Where are we going? Who is in charge?

Note to the reader

The report below is from the archives of the Radiation Safety Institute of Canada (formerly known as CAIRS) and was published in 1987. It is the earliest example of the effective application of "good science in plain language"® by the Radiation Safety Institute of Canada to an issue of public controversy.

Where are we going? Who is in charge? addresses long-standing public concerns about the safe disposal of five million tonnes of radioactive uranium tailings (mine and mill wastes) abandoned by former mining operations in the famously beautiful cottage country of Eastern Ontario. The controversy over these radioactive tailings had been very public, highly charged and apparently intractable.

In 1986, the Paudash Lake Conservation Association, representing some 4,000 cottagers in the affected lake country near Bancroft, approached the independent and relatively new Radiation Safety Institute of Canada for impartial advice and assistance in accordance with its guiding principles of *"good science in plain language."®*

In response, the Radiation Safety Institute worked diplomatically and successfully to achieve agreement by all parties, including the community and five government agencies, to work together towards a mutually satisfactory solution of this major environmental issue. Local media were fully briefed throughout. All pertinent government documents were provided for independent analysis by the Radiation Safety Institute of Canada.

The report, ***Where are we going? Who is in charge?*** came out of this process. In both content and questions raised, the report was shocking to the local residents and disturbing, to say the least, to government regulators. It showed the unwillingness over many years of federal and provincial jurisdictions to grasp the nettle and come to an agreement on the disposal of these 5 million tonnes of historic wastes. It also showed for the first time that, in an area of exclusively federal jurisdiction not a single federal regulation existed to govern the safe disposal of uranium mine tailings.

The world has changed since then. Assisted by the Radiation Safety Institute of Canada, the Paudash Lake Conservation Association met with the president and full board of directors of the then federal Atomic Energy Control Board (AECB) to persuade them to act on the report. To its credit, the AECB took the initiative, decided to effect a real solution and worked with the residents to do so.

The tailings are still there: 5 million tonnes are not easily removed. But now everyone knows where they are: they are marked on maps! Remedial measures are in place, radioactivity is monitored regularly and the tailings are securely fenced off - no longer do local teenagers, innocent of the potential effects of these industrial wastes, use them for picnics and cookouts.

In the end, the residents were part of the solution and approved the results. The long controversy was over at last. And under the subsequent *Nuclear Safety and Control Act*, the disposal of uranium tailings in Canada is now under strict and specific regulation.

RADIOACTIVE AND TOXIC WASTES

FROM THE

BANCROFT URANIUM MINES

WHERE ARE WE GOING?

WHO IS IN CHARGE?

CAIRS REPORT STAGE II

Prepared at the Request of the

Paudash Lake Conservation Association

CANADIAN INSTITUTE FOR RADIATION SAFETY

INSTITUT CANADIEN DE RADIOPROTECTION

Toronto, May 1, 1987

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(...Continued)

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I. PRELIMINARY

WHERE ARE WE GOING?

WHO IS IN CHARGE?

These are two simple and fundamental questions. They do not come out of the air. They come, rather, from a careful examination of government documents pertaining to inactive and abandoned uranium mines in the Bancroft area of Eastern Ontario. They come because of the impression left by these documents of Canada's and Ontario's state of readiness to deal with a difficult and serious problem: the potential effects on human beings and on the environment of huge dumps of radioactive and toxic wastes from inactive or abandoned uranium mines.

These two simple and fundamental questions have arisen specifically out of an examination of the documents pertaining to Bancroft. They are likely, however, to have a wider significance. The reason is not hard to find.

The uranium tailings dumps in the Bancroft area amount to some 5 million tonnes. They are small, in fact, when compared with dumps elsewhere in Canada. In 1982, the Government of Canada estimated that there were about 131 million tonnes of uranium tailings in Canada: 100 million in Ontario, 30 million in Saskatchewan, 1 million in the Northwest Territories. That was five years ago. More have been added since.

The present report deals with concerns raised by the presence of several uranium tailings dumps in the Bancroft area. It attempts to deal with these concerns fairly and dispassionately. It is not judgemental. It leaves people to make up their own minds and provides adequate information for them to do so. Certainly, it raises serious questions for people to think about.

As one considers these questions, however, it may be well to consider also that the residents of Bancroft, of Ontario and Canada generally have benefited directly or indirectly from the industrial activity that has left a legacy of problems we are now trying to understand and to deal with. The shareholders of the several mining companies involved have profited directly from the activity; the tax coffers of both the Ontario and Federal governments also have been the richer for it. All Canadians in fact have participated to some degree, directly or indirectly, in the benefits of the activity. Perhaps it is time now for all Canadians to cooperate also in finding an answer to the question of what to do with the leftovers.

For that, of course, is the problem. What is to be done with these radioactive and chemically toxic leftovers? How are they to be disposed of safely and securely so that no avoidable harm can come to present and future generations? Which government, Canada or Ontario, is to accept responsibility for ensuring the general safety? And last, but not least, the crucial question, the horns of the dilemma at present: Who is to pay, now and for the future?

The Canadian Institute for Radiation Safety (CAIRS) is an independent institute that was founded upon the principle of cooperative, concerted action in pursuit of practical solutions to these very difficult kinds of problems.

CAIRS would urge all parties, therefore - be they residents, cottagers, companies, governments or the news media - to continue to act in the cooperative spirit that has characterized this inquiry from the beginning.

There is no doubt that workable solutions will have to be found and policies and programs developed, in relation to Bancroft and to other places, that in every aspect may not be to every person's liking.

We must concern ourselves, however, with more than the short term. We must be concerned for the future, for the sake of the environment, our own health and the health of our children and heirs. For the problem we are dealing with is not confined to Bancroft. It is widespread. It is serious. It will not go away of its own accord. Nor will it be ignored. It is a problem that demands attention and serious minded attention at that: systematic, careful and deliberate attention.

The time has come, therefore, in Ontario and in Canada, to agree on where we are going and who is in charge.

Fergal Nolan, D.Phil.
President

Ernest Becker, Ph.D.
Senior Scientist

BANCROFT URANIUM MINE TAILINGS

CAIRS' ACTIONS TO DATE

First approach

CAIRS was approached by the Paudash Lake Conservation Association on September 16, 1985 for assistance in obtaining information about possible radiation hazards from the various uranium mine waste dumps ("tailings piles") in the Bancroft mining area of Eastern Ontario, Canada.

The Paudash Lake Conservation Association is an association of residents and cottagers in the Bancroft area.

CAIRS' initial advice

CAIRS advised the Association, as a first step in getting a complete account of the facts, that those government departments and agencies with a public responsibility for overseeing, monitoring and regulating the tailings in all and any of their aspects should be approached to see what information such departments and agencies were able and willing to provide.

The Association agreed that this was a prudent course of action. The Association then asked CAIRS to undertake this action on the Association's behalf. A contractual relationship was agreed to between the Association and CAIRS.

CAIRS' independent, impartial status

It was also agreed by CAIRS and the Association that CAIRS would act only as an independent and impartial adviser and would give its best advice as such and be regarded as such in its dealings with all parties.

Action by CAIRS

CAIRS wrote to three departments and agencies of the Government of Canada and to two ministries of the Government of Ontario outlining under specific headings the nature of the information being sought with respect to the uranium mine tailings in the Bancroft area.

In order to foster a spirit of cooperation and trust in what was (and is) a delicate and potentially controversial exercise, CAIRS reminded all parties, both the Association and the respective departments of government, that the Institute's *modus operandi* was to keep all parties fully informed as the inquiry proceeded.

As some in government were particularly sensitive on the point, CAIRS assured all government departments that their replies to the Institute's request for information would not be edited by CAIRS nor amended in any way, but would be compiled in a single report and transmitted fully, faithfully and in every detail to the Paudash Lake Conservation Association.

Further advice from CAIRS

Apart from these assurances, CAIRS reserved the right to provide a summary of the compilation of government reports as a guide to the reader.

The Institute also reserved the right to give independent advice to the Association on the nature of the information and assessments provided by the several government departments and to assist the Association to understand the information provided.

