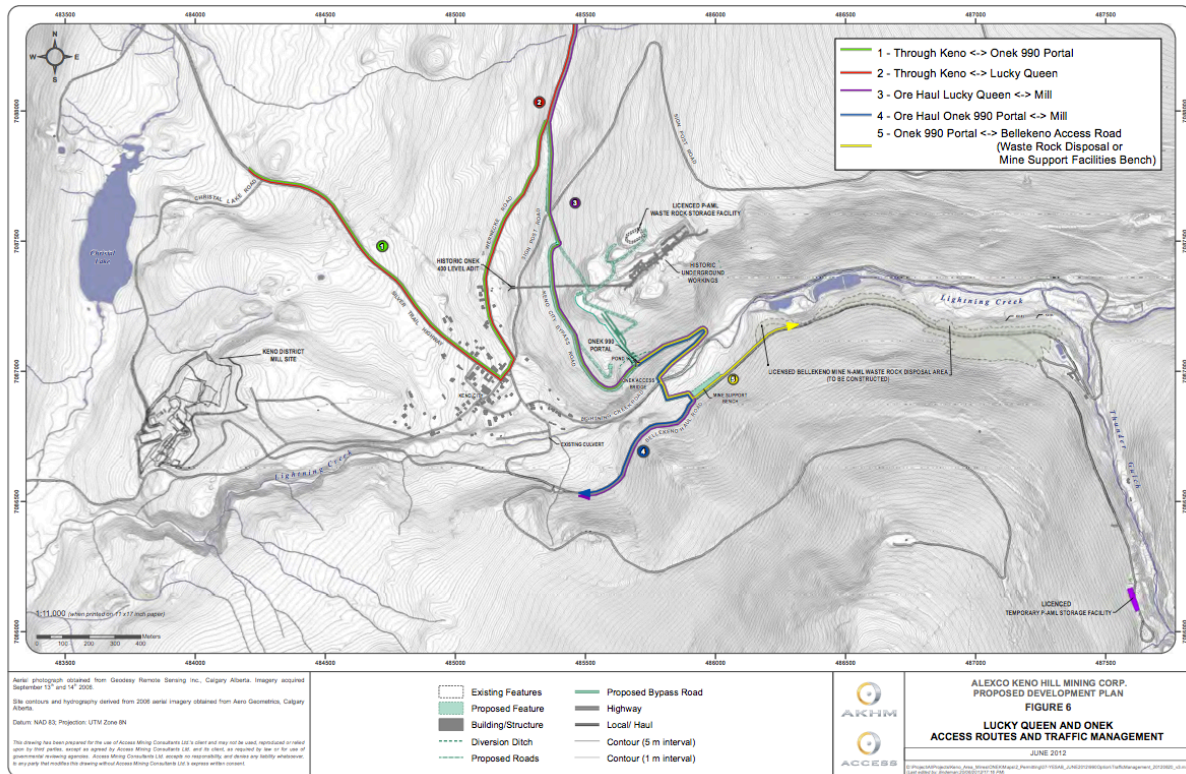
For the entrance into the Onek deposit, Alexco initially put forth two options: the Sign Post Portal and the Onek 990 Portal. While some preliminary work had already been completed on the Sign Post Portal (in late winter 2012), the Onek 990 option was proposed by Alexco in June 2012 following the concerns by Keno City residents that the Sign Post Portal option was too close to the community and would cause a significant amount of noise, dust, and aesthetic disturbance for Keno City residents. The decision to use the 990 portal obviates the previously planned North Bypass Road. Instead, the Keno City Bypass Road will be developed to connect project-related traffic from both the Onek and Lucky Queen Mines to the existing Bellekeno bypass. The north section of the Keno City Bypass road will follow the historic Onek power line, cross over Signpost Road and eventually link up to Wernecke Road. The south section will extend from the Onek 990 portal and join up with the Bellekeno Haul Road over a new bridge crossing Lightning Creek.

The LQO expansion will be comprised of underground development and mining of the Lucky Queen and Onek deposits. The Lucky Queen and Onek deposits will be milled with the Bellekeno ore at the Keno District Mill. There will be support facilities for Lucky Queen and Onek on each site. These facilities include: plant services, miners' dry area, offices, trailers, portal, settling ponds, fuel and explosives storage, and temporary ore stockpile. These facilities are already established at Lucky Queen, with some additional developments to be added to support mine development and production. A full project description of the LQO developments is available in the YESAB Designated Office Evaluation Report (Yukon Environmental and Socio-Economic Assessment Board 2012).

As per the Evaluation Report, there will be no change in the currently licensed and authorized tonnage for ore, waste or tailings deposition proposed. Alexco states that there will be an amendment to the Type A Water Use License and Quartz Mining License needed to support the development of the two proposed deposits (Yukon Environmental and Socio-Economic Assessment Board 2012).

Mining activities at the two new sites will require additional employees; therefore a minor camp expansion at the Flat Creek Camp will be required.

**Figure 5: Onek 990 Portal Option, Onek Deposit**



Source: Alexco Keno Hill Mining Corp., June 2012, p. 17; YESAB document: 2011-0315-095 Onek 990 Portal Options and Keno City Bypass Road\_June 20, 2012.

### Other mining activity

In addition to the projects and proposals by Alexco Keno Hill Mining Corp. there is other mining activity in the region. This activity includes a number of placer miners, most notably in the Lightning Creek drainage. On a larger scale, both Monster Mining Corporation and Rockhaven Resources Ltd have large claims in close proximity to the town of Keno. In recent years, camps and helicopter traffic servicing these claims have intermittently impacted the community. Exploration programs for these and other deposits are continuing.

## Section 5. Scope of Health Issues Included

In order to determine what health-related issues were appropriate to include in the HIA, we undertook a scoping exercise. We reviewed a large number of documents, including:

- All submissions on the YESAB Registry for Bellekeno Mine Development (2009-0030) and Lucky Queen and Onek Deposit Production (2011-0315), including:
  - Submissions from Alexco
  - Submissions from territorial and federal government agencies
  - Submissions from Keno residents
  - Submissions from concerned individuals and organizations (e.g., David Suzuki Foundation, Yukon Conservation Society)
- Published literature related to the effects of mining in communities in other areas of Canada and globally
- The Human Health Risk Assessment for Residents of Keno City, Yukon (SENES Consultants)

Concerns brought up by residents and other stakeholders during interviews (see Section 2) were also considered. A list was compiled of the main issues that emerged; this is shown in Table 4. Issues were grouped by common health pathways. This resulted in the selection of seven areas for investigation in the HIA: air- and soil-related health effects, water-related health effects, noise-related health effects, infectious disease, stress and mental well-being, injury, and emergency medical response. These areas comprise the basis for the analysis in Section 6 of this report.

**Table 4: Health-related Issues Raised by Stakeholders**

AREA OF HEALTH CONCERN	YESAB REGISTRY SUBMISSIONS			Resident Communications	Professional Judgment (see note)
	Alexco	Residents	Other		
<b>AIR- AND SOIL-RELATED HEALTH EFFECTS</b>					
dust from mine/mill operations	*		3,4	*	
dust from drystack tailings	*	*	3,4		
dust from industrial traffic	*		3,4		
<b>WATER-RELATED HEALTH EFFECTS</b>					
potential drinking water contamination from acid metal leaching from waste rock storage facility		*	2,3,4,5,7,8		
contamination of ground (and surface) water from drystack tailings			5	*	
potential contamination from the spill of toxic substances (lead and zinc concentrate) transported by truck		*			
<b>NOISE-RELATED HEALTH EFFECTS</b>					
Noise	*	*	3,4,9	*	
<b>INFECTIOUS DISEASE</b>					
respiratory illnesses					*
sexually transmitted infections					*
gastrointestinal illnesses	*				*
<b>STRESS/MENTAL WELL-BEING</b>					
economic impacts	*	*	4,10	*	
community change	*	*		*	
perceived contamination		*		*	
<b>INJURY</b>					
accidents and malfunctions at the mine and mill sites	*		2,3,6	*	
industrial traffic on public roads	*	*	2,4,6	*	
<b>EMERGENCY MEDICAL RESPONSE</b>					
availability of ground ambulance			3		
<p><i>Note:</i> 'Other' refers to: 1 - Village of Mayo; 2 - First Nation of Na-Cho Nyak Dun; 3 - Health and Social Services, Yukon Government; 4- Tourism and Culture, Yukon Government; 5- Environment, Yukon Government; 6 - Energy, Mines and Resources, Yukon Government; 7- Safe Environments Directorate, Government of Canada; 8 - Fisheries and Oceans, Government of Canada; 9 - International visitors; 10 - individuals representing the film industry).</p> <p><i>Note:</i> "Professional judgment" refers to the inclusion of health areas that have been found to be associated with similar developments elsewhere, but that were not initially raised as a concern by any of the stakeholders consulted for this project.</p>					

## Section 6. Assessment Results

### A. Air- and Soil-Related Health Effects

#### Background

In terms of its ability to affect human health, air quality is usually considered in two different ways. The first way is through the amount of particulate matter (PM) in the air. Particulate matter refers to all airborne solid and liquid particles, except pure water, that are microscopic in size. PM is classified by size, as smaller particles are associated with a greater health hazard since they have the potential to travel further into the body. PM is usually categorized as PM<sub>10</sub> or PM<sub>2.5</sub>, referring to particles no more than 10 and 2.5 micrometers in size, respectively. The amount of PM<sub>10</sub> or PM<sub>2.5</sub> in the air is expressed in micrograms per cubic metre of air.

The second way in which air quality is considered is in terms of the composition of particulate matter in the air. PM may contain compounds such as minerals and elements such as elemental and organic carbon compounds; oxides of silicon, aluminum and iron; trace metals; sulphates; nitrates or ammonia that have the potential to generate adverse health effects (Health Canada/Environment Canada 1998).

A large body of toxicology, epidemiologic and clinical literature has examined the health effects associated with PM<sub>10</sub> and PM<sub>2.5</sub>. These can include cardiovascular damage, asthma, bronchitis, lung damage, cancer, and eye irritation. Effects are strongest among children, older adults, and people with pre-existing cardiovascular health conditions (Sacks et al. 2011). Particulate matter is considered a non-threshold substance, meaning that any increase in exposure will result in an incremental population risk (Canadian Council of Ministers of the Environment 2000). Air quality standards have been set for PM<sub>10</sub> and PM<sub>2.5</sub> by the different provincial and territorial jurisdictions. These standards are based on adverse effects on cardiorespiratory health, but do not take into account the composition of the PM.

Sources of particulate matter include both natural and human activity. Natural sources include windblown soil and mineral particles, biological material such as pollen, spores and bacteria, and debris from forest fires. Sources related to human activity include mineral dust from mining and extraction industries, road dust, windblown agricultural soil, dust from construction, fossil or wood fuel combustion, and as a byproduct of the release of Volatile Organic Compounds (VOCs) (Environment Canada/Health Canada 2000).

Because soil is a major contributor to PM quantity and composition, it is considered together in this section with air quality.

#### Pathways Between Mining Activities and Health Effects

The mining-related activities that have the potential to cause air quality changes that could be linked to human health effects are described in the YESAB Designated Office Evaluation Report of August 6, 2012 (Yukon Environmental and Socio-Economic Assessment Board 2012):

- Construction phase: project-related traffic, generators, compressors, blasting, clearing, leveling/grading and road building.
- Operations phase: traffic, waste rock storage, blasting, generators, compressors, road maintenance and tailings facility.

### Current Knowledge of Mining Impacts

A Human Health Risk Assessment (HHRA) was produced in March, 2012 by SENES Consultants (SENES Consultants 2012) that attempted to evaluate whether current exposures (from historical or current mining as well as from other sources) had the potential to pose health risks to the community. The HHRA focused on potential health effects from inhalation or ingestion of six “constituents of particular concern” (COPCs): arsenic, cadmium, lead, manganese, strontium and zinc.

