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DEPARTMENT OF
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Northport, Washington Air Quality Study
Phase III

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Northport, Washington Air Quality Study

Phase III

Prepared by:

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Air Quality Program
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NOTE: Appendices are available upon request.

Executive Summary

Health concerns by residents in the Northport, Washington area prompted a study, initiated by the Department of Health (Health) in 1992, with involvement by the Department of Ecology (Ecology). The purpose of the study was to evaluate if pollutants from a smelter operated by Cominco, Ltd. in Trail, B.C., Canada were degrading the air quality on the Washington side of the border. Two study phases, Phase I and Phase II, did identify three heavy metals of significance coming from the Cominco, Ltd. smelter. These metals were lead (Pb), arsenic (As), and cadmium (Cd). For detailed information on the results of Phase I and II see "Air Monitoring Data and Evaluation of Health Concerns in Areas of Northeast Tri-County, Washington Department of Health, April, 1994."

A subsequent air quality study, Phase III, was conducted by the Department of Ecology from November 3, 1993, through August 6, 1994. Phase III was conducted for three reasons: 1) to obtain year-long arsenic and cadmium air quality data to facilitate comparison with the state's "screening" values called Acceptable Source Impact Levels (ASILs), 2) to evaluate study area sulfur dioxide (SO_2) concentrations in response to local public concerns, and 3) to generate additional lead data to help quantify the health impacts on children. Meteorological sampling (wind speed, direction, and ambient temperature) was also conducted during Phase III.

Phase III conclusions are that the ambient health-based standards for particulate, lead, and sulfur dioxide were not violated. However, both arsenic and cadmium annual averages did continue to exceed the ASILs.

In October 1995, Cominco, Ltd. submitted an Application for Amendment to its lead smelting permit to replace the existing smelter. Ecology's review of the proposed amendment (including a health risk assessment of the proposed emissions) determined that the proposed technology meets the U.S. federal and state definition of Best Available Control Technology (BACT). It also determined that the predicted ambient air concentrations of sulfur dioxide, lead, and cadmium are within health protection concentrations. However, arsenic concentrations would continue to show elevated risks.

This report contains a summary of the Phase III air monitoring data results and analyses as well as a description of Ecology's involvement in the review of the Cominco, Ltd. air quality permit amendment application. It also outlines the understanding reached between Ecology, BC Environment, and Cominco, Ltd. on the long-term, Phase IV, Northport area monitoring strategy designed to continue tracking Northport area air quality impacts from the improvements made at the Cominco, Ltd. facility.

Introduction

This report contains the results, conclusions, and recommendations of both the Northport Phase III Air Quality Study as well as Ecology's review of Cominco, Ltd.'s application for amending its air permit.

In July 1992, the Washington State Department of Health proposed a study to evaluate citizen health concerns in the Northport area. In the winter of 1992, in response to a request from Health, the Ecology Air Quality Program initiated a series of air quality studies to determine: 1) the possibility of cross border transport of pollutants (Phase I), and 2) source(s) contributing such pollutants and at what concentrations (Phase II). At the same time that Ecology was conducting air quality studies, Health was testing blood lead levels in children. Sampling by Ecology was done for particulates, which were analyzed for metals of concern, especially those that could be used to fingerprint potential sources.

The Northport air quality study consists, to date, of four phases. Data collection for Phase I ran from December 15, 1992, through February 13, 1993, while data collection for Phase II ran from August 10, 1993, through October 30, 1993. Although no state or federal particulate standards were exceeded during these two phases, metal concentrations of lead, arsenic and cadmium were found to be well above expected normal rural background levels.

At the end of Phase II, a public meeting was held in Northport on May 9, 1994, to present the results of the first two phases of the study to local citizens. At this meeting, community members commented about sulfur odors and suggested that Ecology identify the source of the problem. Ecology agreed to sample at the Northport elementary school for sulfur dioxide. Wind speed, direction, and temperatures were also collected at this location to help identify the direction of the sources for both metals and sulfur dioxide. These data were subsequently used to help validate air quality modeling efforts.

Neither arsenic nor cadmium has formal ambient standards. However, the state has set health-based "screening" ambient concentration levels for new sources of air pollution called Acceptable Source Impact Levels or "ASILs" (see Appendix A for a more detailed explanation of the term "ASIL"). Because Phase II monitoring was only approximately three months long, Ecology decided to continue the metals sampling at the Paparich site for an additional nine months in order to be able to better compare these annual ambient concentrations to the ambient ASILs. This additional nine-month sampling period was designated Phase III.

In October 1995, Comico Ltd. submitted an Application for Amendment to Cominco, Ltd.'s permit (PA 02691) to replace the existing lead smelting technology with a new Kivcet unit. The application was submitted to BC Environment for review and approval. Because Ecology has a Memorandum of Understanding with BC Environment which allows Ecology reviews of BC draft air permits for major sources, Ecology was provided the opportunity to review the Cominco, Ltd. application.

Ecology elected to review the Cominco, Ltd. amendment application as if Cominco, Ltd. were a major new source in Washington. This necessitated compliance with both the federal Environmental Protection Agency (EPA) Prevention of Significant Deterioration (PSD) permit requirements for sulfur dioxide, nitrogen oxide (NOx), carbon monoxide (CO), and lead as well as with Washington's New Toxic Source Regulation (Chapter 174-460 WAC) for arsenic and cadmium. Both federal and state regulations mandate a determination that the proposed technology constitutes Best Available Control Technology (BACT). In addition, WAC 173-460 requires a health risk assessment for cases where significant health risks are suspected. The ASILs, which are health risk based screening level concentrations of Toxic Air Pollutants (TAP)s, are used to determine whether or not a source may pose a significant health risk. If a TAP concentration exceeds its ASIL, then the source will receive a more detailed health risk analysis.

Ecology's review of the Cominco, Ltd. application focused on three things: review of proposed technology, a health risk assessment of the anticipated ambient pollutant concentrations resulting from improvements at Cominco, Ltd., and an evaluation of necessary monitoring to track long-term impacts of the new facility on the air quality of the Northport area.

Ecology's review determined that the proposed Cominco, Ltd. technology meets the U.S. federal/state definition of BACT; that the predicted ambient air concentrations of sulfur dioxide, lead, and cadmium are within health protection concentrations (arsenic concentrations, however, showed elevated risks). Ecology further proposed in its review that three long-term monitoring sites be operated in the Northport area to track the impacts of the upgraded Cominco, Ltd. lead facility and to aid in future air quality modeling. Should long term Northport monitoring (and modeling) results (Phase IV) indicate ambient arsenic, cadmium, and lead concentrations sufficiently high for concern, additional emission reductions at the Cominco, Ltd. smelter will be discussed with BC Environment. The results of the Phase IV air quality study will be included in subsequent Ecology reports.

A. Phase III Air Quality

Monitoring Sites

During Phase III, Ecology sampling for metals occurred at only one site, Paparich, located approximately three miles northeast of Northport. Paparich was selected because the second highest average ambient lead concentrations in the Northport area were frequently measured there during the Phase I and Phase II studies. In addition, electrical power was available and the site conformed to all federal/state siting criteria for sampling for both particulate and meteorology. Unfortunately, the site with the highest lead levels (Worthen) was not usable because it did not meet either US Environmental Protection Agency (USEPA) or state air monitoring siting criteria.

In order to facilitate accurate air quality modeling of the study area, a meteorological site was established initially at the Paparich site. However, because of interference from the property owner's cattle, the met site proved impractical and it was quickly relocated to the Northport elementary school where sulfur dioxide, wind speed, wind direction, and temperature data were collected during the study period. Finally, sulfur dioxide data from the sulfur dioxide site operated by Cominco, Ltd. at the Northport airport on Sheep Creek Road was also included in the analysis. (Site locations and parameters are identified in Figure 1.) .

Metals Analyses

Elevated lead and arsenic levels had been identified in Phase I of the Northport study. Subsequent Phase II monitoring showed that cadmium levels were also higher than anticipated. Nevertheless, the lead levels were below the state and federal standard of 1.5 micrograms per cubic meter ($\mu g/m^3$) average concentration over a three-month period. During Phase II, arsenic and cadmium ambient concentration levels exceeded their respective ASILs. However, because arsenic and cadmium ASILs are yearly averages and Phase II only lasted approximately three months, it became necessary to initiate a Phase III study which ran from November 3, 1993 through August 6, 1994, to provide the necessary additional nine month monitoring data for a valid annual comparison. Following the conclusion of the Phase III study and the ensuing data analysis, it became apparent that both arsenic and cadmium still exceeded their respective ASIL values but to a lesser extent.

