

**Summary Evaluation of a Report of Brain Cancer
Cases in the Municipality of Shannon,
Based on Data Self-Reported to the
Regroupement des Citoyens de Shannon,
Québec, Canada**

Report prepared by the **Direction régionale de santé publique**
of the Agence de la santé et des services sociaux
de la Capitale-Nationale

September 2014

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Legal deposit: Bibliothèque et Archives nationales du Québec, 2014
ISBN : 978-2-89616-256-7 (print version)
ISBN : 978-2-89616-257-4 (electronic version)

This publication has been included in the SANTÉCOM database.

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Agence de la santé et des services sociaux de la Capitale-Nationale, *Summary Evaluation of a Report of Brain Cancer Cases in the Municipality of Shannon, Based on Data Self-Reported to the Regroupement des Citoyens de Shannon, Québec, Canada*, Agence de la santé et des services sociaux de la Capitale-Nationale, Direction régionale de santé publique, 2012, 36 p. and appendices.

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PREFACE

This summary evaluation was prepared in the wake of a report of brain cancer cases issued by the Regroupement des Citoyens de Shannon (RCS) in 2010. It aims to describe in detail the admissibility of this report. On the basis of the data provided by the RCS, the evaluation will also specify whether the regional public health director (DSP) should carry out additional work to describe the situation.

Despite the deferred publication of this summary evaluation, the DSP has already embarked on the cluster investigation recommended therein. In fact, it began to solicit funding in 2011 — which it obtained in spring 2012 — in order to document the situation in Shannon and launch a proper cluster investigation (fall 2012). Therefore, the reader should be aware that, even though the present document was prepared later than initially planned, the RCS report has already been addressed and the work announced in the conclusion of the evaluation is already under way.

SUMMARY

This document describes the first phase of the evaluation and management of a brain cancer cluster reported by representatives of the Regroupement des Citoyens de Shannon to the regional public health director for the Capitale-Nationale region in 2010. The methodology used for this phase is based largely on that set out in a guide published by the Institut de veille sanitaire de France for the evaluation and management of spatio-temporal clusters of non-infectious diseases, entitled *Guide méthodologique pour l'évaluation et la prise en charge des agrégats spatio-temporels de maladies non infectieuses* (Germoneau *et al.*, 2005).

The present document outlines the context in which the report by the Regroupement des Citoyens de Shannon was made, as well as the way in which the report is being managed. It describes the information transmitted regarding an excess number of cases of brain cancer and presents the results of surveillance of this type of cancer by the public health director, using the Fichier des tumeurs du Québec. It also discusses the sociodemographic characteristics of the territory of the municipality of Shannon and the extent of environmental contamination in that area.

The report issued by the Regroupement des Citoyens de Shannon has been deemed admissible on the basis of currently available information. Therefore, the cluster investigation of the cases of brain cancer reported in the Courcellette sector, in Shannon, must be continued, particularly to better characterize the cluster and determine whether there is a real excess of cancer cases in that sector. This document describes the future steps that will be taken by the public health director in the epidemiological investigation of brain cancer cases in Shannon, as well as the steps already taken to address the concerns of the Regroupement des Citoyens de Shannon.

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LIST OF ABBREVIATIONS

1,1-DCE:	1,1-dichloroethene
BTEX:	Benzene, toluene, ethylbenzene, xylene
CCME:	Canadian Council of Ministers of the Environment
cDCE:	Cis-1,2-dichloroethene
CSSS:	Health and social services centre
DND:	Department of National Defence
DRSP:	Direction régionale de santé publique de la Capitale-Nationale (regional public health directorate of the Capitale-Nationale administrative region)
DSP:	Regional public health director
FITQ:	Fichier des tumeurs du Québec (Québec tumour registry)
HMX:	Octogen
INRS:	Institut national de recherche scientifique (national scientific research institute)
INSPQ:	Institut national de santé publique du Québec (Québec public health institute)
InVS:	Institut de veille sanitaire de France (health monitoring institute of France)
MAMROT:	Ministère des Affaires municipales, des Régions et de l'Occupation du territoire (ministry of municipal affairs, regions and land occupancy)
MDDELCC:	Ministère du Développement durable, de l'Environnement, et de la Lutte contre les changements climatiques (ministry of sustainable development, the environment and the fight against climate change)
MSSS:	Ministère de la Santé et des Services sociaux (ministry of health and social services)
PMQ:	Private Married Quarters (Courcelette family housing unit)
RCM:	Regional county municipality
RCS:	Regroupement des Citoyens de Shannon (Shannon citizens group)
RDX:	Royal Demolition Explosive (cyclonite; hexahydro-1,3,5-trinitro-1,3,4-triazine)
SIR:	Standardized Incidence Ratio
SIVI:	Société immobilière Valcartier inc.
TCE:	Trichloroethylene
tDCE:	Trans-1,2-dichloroethene
TNT:	Trinitrotoluene
VOC:	Volatile organic compound

CONTEXT OF THE REPORT BY THE REGROUPEMENT DES CITOYENS DE SHANNON

Trichloroethylene (TCE) contamination of residential wells in Shannon was brought to light in December 2000. However, on the basis of the TCE concentrations measured in the wells of Shannon residents at the time, the Direction régionale de santé publique (DRSP, or regional public health directorate) of the Agence de la santé et des services sociaux de la Capitale-Nationale (health and social services agency of the Capitale-Nationale administrative region) judged the risk of cancer to be low. Nevertheless, given the recognized carcinogenicity of TCE, the regional public health director (DSP) requested that the public stop drinking water from contaminated wells and established a cancer monitoring program to better assess the specific situation in Shannon. Consequently, since 2001, the DSP, in collaboration with the Institut national de santé publique du Québec (INSPQ, or Québec public health institute), has been evaluating whether there are more cases of cancer in Shannon than elsewhere in Québec.

Until now, analysis of cancers in Shannon has been performed using administrative data from the Fichier des tumeurs du Québec (FiTQ, or Québec tumour registry). The reference period for this analysis runs from 1984 to 2006. Surveillance is based primarily on place of residence at the time of the diagnosis of cancer. This analysis has shown that the number of cancer cases diagnosed at all times combined in Shannon is similar to the number that can be expected to occur when the cancer rate of this population is compared with that of the population of Quebec as a whole (Lebel and Gingras, 2011).

The DSP has also conducted more specific analyses and surveillance of certain possible TCE-related cancers (Wartenberg *et al.*, 2000). This work has focused on liver cancer, kidney cancer, cervical cancer, lymphoma, leukemia, multiple myeloma and Hodgkin's disease on the territory of Shannon over the past 20 years (DRSP, 2011; Lebel and Gingras, 2011). This targeted analysis has shown that the frequency of liver cancer (5 cases) and multiple myeloma (6 cases) is statistically higher in the population of Shannon than in the population of Québec as a whole (11 observed cases compared with 3 expected cases). However, a review of the clinical records of the people affected by these cancers has shown that the records contain diagnostic classification errors. The review also revealed that known causal risk factors for these two types of cancer are mentioned in the records. Lastly, 10 of the 11 observed cases did not live above the contaminated portion of the groundwater (contamination plume).

Citizens concerned about TCE contamination of groundwater in Shannon and on the Valcartier base formed a group called the Regroupement des Citoyens de Shannon (RCS, or Shannon citizens group). The purpose of this group is to inform the citizens of Shannon about the problem of TCE contamination of groundwater and its possible health effects, to gather data on the damage caused by this situation, and to mobilize the citizens of Shannon in their dealings with the authorities responsible for the contamination. In recent years, the RCS joined a class action suit seeking justice for the presumed health effects of TCE. Within the context of this lawsuit, the RCS compiled an inventory of cases of cancer among people who had lived in Shannon at some point in their lifetime or were still living there. This inventory, which was put together on a voluntary basis by cancer victims and their families, includes 489 cases of cancer that occurred between 1964 and 2010.

On the basis of this case count, representatives of the RCS expressed their concern to the DSP in July 2010, specifically with regard to some 20 cases of brain cancer diagnosed between 1981 and 2010 among people who had lived on the territory of Shannon or were still living there. The representatives found the situation worrisome, especially since the cancers appeared to be concentrated primarily in the Courcellette sector of the municipality and affected a fairly young population. Therefore, they asked the DSP to study this situation more closely.

Even though the RCS believed that there was a link between the cancers that have occurred on the territory of Shannon and TCE contamination of Shannon's groundwater, it specifically asked the DSP during the July 2010 meeting to consider other problems of an environmental nature in analyzing the situation.

In October 2010, the DSP told the RCS that analysis of the information gathered by this group could shed new light on the potential health impacts associated with TCE groundwater contamination (Appendix 1). In addition, several health journals had recently confirmed the specific carcinogenicity of TCE, particularly for kidney cancer, non-Hodgkin's lymphoma and cancers of the liver and biliary tract (USEPA, 2011). In this context, the DSP had to remain vigilant. Therefore, it undertook to assess the validity of the RCS report and, if applicable, to conduct the necessary studies to better characterize the situation.