The HHRA provided an estimate of the levels of these metals in soil and air in Keno City. Soil samples were taken to confirm levels of metals in the soil; however, for airborne particles, the authors stated that measured data were not available. Instead, concentrations of COPCs in the air were estimated via a model based on the measured concentration of COPCs in soil samples and an estimate of particulate matter (PM) in the air taken from a proxy location (the Red Dog Mine in Alaska). Table 5 shows the estimates presented in the HHRA for the concentrations of COPCs in soil and air in Keno.

**Table 5: Estimated Levels of Metals of Concern**

	Soil mg /kg dw		Particulate (air) mg/m <sup>3</sup>	
	Keno City	Background level *	Keno City	Background level
<b>Arsenic</b>	51.1	16.6	$1.3 \times 10^{-6}$	$4.2 \times 10^{-7}$
<b>Cadmium</b>	2.40	1.42	$6.0 \times 10^{-8}$	$3.6 \times 10^{-8}$
<b>Lead</b>	182	30.9	$4.5 \times 10^{-6}$	$7.7 \times 10^{-7}$
<b>Manganese</b>	613	557	$1.5 \times 10^{-5}$	$1.4 \times 10^{-5}$
<b>Strontium</b>	20.3	20.3 (assumed same as Keno)	$5.1 \times 10^{-7}$	$5.1 \times 10^{-7}$
<b>Zinc</b>	281	87.3	$7.0 \times 10^{-6}$	$2.2 \times 10^{-6}$

\* Background – Galena Hill and South McQuesten

Source: derived from table 4.3 in (SENES Consultants 2012)

Using this information, the HHRA then estimated human exposure to the COPCs in air and soil via inhalation, dermal exposure or ingestion. A toxicity assessment evaluated the potential for each COPC to cause “damage, either permanent or temporary, to the structure or functioning of any part of the body”. Finally, a risk assessment then combined all this information – levels of COPCs in Keno, the potential for exposure in Keno residents and the dose-response effects of each substance – to characterize the level of risk.

The HHRA concluded that that current exposure to COPCs through soil and air media did not pose a health hazard, as exposure at estimated levels remained below Health Canada benchmark reference values. While the HHRA was fairly definitive in its assessment of the low risk posed by local exposure to the six COPCs examined, a number of questions remained unanswered about the potential health impacts related to exposure to current air and soil quality levels in Keno.

In May 2012, in response to some of the unanswered questions, EcoMetrix Inc. was asked by YESAB to prepare a summary review of: (1) the constituents of concern in tailings from the existing Dry Stack Tailings Disposal Facility near the Bellekeno Mill; (2) air quality criteria associated with the constituents of concern; and (3) the current dustfall monitoring program for the Bellekeno Mine.

In contrast to the HHRA, the EcoMetrix report (EcoMetrix Inc. 2012a) identified eight potential constituents of concern for Keno, based on samples in the Bellekeno dry stack tailings. These were: arsenic, cadmium, copper, lead, manganese, nickel, silver and zinc. The EcoMetrix report described the Ontario ambient air quality cut-offs for these substances and the health effects associated with inhalation. However, the report did not (and was not intended to) provide an assessment of the level of likely exposure of Keno residents to these contaminants via inhalation of air.

The EcoMetrix report also discussed the Yukon ambient air quality standards for particulate matter, shown in Table 6. The Yukon standards have been set for all particulate matter (total suspended particulates) and for fine particulate matter (PM<sub>2.5</sub>).

**Table 6: Yukon Ambient Air Quality Standards for Particulates**

Parameter	Yukon standard (µg/m <sup>3</sup> )
<b>Total Suspended Particulates (TSP)</b>	
24-hour average	120
Annual geometric mean	60
<b>Fine Particulate Matter (PM<sub>2.5</sub>)</b>	
24-hour average	30

Source: (EcoMetrix Inc. 2012a)

The EcoMetrix report did not describe either the levels of TSP or PM<sub>2.5</sub> in air quality samples or the likely exposure of residents to PM. However, the materials that were presented as part of the LQO Project Proposal included data on dustfall monitoring measurements (Appendix P of the proposal document) (Alexco Keno Hill Mining Corp. 2012). As discussed in the YESAB Designated Office Evaluation Report and in the EcoMetrix report, dustfall monitoring measurements cannot be directly compared with ambient air quality standards because the dust deposition rate does not necessarily reflect the total amount of airborne dust. In particular, fine particulate matter (which carries greater adverse health consequences) settles more slowly or not at all, and may be under-represented in dustfall measurements. The results of dust deposition for the March to May period in 2011 are shown in Table 7. Although these results are not comparable either to the Yukon ambient air quality standards or to indicators of human health risk, they are comparable to the Ambient Air Control Objectives in the *Pollution Control Objectives for the Mining, Smelting and Related Industries of BC* (British Columbia. Ministry of Environment 1979), which provides an “acceptable” range of between 1.7 to 2.9 mg/(dm<sup>2</sup>\*d). The sampled measures fall well under that range.

**Table 7: Dust Deposition Summary for Keno Sampling Stations (2011)**

Station	Collection period	Number of days	Deposition Based on TSS Fixed (mg/[dm <sup>2</sup> *d])
<b>DM1</b>	March 6 - April 3	29	0.012
<b>DM2</b>	March 6 - April 3	29	0.165
<b>DM1</b>	April 3 - May 10	38	0.036
<b>DM2</b>	April 3 - May 10	38	0.036

Source: (Alexco Keno Hill Mining Corp. 2012)

Despite the many pages of information that have been brought forward about air quality and adverse human health effects due to mining activity in the Keno area, a number of outstanding questions and concerns remain among residents and other stakeholders. These include:

Air quality analysis. There has been no air quality analysis conducted that is relevant to the full range of human health endpoints that are associated with exposure to particulate matter. In the context of Keno’s extremely tiny population, quantitative modeling of cardiorespiratory outcomes is not statistically feasible or useful. However, an assessment of predicted air quality changes in terms of Total Suspended Particulates (TSP), PM<sub>10</sub>

and PM<sub>2.5</sub> would be meaningful. This assessment would need to include analysis of whether air quality measures are commensurate with levels below which no significant harm is predicted.

Air monitoring type. The initial plan for ongoing monitoring of air was based on dustfall, monitored through passive deposition. Objections were raised during the LQO YESAB review, because human health effects are better assessed through monitoring based on TSP than through dustfall. Alexco's Monitoring and Surveillance plan has since been amended, and now includes two TSP monitoring devices, which were expected to be operational as of mid-August, 2012. The TSP monitoring will allow for comparison to Yukon's Ambient Air Quality Standards, which was not possible with the passive dustfall monitoring.

Air monitoring location. There are currently four dust monitoring stations set up at the edge of the mill site between the mill and Keno City. While these locations are appropriate for monitoring the dust that is generated from the mill, the locations are not suitable for capturing the effects of dust that may be generated by road use, by construction of LQO roads or facilities, or of mining operations.

Dry stack tailings. Dust from the Flame and Moth Dry Stack Tailings Facility was a major concern of public stakeholders. Alexco has produced a number of documents describing the dry stack technology, the measures that are used for dust suppression and contingency plans for actions that will be taken if dust levels are high (EBA Engineering Consultants Ltd 2010, Access Consulting Group and Alexco Keno Hill Mining Corp. 2012). However, some residents have pointed out that using dry stack technology in such close proximity to a community is new and that there is a short track record in terms of the success of dust suppression. In addition, the dry stack tailings were established with a limited footprint, and the LQO Proposal has been approved on the condition that the tailings stay within that footprint. However, if continued mining and milling prove to be beyond the capacity of the current tailings site, this opens up the possibility of either local expansion of tailings location or truck transportation of the tailings offsite.

Adequacy of current mitigation measures. The mitigation measures that were established in 2009 were bolstered by several later amendments, most recently the seven additional measures that were prescribed in the YESAA LQO Decision Document of September 7, 2012. (Yukon Government 2012) However, the extent to which the mitigation measures will be successful in reducing exposure to airborne particulates to levels in which health effects will not be observed is unknown.

### Summary of the Potential Effect

Previous studies that have been completed on air and soil quality in and around Keno City have focused on health effects from exposure to six metals: arsenic, cadmium, lead, manganese, strontium and zinc. Based on the results of those studies, there is little risk of significant health effects from exposure to these metals. However, no air quality analysis has been conducted that assesses exposure to or health impacts associated with current or future exposure to particulate matter (dust). While particulate matter is likely to comprise primarily a nuisance hazard for the residents of Keno City, it could exacerbate poor health outcomes among those with pre-existing cardiac or respiratory conditions. Because of the lack of information in this area, the extent to which exposure or effects may occur and the adequacy of the current mitigation plans to address this potential impact are unknown. Surveillance activities have recently been expanded to include assessment of total suspended particulates (TSP). However, the sites at which TSP monitoring will take place are few and do not include a number of locations that are likely to be affected by dust from mining-related activities.

Ingestion of soil itself (other than as dust) is unlikely to significantly contribute to exposure to contaminants in Keno. Direct exposure to contaminated soil is most often a concern in communities where there are young children, as children are more likely than adults to put soil or objects that have been in contact with soil in their mouths.

Table 8 summarizes the potential effects to the community from the air and soil pathways outlined above.

**Table 8: Summary of Risk to Community Health from Air- and Soil-Related Environmental Exposures**

Significance Criteria	Description
Direction	<b>Adverse</b> - An adverse or undesirable change
Severity	<b>Medium</b> - Has the potential to cause acute, chronic, or permanent effects that substantially affect function, health or well-being
Duration	<b>Persistent</b> - Has the potential to last for the duration of mining activity
Likelihood	<b>Possible</b> - Evidence suggests that effects do occur, but are infrequent in this setting

#### Potential Additional Mitigation Measures

Although soil contamination is unlikely to be significant, given historic levels of contamination (as well as water contamination issues discussed later in this section), it would be prudent for the HSS to develop a health promotion campaign targeting hand-washing and home gardens. There is no evidence to suggest harm from home gardens; however, the use of raised beds, the avoidance of surface water for irrigation and the washing of locally-produced produce are all appropriate precautionary recommendations.

A number of dust control measures are already in practice by Alexco or are listed in the proposal for expansion of operations. In addition to the listed measures, local operators should employ mitigation measures such as covering haul trucks, using wind screens, and other best practices described in (Cheminfo Services Inc. 2005) to control dust from roads, transported materials, construction of infrastructure, and operation of facilities (YESAB document #2011-0315-079-1).

As suggested by the Yukon Dept. of the Environment, air quality monitoring should be expanded to address all sources of dust generated at the mining site and along the transportation routes to/from the site.

The air quality monitoring program should also be expanded to assess all types of dust (TSP, PM<sub>10</sub>, PM<sub>2.5</sub>). Active sampling, including PM sampling, in areas of concern to the community such as the campground should be considered, taking into account local (non-industrial) sources of road dust, vehicle exhaust and wood fires.

Many Keno residents have expressed an interest in biomonitoring, out of an interest to see what their personal contaminant levels are. While biomonitoring of individuals would not be able to inform an evaluation of exposure (due to the small sample and the inherent inability of biomonitoring to determine the source of any found contamination) it could provide information and possibly reassurance to individual residents. If biomonitoring is offered, the protocols for collection and contaminants measured should be part of a standardized testing plan coordinated through HSS and with careful follow-up and communication strategies developed to ensure that individuals are able to understand the meaning of their results.

## B. Water-Related Health Effects

### Background

Water quality has been the most contentious and most commented-on issue among both Keno residents and other stakeholders during the YESAB proposal process. The possibility of adverse effects to human health or the environment as a result of water contamination has led to a large number of documents being filed with the YESAB registry.