The particulate filters from the Phase III study were analyzed at the shared Ecology/EPA laboratory located at Manchester, Washington. As in Phases I and II, each filter represents the average value from one 24-hour sampling period. Filter analyses were performed using the inductively coupled plasma (ICP) method (see Appendix A for an explanation of ICP). This method is capable of simultaneously analyzing a sample for a total of 31 metals. In Phase III, all 31 metals were analyzed, but the ICP Instrument was only calibrated for the three metals of concern (lead, arsenic, and cadmium). This was done for quality assurance reasons and to reduce analysis costs. Some filters were analyzed for arsenic and lead using the graphite furnace atomic absorption (GFAA) method because it provides a lower detection limit than ICP (see Appendix A for an explanation of GFAA). This method is also more expensive than ICP.

A detailed description of Phase III particulate, lead, arsenic, cadmium, and SO2 data analyses follows:

Lead

The federal EPA lead analysis reference method calls for the use of a total suspended particulate (TSP) sampler which collects all suspended particles regardless of size. During Phase II, lead was sampled at the Paparich site using a TSP sampler from July 9 through September 28, 1993, for a total of 82 sampling days. When analyzed by ICP, the lead average was 0.14 $\mu g/m^3$, significantly less than the quarterly standard of 1.5 $\mu g/m^3$ (three-month average).

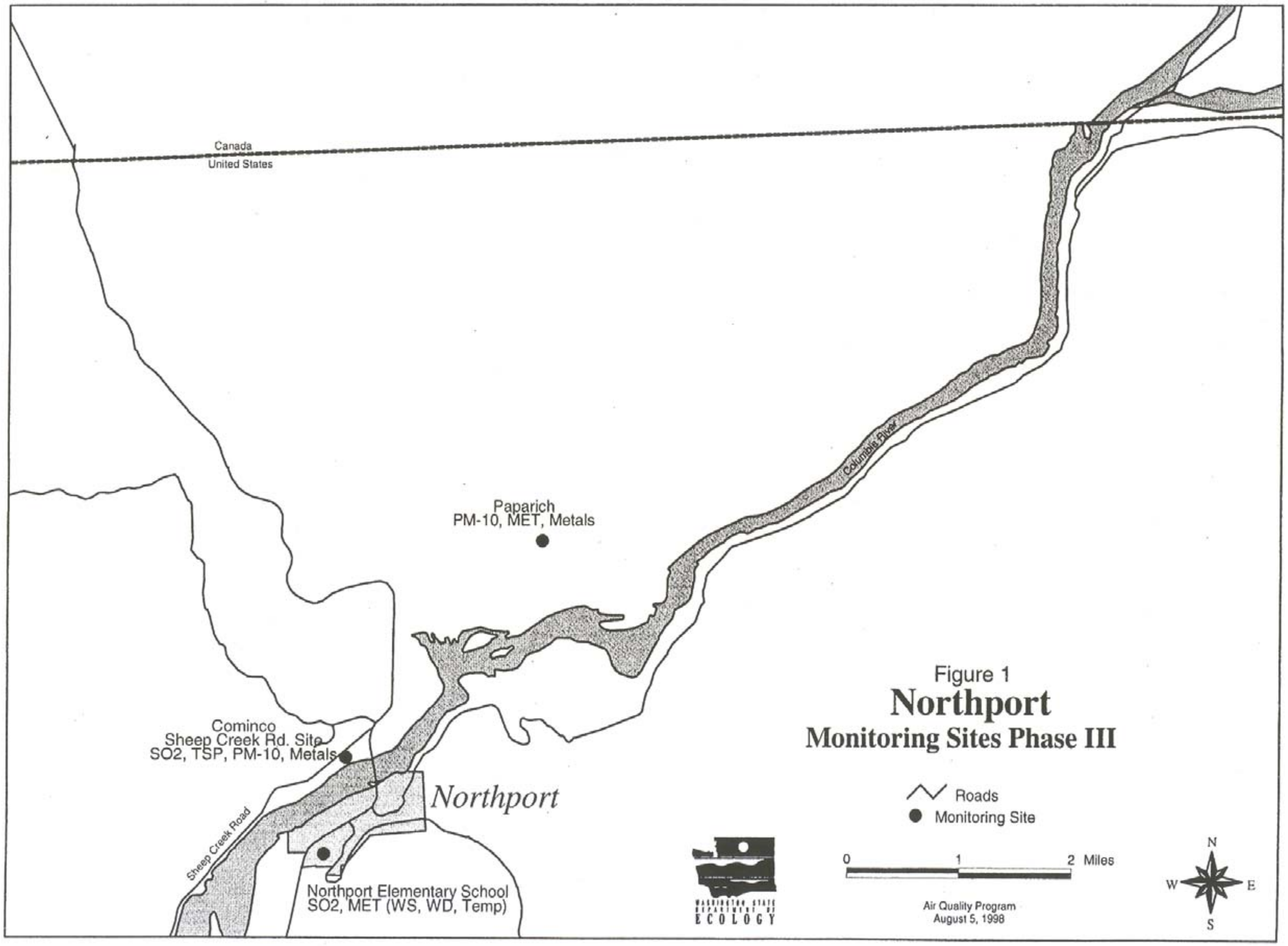


Figure 1
Northport
Monitoring Sites Phase III

ICP lead values obtained from a co-located PM-10 reference sampler at the Paparich site (which only collects the suspended particle fraction 10 microns in diameter or smaller), operating from August 13 through September 28, 1993, averaged 0.15 $\mu g/m^3$. A correlation coefficient of 0.995 was obtained for the eight days when both samplers were running, giving average ICP lead values for the TSP and PM-10 samplers of 0.16 and 0.15, respectively. These results indicate that both TSP and PM-10 sampling give comparable results. This relationship probably occurred because the heavier particles had settled out over the 20 mile distance between Cominco, Ltd. and the Paparich site, leaving only the finer particulate matter to be collected by the TSP and PM-10 samplers.

The 82-day average TSP value of 0.14 $\mu g/m^3$ for lead was slightly lower than the combined Phase II and Phase III annual average ICP PM-10 lead value of 0.19 $\mu g/m^3$. Although the lead standard is based on using the TSP sampling instrument, further sampling for all metals in the Northport area made use of the PM-10 instrument. This change was justified since the two methods gave results that were well within the same order of magnitude and because of the high correlation coefficient indicated above. Therefore, all Phase III particulate data collected were PM-10 data. Paparich PM-10 GFAA and ICP lead data are tabulated, averaged, and compared to the three-month lead standard in Appendix B, Tables 1 and 2, respectively.

Arsenic

The annual average arsenic level at the Paparich site from August 13, 1993, through August 6, 1994, was 0.02 $\mu g/m^3$ when analyzed by GFAA and 0.03 $\mu g/m^3$ by ICP. These values are 87 and 130 times higher, respectively, than the ASIL, value of 0.00023 $\mu g/m^3$ (annual average). GFAA and ICP arsenic data are tabulated, averaged, and compared to the arsenic ASIL, in Appendix B, Tables 3 and 4, respectively.

Cadmium

The annual average cadmium level at the Paparich site from August 13, 1993, through August 6, 1994, was 0.01 $\mu g/m^3$, which is 18 times the ASIL, of 0.00056 $\mu g/m^3$ (annual average). ICP cadmium data for the study are tabulated, averaged, and compared to the cadmium ASIL, in Appendix B, Table 5.

Relationship of Lead, Arsenic and Cadmium

Arsenic levels in Northport during the period from August 13, 1993, through August 6, 1994, were, on average, about one-tenth those of lead. Cadmium levels were about one-nineteenth those of lead (see Appendix B, Table 6 for a listing of the lead, arsenic, and cadmium data and the lead to arsenic and lead to cadmium ratios). A graphic comparison of the lead levels compared to those for arsenic and cadmium is shown in Figure 2. Arsenic and cadmium concentrations have been multiplied by a factor of 10 to make the peaks more apparent. The graph indicates that arsenic and cadmium are almost always deposited with lead in a similar pattern, i.e., where lead concentrations are high, arsenic and cadmium concentrations are also high and vice-versa. This helps confirm one of the conclusions of the Phase II study, i.e., that all three metals are being deposited from the same source, the Cominco, Ltd. smelter.