Finally, if the information provided by the five government departments did not answer all of the Association's questions or did not address fully all of their concerns, the Institute reserved the right to pursue the matter further in a separate report to the Association with copies to all parties.

Fairness and balance

This the Institute believed would be a fair and balanced approach to obtaining the commitment of all parties to work together to resolve in a practical way any serious difficulties that might come to light in the course of this inquiry by the Canadian Institute for Radiation Safety (CAIRS).

Cooperative spirit

So far, the Institute is pleased to say, a spirit of cooperation has prevailed. The Paudash Lake Conservation Association has expressed its questions and concerns to the Institute in a serious minded and responsible way and with an expressed willingness to cooperate in arriving at whatever practical solutions may be required.

For their part, the five government departments took the Institute's request for information most seriously and put a great deal of time and effort into preparing lengthy and detailed replies. As a consequence, the receipt of the information by CAIRS for compiling into a single report for presentation to the Paudash Lake Conservation Association took several months longer than had been anticipated.

THE FIRST CAIRS REPORT

The first CAIRS report, titled **Bancroft Uranium Tailings: Information Obtained by CAIRS from the Federal and Provincial Governments**, was tranmitted to the Paudash Lake Conservation Association on August 25, 1986. Copies were sent to all government departments who had participated in its compilation. Copies were also made available at cost to any person who requested them, without exception.

Contents of the first CAIRS report

The first CAIRS report to the Paudash Lake Conservation Association is a comprehensive document. It contains a multitude of facts and figures, charts, graphs and illustrations, correspondence with mining companies and other material from federal and provincial records concerning the uranium tailings in the Bancroft area.

To guide the lay reader in understanding the information provided, CAIRS provided a brief summary under several heads and noted any continuing problems that had been raised by the respective government departments themselves.

Response to the first CAIRS report

Following receipt of the report, the Paudash Lake Conservation Association asked for a meeting with CAIRS to discuss the replies of the various government departments.

A number of concerns were raised. The Association was particularly concerned, for example, that the question of jurisdiction respecting uranium tailings as between the Federal and Ontario governments was not yet resolved. This problem had emerged from the replies of the governments themselves and was a considerable surprise to the Association.

Other questions and concerns arising from the governments' replies were also raised. Finally, it was decided by the Association to ask CAIRS to compile a report summarizing what had been learned so far and to address the principal concerns of the Association arising from the replies of the Federal and Ontario governments in the first report.

CAIRS agreed to undertake this task.

The News Media: CAIRS' advice

As there appeared to be considerable interest in the news media regarding the outcome of CAIRS' inquiries on behalf of the Paudash Lake Conservation Association, CAIRS advised the Association that the most prudent and helpful course of action would be to provide the news media with the complete report, thereby giving journalists the opportunity to report accurately the information that had been made available.

CAIRS understands that this advice was taken by the Association and that efforts have been made by the Association to assist journalists in obtaining an accurate understanding of the information provided.

For this effort, the Institute commends the Paudash Lake Conservation Association.

What follows now

What follows now is the second CAIRS report, as requested by the Paudash Lake Conservation Association.

Copies will be sent as before to the five government departments and agencies which have cooperated in the inquiry. Copies will also be made available at cost to any person who wishes to receive them.

II. THE PROBLEM AND THE PEOPLE AFFECTED

BANCROFT AND URANIUM MINING: A HISTORICAL NOTE

The first outcrops of uranium in the Bancroft area of Eastern Ontario were discovered in 1922. Various attempts to recover radium from the uranium ore were made in the 1920's and 1930's. Following World War II, there was considerable interest in the mining of uranium. At least four producing uranium mines and three uranium mills were established in the Bancroft area.

1. Regulatory authority

Although these mines were licensed by the Atomic Energy Control Board of Canada (a Federal agency), the Atomic Energy Control Board did not regulate the operations of the uranium mining industry directly until 1977.

Consequently, two of the uranium mines (Bicroft and Dyno) which ceased operations in the 1960's were allowed to abandon their mining and milling operations without any effort being made to minimize the radiation hazards emanating from the abandoned wastes.

2. Madawaska Mines Ltd.

The other two uranium mines in the Bancroft area (Faraday and Greyhawk) were also abandoned in the 1960's but reactivated in 1976 by Madawaska Mines Ltd. That mining operation ceased in 1982.

This time, however, the mining company was obliged to formally decommission the site to standards set by the Atomic Energy Control Board of Canada. This decommissioning is now in progress and **Madawaska Mines Limited will be allowed to abandon its facilities at Bancroft after November 30, 1988,** provided that the Atomic Energy Control Board is satisfied that all the Board's requirements have been met.

BANCROFT AFTER URANIUM MINING: RESIDUAL HAZARDS

1. Getting an abandoned mine into a safe state

When a uranium mine ceases operations, there remain on site a mine shaft or shafts, some buildings and equipment and a quantity of tailings containing the radioactive decay products of uranium as well as some quantity of uranium itself.

Placing these industrial leftovers into a safe state may be more or less difficult, depending on which part of them one is dealing with.

- The mine shafts: They can be sealed with little difficulty.
- The buildings: They can be cleansed of radioactive contamination or they can be demolished and the building materials buried.
- The tailings: They are the most difficult to deal with because of their relatively large volume and because they contain most of the radioactivity that was brought to the surface.

At Bancroft, the amount of the tailings produced ranges from a relatively small amount at the Dyno mine site to an estimated 5 million tonnes at the Madawaska Mines site.

2. Exposure to radiation from the tailings

The ways by which area residents can be exposed to radiation from the tailings include the following:

a) People who walk or ride over the tailings may be exposed to direct, external gamma radiation originating from radioactive material in the tailings.

b) The tailings also emit a radioactive gas called radon. This radioactive gas will drift downwind from the tailings piles and be dispersed in the atmosphere. If people inhale this radioactive gas, their lungs will be exposed to radiation emitted by this gas.

c) Radioactive material can dissolve in water and appear in bodies of water downstream from the tailings. This radioactive material can contaminate fish and plant life as well as drinking water. People who ingest this radioactive material by eating and drinking contaminated food and water will expose their internal organs to radiation.

d) Within a generation or so, tailings piles can become covered with vegetation and be unrecognizable for what they are. Without sufficient control over the Bancroft sites, it is conceivable that, unaware of the risks, people could in the future build homes on these tailings sites or use material from the sites for construction purposes elsewhere.

Once material from the tailings is in people's homes, all of the ways outlined above in (a), (b) and (c) by which people can be exposed to radiation from the tailings then become possible in the home.

To our knowledge, this problem does not exist at present in the Bancroft area. However, it is quite possible that it could become a problem in the future if adequate controls are not in place. It has been a problem in Port Hope, Ontario. It is a problem that has reached serious proportions already in the United States.

3. Hazards from toxic chemicals

In addition to radioactive material, the tailings contain arsenic, aluminum, calcium and barium. Some of these materials (as is, indeed, the case also for uranium), are chemically hazardous. In some circumstances, the chemical hazard presented by these materials may outweigh the radiation hazard.

4. Effects

As is explained in Part IV of this report, there will be no gross visible effects on plant and animal life because of the radiation given off by these tailings.

The primary concern from radiation, however, is not the possibility of visible effects on plant and animal life, but the possibility of cancers induced by radiation occurring in the local human population.

The chemical poisons in the tailings can produce a visible effect on the local ecology. However, as long as the tailings remain secure and undisturbed, these effects appear unlikely to happen. This is particularly the case for the Bancroft area tailings because these tailings are not acidic. (Acids leaching out of tailings piles can have a drastic effect on local fish populations).

5. Summary

The chemical hazards in the tailings are only of concern if the tailings piles are disturbed or if water is allowed to leach through the tailings and carry off these materials.

Radiation, however, will be given off by these tailings whether they are disturbed or not. If the piles are disturbed, the magnitude of the radiation hazard will be increased.