Adverse health effects may arise from exposure to contaminants in water. Two primary contaminants of concern have been identified with respect to Keno's groundwater supply: cadmium and zinc. Cadmium is a hazardous substance. The Guidelines for Canadian Drinking Water Quality specify a maximum acceptable concentration of 0.005 mg/L (Health Canada 2010). High levels of cadmium ingestion have been associated with gastrointestinal irritation, vomiting, and kidney damage (Health Canada 1986). Zinc is an essential dietary element that is required for the maintenance of health. It has not been found to have adverse effects in high quantities; however, the drinking water standard in Canada has been set at 5 mg/L, as concentrations above 3 mg/L may lead to an aesthetic impact on the taste of the water (World Health Organization 2003). Other mining-related groundwater contaminants that have been linked with adverse human health outcomes include acid-generating sulphides, heavy metals, and other contaminants.

### Pathways Between Mining Activities and Health Effects

The mining-related activities that have the potential to cause water quality changes that could be linked to human health effects are described in the YESAB Designated Office Evaluation Report (Yukon Environmental and Socio-Economic Assessment Board 2012):

- Construction phase: waste rock classification and storage above ground and water management.
- Operations phase: waste rock classification and storage above and below ground, including paste backfill, management of historic Onek 400 discharge, and water management.

Keno city residents obtain their drinking water from the Firehall well, located near the centre of Keno. (Three other wells are located in Keno--the Café well, the Van Sut well and the Hotel well--but these have not been reported as drinking water sources.) Potential health impacts that could arise from water quality changes are primarily those that have the potential to impact Keno's drinking water sources; these changes are therefore the focus of discussion in this section.

### Current Knowledge of Mining Impacts

#### Historical mining and legacy contamination

Historical mining practices in the Keno area have left a legacy of contamination in the ground and surface water near Keno. The mining activities that ceased in 1989, prior to Alexco's presence in the Keno area, resulted in a number of abandoned adits, buildings/structures, and waste material that represent an ongoing source of contamination to the downstream watersheds (Minnow Environmental Inc. 2008).

A 2008 study conducted by Minnow Environmental (Minnow Environmental Inc. 2008) compiled, evaluated and interpreted water quality data from 20 monitoring stations throughout the old mining region. Water quality data spanned the 1994-2007 period. The study identified a number of substances that exceeded water quality guidelines in some locations, including aluminum, cadmium, copper, iron, phosphorus, sulphate and zinc. The contamination was found primarily in the tributary stations located immediately downstream of mine sources (Christal Creek, Lightning Creek, Flat Creek and No Cash Creek).

The South McQuesten River appears unaffected. The study identified cadmium and zinc as the key contaminants of concern across the area. The study confirmed that historical mining waste continues to affect water quality presently in the region.

#### Onek 400 adit

One site in particular poses concern for current residents of Keno. The Onek 400 adit--located at the north end of Keno City, within 100 metres of residences (see Figure 6)--has been found to be highly contaminated.

Interralogic Inc. was commissioned by the Access Consulting Group to conduct a surface and groundwater evaluation to characterize the contamination at the Onek 400 portal (Interralogic Inc. 2011). Two surface observation trenches were dug immediately downstream of the portal. However, no free water was observed in either of the trenches.

Groundwater was assessed through a groundwater monitoring well (MW-3) that had been dug in close proximity to the Onek 400 adit. For the period of May to November 2011, Interralogic found exceedences of cadmium and zinc in this monitoring well. Cadmium levels were measured between 0.63 and 1.2 mg/L (compared to the Canada drinking water standard of 0.005 mg/L) and zinc between 41.8 and 71.4 mg/L (compared to the Canada drinking water standard of 5 mg/L). This exceedence was judged by Interralogic to be related to historical mining.

The LQO Proposal also provided Onek 400 adit water quality data from 2005 to 2011, based on surface water discharge flows. Cadmium and zinc concentrations were higher at these surface discharges than for nearby groundwater: 0.308 to 6.4 mg/L for cadmium and 27.4 to 186 mg/L for zinc (Alexco Keno Hill Mining Corp. 2012).

#### Firehall well

Interralogic also assessed water quality at the Firehall well, which is the source for the majority of the potable water for Keno, in order to identify whether drinking water might currently be contaminated. The study showed an exceedence of manganese in the Firehall well on December 8, 2010, with a measured level of 0.0554 compared to the Canada drinking water standard of 0.05 mg/L. The observed level of manganese was not interpreted as related to historical mining.

The Firehall well was not found in this study to have elevated levels of cadmium, zinc or any of the other substances assessed, which included antimony, arsenic, iron, uranium, sulphates, total dissolved solids or over 40 other substances. The study concluded that the drinking water in the Firehall well was safe for consumption when compared with Canada drinking water standards.

#### Migration of contamination

Although the Firehall well is not contaminated at present, concerns remain among Keno residents and other stakeholders that drinking water could be compromised by a plume of contamination migrating to the Firehall well from legacy mining areas or from current mining activities. This fear is bolstered by the proximity of the contaminated Onek 400 adit to the town and from the fact that current mining activities are uphill.

The Interralogic study was therefore also charged with identifying the hydrogeology of the area. Two existing wells were identified that could be used for testing water: the Café well and the Van Sut well. In addition to these existing wells, six new groundwater monitoring wells (MW-1A, MW-1B, MW-2, MW-3, MW-4 and the Onek well) were drilled in spring, 2011. From the measurements taken at these wells, a contour map was created that identified the flow of groundwater in the area (Figure 7). The groundwater flow analysis found that:

- There is a convergence of southwest and northward flowing groundwater below the central

portion of Keno City.

- The groundwater below Keno City is conveyed northwest along a feature that appears to have higher permeability than adjacent geologic units.
- Water level contours suggest that groundwater discharges to Lightning Creek east of Keno City.
- At and downstream (west) of the Onek 400 portal, the groundwater flow direction is generally southwest towards the postulated higher permeability feature, but not toward any of the Keno City water wells.

As a result of these analyses, Interralogic was able to draw some conclusions about possible groundwater impacts and migration. They concluded that:

- Some of the Onek 400 discharge is infiltrating to groundwater as indicated by relatively high zinc and cadmium in MW-3, which is located in overburden just west of the adit portal.
- Elevated concentrations of zinc and/or cadmium suggest that Onek 400 discharge may have affected groundwater at MW-1A/1B and MW-2.
- Wells located in the central portion of Keno City (southeast of MW-1A/1B) do not appear to be impacted.

Despite the conclusions drawn by Interralogic, there remains doubt among some stakeholders that the results are accurate, and that the contamination at Onek 400 or potential contamination from current mining activities will not affect the town. The YESAB Evaluation Report concurred that “There is insufficient information to assert with certainty that groundwater from project activities will not flow towards existing private water wells, or will not adversely affect potential future uses for groundwater within Keno City and as such, additional monitoring, mapping and mitigations will be required.” (Yukon Environmental and Socio-Economic Assessment Board 2012).

#### Human Health Risk Assessment

Among the research activities conducted around groundwater contamination and health related to Keno mining, a Human Health Risk Assessment (HHRA) was produced in March, 2012 by SENES Consultants for the Elsa Reclamation and Development Company (SENES Consultants 2012). The HHRA attempted to model current Keno resident exposure to six “constituents of particular concern” (COPCs): arsenic, cadmium, lead, manganese, strontium and zinc and identify whether a health risk existed. Exposure was assessed from all potential routes of exposure, which included not only ingestion of water, but also ingestion of food, inhalation of soil particles, and dermal contact with soil. The HHRA used the data generated by Interralogic’s 2011 study to estimate the hazard associated with exposure to the six COPCs from the Firehall, Café and Van Sut wells. The HHRA concluded that that current exposure to arsenic, cadmium, lead, manganese, strontium and zinc did not pose a health hazard, as exposure at estimated levels remained below Health Canada benchmark reference values.

#### Effects of LQO expansion on water quality

With the expansion of mining activities outlined in the LQO project proposal, many residents have expressed further concern about the potential for additional contamination from LQO activities to further impact water quality. As with current Bellekeno operations, there are worries about contaminants migrating down the hill to the Firehall wellsite.

The project proposal submitted by Alexco indicated that the development of the LQO deposits could result in increased loadings of zinc and cadmium to the Christal Creek drainage, primarily as a result of additional waste rock storage and discharge from the Lucky Queen adit (YESAB document #2011-0315-103-1). In response, YESAB commissioned Ecometrix to conduct an independent report on water quality changes that

would affect aquatic resources as a result of the LQO expansion. Ecometrix's report (EcoMetrix Inc. 2012b) confirmed Alexco's conclusion that the development of the Lucky Queen and Onek deposits could result in a small increase in loadings of zinc and cadmium to the Christal Creek drainage in the long term.

A number of mitigations and an Adaptive Management Plan have been proposed by Alexco that are intended to minimize the potential for water contamination resulting from the LQO expansion. Additional recommendations have been added to these initial mitigation plans, through the Seeking Views phase of the YESAB process, from the Ecometrix report, and as part of the YESAA LQO Decision Document. The mitigation and management measures identified are critical in ensuring the continuation of good health within the community. However, even with stronger measures, questions and concerns remain about the adequacy of the plans, and definitive answers may never be available.

Uncertainty over the potential for permanent damage of the drinking water supply continues to cause stress and anxiety in a portion of the Keno residents; these outcomes are health effects that manifest separately from any adverse effects that could arise from actual contamination.

#### Plans for Monitoring Keno's water supply

A plan for groundwater monitoring has been developed by Alexco in partnership with the federal government to help provide answers to outstanding questions and data gaps. The 2011 Interralogic study represents the first step in this monitoring plan.

The six wells drilled for the Interralogic study, along with the three existing wells in Keno, comprise the wells that will be used for the planned monitoring of contamination from the Onek 400 adit and other historical and current contamination sources. Water-level monitoring and groundwater sampling is planned to continue on a quarterly basis during 2012. The monitoring frequency of the Firehall well was temporarily increased to monthly, as of January 2012 (YESAB submission 2011-0315-079) but has since returned to quarterly monitoring. At the time that Interralogic wrote their report (March 27, 2012), they stated that consideration was being given to drilling six additional monitoring wells during the 2012 field season: three new wells north of the Silver Trail Highway to investigate southwest flowing groundwater that could be associated with historical mining areas located northeast of Keno City, and three well locations south of the Silver Trail Highway to investigate northwest flowing groundwater that may migrate toward Christal Creek. The decision to install any or all of these wells will require mutual agreement between Alexco and participating Government agencies.

Groundwater monitoring wells are also planned as part of routine monitoring for the LQO mine sites: one well downgradient from the Lucky Queen adit discharge and N-AML waste rock facility, and one well at downgradient from the new Onek deposit. In addition to monitoring cadmium and zinc, Alexco has proposed to monitor pH, suspended solids, ammonia nitrogen, arsenic, cadmium, copper, lead, nickel, radium-226, silver and zinc in water from the Lucky Queen and Onek adits.

In addition to the monitoring plans described by Alexco, the YESAA Decision Document of September 7, 2012 specifies a number of additional requirements that are relevant both to the technical aspects of monitoring and to the communication of results (item numbers 1, 2, 4, 5, 6, 7, 9, and 27). These additional mitigations will further minimize the likelihood of water contamination reaching the Firehall well.