MANAGEMENT OF THE REPORT BY THE REGROUPEMENT DES CITOYENS DE SHANNON

When a public health authority is notified that the number of cancer cases in a given location and time is presumed to be abnormal (i.e. to form a cluster), several steps must be taken to determine whether or not there is an excess of cases and to pinpoint the causes. The methodology guide of the Institut de veille sanitaire de France (InVS) (Germoneau *et al.*, 2005) provides a detailed description of how to conduct this type of analysis. According to the guide, the main phases involved in a cluster study are:

- summary evaluation of the report;
- validation of the cases and environmental exposure;
- in-depth descriptive study;
- additional epidemiological analyses using a causal hypothesis.

This document focuses on the first phase of the cluster analysis, i.e. summary evaluation of the RCS report. The following topics are discussed:

- the nature of the report and cases reported;
- the available surveillance data;
- the characteristics of the population giving rise to the reported cases;
- the main known environmental risks associated with the place where the cluster was reported;
- the main findings on the reported cluster, derived from the available surveillance data.

REPORT OF AN EXCESS OF BRAIN CANCER CASES BY THE REGROUPEMENT DES CITOYENS DE SHANNON

Health problems reported to the regional public health director

In summer 2010, the RCS informed the DSP of what was perceived to be a high number of brain cancer cases in the municipality of Shannon. Between 2001 and 2010, RCS representatives had compiled information on cases of cancer with current and former residents of the municipality. Table I presents the data specifically related to the brain cancers brought to the attention of the RCS.

The RCS representatives identified 17 people who had been affected by brain cancer during the 1981-2008 period. Of these 17 cases, 3 were meningiomas, which are usually benign tumours, while 14 were gliomas, or primary brain tumours originating in the glial cells (Roper and Samuel, 2009). The gliomas consisted of 7 glioblastomas, 1 ependymoma, 4 oligodendrogliomas and 2 astrocytomas, all of which are considered to have a similar histology.¹ For the following reasons, only the gliomas were taken into account in evaluating the RCS report:

- These cancers have a similar histopathology.
- Cases for which cluster investigations usually arrive at clear and indisputable conclusions usually have similar characteristics (Germoneau *et al.*, 2005).
- Cancer surveillance in Shannon has been based on so-called malignant tumours and cancers. Agreement between data originating from self-reported cases and surveillance data facilitates their comparison.

¹The tissue and cellular origin of gliomas is similar.

Table I
Description of cases of brain cancer
among people who lived in Shannon between 1981 and 2008,
self-reported to the RCS

Year of diagnosis	Sex	Age at the time of diagnosis	Type of cancer entered in the medical record according to available pathology data	Period(s) of residence in Shannon		Geographic area lived in
1981	F	53	Brain – glioblastoma	1966-1970		Courcelette
1987	F	29	Brain – glioblastoma multiforme	1971-1975		Courcelette
1989	M	59	Brain – meningioma	1964-1972		Courcelette
1994	M	1	Brain – ependymoma	1994+		Courcelette
1994	F	45	Brain – anaplastic oligodendroglioma	1977-1981	1989-2002	Courcelette and Shannon
1992	M	18	Brain – oligoastrocytoma (1992) glioblastoma (1999)	1977-1978		Courcelette
1995	M	54	Brain – glioblastoma multiforme			Shannon and Courcelette
1995	M	63	brain tumour	1972-1985		Courcelette
1995	M	63	Brain – glioblastoma	1960-1975		Courcelette
1996	M	14	Brain – meningioma	1982-1984	1990-1994	Courcelette
1997	F	36	Brain – anaplastic oligodendroglioma	1961-1964	1964-1972	Courcelette
1999	F	46	Brain – oligodendroglioma	1959-1967		Courcelette
2002	F	39	Brain – anaplastic oligodendroglioma	1985-1988		Courcelette
2004	M	40	Brain - glioblastoma (high-grade astrocytoma)	1965-1972		Courcelette
2006	F	66	Brain – meningioma	1988-1990		Courcelette
2006	F	56	Brain – glioblastoma multiforme	1964-1970		Courcelette
2007	M	17	Brain – multicentric glioblastoma	2000-2007		Courcelette
2008	M	42	Brain – anaplastic astrocytoma	1966-1971	1978-1980	Courcelette

Description of the RCS report

The following findings can be drawn from the data submitted by the RCS representatives:

- An equal number of gliomas (7 cases) were identified among both men and women.
- All of the people with glioma had lived on a specific part of the territory of Shannon, namely, the Courcelette sector. Two had also lived in the Shannon sector.
- Following a review of these individuals' medical records, it appeared that all but one of the people with brain cancer had been living outside the municipality of Shannon (including Courcelette) at the time of diagnosis.
- The arithmetic mean of ages at which the gliomas were diagnosed was 38.5 years (range: 1 to 63 years). The average age was 43.5 years if the 2 cases reported among children are excluded.
- The average period of residence on the territory of Shannon was 7 years and 3 months for all of the people with glioma (range: 5 months to 16 years and 10 months).
- the average period between the year of arrival in Shannon and the year in which a diagnosis of brain cancer was made was 24 years and 9 months (for a median of 20 and a half years).

Specific characteristics of brain cancer

Every year in Québec nearly 600 people receive a diagnosis of glioma, a type of primary brain cancer. From a statistical standpoint, glioma is said to be a rare form of cancer, since it is not very common compared to other types of cancer, such as cancer of the breast or colon. The incidence of glioma is about 7.3 cases per year per 100 000 population (Infocentre de santé publique, 2013).

Astrocytoma is the most commonly diagnosed type of tumour among children, while glioblastoma is more common among adults (Roper and Samuel, 2009).

At present, there are no clearly established known causes of brain cancer (Gomes, 2011; Roper and Samuel, 2009). However, certain risk factors have been observed among people with this type of cancer (Michaud *et al.*, 2012):

Race

- Brain cancer seems to be more common among Caucasians and Northern Europeans, suggesting for some authors the possibility of an environmental source of contamination.

Age

- This disease affects elderly people (aged 65 or over) to a greater extent than it does those who are middle-aged. Certain forms of brain cancer affect only children.

Sex

- Men are affected by glioma more often than women are, whereas women are more commonly affected by meningioma.

Heredity

- Certain brain cancers are associated with genetic anomalies. Some scientists believe that there is a link between epigenetics and environmental and genetic interactions.

History of leukemia or non-Hodgkin's lymphoma

- Certain procedures, particularly prophylactic cerebral irradiation, used during the treatment of blood cancers to limit the risk of cerebral metastases are associated with an increased risk of brain cancer.

Exposure to radiation

- Exposure to ionizing radiation increases the risk of cancer, including brain cancer. As for the risk posed by electromagnetic waves and cell phone radio waves, it seems to be the subject of much controversy in the literature.

Exposure to certain chemicals (nitrates, nitrosamines and nerve gas used in chemical weapons)

- Exposure to certain chemicals appears to increase the risk of glioma.

Exposure to solvents, vinyl chloride, petroleum products, plastics and rubber, as well as pesticides

- Exposure to solvents, vinyl chloride, petroleum products, plastics and rubber, as well as pesticides, has been claimed to increase the risk of brain cancer even though no direct link has been established. The controversy is fuelled by the fact that several epidemiology studies have observed a significant association between some of these contaminants and the risk of brain cancer, while others have not demonstrated any such link.

SURVEILLANCE OF CANCER CASES USING THE FICHER DES TUMEURS DU QUÉBEC

Mandates of the regional public health director

The DSP has a legal mandate to identify situations that could pose a threat to the health of the population and to see that the measures necessary to protect the population's health are taken (R.S.Q., c. S-4.2, s. 373, subparagraph 2 of the first paragraph and R.S.Q., c. S-2.2, ss. 96-107). Therefore, the DSP may monitor the development of certain specific health problems and their determinants within the population. As a public health authority, the DSP can thus give his or her opinion about health concerns formulated (i.e. reported) by the population.

The DSP also has a mandate to identify situations where collaboration with other bodies is necessary to prevent diseases or social problems that have an impact on the health of the population (R.S.Q., c. S-4.2, s. 373, subparagraph 4 of the first paragraph). The situation in Shannon and on the Valcartier base concerns numerous partners. To gain a good understanding of the problem and better evaluate the impact on the health of the affected population, the DSP is working with several bodies, including the Municipality of Shannon, the City of Québec, the INSPQ, Québec's Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC; ministry of sustainable development, the environment and the fight against climate change), the Department of National Defence (DND), Health Canada and Environment Canada.

Lastly, the DSP has a mandate to inform the population on its general state of health (R.S.Q., c. S-4.2, s. 373, subparagraph 1 of the first paragraph and R.S.Q., c. S-2.2, s. 33, subparagraph 6 of the first paragraph).