TIME, WIND AND WATER AND THE INTRUSION OF HUMAN BEINGS

1. Time

The toxins and carcinogens contained within the Bancroft uranium tailings piles will be around for quite a long time.

For example, one source of radioactivity, Radium-226, has a half life of 1600 years. This means that 1600 years from now, half the Radium-226 now present in the tailings, will still be emitting radiation.

The half-life of the chemical toxins and carcinogens within the tailings is, of course, infinite.

All this implies that any measures taken to place uranium tailings piles in a safe state must be effective for the **indefinite future.**

2. Wind and Water

Specifically, future erosion of the piles by wind and water must be minimized. The steps taken to minimize disturbances of the piles should rely on passive measures that will not require active work by government or company personnel. The measures taken should work by themselves.

3. Intrusion by human beings

Because this area has a relatively heavy population of cottagers and is a significant tourist centre close to the Toronto area, **the control of future human activiites that might disturb these tailings may be the most important consideration of any.**

Activities that should be avoided include:

- Diversion of water courses through the tailings.
- Construction on the tailings sites.
- The use of materials from the sites for construction elsewhere.

It should be noted that the growth of vegetation over as little as twenty or thirty years can easily disguise the whereabouts of a uranium tailings pile.

How long will people remember (and their heirs and descendents) what is under the vegetation, if the piles are not controlled?

4. Summary

In summary, these tailings sites have been rendered uninhabitable for the indefinite future.

This, of course, is generally true of tailings from many other kinds of mining activity.

However, the radiation from uranium tailings does add an additional complication above those presented by tailings from other kinds of mining.

WHO HAS JURISDICTION NOW AND FOR THE FUTURE?

1. Historical ambiguity

Government responsibility for regulating the four known inactive uranium mine sites in the Bancroft area depends on when the mines ceased operations.

Before the Atomic Energy Control Board of Canada took an active role in regulating the uranium mining industry in 1977, uranium mining in Ontario was regulated by the Province of Ontario, although the uranium mines did require a federal Atomic Energy Control Board licence to operate.

Because of this historical ambiguity, the jurisdictional responsibility for old abandoned uranium mines has yet to be resolved. This explains why the Dyno and Bicroft mines, closed before 1977, have not undergone any remedial work designed to place them in a safe condition.

2. Madawaska Mines Ltd.

The more recent Madawaska Mines operation is under direct Atomic Energy Control Board regulation. Madawaska Mines Limited may leave this site only after it has carried out remedial work to a standard satisfactory to the Atomic Energy Control Board of Canada.

3. Summary

Even for the formally decommissioned tailings, as in the case of the Madawaska Mines site, the question of jurisdiction remains.

Which level of government will be responsible in the future for the monitoring of these sites? Which level of government will be responsible for future remedial work, if the present decommissioning of the uranium tailings sites proves inadequate?

Even if that decommissioning is adequate, government responsibility must still be assigned. The reason? No decommissioning process, no matter how carefully conceived, particularly one that leaves the tailings in place, can remove the necessity for some measure of supervision and for some remedial work in the coming decades and centuries.

The questions raised here, therefore, require an answer.

QUESTIONS AREA RESIDENTS MIGHT WISH TO CONSIDER

1. The people affected

As CAIRS views the matter, there are a number of questions which the Paudash Lake Conservation Association ought to consider and decide upon.

Some of these questions have a number of difficult implications. There may not be a "right" answer or a "wrong" answer in every case. None the less, the local residents of the Bancroft area are the people who are obliged to live with the legacy of previous industrial activity in the area. It is they and their heirs who will be most affected by potential hazards associated with the uranium tailings left behind by that activity.

2. The questions

The questions facing the Paudash Lake Conservation Association are as follows:

a) What should be done about the abandoned uranium mines at Dyno and Bicroft given the following facts?

- These properties have no accountable owner, according to the Ontario Ministry of the Environment (see first CAIRS report). It should be noted that CAIRS has not verified the accuracy in law of this statement.

- The Dyno and Bicroft sites do most certainly require remedial work. In this connection it should be noted that although the level of contamination of water downstream from these sites is at present only somewhat elevated, this level of contamination may increase rather than decrease with time, as old dams deteriorate and water courses change.

- A decision at the political level needs to be made as to which jurisdiction, federal or provincial, is to be responsible for the abandoned uranium mines at Dyno and Bicroft.

b) Is the decommissioning of the Madawaska Mines site adequate?

- In this case the jurisdictional responsibility is clear. The Atomic Energy Control Board is the controlling regulatory agency.

- Part III of this report provides further information to assist the Paudash Lake Conservation Association in making an informed decision as to the adequacy of the decommissioning of the Madawaska Mines site under present guidelines.

c) What measures are required for the long-term security of all four sites?

Assuming that all four known sites are properly decommissioned, the questions then remaining are the following:

- Who will monitor all the abandoned sites and perform remedial work if it is required?

- Who will be responsible for ensuring that these sites remain completely undisturbed by any industrial, cottage or tourist developments for the indefinite future, that is to say, for hundreds of years?

III. THE POST-MINING ENVIRONMENT:

MAKING IT SAFE

TWO APPROACHES: CANADIAN AND AMERICAN

1. Purpose

The purpose of this section is to acquaint those not expert in radiation safety matters with the present Canadian system intended to ensure that inactive uranium mine sites are in a safe state now and for the future.

2. Forming an opinion

There is sufficient information in what follows for the general lay reader to:

(a) gain an understanding of the difficulties in dealing with the safe disposal for an indefinite future of low level radioactive wastes from a uranium mine; and

(b) to form an opinion about the efficacy of the methods employed in Canada at present.

3. A point to remember

Again, it should be borne in mind that we are not dealing in Bancroft with wastes that have a high level of radioactivity. These are not wastes as from a nuclear reactor, for example, which, in any case, are secured, stored and monitored in carefully controlled conditions on the reactor site. The amount of wastes from reactors is also very small when compared to the amounts of wastes from uranium mining. Radioactive wastes from uranium mining come in huge amounts.

As we said earlier, according to the Canada Centre for Mineral and Energy Technology (CANMET), the research arm of the Federal Department of Energy, Mines and Resources, there were 131 million tonnes of uranium tailings in Canada in 1982: 100 million tonnes in Ontario, about 30 million in Saskatchewan and 1 million in the Northwest Territories.

That was five years ago. More have been added since. At Bancroft, there are about 5 million tonnes of uranium tailings at the Madawaska Mines site.

4. A comparison with the United States

A brief summary of the American approach to the safe disposal of uranium mine tailings is included in this section. The purpose in doing so is to assist the lay reader in forming an opinion about the adequacy of the Canadian approach by providing a comparison taken from the nearest national jurisdiction, our neighbour, the United States.

CAIRS respects the right and ability of the intelligent and conscientious lay reader, once possessed of adequate and accurate information, properly understood, to arrive at his own or her own considered opinion in the matter.

The Institute, therefore, makes no judgement as to which of the two approaches, Canadian or American, is preferable. There may be more (or less) merit in either one.

However, the comparison of the two approaches may be helpful in enabling the Paudash Lake Conservation Association to form its own conclusions about the adequacy of the present approach to the decommissioning of the Madawaska Mines Ltd. mine site.

THE CANADIAN APPROACH TO ENSURING THE SAFETY OF THE POST-MINING ENVIRONMENT

1. Responsibility

The Atomic Energy Control Board of Canada, an agency of the Federal Government, is responsible for regulating all uranium mines operating at present in Canada. This responsibility includes the regulation of the closing-out of such mines when they cease production.

2. Regulation in practice

The Atomic Energy Control Board receives its authority from an Act of Parliament called "The Atomic Energy Control Act". The Act is broadly written, as are most Acts of Parliament. The usual practice is to supplement or flesh out (as it were) an Act of Parliament with a body of Regulations, general and specific, designed to put into practical effect the spirit and intent of the Act of Parliament. These Regulations, once enacted, have the force of law.

The Atomic Energy Control Act is, indeed, accompanied by Regulations, both general and specific. Certain parts of these Regulations are currently under review. New regulations are being developed in areas that have not before had specific regulations to govern their activities: uranium mining, for example.