Particulate Levels and Comparison to Standard

The National Ambient Air Quality Standard (NAAQS) particulate standard for PM-10 is 150 $\mu g/m^3$ for a 24-hour period. Reference to Appendix B, Tables 1 through 5 for Paparich PM-10 (heading marked "Particulate Value") shows that the highest value for this site during Phases II and III is 104 $\mu g/m^3$ on July 31, 1994, which is about two-thirds of the standard.

DOE Paparich ICP Lead Compared to Cominco. Ltd. Sheep Creek Sulfur Dioxide Data

Cominco, Ltd. began monitoring for sulfur dioxide in the Northport area in November 1929, with a permanent site being established at Sheep Creek in June 1934. The Cominco, Ltd. sulfur dioxide data from Sheep Creek were compared, using a scatter graph, to the Ecology Phases II and III Paparich PM-10 ICP lead data for the period from August 13, 1993 through August 6, 1994. (See Appendix C for a discussion of scatter graphs.) This comparison was made to determine if lead values could be correlated to the sulfur dioxide concentrations. If they correlated well, it could be an indication that both pollutants had the same source and sulfur dioxide data could be used as a surrogate to determine relative lead concentrations. If there were a poor correlation, then there may be either an alternate source of sulfur dioxide, or sulfur dioxide and lead have different dispersion characteristics in the atmosphere, or the detection level for either one or both of the pollutants is not good enough to show any relationship.

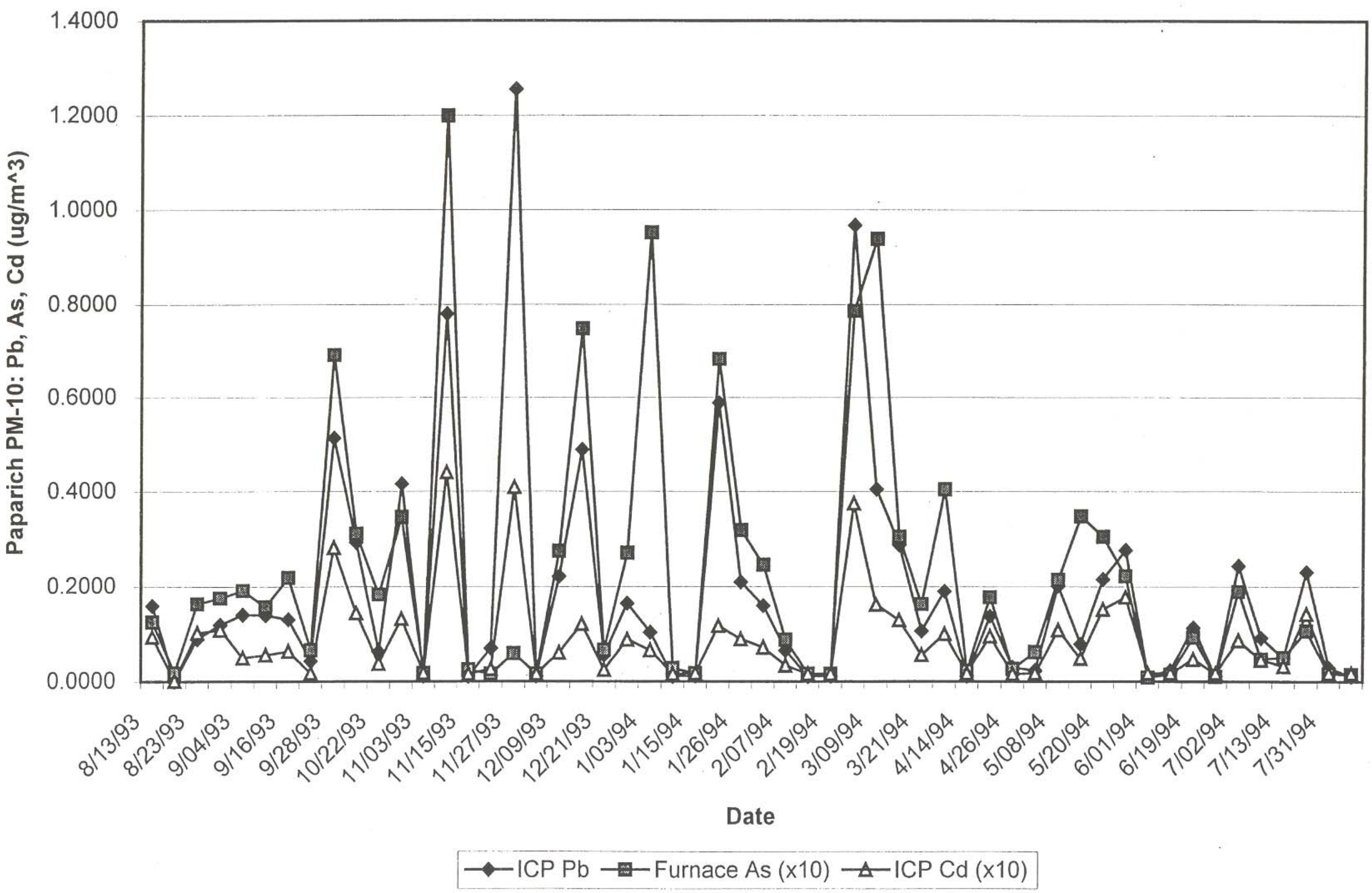
The scatter graph comparing the Ecology Paparich lead data against the Cominco, Ltd. Sheep Creek sulfur dioxide data is shown in Appendix C, Figure 1. The accompanying data are given in Appendix C, Table 1. The complete Cominco, Ltd. sulfur dioxide data are given in Appendix D, Table 1. Calculation of a correlation coefficient between the sulfur dioxide and lead data gives a r^2 correlation coefficient value or 0.485. This poor level of correlation may be caused by the generally low sulfur dioxide values used in the calculation.

In a similar exercise, Cominco, Ltd. Sheep Creek TSP and PM-10 lead data from August 30, 1994, to December 28, 1994, were compared to Ecology sulfur dioxide data for the same period using scatter graphs. The results were similar to those discussed above in that there was no clear correlation.

Sulfur Dioxide Data Compared to NAAOS and State Standards

The highest 24-hour average Cominco, Ltd. Sheep Creek sulfur dioxide value was 0.023 parts per million (ppm) occurring on November 28, 1993. Ecology monitored sulfur dioxide in Northport from August 25, 1994, through May 27, 1995. The highest 24-hour average Ecology value recorded for sulfur dioxide (Northport Elementary School) was 0.064 ppm occurring on January 9, 1995. The maximum Cominco, Ltd. and Ecology values were compared against the 24-hour average National Ambient Air Quality Standard (NAAQS) value of 0.14 ppm and the 24-hour average Washington State standard value of 0.10 ppm. The results show that neither standard came close to being violated during either the Cominco, Ltd. or Ecology monitoring periods. Ecology sulfur dioxide monitoring data are given in Appendix D, Table 2.

Figure 2. Northport Metals: 8/13/93 to 8/6/94 – Lead, Arsenic (x10), Cadmium (x10)



Northport Data Summary Table

Selected Northport data are summarized in Table 1.

Table 1
Northport Data Summary, Phases II and III

Pollutant	Yearly Average ug/m^3	Yearl y Max ug/m^3	Yearly ASIL ug/m^3	3-Month Standard ug/m^3	Washington 24-hour Average ppm	Reference
GFAA Lead	0.20	1.40	N/A	1.50	N/A	Appendix B Table 1
ICP Lead	0.19	1.26	N/A	1.50	N/A	Appendix B Table 2
GFAA Arsenic	0.02	0.12	0.00023	N/A	N/A	Appendix B Table 3
ICP Arsenic	0.03	0.13	0.00023	N/A	N/A	Appendix B Table 4
ICP Cadmium	0.01	0.04	0.00056	N/A	N/A	Appendix B Table 5
Cominco SO2	N/A	0.023	N/A	N/A	0.10	Appendix D Table 1
DOE SO2	N/A	0.064	N/A	N/A	0.10	Appendix D Table 2

B. Cominco, Ltd. Lead Smelter Modifications

Phase I and II of Ecology's Northport air quality study demonstrated that the degradation of the air quality in the Northport area from lead, arsenic, and cadmium was very likely the result of emissions of these metals from the Cominco, Ltd. lead smelter in Trail, B.C. Trail is located approximately10 miles north of the Washington-B.C. border along the Columbia River.

