Initial study of terrestrial forces training sites potentially contaminated by energetic materials, CFB Petawawa

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Study prepared for Defence Research Establishment Valcartier (DREV) and CFB Petawawa

By

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Avis

Le présent document a été conçu à l'aide des informations disponibles à l'époque, soit à l'été 2000. Depuis, certains travaux ont été réalisés ou sont en cours sur certains sites. La nature de ces travaux consiste principalement en la caractérisation des sites à laquelle s'ajoute des analyses d'échantillons d'eau. Pour connaître les derniers résultats, il est fortement suggéré de consulter des ouvrages émis après l'année 2000, s'il y a lieu. En somme, la présente classification ne tient pas compte des résultats recueillis après l'été 2000.

Notice

The current document is a preliminary study. It has been made with the data available at summer 2000. Since then, fieldwork have been undertaken on particular sites in order to have a better understanding of the hydrogeological system. Furthermore, water analysis have been realised on samples taken in the studied areas. For up to date information, it is suggested to verify if other documents, more recent (2000-present), have been issued. This classification does not take into account the data acquired after the summer 2000.

January 2003

Résumé

Le présent rapport évalue le potentiel que pose les différents champs de tir de la base de Petawawa sur l'environnement et la santé humaine. Il traite des récents travaux d'évaluation environnementale effectués sur cette base. Ces travaux s'inscrivent dans le cadre d'un vaste projet de conformation et de gestion environnementale des bases militaires canadiennes entrepris par le Centre de Recherche pour la Défense Valcartier (CRDV).

Le rapport contient en premier lieu une présentation générale de la base. La situation géographique, l'historique et les activités actuelles ayant cours sur la base de Petawawa y sont décrits. Ensuite, les sites sélectionnés sont décrits en détail et sont évalués selon une méthode dérivée de celle du CCME (Conseil Canadien des Ministres de l'Environnement). Ces sites sont ceux où des matériaux énergétiques sont employés. Dans l'ensemble, le risque posé par ces sites est de moyen à fort, en raison des possibilités élevées de transport des matériaux énergétiques dans les eaux de surface et souterraines, ainsi que de la proximité des récepteurs potentiels.

Des conclusions et recommandations sont ensuite émises quant à la gestion des champs de tir de Petawawa et quant aux possibilités d'améliorer les évaluations effectuées. Parmi celles-ci, une meilleure connaissance des eaux souterraines et du degré réel de contamination des sites pourraient aider à définir les risques sur les récepteurs potentiels avec plus de précision.

Abstract

The following report provides an assessment of the potential risk associated with the shooting ranges of CFB Petawawa with respect to the environment and human health. The report gives account of the recent environmental evaluation work of performed in this base. This work is part of a major environmental compliance and management project of the Canadian military bases undertaken by the Defence Research Establishment of Valcartier (DREV).

The report first provides a general introduction to the base. The geographic setting, the site history and the current activities on the base are outlined. Then, the selected sites are described and evaluated with a method inspired by (and compatible with) the CCME's (Canadian Council of Ministers of the Environment) method. The sites are generally selected if their use involves energetic materials. The risk associated with the ranges is medium to high, due to the high migration potential of energetic materials in groundwater and surface water and due to the proximity of potential receptors.

Finally, conclusions and recommendations are made on the environmental management of the firing ranges and on the possible improvements to the evaluations, which were made of the sites. Among others, a better knowledge of the hydrogeological settings and of the actual state of contamination on the base could help better define the possible receptors and environmental risks with more accuracy.

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1. Introduction

1.1 Context

While developing an environmental management program for the Department of National Defence (DND) sites, it was agreed to do a study of the terrestrial forces training sites where the use of energetic materials could threaten the environment. This study, that represents a first step toward the environmental management of DND sites, will allow the identification and classification of potentially contaminated sites by energetic materials so that the need of complementary characterisation, the priority of intervention and the remedial actions be established. The study will also permit a synthesis of available information on each DND site to be done.

In this perspective, some training sites from Canadian Forces military Base (CFB) of Petawawa have been chosen by the DND and submitted to a preliminary evaluation of environmental risks. This evaluation, as well as a synthesis of the available information on each sites, are the subject of this study.

1.2 Evaluation method

The evaluation method used to classify potentially contaminated training sites is mainly based on the method developed by the Canadian Council of Ministers of the Environment (CCME, 1992). The CCME's method is simple, reliable and versatile. However, a few adjustments inspired by a method developed by the French "Bureau des Recherches Géologiques et Minières" (BRGM, 1997) have been made in order to remedy the deficiencies of the CCME method. Consequently, the evaluation of each site will follow these steps (reference of documents in parenthesis) :

- Site description sheet (CCME)
- Checklist of necessary information (CCME)
- Short evaluation form of site (CCME)
- Site classification (modified) worksheet (CCME & BRGM)
- Site classification computerised worksheet (Excel worksheet; INRS Géoressources)

A detailed description of CCME evaluation method and a summary of the modifications brought to it are presented in appendix A. Site classification computerised sheet can be found in appendix B, along with the documents corresponding to each step mentioned above.

The structure of the two studied methods (CCME and BRGM) is divided in three basic steps leading to a contamination:

- 1) Presence and characteristics of contaminants;
- 2) Exposure pathways of contaminant;
- 3) Presence of receptors for contaminants.

This structure has been kept in the modified method.

Although the evaluation method gives a good idea of the site's risk potential, it does not provide a quantitative risk assessment. Furthermore, the study (consisting in the sites evaluations) is only a preliminary step. It should be completed with complementary characterisation studies in some cases. These actions can however be realised afterwards.

2 Characteristics of Petawawa Canadian force base

2.1 Geographic and climatic background

The CFB Petawawa is located in the Ottawa valley and more precisely in the Renfrew county municipality. It is located at 150 km west of Ottawa and 200 km east of North Bay. Its current area covers approximately 21 968 ha. Petawawa garrison's town is at the crossing of the Ottawa River and the Barron River (Topographic map MCE 132 TR89 Ed 7).

The eastern part of the Training and Range Area is mostly flat. There are some hills close to the Sturgeon Lake like Highview Tower Hill. Numerous lakes are found in this area. The western part of the CFB Petawawa is a less flat terrain. Many hills are found throughout the area. Once again, many lakes are found on this part of the base (see Appendix E for maps).

Except for the north-western part, CFB Petawawa is located within the Renfrew Climatic Region. Data show that the average annual temperature is approximately 5°C and that the mean annual precipitation is 711 mm. The mean annual surplus water of 280 mm flows by runoff.

The western part of the Training and Range area is located in the Canadian Shield. Hence, the bedrock is mainly Precambrian rocks (metamorphic and intrusive). Amphibolite, granulite, mafic, ultramafic and anorthositic rocks are commonly found in this area. Over the bedrock, there are some irregular layers of deposits. During the quaternary period, the Champlain Sea was covering the Saint-Lawrence River valley and a part of the Ottawa River valley. This is why marine sediments are found in the eastern part of CFB Petawawa. These sediments are mostly fine sand and are surrounded by sandy till.

The drainage system of the CFB Petawawa is separated in four watersheds: the Ottawa River watershed, the Barron River watershed, the Petawawa River watershed and the Sturgeon Lake watershed. The Petawawa River is a tributary of the Barron River, which is, with the Sturgeon Lake, tributary of the Ottawa River. The direction flow of the Ottawa River is towards south. The Petawawa River is the only one that flows through the military base. Its direction flow is southeast while the Barron River flows towards east.

The study contains the evaluation of 11 training sites that present a potential risk of contamination due to energetic materials. These areas include grenade ranges, impact ranges, demolition range, fighting in built up area (FIBUA) and field firing ranges (direct and indirect firing).

2.2 **Property's boundaries**

The limits of CFB Petawawa are mostly rivers, park and lakes. The Barron River borders the southern part of the Training Area. The west shore of the Ottawa River constitutes another border of the base. On the western side of the Training and Range Area, the Algonquin Provincial Park defines the border. However, the northern frontier is not well defined. It goes along First Egan

Lake, Corry Lake, Porch Lake and the western end of Sturgeon Lake but there some parts that simply go through the wooden area and do not follow any precise physical element.

There are a few municipalities located around the Training and Range Area. The most densely populated are Pembroke, Petawawa and Chalk River. Beside these larger cities, there are some parishes, which are formed due to the low population density in these areas. A list of the main cities and parishes that surround CFB Petawawa is presented in table 1.

Municipalities	Population
Petawawa	15 015
Pembroke	70 000
Chalk River	25 000
Parishes	
Black Bay	N/A
Fort William	N/A

TABLE 1 – POPULATIONS OF MUNICIPALITIES AND PARISHES AROUND CFB PETAWAWA

2.3 ***** Historical and actual activities

The government of Canada bought the land in 1904 but the military activities did not begin until 1905. Before World War I, the "A" and "B" Batteries of the Royal Canadian Horse Artillery, the infantry and the cavalry were training at the base. During the war, CFB Petawawa served as a training site for all Canadian artillery units. Moreover, the Russian government, in accordance with the Canadian government, tested 100 mm shells made in Canada.

World War II gave to Petawawa military base an important role. Three training centres were in operation. There was one for the engineer units and two for the artillery units. The highest number of troops which were present and training during wartime was 20 000.

After the Second World War, Petawawa became a training site for the regular army and some militia units as it was before. In 1948, the 1st Battalion of the Royal Canadian Regiment and the Royal Canadians Dragoons settled at Petawawa. In 1951, the military base became officially a permanent camp and in 1966, it was renamed Canadian Forces Base Petawawa (CFB Petawawa).

Nowadays, the basic training for the infantry, militia and cadet is provided at CFB Petawawa. In addition, the Special Service Forces, which include:

- Infantry
- Artillery
- Armour engineer
- Helicopter
- Support
- Combat service support
- Field ambulance
- Military police headquarter
- Military headquarter

- Signal units

These units are now garrisoned at the base. These units undergo routinely manoeuvres in the Training Area, which involves weapons and pyrotechnics. Small weapons are used on a daily basis either on conventional or on expediate ranges. Heavier weapons such as howitzer and mortar are also use but it occurs sporadically.

2.4 Information sources

Most information were found in the study conducted by Jacques Whitford Environment Limited and on the topographic map of the CFB Petawawa Range and Training Area (MCE 132 TR 89 Ed 7). Some information concerning either energetic materials or the sites were also communicated through contacts at the CFB Petawawa and at the DREV. A list of the persons contacted is presented below.

-	Defence Research Establishment Valcartier (DREV)	(418) 844 - 4000
	Stéphane Jean, Environmental agent	ext. 4263
-	Petawawa military base (CFB Petawawa)	(613) 687-5511
	• Mr. Chris Hogan, Environmental officer	• •

• Mr. Sean Moyles, Range Control officer

Appendix C presents a table containing properties and criteria related to energetic materials. This table is also shown at the end of each site classification worksheet.

3. Sites studied

3.1 Training Area D

3.1.1 Site characteristics

3.1.1.1 Geographic setting

The Impact Area D, now known as the Training Area D, is located at the eastern part of CFB Petawawa and especially, between the square by these co-ordinates: 5092000m N, 5096700m N, 317800m E and 322250m E in the UTM system (NAD 83). The site covers an area of approximately 8.78314 km². This value includes the area occupied by Chalk Bay and Clement Lake. The range is characterised by a flat terrace bordered by a steep slope going towards Ottawa River's level on the eastern side and by another steep slope going uphill towards areas C and L's level. The soil along Chalk Bay is cover with trees. As for the rest of the range, it is covered by either sand or grass. There are some fragile areas such as marshes along Clement Creek in the northern part of the area.

3.1.1.2 Site boundaries

All the limits are well defined on this site. The northern border goes along Deluthier Road. Both Chalk Bay and Ottawa River define the eastern limit. As for the western limit, it is represented by Thackray road. Finally, Bostwick Lake defines partly the southern limit.

3.1.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but only troop manoeuvres.

3.1.1.4 Description of installations

The access to this site is controlled by three gates. On the southern part of the area, there are gates F2 on Clement Road and F3 on River Road. As for the northern part, gate C2 restrains the access on Deluthier Road. PTT Tower is the only major structure within the area. It is used to simulate a building invasion. No explosive ammunition are used on this site.

3.1.1.5 Geological, hydrogeological and hydrological contexts

The geology of Training Area D is composed of limestone, minor dolostone, shale and sandstone. The bedrock is mostly overlain by younger alluvium in terrace remnants and more precisely sand and gravely sand. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. However, there are some small areas near the northern border that show some outcrops sometimes covered by thin drift cover. As for Clement Point, the bedrock is underneath a layer of poorly sorted till. Finally, the shore of the Ottawa River is more likely covered by modern unsubdivided alluvium like clay, silt, sand, gravel and muck.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. The higher this criteria is, the more easily the water can flows. In the case of Training Area D, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-5} m/s and 10^{-2} m/s because of its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The direction of groundwater flow is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.1.2 Risk identification

3.1.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.1.2.2 Potential contaminants

The ammunitions used at Rocket Launcher Range are:

- ATGM BGM 71AE HE (TOW)
- BLANK AMMUNITION
- CS RIOT GAS
- CTG .38
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 38mm FLITERITE
- CTG 38mm SPEDEHETE CS
- CTG 60mm MOR HE
- CTG 60mm MOR SMK WP
- CTG 60mm MOR III
- CTG 76mm HESH
- CTG 76mmSH/P
- CTG 76mmSMK (HOW)
- CTG 81mm MOR HE
- CTG 81mm MOR SMK WP
- CTG 81mm MOR III
- CTG 84mm HEAT FFV 551
- CTG 84mm TP/T
- CTG 105mm HE PD (HOW)
- CTG 105mm ILL (HOW)
- CTG 105mm SMK WP (HOW)
- CTG 105mm SMK (HOW)
- CTG 105mm SMK HCBE (TK)
- CTG 105mm SMK WP (TK)
- MISSILE BLOWPIPE
- PROJ 155mm HE M107
- PROJ 155mm ILL
- PROJ 155mm SMK

- PROJ 155mm SMK WP
- PYROTECHNICS
- RKT 2.75in HE
- RKT 21mm SUB-CAL(M72)

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.1.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a low risk of contamination by other sites. The southern part of Impact Area A appears to be the most probable source of contaminants. Otherwise, the neighbouring sites are not classified as dangerous area. Actually, the odds of finding unexploded ammunitions in the ground of Training Areas C, F and L are non-existent except if these sites were used as training manoeuvres with the support of ammunitions containing energetic materials. Special considerations must be make on groundwater flow direction and to the understanding of the role of watercourses in the base's area, i.e. whether or not they are recharge zones. If so, the concentration of energetic materials in groundwater would increases and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.1.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.1.3 Hazard evaluation

3.1.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolved in water or be easily moved by the wind.