Surveillance of cancer cases on the territory of the municipality of Shannon

The DSP has been conducting surveillance of cancer cases on the territory of the municipality of Shannon (including Courcelette) since 2001 (DRSP, 2011; Lebel and Gingras, 2011) using the FiTQ.² This registry compiles administrative data for surveillance and knowledge acquisition purposes.

According to the results derived from the FiTQ, which are based on provincial cancer trends adjusted to the population of Shannon, it can be expected that approximately 1 or 2 cases of brain cancer will be observed on this territory every 10 years. However, surveillance of cancer cases by the DSP identified only 3 cases of brain cancer for the entire 1984-2006 period. Therefore, the number of brain cancer cases identified in the FiTQ does not indicate an excess of cases in Shannon. In fact, the observed number corresponds to the number that can be expected to occur (Lebel and Gingras, 2011). One of these cases was reported by the representatives of the RCS. It is worth noting that all of the cases of brain cancer identified on the basis of both the FiTQ and the RCS data were observed in Courcelette;

² The FiTQ has been replaced by the Registre québécois du cancer (RQC, or Québec Cancer Registry). As part of its cluster analysis, the DSP will resume its surveillance of cancer cases using the RQC. This cancer registry will incorporate the data from the former FiTQ and the Registre des événements démographiques (Québec registry of demographic events).

none were observed in the Shannon sector. That said, using data from the FiTQ can have certain limitations:

Errors in diagnostic codes or place of residence, for example, may also occur in the FiTQ. The possibility of such errors must be considered, especially when FiTQ data are used for small geographic units such as small municipalities. Indeed, the addition or removal of just one cancer case can change the results. It must also be noted that the addresses of people with cancer recorded in the FiTQ are their addresses at the time of diagnosis. Therefore, new cancer cases diagnosed among people who used to live in Shannon but later moved away, i.e. cases diagnosed when the people no longer lived in Shannon, are not included in the cases we identified in the FiTQ. Conversely, it is impossible to determine, using the FiTQ, how long a person with one of the new cases of cancer identified in Shannon has lived in the municipality. As a result, some of the cases we identified may have developed when people were living in another municipality and were only diagnosed when the people lived in Shannon. When using data from the FiTQ, it must be postulated that the population is in a state of equilibrium, i.e. that deaths, births and residential mobility have impacts that counterbalance one another. When a large population like that of Québec is studied, it is very likely that this postulate is true. With smaller populations, however, it is impossible to gauge the extent to which the postulate applies. (Lebel and Gingras, 2011, p. 15). [Translation]

As reported by Lebel and Gingras (2011), the FiTQ made it possible to identify cases of cancer among people who were living in Shannon at the time of diagnosis; however, it did not allow cases of cancer to be identified among people who used to live in Shannon but were diagnosed with cancer while living somewhere else. Until now, analyses have shown that the total number of cancer cases diagnosed in Shannon is similar to the statistical projections made on the basis of observed cancer rates in Québec (Lebel and Gingras, 2011).

It is hard to compare the FiTQ data with those gathered by the RCS since the latter are not discriminated on the basis of place of residence at the time of diagnosis, as in the FiTQ. In compiling information on cancer cases, the RCS used the criterion of whether the people affected had lived in Shannon at any point during their lifetime. However, we do not know the total number of people who lived in Shannon at different times during the period examined by the RCS. Therefore, it is impossible to put the number of cases reported by the RCS over a denominator (i.e. value) that could be translated into a cancer incidence rate for comparison with the rates available for Québec as a whole. Similarly, in order to support such a comparison, it would be necessary to determine the probability of developing brain cancer associated with the fact of having lived in one municipality rather than another. However, this type of analysis is difficult from a methodological standpoint and requires taking into account numerous limitations.

ISSUES

Mobility of the population of Shannon

According to the census data, the population of Shannon is the most mobile population in the province of Québec. A summary analysis of the *2006 Community Profiles* reveals that 20% of Shannon's population moved during the year prior to the 2006 census. Of that number, only 3% moved within the territory of Shannon itself. In Québec as a whole, the population mobility rate varied between 5% and 6% in the year prior to the census. Over a 5-year period, close to 63% of Shannon's population moved, compared to an average of 18% of the population of Québec as a whole. Of the Shannon residents who moved, only 13% continued to live on the territory of the municipality (Statistics Canada, 2007).

Building a database on the basis of the criterion of whether people "lived" in Shannon (including Courcelette) at some point during their lifetime automatically leads to a higher cancer case count, since the number of people who resided in Shannon is increased by the population's high mobility rate. In other words, over a 5-year period, the number of people who resided in Shannon greatly exceeds the municipality's average population.

Comparing Shannon with another territory, and which could thus serve as a basis for comparison, is also complicated by the fact that Shannon stands out from the rest of Québec in terms of its population's mobility rate. In fact, Shannon is the municipality with the highest population turnover rate in Québec.

Social context in Shannon

The file concerning groundwater contamination in Shannon and on the Valcartier base concerns several institutional actors, particularly DND, the Municipality of Shannon, the City of Québec, the RCS, the MDDELCC, the health and social services network, through the DRSP and the INSPQ, Health Canada and Environment Canada.

Numerous citizens groups and politicians have wanted the DSP to confirm their concerns over potential links between TCE groundwater contamination in Shannon and the health status of the local population. In particular, they have petitioned for additional epidemiological analyses. Today, this complex situation has become judicialized, owing in particular to the lawsuit brought by the citizens of Shannon for the purpose of claiming compensation for the suspected harm to their health.

Since the discovery of TCE in private wells in Shannon in December 2000, members of the RCS and the DRSP have expressed divergent views concerning the health risks associated with the presence of TCE in the system that supplied drinking water to the residents of Shannon and the Courcelette sector until 2001. As mentioned earlier, the INSPQ assessed the risk of cancer linked to this contamination as being low (Valke *et al.*, 2010). In addition, other assessments have emphasized that no valid causal link can be established, using currently recognized scientific methods, between TCE exposure stemming from groundwater contamination in Shannon and the cases of cancer that have occurred in this area (Carrier and Ayotte, 2010; De Wals and Levallois, 2010; De Wals, Levallois *et al.*, 2005; Valke *et al.*, 2010).

In 2006, the Superior Court of Québec agreed to hear a class action suit brought by the RCS regarding suspected TCE-related harm to the health of citizens. The RCS's point of view was based on the expert opinions that it had solicited for the purposes of this action and that reflected an assessment of risk as being high. Justice Godbout's decision recognized the environmental injustice that was present and compensated the citizens for the contamination of their wells. However, he did not recognize that the cancers that had affected them were associated with the presence of TCE in their well water. The citizens have appealed this decision.

For the citizens who belong to the RCS, the situation remains unresolved and the search for answers about the link between TCE and their health problems is still a high-profile priority issue.

SHANNON AND ITS ENVIRONMENT

Sociodemographic environment

The municipality of Shannon is located in the northwest portion of the territory of the Communauté métropolitaine de Québec (Québec Metropolitan Community) (Fig. 1). It is bordered by the municipalities of Saint-Gabriel-de-Valcartier to the north and Sainte-Catherine-de-la-Jacques-Cartier to the west, as well as by Canadian Forces Base Valcartier to the east. The Jacques-Cartier River divides the municipality in two. Shannon falls within the Municipalité régionale de comté (MRC) de la Jacques-Cartier (Jacques-Cartier regional county municipality (RCM)); healthcare system services are provided under the authority of the CSSS de Québec-Nord (Québec-Nord health and social services centre) and, in particular, the CLSC de la Jacques-Cartier (Jacques-Cartier local community service centre).