The Cominco, Ltd. facility has been at the present site since the turn of the century. Between 1986 and 1989, Cominco, Ltd. went through a major modernization program to improve operating efficiency, working conditions, and upgrade environmental performance by installing a new lead smelting process called QSL. The new process subsequently failed and was abandoned in 1993. In 1994, Cominco, Ltd. made the decision to upgrade its lead operation by constructing a new smelter using the Kivcet process, as well as new slag fuming operations.

Before construction could begin, Cominco, Ltd. needed approval from BC Environment to modify its existing air emissions permit. A permit amendment application was subsequently submitted in October 1995 to BC Environment.

Because of standing agreements between the Washington State Department of Ecology and the BC Environment, which provided for the review of each other's draft air permits and modifications applications, Ecology was provided the opportunity to review and comment on the Cominco, Ltd. request for permit modification. Ecology received the permit modification application at the end of October 1995 and began its review to ensure that the proposed Cominco, Ltd. modifications to its lead smelting operation would meet all applicable U.S. federal and state air emission requirements.

Ecology's review focused on three areas. The first was a technology review to determine if the proposed new Cominco, Ltd. process met federal and state Best Available Control Technology (BACT) requirements. The second was a health risk assessment to evaluate the predicted impacts of the new technology on downwind US populations. The third was an evaluation of necessary monitoring needs to track long-term impacts of the facility on the environment of the Northport area. As part of the effort to determine long-term impacts, Cominco, Ltd. also commissioned a study using lichen as environmental indicators. The lichen study is summarized in Appendix F.

Technology Review

Ecology's review of the proposed technology indicated that it met the U.S. federal and state definition of BACT for particulate control. The particulate controls proposed also met the state BACT requirement for toxic pollutants being emitted by Cominco, Ltd. (arsenic, cadmium, and lead) and also appeared to meet state requirements for All Known Available and Reasonable Technology (AKART) for the control of arsenic. In addition, the current and proposed sulfur dioxide emissions from the Cominco, Ltd. facility are within the limits set in the EPA's 1976 New Source Performance Standards (NSPS).

C. Modeling

The modeling of emissions from the Cominco, Ltd. smelter in Trail, British Columbia and their impact on Northeast Washington State is a challenging problem. The Columbia River Valley between Trail, B.C. and Northport, Washington is narrow (about one mile across) and restricts horizontal plume dispersion. Meteorological data are available for only a limited period. The surrounding terrain is composed of mountains with steep slopes and numerous smaller valleys. The river takes a circuitous route from Trail, B.C., into Washington, first traveling easterly, then southward to the international boundary, then in a southwesterly direction past Northport, Washington and on to Kettle Falls where the river turns south again. Few dispersion models can cope with such complex topography.

During the Phase III study, the Department of Ecology had anticipated modeling the area with the CALMET meteorological model and the CALPUFF dispersion model. Computer modeling was undertaken for several reasons: First, to verify the conclusions reached during Ecology's review of the draft Cominco, Ltd. permit, especially regarding the impacts of the new lead smelter technology on air quality in Washington State. Secondly, the Phase III study employed only three ambient air monitoring sites (Paparich, Northport Elementary School, and Cominco, Ltd. Northport sulfur dioxide site) to reduce costs. These three sites, while adequate to address population impacts, were too few to provide a representative picture of pollutant concentrations throughout the study area. In situations such as this, computer simulations (models) are used to estimate such concentrations and existing ambient air quality data are employed to validate modeled results.

Ecology also contemplated the use of output from the NCAR/Penn State Mesoscale Wind Field Model (MM5) to initialize the Calmet model. Developing the MM5 initialization capability is taking longer than anticipated due to problems linking the output of MM5 to CALMET. This issue is currently being resolved by EPA Region 10.

Once resolved, MM5 and the latest dispersion models will be employed during Phase IV to better evaluate Cominco, Ltd. smelter impacts on study area air quality. In the interim, Ecology was forced to utilize the comparatively simple gaussian dispersion Industrial Source Complex Short Term (ISCST) model to estimate the concentrations of emissions of concern from the smelter. These model calculations when validated with the available monitored air quality data provided estimates of ambient concentrations expected from the proposed modifications to the smelter.

Several approximations had to be made in applying ISCST during the Phase III study. The Columbia River Valley was assumed to lie in a straight line from Trail, B.C. to Kettle Falls, Washington and be oriented entirely in a northeast-southwest direction all the way to Northport. Northport is the location where just over one year of meteorological data was measured in 1994-1995. Source – receptor distances were measured along the river from the smelter in Trail. It was expected that the model would predict lower-than-actual pollutant concentrations since the ISCST model assumes the plume from the Cominco, Ltd. smelter dispersing as it moves downwind of the source. In actuality, the narrowness of the valley will restrict the plume dispersion from that computed by the model, resulting in higher ambient pollutant concentrations. Calculations show that, if not for the physical restriction imposed by the valley walls, the expected unconstrained plume width ($\pm 3\sigma$) from the Cominco, Ltd. smelter would be as much as eight kilometers wide at the 30 kilometer (km) Northport distance from Cominco, Ltd.

The dispersion of emissions released from Cominco, Ltd. is also constrained vertically by the depth of the mixed layer. The mixed layer is a layer of air extending from ground surface upwards. Its upper bound is defined by the air being surface heated by the sun. The layer is further characterized throughout by mechanical turbulence and wind-mixed pollutants. The nearest mixing height data comes from the twice-daily soundings taken at the Spokane Washington International Airport. The Spokane airport is located in relatively flat terrain compared with the study area. This difference in surrounding terrain features argues against using the Spokane sounding for mixing heights. Accordingly, the study area mixing height was assumed to be 200 meters for the entire modeling run.

The expected differences between cloud cover in Spokane and the modeling domain also suggests that atmospheric turbulence and stability, usually determined using wind speed and atmospheric conditions, should be estimated by an alternative method. The Northport meteorological data include the standard deviation of the horizontal wind direction, which is an acceptable alternate method for determining stability.

Pollutants of concern for the Phase III study were cadmium, arsenic, lead, and sulfur dioxide. Emission rates and stack parameters were obtained from Cominco, Ltd. Modeling results of expected concentrations of the above pollutants in micrograms per cubic meter ($\mu g/m^3$) at

Northport before and after the imposition of the new lead smelting technology at Cominco, Ltd. are compared with the monitored data shown in Table 2.

Table 2
Modeled vs. Monitored Pollutant Concentrations (Sum of 24-Hour Averages)

Pollutants	Monitored Concentrations (µg/m³)	Northport Modeled Concentrations (µg/m³)	
		Before New Cominco, Ltd. Technology	After New Cominco, Ltd. Technology
Lead	0.20	0.141	0.037
Arsenic	0.02	0.015	0.006
Cadmium	0.01	0.003	0.0006
Sulfur Dioxide	24.36	4.01	1.00

Monitored lead, arsenic, and cadmium data were obtained from PM-10 samples taken at the Paparich site; sulfur dioxide was measured at the Northport Elementary School. The modeled lead, arsenic, cadmium, and sulfur dioxide concentrations are for the period from January 7, 1994 through August 24, 1995. The monitored sulfur dioxide average concentration value was calculated from sulfur dioxide data gathered during the period from August 21, 1994 through June 19, 1995. The monitored lead, arsenic, and cadmium average concentration values were calculated from data gathered during the following time periods:

Lead: November 3, 1993 through August 6, 1994
Arsenic: August 13, 1993 through August 6, 1994
Cadmium: August 13, 1993 through August 6, 1994

Model performance is surprisingly good for lead and arsenic, with the model predicting concentrations that are two-thirds of the observed concentration. The model does not perform nearly as well in predicting the concentrations of cadmium and sulfur dioxide. Since the four pollutants are emitted in differing ratios from the many stacks and processes at the smelter, it should be anticipated that model performance might not be the same for all pollutants.