In practice, however, much of the detailed regulation of facilities and operations in the nuclear energy industry is to be found not in the Atomic Energy Control Act nor in the universal regulations that accompany it, but in the specific conditions attached to specific licences which these facilities and operations must obtain from the Atomic Energy Control Board in order to operate legally.

This practice of regulation by individual licence actually allows for a considerable degree of latitude on the part of government officials who may, at their discretion, decide what conditions are to apply at a particular mine site, for example, and what conditions need not apply.

We are not saying here that this discretion is exercised wisely or unwisely, prudently or imprudently. We are simply describing regulation in practice in Canada as applied to facilities and operations in the nuclear energy industry.

3. Decommissioning a uranium mine

When a company which has been operating a uranium mine under licence from the Atomic Energy Control Board wishes to cease operations and to close the mine, it must obtain a licence to do so from the Atomic Energy Control Board. This licence is called "Decommissioning Approval". It sets out the specific conditions the company must fulfill before it may abandon the mine. Again, these conditions are applicable only to that particular licence holder. They are not universal conditions or Regulations.

4. No detailed Regulations in Canada

In fact, except for the broad terms of the Atomic Energy Control Act by which the Atomic Energy Control Board is governed, **CAIRS has learned that there are no detailed specific regulations in Canada to govern the decommissioning of a uranium mine.**

5. Guidelines

In lieu of Regulations (or, perhaps, in a continuing attempt to develop them), the Atomic Energy Control Board has published a number of "Consultative Documents" in which guidelines are proposed for the safe disposal of radioactive wastes from uranium mines and upon which comments have been sought from interested parties.

Such guidelines, however, have no effect in law. They represent the thinking of the Atomic Energy Control Board and may or may not be imposed on licence holders at the Board's discretion.

An example of Canadian guidelines as applied to the management of uranium tailings follows immediately in Table I.

TABLE I

Canadian Guidelines

Quotation:

- "The dose limits specified in the Atomic Energy Control Regulations shall be observed;
- "Any exposures arising from the site should be kept as low as reasonably achievable, economic and social factors being taken into account;
- "The annual quantities of radioactive and non-radioactive contaminants released to the environment should not exceed the corresponding releases during the operational phase;
- "Dust emissions from the closed-out site should be minimized in a manner consistent with good engineering practice;
- "The use of passive barriers, natural or engineered to control radioactive and non-radioactive releases from the closed-out site should be maximized; and
- "The use of containment systems which may be subject to abrupt degradation of performance should be minimized and preference given to systems which only degrade gradually."

Source

"Long Term Aspects of Uranium Tailings Management, January 1981", Consultative Document C-1, Atomic Energy Control Board of Canada.

THE AMERICAN APPROACH

1. Responsibility

The United States has a relatively large number of inactive and abandoned uranium mines (about 30) in various parts of the country. A number of government agencies are involved at the federal and state levels.

2. Regulation in practice

The American approach is to control the management and disposal of uranium mine tailings by means of detailed regulations issued by the Environmental Protection Agency, a federal government body.

These regulations are supported by voluminous documentation justifying the standards set by the U.S. Environmental Protection Agency for the safe management and disposal of uranium mine tailings. The documentation in support of the standards runs into hundreds of pages.

What follows is a quotation from one of these documents describing how the standard selected for radon emissions from uranium tailings was arrived at.

3. Example: How the U.S. Environmental Protection Agency selects a standard

Quotation:

"Selecting a limit for radon emissions from tailings involves four public health objectives, in addition to reducing health effects from radon released directly from the pile.

"These (objectives) may all be achieved by using a thick earthen cover, which serves to inhibit misuse of tailings, to stabilize tailings against erosion and contamination of land and water, to minimize gamma exposure, and to avoid contamination of groundwater from tailings.

"A radon emission limit of 20 pCi/m^2s or less would require use of a sufficiently thick earthen cover to achieve all of these objectives. Our analysis shows that a limit of 20 pCi/m^2s is also cost-effective for eliminating most health effects in regional and national populations from radon released directly from the pile. Such a limit would also reduce maximum individual risks to residents near tailings piles to less than one in 1,000.

(...Continued)

"We concluded that levels higher than 20 pCl/m^2s are not justified, based on the cost-effectiveness of risk reduction to 20 pCi/m^2s, and the unacceptably high maximum individual risks involved at higher levels."

Source: Final Environmental Impact Statement for Standards for the Control of By-product Materials from Uranium Ore Processing (40 CFR 192), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C.

4. Effect of United States standards

The standards set by the U.S. Environmental Protection Agency are strict. Some might say that they are stringent, leaving no loophole or even room for discretion.

In application, they have necessitated the complete removal of many uranium tailings piles to locations which the Environmental Protection Agency deemed better suited to safe long term management. In one case, in Salt Lake City, Utah, these standards necessitated the complete removal of a large uranium tailings pile to a new location some 120 kilometres away, a lengthy and costly operation.

The United States at present has in place a project to undertake remedial action on old uranium mill tailings across the United States. It is called the "American Uranium Mill Tailing Remedial Action Project". The total cost of that project will be about U.S. $1 billion.

5. Standards for Remedial Work

Those who undertake remedial work on American uranium tailings may use whatever methods they choose so long as the standards are met. The standards themselves are universal. They do not vary from mine site to mine site. Variations do occur only in so far as individual states may impose additional conditions to ensure that remedial work is in conformity with that state's standard for water quality.

The specific American standards set out in Table II are applicable to the safe management and disposal of **all** U.S. uranium tailings.

TABLE II

United States Standards

Quotation:

Subpart A **Standards for the Control of Residual Radioactive Materials from Inactive Processing Sites.**

192.02 **Standards**

Control shall be designed to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average release rate of 20 picocuries per square meter per second or,

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one half picocurie per liter.

Subpart B **Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites.**

192.12 **Standards**

Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than -

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building -

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

Source: United States Federal Register, Vol. 48, No. 3 (January 5, 1983); 40 CFR Part 192.

AN EXAMPLE OF THE CANADIAN APPROACH

MADAWASKA MINES LIMITED

1. Decommissioning approval sought

In June 1983, Madawaska Mines Limited applied to the Atomic Energy Control Board of Canada for "Decommissioning Approval" with respect to its uranium mining operation in Bancroft, Ontario.

In support of its application, the mining company submitted a document entitled "Proposal for Decommissioning and Close-out of the Bancroft Property".

This document describes the remedial actions the mining company proposed to take in order to leave its now inactive uranium mine in an environmentaly stable and safe condition.

2. Approval Granted

The document presented by Madawaska Mines Limited was approved by the Atomic Energy Control Board of Canada.

It is cited, along with other specific conditions (see first CAIRS' report), as a licensing condition in the "Decommissioning Approval" granted to Madawaska Mines by the Atomic Energy Control Board.

3. The Plans

A summary of the company's decommissioning plans as presented by Madawaska Mines Limited is given in Table III, which follows immediately.

TABLE III

Madawaska Mines Limited Decommissioning Proposal As Approved by AECB Licence AECB-DA-139-0, November 24, 1983

Quotation:

"In summary, Madawaska Mines Limited plans to do the following to safely close-out their property:

a) Maintain adequate security to protect the company's physical assets.

b) The sprinkler system in the mill is now being monitored from the mine residences.

c) Complete the contouring of No. 2 Area during the 1983 season.

d) Complete the grassing of the new berm on north-east corner of No. Tailing Area.*

e) Cover No. 1 Tailing Area with rock and/or gravel to allay dust and encourage encroachment of indigenous vegetation.

f) Contour the north edge of No. 1 Area to allow run-off from the area north of the tailing area to drain across the tailing area into the shallow pond. The contoured ditch will be rip-rapped to minimize erosion.

g) Seepage from the west sump will be allowed to flow into old septic tile bed.

h) The decant tower from No. 1 Area will drain to the gravel filter bed, by-passing the concrete settling basin.

i) Monitor surface and ground water for radium 226.

j) The company plans to maintain the property so that it may be reactivated should uranium markets recover. Because recovery does not appear to be probable before the 1990's, the company has sold and will continue to sell expendable stores and equipment which may deteriorate or become obsolete. All sales or donated material will meet the requirements of the AECB as to safe levels of radioactivity."