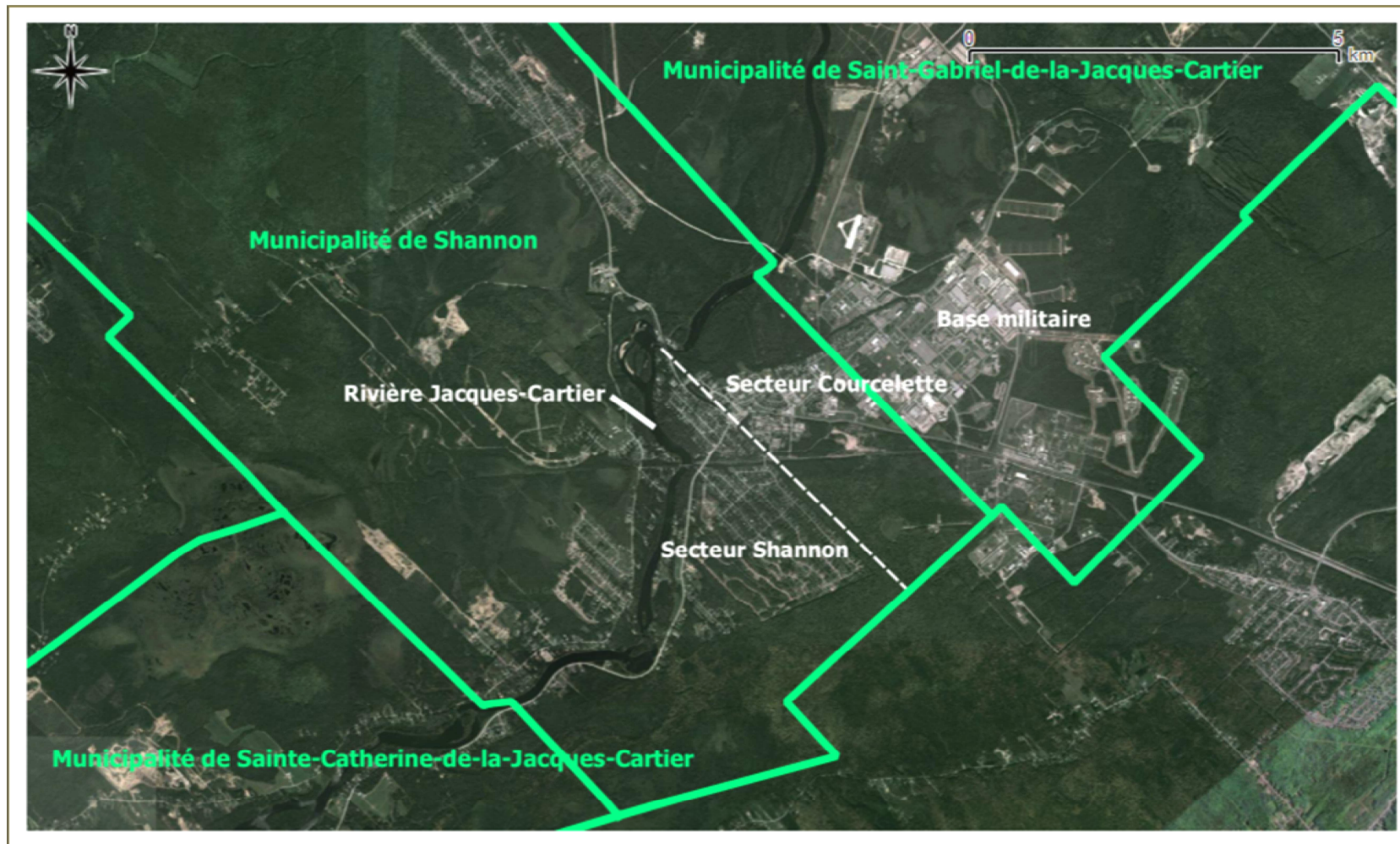


Fig. 1: Location of the municipality of Shannon

Shannon has a population of 5 323 inhabitants (MAMROT, 2013). Two thousand people reside in the family housing and barracks located on the territory of the Valcartier base (also called the Courcelette sector). Courcelette's population consists primarily of Canadian Forces members and their families. It should be noted that one of the streets in the Courcelette sector (Rue Cannon) is located on the territory of the municipality of Saint-Gabriel-de-Valcartier.

The Valcartier military base is located to the east of the territory of the municipality of Shannon. Since the 1940s, it has housed industrial weapons production facilities, particularly the Valcartier Research Centre and Les industries Valcartier inc. The latter is now situated on land owned by the Société immobilière Valcartier inc. (SIVI), a subsidiary of SNC Lavallin. The industrial operations of these facilities, coupled with the base's military and scientific activities (test firing of munitions and weapons research) have entailed some contamination of the surrounding environment.

Environmental context

Due to the industrial nature of this sector, several contaminants have been found in different environments in the vicinity of Shannon and the Valcartier military base. The next few sections of this document will provide a brief description of the current situation, as reported by the various concerned public bodies in Shannon. As knowledge of the sector evolves, other types of contaminants may eventually be identified.

TCE contamination of the environment

Groundwater

TCE use on the territory of the Valcartier base appears to have begun in the 1950s (and perhaps even earlier) and to have ceased in 1985. TCE was used as a degreaser and sealant in the production of missiles and ammunition. The groundwater seems to have been contaminated by inappropriate disposal of TCE in the environment.

Since the early 1990s, DND has launched several campaigns to characterize the quality of groundwater on the territory of the Valcartier base and the communities that border it. Over the years, the Institut national de recherche scientifique (INRS) has conducted various characterization and modelling studies to define the extent, flow and severity of the groundwater contamination (Lefebvre *et al.*, 2010; Appendix 2). The TCE contamination plume modelled in the course of these studies appears to measure over 4 km long and roughly 650 m wide. It stretches between land belonging to Québec city (Val-Bélair sector) to the east and the Jacques-Cartier River to the west, in the municipality of Shannon. The three contamination source areas are located on land owned by DND and SIVI. At the time of the studies, TCE concentrations reached 71 000 µg/l in the plume source areas. Outside of these areas, the maximum concentrations measured in the plume sometimes exceeded 1 200 µg/l.

USS Valcartier water distribution system

The USS Valcartier water distribution system is operated by DND. It continues to supply drinking water to the entire territory of the Valcartier base (including family housing for military personnel [Courcelette sector]). Between 2001 and 2010, following the discovery of TCE in Shannon's groundwater, the system gradually came to supply many of the residences in the municipality of Shannon.

TCE levels in excess of the Québec standard at the time, i.e. 50 µg/l, were first detected in the water distributed by the USS Valcartier system in April 1995 (Godbout, 2012), or 5 years before the discovery of TCE in private wells in Shannon. Prior to that date, no data are available on TCE contamination of water distributed by the USS Valcartier system. Subsequent analyses of the system's water revealed other results that exceeded the standard. The maximum result observed was 101 µg/l in April 1995. Since March 2000, the quality of the water distributed by the USS Valcartier system has been monitored in accordance with the recommendations of the federal and provincial governments. These monitoring activities have shown that any concentrations detected are less than 1 µg/l, and vary generally around 0.2 µg/l (maximum value measured = 2.3 µg/l).

Since 1995, no major problems associated with chemical parameters in the drinking water other than TCE have been reported. However, percholate was reported to be present in the drinking water in 2004. Subsequent analyses have shown that any percholate concentrations detected are less than 0.12 µg/l. The guideline value proposed by the INSPQ to ensure protection of vulnerable populations is 1 µg/l.

Residential wells in Shannon

Prior to the 2000s, all residents of the municipality of Shannon (on both sides of the Jacques-Cartier River) were supplied with drinking water from their personal wells. In December 2000, following the discovery of TCE in drinking water samples from these wells, the DSP made recommendations to reduce or eliminate exposure to TCE. The DSP recommended that residents stop drinking water from the wells and using it to shower or bathe. The DSP also proposed that bottled water be distributed to the local population and that activated-carbon tap water filters be installed. These corrective measures were applied in collaboration with the Municipality of Shannon, citizens, the MDDELCC, DND and Health Canada. To manage the problem, the DSP decided to set a drinking water action level that was below the standard in effect in Québec in 2000 (5 µg/l instead of 50 µg/l). Since February 2001, corrective measures have reduced at-the-tap concentrations of TCE to levels well below 5 µg/l. In addition, starting in 2001, homes to the east of the Jacques-Cartier River were gradually hooked up to the USS Valcartier water supply system. Since 2010, over a third of Shannon residences have been connected to the new municipal water distribution system.

From December 2000 to 2009, the MDDELCC conducted studies to characterize the quality of water in regard to TCE in 665 residential wells in the municipality of Shannon (MDDEFP, 2013, personal communication). Wells that derived their water from sources in the contamination plume were sampled primarily in 2001. The wells most contaminated by TCE were sampled several times over the months and years (especially in 2002 and 2003). The vast majority of these wells were located on King, de la

Station and Jacques-Cartier streets (Fig. 1), in an area referred to as the “red zone” or “red triangle”. Table II presents a compilation of the maximum concentrations measured in the wells where TCE was detected.

Table II
Maximum TCE concentrations measured between 2000 and 2009
in sampled wells where TCE was detected in the municipality of Shannon

Maximum TCE concentrations (µg/l)	Number of wells (total = 153)
≥ 1000*	4
500 to < 1000	2
50 to < 500	20
5 to < 50	14
1 to < 5	25
> detection limit to < 1	88

*Maximum concentration measured = 1 222 µg/l

Source: MDDELCC (unpublished data)

It is very difficult to obtain an estimate of TCE concentrations in the water of private wells in Shannon prior to the discovery of TCE in well water in November 2000. This is due to the lack of data for the period prior to April 1995, when the presence of TCE in the USS Valcartier system was first mentioned. According to hydrogeological assessments, residential wells in Shannon that were located in the main contamination plume (before 2001) would have been exposed to TCE for a period of between 4 and 11 years (Lefebvre, 2010) or 18 and 45 years (Chapuis, 2010). That said, it is impossible to estimate TCE concentrations in the water of the wells concerned.