It is anticipated that a more complete wind flow and dispersion model, such as the MM5/CALMET/CALPUFF models referred to previously, would perform better under these topographic conditions. When these models are available and when the long-term Phase IV monitoring program yields data sufficient to validate the modeled results, Ecology will perform such modeling to continue characterizing health risks in the area.

In order to introduce more conservatism into computing the risk level produced by the proposed changes at the Cominco, Ltd. smelter, and to better relate modeled to observed concentrations, the above predicted model concentrations for lead and arsenic were multiplied by 3/2. The cadmium concentration was multiplied by 4, sulfur dioxide by 6.

D. Phase IV On-Going Ambient Monitoring

There were concerns that, even with the implementation of the new technology at the Cominco, Ltd. facility, the predicted ambient concentration of arsenic in the Northport area would still exceed its ASIL concentration. Therefore Ecology requested, as part of its review of the Cominco, Ltd. draft permit amendment application, that BC Environment require the facility to operate several long-term air monitoring sites in the Northport area. In response to this permit condition, Cominco, Ltd. agreed to monitor select metals concentrations and meteorological parameters in the Northport area for at least one year from September 1997.

According to this agreement, Cominco, Ltd. will forward the acquired raw data to Ecology monthly. Ecology will then analyze the data and summarize the results in a quarterly report designed for public distribution. Ecology will also perform quarterly quality control checks to verify whether Cominco, Ltd.'s TSP and meteorological equipment are functioning appropriately. Finally, Ecology will, on an irregular basis, co-sample at the above sites to verify the Cominco, Ltd. data integrity. In addition, Ecology will continue to computer model the air quality in the area using the latest, most sophisticated models available and, at the same time, utilizing the Phase IV and other data to determine such things as appropriateness of monitoring site locations, need for additional emission reduction measures, and impacts of Cominco, Ltd. emissions on local populations.

E. Phase III Health Risk Assessment

Concerns have been raised regarding the potential health effects of emissions from the Cominco, Ltd. Smelter. These concerns prompted both the Washington State Departments of Health and the Washington State Department of Ecology to conduct several analyses of possible health effects in Stephens County resulting from these emissions. These analyses assessed exposures using monitored ambient air concentrations of smelter-related pollutants and evaluated the potential health effects associated with these concentrations (DOH, 1994).

Results of Phase I and II indicated that exposure to a few pollutants (i.e. cadmium and arsenic) may be slightly above health-based guidelines (DOH, 1994). However, the Cominco, Ltd. Smelter reduced chemical emissions following the phase I/II studies by adding state-of-the-art control technology to the plant. Emission reductions, predicted in the Cominco, Ltd. air permit amendment application, were expected to be: 76% for lead, 85% for cadmium, 65% for arsenic and 74.5% for sulfur dioxide (Cominco, Ltd., 1995). Phasing in of new control technology began in March of 1997.

As part of its review of Cominco, Ltd.'s air permit amendment application, Ecology did a preliminary health risk assessment. The health risk evaluation focused on the four pollutants of concern previously identified: sulfur dioxide, lead, arsenic, and cadmium. The evaluation utilized Phase II data from the Sheep Creek PM-10 monitoring site. Future ambient concentrations were predicted by utilizing an accepted regulatory technique called "roll-back." A fundamental premise of the roll-back approach is the assumption that reductions in emissions result in proportionate reductions in ambient concentrations for the pollutant in question. The Phase II Sheep Creek data was adjusted downward by the anticipated reductions in emissions (from the draft Cominco, Ltd. Amendment application to obtain predicted ambient concentrations. Adjusted daily concentrations were rank-ordered and the upper 95th percentile concentration determined for each pollutant. The upper 95th percentile concentrations were used to provide an additional measure of conservatism in assessing health risks. Ecology recognized that the Northport data sets only reflected approximately 4.5 months of 1993. However, in the absence of true yearly averages, the average and associated 95th percentile were assumed to represent the annual average and a conservative upper bound.

The health risk evaluation concluded that the predicted ambient air concentrations of sulfur dioxide, lead, and cadmium were within health protective concentrations for inhalation exposures. Predicted arsenic air concentrations for both the average and the 95th percentile, however, resulted in risks between 1 in 100,000 and 1 in 10,000, which is higher than normal and is a cause for concern.

Because the above air quality studies reported slightly elevated cadmium and arsenic concentrations in the vicinity of Northport and only 4.5 months of data were available to assess potential exposures, Ecology agreed to complete a Phase III air quality analysis based on a full year of air quality data. The collection of more data allows a more accurate determination of yearly average sulfur dioxide, cadmium, lead, and arsenic concentrations and a more accurate assessment of health risks. Re-analysis of the data showed that concentrations obtained at the Paparich monitoring site were higher than those obtained at Sheep Creek. Consequently, the Phase III health risk analysis was based on data obtained at Paparich. A subsequent health risk analysis was performed using data obtained from 8/13/93 to 8/6/94 with the following results:

Ambient Air Concentrations Used to Evaluate Health Risks

Concentrations of lead, cadmium, and arsenic were obtained from Phase III ambient air measurements at the Paparich site, which is located approximately 3 miles north of Northport. Data on sulfur dioxide were obtained from the Cominco, Ltd. Sheep Creek Road sulfur dioxide site (see Figure 1).

It is reasonable to assume that Northport citizens would be exposed to average concentrations of pollutants over time. However, uncertainties in the actual concentrations of pollutants Northport citizens might be exposed to remain because ambient air measurements are only available for one year and monitors are not located in residential areas. It should be noted that modeling indicates that chemical concentrations in residential areas south of the monitors are likely to be lower than concentrations reported at the monitor locations. Due to these uncertainties, upper 95th percentile concentrations were used to protectively assess health risks.

Concentration values were then adjusted downward to reflect expected reductions from new control technologies added to the Cominco, Ltd. smelter in spring of 1997. Emissions were reduced by the predicted factors of 76% for lead, 85% for cadmium, 65% for arsenic and 74.5% for sulfur dioxide (Cominco, Ltd. Air Permit Modification Application).

The adjusted 95th % concentrations are compared between Phase II and Phase III in Table 3 below. Acquisition of additional data resulted in slightly increased concentrations for all metals for Phase III relative to Phase II.

Table 3
Comparison of Phase III and Phase II Modeled Ambient Concentration from the Paparich Monitoring Station

Pollutant and Averaging Period for Phase II Results	Phase II Adjusted 95th Percentile	Phase III Adjusted 95th Percentile
Lead (3 month average	0.11 $\mu g/m^3$	0.16 $\mu g/m^3$
Arsenic (annual average, 1993-94)	0.02 $\mu g/m^3$	0.03 $\mu g/m^3$
Cadmium (annual average, 1993-94	0.00 $\mu g/m^3$	0.01 $\mu g/m^3$
Sulfur Dioxide (8 month average)	0.0024 ppm	

Health Evaluation

Ambient air concentrations are compared to health-based concentrations (i.e. Acceptable Source Impact Levels or ASILs) as a screening exercise to determine whether or not health effects may be present. Derivation of the health-based concentrations for each chemical are discussed in the following sections. Toxic effects associated with the four chemicals of concern (i.e. lead, arsenic, cadmium, and sulfur dioxide) are also described.

Sulfur Dioxide

Toxicity

Sulfur dioxide is a highly irritating gas which, because of its solubility in water, is absorbed in the upper respiratory tract where it exerts most of its effect (Frank et al., 1969). It can adsorb to fine particles, be carried deep into the lung, and act as a deep lung irritant (U.S. EPA, 1982). Mouth breathing and exercise tend to increase exposure and increase effects (Bethel et al., 1983; Kleinman, 1984). Exposures of 2 to 5 minute duration between 0.5 to 2 parts per million (ppm) cause bronchoconstriction and irritation with attendant symptoms in asthmatics (especially adolescents) and others with hyperresponsive airways (Balmes et al., 1987; Horstman et al., 1988). Controlled exposures of human adolescent volunteers with asthma resulted in bronchoconstriction and increased lower respiratory symptoms after short-term (2 to 10 minute to one hour) exposures at concentrations of 0.1 to 1.0 ppm and above (Koenig et al., 1985; Koenig et al., 1989).

