Giant Mine: Historical Summary

John Sandlos and Arn Keeling, Memorial University

August 8, 2012

Giant Mine: Historical Summary

Author Affiliation

John Sandlos
Associate Professor
Department of History
Memorial University
St. John's, NL
A1C 5S7
709-864-2429
jsandlos@mun.ca

Arn Keeling
Associate Professor
Department of Geography
Memorial University
St. John's, NL
A1B 3X9
709-864-7499
akeeling@mun.ca

Author Background: The Abandoned Mines Project

Since 2009, the research project, Abandoned Mines in Northern Canada, has studied historical social, environmental, and economic impacts of historic mines on Aboriginal communities in northern Canada. The work has been funded by the Social Sciences and Humanities Research Council of Canada and conducted by independent scholars based primarily in the Departments of History and Geography at Memorial University, with co-investigators at the Universities of Winnipeg and Manitoba. Our research has focused on the study of archival documents and oral history research related to five major case studies:

- Giant Mine, NWT;
- Port Radium/Eastern Great Bear Lake District, NWT;
- Pine Point Mine, NWT;
- Keno Hill Silver District, YK;
- Labrador/Quebec Iron-ore District.

In 2010 we received funding to expand our research to cases studies in the Arctic region such as Rankin Inlet, Polaris Mine, Nanisivik, Meadowbank and others.

Table of Contents

Executive Summary

This report examines the history of arsenic pollution from Giant Yellowknife Gold Mine, and its environmental and public health impacts. It is based on extensive archival research in national and territorial archives, as well as oral histories (published and unpublished) and a review of public reports on the issue.

Operating from 1948 to 2004, Giant Mine produced over 7 million ounces of gold mined from arsenopyrite ore formations located on the north shore of Yellowknife Bay. Gold processing entailed roasting the ore, producing as a byproduct arsenic trioxide dust, a highly toxic form of arsenic. In the early 1950s, arsenic emissions from Giant and Con mines totalled an estimated 22,000 lbs. per day. Though Con mine installed a scrubber in 1949, Giant mine (the source of most of the arsenic) did not install pollution control equipment until the end of 1951, after a Dene child died of acute arsenic poisoning at Latham Island. Local livestock also died as from arsenic poisoning. Government and mine officials met at the time to discuss how to address the problem of arsenic pollution, but never contemplated even a temporary shutdown of the mine.

The capture of arsenic using a Cottrell Electrostatic Precipitator reduced but did not eliminate arsenic. Collection rates were further improved by the installation of a baghouse in 1958. Studies undertaken through the 1950s and 1960s revealed persistent high levels of arsenic on local produce and berries. Concerns remained about water pollution from both atmospheric deposition and arsenic- and cyanide-laced tailings effluent. The collection of arsenic, , also resulted in the fateful decision to store arsenic trioxide dust in underground chambers and mined-out stopes. Today, the 237,000 tonnes of arsenic trioxide underground at Giant remains the central environmental challenge for the reclamation and remediation of the site.

Public health studies undertaken in the 1960s suggested a possible link between arsenic exposure and elevated cancer rates in Yellowknife, but these studies were not made public until the 1970s. A series of independent and government studies followed these revelations as public concern mounted over the health effects of long-term arsenic exposure. Further reductions in arsenic emissions from Giant were achieved, and the mine constructed a tailings effluent treatment system in 1981. While local activists raised concerns about sulphur dioxide and arsenic emissions in the early 1990s, territorial government studies concluded these emissions did not pose a public health risk.

For the Yellowknives Dene First Nation in particular, memories of mine development and subsequent arsenic pollution of their traditional lands are painful. Some Dene worked at the mine, but the communities of Ndilo and Dettah saw few benefits from the mines overall. Yet these communities, due to their location in relation to Giant, were on the front line of arsenic exposure over the half-century ofits operation. The Yellowknives Dene not only suffered disproportional health impacts from arsenic pollution, but also the loss of harvesting areas due to the appropriation of land for the mining operations and urban growth in the city of Yellowknife.

Arsenic and Giant Mine Timeline

1935	Government geologists identify gold-bearing formations on west side of Yellowknife Bay, and staking rush ensues. Original 'Giant' gold claims staked by Johnny Baker.
1936	Con, Rycon and Negus gold claims staked by Consolidated Mining and Smelting Ltd. (CM&S). Initial development work on Giant claims by subsidiary of Bear Explorations and Radium Ltd. Supercrest claims staked and exploration undertaken by Akaitcho Yellowknife Gold Mines. These claims did not become productive until acquired by GYGM in 1965.
1937	Giant Yellowknife Gold Mines Ltd. (GYGM) incorporated. Underground drilling undertaken on Giant claims by CM&S under option agreement.
1938	Con-Rycon Mine begins production.
1939	Negus Mine begins production. In 1953, Negus merged with Con Mine.
1942	Con constructs roasting facility and begins roasting arsenopyrite ore.
1943	Giant property acquired by Frobisher Explorations, subsidiary of Ventures Ltd. Con Mine ceases production due to wartime restrictions.
1948	Giant begins gold production; Con resumes production.
1949	Roasting facility opens at Giant.
1949-53	Estimated 22,000 lbs. per day of arsenic trioxide emitted by Giant and Con roasters.
1949	Scrubber (impinger) installed at Con to reduce emissions.
1950-51	Reports of livestock deaths due to arsenic poisoning.
April 1951	Death of Dene boy by acute arsenic poisoning.
June 1951	Meeting of government and Giant Mine officials to discuss pollution control. Adoption of safe threshold level value of arsenic in drinking water of 0.05 parts per million (ppm).
October 1951	Installation of Cottrell Electrostatic Precipitator (ESP) for emissions control at Giant Mine.
1951	Underground storage of recovered arsenic trioxide dust at Giant Mine begins.
1954-58	Reduction of total Yellowknife arsenic emissions to an estimated 7250 lbs. per day.
1951-1960	Monitoring by federal Industrial Health Laboratory of arsenic contamination of Yellowknife water and vegetables.
1958	Installation of baghouse at Giant roasting plant for further arsenic recovery.
1965	Renewed concern over arsenic after high levels found on local vegetables and in local water.
December 1969	Relocation of Yellowknife city water intake to Yellowknife River from Back Bay.

1966-69	Epidemiological study by Dr. A.J. DeVillers. Results not made public until 1975.
1974	Three uncontrolled releases of Giant tailings into Back Bay. Subsequent Environmental Protection Service studies reveal widespread contamination by arsenic of Baker Creek, Back Bay and Yellowknife Bay.
1975	Federal public health studies, including hair and urine sampling, undertaken in Yellowknife, concludes mill workers main at-risk group.
1977	Independent study by National Indian Brotherhood, United Steelworkers and University of Toronto's Institute for Environmental Studies released. High arsenic levels found in mill workers and Aboriginal children.
1977	Canadian Public Health Association Task Force on Arsenic struck in response to arsenic controversy. Report downplays public health threat of arsenic exposure.
1977	Release by National Indian Brotherhood of documents revealing government scientists' concerns with long-term security of arsenic stored underground, dating back to 1973.
1979	Further reductions of arsenic emissions from Giant to 29 lbs per day.
1981	Giant Mine tailings effluent treatment constructed.
1991-93	In response to a request under the NWT *Environmental Rights Act*, territorial government studies sulphur dioxide and arsenic emissions from Giant. Concludes airborne arsenic levels below Ontario standard.
1990s	Studies begun regarding mine closure options relating to permanent storage of underground arsenic trioxide.
1995	Testimony by Yellowknives Dene elders before hearings on *Canadian Environmental Protection Act*.
1999	Royal Oak Mines, Ltd., owner of Giant Mine since 1990, files for bankruptcy. Giant Mine rights sold by Indian and Northern Affairs, with environmental liabilities severed, to Miramar Mining. Ore processed at Con.
2004	Giant Mine closes.