Indoor air of homes in Shannon

TCE contamination of groundwater can lead to the release of vapours that infiltrate the basements of homes and contaminate the indoor air. DND assessed the potential intrusion of TCE vapours in the indoor air of certain residences in Shannon and Québec City (Val-Bélair sector). The study was conducted in collaboration with Health Canada and the DRSP. Participation of the DRSP was related to the DSP’s health protection mandate and was aimed at assessing the health risk associated with TCE vapour intrusions.

The analyses performed in 2007 and 2008 revealed the presence of TCE in the indoor air of a few residences, but at concentrations below Health Canada’s guideline value of 5 µg/m³ (Table III). The maximum concentration measured was 2.9 µg/m³. It is important to mention that all of the residences selected in Shannon were situated above the most contaminated portion of the plume (red triangle). Generally speaking, the concentrations measured in the residences were comparable (< 1 µg/m³) to

those found, during studies conducted elsewhere in Québec and Canada, in homes located in areas not contaminated by TCE.

Table III
TCE concentrations measured in the indoor air of residences in Shannon (SH)
and buildings in Courcelette (PMQ) between November 2006 and July 2008
(according to a study by the Department of National Defence)

Residences	Monitoring program					
	November 06 ($\mu\text{g}/\text{m}^3$)	February 07 ($\mu\text{g}/\text{m}^3$)	November 07 ($\mu\text{g}/\text{m}^3$)	February 08 ($\mu\text{g}/\text{m}^3$)	May 08 ($\mu\text{g}/\text{m}^3$)	July 08 ($\mu\text{g}/\text{m}^3$)
SH-1		ND	ND	ND	ND	ND
SH-2		0.97	ND	ND	ND	ND
SH-3 ^a		ND				
SH-4		0.75	ND	1.0	1.0; 0.96 ^b	-- ^c
SH-5		1.2	0.64	1.0	0.64; 0.51 ^b	ND
SH-6 ^d		2.9	ND			
SH-7		ND	ND	ND	ND	ND
SH-8		0.53	ND	0.64	0.81	1.2
SH-9 ^a		0.75				
SH-10		ND	ND	ND	ND	ND
PMQ_A	1.5; ND ^b	ND	ND	ND	ND	ND
PMQ_B ^e	ND ^f	ND				

Notes: The guideline value for TCE in indoor air = $5 \mu\text{g}/\text{m}^3$.

The empty boxes indicate that no sampling was carried out.

SH = Shannon residence.

PMQ = Private Married Quarters (Courcelette family housing unit).

ND: Not detected ($< 0.48 \mu\text{g}/\text{m}^3$).

^a The residents of SH-3 and SH-9 did not wish to participate in the monitoring program.

^b Two samples were taken simultaneously.

^c The results of the two samples taken simultaneously were rejected because of their improbable variance ($1.7 \mu\text{g}/\text{m}^3$ and $9.1 \mu\text{g}/\text{m}^3$).

^d The residents of SH-6 stopped participating in the monitoring program for personal reasons.

^e This building was not included in the monitoring program because of the results obtained (TCE not detected) during the sampling campaigns of November 2006 and February 2007 .

^f Three samples were taken in November 2006.

From DRSP, 2008.

Other characterization studies of the indoor air of homes in Shannon were conducted on behalf of the RCS in March 2009 and January 2010, within the context of the lawsuit, using sampling methods comparable to those applied during the DND study. These studies showed that TCE was present in concentrations of up to $10 \mu\text{g}/\text{m}^3$ (LNA, 2010, a, b). The federal government then did an independent check of TCE concentrations in the indoor air of residences where TCE had been detected. This analysis, performed in 2010, showed that TCE was not detected in most of the homes. Furthermore, when it was detected, the concentrations were below the value set out in Health Canada's guidelines for TCE (unpublished data).

Environmental contamination by other chemical parameters

Residential wells in Shannon

a) Volatile organic compounds

The analyses conducted by the MDDELCC of the water of residential wells in Shannon from 2001 to 2009 included over 50 volatile organic compounds (VOCs) (unpublished data). Special attention was paid to degradation products of TCE, namely, vinyl chloride, 1,1-dichloroethene (1,1-DCE), trans-1,2-dichloroethene (tDCE) and cis-1,2-dichloroethene (cDCE). Vinyl chloride was detected in around a dozen wells, at concentrations of less than $1 \mu\text{g}/\text{l}$, except in one case where a value of $2.4 \mu\text{g}/\text{l}$ was obtained. The Québec standard for vinyl chloride in drinking water is $2 \mu\text{g}/\text{l}$. A few wells also contained 1,1-DCE, tDCE and cDCE at concentrations usually below $1 \mu\text{g}/\text{l}$. The Québec standard for 1,1-DCE in drinking water is $10 \mu\text{g}/\text{l}$. The USEPA has proposed criteria of $10 \mu\text{g}/\text{l}$ and $100 \mu\text{g}/\text{l}$ for tDCE and cDCE respectively.

Other VOCs were also detected from time to time in the water of certain wells, at concentrations currently considered to pose no health risks by national and international health authorities.

b) Metals

The MDDELCC analyzed over 20 metals in residential wells in Shannon up to 2009. These analyses did not reveal any widespread problem related to the presence of these chemical parameters in the drinking water. Nevertheless, a few residential wells contained certain metals in concentrations exceeding Québec's standards or the available national and international criteria, in particular for aluminium, manganese and iron. It is important to specify that these sporadic excess concentrations were measured primarily on the territory of Shannon, which was not affected by the TCE contamination plume.

In 2001, the MDDELCC conducted a characterization study of a few residential wells in the area of influence of the TCE contamination plume, which specifically targeted certain metals (chromium, copper, nickel, lead and zinc) and other chemical parameters (nitrogen, nitrates/nitrites, chlorides, total phosphorus and C10-C50 petroleum hydrocarbons). Although these substances were detected in a few

cases, the available results do not indicate any particular problem for these parameters. The concentrations measured were less than the proposed guideline values.

Surface water

Since the 1990s, DND has done several characterization studies to determine the contamination of various environments located on the territory of the Valcartier base as a whole. The sites selected for surface water sampling (e.g. rivers, streams, drainage ditches) were generally located near or in environments that could have been affected by military or industrial activities (e.g. military test sites, waste disposal sites, dumps).

It is important to know that all sections of watercourses located on the territory of the Valcartier base cannot be used for swimming or for supplying residences with drinking water. The characterization studies conducted by DND focused primarily on the Jacques-Cartier, Nelson and aux Pins rivers. Depending on when and where the studies were done, different chemical parameters were analyzed, particularly VOCs, metals, hydrocarbons, pesticides, polycyclic aromatic hydrocarbons (PAHs) and energetic materials (e.g. RDX, HMX and TNT). Generally speaking, VOCs (including TCE) were not detected.

Certain metals, particularly copper, lead, zinc, silver and cadmium, as well as nitrates/nitrites, sometimes exceeded provincial and national criteria for the protection of aquatic life.

Since 2010, RDX has been detected in the Rivière aux Pins. The concentrations measured in areas outside the limits of DND's property, including Lake Saint-Joseph, are generally below the Québec criterion (0.3 µg/l) for use protection.

The MDDELCC (Laliberté, 2010) also did a characterization study of water in the Jacques-Cartier River. This study concerned a section of the river stretching between the northern part of the municipality of Shannon, upstream, and the municipality of Donnacona, downstream. TCE (max = 0.34 µg/l) and cis-1,2-dichloroethylene (max = 0.11 µg/l) were the only VOCs detected. A large number of metals were also detected, but at concentrations below the chronic effect criterion for the protection of aquatic life. Aluminium was the only exception, with concentrations in excess of the criterion. However, given the similarity between the concentrations in all of the sampling sites, the aluminium in the water of the river is probably of natural origin (Laliberté, 2010). No petroleum hydrocarbons (C10- C50) or perchlorates were detected.

Groundwater

It should be emphasized that groundwater can no longer be used for the supply of drinking water, unless it has been captured by wells of the USS Valcartier system.

The contamination plume was characterized for VOCs other than TCE. In particular, TCE degradation products (vinyl chloride, 1,1-dichloroethene, trans-1,2-dichloroethene and cis-1,2-dichloroethene) and BTEXs (benzene, toluene, ethylbenzene and xylene) were detected. It should be noted, however, that

the concentrations of these substances tended to taper off rapidly as groundwater flowed away from the contamination source areas. As a rule, the concentrations detected were below the criteria proposed for human consumption.

The groundwater analyses conducted over the years at various sampling sites on the territory of the Valcartier base (outside the plume) revealed the presence of certain metals (aluminium, zinc, iron, manganese, cadmium, copper and lead) and other chemical substances (energetic materials, particularly HMX, RDX and TNT) that sometimes exceeded provincial and national criteria for the protection of aquatic life. Perchlorate was also measured in certain observation wells (outside the plume) at concentrations above 1 µg/l (max = 24 µg/l). The guideline value proposed by the INSPQ for the protection of vulnerable populations is 1 µg/l.