Epidemiologic studies of health effects related to sulfur dioxide exposure, as part of combustion mixtures including particles, have noted respiratory symptoms, decreases in pulmonary function, and increased mortality. Such community studies indicate that levels of sulfur dioxide as low as 0.01 ppm can result in decreases in pulmonary function and increased respiratory symptoms (Ware et al., 1986). Exposure to levels of 0.05 ppm can result in increased mortality of susceptible populations (Ostro and Lipsett, 1991; U.S. EPA, 1994a).

Co-exposure of susceptible individuals in controlled exposures to ozone (O_3) and nitrogen dioxide (NO_2) have demonstrated exacerbating effects, suggesting that ambient mixtures containing sulfur dioxide may have greater effects than those seen with sulfur dioxide alone (Koenig et al., 1990).

Such considerations have resulted in the U.S. EPA recently proposing the addition of a short-term National Ambient Air Quality Standard (NAAQS) for sulfur dioxide of 0.6 ppm averaged over 5 minutes (Federal Register, 1994).

The primary annual NAAQS for sulfur dioxide is 0.03 ppm (80 $\mu g/m^3$). This is based on community studies that suggest increased risk of respiratory symptoms (cough, phlegm production, wheeze) in populations (children and adults) exposed to high (>100 $\mu g/m^3$), long-term levels of sulfur dioxide, with and without high particle concentrations (U.S. EPA, 1994b). While no single study has sufficiently strong evidence for substantial risks, there is consistency across studies to indicate the possibility of respiratory impact from low-level long-term exposure to sulfur dioxide, or, more certainly, with repeated exposures to peak exposures to sulfur dioxide over long periods. The Office of Air Quality Planning Standards (OAQPS) staff used this information to recommend the retention of the annual standard NAAQS for sulfur dioxide of 0.03 ppm (80 ug/m3) (U.S. EPA, 1994b).

Health Evaluation

If the concentrations measured in the Northport area over the 12 month period are averaged and reduced by the 74.5 percent to be achieved with the new smelter technology under the permit, and are then compared to the NAAQS annual average, the resulting 0.0024 ppm will not exceed the 0.03 ppm of the sulfur dioxide NAAQS. If the maximum hourly average (0.16 ppm) is reduced 74.5 percent (to 0.04 ppm), Ecology's hourly standard of 0.4 ppm will not be exceeded. The maximum hourly average can be interpolated to a maximum five-minute average of 0.26, which can then be converted to 0.07 ppm with a 74.5 percent reduction. The proposed federal standard of 0.6 ppm for five minutes would not be exceeded by the projected concentration.

Uncertainties/Limitations

Uncertainties of this evaluation include the inability to derive a threshold of effects for chronic exposures from epidemiological studies. Additionally, highly sensitive people, i.e., people with severe asthma, are more susceptible to sulfur dioxide than those accounted for in this analysis.

LEAD

Toxicity

Young children and fetuses are the groups most susceptible to the toxic effects of lead (ATSDR, 1993). Chronic exposure to even low concentrations of lead in young children can cause irreversible learning difficulties, mental retardation, and delayed neurological and physical development. Children between one and three years of age are at higher risk than older children. Their risk is higher because they have more hand-to-mouth activity and are smaller in size, leading to a higher dose of lead per unit of body weight. In addition, the blood-brain barrier is not completely formed and the nervous system is still developing. The Centers for Disease Control and Prevention (CDC) currently states that blood lead levels greater than 10 micrograms of lead per deciliter (ug Pb/dl) (where dl = deci-liter of blood or a tenth of a liter) are of concern (ATSDR, 1993).

Health Evaluation

The NAAQS for lead is 1.5 $\mu g/m^3$ averaged over three months. The NAAQS is based on protection against blood lead levels exceeding 15 µg lead/dl (Federal Register, 1978). The NAAQS accounts for both the contribution of lead from non-air and air sources and is based on an allowable contribution of 3 µg lead/dl from air (Angle and McIntire, 1979). A 1986 review of the NAAQS by the EPA concluded that in light of declining ambient air lead concentrations as a result of the reduced use of leaded gasoline, the biokinetic model should be used to predict blood lead concentrations in populations near stationary sources of lead (EPA, 1989). Subsequent revisions to the existing NAAQS were not made.

An evaluation of the impact of lead air concentrations was done to determine if the levels measured in Northport could be a concern even though they do not exceed the NAAQS. This valuation relied on estimating exposures from air as well as from soil, dust, and vegetables since it is expected that exposure from several pathways is occurring in the Northport area, given the historical level of deposition.

EPA's Integrated Exposure Uptake Biokinetic Model for lead in children (IEUBK), version 0.99d, was used to estimate blood lead concentrations from environmental data reported for the Northport area (U.S. EPA, 1994c). Parameters used in the model included environmental data measured in the Northport area as well as some default assumptions: a garden vegetable concentration of 0.1 ppm (wet weight) (DOH, 1995), an ambient air concentration of 1.0 $\mu g/m^3$ (DOH, 1994), 200 ppm for soil and dust (DOH, 1995), 15 µg/l drinking water concentration (model default), and 4 hours/day time spent outdoors. Running the model with these parameters yielded blood lead concentrations ranging from 5.2 to 6.3 µg/dl for children age 0.5 to 7 years old. Using these exposure parameters, the biokinetic model predicts blood lead levels in children well below the CDC's action level of 10 µg/dl.

Based on Washington State Department of Health (DOH) experiences with the biokinetic model, the model does not appear to be sensitive to exposure via the air pathway. Due to this limitation, the contribution of air lead concentrations to blood lead concentrations was evaluated further in order to adequately account for this exposure pathway. Epidemiological studies have reported the general relationship of 1:2 between air lead (μg lead/m^3) and blood lead (μg lead/m^3) (U.S. EPA, 1989). Using this relationship for lead, estimated average (0.04 $\mu g/m^3$) and estimated adjusted 95th percentile (0.16 $\mu g/m^3$) air lead concentrations would be expected to contribute an additional 0.09 to 0.31 µg lead/dl to blood lead levels estimated using EPA's IEUBK model. Using estimated lead air concentrations, predicted blood leads remain within CDC's action level of 10 µg/dl even after considering the additional contribution of current and expected lead exposures from air.

Uncertainties/Limitations

Uncertainties of this analysis include lack of environmental data with which to adequately characterize exposures from non-air sources such as soil, dust, and food. At least part of these exposures would presumably be the result of historical deposition from the Cominco, Ltd. smelter. Accumulation over time would be likely to contribute significantly to blood lead concentrations. Additional testing of soil, dust, and food for lead would decrease uncertainty in blood lead estimates.

Limited blood lead screening has been conducted in the Northport area by the Northeast Tri-County Health District in order to ascertain actual baseline blood lead information. However, these screening programs may not have targeted appropriate populations and therefore should be expanded in order to develop conclusions about actual baseline blood lead levels in the Northport area.

Cadmium

Toxicity

Toxic effects associate with chronic cadmium exposure include non-carcinogenic effects such as renal dysfunction, osteomalacia, gastrointestinal inflammation, emphysema, and bronchitis, and carcinogenic effects such as cancer of the lung, trachea and bronchus (DOH, 1994). In order to evaluate the potential for these health effects in a relatively short timeframe, health-based exposure guidelines from Ecology, USEPA and ATSDR are used as a basis to compare current and predicted ambient air concentrations in the town of Northport.

Carcinogenic Effects

The USEPA has rated cadmium as a B1 or probable human carcinogen via inhalation based on sufficient evidence in rats and limited evidence in humans. The Washington State ASIL, calculated from the USEPA inhalation unit risk, is based on an increase in lung, trachea and bronchus cancer deaths in cadmium smelter workers in Thun et al., (1985).

Non-carcinogenic Effects

Non-carcinogenic effects associated with inhalation of cadmium were evaluated using both the USEPA interim reference concentration (RfC) and the ATSDR minimal risk level (MRL). The non-carcinogenic effect seen at the lowest dose, referred to as the critical effect, is a form of renal dysfunction called proteinuria. This effect forms the basis of the USEPA inhalation reference concentration (RfC = 0.18 $\mu g/m^3$) and the ATSDR Minimal Risk Level (MRL = 0.20 $\mu g/m^3$) (USEPA, 1995a, ATSDR, 1992).