Overview

This report will provide an overview of detailed and extensive research on the history of Giant Mine, with a focus on the issue of arsenic pollution. The report's lead authors have conducted extensive archival research on the history of the mine at the Library and Archives Canada and the Prince of Wales Northern Heritage Centre in Yellowknife. We have also conducted oral history interviews with 11 elders in Dettah and Ndilo, working in partnership with the Goyatiko Language Society. Finally, we have gathered an extensive collection of reports and newspaper articles from various libraries and digital archives. This work was conducted as part of general research for the Abandoned Mines in Northern Canada Project (funded by the Social Sciences and Humanities Research Council and others – see http://www.abandonedminesnc.com/), and specifically for a chapter in a book titled, *Mining North America: An Environmental History*, currently under contract to the University of California Press. We have submitted a full draft of the chapter to the book editors, but the work has not undergone peer review, and thus at this point our findings must be regarded as preliminary. We were asked whether we could summarize our research to date to provide an historical overview that could contribute to the ongoing environmental assessment of the Giant Mine Remediation Project. We hope our work leads to a better understanding of the history of the site and how it was regulated by government authorities.

Arsenic and Gold Mining in the Yellowknife Bay Area

In 1936 the Canadian mining giant Consolidated Mining and Smelting Company (CM&S, later Cominco) staked claims along the shores of Yellowknife Bay and opened Con Mine in 1938. One year later, Negus Mines Ltd. opened its namesake mine next to the Con Property. After a lengthy period of exploration and development in the late 1930s, Giant Mine on the north shore of Yellowknife Bay was brought into full production in May 1948 by a subsidiary of Ventures Ltd.[1]

Arsenic pollution did not present a problem in the earliest years of production at Con and Negus. The two companies processed the initial ore bodies targeted for exploitation using the standard process of dissolving the gold in cyanide and separating the surrounding waste rock. In 1940, however, Con discovered ore within arsenopyrite rock formations, a type of refractory ore that resists cyanidation due to the presence of sulfides, and which must be roasted at high temperatures to burn off the sulfur. The process of roasting refractory ore oxidizes the arsenic in the rock, producing the highly toxic compound arsenic trioxide (in addition to sulfur dioxide). In March 1942 Con Mine completed construction of a roasting facility, but very little documentation exists on the impact of this early period of arsenic air pollution. We do know that Con produced arsenic pollution for only a very short time at this initial phase of production; wartime restrictions on gold production forced a shutdown of the roaster in November 1942.[2]

The resumption of roasting operations at Con in 1948 and the commencement of roasting at Giant in 1949 produced a dramatic increase in arsenic pollution in the Yellowknife area. Although there was no formal monitoring during this period, a report from the 1960s used ore production figures to estimate that Con and Giant produced an average of 22,000 pounds per day of arsenic trioxide dust between 1949 and 1953. Emissions at Giant Mine accounted for most of this daily total (about 16,500 pounds per day) because all of the ore processed at the mine was contained in refractory

arsenopyrite formations, while at Con only 20 percent of the ore required roasting. At this early production phase, neither mine installed any form of emissions control on their roasters, even though arsenic was widely known as an industrial poison and the technology for stack emission abatement (the Cottrell Electrostatic Precipitator) had been invented in 1907. Con Mine operated from 1948-49 and Giant from 1948-51 with no pollution control installed on their roasting stacks.[3] At the early development stage of Giant Mine, government officials expressed some concern about the potential for arsenic pollution in air and water, but suggested that well-built tailing impoundments and roaster stack of sufficient height would eliminate the danger from arsenic trioxide dust (and sulfur dioxide).[4]

Environmental and Health Impacts

The human health impacts of arsenic are varied and dependent on the dose. Arsenic trioxide kills human beings at minimum dose level ranging from 70-180 milligrams. Ingestion of dose levels below the lethal threshold produces a range of health effects: vomiting, diarrhea, muscle pain, skin rashes, burning sensations in extremities (parenthesias), thickening of the skin in hands and feet (keratosis). Lower dose exposure over a period of years may also produce black spots on the skin termed hyperpigmentation. Epidemiological studies of populations in South and Southeast Asia exposed to very low doses over long periods of time through ingestion of contaminated drinking water indicate that arsenic is a carcinogen, producing potentially fatal lung, liver, and bladder cancers. Currently the United States and Canada have a safe drinking water level of 0.01 parts per million (ppm), though studies suggest that a level of zero parts per million is the only reliable defense against the long term risk of cancer.[5]

The spread of arsenic trioxide from the Con and Giant roaster stacks undoubtedly posed a potential health hazard to humans and other biota living in the Yellowknife. Arsenic trioxide is soluble in water, and would have posed a health threat to organisms who drank from, and potentially those that lived in, streams, lakes and puddles contaminated by falling arsenic dust. In the winter months, generally October to May in Yellowknife, arsenic trioxide settled on snow. As the poisonous dust accumulated on the ground through the winter, arsenic levels would have risen dramatically in the absence of any rain to wash away the arsenic, posing an elevated threat to anyone eating the snow or using it as drinking water. In the spring, the accumulated arsenic in snow produced highly contaminated runoff, causing spikes in arsenic levels in the streams and lakes surrounding Yellowknife. In addition, archival documents suggest several spills and arsenic laden slurry and waster rock into Baker Creek, Great Slave Lake, Kam Lake, and other small bodies of water around Yellowknife. Arsenic trioxide dust also settled on local sources of food, especially berries and vegetables gathered or grown in the Yellowknife area.[6]

Arsenic pollution proved dangerous, even deadly for the Yellowknives Dene in the earliest years of Giant Mine. Although Yellownife residents were also exposed to arsenic in their water supply (see below), Native communities were at far greater risk because of their location in proximity to the roasting facility and the fact that residents relied on polluted snow and lake water and lake water for their drinking needs. At a meeting of government officials held in June 1951 to assess the arsenic situation, the minutes suggest that inspectors of the Department of Resources and Development

had noticed large concentrations of arsenic in snow in the Yellownife area, "particularly at the northern end of Latham Island."[7]

In April 1951, arsenic deposition from the gold mines killed a two year old Yellowknives Dene boy on Latham Island (today's Ndlio). A coroner's inquest ruled that the boy had died from "acute gastroenteritis caused by arsenical poisoning administered by unknown means."[8] Subsequent reports clarified the precise cause of death. I.F. Kirkby, the Superintendent of Indian Affairs, reported that the boy had died from contaminated drinking water.[9] Giant Yellowknife Gold Mines, Ltd. provided the family with $750 for the loss of their son.[10]