Soil

In the mid-2000s, a soil characterization study was conducted for DND on the territory of the municipality of Shannon (SANEXEN, 2005). All concentrations for the 24 VOCs analyzed in nearly 100 soil samples were below the detection limit and the A criterion of the MDDELCC's Soil Protection and Contaminated Sites Rehabilitation Policy.

Another soil characterization study was performed by DND in military training areas to assess the environmental contamination possibly linked to explosives and metals (RDDC, 2004). Soil samples were taken in small- and large-calibre munitions impact areas, as well as along firing lines, i.e. the lines of positions at which soldiers are stationed to fire upon targets. In all, 199 surface soil samples and 18 biomass samples were taken in 9 areas. Forty-nine heavy metals and 13 energetic materials (found in explosives) were analyzed in each sample. Depending on the sample, certain metals were detected at concentrations above the average concentrations measured in the background samples. In some cases, 11 of the 31 metals analyzed were detected at concentrations above the quality criteria set by the Canadian Council of Ministers of the Environment (CCME) for industrial soils. The 11 metals concerned were lead, copper and antimony (the 3 most common), as well as arsenic, cadmium, chromium, tin, nickel, selenium, thallium and zinc.

As far as energetic materials are concerned, the analyses detected the presence of nitroglycerine (NG), octogen (HMX), trinitrotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT) and 2,6-dinitrotoluene (2,6-DNT) in some of the soil samples. There is no CCME criterion for these materials. None of them were detected in the background samples.

ADMISSIBILITY OF THE REPORT BY THE REGROUPEMENT DES CITOYENS DE SHANNON

On the basis of the cases reported and the surveillance of cancer cases in the FiTQ related to environmental contamination on the territory of Shannon, the following findings have been made:

- In 2011, the RCS submitted a report on cases of brain cancer that had been diagnosed between 1981 and 2008 among people who had lived in Shannon. These new data must be analyzed.
- The cancer cases reported by the RCS and those identified in the FiTQ are all located on the territory of Courcelette. The distribution of the cases in Courcelette may be a matter of chance, but this must be validated before it can be affirmed.
- The number of cases reported (14) over a 27-year period appears to be large. In the absence of an available denominator, the possibility of an excess cannot be completely ruled out.
- Currently, the latency period between time of residence in Shannon and a diagnosis of brain cancer among the reported cases is over 20 years.
- The mobility of the population of Shannon is unusually high, and it is impossible at the moment to qualify or quantify the risk of brain cancer associated with having lived in one geographic location rather than another, solely on the basis of available Québec surveillance data.
- Brain cancer is rare from an epidemiological standpoint, making it possible to identify clusters.
- Brain cancer usually affects young people or the elderly. However, the average age of the cases reported in Shannon is 38.5 years, which is younger than would normally be expected. Even if the two cases involving children are excluded, the average age is still young, i.e. 43.5 years, and this raises questions.
- Citizens are concerned about their environmental exposures.
- Environmental contamination by TCE has been clearly demonstrated on the territory of Shannon, but it is difficult to quantify people's exposure.
- TCE exposure has fallen substantially since 2001. Nevertheless, citizens are still concerned about delayed-effect diseases, such as cancer.
- The military and industrial use of the Valcartier base have caused many types of contamination.
- The RCS representatives appealed directly to the DSP by reporting the cases of brain cancer to it. Within the context of the lawsuit, they said that they were concerned about this situation.

Consequently, the DSP concludes that the possibility of an excess of brain cancer cases among people who have lived in Shannon cannot be excluded and that additional epidemiological work is necessary.

CLUSTER STUDY OF CASES OF BRAIN CANCER IN SHANNON

Since the presence of an excess of brain cancer in Shannon cannot be ruled out, the DSP has decided to continue the analysis of brain cancer cases in the municipality using the methodology proposed by the InVS (Germoneau *et al.*, 2005). Following the present summary evaluation of the RCS report (Phase 1 of a cluster analysis), the DSP would like to validate the cases and, if necessary, check environmental exposure in Shannon (Phase 2). The DSP would also like to conduct descriptive studies of the situation (Phase 3).

The cluster study will deal with cases of brain cancer, owing to the report submitted by the RCS in July 2010 and this summary evaluation. It will also focus on the seven other types of cancer that have been under surveillance by the DRSP since 2001 (liver cancer, cervical cancer, kidney cancer, multiple myeloma, acute lymphoid leukemia, non-Hodgkin's lymphoma and Hodgkin's disease) owing to the monograph by Wartenberg *et al.* (2000) concerning cancers potentially linked to TCE exposure. Including these cancers in the cluster study is designed to honour the commitments already made to citizens by the DSP.

The study will strive to determine whether or not there is a real excess of cases of brain cancer, liver cancer, cervical cancer, kidney cancer, multiple myeloma, acute lymphoid leukemia, non-Hodgkin's lymphoma and Hodgkin's disease among current and former residents of the municipality of Shannon. The project will follow the various phases involved in a cluster investigation, which are described in Appendix 3.

The study will be carried out using the individual, geographical and temporal data compiled by the RCS, along with the data already derived from surveillance by the DSP over the past 10 years. It will also take into account data from the Registre québécois du cancer (formerly, the FITQ), which now includes the Registre des événements démographiques du Québec and all cancers by histopathological origin for the 1984-2010 period. In addition, the DSP will try to build a cohort of people who lived in Shannon at one point or another in order to better describe the cases over time based on place of residence.

The DSP has already received special financial support from MSSS to carry out its cluster study. This funding will make it possible to remunerate the independent scientific experts making up the committee that will advise the DSP on the study. The list of experts recruited, their expertise, and their mandate as members of the advisory committee are presented in Appendix 4. The funding provided by the MSSS will also help to improve surveillance through case finding and the creation of a case description database.

The INSPQ will continue to support the DSP with its epidemiological and statistical expertise. Indeed, such expertise is necessary for the study to run smoothly. Furthermore, the Centers for Disease Control, through their environment cancer unit, are already committed to assisting the DSP in interpreting the study's results.

The purpose of the cluster study, which corresponds to phases 2 and 3 of the methodology outlined in the InVS guide, is to qualify the apparent excess number of cases of brain cancer, liver cancer, cervical

cancer, kidney cancer, multiple myeloma, acute lymphoid leukemia, non-Hodgkin's lymphoma and Hodgkin's disease in the municipality of Shannon for the 1984-2006 period, on the basis of the self-reported cases compiled by the RCS.

To that end, the study consists of four components with the following respective objectives:

1. Describe the reported cases in detail and cross-reference them in relation to place of residence, the different latency periods considered and the histologic type of cancers reported (case series)

This will involve developing a database that integrates all of the reported cases; cross-referencing these cases with the data available in the Registre québécois du cancer; mapping the reported cases; and cross-referencing the descriptive analyses.

2. Validate environmental exposure

Several expert opinions in environmental toxicology have been produced by various partners concerning chemical environmental quality in the study area. These opinions will be reassessed in light of the case analyses and will support evaluation of the file.

3. Determine, on the basis of the expert opinion requested in this regard, whether it is possible to estimate the real size of the population giving rise to the reported cases (in particular through statistical inference); or, if the administrative databases so permit, build a cohort of the population of Shannon and observe the actual rates of cancer in that cohort.

In this regard, it would also be useful to better characterize the actual mobility of the population of Shannon over the past 30 years.

4. Offer an opinion about the nature and type of work that should be conducted by the DRSP as part of monitoring the health status of the population of Shannon.

CONCLUSION

This summary evaluation of reported cases of brain cancer in the municipality of Shannon was conducted in the wake of a report by the RCS, which noted an apparently abnormal number of brain cancer cases among the residents of the Courcelette sector.

The immediate environment of Shannon has certain environmental problems, the main one being contamination of groundwater by TCE. Other contaminants have also been observed in residential wells, the region's surface water and certain properties on the military base next to Shannon.

To date, surveillance of cancer cases on the basis of administrative files has not revealed a specific excess of cancer cases. However, analysis of the RCS data has not excluded the possibility of an excess of brain cancer requiring additional epidemiological work.

The DSP is responsible for evaluating all reports about health threats that are brought to his or her attention. In the case of cancer clusters, the DSP must not only validate the information, but look into the possible cause. In addition, the DSP has a mandate to inform the population on its state of health.

The situation that prevails on the territory of Shannon in connection with groundwater contamination is complex. The fears expressed by many citizens, coupled with mediatization of the problem and its referral to the court, have given rise to numerous concerns and questions of a scientific, technical and social nature. The DSP has thus embarked on a systematic process to better document the situation regarding brain cancer, as well as other types of cancer historically associated with TCE, and has undertaken to publish the results when they become available.

Through this cluster study, the DPS would like to answer the main question raised by the representatives of Shannon: Is brain cancer really more common in Shannon than in other parts of Québec?