3.1.3.1.1 Groundwater

As known (see section 3.1.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Training Area D, groundwater would flows into Chalk Bay or into the Ottawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account into the classification, it is important to consider it. If the sand aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminant can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot *et al.*, 1998).

3.1.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. Chalk Bay and the Ottawa River are watersheds that border what is now Training Area D to the east and the north. The flow is towards south-east. As for Clement Lake, it drains water of the western part of the site and the eastern part of Training Area C. Clement Creek is a link, which is tributary of the Chalk Bay.

3.1.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. When used in ammunition, they are under a powder state. After the explosion, there is a possibility that particles present at the surface of the ground or in the air undergo an aerial transport. Another possibility would involve that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. Some ammunitions contain energetic materials that release toxic fumes while burning. As an example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their persistence in the environment.

The direction of the wind varies a lot, but is more often towards east (Climatic atlas of Canada, 1988). If an aerial transport occurs due to the destruction or the leakage of an unexploded shell, the cities that are more likely to be affected are Petawawa (south-east) and Fort William (East).

Otherwise, the others habitat possibly affected would be the aquatic fauna of the Ottawa River and the closest fragile areas, i.e. the marshes located along Clement Creek.

3.1.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same as the surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.1.3.2.1 Humans

The closest city to the site is Fort William in the Province of Québec on the eastern shore of the Ottawa River. However, considering the flow direction of the river and the direction of the wind, the Town of Petawawa located approximately 7 km south-east of the range, would be the most probable receptor affected by a contamination by energetic materials. Furthermore, the water plant intake is situated downstream of the range.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.1.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Clement Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas C and L. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.1.3.3 Known contamination cases

According to the Environmental Impact Assessment of Military Training Activities at CFB Petawawa and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Training Area D at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.1.3.4 Potential hazards inherent in site

The site presents a high risk of soil erosion especially because of its proximity to the Ottawa River and to Chalk Bay. Furthermore, the lack of vegetation increases the sensitivity to aerial erosion of the area. Flood is another risk of propagation of energetic materials because of the relatively flat terrain. During a flood, all energetic materials particles would be in suspension and would undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.1.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

The last major clearance operation occurred in the late 80's. However, newly constructed roads and installations have been clean in order to create a zone where there is no doubt about security.

The following table shows the different level of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the impact area 2. As for level 3, it is not often used mostly because of its important cost.

 TABLE 2 - CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-45 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.1.5 Site classification

The Training Area D is being given a score of $72.7 \pm 4.3 / 100$, or between 68.4 and 76 / 100. This score puts the site in class 1; thus, the potential risk is high. However, it could changes to a medium potential risk if there were more information available on this site. In order to respect the limits, many special considerations have been lowered. The evaluation has been based on the uses of this site in the past years. Nowadays, there is no high explosives ordnance fired on this range. The sections concerning the environment, the groundwater and the surface water receive the maximum amount of points because of the lack of information.

Threats to humans and to other receptors are quite low mostly because of the distance that separates the range from fragile areas.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.1.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used. Knowing the exact impact or training locations (for example the locations of the targets used if so, would also help to estimate the real potentially contaminated area and to determine the direction followed by contaminants (this direction can vary depending on the part of the range where contamination occurs).

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established; while waiting for information, groundwater has been supposed to go towards south-east, i.e. towards Ottawa River and hydraulic conductivity of the sand has been estimated between 10^{-5} and 10^{-2} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.2 Demolition Range

3.2.1 Site characteristics

3.2.1.1 Geographic setting

The Demolition Range, is located within Impact Area 8 on the south-western part of CFB Petawawa and especially, at these co-ordinates: 305700m E and 5083300m N in the UTM system (NAD 83). The site covers an area is less than 1 km². The range is located in an area characterised by important hills. However, the Demolition area is on a flat terrain. Biggar Lake is the closest basin approximately 300m north. That portion of Impact Area 8 is covered with grass and sand, but surrounded by trees and marshes. These marshes are considered as fragile habitats. They are concentrated around Biggar Lake and along Biggar Creek.

3.2.1.2 Site boundaries

The Demolition Range is located within the Area 8 and especially at the southern part of it. There is no particular physical feature, which could delimit precisely the area. Biggar Lake and Biggar Lake Road are the only features present within the range and the security area.

3.2.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, the eastern areas were used as impact zones for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells at Petawawa. Gradually, the government expropriated the lands located in the western part. Progressively, military exercises were undergoing in the western part of CFB Petawawa leaving the eastern areas as dry-firing ranges.

3.2.1.4 Description of installations

The area where duds are destroyed do not exceed 3 ha. It is a small range surrounded by a fireguard and a wired fence. Near the gate, there is a bunker where military personnel can witness the destruction of ammunition, explosives, etc.

3.2.1.5 Geological, hydrogeological and hydrological contexts

The geology of Demolition Range is composed of Precambrian rocks (metamorphic and intrusive). That land is a part of the Canadian Shield. The bedrock is overlain by gravel, gravely sand, sand and by poorly sorted till.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals. According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of the Demolition Range, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and its nature. The comparison with the materials that overlain the bedrock, i.e. gravel, gravely sand, sand and poorly sorted till. The hydraulic conductivity of the deposits has been estimated to vary between 10^{-12} m/s and 10^{-2} m/s depending of the material and its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Barron River as a discharge. As for the recharge areas, there is no information that specified where the aquifer recharges. However, mountains are usually known to be a recharge zone due to the contact between bedrock and permeable surface deposits. The influence of Biggar Lake is not well known. It could be either a discharge or a recharge zone.

3.2.2 Risk identification

3.2.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.2.2.2 Potential contaminants

The ammunitions used at Rocket Launcher Range are:

- EXPLOSIVES

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of this material are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.2.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a risk of contamination by other sites. The Impact Area 8 constitutes the most probable source of contaminants because the Demolition Range is a part of it. Otherwise, the neighbouring sites do not appear to be potential sources of contamination. Area P and Area Q are not classified as dangerous, which lower the possibility of finding duds in the ground. As for Impact Area 6, its location downstream of the Demolition Range classify this site as potentially contaminated. Finally, the Petawawa River separates Impact Area 7 from Impact Area 8. It implies that energetic materials will go downstream. Considerations on the groundwater flow direction must be made to provide a good analysis of a particular site.

3.2.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.2.3 Hazard evaluation

3.2.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.2.3.1.1 Groundwater

As known (see section 3.2.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Demolition Range, groundwater would flows into Barron River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.2.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Demolition Range does not have any well-defined border like river, pond or lake. However, Biggar Lake is located in the middle of the area. It defines the area as well drained. According to the topography, surface water flows towards the centre. Biggar Creek drains the water to the Barron River, which is the closest watershed in this part of the Training Area. There are some wetlands surrounding Biggar Lake that might be affected by energetic materials.

3.2.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunition, which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment. The wind has a relatively important influence on the Petawawa ranges. Eastern lands were in the past and nowadays influenced by the wind. As for the western lands, their rocky composition lowers the wind incidence. However, drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The CFB Petawawa is located in a remote area. The closest city is located far east of the Demolition Range. Beside the Town of Petawawa (including the garrison), the lands that might be influenced by the energetic materials

3.2.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same as the surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.2.3.2.1 Humans

CFB Petawawa is located in a remote area of north-eastern Ontario. The cities surrounding the base have for the majority, a low population. If we consider the groundwater flow, the cities that is the more likely to be affected would be the garrison and the town of Petawawa and other municipalities that have its water supplies downstream into the Ottawa River. Otherwise, the remoteness of the range lower the risks that energetic materials that are undergoing an aerial transport affect the cities in the areas surrounding the base.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.2.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Clement Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas C and L. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.2.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Demolition Range at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.2.3.4 Potential hazards inherent in site

The site shows a high risk of soil erosion especially because of the presence of Biggar Lake within the area. However, the vegetation that partly surrounds the lake lowers the sensitivity to both aerial and water erosion. The terrain just east of the lake is treeless which makes it propitious to both erosion and flooding. If these events occur, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.2.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. As for the Demolition Range, the presence of UXO in the ground is probable but do not represent a major concern. The issue is more the residues of energetic material thrown away after an explosion.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 3 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.2.5 Site classification

The Demolition Range receives a score of $61 \pm 4.3 / 100$ or ranging from 56.7 to 65.3 / 100. This grade puts the site in class 2 and the risk potential associates with this classification is medium.

Higher grades were given for the groundwater, surface water and the receptors. The lack of information concerning the geological, hydrogeological and hydrological contexts forced us to some suppositions especially for the flow direction of water in and on the ground. As for the hydraulic conductivity of the aquifer, it was estimated in accordance with the nature of the surface deposits and to with the chart of values of hydraulic conductivity and permeability (p.34 of the site classification worksheet). However, the map of the surface deposits was not precise enough to characterise the real nature of materials in place. That is why an average value of hydraulic conductivity was given. There was no trace of engineered or natural containment system. The presence of Biggar Lake can not be neglected. In fact, we think it represents the main drainage basin and the potential pathway for the contaminants contained in runoff water by spreading down the slopes beside the lake and then, towards Biggar Creek. The marshes around the lake increase the score for the presence of fragile sites to its maximum value.

The receptors received a low grade because of the remoteness of the site. The closest village is Black Bay located approximately 10 km east. Another reason is that the site is within the Impact Area 8 where ordnance land. Furthermore, only military personnel has an access to this part of the base

Even if the Demolition Range had a low score, it does not mean that there is no chances of a contamination by energetic materials. On the contrary, it is on these small areas often used that the concentration of contaminants in water ought to be higher than usual. If traces of TNT, RDX or HMX are in the water, it would be hard to determine the real influence of the Demolition Range. For this reason, it is important to see the global influence of the ranges upstream and see which sites had and still have an extensive use that could be directly related to the contamination.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.2.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if it was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of materials destroyed.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established in order to obtain these data necessary to know the direction a potential contamination would follow. While waiting for information, groundwater has been supposed to go towards south-east, i.e. towards the Barron River and hydraulic conductivity of the surface deposits has been estimated to range between 10^{-8} and 10^{-02} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.3 DZ Anzio Area 1

3.3.1 Site characteristics

3.3.1.1 Geographic setting

The DZ Anzio Area 1 is located at the eastern part of CFB Petawawa and especially, between the square formed by these co-ordinates: 5089350m N, 5092450m N, 315000m E and 318200m E in the UTM system (NAD 83). The site covers an area of approximately 5.44656 km². The range is characterised by a flat terrain with small hills sparsely located. The soil along Highway 17 and along Impact Area 4's limit is cover with trees. The rest of the range looks like a corridor covered by either sand or grass. There are some fragile areas such as marshes along Tucker Creek in the northern part of the Impact Area 4.

3.3.1.2 Site boundaries

The DZ Anzio Area 1's borders are well defined. Actually, this site is located within the area defined by Gust Trail, Old Bran Road, Stewart Road, tucker Road, Orange Road and Road 17.

3.3.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but only troop manoeuvres.

3.3.1.4 Description of installations

The access to this site is controlled by eight gates. On the southern part of the area, there are gates 1D and 1C which control the access to Gust Trail. As for the northern part, gate 4C restrains the access to Tucker Lake Road from Orange Road. The western part of the area contains three gates. Two of these gates, i.e. 4A and 4B, control the access to Totalize Road that goes across the area. As for the third one(4G), it restrains the traffic coming from the south on Old Bran Road. Finally, gates 1A and 1B control the eastern side of the area that come from Messer Trail. Their is also a building within the area located west of gate 1A.

3.3.1.5 Geological, hydrogeological and hydrological contexts

The geology of DZ Anzio Area 1 is composed of limestone, minor dolostone, shale and sandstone. The bedrock is mostly overlain by fine sand. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The monitoring wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not depending on its nature and . The velocity of water depends of the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of DZ Anzio Area 1, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the fine sand. The hydraulic conductivity of the fine sand has been estimated to vary between 10^{-6} m/s and 10^{-4} m/s because of its relatively porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.3.2 Risk identification

3.3.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.3.2.2 Potential contaminants

The ammunitions used at DZ Anzio Area 1 are:

- BLANK AMMUNITION
- CS RIOT GAS
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 38mm FLITERITE CS
- CTG 38mm SPEDEHETE CS
- PYROTECHNICS

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.3.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a low risk of contamination by energetic materials coming from other sites. Preferential pathway of surface water outside the site is more likely towards west and south. Other neighbouring sites are not classified as danger areas. The risk of contamination by water coming from Area C, E, L and O is improbable. Special considerations must be make on groundwater flow direction. In addition, the understanding of the role of waterways in the base's area, i.e. whether or not they are recharge zones. If so, the concentration of energetic materials in groundwater would increases and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.3.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.3.3 Hazard evaluation

3.3.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.3.3.1.1 Groundwater

As known (see section 3.3.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the DZ Anzio Area 1, groundwater would flows towards Petawawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.3.3.1.2 Surface water

Surface water appears to be another pathway considering the important runoff. Soils and surface deposits are mostly composed of fine sand. The DZ Anzio Area 1 does not have any well defined border like river, pond or lake. However, Tucker Creek and Duke Lake are the closest basin where surface water could tip into it by runoff because of the absence of watercourse within the area. Due to the important distance which separate basins from this area, it is considered as poorly drained. There are some wetlands located along Tucker Creek that might be affected by energetic materials and then, flow towards Sturgeon Lake.

3.3.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. When used in ammunition, they are under a powder state. After the explosion, there is a possibility that particles present at the surface of the ground or in the air undergo an aerial transport. Another possibility would involve that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. Some ammunitions contain energetic materials that release toxic fumes while burning. As an example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their persistence in the environment.

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The wind has a relatively important influence on the Petawawa ranges. Western lands with their rocky composition are not so influenced by the wind. As for the eastern lands, the sandy content in the surface materials are more propitious to be modified by the wind. Drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected especially at DZ Anzio Area 1 where records show the modifications of the topography trough time. Impact Area A is a different case because of its highly dense wooded areas and the use of non explosive ordnances. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, it ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The direction of the wind varies a lot, but is more often towards east. If an aerial transport occurs due to the destruction or the leakage of unexploded shells, the cities that are more likely to be affected are Petawawa (south-east) and Fort William (East). Otherwise, the others habitat possibly affected would be the aquatic fauna of the Ottawa River and the closest fragile areas, i.e. the marshes located along Clement Creek.