*No number is given in the approved proposal.

Source: F.C. Lendrum, Proposal for Decommissioning and Close-Out of Madawaska Mines Limited, Bancroft, Ontario, June 1983.

Received from the Atomic Energy Control Board subsequent to the first CAIRS report. Decommissioning Approval (AECB-DA-139-0) is included in the first CAIRS report.

CAIRS' COMMENT

On The Approved Madawaska Mines Decommissiong Plan

The Canadian Institute for Radiation Safety (CAIRS) believes it is pertinent at this point to draw the attention of the Paudash Lake Conservation Association to certain aspects of the company's decommissioning plans, as approved by the Atomic Energy Control Board.

These aspects may warrant further serious consideration. Further discussion with government and company representatives may be in order.

The comments that follow are based on the documents provided by the appropriate government authorities. CAIRS has not been made aware of any other government documentation pertaining to the decommissioning of the Madawaska Mines Limited site. It is assumed, therefore, that the documentation provided in the first and second CAIRS' reports is complete.

1. Radon gas emissions

In the decommissioning plan approved by the Atomic Energy Control Board, there is no reference to required limits on the rate of radon gas emission from the uranium tailings pile. Nor is there any reference to the actual rate, at present, of radon emissions from the tailings pile.

2. Gamma radiation

There is no reference in the approved plan to allowable gamma dose rates, other than a reference to dose limits governed by the Atomic Energy Control Act for the general public.

3. Numerical limits on emissions

The only numerical limit imposed on emissions from the Madawaska Mines uranium tailings is on run-off water from the site. The limits imposed are:

- Ammonia (NH_3 as N) - 0.02 mg/L
- Radium-226 - 1 Bq/L

4. Time

There is no reference in the approved plans to the length of time for which the company's remedial actions must continue to be effective.

5. Future Monitoring

There is no reference in the approved plans to provisions for monitoring the mine site and the uranium tailings pile after the final abandonment of the mine, scheduled for November 1988.

6. Future Responsibility

There is no reference in the decommissioning plan to the question of who is to be responsible for the uranium tailings following their abandonment.

IV. EXPOSURE TO LOW LEVEL RADIATION: HOW DO WE ASSESS THE EFFECTS ON HUMAN BEINGS AND THE RISKS INVOLVED?

1. Research

Except, perhaps, for the Bible and Shakespeare, there is scarcely a subject that has been more closely studied than the effects of radiation on living things, on plants, animals and human beings.

That research has not exhausted all the possibilities of knowledge about the effects of radiation. Even so, a wealth of information has already been collected by thoughtful people who have undertaken careful and prolonged research into the effects of low level and high level radiation on the population (plant, animal and human) of our planet.

In what follows, CAIRS will draw on the fruits of that research to guide the reader in assessing for himself or herself the possible effects and the risks involved from living in the general vicinity of the Bancroft uranium tailings.

2. Education

Most people do not make a distinction between different kinds of radiation or between different levels of radiation. The word "radiation" is itself sufficient to create concern in most people's minds.

That is not surprising. For most people in Canada, whether they are well educated or not so well educated, know very little, if anything at all, about radiation. The subject is not taught in the nation's schools. It is barely touched upon in our universities, except for certain specialized areas of study. Radiation is not part of a Canadian's general education.

That omission is remarkable when one comes to think about it.

Many billions of dollars of taxpayer's money and of private investment over the years have been spent in making Canada one of the world's leaders in medical and industrial technologies involving radiation. Yet Canadians on the whole do not possess even the rudiments of a general knowledge about radiation that would assist them in beginning to assess the pros and cons of these technologies for themselves. There is no doubt that the knowledge exists. It is freely available. It takes only the will, the imagination and the ingenuity of our society to organize matters so that knowledge about radiation, its uses and abuses, can become part of the general knowledge of Canadians.

3. High level and low level radiation

When we think about the possible effects of exposure to radiation from the uranium tailings at Bancroft, we should again bear in mind that we are not dealing with exposure to high level radiation. We are dealing with the possible effects of prolonged exposure to low level radiation.

4. Effects of exposure to low level radiation

CAIRS is convinced that the nature of radiation and the effects on human beings of exposure to radiation are subjects that are capable of being understood (and that ought to be understood) by ordinary, intelligent, thinking Canadians.

The general concepts about the nature of radiation and the effects on human beings of exposure to radiation are not difficult to understand. One should be aware, however, that there is an enormous body of research material behind these general concepts. What follows, therefore, is only a brief summary of this research. No attempt is made in this summary to cover all aspects of what is known or still uncertain about the effects of exposure to radiation.

5. Cancers, birth defects, genetic damage

Scientists who have conducted careful and prolonged investigation into the effects on human beings of exposure to radiation have discovered the following general effects:

(a) Cancers in some people who have been exposed to radiation, as a consequence of their exposure.

(b) Cancers in some children who had been exposed to radiation before they were born, (i.e. exposed while they were in the uterus), as a consequence of exposure.

(c) Birth defects in some children who had been exposed to radiation before they were born (i.e. exposed while they were in the uterus), as a consequence of their exposure.

(d) Genetic damage not in human beings but in laboratory animals. So far, genetic damage has not been observed in human beings. However, from the laboratory experiments on animals, scientists conclude that genetic damage will occur in human beings also.

6. Thinking about the effects

These known effects may sound alarming. But, before we give way to panic, let us consider the matter more carefully.

The first thing to be said is that, so far, scientists have found it impossible to observe these effects in human beings who have been exposed to low levels of radiation, such as those on the Bancroft tailings. The reason is that the effects of radiation exposure (cancer and birth defects) are indistinguishable from the large number of cancers (20-25%) and birth defects (5-10%) that occur anyway in the general population.

The second thing to be said is that scientists have indeed observed these effects (cancers and birth defects) in human beings who have received higher levels of exposure than they would on the Bancroft tailings. Scientists have observed these effects in varying degrees. But, they have observed them and with sufficient evidence to be certain that these effects do occur as a result of exposure to higher levels of radiation.

The third thing to be said is that scientists have also observed that with each reduction in exposure, these effects occur in fewer and fewer people, generally speaking. So much so, that at low levels of exposure, the numbers of people in which these effects occur are so few that scientists find it impossible to say with certainty that the birth defect or the cancer that shows up in this or that person is the result of exposure to low levels of radiation. The birth defect or cancer, after all, could have come from some other cause. Cancers and birth defects do also occur in people who have had no exposure to any unusual source of radiation.

Still, from their knowledge about the effects of higher levels of exposure to radiation, scientists have concluded that it is prudent to assume that these same effects will occur (even if they cannot be observed), but to a far lesser extent, from lower levels of exposure.

Scientists conclude, therefore, that where there are unusual sources of radiation, whether they be high level or low level, prudence demands precautions.

7. Questions and Answers

First Question:

"Is it true that every person who is exposed to low-level radiation will develop one or other of the effects listed above?"

Answer:

No, it is not true that every person exposed will suffer one or other of the ill effects from exposure to radiation that scientists have identified. That should be clear now from what we have said above.

Still, it is useful to raise the question because it reflects a belief that many people share. For it is not uncommon for people to believe that if they were to be exposed to radiation, cancer would result inevitably.

That belief is mistaken. It is not true. It is not even true (surprisingly) for people who receive high levels of exposure. Cancer does not follow inevitably in every case. It is even less true for those who receive low levels of exposure.

What is true is that exposure to radiation at high levels is certain to cause cancers and birth defects in a proportion of the population exposed and that these cancers and birth defects are a consequence of that exposure and not a result of any other cause.