#### **Summary of the Potential Effect**

Water contamination is a key health concern among residents of Keno City. Historical mining has left a legacy of water contamination in the project area and some local water sources—in particular water near the Onek 400 adit—have been found to have elevated levels of metals (i.e. cadmium and zinc) that exceed Canadian Drinking Water Guidelines. Water in the Firehall well, which supplies the town's drinking water, has not been

found to contain contamination hazardous to human health. However, the fact that there are contaminated wells near the Firehall well has led to considerable fear among some residents that the town's water supply, while currently safe, is not secure and that its security is further jeopardized by the planned Lucky Queen and Onek expansion. A robust groundwater monitoring plan with an adaptive management component and a strong focus on communications is essential both to ensuring the safety of the local drinking water supply and to reducing stress and anxiety. In addition, commonsense public health interventions and a robust plan for backup water may be needed to ensure that residents and visitors access only safe sources of water.

Table 9 summarizes the potential effects to the community from the water exposure pathways outlined above.

**Table 9: Summary of Risk to Community Health from Water-Related Environmental Exposures**

Significance Criteria	Description
Direction	<b>Adverse</b> - An adverse or undesirable change
Severity	<b>High</b> - Has the potential to cause acute, chronic, or permanent effects that are potentially disabling or life threatening
Duration	<b>Permanent</b> - Has the potential to result in irreversible change
Likelihood	<b>Unlikely</b> - There is little evidence that effects will occur in with resource development activity in this setting

#### Potential Additional Mitigation Measures

The HSS, in consultation with the community, should continue to develop a comprehensive water management strategy that will:

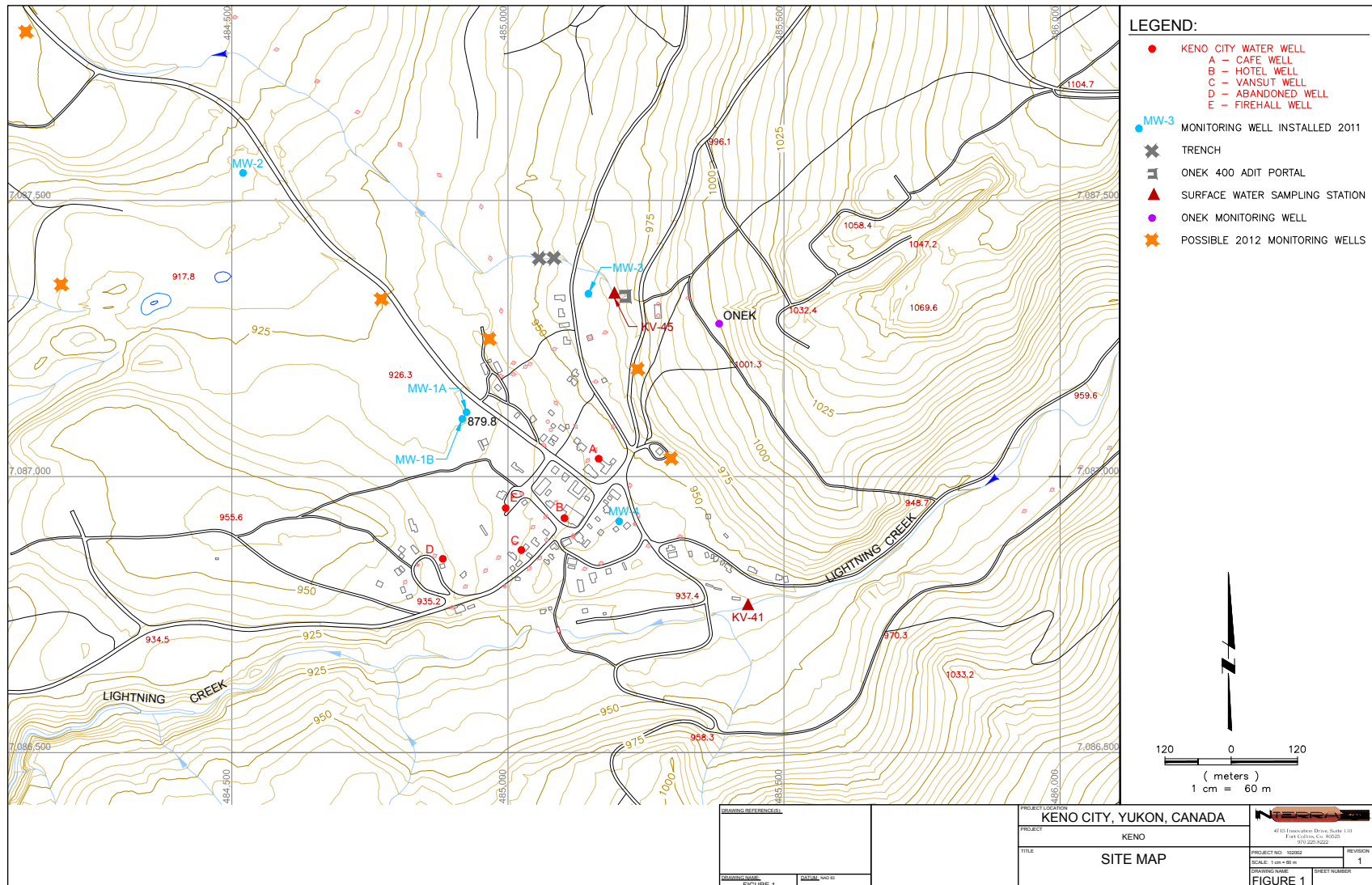
- Identify a single source of well water for the community (presumably the Firehall well) and one backup source.
- Provide for active monitoring of any well sources with public reporting of both the data and descriptive interpretation of results, occurring at a minimum of once every three months throughout the duration of underground mining at Onek occurring at a minimum of once every three months or when there is surface disruption in the immediate vicinity of Keno City.
- Actively discourage the use of any other well, public or private, in the community.
- Discourage the use of collected surface water for watering gardens or for human use.

The groundwater monitoring plan proposed by Access will further characterize the groundwater hydrology with a focus on assessing the contamination that is assumed to be coming from the Onek 440 adit. The results of this monitoring plan should be disclosed to the community and the HSS in a timely manner and include both data and an interpretation of results.

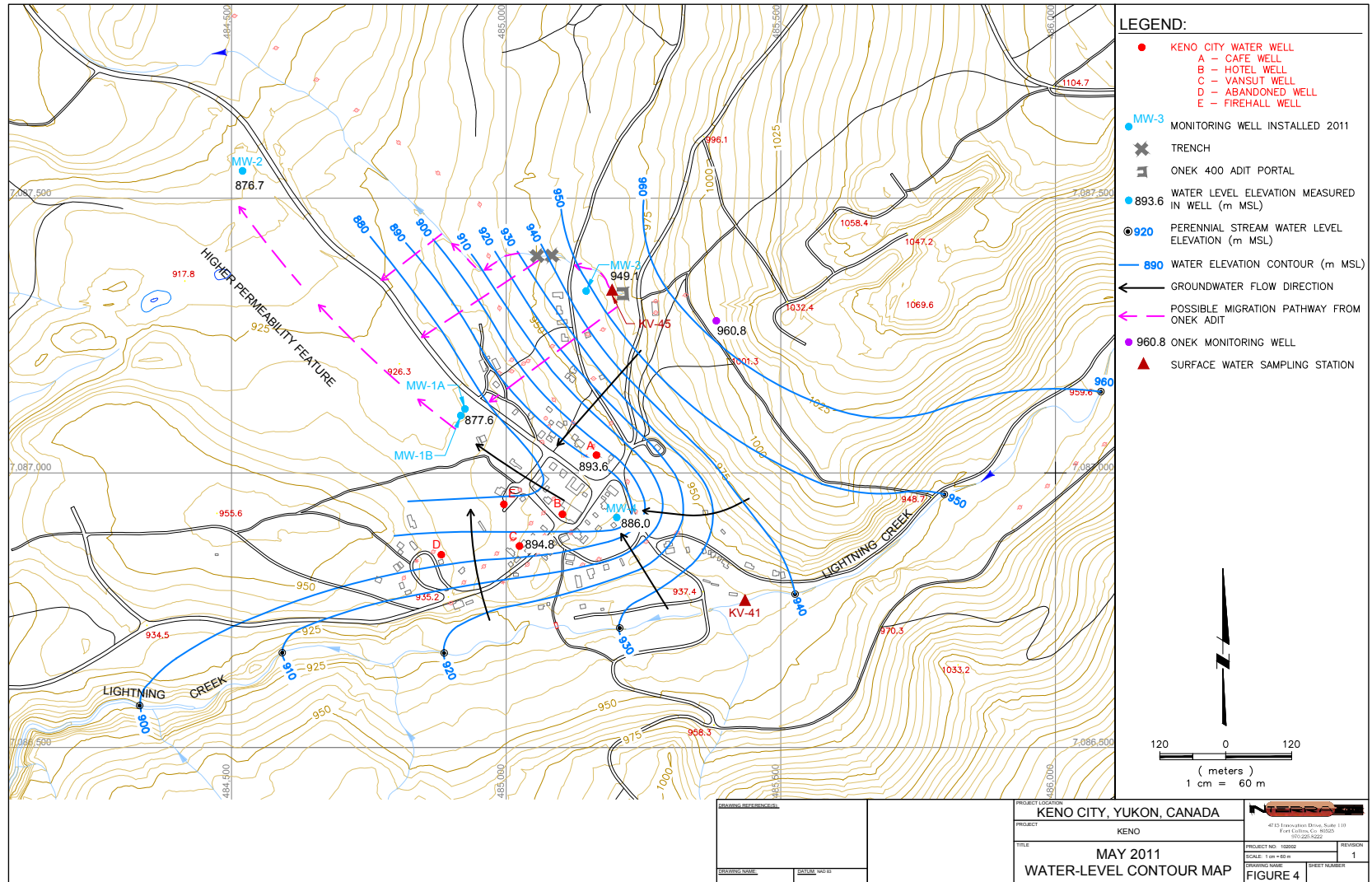
The selection and monitoring of an additional well in the area between the Firehall well and the Onek workings should be undertaken to assess and observe for any evidence of a plume crossing the town that could risk the ongoing safety of the Firehall well.

The planned installation of a treatment plant at the 440 adit must be completed as soon as possible. Once the treatment plant is completed, ongoing groundwater monitoring should be undertaken to assess subsequent changes in observed cadmium levels in the groundwater in the surrounding area. Results of the treatment and follow-up monitoring will be communicated to the community and the HSS for consideration in future reassessment of the water management strategy.

Figure 6: Map of Groundwater Monitoring Wells in and near Keno



### Figure 7: Water Level Contour Map



Source: (Interralogic Inc. 2011)

## C. Noise-Related Health Effects

### Background

Noise was identified by Keno City residents as one of the most substantial impacts of the current and proposed mining activities.

Noise is measured in decibels (dBA). Near total silence is measured as 0 dBA, a whisper is 15 dBA, normal conversation is 60 dB, a lawnmower is 90 dB, a car horn is 110 dB, and a gunshot or firecracker is 140 dBA. Literature related to noise and health indicates that:

- Environmental noise ranging from 40 to 55 dBA is likely to lead to annoyance in a portion of the population.
- Noise levels between 40 and 60 dBA may interfere with sleep.
- Extended exposure to noise levels in the range of 65 to 70 dBA have been linked with decreased concentration and ischemic heart disease.
- Exposure to acute high decibel noise (>85 dBA) can lead to hearing loss and hearing impairment (*London Health Commission 2003*)

The extent to which noise causes adverse effects (including annoyance) depends on several factors that include whether the noise is transient or continuous, the pitch or sound frequency, when the noise occurs (daytime vs. nighttime), and whether the noise is perceived to be unwanted.

### Pathways Between Mining Activities and Health Effects

Mining activities in and near Keno may generate noise from a number of sources, including:

- Construction of roads (e.g. the Keno Bypass Road)
- Construction of facilities
- Operation of the mine sites, including use of explosives, underground excavation, drilling, and vehicles and machinery
- Operation of the mill, including crushing and processing of ores and stack management at the Dry Stack Tailings Management Facility
- Truck and other vehicle transport

### Current Knowledge of Mining Impacts

Several noise studies have been conducted, the relevant results of which are summarized below.