Beyond April 1951, it is not clear from existing records how many other Yellowknives Dene were sickened by arsenic. Nonetheless, a memo from P.E. Moore, Director of Indian Health Services from November 1953 describes one additional possible case associated with an "indigent Indian." In 1977 O. Schaefer, a Yellowknife doctor, recalled treating a "middle aged Indian" in winter 1957-58 for keratosis, hyperpigmentation, anemia and parenthesias.[11]

Local officials did make some attempt to warn people of the dangers from arsenic. Dr. O.L. Stanton, the Yellowknife Medical Health Officer, placed small advertisements in back pages of six issues of the local paper (*News of the North*) in 1951 and signs around the area warning people to be cautious with their use of water during spring runoff. The local media did not mention the death of the Dene boy, and did not run any stories on the issue of arsenic contamination in 1951.[12] Barriers of literacy and language likely reduced the effectiveness of the local advertising campaign.[13] The Yellowknife Indian Agent claimed he had previously warned the local Chief of the arsenic danger, but government officials at the June 1951 meeting suggested that, "in spite of these precautions certain Indians living on the north end of Latham Island used the water in the vicinity, with the result that a number of them had to be given hospital treatment and one died."[14]

However effective these warnings might have been, the Yellowknives Dene had no option but to get drinking water from local sources. Piped or trucked water was unavailable in Native settlements until long after this service was provided to Yellowknife proper in the 1940s.[15] Without comprehensive water testing and warning regimes, programs that developed slowly and intermittently (see below), it would have been almost impossible to determine which local sources of water were safe or dangerous, especially since arsenic in its soluble form is a tasteless and odourless substance.

The severity of arsenic pollution around Yellowknife can also be traced through impacts on non-humans. Several Yellowknives Dene have told stories about sled dogs, cattle and chickens dying from drinking arsenic-laden water.[16] In an oral history collection, Yellowknife resident Laurie Cinnamon recalled that her father's horse team, used for hauling cordwood, died in spring 1950 because it "got arsenic poisoning from drinking the spring run-off water lying about in puddles."[17] Similarly, Barbara Bromley remembers that milk deliveries from Collus and Veta Bevan's small farm came to an end in 1951 because, "they [the cows] died and I think he had an investigation and stated that they were poisoned by arsenic and that Cominco was to blame. I don't remember the outcome, although I believe there was a court case. So after that we didn't have the fresh milk every day."[18] Helen Kilkenny, a farmhand at the Bevan's from 1947-51, similarly describes the "hard luck"

that plagued the farm due to arsenic: "we watered the cows from Kam Lake about 500 yards from the barn. In winter we would cut a hole in the ice for the cows to drink. In the summer the cows would feed along the road and in the grassy places in the rocks. But after four years the cows got arsenic poisoning and they all died."[19] The incident raises further questions about the effectiveness of warning signs and advertisements, as government officials clearly identified Kam Lake as an arsenic hot spot at the June 1951 meeting, a situation that CM&S officials had admitted arose because they had previously dumped arsenic laden slurry from their stack scrubbers directly into Pud Lake, a body of water that drained directly into Kam. The fact that a local farmer deliberately cut holes to water his cattle in water system that industry and government officials knew was contaminated suggests an inadequate warning system for all people living in the Yellowknife area.[20]

Public Health and Mitigation: 1950s and 1960s

At the previously mentioned meeting of government officials in June 1951, A.K. Muir, General Manager and A.C. Callow, Giant Yellowknife's Secretary Treasurer, met with a dozen bureaucrats in Ottawa to form a response to the arsenic issue. The meeting participants developed a three-pronged approach to mitigating arsenic impacts:

- continuation of the public information campaign warning about the dangers of consuming local water, fruit and vegetables;
- a stepped up program of testing and monitoring of public water and food sources as well as urine samples from humans;
- the installation of pollution control technology on the Con and Giant stacks (a Cottrell Electrostatic Precipitator). [21]

Remarkably, however, Muir reported that his company had not yet installed the precipitator at Giant Mine due to shipping delays. At the meeting and in subsequent correspondence, government officials expressed only mild concern; G.E.B. Sinclair, Director of the Northern Administration and Lands Branch, later merely requested that Muir "expedite" the installation of the pollution control equipment.[22] Muir promised that the unit would be up and running by the summer, but the Cottrell ESP was not operational until October 29, 1951.[23] Thus, Giant Mine was permitted to operate full tilt for more than six months with no pollution control equipment on a roaster stack that had poisoned a small boy to death and sickened an unknown number of his fellow community members.

Giant Mine's Cottrell ESP was not initially a particularly effective form of pollution control on its own, permitting thousands of tons of arsenic dust fallout to spread over the Yellowknife area until the late 1950s. Furthermore, there was no testing of roaster emissions until 1954, a monitoring procedure one would think of as essential to the arsenic control program. Tests from 1954-58 revealed a relatively large percentage reduction in total Yellowknife arsenic emissions, from an estimated 22,000 lbs. to 7250 lbs. per day, due to the installation of a second Cottrell ESP, but in absolute terms a large amount of toxic material was still being loaded into the local environment. No doubt the majority of these emissions originated with Giant Mine: the Con impinger removed 85% of arsenic from roaster smoke, and in any case Con processed lower amounts of arsenopyrite ore (as noted above). The installation of a baghouse at Giant in 1958 (a secondary treatment

method that captured arsenic dust in a large filter) resulted in a much more dramatic absolute reduction in total arsenic arsenic emissions to 695 lbs. per day.[24]

In addition to pollution control, the federal government continued to monitor the impact of arsenic on water and food supplies in the region throughout the 1950s and 1960s. Dr. Kingsley Kay, Chief of the federal government's Industrial Health Laboratory, led a survey team to Yellowknife to conduct water and vegetable testing in the fall of 1951; the archives contain results from ongoing monitoring to 1960.[25] Federal officials had adopted the Canadian standard of 0.05 ppm as the concentration of arsenic considered a safe threshold level for drinking water (five times the current threshold level in Canada). If higher concentrations were detected, warning signs would be posted around the contaminated body of water. [26]

Current assessment of 0.05 ppm as a lax standard certainly benefits from hindsight derived from current knowledge about the health impacts of chronic long term exposure to arsenic. Regardless, the federal government's files on arsenic suggest a public health regime that was not even effective enough to protect tap water according to the standards of the day. One data sheet within the archival files shows two spikes above the arsenic threshold levels to 0.06 ppm in summer 1957 and 0.068 in summer 1959 in the Yellowknife's municipal tap water. A second data sheet shows spikes in city tap water to 0.07 ppm in summer 1957 and to 0.14 ppm in summer 1959 (the reason for the discrepancy with the previous result is not entirely clear, though likely they are results from different sampling stations). Two other data sheets revealed arsenic levels as high as 0.10 ppm for tap water at Con Mine and 0.25 ppm in the tap water at Giant Mine.[27] In other words, despite the strong rhetoric surrounding pollution control and public health after the crisis of 1951, roaster emissions and tailings spills from the mines into Back Bay resulted in the contamination of the Yellowknife (and mine) tap water supply to arsenic concentrations above an already inadequate threshold level. One retrospective report has suggested that the Yellowknife water supply contained arsenic levels above the acceptable limit of 0.05 ppm approximately 15% of the time between 1951 and 1960.[28]

Similarly, reports from the 1950s and 1960s on arsenic contamination of vegetables and grass samples revealed staggeringly high levels of arsenic contamination, with mean values ranging from 18 ppm to 2228 ppm over eight years, levels that federal officials acknowledged were many orders of magnitude greater than a United States Public Health Service recommended value of 1 ppm.[29] Clearly the installation of the Cottrell ESP at Giant Mine failed to prevent the ongoing arsenic contamination of food and water in the Yellowknife area through the 1950s, with tests merely confirming that status quo mining operations continued to poison local residents.