What is also true is that scientists believe that it is prudent to assume that at low levels of exposure to radiation, cancers and birth defects will also occur in some of the people exposed as a direct result of that exposure and not as a result of any other cause. (The great majority of people exposed to low levels will suffer no effects.) Scientists advise again, therefore, that **prudence demands precautions**.

Second Question:

"If, as you say, some people suffer these effects from exposure to low level radiation and most people do not, what are my chances of suffering these effects, supposing that I am exposed to low level radiation from, for example, the Bancroft uranium tailings? Am I at risk? How great a risk is it? How do I find out?"

The short answers are:

- Are you at risk? Yes, you are.
- How great a risk is it? We're getting to that.
- How do I find out? We'll show you.

8. Thinking about risk

We cannot tell, in the present state of scientific knowledge about the effects of exposure to radiation, who among those exposed will suffer harmful effects and who will not. For all we know at the present time, it is purely a matter of chance.

For practical purposes, therefore, we must assume that we are all at risk. In the unhappy absence of certainty about who will or will not suffer harmful effects, we are reduced to estimating our chances.

Now, many people might say that this is a most unsatisfactory way of going about things. It is difficult to disagree. Difficult, at least at first sight. Yet, if we think about it for a moment or two, we shall find that this is the way we make many, perhaps most, of our decisions in life; including decisions every day that we scarcely give a thought to.

We estimate the chances, one way or the other. We do it not mathematically, but by weighing the matter according to our experience, intuition and judgement. Then, we act. Estimating our chances, when we think about it, is a very common, everyday, human experience.

Consider the following analogy

9. The fear of flying

There are some people who will not, under any circumstances whatsoever, get into an aircraft. They fear the plane will crash. They will not take the risk.

Millions of others do fly every year in Canada in large aircraft and in small, in fair weather and in foul. Few of those people would say that there is no risk in flying. They believe there is a risk. They have felt the tension, more or less, of the take-off run and of the approach to landing. If they have been in especially foul weather, with the aircraft pitching violently and the seat belt signs on, they have cheered and clapped with the rest of the passengers when a skillful crew has landed the aircraft safely. They are relieved. They did not crash. They will fly again. And again. Millions of them do it every year.

Yet, planes do crash every year and people are killed. Even at airports when crashes occur, traffic is halted for a relatively brief time only. Flights soon come and go as often as they have done before. People continue to fly.

One cannot, of course, account for every nuance of motivation in every individual. Generally, however, the pattern seems to be that people assess the risk for themselves on the basis of the general consensus among the travelling public on air safety standards, the reputation of the airline, the clearly large numbers of other people who travel by air and who have suffered no grave consequences, the reputation of the air crews and traffic controllers, the infrequency of accidents.

All of these factors (and others, too, no doubt) lead many millions of people to decide that the probability of their particular aircraft crashing is so small that the risk is worth it. It is a risk they are prepared to accept. They step on board, take off, and arrive safely.

10. The fear of radiation

The question of risk, therefore, is not an unusual one for people to consider in everyday life. Daily, people assess the risks, great or small, of taking one course of action or another. They draw their conclusions and they act. If they did not go about things in this way, life would come to a standstill. For, very few things in our lives are amenable to mathematical certainties. We rely mostly on our experience and judgement.

Radiation, however, is so exotic a subject to most people, so filled with grave and fearful uncertainties and consequences and so little known and understood, no matter how intelligent or well-educated people are, that many people are not willing to accept any element of risk, any possibility of uncertainty about the outcome. In their anxiety, they look for absolute assurances and absolute certainty.

Let us, therefore, be absolutely frank: no such assurances are possible. Nor can they reasonably be expected. No pilot of an aircraft can assure his passengers absolutely that they will arrive at their destination without mishap. No reasonable passenger would expect such an assurance. He or she might, indeed, rightly suspect the pilot's competence if the assurance were given. The passenger however, may quite rightly expect that every reasonable effort has been made by the airline, the crew and everyone else responsible, based on the best knowledge and skill available, to ensure that the aircraft will get to its destination safe and sound.

The same holds true for exposure to radiation from a uranium tailings pile. Those who live in its vicinity cannot expect an absolute assurance that no single individual will ever come to any harm from exposure to the low level radiation from the tailings. However, those who live in the vicinity do have a right to expect that every reasonable effort will be made, by

those who are or who ought to be responsible, based on the best knowledge and skill available, to ensure that the tailings will not be a source of injury to those who live in the vicinity, either now or in the future.

That said, just as for the airline traveller, so for a Bancroft area resident: there is still an element of risk. How, then, do we assess that risk?

11. Assessing the risk for yourself at Bancroft

Everyone everywhere on the planet is exposed to radiation to some extent. This has always been so for the whole existence of the human race. It is nothing new. It is just that human beings were not aware of radiation until its existence was discovered by the French scientist, Henri Becquerel at the turn of the 20th century.

The level of naturally occurring radiation varies from place to place on the planet's surface. It is higher generally, for example, on the Canadian Shield than in many other areas of Canada. The Bancroft area of Eastern Ontario has a higher level of naturally occurring radiation than, say, Toronto, in Southern Ontario. Bancroft area residents, therefore, receive a greater exposure to naturally occurring (called "background") radiation than do residents of Toronto. The difference is infinitesimal. But a difference there is. The risk to health for Bancroft residents, therefore, may also be greater than for Toronto residents. These are simply the realities of the planet.

In addition to this naturally occurring radiation, however, Bancroft area residents, members of the Paudash Lake Conservation Association and other residents, are exposed to radiation from the uranium tailings, a legacy of past industrial activity in the area. This means of course, that their risk of suffering ill effects has been increased. By how much has it been increased?

Scientists generally, physicists and mathematicians in particular, strive to express physical realities such as radiation, in quantities, by numbers. They find it particularly difficult, however, to arrive at numerical values for assessing the additional risk to residents of radiation from uranium tailings piles.

The problem, after all, is a relatively new one. The variables are many. In Canada, for Canadian tailings, the theoretical work is still underway, particularly at the Department of Energy, Mines and Resources in Ottawa where the research is being done. No calculations have yet been done for the Bancroft area.

The Atomic Energy Control Board of Canada, the regulatory agency in these matters, has concluded that people living near the Bancroft tailings sites will receive a very low radiation dose. The Atomic Energy Control Board's conclusions may, possibly, be correct.

CAIRS believes, however, that people who live near the tailings sites need something more than official assurances, however correct these assurances may be.

CAIRS believes that people who live near the sites need to have some way of calculating for themselves what their additional dose might be from the uranium tailings piles in their ordinary, everyday activities. A little, simple, hands-on arithmetic might help in understanding.

CAIRS hopes, therefore, that the following examples will help. The Institute hopes that these examples will assist members of the Paudash Lake Conservation Association and other local residents to get a sense of the degree of risk involved from three separate ways by which local residents could be exposed to radiation from the Bancroft tailings piles.

Caution:

The examples that follow assume that the tailings remain in their present state, undisturbed.

If the tailings are disturbed (e.g., tailings material is used for construction), additional sources of radiation exposure will have been created.

EXAMPLE I

EXPOSURE TO GAMMA RADIATION

Gamma radiation is one form of radiation to which a person can be exposed from uranium tailings piles. The general level of gamma radiation on the Madawaska uranium tailings piles has been found to vary between 0.05 to 0.3 milliRems (mR) per hour. For the following example, let us assume a constant general level of 0.2 milliRems per hour. (A milliRem is simply a unit of measurement.)

Taking your daily stroll across the tailings piles

Question:

Suppose you are in the habit of taking a walk over the uranium tailings piles every day. Suppose that your walk lasts one hour. What amount of exposure to gamma radiation would you receive in the course of one year?

Answer:

Your total radiation exposure from such daily walks is computed in the following way:

Radiation dose= 0.2 mR per hour x 1 hour per day x 365 days per year

= 73 mR per year.

What does this mean for you?

The number 73 mR per year has to be put into a context to make sense. Remember that everyone on the planet is exposed to naturally occurring radiation to some extent. Scientists have found that each of us is exposed on average to 100 mR of gamma radiation from various natural sources every year. Your daily walk on the tailings piles exposes you, therefore, to an additional 73 mR per year, provided you take that walk for one hour every day of the year.