3.3.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.3.3.2.1 Humans

The closest city to the site is the Town of Petawawa that would be the most probable receptor affected by a contamination by energetic materials.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.3.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Tucker Creek in the northern part of the range. A survey of the marshes did a few years ago showed that they were classified as high priority marshes in. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.3.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on DZ Anzio Area 1 at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.3.3.4 Potential hazards inherent in site

The site presents a low risk of soil erosion especially because of the distance that separates it from the closest basins. However, the absence of vegetation and the type of surficial deposits, i.e. fine sand, constitute a propitious environment to aerial erosion and erosion caused by runoff water. Flooding in this area are not considered as a potential hazard due to the distance to Ottawa River. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.3.5 **Prevention and emergency measures**

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 4 - CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.3.5 Site classification

The DZ Anzio Area 1 receives a score of 71.3 ± 4.3 /100 or varying between 67 and 75.6 /100. This result puts the range in either class 1 or class 2. The risk potential associated with this score goes from medium to high.

The higher scores have been given for groundwater, contaminant quantity and receptors (environment). According to the topographic map and the one of surface deposits, there is no trace of containment system either natural or engineered. The hydraulic conductivity has been estimate in regard of the nature of the deposits. Thus, the materials in place is mostly sand. This results in a range of high values of hydraulic conductivity of the aquifer of concern (see p.34 of the site classification worksheet). The marshes beside Clement Creek increase the score in the section proximity to fragile areas. As for the groundwater resources, we assume that Quaternary deposits constitutes a permeable recharge area, which increase the sensibility of the site to contamination. Finally, the quantity of contaminants has been estimate according to the area of the range because of the lack of information concerning the number of ordnance fired throughout the time. The facts that no register was hold in the past and that the quality of ammunition used was sensibly lower than nowadays, are a concern because of the potential contamination risks. Moreover, it appear to be a treat for the militaries who are walking in a "mine field".

The lower scores have been given to the receptors (humans and others). The main reasons are that the water plant intake is located 5 km south-east and that people who are using the site are militaries. Furthermore, the closest city is the Town of Petawawa approximately 6 km south-east. Nowadays, there is no artillery exercises but more troop manoeuvres.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.3.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used. If a contamination due to energetic materials is detected in this area, it would be because of the presence of either unexploded shells in the ground or transport of materials by pathways like aerial transport, groundwater and surface water.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the surface deposits mostly composed of sand modified by the wind. Groundwater flow direction and hydraulic conductivity of the sediments should be established. Because of the absence of monitoring wells, it becomes harder to have a precise knowledge of the actual quality of water on the base and the groundwater flow direction. All we can do is make some hypothesises on what would be logical. For this reason, groundwater has been supposed to go towards south-east, i.e. towards Petawawa River and the hydraulic conductivity of the sand has been estimated between 10^{-06} and 10^{-03} cm/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to differentiate the areas of recharge from the areas of discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. DZ Anzio Area 1 appears to be the area the more influenced by wind erosion. As for the flood potential, it is quite non existent mostly because of the distance that separates the site from the nearest watercourse. In addition, the water level of the Ottawa River would have to raise up of more than 30 m. Even local flood in the Tucker Lake area, due to heavy rainfalls or melting of snow, could not affect the site.

It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.4 Impact Area A

3.4.1 Site characteristics

3.4.1.1 Geographic setting

The Impact Area A is located on the north eastern part of CFB Petawawa and especially, between the square formed by these co-ordinates: 5094600m N, 5100500m N, 313200m E and 319500m E in the UTM system (NAD 83). Chalk River is the closest city situated at 3 km west. Approximately 9 km separate the site from CFB Petawawa. The site covers an area of approximately 22.5926 km². This value includes the area occupied by Sturgeon Lake, Gwatkin Lake, Rafting Bay and Thompson Bay. The range is characterised by its topography. There is a flat area beside the southern limit. The Rifle Ranges B, C, D and E are located within it. As for the rest of the site, it is more undulating. Furthermore, trees cover almost all the area. Only the riffle ranges and the Rocket Launcher Range are treeless and covered mostly with sand and grass. There are some fragile habitats and especially marshes close to Chalk River Road. The locations of these fragile sites in the UTM system (NAD 83) are: 317850m E, 5099900m N and 317600m E, 5099100m N.

3.4.1.2 Site boundaries

The western part of Impact Area A is well delimited by Road 17. As for the southern border, it goes along Deluthier road. A cut line and the southern end of Perch Lake define the northern frontier. On the East Side, there is no physical feature. The neighbouring site is the Training Area B.

3.4.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but mostly firing exercises. Due to its proximity to the nuclear power plant, only training rockets, i.e. without explosives, are used to avoid or lower the risks of a forest fire.

3.4.1.4 Description of installations

Two gates, C1 and C2, control the access on Deluthier Road that constitutes the southern border of Impact Area A. C1, which location is 315550m E and 5094650m N, restrains the traffic coming from highway 17. As for C2, which location is 318000m E and 5095200m N, it regulates the traffic coming from Impact Area A. These two gates isolate the Rocket Launcher Range and the Rifle Ranges B, C, D and E, which are one beside each other. These ranges have a firing point at the southern extremity and the targets are at the northern extremity. The topography of ranges B, C, D and E is flat. However, range A, i.e. Rocket Launcher Range is more undulating. Finally, gate B1 controls the access to Deluthier Road.

3.4.1.5 Geological, hydrogeological and hydrological contexts

The geology of Impact Area A is composed of limestone, minor dolostone, shale and sandstone. The bedrock is partly overlain by younger alluvium in terrace remnants and more precisely sand and gravely sand. These sediments cover the southern part of the area. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. However, the geology in the region surrounding Sturgeon Lake is different. There are some small areas that show abundant bedrock exposures. Sometimes, it is underneath a thin and/or discontinuous drift cover. Some glaciofluvial outwash and deltaid deposits that recover the bedrock are surrounding the older alluvium.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a higher concentrations of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends of the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of Impact Area A, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-05} m/s and 10^{-02} m/s because of its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.4.2 Risk identification

3.4.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.4.2.2 Potential contaminants

The ammunitions used at Impact Area A are:

- CTG .38
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 60mm MOR HE
- CTG 60mm MOR SMK WP
- CTG 60mm MOR III
- CTG 76mm HESH
- CTG 76mmSH/P
- CTG 81mm MOR HE
- CTG 81mm MOR SMK WP
- CTG 81mm MOR III
- CTG 84mm HEAT FFV 551
- CTG 84mm TP/T
- CTG 105mm HE PD (HOW)
- CTG 105mm ILL (HOW)
- CTG 105mm SMK (HOW)
- PROJ 155mm HE M107
- PROJ 155mm ILL
- PROJ 155mm SMK
- PROJ 155mm SMK WP
- PYROTECHNICS
- RKT 66mm HEAT(M72)

This ammunition list can be found in appendix D (Impact Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. However, the ratios and weights of these materials are unknown except for the RKT 66mm which contains Octol; the main explosive compound. It includes 60 % of HMX, 20 % of TNT and 10 % of RDX. One rocket is filled with 300g of this explosive mixture.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a

good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.4.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is low risk of contamination by other sites surrounding the Impact Area A. The pathway of surface water is towards Sturgeon Lake. So do most of the waterways present in this area. Neighbouring sites do not appear to be potential sources of contamination. Training Area C and Petawawa National Forest Institute are not classified as dangerous areas. The odds of finding any duds in the ground are low. Special considerations on groundwater have to be made. Recharging zones and direction flow have to be known for a better analysis of that particular site.

3.4.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.4.3 Hazard evaluation

3.4.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.4.3.1.1 Groundwater

As known (see section 3.4.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Impact Area A, groundwater would flows into Chalk Bay or into the Ottawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.4.3.1.2 Surface water

Surface water appears to be another pathway considering the important runoff. Chalk Bay borders the impact area A to the south. Sturgeon Lake occupies the centre part of the land. All these basins define the area as well drained. According to the topography, surface water flows towards both Sturgeon Lake and Chalk River. There are some wetlands sparsely located within the area that might be affected by energetic materials.

3.4.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. When used in ammunition, they are under a powder state. After the explosion, there is a possibility that particles present at the surface of the ground or in the air undergo an aerial transport. Another possibility would involve that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. Some ammunitions contain energetic materials that release toxic fumes while burning. As an example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Western lands with their rocky composition are not influenced by the wind. As for the eastern lands, the sandy content in

the surface materials are more propitious to be modified by the wind. Drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected. Impact Area A is a different case because of its highly dense wooded areas and the use of non explosive ordnance. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The CFB Petawawa is located in a remote area. The closest city is located south-east of the site. It is the city of Fort William on the border between the province of Quebec and the Ontario. Beside this small village, the Town of Petawawa (including the garrison) represent the other major land that might be influenced by the energetic materials.

3.4.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.4.3.2.1 Humans

CFB Petawawa is located in a remote area of north-eastern Ontario. The cities surrounding the base have for the majority low population. If we consider the groundwater flow, the cities that are the more likely to be affected would be the garrison and the town of Petawawa and other municipalities that have its water supplies downstream into the Ottawa River. Otherwise, the remoteness of the range lower the risks of an aerial transport of energetic materials towards cities in the surrounding areas of the base.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.4.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Chalk River in the north-western part of the range. A survey of the marshes did many years ago showed some high priority marshes just south of the tree nursery. The influence of energetic materials coming from Impact Area A would have to be proved considering both groundwater flow direction and wind directions.

3.4.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Training Area A at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.4.3.4 Potential hazards inherent in site

The site presents a high risk of soil erosion especially because of its proximity to the Sturgeon Lake. However, the presence of vegetation lowers the sensitivity to both aerial and water erosion. The terrain surrounding the lake is relatively flat and low which makes it sensible to flooding. If it occurs, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.4.4 **Prevention and emergency measures**

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

 TABLE 5 - CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.4.5 Site classification

The Impact Area A receives the score $69.8 \pm 4.3 / 100$ or ranging between 65.5 and 74.1 / 100. This grade puts the site in both classes 2 and 1. The risk potential associated with this classification goes from medium to high.

The higher scores have been given for groundwater, contaminant quantity and receptors (environment). According to the topographic map and the one of surface deposits, there is no trace of containment system either natural or engineered. The hydraulic conductivity has been estimated in regard of the nature of the deposits. Thus, the materials in place are mostly sand, gravely sand and gravel. This results in a range of high values of hydraulic conductivity of the aquifer of concern (see p.34 of the site classification worksheet). The presence of Sturgeon Lake had an impact on the section related to surface water. The marshes within the site increase to the maximum amount of points allowed for the proximity to fragile areas. As for the groundwater resources, we assume that Quaternary deposits constitutes a permeable recharge area, which increase the sensibility of the site to contamination. Finally, the quantity of contaminants has been estimate according to the area of the range because of the lack of information concerning the number of ordnance fired throughout the time. The facts that no register was hold in the past and, that the quality of ammunition used was sensibly lower than nowadays, are a concern because of the potential contamination risks. Moreover, it appear to be a treat for the militaries who are walking in a "mine field".

The lower score have been given to the receptors (humans and others). The main reasons are that the water plant intake is located 9.5 km downstream and that people who are using the site are militaries. Nowadays, there is no more high explosive shells used on this site due to the risks of starting a forest fires that could be a danger for the nuclear power plant.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.4.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown. No register has been hold in the past when they started their activities at the beginning of the century. However, no highly explosive ordnance are used on this site because of the risks of ignition of a forest fire and of the presence of the nuclear power plant only 1.5 km north and the waste disposal site also north of the Impact Area A. This makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Knowing the exact impact or training locations when there were live-firing exercises (for example the locations of the targets used if so, would also help to estimate the real potentially contaminated area and to determine the direction followed by contaminants -this direction can vary depending on the part of the range where contamination occurs).

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established in order to have a precise view of the potential pathway of contaminants. That is why monitoring wells are necessary to determine these information and to observe the quality of groundwater throughout the time. While waiting for information, groundwater has been supposed to go towards south-east, i.e. towards Ottawa River and hydraulic conductivity of the sand has been estimated between 10^{-3} and 10^{-1} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is important to specify that the odds of a major flood are low in part because of the higher level of the land compare to the water level. However, local flood may occur because of heavy rainfalls or snow melting. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.5 Training Area B

3.5.1 Site characteristics

3.5.1.1 Geographic setting

The Impact Area B, now known as the Training Area B, is located on the eastern part of CFB Petawawa and especially, between the square by these co-ordinates: 5094900m N, 5100900m N, 317500m E and 323400m E in the UTM system (NAD 83). The site covers an area of approximately 14.6881 km². This value includes the area occupied by Mason Lake and Highview Lake. The range is characterised by flat terrain in its centre and southern parts. These areas are surrounded by mountains. Almost all the range is covered with trees. Some marshes can be find at different places such as 500m south of Highview Lake, approximately 300m north-west of Mason Lake and along a watercourse just north of Vaulin Creek.

3.5.1.2 Site boundaries

The Ottawa River constitutes the eastern limit. As for the northern end of the area, a cut line defines it. The southern border goes along the Chalk Bay. However, the western limit is not well defined. Its neighbouring site is Impact Area A.

3.5.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but only troop manoeuvres.

3.5.1.4 Description of installations

There is not much installations on this site. Only gate B1 restrains the access to Chalk River Road and therefore, to northern part of the range. There is also a bivouac area located at these coordinates: 321950m E and 5095250m N. On Highview Tower Hill, there is a lookout that gives an overview of the area. Its location is 32250m E and 5097700m N. Every co-ordinates are based on the UTM (NAD 83) system.

3.5.1.5 Geological, hydrogeological and hydrological contexts

The geology of Training Area B is composed of limestone, minor dolostone, shale and sandstone. The bedrock is partly overlain by younger alluvium in terrace remnants and more precisely sand and gravely sand. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. In the mountainous sections, there are more bedrock exposures that might have a thin drift cover. The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of Training Area B, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the fine sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-06} m/s and 10^{-04} m/s because of its relatively porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.5.2 Risk identification

3.5.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.5.2.2 Potential contaminants

The ammunitions used at Impact Area B are:

- BLANK AMMUNITION
- CS RIOT GAS
- CTG.38
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 38mm SPEDEHETE CS
- CTG 38mm FLITERITE
- CTG 60mm MOR HE
- CTG 60mm MOR SMK WP
- CTG 60mm MOR III
- CTG 81mm MOR HE
- CTG 81mm MOR SMK WP
- CTG 81mm MOR III
- CTG 105mm HE M1
- CTG 105mm HE PD (HOW)
- CTG 105mm HE PLGD (HOW)
- CTG 105mm ILL (HOW)
- CTG 105mm SMK WP (HOW)
- CTG 105mm SMK (HOW)
- CTG 105mm SMK HCBE (TK)
- CTG 105mm SMK WP (TK)
- PROJ 155mm HE M107
- PROJ 155mm ILL
- PROJ 155mm SMK
- PROJ 155mm SMK WP
- RKT 21mm SUB-CAL(M72)
- PYROTECHNICS

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.5.2.3 Potential sources of contamination outside the site

According to topography and to direction flow of surface water, there is a risk of contamination by energetic materials coming from other sites. As for Training Area B, only the north-eastern part of impact Area A constitutes a potential source of contamination. Otherwise, the preferential pathway of surface water is towards east, i.e. towards the Ottawa River. Almost all the watercourses present in this area are tributary of the Ottawa River. However, surface water on the south-western part of the area flow towards Chalk Bay. Special considerations must be make on groundwater flow direction. In addition, the understanding of the role of watercourses in the base's area, i.e. whether or not there are recharge zones. And if so, the concentration of energetic materials in groundwater would increase and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.5.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.5.3 Hazard evaluation

3.5.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.5.3.1.1 Groundwater

As known (see section 3.5.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Training Area B, groundwater would flows into Chalk Bay or into the Ottawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.5.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Training Area B is partly surrounded by Chalk Bay and the Ottawa River which define it as well drained. Surface water flows towards east. There are some lakes (Manson Lake and Highview Lake) which also act as watersheds. They are all tributary of the Ottawa River. The energetic materials might affect some wetlands located on the eastern part of the area.