Federal and Yellowknife public health authorities seem to have adopted a relatively passive approach to the arsenic issue through the late 1950s and early 1960s. It is difficult to know if the relatively sparse correspondence on the issue during this period in the relevant archival files is due to gaps in the record base or complacency among government officials after the baghouse installation at Giant resulted in such dramatic reductions in arsenic emissions.

Public health officials nevertheless did begin to refocus on the issue in 1965. One official from Indian and Northern Health Services Division declared on December 10th, "I have recently discovered that

the problem of arsenic pollution at Yellowknife is far from solved," due to tests showing 40-50 ppm of arsenic on lettuce and cabbage leaves in the area and data showing the mines were still pumping out 300 to 400 pounds of the material each day.[30] At a meeting on December 10th, public health officials from across several divisions of the Department of National Health and Welfare declared that "a definite problem exists" and called for a study of the issue.[31] During the same period, Dr. G.C. Butler, the department's Regional Director, alerted Ottawa to the fact that local doctors were reporting high rates of anemia, an indicator for low-level arsenic poisoning, among female patients who had moved to Yellowknife more the four months previously.[32]

Arsenic contamination of the local water supply in Back Bay continued to be a concern through the 1960s. In September 1967 the health engineer P. Grainge of the Northern Health Service raised the possibility that current arsenic levels in Yellowknife's water could be carcinogenic, but Dr. H.A. Proctor, the Director General of Medical Services (Department of Heath and Welfare) suggested dismissively that the claim was based on one article from the United States, and "we are unwilling to assume, without some further evidence, that 0.1 ppm of arsenic in the water would be as toxic in a cold climate as in a warm one since in the former the water consumption per capita would be far less."[33] Dr. Butler, in turn, replied derisively to Proctor that Grainge had provided extensive references on the possible carcinogenic properties of arsenic, and northerners did tend to drink lots of water in the form of tea, coffee, and alcohol with a water mix.[34] Public officials could ultimately only solve the drinking water issue not through pollution control, but by moving the pipeline intake further upstream from pollution sources to the mouth of the Yellowknife River in December 1969.[35] This solution failed to help Native residents of Latham Island and Dettah, however, who either relied on trucked water or, if they could not afford it, continued to collect ice and water from the bay.[36]

Dr. A.J. de Villiers from the Biomedical Unit led a comprehensive study of the arsenic issue between 1966 and 1969, but information on results was not forthcoming until 1971, much to the continual frustration of Dr. Butler, who complained of making 20-30 requests for even an interim report through the late 1960s.[37] De Villiers blamed staffing issues on his slowness.[38]

Three years later, Dr. Butler managed to pry enough information from his department's arsenic survey to determine that rates of contamination on vegetables had declined, but were still in most cases 0.05 ppm to 3 ppm above the allowable limit of 1 ppm for foods. Butler threatened to commission an independent investigation of the arsenic situation from a university or a provincial government (one that might actually be completed), and warned he would issue a public statement informing Yellowknife residents not to eat locally grown vegetables, a move that was "likely to make headlines."[39]

Public Controversy: the 1970s

The perceptions of incompetency and secrecy surrounding the 1966 arsenic survey prompted a third wave of public concern about the issue in the 1970s. One measure of this concern is the large number of angry requests the federal government received for more information on the 1966 survey from the City of Yellowknife, the Indian Brotherhood of the Northwest Territories (a Native advocacy group), and the Canadian Broadcasting Corporation. In 1975 CBC radio's *As it Happens*

brought the issue to national attention by suggesting that the results of the de Villiers report had been suppressed, particularly sections pointing to high rates of lung cancer in Yellowknife due to long term arsenic exposure and the fact that some Yellowknife residents still used the water from Back Bay.[40] In response to the CBC story, Health Minister Marc Lalonde issued a statement in January 1975 claiming that the de Villiers report contained no data on links between arsenic and cancer rates in Yellowknife, but promising to conduct a study on arsenic rates in Yellowknife residents as a precaution.[41] The federal government proceeded with these public health studies in 1975, testing arsenic rates in human hair and urine samples and finding elevated levels only in mill workers at Giant Mine, results that public health officials interpreted as a minor localized workplace matter rather than a widespread health issue.[42]

Native and labour groups remained extremely doubtful about the government's claims, so much so that they proceeded to produce their own research on the issue. In 1975 the National Indian Brotherhood (NIB) expressed frustration that the federal government's voluntary arsenic survey included no Native people. The advocacy group conducted a small hair sampling study of 18 Native people in the Yellowknife area and arranged for the samples to be analyzed in a laboratory at the University of Toronto's Institute for Environmental Studies. Although high arsenic levels were found in samples from children, the government refused direct requests from the NIB to conduct testing on this seemingly at-risk group. In response, the NIB joined forces with the United Steelworkers Union and researchers at the University of Toronto to release a comprehensive hair study sample of all local Native children and the other at-risk group, Giant mill workers, in 1977. The results showed arsenic rates greater than 10 ppm in 30 percent of the study group and greater than 5 ppm in 50 percent of the samples tested. Robert Jervis, a Professor in the University of Toronto's Institute for Environmental Studies, issued a statement in January 1977 suggesting the results above 5 ppm were extremely rare in Canada, and that none of the samples collected from a control group study in Whitehorse showed arsenic levels above this level. In Jervis' analysis, the NIB and Steelworkers hair samples "clearly demonstrate a very high degree of exposure to arsenic for Indian children living at Yellowknife."[43]

Almost immediately after the NIB and the Steelworkers went public with their finding, the embattled Health Minister Marc Lalonde and his department's previous research efforts came under fire. Accusations of a cover-up persisted due to the department's failure to release a major environmental study of arsenic in the Yellowknife area completed in 1975, and the leaking of a confidential memo suggesting an impending recommendation for dramatic reductions in arsenic levels in air should be kept from the public "as it may cause undue concern."[44] In response to the mounting criticism, Lalonde ordered a new independent study be contracted to the non-profit Canadian Public Health Association (CPHA).[45] Much of the CPHA's work focused on urine samples from workers and local Native people. After extensive testing, the CPHA concluded that the impacts were largely confined to the workplace and levels in the general population remained below threshold safety levels. The CPHA final report recommended ongoing monitoring of arsenic levels, careful washing of vegetables and berries, and the trucking of water to Ndilo and Dettah in winter, with warnings to locals not to use snow as a source of drinking water as studies still indicated high levels of concentration in this source.[46]