A preliminary sound study in the Keno City area was prepared for Alexco by Access Consulting Group using data collected from four locations [Onek 400, the Campground, a residence (in the West of Keno at the nearest point to the mill site), and the Fire Hall] between May 5 and July 28, 2009 (Access Consulting Group 2009). The measurements collected in the preliminary sound study were considered to represent baseline conditions in Keno, as the measurements were taken prior to any major mine and mill site construction by Alexco when mining-related activities consisted primarily of light traffic (Allen 2011). The noise estimates are shown in the second column ("Baseline") of Table 10.

Further noise monitoring has continued through the present; the number of monitoring locations expanded to eight from the initial four. Measurements from ongoing monitoring at the eight sites is also shown in Table 10. A report prepared in August 2011 stated that "No statistical increase in avg. dBA was observed at any of the development/operations blocks when compared to the baseline conditions" (Allen 2011). It should be noted that in this statement, the term significant refers to statistical significance rather than significance to local

residents. While it appears accurate that the median measured dBA did not record a statistically significant change from baseline during that period, marked increases appear at all locations in terms of maximum decibels recorded. This was not noted in the original report.

**Table 10: Sound Measurements in Eight Keno Locations, 2009-2011**

	Baseline	During Mill Construction	During Mill Construction and Bypass Road Construction	During Mill Operations and Ore Haul
<b>Residence (West)</b>				
Minimum dBA	34.0	33.8	33.8	33.1
Maximum dBA	48.9	47.3	52.4	53.9
Median dBA	40.4	39.7	40.0	39.1
Mean dBA	40.3	40.4	40.3	39.9
<b>Firehall</b>				
Minimum dBA	36.1	31.4	34.5	34.3
Maximum dBA	47.6	50.6	50.0	63.2
Median dBA	39.1	38.5	38.6	37.7
Mean dBA	39.8	39.5	40.1	39.4
<b>Campground</b>				
Minimum dBA	40.9	31.4	47.6	33.1
Maximum dBA	56.7	62.1	65.0	72.6
Median dBA	50.2	43.5	50.1	46.4
Mean dBA	49.4	44.6	51.2	44.7
<b>Onek 400</b>				
Minimum dBA	36.0	32.0	32.9	33.3
Maximum dBA	49.6	52.1	57.1	71.8
Median dBA	42.5	37.5	35.7	36.9
Mean dBA	41.9	38.3	37.0	38.9
<b>Residence (North)</b>				
Minimum dBA	-	32.3	33.4	33.3
Maximum dBA	-	46.9	53.6	76.2
Median dBA	-	38.0	35.9	36.7
Mean dBA	-	38.9	38.2	39.8
<b>Dump</b>				
Minimum dBA	-	32.2	33.8	32.9
Maximum dBA	-	55.9	51.8	55.8
Median dBA	-	39.2	41.2	38.3
Mean dBA	-	39.8	41.0	40.8
<b>Mill</b>				
Minimum dBA	-	33.3	52.2	46.6
Maximum dBA	-	74.9	69.7	68.7
Median dBA	-	44.3	60.3	61.1
Mean dBA	-	48.2	59.7	59.1
<b>Onek Pit</b>				
Minimum dBA	-	32.2	32.7	32.5
Maximum dBA	-	53.5	41.7	67.2
Median dBA	-	38.4	35.6	34.3
Mean dBA	-	40.4	35.6	38.7

Source: adapted from (Allen 2011).

As part of the LQO project application, Alexco provided noise level estimation for the Onek 990 portal and mine, based on the Roadway Construction Noise Model from the US Department of Transportation. The results of the model predicted that noise from the portal, Bypass road and mine support facilities would not exceed a maximum of approximately 54 dBA.

Finally, in July 2012 two studies were prepared for YESAB by Patching Associates Acoustical Engineering. The two reports were:

- A Comprehensive Sound Survey that was conducted in order to assess current (existing) noise levels in Keno City from all sources (Patching et al. 2012a);
- A Noise Impact Assessment that was conducted in order to predict the noise level from the combined existing and proposed Alexco mining operations (Patching et al. 2012b).

Measurements were taken at five different monitoring locations between June 25, 2012 and June 29, 2012. As shown in Table 11, measured levels of noise fell in the range of 32 to 47 dBA. Two of the sampling locations (R01 and R05) were deemed to be “unrepresentative” because of other close-by noise sources such as rain, wind and birds.

**Table 11: Results of Sound Level Measurements in Keno City, 2012**

Residence	Measured dBA	
	Day	Night
R01	-	-
R02	35	32
R03	41	37
R04	47	41
R05	-	-

*Source: (Patching et al. 2012a)*

In the Noise Impact Assessment, the report author attempted to estimate the level of noise that would be experienced in Keno as a result of combined current and proposed mining operations. The results of the assessment are shown in Table 12. The Noise Impact Assessment report suggests that there will be either no increase in noise as a result of the proposed operation of the Onek 990 portal and Keno City Bypass Road (at four receptors) or that there will be only a one decibel increase (at one receptor). At least one resident has expressed that these results seem improbable (pers. comm., August 21, 2012).

**Table 12: Predicted Noise Levels Generated by Alexco Current and Proposed Mining Operations**

Residence	Predicted facility noise levels in daytime (dBA)	Measured ambient sound levels (dBA)	Predicted noise levels daytime plus ambient sound levels (dBA)	Predicted noise level increase based on current noise level (dBA)
R01	30	39	39	0
R02	30	35	36	0
R03	31	27	32	0
R04	32	34	36	0
R05	31	32	35	1

*Source: (Patching et al. 2012b)*

A number of the studies reporting on observed and predicted noise levels have drawn comparisons to standards developed for construction or industrial noise elsewhere, often in the United States. These standards—which often use the exceedence of 55 dBA as the minimum for creating noise annoyance -- are often based on typical ambient sound profiles for more urbanized environments and are unlikely to be representative of either ambient (without mining activity) sound levels in Keno, or of the level of noise that is tolerable to some Keno residents; thus, the standard being used for judging effect may be inappropriate.

Alexco’s noise abatement plan was developed in November, 2009. The plan describes eleven commitments from Alexco to minimize noise disturbance in Keno. The YESAA LQO Decision Document adds seven new

required noise mitigation measures. These include a limit on the hours of waste rock movement, the use of broadband beepers rather than backup beepers on vehicles, quarterly noise monitoring that assesses the effects on local business, the requirement to work with Keno City residents to identify appropriate locations for noise monitoring, and the establishment of a formal complaint resolution process.

A final concern raised by Keno City residents had to do with vibration. Several residents have asked whether the underground blasting at Onek might result in blasting vibrations that might be felt in their homes. Alexco has stated in the project proposal that it is very difficult to predict the amount of vibrations that might be felt from blasting, but has offered to work closely with the residents to monitor the blasting impacts. Alexco has stated it will: notify all residents when blasting is to begin; work with residents to decide on appropriate blasting timing windows; coordinate group blasting events to reduce the frequency of disturbance; and if blasting vibrations are felt, implement mitigations (Alexco Keno Hill Mining Corp. 2012).

Finally, it should be noted that all sound assessments to date have been done in regard to Alexco's current or proposed activities. There are significant sound sources related to mining activities in the Keno area that are not associated with Alexco's activities, including the intermittent use of helicopters for exploration and transportation of mining crews. The staging of helicopter traffic in the vicinity of Keno, though infrequent, is a significant source of noise irritation that has not been captured in any previous assessment.

### Summary of the potential effects

Several studies have modeled the actual and predicted noise levels associated with Alexco's current and proposed mining operations. While the noise levels have fallen within limits that are generally considered "acceptable" for industrial development in proximity to a community, both the models and the levels used to delimit an acceptable noise level may be inappropriate for Keno City, given that Keno City ambient noise levels pre-development were extremely low and that quiet is a valued community resource. However, noise levels are unlikely to be associated with adverse health events other than annoyance. Alexco has proposed a number of mitigations to lessen the effects of noise, and adherence to these mitigations will be important for the effects of noise to be as low as practicable.

Table 13 summarizes the potential effects to the community from noise, as outlined above.

**Table 13: Summary of Risk to Community Health from Noise**

Significance Criteria	Description
Direction	<b>Adverse</b> - An adverse or undesirable change
Severity	<b>Low</b> - Has the potential to cause acute, short-term effects with limited and reversible effects on function, health or well-being.
Duration	<b>Persistent</b> - Has the potential to last for the duration of mining activity
Likelihood	<b>Certain</b> - Effects are already being reported in the study area

### Potential Additional Mitigation Measures

For long-term or significant construction and/or operation noise, Health Canada advises that health impact endpoints be evaluated based on the change in the percentage of the population who become highly annoyed (%HA), with the suggestion that mitigation be proposed if the predicted change in %HA is greater than 6.5% between project and baseline noise environments. While the use of %HA to evaluate noise impacts is more sensitive than a dB measurement in a rural setting such as Keno, the small population size makes quantification of annoyance difficult. In absence of a reliable measure of %HA, Health Canada's recommendations strongly support the development a community consultation and complaint resolution system whereby residents'

concerns would be documented. Alexco and other industrial operators in the region would be required to follow up and resolve these concerns.

Patching Associates' suggestion for continued monitoring and the potential installation of a permanent monitoring station, if followed, would help evaluate new noise sources that evolve out of the LQO expansion. The new Keno City Bypass road and 990 portal carry the potential for significant new noise on the east side of the community – any siting of future or permanent monitors should take these new noise sources into consideration.

Construction and use of the new bypass road immediately to the east of Keno City is intended to accommodate limited traffic, with infrequent and lighter haul trucks to Lucky Queen. Expansion in the use of this road by Alexco or other industrial operators, including any backhauling of waste rock or tailings up to the open pits on top of Onek, should be avoided.

All operators in the region should employ current best practice noise abatement strategies which will include but are not limited to covering of crushers, restrictions on air-brake use, time restrictions on hauling and explosives, proper maintenance of vehicles and a switch away from back-up beepers to broadband warning systems.

## D. Infectious Disease

### Background

Infectious disease is a common issue in resource development contexts in Canada as well as globally. The spread of infectious disease typically results from an influx of people (e.g. workers) moving temporarily into a rural or remote area, combined with work camp environments and interaction between the workers and local populations. Three types of infectious diseases that are of potential concern for the study area that could be associated with mining development in general and the Bellekeno Development and the LQO Expansion in particular are: sexually transmitted infections, gastrointestinal illnesses; and respiratory infections.

**Sexually transmitted infections (STIs)** include gonorrhea, chlamydia, syphilis, hepatitis C, and HIV/AIDS. These diseases are transmitted from one person to another through unprotected sexual contact. The diseases can cause irritating symptoms that need to be treated; they can also have much more serious consequences, including infertility or sterility, and some rare cases death. They represent a large public health concern because of their ability to spread rapidly through the population. While the costs to individuals and the public health care system due to STIs run high, STIs are largely preventable and treatable. Literature related to STIs within resource development contexts indicates that:

- Communities adjacent to resource development projects frequently experience an increase in STI rates when male worker populations come into an area for work (Goldenberg et al. 2008a, Goldenberg et al. 2008b, Goldenberg et al. 2007). This phenomenon has been documented in British Columbia and Alberta as well as elsewhere worldwide.
- Key factors that influence the spread of STIs within extractive industries include: mobility and the transient nature of workers (workers are away from the 'social controls' of their home community); long and difficult days and need to release stress; high levels of disposable income; binge partying; and a general disregard for the practice of safe sex (Goldenberg et al. 2007, Government of the Northwest Territories 2006).
- Research among young male resource workers in remote work camps in northern British Columbia has identified a number of recommendations for limiting the spread of STIs in work camp contexts: a locally-tailored STI awareness campaign to decrease stigma; mobile STI testing units; condom distribution at camps, bars, and hotels; and inter-sectoral partnerships among public health agencies, local non-profit health organizations and industry.