3.5.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunitions which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Western lands with their rocky composition are not influenced by the wind. As for the eastern lands, the sandy content in

the surface materials are more propitious to be modified by the wind. Drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected. Impact Area B is a different case because of its highly dense wooded areas. In addition, this area is now use only for dry-firing exercises, i.e. there is no more explosive shells fired on this range. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

Wind appears to be a potential pathway for contaminants. However, the incidence on the Training Area B does not seem important due to the presence of vegetation.

3.5.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.5.3.2.1 Humans

Although the Training Area B is quite far from the Town of Petawawa, the major city in the area, a potential contamination is still possible. Thus, there are some houses just across the Ottawa River. The probability that they might be affected is low but present. This is mostly due to the distance the contaminants would have to do. As for the population of Chalk River, it has not been considered because of its location upstream the site.

The CFB Petawawa is located in a remote area. The closest city is located south-east of the site. It is the city of Fort William on the border between the province of Quebec and the Ontario. Beside this small village, the Town of Petawawa (including the garrison) represent the other major land that might be influenced by the energetic materials.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.5.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Vaulin Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes north of Mason Lake and south of Highview Lake. The real influence of energetic materials coming from

Training Area B would have to be proved considering both groundwater flow direction and wind directions.

3.5.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Training Area B at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.5.3.4 Potential hazards inherent in site

The site presents a high risk of soil erosion especially because of its proximity to the Ottawa River and to Chalk Bay. However, the presence of vegetation lowers the sensitivity to erosion of this impact area. The southern part of the site is relatively lowland and flat terrain, which makes it sensible to flooding. If it occurs, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.5.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. The last major clearance operation occurred in the late 80's. However, newly constructed roads and installations have been clean in order to create a zone where there is no doubt about security.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 6 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.5.5 Site classification

The Impact Area B receives a score of $74.7 \pm 4.3 / 100$ or ranging from 70.4 to 79 / 100. This grade puts the site in class 1. The risk potential associated with this classification is high.

The higher grades were given for the groundwater, surface water, quantity of contaminants and the receptors (especially the environment). The map showing the surface deposits has no trace of any engineered or natural containment system. This is why the site got the highest number of points allowed for these criteria. The presence of the Ottawa River and Chalk Bay as borders of the site increased the scores related to the surface water. As for the environment, the marshes within the area, it contributes to raise the grade of potentially affected fragile sites. The accessibility to the site also got a high score mostly because of the civilians who are coming on the site by boat. The numerous "no trespassing" signs and warnings on the presence of unexploded shells are not enough to dissuade people. Finally, the quantity of contaminants has been estimate according to the area of the range because of the lack of information concerning the number of ordnance fired throughout the time. The facts that no register was hold in the past and that the quality of ammunition used was sensibly lower than nowadays, are a concern because of the potential contamination risks. Moreover, it appear to be a treat for the militaries who, are walking in a "mine field".

The lower score have been given to the receptors (humans and others). The main reasons are that the water plant intake is located 7 km downstream and that people who are using the site are militaries. However, the facts that the Ottawa River and Chalk Bay are close to the site and are used for activities like fishing, swimming and sailing elevate the maximum amount of points allowed to the criteria of concern.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The hydraulic conductivity of the aquifer has been estimated in accordance with the nature of the surface deposits and with the chart of values (p.34 of the site classification worksheet).

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.5.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used. Even if no register was hold when the military exercises started on this site. Knowing the exact impact or training locations (for example the locations of the targets used if so, would also help to estimate the real potentially contaminated area and to determine the direction followed by contaminants - this direction can vary depending on the part of the range where contamination occurs).

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. However, it stays a hypothesis due to the fact that no monitoring well has been installed. With these additions, groundwater flow direction and hydraulic conductivity of the sediments would be established. For this initial study, groundwater has been supposed to go towards south-east, i.e. towards the Ottawa River and hydraulic conductivity of the deposits has been estimated to vary from 10^{-5} and 10^{-2} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. The flood potential appears to be low due to the fact that the level of the Ottawa River would have to raise of at least 10 m to get inland. However, local flood on the areas surrounding creeks and lakes are possible due to the snow melting. As for the influence of the wind, it is limited because there are plenty within the area but still present. Occasions like a leakage or the explosion of an unexploded shell are susceptible to aerial transport. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.6 Petawawa Grenade Range

3.6.1 Site characteristics

3.6.1.1 Geographic setting

The Petawawa Grenade Range is located within Impact Area 2 on the eastern part of CFB Petawawa and especially, at these co-ordinates: 318800m E and 5088300m N in the UTM system (NAD 83). The site covers an area less than 1 km². The range is characterised by a flat terrain partially surrounded by trees. The soil is covered by either sand or grass. There are some fragile areas are in Training Area E and approximately 2.5 km south-west of the site. Jorgens Lake represents the closest basin and the Ottawa River, the closest watercourse.

3.6.1.2 Site boundaries

The Petawawa Grenade Range is located within the Area 2 and especially beside the eastern limit. The junction of Brindle Road and Road 17 at the north-eastern end of the area is the only well defined frontier. Elsewhere, there is no particular physical feature.

3.6.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until many years ago when it became a grenade range. Nowadays, the range is still in use and its vocation has not change.

3.6.1.4 Description of installations

The only way to get to the range is by taking Messer Trail that goes along the Canadian Pacific railroad and the Trans Canada Highway 17. Gates 2C and 2D give a direct access to the cart-tracks that directly go to the range. The site itself is simple. There is concrete "bunker" that protect the military personal from the grenade fragments. Otherwise, the impact zone is flat.

3.6.1.5 Geological, hydrogeological and hydrological contexts

The geology of Petawawa Grenade Range is composed of limestone, minor dolostone, shale and sandstone. The bedrock is overlain by sand deposits modified by wind. This layer of sediments is commonly known to be a part of the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of Petawawa Grenade Range, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-06} m/s and 10^{-03} m/s because of its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability. However, without any geological assessment, these hypothesises stay questionable.

3.6.2 Risk identification

3.6.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.6.2.2 Potential contaminants

The ammunitions used at Rocket Launcher Range are:

- GREN FRAG M67
- GREN FRAG M61
- PYROTECHNIVCS

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.6.2.3 Potential sources of contamination outside the site

According to topography and to the direction flow of surface water, there is a low risk of contamination by energetic materials coming from other sites. Preferential pathway of surface water is towards south and west. The most probable source of contamination is the DZ Anzio Area 1 to the north. Furthermore, other neighbouring sites are not even classified as danger area. Thus, the probability of finding any unexploded duds is low. Special considerations must be make on groundwater flow direction. In addition, the understanding of the role of watercourses in the base's area, i.e. whether or not they are recharge zones. If so, the concentration of energetic materials in groundwater would increases and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.6.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be

buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.6.3 Hazard evaluation

3.6.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.6.3.1.1 Groundwater

As known (see section 3.6.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Petawawa Grenade Range, groundwater would flows towards either Jorgens Lake or Petawawa River, i.e. towards south-east.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.6.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Petawawa Grenade Range is on the northern part of Jorgens plain. There is no precise border such as river, lake or pond. Duke Creek is the closest basin in the area. The rarity of watercourse indicates that the grenade area is poorly drained. According to the topography, surface water flows towards east. There are some wetlands along Duke Creek that might be affected by energetic materials.

3.6.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunitions which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The direction of the wind varies a lot, but is more often towards east. If an aerial transport occurs due to the explosion of a grenade, the cities that is more likely to be affected is Petawawa (south-

east). Otherwise, the others habitat possibly affected would be the wildlife, the aquatic fauna of the Ottawa River and the closest fragile areas, i.e. the marshes located along Duke Creek and Antler Lake.

3.6.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.6.3.2.1 Humans

The closest city to the site, considering the direction flow of the river and the direction of the wind, is the Town of Petawawa located approximately 5 km south-east of the range, would be the most probable receptor affected by a contamination by energetic materials. As for the water plant intake or the residential wells, there is no proof of the presence of energetic materials coming from the grenade range because water has never been tested for that type of contaminants and there is barely no information on the groundwater context.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.6.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Duke Creek and around Antler Lake respectively in the western and in the eastern parts of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas E and G and within Impact area 2. The influence of energetic materials coming from Petawawa Grenade Range would have to be proved considering both groundwater flow direction and wind directions.

3.6.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Petawawa Grenade Range at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.6.3.4 Potential hazards inherent in site

The site presents a low risk of soil erosion especially because of the distance that separates it from the closest basins. However, the absence of vegetation and the type of surficial deposits, i.e. fine sand, constitute a propitious environment to aerial erosion and erosion caused by runoff water. Flooding in this area are not considered as a potential hazard due to the distance that separates it from the Ottawa River. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.6.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

Since 1974, over 87.25 km² on the impact areas have been swept at a clearance level 1. As for the Grenade Range Area A, the records do not show that a clearance operation ever occurred. On the other hand, the construction of the concrete bunker needed a characterisation of the soil on which it would be constructed.

The following table shows the different levels of clearance. Level 1 is the more frequently used. Thus, the construction of roads or any other structures might need a level 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 7 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-45 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

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3.6.5 Site classification

The Petawawa Grenade Range has received a score of $48.8 \pm 4.3 / 100$ or ranging from 44.5 to 53.1 /100. This mark classified the site at the limit of classes 2 and 3. Thus, the risk potential vary from medium low to medium.

Higher marks were given to the groundwater as a potential pathway of contaminants. The lack of information on this issue leaves us no choice but to make few suppositions. A closer look to the surface deposits map showed that there were neither natural nor engineered containment layer. As for the hydraulic conductivity of the aquifer, it has been estimate in accordance with the nature of the surface deposits and to the chart on the range of values of hydraulic conductivity and permeability (p.34 of the site classification worksheet).

The relatively low grades of surface water are due to the fact that there is no major water course or basin close to the site. The remoteness also explains the low scores related to the receptors. The closest city is the Town of Petawawa approximately 5 km south-west.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

Even if the Petawawa Grenade Range had a low score, it does not mean that there is no chances of a contamination by energetic materials. It becomes important to consider the previous uses of the site and low order detonation in order to evaluate the potential of contamination. If traces of TNT, RDX or HMX are found in the water within Impact Area 2, it would be hard to determine the real influence of the grenade range. For this reason, it is important to see the global influence of the ranges upstream and see which sites had and still have an extensive use that could be directly related to the contamination.

3.6.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the sand that compose the surface deposits. Monitoring wells would be a good way to characterise the hydrogeological context, such as groundwater flow direction and hydraulic conductivity of the sediments, and to witness the quality of water in the future. While waiting for information, groundwater has been supposed to go towards south-east, i.e. towards Petawawa River and hydraulic conductivity of the sand has been estimated to vary between 10^{-06} and 10^{-03} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

The lack of information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. However, flood is not a major concern mostly because of the remoteness of the range from water courses or basins. Even local flood that could occur in the Jorgens Lake area due to the melting of snow would not affect the range. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.7 Impact Areas 7 and 8

3.7.1 Site characteristics

3.7.1.1 Geographic setting

The Impact Areas 7 and 8 are located on the western part of CFB Petawawa and especially, in the square produced by the following co-ordinates: 301400m E, 308500m E, 5082000m N and 5092500m N in the UTM system (NAD 83). The site covers an area of more than 56 km². The areas are located in a part of the base characterised by important hills. There are many basins, but the more important are Centre Lake, Military Lake and the east end of Montgomery Lake. The major drainage feature is the Petawawa River which has as source the Montgomery Lake. Its direction flow is due east and it acts as a border between area 7 and area 8. These areas are mostly covered with grass and sand. There are many marshes especially in the northern part of area 8 and eastern part of area 7, along Centre Creek. These marshes are considered as fragile habitats.

3.7.1.2 Site boundaries

As said before, the impact areas 7 and 8 are located in the eastern part of CFB Petawawa. The areas are not well delimited, i.e. there is no particular physical feature. However, it is bordered by the Petawawa Range and Training Area to the north, the Training Areas P and Q to the west, the Impact Areas 5 and 6 to the east and finally by the Training Area R to the south.

3.7.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, the eastern areas were used as impact zones for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells at Petawawa. Gradually, the government expropriated the lands located in the western part. Progressively, military exercises were undergoing in the western part of CFB Petawawa leaving the eastern areas as dry-firing ranges. Nowadays, the impact areas 7 and 8 are used for long range firing exercises. Targets are usually tops of hills, but sometimes duds are off target and hit roads, marshes or watercourses.

3.7.1.4 Description of installations

There is many access road to these sites. Most of them are relatively well maintained, but it happens that they are damaged by shells. Orange Road to the north, Race Horse Road to the east and Survey Lake Road to the south and west provide access to the multiple gates the control the access to the impact areas. Impact area 8 contains the Demolition Range which has been studied previously in this assessment. There are some bunkers where military personnel can witness the destruction of ammunition, explosives, etc. They also provided the location of unexploded ordnance.

3.7.1.5 Geological, hydrogeological and hydrological contexts

The geology of Demolition Range is composed of Precambrian rocks (metamorphic and intrusive: amphibolite, granulite, mafic, ultramafic and anorthositic rocks). That land is a part of the Canadian Shield. The bedrock is overlain by gravel, gravely sand, sand and by poorly sorted till.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the mouth of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of the Impact Areas 7 and 8, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and its nature. The hydraulic conductivity of the deposits has been estimated to vary between 10^{-12} m/s and 10^{-2} m/s depending of the material and its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west for area 8 considering the Barron River as a discharge and towards south for area 7 considering Petawawa River as a discharge watercourse. As for the recharge areas, there is no information that specified where the aquifer recharges. However, mountains are usually known to be a recharge zone due to the contact between bedrock and permeable surface deposits. The influence of Biggar Lake is not well known. It could be either a discharge or a recharge zone.