If the CPHA report reinforced the federal government's earlier claims that arsenic did not constitute a public health crisis, its release did not blunt criticism and concern. Dr. Hector Blejer, an occupational health expert from the United States who had been appointed as advisor to the task force at the request of the Steelworkers and the NIB, suggested that the task force focused too narrowly on the threat from short term arsenic poisoning while ignoring the increasingly well established lung and skin cancer threat from long term chronic exposure.[47] The final task force report ignored these criticisms, but the NIB and Steelworkers applied them liberally in public comments, questioning the idea that arsenic levels in Yellowknife were safe because, as Dr. Blejer had suggested, safe levels simply do not exist for substances that cause cancer.[48]

Studies by the federal Environmental Protection Service in the 1970s fingered contaminated effluent from Giant tailings ponds as a key source of arsenic pollution in Back Bay. Several uncontrolled releases of effluent in 1974, as well as ongoing seepage from tailings ponds, spurred studies that showed continued elevated levels of arsenic, heavy metals, and in some cases cyanide in Baker Creek and Yellowknife Bay, especially in the vicinity of Latham Island.[49] These arsenic contaminated sediments in Yellowknife Bay, affected benthic organisms up to 3 km from mouth of Baker Creek.[50]

Further Reductions in the 1980s

The arsenic issue at Yellowknife faded from public prominence in the 1980s. Official voices had declared that arsenic levels at Yellowknife were safe, while improvements to the arsenic collection technology for water and air emissions produced further dramatic reductions in pollution. At Giant Mine, stack emission fell dramatically from 850 lbs. per day in 1973 to 29 lbs. per day in 1979.[51] The result was a marked decline in arsenic in the local environment, with one study suggesting an 80% drop in arsenic trioxide in snow core samples from 1976 to 1986.[52] This, combined with improvements to tailings storage and treatment (including the construction of an effluent treatment plant at Giant in 1981),[53] suggest that after nearly three decades the federal government had finally mitigated the problem of acute arsenic pollution problems in Yellowknife. Concerns about arsenic resurfaced in the 1990s, however, when Yellowknife environmental activists Chris O'Brien and Kevin O'Reilly requested an investigation of the environmental and health impacts of arsenic and sulphur dioxide from Giant Mine under the NWT *Environmental Right Act*, focusing in particular on the fact that regulators were permitting a known carcinogen to be emitted in proximity to an urban area. Although the subsequent investigation concluded that emissions were well within safe limits, the arsenic air pollution issue at Yellowknife was not fully resolved until the closure of Giant Mine in 2004.[54]

The Adoption of Underground Storage

Officials from Giant Mine and the federal government chose the underground storage method for arsenic because they favoured this 'dry' method over the 'wet' method of mitigation and storage that Con Mine had implemented. Indeed, federal officials heavily criticized the impinger (or

scrubber) method of pollution control CM&S had developed, noting that that because the technology was based on cleaning the arsenic gas with water spray, the resulting contaminated slurry might leak from containment ponds and pollute local water sources, including Great Slave Lake. Government officials, along with Chief Medical Officer Stanton, were unanimous that Giant's proposed approach—the installation of a Cottrell electrostatic precipitator with the storage of dry arsenic underground—was much preferred to Con's wet method.[55]

Giant manager A.K. Muir and several government officials were confident that arsenic trioxide dust deposited underground would be contained as permafrost became reestablished in the mine, even if Muir suggested that cold air might have to be pumped in to counteract the heat rising from deeper tunnels.[56] Even before closure, as the mine was winding down operations, it quickly became apparent that permafrost was not reestablishing itself and the water table was rising inevitably toward the chambers containing 237,000 tons of arsenic dust. Government memoranda obtained by the National Indian Brotherhood in the 1970s revealed mounting concern about potential for the mobilization of this highly toxic stored arsenic in groundwater if permafrost never re-established itself.[57]

Arsenic and the Yellowknives Dene

Primary sources tracking Native reactions to the introduction of mining to Yellowknife in the 1930s and subsequent issues with arsenic are difficult to track down as the archival record belongs exclusively to the voices of government and mine company officials. Nonetheless, publicly available sources such as a Yellownives Dene Community History and set of hearing transcripts on revisions to the *Canadian Environmental Protection Act* (CEPA) from 1995, offer a clearer window into the historical impacts of Giant Mine on the Yellowknives Dene. *Currently we are in the process of developing translated transcripts for oral history interviews conducted in partnership with the Goyatiko Language Society, but we have not yet developed protocols for their public use. We can say that the oral history material echoes many of the historical themes outlined below.*

Many elders clearly see the mines as the central agent of colonialism in the Yellowknife region, a progenitor of social, economic and ecological changes that dramatically altered the Yellowknives' way of life based on hunting and trapping. At the 1995 CEPA hearings, elder Michel Paper described the Yellowknives way of life before the mine, and suggested how little contact the Yellowknives had with non-Native southerners:

> At that time, trapping was the way the people survived. Caribou was another source...by which the people survived. All the fish that were available were known by the people. The people lived a very healthy life by hunting for wildlife. All year long we would follow the caribou, and at that time we did not have to pay for wood. We did not pay for the food we gathered. We travelled by dog team only. When the firewood ran low in the camping area, we would move on to another place where there was plenty of wood. We did not pay for the firewood. That was the way our people lived in the past.

> In 1934-35 we heard news that the white people had arrived in the Yellowknife area. It was at Burwash Point. We travelled at night by dog team back to Yellowknife and we could see Burwash Point lit up from a distance. We heard that the white people had arrived, and we were afraid of them so we travelled back around the way of Dettah. At that time, the white people were also afraid of us.[58]

A community history prepared by the Yellowknives Elders Advisory Council in 1997, describes the impact of these new arrivals on patterns of subsistence in the local area:

> Explosions of dynamite by prospectors, air traffic, the development of a town and mines, the building of commercial fish plants, a prison, and roads, and the use of the land and waters for recreation. These developments contributed to the gradual withdrawal of moose and other animals, and to caribou changing their migration route through the area. In spring, Weledeh Yellownives Dene used to wait for caribou returning north where the Prince of Wales Northern Heritage Centre now sits on Frame Lake. Although now it is rare to see moose near the Weledeh, these animals used to be common and could be relied on by Weledeh Yellowknives for food and clothing.[59]

The Yellowknives were not passive in the face of such broad-scale changes. Paper and elder Isidore Tsetta suggested that they and 12-15 other Yellowknives Dene found work at the mines (often hauling lumber), but such adaptations to the new mining economy did not erase the deleterious impacts of the mines from the elders' memories.