Health Evaluation

The 95th percentile atmospheric cadmium concentration, after adjusting for the expected benefit of additional smelter controls, is 0.01 $\mu g/m^3$. Comparison of this value to the ASIL for cadmium, a conservative screening value used by Ecology to evaluate air contaminant levels, indicates that the 95th percentile annual cadmium concentration is approximately 8.9 times the ASIL, but does not exceed either the USEPA interim RfC or the ATSDR MRL.

Under Washington State regulations WAC 173-460, sources applying for air permits may exceed ASILs if the source can demonstrate that its emissions do not expose residents to a cancer risk greater than 1 in 100,000 taking into account exposures from other facilities for the given contaminant. Assuming that there are no other facilities that emit cadmium, a health-based limit reflecting the 1 in 100,000 risk is estimated to be approximately 0.0056 $\mu g/m^3$. The 95th percentile cadmium concentrations are below this health-based guideline. With regards to smelter modifications to control cadmium, Ecology concludes that the proposed modifications appropriately reduce air concentrations of cadmium to an acceptable level for protection of human health. The data are summarized in Table 4.

Table 4
Cadmium Health-Based Guidelines

Health-Based Guidelines	Concentrations ($\mu g/m^3$)
ASIL	0.00056
Interim RfC	0.18
MRL	0.20
Risk-based Concentration (1 in 100,000)	0.0056

Uncertainties/Limitations

Uncertainties associated with risk estimates from cadmium inhalation primarily include high to low dose extrapolation. Incidental ingestion of contaminated soils and dust may be partly accounted for in the lung cancer estimates as exposed populations in the human study probably were exposed to cadmium in contaminated soils or dusts. However, this analysis does not evaluate potential health risks from non-cancer effects such as proteinuria that might occur as a result of ingestion of contaminated soils or water sources. In addition, behavioral related exposures to cadmium, such as smoking, are not included in the risk estimates but could pose significant health risks to the community (DOH, 1994).

Arsenic

Toxicity

Cancer

USEPA rates inhaled arsenic as a class A, or known human carcinogen, based on positive results for lung cancer in occupationally exposed workers (USEPA, Dec. 1995b). Lung cancer is associated with inhalation of inorganic arsenic in occupationally exposed populations in a number of studies, and forms the basis of the USEPA inhalation unit risk value and Ecology’s ASIL (ATSDR, 1993). In addition, several studies conducted in communities living around smelting facilities still in operation have shown increased lung cancer rates at lower exposure levels (Matanowski, et al., 1980, Pershagen, 1985, Cordier et al., 1983, Brown et al., 1984). Ambient arsenic concentrations are reported in these studies to be below 0.5 $\mu g/m^3$. Study values are 60 times higher than the predicted Northport average arsenic concentration of approximately 0.01 $\mu g/m^3$, and 17 times higher than the predicted 95th percentile arsenic concentration of 0.03 $\mu g/m^3$.

Non-carcinogenic Effects

Non-carcinogenic effects associated with low levels of inorganic arsenic primarily include dermal effects such as hyperkeratinization and hyperpigmentation of the skin, although these effects have only been found in populations exposed through ingestion (ATSDR, 1993). It is uncertain how relevant these effects are to inhalation exposure, and no MRLs or RfCs were available to quantify non-carcinogenic health effects resulting from inhalation of airborne arsenic. However, USEPA has developed a reference dose of 0.0008 mg/kg-day based on dermal effects in humans (USEPA, December, 1995).

Health Evaluation

Comparison of the 95th percentile predicted air arsenic concentration in Northport to the risk based concentrations (see Table 3 above and Table 5 below) indicates that arsenic risks range between 1 in 100,00 to 1 in 10,000. It is important to note here that the WADOH has reviewed morbidity and mortality data for Northport, and did not find increased rates of lung cancer or respiratory illness. However, the number of lung cancer cases that might be associated with arsenic exposure in a town of Northport's population would be exceedingly small, and would not result in a noticeable increase in cancer cases.

Non-carcinogenic health effects may be evaluated by calculating an individual's dose from inhaled arsenic, approximately 0.000006 mg/kg-day[1], and comparing this value to the USEPA reference dose of 0.0008 mg/kg-day. Because exposures in Northport are considerably less than the USEPA reference dose value, non-carcinogenic effects associated with arsenic are not expected to occur in the Northport community. However, from a regulatory standpoint, Cominco, Ltd. emissions may still result in an excess cancer risk of as much as 1 in 10,000 for the town of Northport, and Ecology recommends further emission reductions whenever possible.

Table 5
Arsenic Health-Based Guidelines

Health-Based Guidelines	Concentrations ($\mu g/m^3$)
ASIL	0.00023
Interim RfC	None
MRL	None
Risk-based Concentration (1 in 100,000)	0.0023

Uncertainties/Limitations

Health-based guidelines for arsenic are based primarily on studies in human populations exposed to airborne arsenic in both occupational and community settings, thus reducing common sources of error such as animal to human extrapolations and pathway extra-polations. Uncertainty may result in extrapolating from high to low-doses since cancer risks

[1] ($0.02\ \mu g/m^3$ x 20 m3/day)/(70 kg x 1000 $\mu g/mg$) = 0.000006

determined at high doses, such as those observed in the occupational studies, may not linearly scale to produce actual risks at low doses such as those seen in the Northport area. However, studies in communities exposed to lower levels of airborne arsenic show slightly increased lung cancer risks, although air concentrations at Northport are still approximately 50 times lower. In addition, more recent research suggests that cancer risks at lower doses may be underestimated, as the dose-response curve may be supralinear at lower doses (i.e., actual cancer cases were higher than those expected based on a linear extrapolation from high to low doses) (Enterline et al., 1995).

Uncertainty may also result from the lack of exposure quantification from incidental ingestion of contaminated soils and house dust. However, it should be noted that populations exposed in both the occupational and community studies probably were exposed to arsenic through these pathways as well. Thus, although some uncertainty exists, the resulting lung cancer risk estimates may account for some exposure via other pathways but not for other health endpoints such as dermal effects, skin cancer, liver cancer or other effects associated with ingestion of arsenic (ATSDR, 1993b). Other uncertainties associated with the human studies such as concomitant exposure to other chemicals or other confounding factors could also result in an underestimation of risk for the Northport community.

Results

Predicted ambient concentrations are compared to risk-based guidelines in Table 6 below.

Table 5
Comparison of Ambient Concentrations to Risk-based Concentrations

Pollutant	Ambient Concentrations Adjusted for New Controls		Risk-based Concentration
	95th Percentile	Average	
Lead, μg/m³	0.16	0.04	1.5
Arsenic, μg/m³	0.03	0.01	0.0023
Cadmium, μg/m³	0.01	0.00*	0.0056
Sulfur Dioxide, ppm	0.0024	–	0.03

*Cadmium value was 0.001 μg/m³ before rounding.

The only chemical to exceed a risk-based concentration is arsenic. None of the other predicted concentrations exceed risk-based concentrations.

As noted in this report, these risk estimates should better incorporate consideration of exposures from other media such as ingestion of contaminated soils, water, or house dust. Consequently, these risk estimates are associated with some uncertainty.

F. Conclusions

These conclusions are based on the results of the Phase III study, which ran from November 3, 1993, through August 6, 1994.

<u>Section A: Phase III Air Quality</u>

1. Lead values in Northport were below the state and federal standards. Particulate values were below the state standard for both TSP and PM-10.

2. The arsenic annual average concentration exceeded its ASIL, value by a factor of at least 87. The cadmium annual average concentration exceeded its ASIL, value by a factor of 18.

3. A correlation coefficient of 0.995 shows that PM-10 can be used in place of TSP for lead sampling in Northport.

4. Sulfur dioxide levels in Northport were below both the NAAQS and Washington State standards throughout the Cominco, Ltd. and Ecology Phase III monitoring periods.

5. Lead, arsenic and cadmium are deposited in the Northport area in ratios that stay consistent between the metals and indicate a common source, i.e., Cominco, Ltd.

6. Analysis of available data indicates a poor correlation between lead and sulfur dioxide in the Northport area.

<u>Section B: Cominco. Ltd. Lead Smelter Modifications</u>

The proposed technology meets the definition of Best Available Control Technology (BACT), the requirements for All Known Available and Reasonable Technology (AKART), and the limits of the 1976 New Source Performance Standards (NSPS).