3.7.2 Risk identification

3.7.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.7.2.2 Potential contaminants

No authorisation form was available. Hence, the nature of ammunitions used on these sites has to be determine in order to evaluate if there is a chance to find energetic materials in the ground.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.7.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a minimum risk of contamination by other sites. The reason is that artillery exercises are concentrated in areas 7 and 8. Otherwise, the neighbouring sites do not appear to be potential sources of contamination. Area P and Area Q are not classified as dangerous, which lower the possibility of finding duds in the ground. As for Impact Area 6, its location downstream of the Impact areas 7 and 8 classify this site as potentially contaminated. Finally, the fact that Petawawa River separates Impact Area 7 from Impact Area 8 implies that energetic materials would travel downstream. Considerations on the groundwater flow direction must be made to provide a good analysis of a particular site

3.7.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.7.3 Hazard evaluation

3.7.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.7.3.1.1 Groundwater

As known, groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Impact Areas 7 and 8, groundwater is taught to flow towards south and south-east.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.7.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Impact Areas 7 and 8 have well-defined border like river, pond or lake. Barron River and Petawawa River define the areas as well drained. According to the topography, surface water flows mostly towards the Petawawa River in either areas. There are some wetlands within these areas that might be affected by energetic materials.

3.7.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunition, which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Eastern lands were in the past and nowadays influenced by the wind. As for the western lands, their rocky composition

lowers the wind incidence. However, drift cover might undergo an aerial transport. For this reason, aerial transport cannot be neglected. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The CFB Petawawa is located in a remote area. The closest city is located far east of the Impact Areas 7 and 8. Beside the Town of Petawawa (including the garrison), the lands that might be influenced by the energetic materials

3.7.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.7.3.2.1 Humans

CFB Petawawa is located in a remote area of north-eastern Ontario. The cities surrounding the base have for the majority, a low population. If we consider the groundwater flow, the cities that is the more likely to be affected would be the garrison and the town of Petawawa and other municipalities that have its water supplies downstream into the Ottawa River. Otherwise, the remoteness of the range lower the risks that energetic materials that are undergoing an aerial transport affect the cities in the areas surrounding the base.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.7.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Clement Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas C and L. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.7.3.3 Known contamination cases

According to the Environmental Impact Assessment of Military Training Activities at CFB Petawawa and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by

the past activities on Impact Areas 7 and 8 at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.7.3.4 Potential hazards inherent in site

The site shows a high risk of soil erosion especially because of the presence of many lakes and watercourses within the area. However, the vegetation that partly surrounds the lakes lowers the sensitivity to both aerial and water erosion. The terrain just east of the lake is treeless which makes it propitious to both erosion and flooding. If these events occur, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.7.4 **Prevention and emergency measures**

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. As for the Impact Areas 7 and 8, the presence of UXO in the ground is probable and might represent a major concern. Many years ago, an important forest fire took place on the western part of CFB Petawawa. Three cases of cooked off ordnance have been registered. Still, these cases are under investigation due to the fact that the shells can resist to high temperature. Nevertheless, the procedures concerning forest fire have been changed in order to prevent any accident.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 8 - CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.7.5 Site classification

The Demolition Range receives a score of $77.5 \pm 4.3 / 100$ or ranging from 73.2 to 81.8 / 100. This grade puts the site in class 1 and the risk potential associates with this classification is high.

Higher grades were given for contaminants characteristics, groundwater, surface water and the receptors. The lack of information concerning the geological, hydrogeological and hydrological contexts forced us to make some suppositions especially for the direction flow of water in and on the ground. The hydraulic conductivity of the aquifer was supposed to be in accordance with the nature of the surface deposits and with the chart of values (p.34 of the site classification worksheet). However, the map of the surface deposits was not precise enough to characterise the real nature of materials in place. That is why an interval of hydraulic conductivity was given. There was no trace of engineered or natural containment system. The presence of many lakes, marshes and rivers can not be neglected. In fact, we think it represents the main drainage systems and the potential pathways for the contaminants contained in runoff water by spreading down the slopes beside the hills. The marshes within the areas increase the score for the presence of fragile sites to its maximum value.

The receptors received a low grade concerning humans because of the remoteness of the site. The closest village is Black Bay located approximately 10 km east. Another reason is that the site is within the Impact Area 8 where ordnance land. Furthermore, only military personnel has an access to this part of the base. However, other receptors got a relatively high score due mostly to the presence of marshes and dense forests. As known, they constitute rich natural habitats.

The results clearly show that the impact areas have a high score. It does not mean that there is a contamination by energetic materials, but it indicates that further studies should be undergone. The fact that the impact zones are not well defined influences a lot the score concerning the estimate of contaminant. A more detailed study on the zones of interest, i.e. the targets, would facilitate future studies of these sites. If traces of TNT, RDX or HMX are in the water, it would be hard to determine the real influence of the Demolition Range. For this reason, it is important to see the global influence of the ranges upstream and see which sites had and still have an extensive use that could be directly related to the contamination.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

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3.7.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if it was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of materials destroyed.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lays in the Q uaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established in order to obtain these data necessary to know the direction a potential contamination would follow. While waiting for information, groundwater has been supposed to go towards south and south-east, i.e. towards either Barron River or Petawawa River and hydraulic conductivity of the surface deposits has been estimated to range between 10^{-12} cm/s and 10^{-2} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

4. General conclusions and recommendations

The present report intended to evaluate sites potentially contaminated by energetic materials at CFB Petawawa. These evaluations are meant to facilitate management of each site and understanding of the global environmental situation at CFB Petawawa. Four evaluations were completed in this study, some of which including more than one range. Notably, the Rocket Launcher Range is located within the Impact Area A. The Demolition Range has been studied independently of the Impact Area 8 because of its specific use and area. Impact Areas 7 and 8 have been evaluate together because they are now the only impact zones during artillery exercises. As for the Impact Area A, Training Areas B and D, the evaluations were done on the base of their uses in the past. Nowadays, non explosives ordnance are used on these sites.

The scores resulting from the classification of the sites are showed in this table:

Site	Scores	Potential risk
Demolition Range	57.1 ± 4.3 /100	Medium
Impact Area 7,8	77.5 ± 4.3 /100	High
Training Area D	72.7 ± 4.3 /100	High
Training Area B	74.7 ± 4.3 /100	High
Petawawa Grenade Range	48.8 ± 4.3 /100	Medium
Impact Areas A	69.8 ± 4.3 /100	High
DZ Anzio Area 1	71.0 ± 4.3 /100	High

TABLE 9 - POTENTIAL RISK OF EVALUATED SITES

The evaluated sites got scores that indicated medium to high risk. The criteria that had a real influence on the results is the quantity of contaminants on the ranges. It has been evaluated in accordance with the area of the range. Consequently, it induces an error that can lead to either overvalue or to undervalue the real potential risk. In this way, the Petawawa Grenade Range got the lowest score because of its little area (less than 1 ha) and the Impact Areas 7 and 8 got the highest also because of the area they cover (56.3789 km²). Moreover, the presence of several sensitive areas, lakes, wetland and groundwater resources within the site contribute to increase the score.

On the basis of these results, two hypothesis have to be considered: the first one is to suppose that the sites are indeed potentially dangerous. The other hypothesis, which is not necessary contradictory with the first one, is that the present form of evaluation tends to overestimate the contamination of the sites when the source of contaminants is unexploded ordnance. The estimation of the quantity of energetic materials should therefore be examined and possibly changed to take into consideration the punctual nature of this kind of contamination source. It is important to understand that this conclusion is not made to reduce the scores of the ranges; it has just been felt that the initial CCME's evaluation had not been conceived to be used for this sort of contamination. This is easily understood when looking at the limit of contamination classes in the section about contaminant quantity. A site where the area of impact is estimated to be greater than 10 ha gets the maximal score. This is not very useful to discriminate sites at CFB Petawawa, where area of the sites can reach 3017.15 ha.

History of the sites is generally not well known. This can be a problem if dangerous operations previously took place on a range and could still contaminate the environment. Furthermore, the danger caused by the presence of UXO in the ground prevent military personnel from passing through some part of the Training Area even if there is a low potential of contamination. Even within the garrison, there are possibilities to find unexploded shells fired at the opening of the base. No records on this exist, but the discovery of these duds beside a building happens occasionally.

The clearance reports from range control showed that compilation of fired and destroyed ordnance is already done. This should be continued, and cumulative balance sheets should be produced for each site, in order to control, evaluate and limit the quantity of duds potentially contaminating the environment. However, the cleaning of Danger and Training Areas, which are very large, require a lot of time, money and personnel. A level 1 clearance does not prevent duds in the ground from coming up to the surface. The result is that time and money will still have to be spent on a previously cleaned area.

Finally, this report is meant to help summarising the available information on potentially dangerous sites at CFB Petawawa, and to give a preliminary evaluation of the risk created by these sites. The sources of information were not numerous. This is why the evaluations should not be seen as a final step of environmental assessment of the base. The evaluations should be reviewed if felt necessary by personnel of the base; they should also be kept up to date regularly, in order to be used as a tool for the management of the ranges.

From this point of view, recommendations can be made to improve the accuracy of the evaluations:

1) Geological, hydrological and hydrogeological context

The important lack of information on the geological, hydrological and hydrogeological context did not facilitate the writing of this report. Many suppositions have been made in order to evaluate accurately the actual status of each sites. However, it is impossible to affirm that all the scores are close to the reality. It would be more than useful to do an assessment on the geological, hydrological and hydrogeological context.

2) Soil and groundwater sampling

Further assessment of the studied sites should be carried out in order to confirm or not the present report. This assessment should consist of soil sampling and analysis. If significant contamination is detected, installation of observation wells and analysis of groundwater samples should be conducted to assess potential contaminant impacts on local groundwater quality. As for CFB Petawawa, a monitoring campaign of groundwater in the north-eastern part of the base and in Impact Areas, especially areas 7 and 8 would help to prevent the deterioration of the quality of groundwater.

3) Compilation of existing data

Despite of the few documents available for this study, there will have surely other sources of information on the base in a near future. It is important to continue to collect information in order to build an environmental database for CFB Petawawa sites. This database should comprise a summary of the information available as well as a map for each site. Such a database will make environmental work more easier and useful that it has been in the past, because access to information would be easier and faster.

4) Study of aerial transport of contaminants

Unlike the groundwater or surface water migration of energetic materials, the mechanisms of aerial transport is poorly known. Some studies could be done in order to conclude on the real potential of such a pathway. Moreover, other studies on the mechanism of explosion (whether or not residues are loosen in the air)

5) Hydrogeological data

Hydrogeological context of the base is not precisely known. The installation of observation wells to know the depth and direction of groundwater flow in the aquifers could also be very significant. In addition, it would allow a better understanding of the migration of contaminants and a better knowledge of Quaternary deposits and bedrock.. Grain size curves and hydraulic conductivity of the Quaternary deposits would be interesting data, since there is come contradicting information about the permeability of deposits.

6) Compilation of the quantity of energetic materials

A compilation should be done on each site to determine the quantity of energetic materials released in the environment. This could be done in calculating the difference between the number of unexploded fired ammunitions and the number of destroyed duds (of corresponding calibre) on a same site for a given period. Information such as exact composition of ammunitions and nature of energetic materials comprised in each type of ammunitions which was not available should also be compiled and included in the database previously mentioned.

7) Identification of preferential pathways

Physical or virtual modelling of contamination should be done to determine their importance in the different media (groundwater, surface water, air) depending on topography and soil type. The wind is also an important factor, especially in treeless areas where the risks of aerial erosion are high. Adsorption and biodegradation processes could also be studied in the meantime.

8) Study of the global influence

The present study present the potential risk of contamination for a site. It would be also useful to know the combined influence of different sites that have a common preferential pathway (wind, groundwater or surface water).

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Appendix A – Evaluation procedure for sites potentially contaminated with energetic materials

Evaluation procedure for sites potentially contaminated with energetic materials

Introduction

Training on military bases often involves the use of dangerous materials. Energetic materials are considered to be dangerous; they must be handled with care because of their explosive characteristics and can also have toxic effects on humans and on the environment. Normally, there are no major problems associated with the use of ammunitions containing energetic materials, because they explode and the toxic substances are transformed in simpler and less toxic gases by the process. CO_2 and water can be produced this way. However, some ammunitions sometimes fail to explode. The duds then lie on the ground and could be a source of contamination if energetic materials leach out of the unexploded shell.

Over the last few years, the Canadian Forces have undertaken a plan of environmental conformation. It was thus suggested to list and evaluate all potentially contaminated training sites. This process would then facilitate the management of the ranges, notably helping to set a priority order of intervention between all those sites. The following text explains the recommended procedure for succint evaluation and classification of potentially contaminated military training sites.

Existing methods

Two existing methods of environmental risks evaluation have been particularly studied: the CCME's (Canadian Council of Ministers of the Environment, 1992) method and the BRGM's (Bureau de recherche géologique et minière, 1998). The procedure suggested by the EPA (Environmental Protection Agency) was also studied, but it appeared to need a lot of information to be completed. Because a simple method had to be used, the EPA's procedure was set aside. However, let's mention the impressing computerised system built by the EPA.

CCME's method

The CCME is a canadian organism regrouping the provincial and federal ministers of the environment. In 1992, the CCME published a succint method for evaluation of potentially contaminated sites. This method is quite simple and can evaluate either the potential or known risks related to a site.

BRGM's method

The BRGM, a French organism affiliated to the Ministère de l'Aménagement du Territoire et de l'Environnement français, has built a simplified method for risk evaluation of potentially contaminated sites. The method is more complex than the CCME's method; the potential and current risks are all evaluated. The only receptors

considered, however, are humans. Another particularity is the fact that the weighting of the different section changes depending on the use of the site.

Selection of a method

Even if the two method are similar, many differences can be noted between them. First, the CCME's method appears to be much simpler than the other. Nevertheless, this does not necessarily imply a loss of accuracy for the evaluation. Indeed, the problems caused by such a simplification (comparatively to the BRGM's method) were judged insignificant. Two other points were also considered uninteresting in the BRGM's method: 1) the only receptors considered are humans, even if a disturbed environment will eventually have some effects on human life; 2) the use-depending weighting also seemed to be a problem, since the use of sites could eventually change.

It was thus concluded that the CCME's method was the most convenient for the classification of the sites of the Department of National Defence. However, some modifications were made to it in order to adapt it to contamination with energetic materials.

a) Modification made to the CCME' method

The first modification was to make a list of the possible contaminants. Such a list was presented with the BRGM's method and was adopted. However, because some contaminants, such as energetic materials, were not in the list, a literature review was done to find information on the characteristics of energetic materials and on related criteria. It is recommended that the list from the BRGM be used as reference; of course, missing information will have to be found and added to this list.