Indeed, memories of the arsenic crisis of the early 1950s continue to be discussed widely in the communities of Dettah and Ndilo, forming the core narrative of the Yellowknives' encounter with the gold mines. The number of the dead and dates often vary according to the speaker (and may indicate that more fatalities occurred than the young boy described in the archival record). Regardless, the Yellowknives elders and community leaders continually point to the tragic death and sickness of the 1950s as the most profound injustice associated with the gold mines. At the 1995 hearings, then Chief Fred Sangris suggested

> The first case of death within our community came in 1959, when three children in the same family died in the Yellowknife Bay area. At that time, there was no adequate water delivery from either the government or DIAND. You had the responsibility to look after first nations, because there was that fiduciary obligation to do so. The family that lost the three children were compensated $1,000. That's all they were given. They were told, "Here, take the money, and forget about everything." Eventually, this person and his wife got into drinking because they couldn't deal with that. A lot of the first nations in this area did the same thing. One person mentioned here that they were powerless; yes, it's true.[60]

The community history produced by the Yellowknives' Elders Advisory Council tells the poisoning story in this way:

> The people were never warned about the impacts and risks of living near mines. In late December of 1949, a massive emission from the Giant mine dispersed huges amounts of of arsenic into the air, settling into the ice and snow. Melting snow in the spring of the following

> two years was so toxic that notices were printed in Yellowknife newspapers warning people not to drink or use the meltwater. Few Weledeh Yellowknives Dene could read the notices. Anyone who washed their hair with arsenic-laden meltwater in the next two springs went bald…. But the greatest tragedy occurred in spring 1951: four children in family camps in Ndilo died. The mine owners gave their parents some money, as if it could compensate for the loss. Women stopped picking medicine plants and berries, which used to grow thickly in the area of Giant mine. The people moved away, avoiding the mine area for some years, although it had once been so important to them.[61]

Isadore Tsetta suggested that that even in 1995 the Yellowknives remained wary of the dangers associated with subsistence activity on the land, a loss of an economic base for which the Yellowknives should be compensated:

> We do not know what to do with the contaminated water now. We cannot use the water now. After the land is spoiled, plants cannot grow in the contaminated soils. That is the situation with us now. If justice was done…we should be compensated somehow for the contaminated water. Giant Mines and Con Mines have ruined the water and we cannot use it any more. We were here first, before the white people arrived and the mining started. We all know how the land was.[62]

At a workshop on perpetual care held in 2011 (and organized by YKDFN and Alternatives North), Michel Paper suggested much the same idea when he said very simply, "people love the land but mining has changed the land and made it dangerous."[63]

Summary and Conclusions

- Giant and Con Mines both emitted large amounts of untreated arsenic dust from their roaster stacks, Con from 1948-49 and Giant from 1949 to 1951;
- Although efforts were made to control pollution from the two roaster stacks, reductions in arsenic emissions were incremental over time, leaving the Yellowknife population continually exposed to arsenic on food and in drinking water, with data from the 1950s and 1960s suggesting levels above accepted thresholds at the time;
- Native communities in the Yellowknife area, particularly the Yellowknives Dene of present-day Ndilo and Dettah, suffered sickness and at least one death in the early 1950s because of the concentration of arsenic trioxide in their supply of water (and the snow from which it was derived);
- The trucking of water to Ndilo and Dettah provided only a partial solution to the arsenic problem, as residents were forced to pay for delivery, often from meager welfare payments. The archival evidence suggests that many Native people continued to draw drinking water from polluted Back Bay. Giant Mine was never required to pay for the delivery of water to local Yellownives communities to replace the local supply that had been polluted;
- Epidemiological surveys from other regions suggest that the long term exposure to low levels of arsenic in drinking water supplies would have produced higher cancer rates in Yellowknife.

However, public health records from the 1970s suggest it was impossible to track long term health impacts on former residents of Yellowknife and employees of the mines because there was no way to find these individuals. To the best of our knowledge, no study exists on long term health impacts of arsenic pollution among the Yellowknives Dene;

- Many Yellownives Dene remember the advent of mining and arsenic pollution as central to their experience of colonialism and alienation from lands that had once supported them through subsistence hunting, trapping and gathering activities.

Notes

[1] For general overviews of mining development in northern Canada in the early to mid-twentieth centuries, see K.J. Rea, *The Political Economy of the Canadian North.* (Toronto: University of Toronto Press: 1968); Morris Zaslow, *The Northward Expansion of Canada, 1914-1967.* (Toronto: McClelland and Stewart, 1988); Liza Piper, *The Industrialization of Sub-Arctic Canada* (Vancouer: UBC Press, 2009). For details on early staking in the Yellowknife Bay area, see Ryan Silke, The Operational History of Mines in the Northwest Territories, Canada (self-published report, 2009). Information on the corporate structure and early development of Giant Mine was taken from a corporate historical pamphlet, titled simply Giant Yellowknife Mines Limited, found in the Giant Clippings File at the Prince of Wales Northern Heritage Centre (hereafter PWNHC), Yellowknife, NWT. According to this publication, Ventures merged with Falconbridge in 1962, placing Giant Yellowknife Mines, Ltd. under the control of one of Canada' largest mining companies at that time.

[2] For Con's early history, see Silke, Operational History, 115-118; For information on arsenic trioxide production in the roasting process, see Markus Stoeppler, *Hazardous Metals in the Environment* (Amsterdam: Elsevier, 1992), 289.

[3] For early emissions data and the unregulated nature of emissions from 1949-51, see A. J. de Villiers and P.M. Baker, *An Investigation of the Health Status of Inhabitants of Yellowknife, Northwest Territories, Occupational Health Division*, Environmental Health Directorate, Department of Health and Welfare (Ottawa, 1970), 3-5. Detailed emissions data was also contained in a correspondence from Dr. O. Schaefer, Northern Medical Research Unit to the A/Regional Director, Northern Region, National Health and Welfare, 4 November 1971. RG 29, vol. 2977, file 851-5-2, pt. 1, Library and Archives Canada (hereafter LAC). Details on the pollution control equipment at Con and Giant were found in W.H. Frost, Senior Medical Advisor, Medical Services Branch, National Health and Welfare, "Arsenic – Yellowknife," 28 October 1970. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC. The roasting process also produced emissions of sulphur dioxide, the impact of which is not well documented save for references to local respiratory problems among asthmatics in testimony from Yellowknives Chief Fred Sangris and Deh Cho Grand Chief Jim Antoine at hearings on the *Canadian Environmental Protection Act* in 1995. Fred Sangris and Gerry Antoine, Evidence, Parliamentary Hearings on *Canadian Environmental Protection Act*, 11 May 1995 http://www.parl.gc.ca/content/hoc/archives/committee/351/sust/evidence/122_95-05-11/sust122_blk-e.html#0.1.SUST122.000001.AA1040.A (accessed March 13, 2012). For broad background to the development of the Cottrell ESP, see Timothy LeCain, "The Limits of 'Eco-Efficiency': Arsenic Pollution and the Cottrell Electrical Precipitator in the U.S. Copper Smelting Industry," *Environmental History* 5, no. 3 (July 2000): 336-51.

[4] R.A. Gibson, Deputy Commissioner of the NWT to Fred Fraser, Mining Recorder, Yellowknife, 30 August 1946. RG 85, vol. 253, file 992-2, LAC.