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APPENDICES

APPENDIX 1

Letter addressed to representatives of the RCS
in connection with their concerns about brain
cancer (letter of October 26, 2010)

October 26, 2010

EMAIL

Marie-Paule Spieser
President
Regroupement des citoyens de Shannon
15, rue King
Shannon (Québec) G0A 4N0

SUBJECT: Evaluation of cancer cases in Shannon

Ref. No. 735-1998-01-08

Dear Madam President:

During our meeting of July 15 at the town hall of the municipality of Shannon, we discussed the possibility that the Direction régionale de santé publique de la Capitale-Nationale could analyze the information gathered by the Regroupement des citoyens de Shannon on cases of brain cancer among the population of Shannon. At the time, we invited you to send us a request to that effect in writing.

Even though we have still not received your request, we have gone ahead and assessed the situation, as we agreed to do at the meeting, and have concluded that a descriptive analysis of the information gathered by the Regroupement des citoyens de Shannon could shed new light on this matter. The analysis would focus first and foremost on cases of brain cancer. However, given that we have specifically monitored certain other types of cancer since we first became involved in this file, we would also like to include the following types of tumours in the analysis: kidney cancer, liver cancer, cervical cancer, multiple myeloma, non-Hodgkin's lymphoma, leukemia and Hodgkin's disease. If you are particularly concerned about any other types of cancer, we could include them as well.

For the purposes of the analysis, we would like to receive a copy of the entire file pertaining to the above-mentioned cancers. This would include, for each case of cancer, the medical record, survey questionnaire and personal information of the person concerned, including the person's health insurance number and telephone number, or the telephone number of a member of the person's family. At the very least, the information should include the name of the person associated with each self-reported case of cancer, as well as his or her health insurance number and contact information, or the contact information of a family member.

Marie-Paule Spieser
October 26, 2010

page 2

Please rest assured that we will proceed with this analysis as expeditiously as possible and be transparent throughout the entire process.

We are also available to discuss in greater detail our intentions with regard to this study and the methods that will be used to transfer information.

Yours truly,

François Desbiens, M.D.
Regional Public Health Director
FD/lb

APPENDIX 2
















Contamination plume

Interprétation de la caractérisation
du TCE dans l'eau souterraine
à Shannon, Québec, Canada

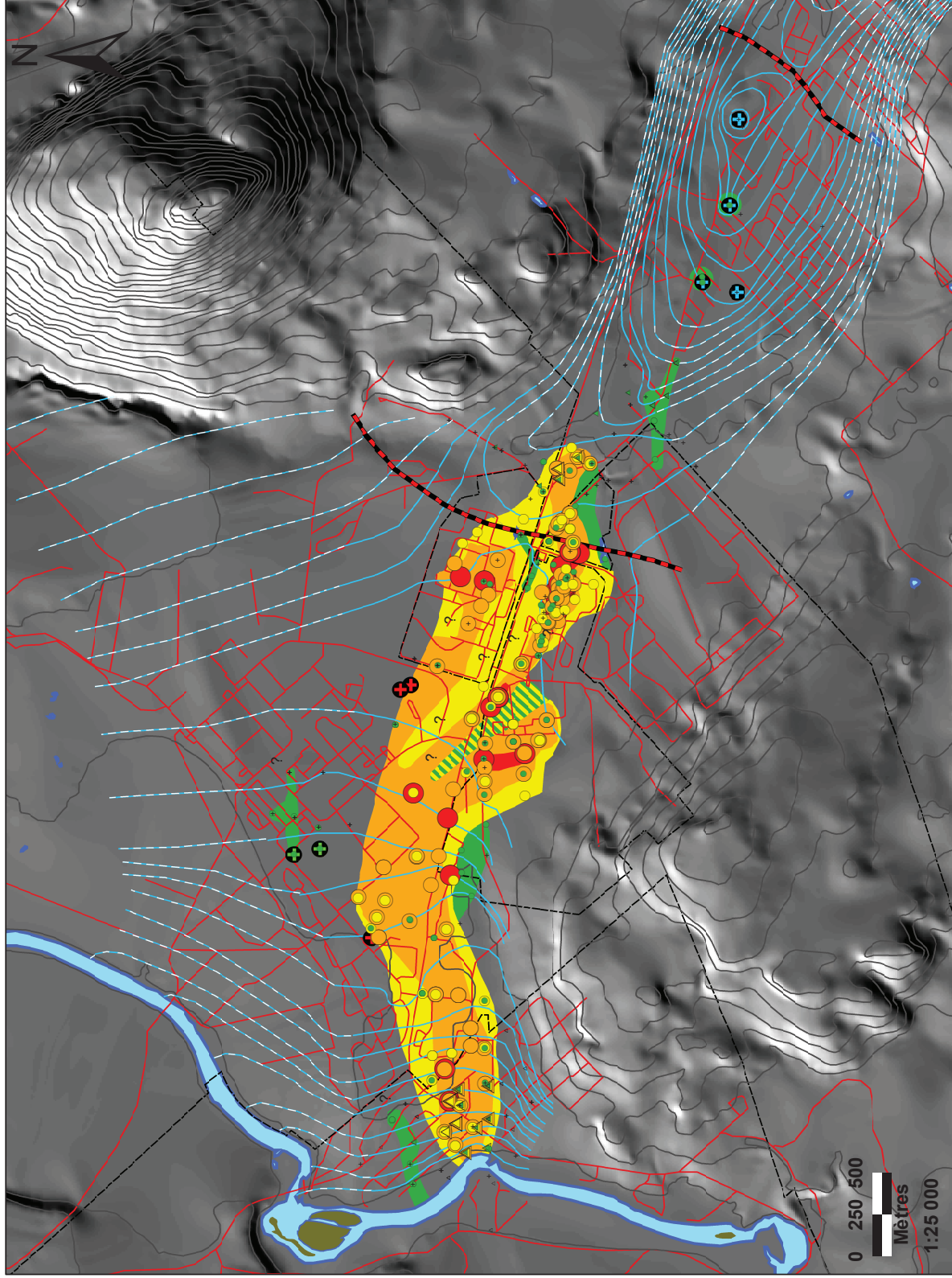
René Lefebvre, Véronique Blais,
Thomas Ouellet, Michel Parent
Jean-Marc Baillard et Cintia Racine

INRS, Centre - Eau Terre Environnement
RAPPORT FINAL
Juillet 2010

Planche 19 Panache de TCE régional en 2004-2005

- Données [TCE] - Puits
- ▲ Données [TCE] - Sondages
-  [TCE] Incertaine
-  Non détecté ou Limite de détection-5 µg/L
-  Limite de détection <[TCE]< 5 µg/L
-  [TCE] Incertaine
-  Limite de détection-5 ou 5-50 µg/L
-  5 <[TCE]< 50 µg/L
-  50 <[TCE]< 590 µg/L
-  [TCE] > 590 µg/L
-  Isopièzes
-  Isopièzes incertains
-  Ligne de partage des eaux souterraines
-  Puits de captage - MDN - Inactifs
-  Puits de captage - MDN - Actifs
-  Puits de captage - Québec - Actifs
-  Extension du panache et concentrations inconnues ou incertaines

Modèle numérique de terrain utilisé comme fond de carte



Modèle numérique de terrain produit par le LCNP



1- Les zones hachurées ont des concentrations couvrant les plages des deux couleurs utilisées
2- Les couleurs des points correspondent aux mêmes plages de concentrations que les couleurs des zones du panache

APPENDIX 3

Adapted version of the appendix to the Project Organization Manual

Evaluation of a reported excess of brain cancer cases in
the municipality of Shannon

Main phases of the cluster investigation

Evaluation of a reported excess of brain cancer cases in the municipality of Shannon

Main phases of the cluster investigation

PHASES	ACTIVITIES	DESCRIPTION	DELIVERABLES
1. Summary evaluation of reported excess	1.1 Receipt of report	Opening of file	Acknowledgment of receipt
	1.2 Description of reported cases	Description of reported cases (time, place, person)	Table supplied by the RCS
	1.3 Summary investigation of the environment	General data on the quality of the environment	Inventory of documented environmental contaminants on the territory of Shannon Other non-targeted contaminants
	1.4 Analysis of all files	Data analysis based on <ul style="list-style-type: none"> - rare/unusual nature - number of cases and possibility of an excess - plausibility (latency, nature of exposure, risk factors) - specificity - potential for extension 	Summary evaluation of the report of cases of brain cancer Commitment by the regional public health director to conduct a cluster study
2. Validation of cases and environmental exposure	2.1 Validation of cases	Analysis of medical records Description of cases (time, place, person)	Follow-up note Database Case map (confidential)
	2.2 Validation of environmental exposure	Assessment of available data on environmental exposure (Component 2)	List of risk factors present in the known environment
	2.3 Evaluation of epidemiological and environmental data	Data analysis based on (Components 1 and 2) <ul style="list-style-type: none"> - rare/unusual nature - apparent excess of cases according to the raw numbers (without any adjustment for population mobility) - plausibility (latency, nature of exposure, risk factors) - specificity 	Progress report to be prepared