Another problem with the CCME's evaluation is that migration risks are evaluated depending only on the site, and not on the contaminant itself. For instance, potential groundwater migration is evaluated according to the permeability of the aquifer and the presence of a confining layer, but it does not take the solubility and mobility of the contaminants in account. These missing items were therefore put in the special considerations of the corresponding sections and are the following:

Exposure pathways

Groundwater

- Solubility of contaminants (Ratio solubility/criteria);
- Retardation factor;
- Bio-degradation.

Surface water

- Solubility of contaminants (Ratio solubility/criteria);
- Bio-degradation.

Direct contact

- Vapour pressure of contaminants;
- Powderiness of soil (based on BRGM criteria)

Receptors

Human and animal uses

- Number of people affected by contamination (inspired by BRGM criteria, but adapted for Canadian demography);
 - Type of person using the site.

The special considerations are given the same weighting than in the original evaluation. Furthermore, in a given section, the special consideration cannot make the score exceed the minimum or maximum score for that section. This way, the modified classification method stays compatible with the original method.

b) Modifications made to the score calculation

The CCME states that the method can be used for calculating either potential or current risks related to sites. However, it was felt that both scores should be calculated, because they do not give the same information. Indeed, potential risks are linked to the estimated vulnerability of a site, and current risks are related to known contamination cases. Some sites can show a very high potential risk and still not be contaminated. This is the case at CFB Dundurn (Saskatchewan), where the high soil permeability raises the potential of contamination of the aquifer, but where no significant contamination was measured in spite of the intensive use of the detonation range. On the other hand, some ranges could also show a small potential risk and be highly contaminated. In fact, it seems that calculation of the two scores can limit the incorrect conclusions caused by an imperfect knowledge of a site.

This is why two scores are calculated: the "potential" and the "mixed" score. The "potential" score gives information on the potential risks. The "mixed" score gives information on the current risks, according to all available field data. The score is qualified of mixed because the information is seldom completely available. The missing information on current risk is replaced by information on potential risks. Ideally, the "mixed" score should be based only on field data.

To facilitate calculation of the scores, a site classification computerised sheet was created in Microsoft ExcelTM. The two scores are automatically calculated based on the site characteristics and on the other field data. It can be noted that the default value for all known contamination cases is -100. A default value had to be written to respect the programming procedure; -100 was chosen to avoid any confusion with a possible value. The presence of this number indicates that no contamination is known for the site.

3

Finally, according to the CCME's method, the incertitude on a site can never be higher than 15 points (on 100). No evaluation exceeding this limit will be considered valid. Further information will then have to be collected before performing the evaluation again.

4

The method in a context of global evaluation

The suggested method is based on the detailed evaluation from the CCME. However, it is suggested that this method be used in a more complete procedure. These are the steps to follow in order to perform an exhaustive evaluation of the sites (source documents are indicated in brackets:

- 1) Compilation and inventory of the available information;
- 2) Facility/Site Description (CCME)
- 3) National Classification System Process Checklist (CCME)
- 4) Short evaluation form (CCME)
- 5) Site classification Worksheet (CCME&BRGM)
- 6) Site classification computerised sheet (feuille Excel)
- 7) Final report (based on the BRGM report)

A final report will be presented for each selected base of the Canadian Forces (CFB). This report will help summarising the available information in one document. The report will give general information on the base (context, number and type of training sites, meteorological data, etc.) and specific information and classifications for all the evaluated sites. The plan of this report is inspired from that of the BRGM' method:

1) Introduction

Context

- Evaluation method
- 2) Characteristics of the base :
 - Geographic and climatic background
 - Property's boundaries
 - Historical and actual activities
 - Information sources
- 3) Studied sites
 - Site characteristics
 - Geographic setting
 - Site boundaries
 - Site history and activities
 - Descrition of installations
 - Geological, hydrogeological and hydrological contexts
 - Risk identification
 - Potential or known sources of contamination
 - Potential contaminants
 - Potential sources of contamination outside of site
 - Natural or human risks of increasing damages

- Hazard evaluation
 - Potential pathways for contaminants
 - Receptors
 - Known contamination cases
 - Potential hazards inherent in site
 - Prevention and emergency measures
- Site classification
- Recommendations and supplementary information required

4) General conclusion and recommendations

5) References

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6) Appendixes

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N.B.: Point 3) is done for each range where the use of energetic materials is possible.

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Appendix B – Evaluations of sites

	Training Area D Date: 06-27-2000 User (s):	Marc-André	Lavigne				
	Sections	Score for potential impacts	known and/or potential impacts			?	Comments
	CONTAMINANT(S) CHARACTERISTICS		<u></u>	<u></u>			
A)	DEGREE OF HAZARD	11	11	/14		0	Energetic materials found in ordnances.
B) C)	CONTAMINANT QUANTITY PHYSICAL STATE OF CONTAMINANTS	10	10	/10	8	0	Area = 8.78314 km ³ , no register before 1995
<u> </u>	Special considerations	0	0	/6			TNT, RDX, HMX, etc
	TOTAL	24	24	/33		0.	N.B.: If the total is < 0 or > 33 , the score assigned to special consideration: must be changed in order to respect the limits for the corresponding section (i.e.
	EXFOSURE FATHWAYS				***		
A)	GROUNDWATER				***		
	Litown contamination at or beyond property boundary		-109	- 41			
	Engineered subsurface containment	4	4	/4	***	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5		0	No confining layer.
	Hydraulic conductivity of the confining layer	1.5	1.5	/1,5	***	0	No confining layer.
	Annual rainfall	0.7	0.7	/1		0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	2.5	2.5	ß	***	0	From 10E-03 cm/s to 1 cm/s.
	Special considerations	0.8	0.8	/4	***		Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
	TOTAL	11.0	11.0	/11		0.0	N.B.: If the total is < 0 or > 11 , the score assigned to special consideration must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 11).
B)	SURFACE WATER				***		
	Observed or mesared contamination of water/effigent discharged from site		-100	243			
	Surface containment	5	5	/5		0	Trees that border the northern part of the area.
	Distance to perennial surface water	3	3	/3	**	0	Chalk Bay, Clement Lake within the area and Ottawa River to the east
	Topography	1	1	/1,5		0	Flat with steep slopes E and W, contaminants at or below ground level.
	Run-off potential (see nomograph)	0.31	0.31	/1	***	0	
	Flood potential	0.25	0.25	/0,5		0.25	No flood in the last 50 years but Chalk Bay increases the possibilities.
	Special considerations	1.4	1.4	/4			Solubility: 2
	TOTAL	11.0	11.0	/11		0.3	N.B.: If the total is < 0 or > 11 , the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
<u>C)</u>	DIRECT CONTACT	1					
	Known contamination of media off-site		-100	10			
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5			Possible but unknown.
	Accessibility of site (ability to contact materials)	3.5	3.5	/4			People come by boat, contaminants not totally covered.
	Hazardous soil gas migration	0	0	n		0	No putrescible contaminants
	Special considerations	-1.3	-1.3	/4			Vapor pressure: -2, powderiness: 2/3
	TOTAL	4.7	4.7	/11		2.5	N.B.: If the total is < 0 or > 11 , the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 11).
<u></u>	RECEPTORS						
<u>A)</u>	HUMANS AND ANIMALS				.		
	Known edverse inspact on hving things as a result of the contaminated suc-		-108	/18			
	Known impact on drasking water supply		100	<u></u>			
	Proximity to drinking water supply	3	3	/6		0	Water plant intake approx. 5 km south.
	"Availability" of alternate drinking water supply	1.5	1.5	/3		1.5	Unknown but possible.
	Known impact on used water resource		-100	<u></u>		<u></u>	
	Proximity to water resources used for activities	0.5	0.5	<u>n</u>	44	0	Ottawa River and Chalk Bay.
	Use of water resources	2	2	/2	**	0	Fishing and swimming.
	Koven contantination of land need by humans		<u></u>	15 15			U
	Use of land at and surrounding site Special considerations	3 0.0	0.0	15 15		0	Houses approx. 5 km downstream. People affected lower than 250, military people.
	TOTAL			/18	**		
8)	ENVIRONMENT	10.0	10.0	/18		1.5	N.B.: If the total is < 0 or > 18, the score assigned to special consideration: must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
Ś	Live intervention of the containing of the containing of the containing of the containing of the		-100	A6	**		
	Distance from site to nearest sensitive environment as a treat prime containing of the	6	6	/10	*	0	Some marshes within training areas C and L.
	Distance to important or susceptible groundwater resource(s)	6	6	/6	8	ŏ	Chaik Bay and Ottawa River are discharge zones.
		0		/5	1		The can be reading to the second for the second for the second se
	Special considerations TOTAL	12	12	/16	*	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations

Total score (potential impacts)	71.8	+	0.9	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	71.8	+	0.9	/100	+/-	4.3
	-					

 0.9
 .7100
 147
 4.3

 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class 1 (for insufficient information).

 N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Class	Kisk potential	Action required
1	High	Yes
2	Medium	Likely
3	Medium low	May be
N	Low	Not likely
	1 2 3 N	2 Medium 3 Medium low

Appendix C

Facility/Site Description

	Site No.: RA GB3	Site Name:ACTARE	<u>A</u> D	Province/Territ	ONTARIO
	Custodian Dept.:DND	Facility Name: <u>CFP PET</u>	Facility Name: <u>CFP PETAWAWA</u>		lanager: <u>CEB_PET4W4</u> W
	Type of Site:MILITE	RY TRAINING	*	Site Owner:	010
	Zone:	•	Easting Northing		deg min sec deg min sec.
	Location:	•	Legal Land	Description:	
	Address		_ Provincial F	arcel No.:	
	Brief Description of Site:				
	Site Land Use: Current:	MILITARY. TRAINING	Proposed:	INEM	
	Comments:		Summary of	Site Classification	Information:
			•		$\underline{\times}$ Detailed $\underline{\times}$ Short
12			•		± <u>4.3</u> Estimated Score
					ľ
		HOGAN / SEAN MOYLES	Class: (1, 2 Notes:	, 3, N, or I)	<i>Risk:</i> <u></u>
	Position:	1 	• •	, 3, N, or I)	Risk:
	Position:Address:	······································	• •	, 3, N, or I)	Risk: <u>HIGH</u>
•	Position:	······································	• •	, 3, N, or I)	Risk: <u>HIGH</u>
•	Position: Address: City: PETAWAWA Prov./Terr Phone No.:	: ONT. Postal Code:	Notes:		Risk: <u>HIGH</u>
•	Position: Address: <u>City: PETAWAWA Prov./Terr</u> Phone No.: Site Classified by above	: ОNТ. Postal Code: Fax No.:	Notes:	Ч174GNE	Risk: <u>HIGH</u>

APPENDIX B

National Classification System Process Checklist

USER'S GUIDE REVIEWED

MINIMUM DATA REQUIREMENTS MET

- Description of site location
 - Type of contaminants or materials likely to be present at site (and/or description of historical activities)
 - Approximate size of site and quantity of contaminants
 - Approximate depth to water table
 - Geologic map or survey information (soil, overburden, and bedrock information) Annual rainfall data (can be inferred from rainfall map of Canada) Surface cover information Proximity to surface water
- Topographic information
 - Flood potential of site
 - Proximity to drinking water supply
 - Uses of adjacent water resources
 - Land use information (on-site and surrounding)
- FACILITY/SITE DESCRIPTION COMPLETED
- SITE CLASSIFICATION WORKSHEET COMPLETED
- **REFERENCES ATTACHED/CITED**
- **EVALUATION FORM COMPLETED**
 - $\underline{\downarrow}$ Detailed Form $\underline{\downarrow}$ Short Form
 - SCORE SHEET COMPLETED
 - SITE CLASSIFICATION

Class: <u>x</u> 1 <u>2</u> <u>3</u> <u>N</u> <u>1</u>

Score: <u>73.7 + 4.3</u> Total Estimated Score

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:

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SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes	Refere Attacl
1	 a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? 	R		 → Class 1 → Class 1
1	Contaminant(s) Characteristics		<u></u>	,
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?			
	 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha 		i .	
	• distributed or placed in such a manner as to have the potential to cause significant off-site contamination			
11	Pathways		 	·····
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	Ø	Ċ	
111	Receptors	· · · · · ·		
	 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? 		· · · · · · · · · · · · · · · · · · ·	in the second
(A Yes	answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	Ø		

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
Contaminant(s) Characteristics	 A. Degree of hazard High concern contaminants - high concentration Hedium concern contaminants - high concentration Medium concern contaminants - low concentration Low concern contaminants 		In determining the degree of hazard	 Hish Concern Contaminants Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) Materials regulated by the Canadian Environmental Protoction Act (e.g., PCBs) Institutional waste (lab, schools hospitals, etc.) Pathological wartes and animal carcasses 	Transport Dangerous Good Act; Provincia Territorial Hazardous Waste lists; regulation under Canadia
	 B. Contaminant Quantity (area/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	(10) 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 73	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.		
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SCORE

SITE CLASSIFICATION wORDSHELL (Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

::

• Degree of Hazard A.

List possible contaminants estimated concentrations:	and ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT. HMX. RDK)
	POSSIBILITY OF MEANY METAL CONTAMINATION
Scoring Rationale & Inform	nation Source:
• Contaminant Quantity	
Estimated or measured are	
volume of contaminated zo	AREA : 8. 78314 Ym ²
	AREA 8.70217 [m
Scoring Rationale & Inform	mation Sources
Scoring Kattonale & Injoh	<i>Tullon Source</i> .
• Physical State of Cont	laminant
•	
Does the site contain: a) Predominantly liquids/	onsets
b) Primarily sludges	<i>zascs</i>
c) Primarily solids	ENERGETIC MATERIALS (TNT, RDr, HMK)
Scoring Rationale & Inform	mation Source:
 Special Consideration 	S
Document any other impor	tant
contaminant characteristics	s not
addressed above:	
Scoring Rationale & Information	mation Source:
Scoring Rationale & Hjor	
e Identification:	

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· USER'S GUIDE - cont'd

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALB	METHOD OF EVALUATION	SOURCES OF
II. Exposure Pathways	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0.	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Quality Guidelines; Provincial/
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	() 2 0	potential for pollution. Potential	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over squifer(s) of concern 3 m or less 3 to 10 m >10 m 	6 1 0	(e.g., clay, shale, etc.) between contaminants and any squifers of concern will affect the attenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	maps, well records, government hydrogeologist or
	 (c) Hydraulle conductivity of the confining layer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	6.3	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and other

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SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS

SCORE

Groundwater Α.

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• Known Groundwater Contamination 1.