[5] See Andrew Meharg, *Venomous Earth: How Arsenic Caused the World's Worst Mass Poisoning (*New York: MacMillan, 2005), 7-12

[6] A comprehensive overview of all these issues, including the prevalence of tailings spills, is contained in A. J. de Villiers and P.M. Baker, *An Investigation of the Health Status of Inhabitants of Yellowknife*, and a report authored by the Canadian Public Health Association, *Task Force on Arsenic – Final Report, Yellowknife Northwest Territories* (Ottawa: CPHA, 1977). The toxicity of these tailings overflows was documented in a federal Environmental Protection Service report, R.R. Wallace, M.J. Hardin and R.H. Weir, "Toxic Properties and Chemical Characteristics of Mining Effluents in the Northwest Territories," EPS Report no. EPS-5-NW-75-4, Department of the Environment, Feburary 1975.

[7] See Minutes of Meeting held to Discuss the Death of Indian Boy, Latham Island, 1 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[8] The information from the coroner's report was discussed at a meeting among government officials and two Giant Mine managers held in Ottawa June 1st, 1951 to discuss the fatality. The minutes are contained in the file RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[9] Kirkby's assessment of the situation is summarized in a memo from Dr. M. Matas to Dr. H. Falconer, RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[10] A.K. Muir, General Manager, Giant Yellowknife Gold Mines, Ltd. to G.E.B. Sinclair, Director, Northern Administration and Lands Branch, Department of Resources and Development, no date. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[11] The specific references to skin conditions were found in a memo from Dr. O. Schaeffer to Dr. B. Wheatley, Environmental Contaminant Program, Medical Services Branch, Health and Welfare Canada, 1 May 1978. Prince of Wales Northern Heritage Centre (hereafter PWNHC), G-2008-028 Box 9, File 16.

[12] The advertisements appeared in on the following dates and pages numbers of *News of the North*: April 6 1951, pg. 6; April 13 1951, pg. 5; April 20 1951, pg. 5; July 6 1951; July 13 1951, pg. 6.

[13] A study produced in the 1970s by the National Indian Brotherhood (a Native advocacy group) claimed that warning signs about drinking water from Back Bay were not posted in local Native languages until Fall 1974. See Lloyd Tateryn, "Arsenic and Red Tape," National Indian Brotherhood, University of Alberta Library.

[14] See Minutes of Meeting held to Discuss the Death of Indian Boy, Latham Island, 1 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[15] See discussion of this issue in Tataryn, "Arsenic and Red Tape," 10-14.

[16] Yellowknives Dene First Nation, *Weledeh Yellowknives Dene: A History*, 54-55.

[17] Laurie Cinnamon, Oral Interview, *Yellowknife, NWT: An Illustrated History*, 85.

[18] Barbary Bromley, Oral Interview, *Yellowknife Tales: Sixty Years of Stories from Yellowknife*, 97-98.

[19] Helen Kilkenny, Oral Interview, *Yellowknife, NWT: An Illustrated History*, 114-15.

[20] Minutes of Meeting held to Discuss the Death of Indian Boy, Latham Island, 1 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC. See also K. Raht to W.G. Jewitt, Manager of Mines, CM&S, 28 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[21] Minutes of Meeting held to Discuss the Death of Indian Boy, Latham Island, 1 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[22] The reference to the request that Giant expedite installation of the Cottrell ESP is contained in a letter from Sinclair to S. Homulos, Mining Inspector, Yellowknife, 19 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[23] C.K. LeCapelain, Acting Director, Northern Administration and Lands Branch, to Muir, 14 August 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[24] For emissions data, see A. J. de Villiers and P.M. Baker, *An Investigation of the Health Status of Inhabitants of Yellowknife*. Reference to the second ESP and its impact on emissions was found in D.A. Gemmill, Yellowknife Environmental Survey, Summary Report, Environmental Protection Service , Department of the Environment (Ottawa, 1975), RG 29, vol. 2977, file 851-5-2, pt. 4, LAC. . Negus mine was permitted to construct an impinger using Con's "wet" scrubber technology, though the government preferred Giant's "dry" storage method. See Minutes, Meeting held in Room 101 of the Norlite Building to discuss the Arsenic Problem at Yellowknife as the Result of the Proposal of Negus Mines Limited to Commence Roasting Operations, 30 July 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC. Negus Mines constructed a roaster in November 1951 and the plant went into full operation in November 1952. Problems with the plant and the recovery of lower than expected ore grades resulted in the closure of the mine and the sale of all claims to Cominco in March 1953. See Silke, "Operational History of the Mines in the Northwest Territories of Canada," 316.

[25] Plans for the survey are laid out in a memo from Dr. Kingsley Kay, Chief, Industrial Health Laboratory to G.E.B. Sinclair, Director, Northern Administration and Lands Branch, 25 October, 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[26] See Minutes of Meeting held to Discuss the Death of Indian Boy, Latham Island, 1 June 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[27] The archival files contain two graphs displaying arsenic measurements from 1953-60 titled, "Arsenic in Townsite Tap Water, Yellowknife, N.W.T." Another is titled "Arsenic in Giant Tap Water, Yellowknife, N.W.T.," and also "Arsenic in Con Tap Water, Yellowknife, N.W.T.," 1953-60. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.

[28] Dr. O. Schaefer, Northern Medical Research Unity to the A/Regional Director, Northern Region, National Health and Welfare, 4 November 1971. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC. For background on liquid effluent in Back Bay, see Canadian Public Health Association, *Task Force on Arsenic – Final Report, Yellowknife Northwest Territories* (Ottawa: CPHA, 1977), 59-62.