**Gastrointestinal (GI) illnesses** are caused by bacterial and viral pathogens such as norovirus and hepatitis A. Symptoms can include stomach cramping, fever, vomiting, and/or diarrhea that lasts between several hours and several weeks. GI illnesses are spread from person to person by direct contact (hand to mouth) but can also be spread through contaminated food, water, or surfaces such as tables, chairs, door handles, etc., and may be linked to poor food-handling practices or sanitation. Literature related to GI illnesses in resource development contexts shows that:

- GI outbreaks are common in communal living settings, such as work camps, children's camps, military camps, long-term care homes and cruise ships (Colorado Department of Public Health & Environment 2006, Public Health Agency of Canada 2003). Individuals in camp setting can be particularly vulnerable to GI illnesses because they typically live in close quarters, which increases the risk of person-to-person transmission. In addition, there is a potential for decreased personal hygiene amongst individuals in a camp setting if there is limited availability of water or poor cleanliness of facilities. In the case of work camps, workers might also be reluctant to report symptoms of GI illnesses so as not to miss work valuable hours and pay and thus be more likely to infect others.
- One of the most effective ways to prevent GI illnesses, and the spread of communicable diseases in general, is through frequent hand washing. Other prevention and control measures include providing

hand sanitizing gels or wipes; ensuring a safe drinking water and food supply; maintaining clean restrooms, bedding, etc.; and adequate clean-up of vomit or fecal accidents within the camp sites (Colorado Department of Public Health & Environment 2006).

Common **respiratory infections** include the common cold, strep throat, influenza, pneumonia, bronchitis, measles, and chicken pox. Although often mild, infectious respiratory disease can be very serious or life-threatening. As an example, between 700 and 2,500 people die in Canada every year from influenza, with those who are very old, very young, or who have pre-existing health conditions at highest risk (Sibbald 2003). Literature related to respiratory infections in resource development contexts reveals that:

- Respiratory infections can spread quickly whenever there are groups living or working in close conditions, such as overcrowded housing or a camp. Disease can spread easily if beds are too close together or if infectious workers come in physical contact with one another.

### Pathways Between Mining Activities and Health Effects

Infectious diseases transmission within the study could occur via several pathways. Infections could be spread among the workforce; between workers and individuals living in Keno, Mayo or Whitehorse during interactions on workers' days off, during the commute to and from Mayo/Whitehorse, or during layovers in Mayo/Whitehorse; or from workers to their home communities.

### Current Knowledge of Mining Impacts

Alexco's workers reside at the Flat Creek Camp. The Camp, which will accommodate up to 200 workers pending the approval of the LQO Expansion, is located approximately 13 km from Keno and 45 km from Mayo. Workers are on a rotational schedule (4 weeks in and 2 weeks out). Every fifth day, a charter aircraft flies personnel into Mayo; workers are then transported by company vehicle to the Flat Creek Camp and to the work sites.

Workers are allowed to travel into Keno on their days off. This interaction is generally encouraged by Keno's business community, which sees social and economic benefits of inviting workers into the community to enjoy the local amenities. There is also opportunity for workers to spend free time in Mayo while on shift changes or during their days off.

There has been little mention of infectious disease as a concern within the Study Area by any stakeholders, either in the YESAB submissions or during individual interviews, and interviews with health service providers indicate that no increases in disease rates have been noted, although opinions were based on personal observation rather than surveillance data.

The potential for STI transmission remains, as this phenomenon has been commonly observed with resource development projects elsewhere in Canada. If STI transmission does occur with respect to the mining workforce, it is likely that it would appear in Mayo or possibly Whitehorse; it is unlikely to be an issue for Keno City, due to the small size and the composition of the community.

Both Alexco and Health Canada have made note of the potential for GI disease transmission in the work camps if sanitation resources are strained [YESAB document: 2011-0315-049, (Alexco Keno Hill Mining Corp. 2009)]. HSS files indicate that the Flat Creek Camp sewage disposal and drinking water system is currently designed to accommodate 143 people, whereas the LQO expansion is projected to raise the camp population to 200 workers.

Respiratory infections that are of highest concern are tuberculosis (TB), influenza, and pneumonia. As these are airborne infections, there is an elevated risk of transmission in the shared spaces of work vehicles (including aircraft) and work camps.

### Summary of the potential effects

Impacts to rates of sexually transmitted infections, gastrointestinal illnesses and respiratory infections were examined. While solid information exists in the published literature on the association between resource development activities and increases in worker and community infectious disease rates in Canada and elsewhere, there is limited applicability of this information to the current situation due to unique contextual factors such as the very small size of the Keno population. Neither the literature nor specific information about the current and proposed mining activities allows estimations to be made of the size of any potential increases in rates of infectious diseases in Keno or in Mayo.

Table 14 summarizes the potential effects to the community from the infectious disease pathways outlined above.

**Table 14: Summary of Risk to Community Health from Infectious Disease**

Significance Criteria	Description
Direction	<b>Adverse</b> - <i>An adverse or undesirable change</i>
Severity	<b>Medium</b> - <i>Has the potential to cause acute, chronic, or permanent effects that substantially affect function, health or well-being</i>
Duration	<b>Persistent</b> - <i>Has the potential to last for the duration of mining activity</i>
Likelihood	<b>Possible</b> - <i>Evidence suggests that effects do occur, but are infrequent in this setting</i>

### Recommended Additional Mitigation Measures

In addition to the regulatory requirements regarding public health and hygiene, employers and camp operators, in consultation with department of health and social services, should follow best practice standards with regard to the following:

- STI education and prevention strategies, including free condom distribution in camps
- Proper hand washing signs and hand washing stations in common areas at work and in camp
- Mandatory annual influenza vaccination for camp residents

Camp operators should be trained to recognize signs of outbreaks in their community and report suspected outbreaks to the nurse in charge at the Mayo Health Centre.

## E. Stress and Mental Well-Being

### Background

Stress and mental health are key components of overall health and well-being, and changes in stress and mental health are often linked to development projects, including resource development projects such as mines. The relationship is complex, and stress and mental well-being can be either adversely or beneficially affected. Resource development projects have the potential to reduce stress, enhance mental well-being and, in turn, improve overall health. Conversely, resource development projects also have the potential to increase stress, degrade mental well-being, and as a result, contribute to negative health outcomes.

The links between stress, mental health and physical health are well-documented. Research shows that:

- Unmanaged stress has physical health consequences that include weakened immune systems, weakened functioning of the circulatory and metabolic systems, and increased incidence of cardiovascular disease and Type 2 diabetes (Brunner and Marmot 2006).
- Stress can lead to the adoption of health-threatening coping behaviours such as tobacco use and alcohol consumption (Mikkonen and Raphael 2010).
- Impaired mental health has a worsening effect on other conditions such as cardiovascular disease, diabetes, and addictions; as well it can influence the onset and transmission of infectious disease due to its lowering of the immune system and significantly reduce life expectancy (Wilson and Wilkerson 2011).

Stakeholder consultation identified several key areas of Keno-area mining that were affecting stress and mental well-being among residents. These areas, examined in this section, are:

- Economic impacts
- Community change
- Perceived contamination

Noise can also be a source of annoyance or stress, and is examined in this report in the section on environmentally-mediated health effects.

### Pathways Between Mining Activities and Health Effects

Communities adjacent to resource projects may experience both beneficial and adverse **economic impacts** depending upon the type of development and the nature of the community and how they interact. These economic impacts, in turn, affect the health and well-being of the local population: positive economic impacts can reduce stress, provide a sense of control over one's life and enhance the mental health and well-being among local residents; conversely, negative economic impacts can increase stress, lead to feelings of powerlessness and diminish the mental health and well-being among locals (International Council on Mining and Metals 2010). With respect to current and proposed mining developments in the Keno area, the following pathways represent potential ways in which economic impacts may occur and thereby impact stress and mental well-being in the community.

Positive economic impacts may accrue due to:

- An increase in mining-related jobs, income, or training opportunities.
- An increase in economic activity for local businesses that provide food, drink, accommodations or other services to project workers.

Negative economic impacts may accrue as a result of:

- A decrease in tourists and tourist revenues for local businesses and attractions and a potential loss in the return on investment in marketing and facility upgrades due to the negative effects mining has on the natural environment (e.g., increase in noise and traffic; visual changes to the landscape).
- A decrease in property values due to the effects mining has on the natural environment.
- An increase in damage to personal vehicles and associated repair costs due to the degradation of roads from increased mine/truck traffic.
- An increase in costs due to a potential increase in substance abuse, crime or violence that may be associated with sudden increases in income for a portion of local residents, and spending by transient workers (Kohrs 1974, Wilkinson et al. 1982).

**Community change** refers to alterations in the social, physical, institutional or economic makeup of a community. Community change is commonly associated with development projects, and is often welcomed by some residents, while being rejected by others. Components of community change that have been associated with resource development projects and that have also been associated with changes in stress, mental health and similar outcomes include:

- Changes in the surrounding landscape and environment
- Changes in social networks and support systems
- Changes in governance structures
- Increasing residential proximity to industrial activity
- Individual perceptions of powerlessness and lack of control

(Downey and Van Willigen 2005, Wallerstein 1992, Marques and Lima 2011, Albrecht et al. 2007).

**Perception of contamination** refers to an individual's belief that environmental media (air, soil, water), food supplies or animals (pets, livestock or wildlife) may be contaminated. The perception of contamination may result from there being actual contamination, or may arise in absence of measurable or plausible contamination. The perception of contamination can be based on individuals' personal dispositions and coping mechanisms and the environmental quality at a particular point in time, or industrial events (e.g., siting industrial activities, chemical spills, foul odour days). Perceived contamination in Keno is strong at present, as expressed in numerous references in the YESAB submissions and community consultations to concerns over the air, soil and water contamination. This perception, however, is not universal in the community. While the health consequences of exposure to contaminants is fairly well-documented (see the section on environmentally-mediated health effects), the perception of contamination can itself result in a number of physical and mental health effects. These may include increased stress, worsened mental health, eating and sleeping disorders, changes in diet and eating patterns (to avoid food believed to be tainted), somatic effects (e.g., headache, fatigue, respiratory disorders, and decreased overall health and well-being. (Cavalini et al. 1991, Chattopadhyay et al. 1995, Lima 2004, Matthies et al. 2000, Taylor et al. 1991).

### Current Knowledge of Mining Impacts

The potential impacts of current mining activities on recreation and tourism were assessed by Alexco in its Bellekeno proposal. The assessment stated that a consequence of its mining activities would be "a reduction in recreational uses and conflict with tourism" due to physical and aesthetic disturbance of the landscape, mine traffic, noise, and dust. According to the assessment, the Bellekeno Development's effects on Keno City's recreation and tourism was characterized as:

- Direction: negative
- Duration: 10 years
- Geographic extent: low/moderate
- Magnitude: low
- Reversibility: moderate
- Overall rating: low
- Significance: not significant

For the LQO expansion, Alexco's proposal identified further negative impacts on recreation and tourism due to further changes in the aesthetic quality of the landscape/environment and public safety. These predictions of negative impact to recreation and tourism from current activities and future plans are in accordance with statements made by some Keno residents and other stakeholders, including the Yukon Department of Tourism and Culture; the Wilderness Tourism Association of the Yukon; and the Klondike Visitors Association, in submissions to YESAB and during in-person consultations. (YESAB documents 2011-0315-049; 2009-0030-058; 2009-0030-057; 2009-0030-082; 2009-0030-041; 2009-0030-032; 2011-0315-064).