		Document information on known groundwater contamination:	NO RECORD	-
				-
		Scoring Rationale & Information Sou	rce:	
2.a	• -	Engineered Subsurface Contain	iment	
		Document engineered systems protecting groundwater:	NO FUGINEERED SYSTEM	•
		Scoring Rationale & Information Sou	rce:	4
2.b	٠	Thickness of Confining Layer	Over Aquifer(s) of Concern	
		Document local geological conditions:	BEDROCK (PRECAMBRIAN ROCKS - INTRUSINE AND METAMORPHIC) OVERIAIN BY OLDER ALLUVIUM IN TERRACE REMNANTS : SAND,	
•		Identify water-bearing zones used for water supply:	· <u>GRAVELLY SAND, MODERN ALWININM : CLAY, SAND, SILT, GRAVEL</u> AND TILL (POORLY SORTED DIAMICTON)	
		Scoring Rationale & Information Sou	rce:	1.5
2.c	٠	Hydraulic Conductivity of the	Confining Layer	
		Estimate hydraulic conductivity of any confining layer:	IT RANGES FROM 10" TO 1	• · · ·
		Scoring Rationale & Information Sou	rce:	1.5
		tification:)	

USER'S GUIDE - cont'd

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE ,	METHOD OF EVALUATION	SOURCES OF INFORMATION
ll. Exponues Pathways (cont'd)	A.2. (d) Annusi Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	1 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.		Hydrological Atla of Canada (Fisherie and Environmen Canada, 1978).
	 (c) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻²_10⁻⁴ cm/sec <10⁻⁴ cm/sec 	3 () 1.5 0.5	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Preeze and Cherry 1979.
	3. Special Considerations	-4 10 +4	(See 3.7.3 in text)	Technical judgment.	
5	 3. Special considerations (detailed) : Solubility (S) : low (S/standard = 10¹) medium (S/standard = 10²) high (S/standard = 10³) 	-4/3* 0 473*	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	Retardation factor (R) :• important delay $(R / R_{\Omega} = 10^2)$ or $(K_d \approx 12,51)$ • delayed $(R / R_{\Omega} = 10^1)$ or $(K_d = 1,14)$ • little or no delay $(R / R_{\Omega} = 10^0)$ or $(K_d = 0)$	-4/3* 0 05 4/3*		ing $n = 0.33$ et $\rho_b = 1.75$ g/cm ³ ; if the studied soil is neither recalculated because n et ρ_b change. (R _{Cl} = 1)	
	 Biodegradation (μ): observed nón observed non biodegradable 	-4/3* © 4/3*			
	Other special considerations	(-4 à 4)	weighting of the special consider	rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special ount the new weighting. However, the total of points allowed	

II. EXPOSURE PATHWAYS (cont'd)

- A. <u>Groundwater</u> (cont'd)
- 2.d Annual Rainfall

Document rainfall data: <u>BETWEEN 1951 AND 1980 -> - 100 mg</u>

Scoring Rationale & Information Source: CLIMATIC ATLAS - CAUADA

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s):

Scoring Rationale & Information Source:

3. • Special Considerations

5

Document any other important ground water issues not addressed above:

130/0.12 = 5/STANDARD) => 4/3 SOLUBILITY RETARDATION FACTOR 0.6

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BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ARBITRARY SCORE FOR RETARDATION FACTOR

IT RANGES PROM



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SCORE

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF BVALUATION	SOURCES OF
ll. Exposure Pathwaya (cont'd)	 B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	jurisdictions is not to contaminate	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	Water Quality Guidelines;
	 2. Potential for surface water contamination a) Surface Containment No containment Partial containment Full containment 	(3) 3 0.5	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, diker; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
•	b) Distance to peremial surface water • 0 to <100 m • 100 to 300 m • >300 m	(3) 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.		
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.3 1.2 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

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II. E	XI	POSURE PATHWAYS (cont'd)		SCORE
B .	S	urface_Water	*	
1.	•	Observed or Measured Contaminat	tion	
		Document information on surface water contamination:	HO RECORD	
				-
		Scoring Rationale & Information Source:		-
2.a	٠	Surface Containment		
		Review and document engineered or natural systems protecting surface water:	NO SURFACE CONTAINMENT	-
		Scoring Rationale & Information Source:		5
2.b	•	Distance to Perennial Surface Wat	er	
		Estimate distance from site to nearest stream or other water body:	CHALE BAY AND OTTAWA RIVER TO THE EAST	-
		Scoring Rationale & Information Source:		3
2.c	٠	Topography		
		Document terrain conditions:	PELATIVELY FLAT TERRAIN WITH STEEP SLOPES TO THE WEST AN TO THE EAST	ы р -
		Document position of contaminants (are they above ground or buried?)	CONTAMINANTS AT AND UNDER GROUND LEVEL	-
		Scoring Rationale & Information Source:		0.6
016- 1		vification:		

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE -	METHOD OF EVALUATION	SOURCES OF
	۱ ـ	•	•		
II. Exposure Pathways (cont'd)	 B. 2. d) Run-off potential (see nomograph, end of Appendix D) > >1000 mm rainfall and low permeability surface material 500 to 1000 mm rainfall and moderately permeable surface material <500 mm rainfall and highly permeable surface material 	1 0.6 0.2	into water bodies. Water run-off is a function of precipitation and the	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada Fisheries and Environment Canada, 1978).
· · ·	 e) Flood potential 1 in 2 years 1 in 10 years 1 in 50 years 	0.5 03 6:1	and concentrations of contaminants to be released to surface water	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	plain guidelines/ maps: provincial/
•	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	 3. Special considerations (detailed) : Solubility (S) : low (S/standard ~ 10¹) medium (S/standard ~ 10²) high (S/standard ~ 10³) 	-2* 0 2*	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	 Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-2* © 2* (-4 à 4)	weighting of the special consideration	tant elements have been neglected, he can change the internal ations and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

II. EXPOSURE PATHWAYS (cont'd)

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- Surface Water (cont'd) Β.
- Run-off Potential 2.d

	Document geological and rainfall conditions:		PRECIPITATION - 700 mm + PERMEMBLE SURFACE MATERIALS	
		Scoring Rationale & Information Source.		15.0
2.e	•	Flood Potential		•
		Estimate flood frequency of nearby water courses or water bodies:	NOKNOWN ACCORDING TO CHRIS HOGAN NO FLOOD HAPPENS IN THE LAST 50 YE	 A.~ S
		Scoring Rationale & Information Source.		0.25
3.	٠	Special Considerations		
		Document any other important surface water conditions not addressed above:	SOLUBILITY (3/STANDARD = 130/0.12) => 2	
			BIODEGRADATION (NOT OBSERVED) =>0	
		Scoring Rationale & Information Source:	•	2

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3.

SCORE

CATEGORY		SCORING	RATIONALE	METHOD OF BYALUATION	SOURCES OF
II. Exposure Pathways (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered); Strongly suspected contamination of media off-site No contamination of media off-site 	11 6 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	1.
	 2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) Known or surpected airborne emissions impacting on neighbouring properties Airborne emissions generally restricted to site No airborne emissions 	5 3 0 3	there is a great hazard for direct contamination of neighbouring blots and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	reports, etc.
	 b) Accessibility of Sits (ability to contact materials) Limited or no barriers to prevent sits access; contaminants not covered Moderate accessibility or intervening barriers; contaminants are covered Controlled access or remote location and contaminants are covered 	4	site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low-rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 ·	known to cause explosions adjacent	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-	(See 3.7.3 in text) .	Technical judgment.	
<u>ا ا</u>	3. Special considerations (detailed) :		_		
	Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa	2	(N.B. : vapor pressure limits are valid a * The weighting suggested is valid if the	at a 20°C temperature) there are no points affected to other special considerations.	
P .	Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Guide special considerations	-2* -2/3* 2/3* 2*	weighting of the special considerat	s 45 μm) rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

II. EXPOSURE PATHWAYS (cont'd) C. <u>Direct Contact</u>		SCOR
1. • Known Contamination Off-site:		
Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.:	NO_RECORD .	
Scoring Rationale & Information Sour	rce:	
2.a • Airborne Emissions		
Document incidents or complaints about fumes, gases, dust, odours, etc	UNKNOWD BUT POSSIBLE	
Scoring Rationale & Information Sour	rce:	3
2.b • Accessibility of Site		
Review and document avenues of site access by humans and animals:	<u>THE ACCESS IS CONTROLED BUT THERE ARE PEOPLE WHO</u> NEGLECT THE "NO TRESPASSING" RULE	
Scoring Rationale & Information Sout	rce: <u>sean moyles</u>	3
2.c • Hazardous Soil Gas Migration		
Review potential for hazardous soil gas production and migration from sit	NO PUTRESCIBLE CONTAMINANTS	
Scoring Rationale & Information Sou	rce:	0
3. • Special Considerations Document any other conditions wher humans/animals could contact contan	ebyAPORPRESSURE (=, +9 x10 ⁻⁷ atm) mination:POWDERINESS_==2/3	
Scoring Rationale & Information Sou	rce:	-2

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF BVALUATION	SOURCES OF INFORMATION
III. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site Known adverse effect on humans or domestic animals Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination. from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or mormal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination Known contamination of drinking water supply to levels abore CDWG Strongly suspected contamination of drinking water supply Drinking water supply is known not to be contaminated 10) Potential for impact on drinking water supply Oto <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	9 7 0 6 5 4	to a contaminant source, the greater the potential for contamination. Well water used for irrigation/ agricultural purposes should also be included as it may be used for human	water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water	
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	3 2 0.5	consumption. This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	source and location. Determine availability of alternate drinking water supply or distance to alternate source.	

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III. RECEPTORS

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SCORE

	NO RECORD
dverse effects on humans or	
lomestic animals:	
coring Rationale & Information Source:	
Known Contamination of Drinking	Water Supply
	NO RECORD
ncidents of contamination of	
	PETAWAWA'S WATER WELL IS LOCATED 5 KM SOUTH FROM THE SITE
coring Rationale & Information Source:_	
vailability of Alternate Drinking V	
ocument availabiilty of alternate ources of drinking water and ease f implementation:	OTHER WATER SUPPLIES WOULD BE DIFFICULT TO OBTHIN (PEMBROKE, DEEP RIVER)
	Coring Rationale & Information Source: Coring Rationale & Information Source: Chown Contamination of Drinking Secord known or suspected Incidents of contamination of rinking water: Coring Rationale & Information Source: Distance to Nearest Drinking Wate dentify nearest drinking water well ind measure distance to site: Coring Rationale & Information Source: Vailability of Alternate Drinking Vate Occument availability of alternate ources of drinking water and ease

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALB ,	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	 A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated 	4 3 0	(groundwater or surface water)	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other- relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	Water Quality Ouidelines;
	 ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	Ø 1.5 1 0.5	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• Use of water resources - if multiple uses, give highest score (use following table) <u>Prequency of Use</u> <u>Water Use</u> <u>Prequent</u> <u>Occasional</u>	0.2 -2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	
	Recreational (swimming, fishing)21Commercial food preparation1.50.8Livestock watering10.5Irrigation10.5Other domestic or food chain uses0.50.3Not currently used but likely future use0.50.2				

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III. RECEPTORS (cont'd)

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A. <u>Human and Animal Uses</u> (cont'd)

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2.b.i • Known Impact on Used Water Resource

	Record information on water resource that is or is potentially affected by site contamination:	NO RECORD	
	Scoring Rationale & Information Source:		
2.b.ii.°•	Proximity of Water Resources to	Site	
	Locate and measure nearest water resource areas to site:	CHALK BAY AND ALWMETTE LAKE /OTTAWA RIVER TO THE EAST	-
	Scoring Rationale & Information Source:	· · · · · · · · · · · · · · · · · · ·	2
2.b.ii.°°	• Water Uses		
•	Record uses of nearby water resources:	RECREATIONAL SWIMMING AND FISHING	-
	Scoring Rationale & Information Source:		2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
II. Receptors (cont'd)	 A. 2. c) Direct human exposure Known contamination of land used by humans Known contamination of land used for agricultural or residential/parkiand/school purposes above AG or R/P EQC values Known contamination of land used for commercial or industrial purposes above C/I EQC values Land is known not to be contaminated 	5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Bvaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadi Environmental Quality Criteria i Contaminated Site
	 ii) Potential human exposure through land use Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) 0-300m 300m - 1km 1 - 5km Residential 5 4.5 2.5 Parkland/School 4 3 1.5 Commercial/Industrial 3 1 0.5 	0.5 5	contamination are directly related to land use and distance of the used land from the site. Residential and		
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :	1	L		
	People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000	0 1,5* 3*	* The weighting suggested is valid if	f there are no points affected to other special considerations.	
	Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	(-5 à 5)	weighting of the special consider	ortant elements have been neglected, he can change the internal rations and assign a score to the section "Other special ount the new weighting. However, the total of points allowed	

SCORE

III. RECEPTORS (cont'd)

A. <u>Human_and_Animal_Uses</u> (cont'd)

2.c.i • Known Contamination of Land Used by Humans

	Record land use type (current or	NO RECORD	-
	proposed) and level of contamination for land known to be		-
	contaminated due to site:		•
		•	·
	Scoring Rationale & Information Source.	P	
2.c.ii •	Land Use at and Adjacent to the Site		
	Document land uses (current and	INPAC AREA A THUMETTE LAKE GARRISON AREA TRAINING	AREAS
	proposed) for up to 5 km from the site:	N E S W	•
	0 - <300 m	<u>n</u>	
	<u> </u>	THERE ARE RESIDENCES LOCATED 1-5 KM DOWNSTREAM	•
	<u>1 km - 5 km</u>		
	Scoring Rationale & Information Source.)• ••	3
3. •	Special Considerations		
	Document any other important human or animal use information,	PEOPLE AFFECTED (POTENTIALLY) > 250 =>1	•
	including details of air contamination	THE SITE IS USED BY MILITARY PEOPLE	•
	if known:		ļ.
	Scoring Rationale & Information Source	n de la companya de l Per se companya de la	
	Scornig Kanonane & myormanon bource.		2

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF
III. Receptors (cont'd)	 B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	16 14 12	protected against site	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive squatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or sammal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	10 2 2 0.5	approximately 1 km of the site there is immediate concern for	and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	 b) Groundwater - distance to important or susceptible groundwater resource(s) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

Sec. Store .