[29] Data on contamination of vegetation is contained in, "Arsenic on Grasses in Yellowknife, 1954-61," and "Mean Values of Arsenic Yellowknife Vegetation, PPM," RG 29, vol. 2977, file 851-5-2, pt. 1, LAC. Mention of the US standard of 1 ppm is made in a memo from the coded M17 to Dr. Procter, 10 December 1965. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[30] M17 to Dr. Procter, 10 December 1965. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[31] The results of the meeting are reported in a memo from M17 to Dr. Procter, 20 December 1965. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[32] Mention of the anemia is made in memos from Dr. Butler, Regional Director, National Health and Welfare, to Dr. Frost, Director General, Medical Services, Ottawa, 24 August 1967 and 17 August 1967. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[33] Dr. H.A. Proctor, Director, Medical Services to Dr. E.A. Watkinson, Director, Health Services, 29 September 1967. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[34] Butler to Proctor, 30 October 1967. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[35] Canadian Public Health Association, *Task Force on Arsenic – Final Report,* 49-51.
[36] See discussion of this issue in Tataryn, "Arsenic and Red Tape," 10-14.
[37] Dr. G.C. Butler, Regional Director, Northern Region, to Director General, Medical Services, 9 June 1970. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[38] Dr. A.J. de Villers to E.A. Watkinson, Health Services Branch, 26 August 1969. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[39] Butler to Director General, Medical Services, 23 September 1970. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[40] For an overview of this third period of heightened public concern over arsenic, see F.J. Colvill, Senior Advisor, NWT Region, Arsenic in Yellowknife – A Perspective, 25 September 1979. G-2008-028, Box 9, File 17, PWNHC.
[41] Statement by the Honourable Marc Lalonde on Arsenic Pollution in Yellowknife, NWT, 9 January 1975. RG 29, vol. 2977, file 851-5-2, pt. 2, LAC. The de Villiers study concluded that there was evidence of skin rashes among those occupationally opposed to arsenic in Yellowknife, and also high rates of respiratory disease that could be linked to arsenic. But the report concluded that the links between arsenic and lung cancer were "uncertain." A. J. de Villiers and P.M. Baker, *An Investigation of the Health Status of Inhabitants of Yellowknife,* 10.
[42] R.D.P. Eaton, Analysis of Hair Arsenic Results, Yellowknife, 1975. G-2008-028, Box 9, file 17, PWNHC.
[43] Statement by Prof. Robert E. Jervis, Department of Chemical Engineering and Applied Chemistry, and Institute for Environmental Studies, re: Yellowknife Arsenic Pollution Problem, 15 January 1977, University of Alberta Library. See also report by Tataryn, "Arsenic and Red Tape," and "Document Released by the National Indian Brotherhood, the United Steelworkers of America, and the University of Toronto on January 15, 1977," unpublished manuscript, Canadian Circumpolar Institute Library. The federal government's Acting Director of the Environmental Contaminants program cited a consensus among some researchers the hair levels below 1 ppm indicated a person who was not exposed to arsenic, while others suggested anything below 5 ppm as a normal level for arsenic. See Brian Wheatley to L.M. Black, Director General, Program Management, 28 January 1977. RG 29 vol. 2977, file 851-5-2, pt. 4, LAC
[44] Editorial, "Ottawa Hides the Poison," *Globe and Mail*, 19 January 1977. See also Victor Malarek, "Yellowknife Arsenic Level 'Horrendously High,'" *Globe and Mail*, 17 January 1977; no author, "Private Study Shows Yellowknife Arsenic Level Dangerously High," *Edmonton Journal,* 17 January 1977. All clippings found in RG 29 vol. 2977, file 851-5-2, pt. 4, LAC. The report in question is the D.A. Gemmill, Yellowknife Environmental Survey, Summary Report, Environmental Protection Service , Department of the Environment (Ottawa, 1975), RG 29, vol. 2977, file 851-5-2, pt. 4, LAC.
[45] News Release, "Task Force to Study Arsenic," 18 January 1977. G-2008-028, Box 9, file 17, PWNHC.
[46] Canadian Public Health Association, *Task Force on Arsenic – Final Report, Yellowknife Northwest Territories* (Ottawa: CPHA, 1977).
[47] H.P. Blejer, Evaluation of Canadian Public Health Association Task Force on Arsenic Interim Report of May 1977. RG 29, vol. 2978, file 851-5-2, pt. B, LAC.
[48] Tateryn, "Arsenic and Red Tape." Paul Falkowski, Environmental and Occupational Health Representative, United Steelworkers of America, Presentation to the National Indian Brotherhood 8th Annual General Assembly, 14 September 1977. Unpublished transcript, University of Alberta Library.
[49] R.R. Wallace and M.J. Hardin, "Chemical and Biological Characteristics of Seepages from Tailings Areas at Giant Yellowknife Mines, Ltd., into Great Slave Lake, Northwest Territories, in 1974," EPS Report no. EPS-5-NW-74-1, Department of Environment, November 1974..
[50] R.R. Wallace, M.J. Hardin and R.H. Weir, "Toxic Properties and Chemical Characteristics of Mining Effluents in the Northwest Territories," EPS Report no. EPS-5-NW-75-4, Department of the Environment, Feburary 1975; J.W. Moore, S. J.

Wheeler, and D.J. Sutherland, "The Effects of Metal Mines on Aquatic Ecosystems in the Northwest Territories: II. Giant Yellowknife Mines, Ltd.," EPS Report no. EPS-5-NW-78-9, Fisheries and Environment Canada, June 1978;
[51] Associate General Director, Medical Services Branch to A/Regional Director, NWT Region, 11 October 1984. G-2008-028, Box 9, file 17, PWNHC.
[52] Lorne C. James, Pollution Control Officer, Department of Renewable Resources, Government of the Northwest Territories to Ranjit Soniassy, Northern Affairs Program, 23 June 1986. G-1993-006, Box 19, File 13 408 024, PWNHC.
[53] Indian and Northern Affairs Canada, *Giant Mine Remediation Plan* (prepared by Giant Mine Remediation Team, SRK Consulting and SENES Consulting), http://reviewboard.ca/upload/project_document/EA0809-001_Giant_Mine_Remediation_Plan_1328900464.pdf (accessed March 13, 2012), 14-15.
[54] Chris O'Brien and Kevin O'Reilly to Titus Allooloo, Minister of Renewable Resources, Government of the Northwest Territories, 22 April 1991. The results of the study are summarized in Allooloo to O'Reilly, 5 July 1993. For media coverage, see Editorial, "Report Fails to Clear the Air," Yellowknifer, 9 July 1993, p. 7. All correspondence and clippings from the private papers of Kevin O'Reilly.
[55] For Dr. Stanton's approval of the underground storage method, see his letter to G.E.B. Sinclair, Director, Northern Administration and Lands Branch, Department of Resources and Development, 27 February 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[56] Muir to G.E.B Sinclair, Director, Northern Administration and Lands Branch, 24 February 1951. RG 29, vol. 2977, file 851-5-2, pt. 1, LAC.
[57] These memos from mining engineers and Environment Canada officials are reproduced in Document [sic] Released by the National Indian Brotherhood, the United Steelworkers of America and the University of Toronto on January 15, 1977."
[58] Michel Paper, Evidence, Parliamentary Hearings on Canadian Environmental Protection Act, 11 May 1995 http://www.parl.gc.ca/content/hoc/archives/committee/351/sust/evidence/122_95-05-11/sust122_blk-e.html#0.1.SUST122.000001.AA1040.A (accessed March 13, 2012).
[59] Yellowknives Dene First Nation, *Weledeh Yellowknives Dene: A History* (Dettah: Yellowknives Dene First Nation Council, 1997), 50.
[60] Fred Sangris, Evidence, Parliamentary Hearings on *Canadian Environmental Protection Act*, 11 May 1995 http://www.parl.gc.ca/content/hoc/archives/committee/351/sust/evidence/122_95-05-11/sust122_blk-e.html#0.1.SUST122.000001.AA1040.A (accessed March 13, 2012).
[61] Yellowknives Dene First Nation, *Weledeh Yellowknives Dene: A History* (Dettah: Yellowknives Dene First Nation Council, 1997), 52.
[62] Isadore Tsetta, Evidence, Parliamentary Hearings on Canadian Environmental Protection Act, 11 May 1995 http://www.parl.gc.ca/content/hoc/archives/committee/351/sust/evidence/122_95-05-11/sust122_blk-e.html#0.1.SUST122.000001.AA1040.A (accessed March 13, 2012).
[63] Alternatives North, *From Despair to Wisdom: Perpetual Care and the Future of Giant Mine*, A Report on a Community Workshop, September 26-27, 2011, http://aged.alternativesnorth.ca/pdf/Perpetual%20Care%20Workshop%20Full%20Report%20(lo-res%20revised).pdf (accessed March 16, 2012)