In terms of the potential for the mining activity to provide benefits through employment and income, opinion appears to be divided. The Bellekeno Development has increased employment in the Project Area. Alexco currently employs 70 Yukoners and 15 Mayo residents and FNNND citizens on site. Alexco has entered into joint venture partnerships through the FNNND Development Corporation and has hired local contractors to provide a number of services (Alexco Keno Hill Mining Corp. 2012), YESAB document: 2011-0315-032). It is expected that production at the Lucky Queen and Onek sites will create an additional 35 positions; Alexco plans to hire workers for these positions locally or regionally. The mine contractor that will work on the development of the Onek and Lucky Queen mines is a FNNND joint venture company (Alexco Keno Hill Mining Corp. 2012). Several Keno City residents have expressed support of Alexco's projects because of the benefits that accrue locally and across all of Yukon from the economic spinoff of mining (YESAB document: 2009-0030-087). However, a larger number of Keno residents who have submitted documents to the YESAB process have strongly expressed concern about negative economic effects, both in terms of negatively impacting current sources of income and lowering property values (YESAB documents: 2011-0315-067; 2011-0315-061; 2009-0030-041; 2009-0030-090).

Health service providers in Mayo were asked whether they had observed any changes in substance abuse, crime, or violence that could be associated with an increase in mining activity, mining-related revenue and mining workers spending time in Mayo. No such impacts were reported, although providers' reports were based on personal opinion rather than surveillance data.

There is ample evidence to support the contention that the community of Keno has been changing and continues to change in response to recent and planned mining activities. Submissions to the YESAB Registry and in-person interviews with local residents have brought out a number of overlapping themes that touch on community change and associated impacts to quality of life, stress and mental well-being:

- Changing character of the community – from a quiet and serene tourist setting to a noisy industrial setting
- Decreased enjoyment of living in the area and changes to personal sense of "place"
- Fear of having little to no control of the industrial activities within and surrounding the community
- Fear of not being able to enjoy one's own property and adjacent lands
- Diminished access and quality of outdoor recreational areas due to traffic, noise, and air pollution and other visual changes to the landscape
- Increased time away from or moving away from the community to avoid effects

The response to change in the character of the community has not been uniform. Residents appear to have differing views of the impact and its meaning to the community. Some residents are 'okay' with the mine expansion, as long as certain aspects of the expansion are changed and specific mitigation measures are followed; whereas other residents saw 'community change' as a negative phenomenon, leading to undesirable changes and contributing to increasing stress levels and diminishing mental health among residents. These different perceptions of the 'identity' or nature of Keno have produced social divisions within the community that amplify the tension and stress felt by some residents. In addition, the lack of governance within the community has made it difficult to develop a unified vision, plan and voice on the position of their community with respect to Alexco Keno Hill Mining Corp.'s mine and proposed expansion. This inability to meaningfully direct the future of the community adds further stress to Keno City residents.

The perception of contamination is a dominant theme that has emerged from the Keno City residents' submissions to the YESAB Registry. Contamination issues mentioned include high cadmium levels in the water and soil, the unknown health impacts of the Dry Stack Tailings Facility and associated dust blowing from this facility and truck traffic, as well as the potential for industrial accidents. While the issue of direct physical effects from contaminants associated within the mines is examined by Alexco (and is summarized in the section on environmentally-mediated health effects), the *perception of contamination* has not been considered.

### Summary of the Potential Effect

Stress and mental well-being have been adversely affected for a number of Keno residents due to changes in the character of the community, the viability of some businesses, the impact of mining activities on landscape and noise levels, the time needed to remain informed about ongoing mining plans, perceived contamination of air and water sources, and the lack of stable future planning. While negative reactions are not uniform across all community members (stress and mental wellbeing may improve for some residents as a result of increases in economic activity and local hiring), this has emerged as a dominant theme. Although a number of stressors can be mitigated or minimized through collaboration among industry, the Yukon government and Keno residents, the lack of a governance structure or organized representation within the community poses significant challenges in terms of developing a strategy that responds to a unified community vision.

Table 15 summarizes the potential effects to the community from the stress and mental well-being pathways outlined above.

**Table 15: Summary of Risk to Community Health from Stress and Mental Well-Being**

Significance Criteria	Description
Direction	<b>Adverse</b> - <i>An adverse or undesirable change</i>
Severity	<b>Low</b> - <i>Has the potential to cause acute, short-term effects with limited and reversible effects on function, health or well-being</i>
Duration	<b>Permanent</b> - <i>Has the potential to result in irreversible change</i>
Likelihood	<b>Certain</b> - <i>Effects are already being reported in the study area</i>

### Recommended Additional Mitigation Measures

With regard to the perception of contamination, additional mitigation efforts are required with regard to monitoring and communication of results. These recommendations, along with mitigations related to noise, are provided in the section on environmentally-mediated health effects.

Socio-economic stressors, including those related to the stress of community change, are partially addressed in the YESAA LQO Decision Document of September 7, 2012 (Yukon Government 2012). These actions include:

- 35. The proponent shall work with local residents and First Nation community members to develop the proposed Keno City Socio-economic Mitigation Plan that outlines not only the necessary measures to maintain quality of life, but also the needs of each group in terms of land usage. This shall be completed prior to closure, and implemented in such a way as to incorporate recommendations into closure plans.
- 54. The proponent shall work with the residents of Keno City to ensure that aesthetic factors, which are a key part of Keno's image and appeal, are maintained.

The potential of these suggested mitigations is limited by the lack a cohesive governance structure for Keno City. It is recommended that the Department of Community Services work with residents of Keno City to

develop a community plan and new approach to town management. Though Keno City, as an unincorporated place, can rely on the Integrated Community Sustainability Plan for basic infrastructure needs, the lack of organized representation or planning is a serious impediment to the community's ability to negotiate with or respond to industrial activities and proponents in the area. This difficulty is recognized in the removal of one of the Evaluation Report's recommendations from the final Decision Document. Recommendation #51 emphasized the need for the development of a local area plan that would meet the needs of Alexco while simultaneously acknowledging values of importance to the community of Keno and the FNNND that must be preserved. The Decision Document removed this recommendation on the grounds that local area planning is a government responsibility.

## F. Injury

This section explores the potential for impacts to health via two injury pathways: 1) increase in risk of traffic-related injury due to mining-related activities and 2) industrial accidents and malfunctions that could impact community safety.

### Background

Although traffic collisions and accidents are relatively rare events, they are known to occur in connection with resource development projects in Canada. From a public health perspective, traffic collisions are important despite their infrequency due to their potential to cause serious injury or death. There are several attributes of resource road use that can impact the risk or severity of traffic accidents involving members of the public:

- An increased number of vehicles on the road. The risk of collision is directly related to the number of vehicles using the road. A higher number of vehicles due to industrial activity leads to a higher number of accidents.
- The types of vehicles on the road. Large and slow moving trucks have been found to cause other drivers on rural roads in Canada to engage in risky or illegal passing manoeuvres, increasing the likelihood of collisions (Canadian Council for Motor Transport Administrators 2006).
- The location of vehicles. The risk of severe injury increases when vehicles travel in areas where there may be pedestrians, such as through communities.
- Driver behaviour. The behaviour of workers behind the wheel is another determinant of traffic safety. Behaviours of greatest concern include inappropriate or excessive speed, presence of alcohol, medicinal or recreational drugs, fatigue, and traveling in darkness (World Health Organization 2004).
- Road quality. The condition of the road can also influence traffic accident collisions with heavy trucks. Specifically, undivided roads, curved roads with a gradient and poor road surface conditions (e.g. wet, snow, and ice) are road characteristics that have been found to contribute to traffic accidents with heavy trucks (Jonah et al. 2009).

Industrial accidents and malfunctions are unintended incidents that result in human health impacts. They can occur for reasons such as human error, equipment failure and external environmental factors. The major accidents that have occurred in relation to mines in Canada and that have the potential to harm members of the public have generally resulted from blasting activities and generation of seismic activities in underground mines. While these incidents can result in severe workplace injuries, injuries occurring in members of the public are very rare.

### Pathways Between Mining Activities and Health Effects

Traffic safety has been raised a concern by Keno residents and other stakeholders including the Village of Mayo, the First Nation of Na-Cho Nyak Dun, the Yukon departments of Tourism and Culture and Energy, Mines and Resources. Specific issues raised were the temporary increase in traffic through Keno City during the construction of the bypass roads and the overall increase in traffic on the Silver Trail Highway during the life of the project.

The project has the potential to impact traffic collision rates on the roadways via the following mechanisms:

1. Transportation of workers to and from the worksite.  
Approximately every five days a group of workers fly into and out of the Mayo Airport. Workers are transported to and from Elsa in a company-owned bus to minimize the number of vehicles on the local roads. During winter months and when weather is poor workers are

transported from Whitehorse to Elsa in company-owned vehicles. There is also transportation of workers between Elsa and the three mine sites and mill site.

2. Work trucks on public roads.

Currently ore is being hauled from Bellekeno Mine to the mill site via the Bellekeno Haul Road bypassing to the south of Keno City. The ore haulage route between Lucky Queen and Onek Mines and the mill site will depend on the selection of Onek portal options, and will either tie into the Bellekeno Road via the new Keno City Bypass or into the existing Christal Creek and Duncan Creek Roads via the North Side Bypass. During construction of bypass roads, some project-related traffic from LQO expansion projects will travel through Keno City. While the majority of these routes are radio-controlled roads closed to public use, some areas of shared use exist.

3. Public vehicles on industrial roads.

Visitors and residents of the area travel on some roads that are being used and will be used by Project-related vehicles. Silver Trail Highway and Signpost Road are two of the main roads used to access Keno City and various tourist destinations.

The main hazards to the public from accidents or malfunctions at the current and proposed mines results from the storage of explosives and other hazardous materials on site. Keno residents have also mentioned concerns about system failure, fires, spills, mishandling of toxic substances and human exposure to these contaminants. As noted by Health Canada in their response to the project proposals, factors that can exacerbate the occurrence of on-site accidents include employee use of drugs or alcohol while working (YESAB document: 2011-0315-049).

### Current Knowledge of Mining Impacts

#### Transportation of workers to and from the site/camp

Although the increase in traffic from worker transport poses a theoretical increased risk of traffic collisions, Alexco's approach to worker transport (in which buses are used rather than individual worker vehicles) minimizes the risk of collisions occurring. Currently staff is bussed from the Mayo airport to Flat Creek camp using a 24-passenger bus. The bus service is contracted to Na Cho N'yak Dun Development Corporation. These trips occur every five days when charter flights arrive from Whitehorse. To travel from the camp at Elsa to the worksite, workers are transported along Silver Trail Highway from the camp at Elsa to either the mill site or the Bellekeno mine. With the proposed new mine operations at Onek and Lucky Queen, the number of bus trips from the Mayo airport will increase as will the number of trips between Elsa (camp location) and the various mine sites; however as previously stated, the use of buses rather than individual vehicles minimizes additional traffic on the road and therefore risk of traffic collisions.

#### Work trucks on public roads

Traffic estimates for the Bellekeno, Lucky Queen and Onek mines were presented in project proposal documents submitted by Alexco and are presented in Table 16. Currently, project-related traffic from Bellekeno Mine to the mill flows along the Bellekeno Bypass Road, which runs along the south edge of Keno City. With the addition of the LQO expansion, project-related traffic is estimated to increase according to the project proposal, mainly with the use of smaller 15-tonne haul trucks at Lucky Queen and Onek mines so that they are able to travel on Silver Trail Highway and Wernecke Road. This increase in traffic also includes other project-related traffic for the additional two mines.