What, then, do you conclude? Is this amount of additional exposure a risk you are prepared to accept?

Caution

As we have said, some parts of the tailings will emit higher levels of gamma radiation and other parts, lower levels, than the general level we have used in our example.

Some people, also, might spend more than one hour a day on the tailings piles for whatever reason or might spend some time unknowingly in a particularly hot spot. There are some hot spots on the tailings, according to information given by the Atomic Energy Control Booard in CAIRS' first report (AECB reply, p.6).

Such differences in the terms of the equation, therefore, would have to be taken account of in calculating the exposure of any one individual.

EXAMPLE II:

EXPOSURE TO RADIOACTIVE RADON GAS

Another way by which a person can be exposed to radiation is by inhaling radon gas from the tailings.

Radon gas is a radioactive gas that is heavier than air. It is a naturally occurring gas that seeps from rock containing radioactive ores. It seeps out of the uranium tailings, therefore, travels with the air and is dispersed in the atmosphere.

Clearly, the greatest concentration of this gas will be immediately above and around the tailings pile. As it disperses more widely in the atmosphere, the concentration becomes less and less. The closer one lives to the uranium tailings, therefore, the more radioactive radon gas one is likely to inhale.

What danger does radon present?

Because it is inhaled into the lungs, radon gas brings sources of radiation inside the body where vulnerable tissues, the lungs, are exposed. Lung cancers are known to be a consequence of the inhalation of radon gas in a statistically identifiable number of people. Those who inhale radon gas, therefore, are increasing their chances of some day developing lung cancer.

Increasing their chances? By how much?

It is not easy to arrive at a numerical quantity for estimating this particular risk from a uranium tailings pile.

The United States Environmental Protection Agency has undertaken a number of mathematical calculations on the risk to people who live near a uranium tailings pile and has drawn the following conclusions:

1. For someone living a lifetime adjacent to uranium tailings decommissioned to U.S. standards, the chances of getting lung cancer from that source are estimated to be 1 in 1,000.

2. For someone living a lifetime adjacent to uranium tailings not decommissioned to U.S. standards, the chances of getting lung cancer from that source are estimated to be as high as 10 in 1,000.

These estimates are for people living very close to the tailings piles. As the distance from the tailings increases, the risk of getting lung cancer diminishes rapidly as the gas disperses in the atmosphere.

What does this mean for you?

The chances of getting lung cancer in the general population are estimated to be 50 in 1,000.

If you were living adjacent to a tailings pile decommissioned to U.S. standards, the U.S. Environmental Protection Agency estimates that your chances of getting lung cancer from the radon gas would be 1 in 1,000. This is in addition to your chances as a member of the general population. Your chances, therefore, would have increased to 51 in 1,000.

Similarly, if you are living next to a uranium tailings pile not decommissioned to U.S. standards, your chances of getting lung cancer have increased by up to 10 in 1,000. They are now possibly as high as 60 in 1,000.

What, then, do you conclude? Is the additional internal exposure to radiation from the radon gas you inhale a risk you are willing to accept and to live with?

Caution

The calculations given in this example are for the general situation as calculated by the United States Environmental Protection Agency.

No specific data are available for the Madawaska uranium mine tailings in Bancroft.

EXAMPLE III

EXPOSURE BY EATING CONTAMINATED FISH

A third way by which people can be exposed to radiation from the tailings is by eating fish that have been contaminated with radioactive material. This is called exposure by ingestion. Again, it is exposure to the unprotected internal organs of the body.

In Farrel Lake, for example, in the Bancroft area, the flesh of fish has been found to contain 22 Becquerels per kilogram (22 Bq/kg) of the radioactive element, radium-226. Twenty-two Becquerels (again, the Becquerel is simply a unit of measurement) per kilogram is about ten times the level of radioactivity found in fish in other Ontario lakes.

Why is the level of radioactive contamination in Farrel Lake fish so much higher than in the fish of other lakes? The reason would seem to be that radium-226 is leaking into Farrel Lake from uranium tailings at the site of the old Dyno uranium mine.

GOING FISHING

Question

Suppose you spend the summer (sixteen weeks) fishing in Farrel Lake. Suppose that each week for sixteen weeks you catch and eat one kilogram of fish from the lake. How much exposure to your internal body organs will you receive from ingesting radioactive radium-226 in the contaminated fish?

Answer

The total amount of fish you will have eaten over the summer is 16 kilograms (1 kg x 16 weeks).

The total amount of radium-226 you will have ingested is computed as follows:

16 kg. of fish x 22 Becquerels per kilogram of radium-226 equals 352 Becquerels of radium-226.

What does this mean for you?

You have ingested 352 Becquerels of radioactive radium-226. The International Commission on Radiological Protection has estimated that your 352 Becquerels is equivalent to a total radiation exposure of 25 milliRems (25 mR). Remember the numbers in Example I? The annual gamma radiation exposure from natural

sources to everyone on the planet is estimated to be, on average, 100 milliRems. By eating 16 kilograms of fish from Farrel Lake over the summer, you have added 25 milliRems of exposure to what you would ordinarily receive (more or less) that year from naturally occurring sources.

What, then, do you conclude? Is this additional risk one that you are prepared to accept and to live with?

Caution

Radium-226 may not be the only source of radioactive contamination in the fish of Farrel Lake. Other radioactive contaminants in the Dyno uranium tailings may also have leached into the lake and be present in the fish. If so, these may produce additional internal exposure to radiation in those who eat the fish. There is the possibility, also, that other fish at higher or lower levels in the waterway are contaminated. An extensive fish sampling program has not been undertaken, to our knowledge, to investigate this possibility.

SUMMARY

The three examples given above are to show how residents of the area could be exposed to radiation from the Bancroft uranium tailings piles.

A numerical estimate of the actual exposure of local residents to radiation from these piles has not been given because no figures are available for actual exposures.

RADIATION AND CANCERS: A FREQUENT QUESTION

Powerful sources of radiation are widely used as medical tools to destroy cancerous growths in the body. Exposure to radiation at other times, however, both at low levels and at high levels, may also initiate the growth of cancerous tumours in our bodies. Radiation is a two-edged sword.

We can say of radiation, therefore, as of many of the other realities of our physical universe that human beings have put to use over the centuries, that radiation can be remarkably helpful if used wisely and skillfully. It can also be remarkably harmful if approached carelessly or in ignorance.

(We are considering here, of course, the ordinary use of this physical reality of our universe; not its extraordinary abuse in weapons of war.)

As we have seen, people who are or who may be exposed to extra radiation in their daily lives, either at work or in the environment or at home, need to understand what radiation is and how to deal with it safely. That is why the Canadian Institute for Radiation Safety was brought into being.

By way of enlarging poeple's understanding, therefore, let us try to answer a frequent (and quite sensible) question.

Question

> "You say that radiation is known to cause cancers and birth defects in some of the people exposed. What is the lowest number of milliRems or Becquerels or whatever of radiation exposure I can get to be certain of avoiding cancer from radiation in myself or birth defects in my children?"

Answer

A simple and unambiguous answer to that question is that nobody knows for certain. We don't know. And that's the truth.

But that is not all of the truth.

No doubt, you have heard it said that no level of radiation is safe. A competent (some are not), careful and cautious scientist, for example, who has an infinite dislike of exaggeration and an infinite respect for exactitude will say there is no minimum level of exposure to radiation that has been proved to be safe, beyond a shadow of doubt. The only exposure that would be certain to be safe is no exposure whatsoever.

Now, we know already that to have no exposure whatsoever we would have to step off the planet and outside the universe. We are all exposed to radiation all the time and always have been in the whole history of the human race.

It has been estimated, for example, that, on average, we are exposed to 100 milliRems (more or less) of gamma radiation from natural sources each year. What effect has that exposure on cancer rates? We cannot tell for certain.