<u>Section C: Modeling</u>

Overall, ISCST model performance for predicting the impact of Cominco, Ltd. smelter emissions on northeast Washington State was disappointing since it grossly underpredicted cadmium and sulfur dioxide concentrations. However, it was surprisingly good for predicting lead and arsenic concentrations. In general, use of the ISCST model in situations with complex topography and meteorology is not recommended.

<u>Section D: Phase IV On-Going Ambient Monitoring</u>

A phase IV study to monitor metals and meteorology in the Northport area is necessary to determine if the modified smelter is impacting the local residents.

Section E: Phase III Health Risk Assessment

1. No substantial health risks are expected from exposure to sulfur dioxide, as none of the current regulatory standards are exceeded.
2. Lead health risks from environmental media other than air were evaluated by using an EPA computer model. The impact of predicted air lead concentrations was analyzed separately and added to health risks obtained from computer modeling. The analysis concluded that intake of lead from all sources would not pose undue health risks.
3. Predicted air concentrations for cadmium, while exceeding the ASIL, for cadmium, do not exceed a risk level of 1 in 100,000. Air cadmium concentrations do not exceed EPA guidelines considering non-carcinogenic effects, nor do they exceed the Agency for Toxic Substances and Disease Registry's minimal risk concentration. The analysis concluded that current exposure to cadmium would not pose undue health risks.
4. Predicted air arsenic concentrations do not exceed EPA's guidelines to protect against non-carcinogenic effects. Upper bound estimates of air arsenic concentrations may exceed the 1 in 100,000 risk level Ecology finds acceptable.

G. Recommendations:

Section A: Phase III Air Quality

1. Cominco, Ltd. should continue to monitor, on a long-term basis on the Washington side of the border, the levels of emissions from the new Cominco, Ltd. smelting technology to determine if they are below the levels of concern for lead, arsenic, and cadmium.
2. For the duration of the studies, Ecology should perform checks of the Cominco, Ltd. sampling equipment to ensure data validity and should monitor data precision through co-sampling and sample analysis. Quarterly reports by Ecology should be performed to provide updates on ambient air quality in the Northport area.
3. Once the Kivcet process has been shown to reduce emissions to or below the levels predicted, the potential for air pollution in Northport from the Cominco, Ltd. operation should no longer be of concern. At that time, Ecology will have completed its Phase IV work and should be able to verify predicted changes in ambient air quality. An exception would be if operating conditions at Cominco, Ltd. were changed and caused a health threat to citizens in Washington State, or if arsenic proves to have a greater health impact than currently thought.

Section B: Cominco, Ltd. Lead Smelter Modifications

B.C. Environmental should continue to review smelter operations and share the results with Ecology so that Ecology can track continued compliance with the NAAQS.

Section C: Modeling

Use more complex and sophisticated models, i.e., MM5, CALMET, and CALPUFF in order to adequately characterize potential air quality impacts in northeast Washington from the Cominco, Ltd. operations.

References for Section E – Phase III Health Risk Assessment

Angle, C.R. and M. S. McIntire, 1979. Environmental Lead and Children: The Omaha Study. Journal of Toxicology and Environmental Health, 5:855-870.

Agency for Toxic Substances Disease Registry (ATSDR) 1993 a. Toxicological Profile for Arsenic. US Dept. of Health and Human Services. Atlanta, GA.

Agency for Toxic Substances Disease Registry (ATSDR) 1993b. Toxicological Profile for Cadmium. US Dept. of Health and Human Services, Atlanta GA.

Agency for Toxic Substances Disease Registry (ATSDR), 1993c. Toxicological Profile for Lead. US Department of Health and Human Services, Atlanta, GA.

Balmes, J .R., Fine,.J .M., Sheppard, D. (1987) Symptomatic bronchoconstriction after short-term inhalation of sulfur dioxide. American Review of Respiratory Disease 136: 1117-1121.

Bethel, R.A., Epstein, J., Sheppard, D., Nadel, J.A., Boushey, H.A. (1983). Sulfur dioxide-induced bronchoconstriction in freely breathing, heavily exercising, asthmatic subjects. American Review of Respiratory Disease 128:987-990.

Brown L.M., Pottern L.M., Blot W.J. 1984. Lung cancer in relation to environmental pollutants emitted from industrial sources. Environ Res. 34:250-261.

Cominco, Ltd., 1995. Trail Operations Lead Operation Permit PA0269 Application for Amendment.

Cordier S., Theriault G., lturra H. 1983. Mortality patterns in a population living near a copper smelter. Environ Res. 31:311-322.

DOH, 1994. Air Monitoring Data and Evaluation of Health Concerns in Areas of Northeast Tri-County, Summary of Activities.

DOH, 1995. Health Impact Assessment of Metals Detected in Gardens in Northport, Washington.

Federal Register, 1978. National Ambient Air Quality Standard for Lead, Final Rules and Proposed Rulemaking (October 5), 24:46246-46271.

Federal Register November 15, 1994. 40 CPR Parts 50 and 53 Part III National Ambient Air Quality Standards for Sulfur Oxides (Sulfur dioxide) Reproposal: Proposed Rule Vol. 59, No. 219 pp. 58958-58980.

Frank, N.R., Yoder, R., Brian, J., Yokoyama, E. 1969. Sulfur dioxide ($_{35}$S-labeled) absorption by the nose and mouth under conditions of varying concentrations and flow. Archives of Environmental Health, 18:315-322.

Horstman, D.H., Seal, E. Jr., Folinsbee, L.J., Ives, P., Roger, L.J. (1988). The relationship between exposure duration and sulfur dioxide-induced bronchoconstriction in asthmatic subjects. American Industrial Hygiene Association Journal 49:38-47.

Kleinman, M. T. 1984. Sulfur dioxide and exercise: relationships between response and absorption in upper airways. Journal of the Air Pollution Control Association 34:32-57.

Koenig, J.Q., Morgan, M.S., Horike, M., Pierson, W.E. 1985. The effects of sulfur oxides on nasal and lung function in adolescents with extrinsic asthma. Journal of Allergy and Clinical Immunology 76:813-818.

Koenig, J.Q., Covert, D.S., Pierson, W.E. 1989. Effects of inhalation of acidic compounds on pulmonary function in allergic adolescent subjects. Environmental Health Perspectives 79: 173-178.

Koenig, J.Q., Covert, D.S., Hanley, Q.S., Van Belle, G., Pierson, W.E. (1990) Prior exposure to ozone potentiates subsequent response to sulfur dioxide in adolescent asthmatic subjects. American Review of Respiratory Disease 141:377-380.

Matanowski G., Landau E., Tonascia J. et al., Lung cancer mortality in proximity to a pesticide plant. Washington DC American Public Health Association and USEPA, Office of Toxic Substances. NTIS No. pb80-207376.

Ostro, B.D. and Lipsett, M. 191. Recommendation for the 24-hour ambient air quality standard for sulfur dioxide. California Department of Health Services.

Pershagen G. 1985. Lung cancer mortality among men living near an arsenic-emitting smelter. Am. J. Epidemiol. 122:684-694.

U.S. EPA (1982) Air Quality Criteria for Particulate Matter and Sulfur Oxides. EPA-600/8-82-029a. December 1982.

U.S. EPA, 1989. Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and Validation, OAQPS Staff Report. EPA-450/2-89-011.

U.S. EPA (1994)(a) Supplement to the Second Addendum (1986) to the Air Quality Criteria for Particulate Matter and Sulfur Dioxide (1982): Assessment of New Findings on Sulfur Dioxide Acute Exposure Health Effects in Asthmatic Individuals. EPA-600/FP-93/002.

U.S. Environmental Protection Agency (1994)(b) Review of the National Ambient Air Quality Standards for Sulfur Oxides: Updated Assessment of Scientific and Technical Information, Addendum to the 1982 OAQPS Staff Paper. EPA 450/05-86-013.

U.S. EPA, 1994c. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (version 0.99d). EPA/540/R-93/081.

U.S. EPA 1995a. IRIS file for cadmium Retrieved December 1995.

U.S. EPA 1995b.IRIS file for arsenic. Retrieved December 1995.

Ware, J.H. , Ferris, B.G., Dockery, J.D., Spengler, J.D., Stram, D.O., Speizer, F.E. (1986) Effects of ambient sulfur oxides and suspended particles on respiratory health of preadolescent children. American Review of Respiratory Disease 133:834-842.