**Table 16: Estimated Traffic Volumes for Current and Proposed Mines During Operations**

Vehicle Type	Average Estimated Traffic Volumes (round trips/week)		
	Bellekeno	Lucky Queen	Onek
Light truck (< 1 ton) and autos	22	6	6
Buses	4	4	4
Heavy trucks (> 5 ton) bulk materials	6	2	2
Ore trucks (> 20 ton)	12	0	0
Light ore trucks (< 20 ton)	0	15	25
<b>Round trip total</b>	<b>44</b>	<b>27</b>	<b>37</b>

Source: Keno Hill Silver District Operations Lucky Queen and Onek Deposit Production Project Proposal Submission to YESAB, April 2012.

During the construction phase of the LQO expansion, the Keno City Bypass Road will be developed so that project-related traffic from the Onek and Lucky Queen Mines will be able to bypass Keno City. The north section of the Keno City Bypass road will follow the historic Onek power line, cross over Signpost Road and eventually link up to Wernecke Road. The south section will extend from the Onek 990 portal and join up with the Bellekeno Haul Road. This road will be radio-controlled and open to mine traffic only. To prevent public access, signs will be posted at both ends prohibiting public traffic from traveling on the road. The maximum speed limit will be 40 km/hr and 20 km/hr at blind corners and road crossings to reduce the risk of fatal injuries. Signs will be installed warning other drivers of crossing and turning mine vehicles. Stop signs will also be installed at the intersections of Sign Post Road, Wernecke Road, Lightning Creek Road and the Silver Trail Highway.

The Keno City Bypass would require a bridge to be built across Lightning Creek. During the construction of the bridge (expected to last 4-5 months) project-related traffic will be routed through Keno City. Estimated traffic volumes during this time period are 114 round-trips per week (Table 17)

Haul trucks will only be operational during the daytime shift (7am to 7pm). In the summertime this will result in all truck traffic traveling during daylight hours; however, in the winter months, daylight hours are limited meaning that much of this truck travel will be occurring at night (daylight on Dec 20 2012 is from 10:09am – 3:47pm) which may increase risk of collisions.

**Table 17: Estimated Traffic Volumes Through Keno City During Bypass Road Construction**

Vehicle Type	(Average Estimated Traffic Volumes round trips/week)
Light Truck	95
Water truck	3
Sewage truck	3
Semi trailer loads (mining equipment, building supplies, construction equipment, etc.)	6
Grader	2
Dump truck(hauling P-AML waste rock to Onek WRSF)	5
<b>TOTAL</b>	<b>114</b>

Sources: Alexco Keno Hill Mining Corp. 2012. Keno Hill Silver District Operations Lucky Queen and Onek Deposit Production Project Proposal Submission to YESAB - Revised version *and* Alexco Keno Hill Mining Corp. 2012. Onek Deposit Production Onek 990 Portal Option & Keno City Bypass Road (YESAB documents: 2011-0315-032; 2011-0315-095).

#### Public vehicles on industrial roads

Although most of the bypass roads and haul roads are radio-controlled and private access, there are a few sections of shared use where public vehicles and industrial traffic occupy the same roads. These include the Silver Trail between Mayo and Elsa and between Elsa and the Christal Lake Road. In the immediate vicinity of Keno City, shared roads include:

1. Wernecke Road north of the Bypass (either the North Bypass Road or Keno City Bypass, depending on portal choice).
2. Crossing at Signpost Road (Keno City Bypass only)
3. Crossing of Duncan Creek Road and Bellekeno Haul Road
4. Bellekeno Haul Road & road to Sourdough Hill

Most residents and visitors to the area use the Silver Trail Highway to access Keno City and other destinations. The Signpost viewpoint and popular interpretive hiking trails are also accessed by Signpost Road (Tourism and Culture, May 4, 2012; YESAB document: 2011-0315-062).

#### Accidents and malfunctions

As stated above, stakeholder concerns around accidents and malfunctions centre around system failure, fires, explosions, spills, mishandling of toxic substances and human exposure to contaminants.

Explosives are used at all three mines. Use, handling, storage, transportation and disposal of explosives are governed by the Yukon Occupational Health and Safety Act Blasting Regulations and Occupational Health & Safety Regulations, and the Transport of Dangerous Goods Act and Regulations. Alexco's proposal specifies a number of safety-related protocols that are intended to minimize the risk of harm, including: all new employees are required to have a site-wide and safety orientation and another underground safety orientation before starting work; regular safety meetings are held with supervisors, safety officers and employees, as required by OH&S safety regulations; all contractors and Alexco staff must adhere to Yukon OH&S regulations as well as internal policies of Alexco or contractors (Alexco Keno Hill Mining Corp. 2012). Strict adherence to these and other safety protocols will help minimize the risk of accidents and malfunctions from occurring. A well-developed disaster preparedness plan will also help to reduce the impact to the public should an accident or malfunction arise.

Drug and alcohol use by employees while on the job increases the risk of accidents and injuries. Although most workers will be staying at the camp in Elsa, which is a dry camp, some workers reside in Keno City or Mayo and this number is expected to increase with the LQO expansion. Easier or more frequent access to town will result in workers having easier access to alcohol and drugs. Nevertheless, all Alexco mine employees are required to undergo pre-employment medical exams, including drug and alcohol tests. Company policy specifies that workers will also be tested for drug and alcohol use with cause at any time during their employment with positive drug testing resulting in dismissal. Enforcement of these measures will help to reduce risk of alcohol or drug use and resulting occupational accidents.

### Summary of the Potential Effect

In the study area, there are relatively low volumes of traffic; in addition, traffic collisions and injuries are rare events. Therefore, while the risk of traffic-related injury does increase with present and proposed mining activity, there is a low likelihood that a traffic-related injury will occur. However, certain aspects of the study area, such as the mixed-use industrial roads and rural highways, exacerbate the risk beyond the increase in volume alone. The YESAA LQO Decision Document from September 7, 2012 (Yukon Government 2012) lists a number of terms and conditions that will improve traffic safety and minimize risk. Strong attention to this issue by Alexco and other mining companies working in the area is imperative.

Concern has also been expressed by a number of local residents over the possibility for accidents or malfunctions at the mine site that could affect public health or safety. While this risk is also very low, attention to worker safety and enforcement of worker drug and alcohol policies will additionally minimize risk.

Table 18 summarizes the potential effects to the community from the injury pathways outlined above.

**Table 18: Summary of Risk to Community Health from Injury**

Significance Criteria	Description
Direction	<b>Adverse</b> - <i>An adverse or undesirable change</i>
Severity	<b>High</b> - <i>Has the potential to cause acute, chronic, or permanent effects that are potentially disabling or life threatening</i>
Duration	<b>Persistent</b> - <i>Has the potential to last for the duration of mining activity</i>
Likelihood	<b>Possible</b> - <i>Evidence suggests that effects do occur, but are infrequent in this setting</i>

### Recommended Additional Mitigation Measures

Standard occupational health and safety procedures regarding the use and storage of dangerous materials should be sufficient to minimize the risk of injury to the public. Accidents involving any mining activity on or off company sites should be fully disclosed to public.

With regard to the shared use of roadways, all employers in the region should be required to operate vans or buses to transport workers to camp from outside the region and to and from the worksite.

As per the YESAA LQO Decision Document, project proponents must provide proper signage and ensure road safety measures will be maintained and enforced, with regular reporting of incidents and complaints to both regulators and the Keno City community.

Any substantive changes to patterns of use on shared roadways needs to be discussed with both Highways and Public Works and the local community. Industrial use of the roads within Keno City during construction or repair of bypass routes or bridges should be avoided.

## G. Emergency Medical Response

### Background

Emergency medical care comprises the network of ground and air ambulance, Emergency Medical Response (EMR) crews, acute care facilities and personnel that are required to respond to incidents in which someone requires urgent care for an injury or illness. The ability to access effective emergency medical care in a timely manner has been shown to have an impact on positive outcomes including survival. Access to emergency medical care is therefore an essential component of ensuring the health of the local population.

However, in rural and remote areas, emergency medical care can be distant and take time to reach. In addition, there is often limited capacity in terms of how many patients can be handled at one time; too many patients at once and the system can become overwhelmed, leading to poor outcomes for the patients as well as strain on other health care resources.

### Pathways Between Mining Activities and Health Effects

Although accidents are rare -- in one year of operation and 150,000 man-hours worked, the Bellekeno mine has gone without any Lost Time Accidents -- mining-related activities have the potential to cause situations where a small or a large number of people require emergency medical response. This could happen either from workplace injuries occurring onsite or from accidents resulting from project-related traffic. The most severe impact to emergency medical care would occur if a mine or road accident resulted in multiple critically injured persons, overstressing the capacity of the local emergency response system.

### Current Knowledge of Mining Impacts

The closest medical facility to the study area is the health centre located in Mayo, 68 km southwest of Keno City. The station has two full-time nurses and one part-time physician. The nursing station also has an ambulance and a staff of volunteer emergency medical personnel to assist in emergencies. The volunteers are trained to Emergency Medical Responder (EMR) standards. The clinic is open regular clinic hours with the nursing staff on call 24 hours a day. All serious illnesses/injuries are stabilized at the Mayo Health Clinic and flown out by air ambulance to Whitehorse.

At the project site, Alexco has emergency first aid responders who are able to provide care 24 hours a day to staff at the mining facilities. First aid staff is trained to industrial standards, meaning they are able to treat minor injuries and illnesses and stabilize any serious injuries. There are first aid rooms and two ambulances on the mine sites. Minor injuries at the work site are handled by Alexco's first aid staff. Any cases that are more serious are stabilized by the first aid staff and then sent by ground ambulance to Mayo for further treatment or for transfer to Whitehorse via air ambulance.

In discussions with the Mayo clinic staff, concern was expressed over the capacity of the Alexco first aid and Mayo ambulance services to handle a mining disaster or major trauma event. Access to the site is limited; air ambulance (fixed wing) lands at Mayo and any critically injured patients require transport from the accident scene to Mayo via ground ambulance or private helicopter. With only two ambulances on site and one located in Mayo, the capacity for handling multiple trauma is limited. It is likely that more than two major injuries at one time would significantly strain local capacity.

### Summary of the Potential Effect

Accidents, malfunctions or other incidents that would require the involvement of local emergency medical response is rare, but remain a constant possibility of mining-related activities. While the current capacity and protocols of local emergency medical responders are sufficient to handle an emergency involving only a small number of people, emergency medical response personnel have expressed concern over the capacity for on-site first aid and Mayo ambulance services to handle a mining disaster or a road accident involving in multiple critically injured persons. It is essential for Alexco and other regional mining operators to maintain updated emergency and disaster response plans that are coordinated with local emergency responders.

Table 19 summarizes the potential effects to the community from the emergency medical response pathways outlined above.

**Table 19: Summary of Risk to Community Health from Emergency Medical Response Availability**

Significance Criteria	Description
Direction	<b>Adverse</b> - <i>An adverse or undesirable change</i>
Severity	<b>Low</b> - <i>Has the potential to cause acute, short-term effects with limited and reversible effects on function, health or well-being</i>
Duration	<b>Persistent</b> - <i>Has the potential to last for the duration of mining activity</i>
Likelihood	<b>Possible</b> - <i>Evidence suggests that effects do occur but are infrequent in this setting</i>

### Recommended Additional Mitigation Measures

Disaster response plans for all industrial operators in the area should be available for public scrutiny and comment. As is currently required, all operators must share with local healthcare providers information regarding the use of dangerous or poisonous substances at industrial sites.

All operators must develop explicit plans regarding initial response, triage, communication and transport of casualties in the event of medical emergencies. These plans should be developed in consultation with the nursing staff and ambulance services in Mayo. Emergency Medical Services in the Department of Community Services could provide a central coordinating role in any event resulting major injuries or multiple casualties. Site specific emergency response plans need to be coordinated and communicated with local providers, Whitehorse air ambulance services and the Emergency Measures Organization.

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