We do know, however, because the trend has been observed in scientific investigation, that an increase in the level of exposure to radiation, sees an increase in the numbers of cancers. Whether that increase is relatively insignificant or relatively significant depends, of course, on the level of the exposure and the length of time.

Understanding

An understanding of radiation and an awareness of radiation safety have become increasingly necessary in our Canadian society not only because of the existence of industrial leftovers such as the Bancroft tailings, but because of the widespread use, far more widespread than most Canadians realize, of radioactive sources as the new hi-tech tools of our industrial technologies.

Immagination and Daring

As Canadians, we should approach these new questions not in paralyzed apprehension, but with imagination, ingenuity and daring, confident that together, in a cooperative spirit, we have the will and the ability to create in Canada a new awareness, soundly based, of what is required for our environmental and personal safety.

The task is not insuperable. It needs the talents of all of us, residents, workers, companies, governments, scientists, engineers.

Canadians can do it, if Canadians do it together. The time has come to begin.

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APPENDIX I

Pathways for the Transport of Contaminants from Tailings to Humans

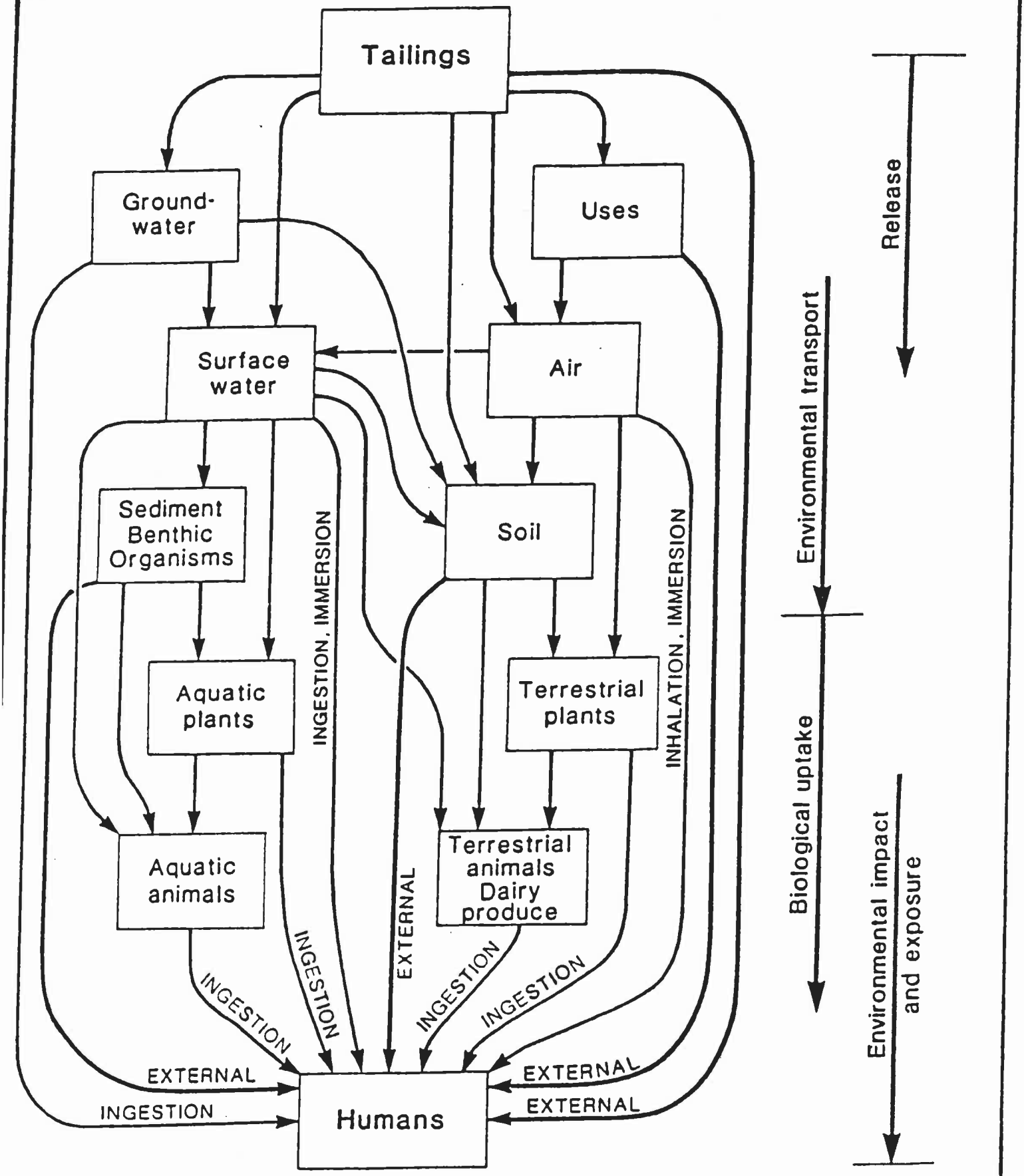
A Note

The diagram that follows may be additionally helpful in assisting residents of the Bancroft area to understand the many questions involved in dealing with the safe disposal and management of uranium tailings.

The diagram was prepared by the Canada Centre for Mineral and Energy Technology (CANMET), the research arm of the Department of Energy, Mines and Resources in Ottawa.

CANMET has been engaged in tailings research for a number of years and has added considerably to our general knowledge about uranium tailings.

The diagram was published in the Research and Development Bulletin, No. 165 (December 1986) by the Department of Supply and Services, Ottawa.



PATHWAYS FOR THE TRANSPORT OF CONTAMINANTS FROM TAILINGS TO HUMANS

(Courtesy of Canmet, Energy, Mines and Resources)

APPENDIX II

WHAT IS CAIRS?

Cooperative and independent

CAIRS (pronounced "cares"), the Canadian Institute for Radiation Safety, is a cooperative and independent national institute solely concerned with the safety of Canadians who are exposed to radiation in the workplace, in the home and in the environment.

CAIRS is a non-profit organization and a registered charity.

Practically oriented

The Institute's aim is to draw upon the best knowledge and experience of radiation safety available and to apply that knowledge and experience to practical difficulties faced by Canadians who are or may be exposed to harmful sources of radiation.

Impartial

The Institute is an impartial body. It does not take sides in the debate over nuclear energy. It is the Institute's considered opinion that there are a number of organizations already fully prepared to debate either side of that important public question. To add one more to either side would serve no useful purpose. CAIRS, therefore, is neither "pro-nuke" nor "anti-nuke".

Need

CAIRS turns its attention instead to those people whose needs may not be fully attended to while the debate over nuclear energy is taking place: to Canadians who are exposed every day to radiation in the workplace, in the home and in the environment.

It may come as a surprise to many people that only a small percentage of such Canadians have any connection with the nuclear energy industry.

How does CAIRS act?

CAIRS acts cooperatively. That is to say, CAIRS works to get the cooperation of industry, labour and government (federal and provincial) and the scientific, medical, university, business and lay communities of Canada in the practical resolution of radiation safety problems.

All these sectors are represented on the CAIRS Board of Governors. It is a Board of experience, distinction and sound reputation in the various fields from which it is drawn.

How is CAIRS funded?

From its beginnings in 1981, CAIRS has been able to provide up to forty percent of its revenue from its own programs and services. The Institute's aim is to increase that proportion.

In addition, because CAIRS is a non-profit, charitable organization that provides services and conducts research that do not provide revenue, CAIRS also receives grants-in-aid from government and industry and (most recently) from the labour movement in recognition of the important contribution CAIRS is making in the field of occupational health and safety.

Information on CAIRS' sources of funding is freely available to any interested person.

One of a kind

This, then, is CAIRS: the only institute of its kind in Canada created solely to deal with the practical problems faced by Canadians who are exposed to radiation in the workplace, the home and the environment.

CAIRS believes that there is much work to be done, more than most people realize. The Institute hopes that Canadians will not only watch carefully what CAIRS does, but also assist CAIRS in the important task it has set itself to accomplish.

Note:

A list of the Board of Governors is given in the following pages.

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CANADIAN INSTITUTE FOR RADIATION SAFETY

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