PHASES	ACTIVITIES	DESCRIPTION	DELIVERABLES
		- potential for extension (risk/exposure still present)	
3. In-depth descriptive study	3.1 Organization of the investigation	Solicitation of funding Filing of descriptive analysis protocol Creation of advisory committee (scientific committee) Recruitment of necessary resources and expertise	Project Organization Manual Partnership application Research protocol
	3.2 Confirmation of an excess	Strict case definitions Case finding (missing files) Description of cases using the definitions chosen, according to time, place and person characteristics	Database Search for missing files Geolocation of cases (confidential)
		Development of a denominator (INSPQ expertise) Evaluation of the excess (INSPQ expertise)	Calculation of various denominators on the basis of the source population Progress report on the excess
	3.3 Description of cases	Search for information on cases	Possible progress report
	3.4 Evaluation of health impact	Evaluation of the environmental exposure of the population	Possible progress report
	3.5 Evaluation of the plausibility of a link (exposure/disease)	Characterization of the presence of an excess Demonstration that the population is over-exposed Demonstration of an excess risk for the population Agreement between the quantitative risk assessment and the excess of cases measured	Final report on Components 1, 2 and 3 of project
4. Additional epidemiological work	4.1 Drafting of an epidemiological surveillance protocol	Development of a summary protocol for an etiological study according to power, feasibility and cost	Expert report
	4.2 Organization of the surveillance system's operation	Monitoring of cancer incidence through the FITQ	Study of the Registre québécois du cancer

APPENDIX 4

Mandate of the advisory committee

MANDATE OF THE ADVISORY COMMITTEE

BACKGROUND

The regional public health director (DSP) of the Direction régionale de santé publique of the Agence de la Santé et des Services sociaux de la Capitale-Nationale (DRSP) has **a legal mandate to conduct the necessary epidemiology studies when he or she is notified of a health problem.** To that end, the DSP may enlist external experts and resources to obtain advice or to carry out certain methodological or scientific aspects related to this legal mandate.

In 2010, citizen representatives of the municipality of Shannon voiced their concerns to the DSP, specifically with regard to an excess of primary brain cancers observed in cancer data gathered within the context of a class action suit filed with the Superior Court. In accordance with its legal mandate, the DSP undertook to conduct a cluster study in order to confirm or disprove the presence of such an excess among the residents of the municipality.

A project in the form of a project organization manual was submitted to the Ministère de la Santé et des Services sociaux to support the funding of the cluster study (2012). The project provides that the DSP will solicit assistance and guidance for conducting its cluster study from the Centers for Disease Control and Prevention (CDC), the Institut national de santé publique du Québec (INSPQ) and an advisory committee. The expertise of these bodies is deemed necessary due to a particular characteristic of the territory of Shannon, namely, the high mobility and relatively young age of its population. The project as a whole must enable the **cancer incidence rates in an open population to be compared with provincial rates in order to determine whether or not there is an excess of cancer cases in Shannon.**

As indicated in the Project Organization Manual, the advisory committee will be entrusted with a mandate to:

- advise the regional public health director, Dr. François Desbiens, on the quality and nature of the work performed and the follow-up required to evaluate the reported excess of cancer cases in the municipality of Shannon;
- act as a scientific committee during the project;
- validate and approve the proposed protocol;
- validate the analyses;
- provide opinions on the working hypotheses, particularly on the plausibility of a cluster, as well as on the analysis methods, reference periods and conclusions of the work;
- validate and approve the conclusions of the work performed during the four components of the project:
 - 1) Exhaustively describing the reported cases (case series);
 - 2) Summarily investigating the environment;
 - 3) Determining whether it is possible to estimate the real size of the population giving rise to the reported cases (in particular, by statistical inference);

- 4) Offering an opinion about the nature and type of work that should be conducted by the DRSP as part of monitoring the health status of the population of Shannon;
- reflect on hypotheses that might explain the different situations brought to the committee's attention;
 - propose avenues for future work and analysis.

FOCUS OF THE PROJECT

Since the citizens of Shannon are concerned about brain cancer, the cluster investigation will initially focus on this type of cancer.

However, due to trichloroethylene (TCE) contamination of groundwater and citizens' concerns about the carcinogenicity of TCE, the DRSP undertook as of 2001 to conduct surveillance of cancer on the territory of Shannon on the basis of administrative files in order to detect any excess whatsoever. To that end, it has studied the incidence rates for cervical cancer, kidney cancer, Hodgkin's and non-Hodgkin's lymphoma, acute lymphoid leukemia, liver cancer and multiple myeloma.

In 2011, the United States Environmental Protection Agency (USEPA) declared that TCE was a proven carcinogen for humans. The epidemiological data are sufficient to conclude that there is a causal association between TCE exposure and kidney cancer and, though to a lesser degree, non-Hodgkin's lymphoma. The evidence is also sufficient, but weaker, when it comes to establishing a link with liver cancer and biliary tract cancer. In 2012, the International Agency for Research on Cancer (IARC) also declared that TCE was a proven kidney carcinogen (Group I). At the suggestion of Dr. Pierre Band, who will chair the advisory committee, the work of the DRSP must take these findings into account given the groundwater contamination observed in Shannon.

Therefore, it has been suggested that the committee's work **focus first and foremost on brain cancer, kidney cancer, non-Hodgkin's lymphoma, liver cancer and biliary tract cancer.**

INDEPENDENCE OF THE COMMITTEE

The committee shall be independent in its opinions and scientific advice. It will be chaired by Dr. Pierre Band and report to Dr. François Desbiens, the public health director. The committee will also seek advice from Dr. Desbiens.

COMPOSITION OF THE COMMITTEE

The committee will be made up of eight experts.

Name	Education	Expertise	Organization
Chair			
Pierre Band	M.D., FRCPC	Oncology	
Members			
Florence Kermarec	M.Sc.	Epidemiology	Institut de veille sanitaire (France)
Larissa Takser	M.D., Ph.D.	Epidemiology	Université de Sherbrooke
Lise Parent	Ph.D.	Ecotoxicology	Université du Québec à Montréal, Centre interinstitutionnel de recherche en écotoxicologie
Mélicha Généreux	M.D., M.Sc., FRCPC	Public Health	Direction de santé publique de l'Estrie
Claude Tremblay	M.Sc., D. Sc., Ph. D.	Tocicology	
Robert A. Moumdjian	M.D., M.Sc., C.S.P.Q., FRCS, FACS	Neurosurgery	Centre hospitalier universitaire de Montréal, Hôpital Notre-Dame
Thomas Kosatsky	M.D., MPH	Epidemiology	Centers for Disease Control and Prevention – British Columbia

OPERATION OF THE COMMITTEE

Dr. François Desbiens has mandated Dr. Alice Nourissat to conduct the cluster study¹. She will appoint the necessary professionals to help her with this task. Jean-François Duchesne is already slated to assist her, as is Joël Riffon, who will pilot the project. In addition, Denis Hamel and Louis Rochette of the INSPQ will help with the statistical analyses and the choice of methodology used to determine if there actually is an excess of cancer cases. Isabelle Théberge will assist with the epidemiological aspects. The DRSP will inform the committee about the progress of its work and its reflection on the issues concerned.

Dr. Pierre Band will chair and coordinate the committee. The regional public health director, Dr. François Desbiens, will receive the committee's recommendations when documents are completed and deemed admissible by the committee members.

The committee's proceedings will be prepared by the DRSP and approved, in regard to their conformity, by the members of the committee. The DRSP will look after the operational logistics of the committee's meetings and compensate the experts for their participation and preparation time. It will also provide financial monitoring to ensure that the works stays within budget.

¹ This mandate was entrusted to Dr. Isabelle Goupil-Sormany until January 2014.

DELIVERABLES

Once the DRSP has analyzed the cancer cases, the committee will provide **a scientific opinion** on the rigour of the methodology used, as well as **recommendations** on future work that should be carried out by the DRSP in regard to surveillance and investigation of cancer cases on the territory of Shannon. This opinion will be completely independent.

TIMELINE (completion: 1st quarter 2015)

The committee is scheduled to hold five working meetings and two preparatory meetings.

- *Preliminary meeting (December 12, 2012): presentation of the file
- First meeting (April 15, 2013): approval of the mandate; examination of the methodological approach envisaged by the DRSP and its partner, the INSPQ; presentation of time, place and person data on the reported cases
- Second meeting (September 18, 2013): validation and approval of the summary analysis
- *Information meeting (January 8, 2014): update on activities
- Third meeting (to be scheduled): discussion and approval of the protocol
- Fourth meeting (to be scheduled): presentation of the cluster study results
- Fifth meeting (to be scheduled): discussion and preparation of the final opinion