See 2

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III. RECEPTORS (cont'd)

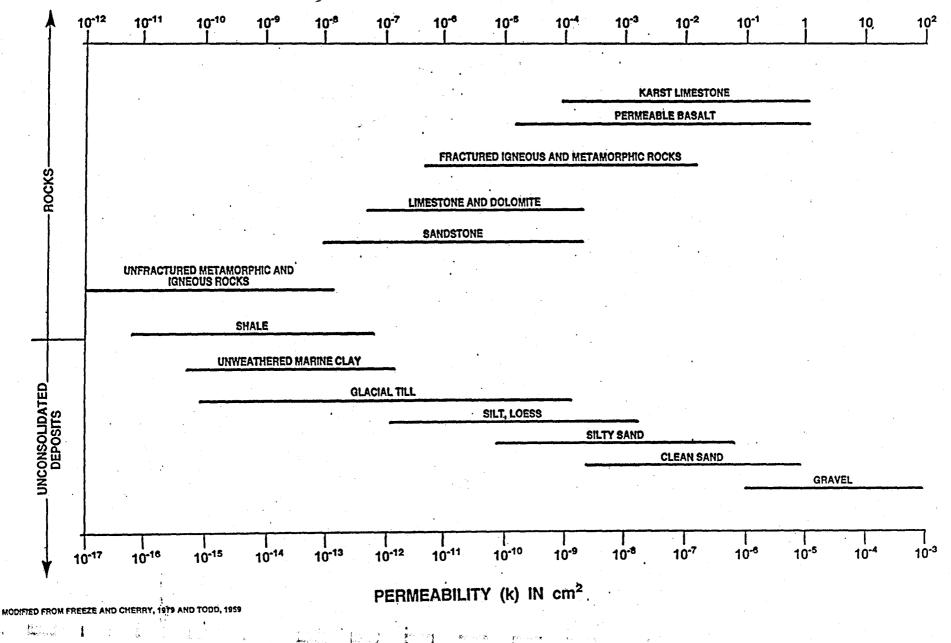
SCORE

- B. Environment
- 1. Known Adverse Impact(s) on Sensitive Environment

		Record known impact(s) on any	LO RECORD	
		sensitive biological environment at and/or around the site:		
		Scoring Rationale & Information Source	R <u></u>	E
2.a	•	Distance from Site to Nearest Ser	nsitive Environment	
		Document location, distance, type and details of any nearby sensitive environments or habitats:	SOME MARSHES WITHIN TRAINING AREAS CAND L	-
				_
		Scoring Rationale & Information Source	k <u></u>	6
2.b	٠	Groundwater		
		Measure distance to major recharge or discharge area:	SOME BEDROCK EXPOSURES AND OUTCROP WITHIN THE AREA	<u> </u>
		Scoring Rationale & Information Source	k <u></u>	6
3.	٠	Special Considerations		
		Document any other important impacts on the environment not addressed above		•
		Scoring Rationale & Information Source	2	
Site]	iden	tification:		

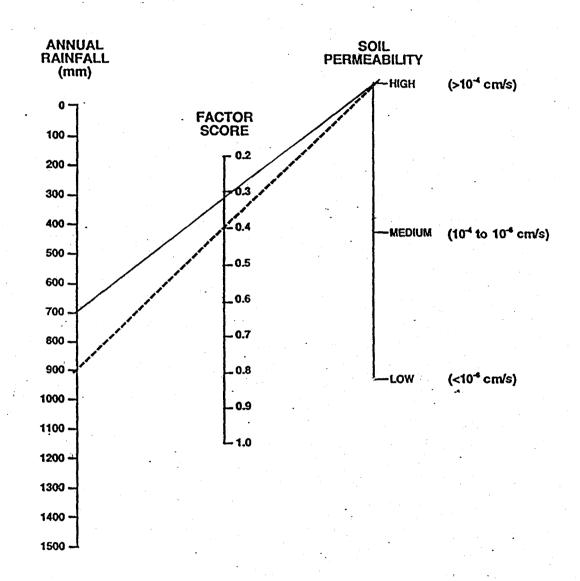


HYDRAULIC CONDUCTIVITY (K) IN cm/s



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RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	. T'	Vapour pressure	т	Degradation	Degra	dation constan	its (mu)	Kd	Toxicity	"EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay		1]	1
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/ħr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	1
2,4.6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic		,			Possibly toxic	0,02					(1)
		130	20	1,45E-09	20.	<u> </u>		l						1	0,3	0,024	(2)
		150	25	9,49E-09	25				· · · · · · · · · · · · · · · · · · ·	<u> </u>	İ					· · · · · · · · · · · · · · · · · · ·	(3)
		130	20	4,61E-09	20				ļ	 	<u> </u>		L				(3)
				1,86E-09	20			L			<u> </u>		·				(4)
		-					3,20E-03	1,40E-01_	8,30E-02	L	<u>l</u>		l				(5)
		÷		<u> </u>					·	Ottawa sand: 1,	<u>a</u>						(6)
										Silt: 4,5		<u> </u>					(6)
				<u>├</u>						Clay: 10							(6)
				ļ		A suble and					Constant.		0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,865-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
·				3,17E-08	25	ļ		ļ	ļ	ļ		ļ				1	(3)
		270	20	1,61E-08	. 20			ļ									(3)
				<u> </u>						h		ļ	1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,48E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20	· · · · · · · · · · · · · · · · · · ·			L	L	L	L		5			(2)
								· · ·			l		0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1		;			(1)
		42 .	20	5,53E-12	20			1						2	0.3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine,		50	20	2,56E-12	20	· ·											(3)
				<u></u> ┤{-			0	6,50E-03	1.40E-02		{						
				 -			·	0,002-03	1 117V57VZ	0,1 4 13,28		<u> </u>					(5)
cyclo - 1,3,5,7 -				<u>├</u>						0,1 4 10,20		<u></u>					
tetramethylene - 2,4,6,8 - tetranitramine	нмх	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 -		5	25	4,348-17	20	1			[1	1	(2)
tetranitro - 1,3,5,7 - [1		0,2 4 4,2		L					(6)
tetrazocine)							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995 (2) Thiboutot *et al.*, 1998 (3) Pheelan and Webb, 1997 (4) Hayes, 1992 (5) Myers *et al.*, 1996 (6) Townsend *et al.*, 1996 (7) http://www.mef.gouv.qc.ca/lr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

8

Conversion table for pressure units

	atm ·	mm Hg	torr	kPa	bar
1 atm =	1 1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0.986923	750.06148	750.06148	99.9752999	1

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Date: 07/04/1999

MINISTERE DE LA DEFENSE NATIONALE DEPARTMENT OF NATIONAL DEFENCE Gouvernement du Canada / Government of Canada

SISEFC

FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: RA700 Nom de secteur: Range Id: Range Name:	FIBUA RGE
Locale / Location: CFB PETAWAWA Base / Base: CFB PETAWAWA Commandement / Command: Director Land Forces Re	
État / Status: Actif Active Feuille de carte / Map Sheet: MCE132 TR 89 ED 7	Grandeur / Size: 500.00 Metres GR187914 Allées / Lanes: 0
ARMES WEAPONS	MUNITIONS AMMUNITION
RIOT GUN 38mm PYROTECHNICS PISTOL M85	CN Riot M7 (MIL & CIV) CTG 38mm SPEDEHETE CS CTG 38mm FLITERITE CS PYROTECHNICS CS Riot Gas GELATIN CAPSULES M85
RESTREINTS:	RESTRICTIONS
Sécurité / Safety: 1. No CS/Tear gas in sewer line 2. No live ammo to be used in or Autre / Other: None	•
Date autorisé / Authorized Date: 18/06/1998 Commandement / Command: Director Land Forces F Date inspectée / Inspected Date: 18/11/1997 Central	

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Sections	Score for potential impacts	known and/or potential impacts			2	Comments
CONTAMINANT(S) CHARACTERISTICS						
DEGREE OF HAZARD	11	11	/14		0	Energetic materials found in ordnances.
CONTAMINANT QUANTITY	2	2	/10	**	0	Area < 1 km ¹ , no register before 1995
PHYSICAL STATE OF CONTAMINANTS	3	3	/9		0	TNT, RDX, HMX, etc
Special considerations	0	0	/6			······································
TOTAL	16	16	/33		0-	N.B.: If the total is < 0 or > 33 , the score assigned to special consid- must be changed in order to respect the limits for the corresponding sect between 0 and 13)
EXPOSURE PATHWAYS				**		
GROUNDWATER				**		
Encourt contaminations at or beyond property boundary		100	-71 C			
Engineered subsurface containment	4	4	/4	**	0	No engineered system.
Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	***	0	No confining layer.
Hydraulic conductivity of the confining layer	1.5	1.5	/1,5		. 0	No confining layer.
Annual rainfall	0.7	0.7	/1		.0	700 mm between 1950 and 1981.
Hydraulic conductivity of the aquifer(s) of concern	0.5	0.5	ß	*	0	From 10E-10 cm/s to 10E-04 cm/s, average value.
Special considerations	0.8	0.8	/4			Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
TOTAL	9.0	9.0	/11		0.0	N.B.: If the total is < 0 or > 11, the score assigned to special consid
	1					must be changed in order to respect the limits for the corresponding sec
						between 0 and 11).
SURFACE WATER						
Observed or mesared contamination of water/efficient ductarged from site		-190	<i>i</i> 11			
Surface containment	5	5	. 15		0	Trees all over the area but no particular surface containment.
Distance to perennial surface water	2	2	ß	*	0	Biggar Lake beside the area, Barron River to the south.
Topography	0	0	/1,5		· 0	Flat area, contaminants at or below ground level.
Run-off potential (see nomograph)	0.52	0.52	/1		0	Average value.
Flood potential	0,25	0.25	10,5		0.25	No flood in the last 50 years but Sturgeon Lake increases the possibili
Special considerations	2.0	2.0	/4			Solubility: 2
TOTAL	9.8	9.8	/11		0.3	N.B.: If the total is < 0 or > 11, the score assigned to special consid
						must be changed in order to respect the limits for the corresponding sec
					i	between 0 and 11).
DIRECT CONTACT						
 Knowo contamination of media off-site. 		-100	8018			
Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5		2.5	Possible but unknown.
Accessibility of site (ability to contact materials)	2	2	/4		0	Remote area but contaminants are not covered.
Hazardous soil gas migration	0	0	12		0	No putrescible contaminants.
Special considerations	-1,3	-1.3	/4			Vapor pressure: -2, powderiness: 2/3
TOTAL	3.2	3.2	/11		2.5	N.B.: If the total is < 0 or > 11, the score assigned to special consid
Tomb		5.4				must be changed in order to respect the limits for the corresponding sec
	1		E		1	hetween 0 and 11)
RECEPTORS						
HUMANS AND ANIMALS						
Known adverse impact on hung things as a result of the concerninated site			118		*****	
Knows supported draking weier supply		100	79			
Proximity to drinking water supply	3	3	/6		0	Some cabins beside Barron River.
"Availability" of alternate drinking water supply	13	1.5	B		1.5	Other water supply available (lakes, rivers, etc), but quality not known
Konwa mpact on used water resource			- A			Outer water supply available (lakes, lives, etc), but quality not know
Proximity to water resources used for activities	0.5	0,5	12		0	Barron River
Use of water resources	2	2	12		0	Fishing, swimming
Kapiya contentination of land nave by humans			- Á			r isnaug, swimming
Use of land at and surrounding site	0	0	/5	*		Military exercises.
Special considerations	0.0	0.0	15			People affected lower than 250, military people.
TOTAL	7.0	7.0	/18	1	1.5	N.B.: if the total is < 0 or > 18, the score assigned to special consid
IVIAL	1.0	7.0		ं	1.5	nust be changed in order to respect the limits for the corresponding sec
			ł	1		
ENVIRONMENT			{	-		between 0 and 18).
ENVIKONMENT Ritowit advorse angazt en possiave environment as a textil of the contaminates			A6	1		
	10		/10	-	0	Some marshes within the area 8.
Distance from site to nearest sensitive environment		<u> </u>	/10	4		Some marshes within the area 8. Biggar Lake act as either a techarge or discharge area.
Distance to important or susceptible groundwater resource(s)	6		15	-	v	DISEAL LAKE ACLAS CHINE & CEREIEC OF DISCALLYE ALES.
Special considerations	0	0 16	16	4		
TOTAL	16	10	/10	<u>نان</u>	0	N.B.: If the total is < 0 or > 16, the score assigned to special consid must be changed in order to respect the limits for the corresponding sec

					-	
Total score (potential impacts)	59.5	+	1.5	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	59.5	+	1.5	/100	+/-	4.3
				-		

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

 1.5
 /100
 +/4
 4.3

 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

 N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

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Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

	Site No.: <u>RA 72</u>			HOLITION RANGI		Site Operator/M	Manager: <u>CFB</u>	PETALLA
	Custodian Dept.:				* .	/	DND	
	Type of Site:	DEMO						_
	Zone:	•	UTM Coordinates:	<u>3057000</u> 5083300			deg	
			•			•	deg	•
	Location:	<u></u>			Legal Land L	• -		
	Address		· · · · · · · · · · · · · · · · · · ·		Provincial Pa	arcel No.:	· · · · · · · · · · · · · · · · · · ·	
	Brief Description of Site	?:			۰۰۰۰۰	~		
	Site Land Use:	Current: <u>P</u>	ETAWAWA	Propos	red: <u>1DE P</u>	1		
	Comments:	•			Summary of S	Site Classification	Information:	
					Completed E	valuation Form:	× Detaile	d <u>×</u> Short
5					٠	<u>61</u> Total		
					•			
	• • • •	•				3, N, or I)	Risk: _	MEDIUM
	Contact Name: <u>CHRL</u>	<u>5_HOGAN</u>	U /SEAN MOYLE	<u>S</u>	Notes:		· · · · · · · · · · · · · · · · · · ·	
	Position:					<u></u>		
	Address:			······	•.			
•	CITY: PETAWAWA I	<u> rov./Terr.:</u>	ONT. Postal Code:	<u></u>			· · · · · · · · · · · · · · · · · · ·	
	Phone No.:		Fax No.:	<u></u>				
	Site Classified by above	<u>}</u>	or MARC-ANDA	E LAVIGNE/KAN	RINE CHAM	IPAGNE		
	Degree of Familiarity w Visited site:	rith Site: Yes	Very familiar No	Moderately familiar	Indir	ectly familiar	Unfamil	iar
	Position: <u>RESEARCH</u> Address: <u>880 CHEE</u> <u>City: QUEB</u>	UN Ste-		No.: (418) 654- CP 7500 C Postal Code: 6		Date of Comple	ted Classification	n:

APPENDIX B

National Classification System Process Checklist

USER'S GUIDE REVIEWED

- MINIMUM DATA REQUIREMENTS MET
 - Description of site location <u>____</u>____X Type of contaminants or materials likely to be present at site (and/or description of historical activities) Approximate size of site and quantity of contaminants Approximate depth to water table Geologic map or survey information (soil, overburden, and bedrock information) Annual rainfall data (can be inferred from rainfall map of Canada) × × × × Surface cover information Proximity to surface water Topographic information Flood potential of site Proximity to drinking water supply Uses of adjacent water resources Land use information (on-site and surrounding)
- FACILITY/SITE DESCRIPTION COMPLETED x
- SITE CLASSIFICATION WORKSHEET COMPLETED
- **REFERENCES ATTACHED/CITED**
- **EVALUATION FORM COMPLETED**

X____ Detailed Form

Short Form

SCORE SHEET COMPLETED

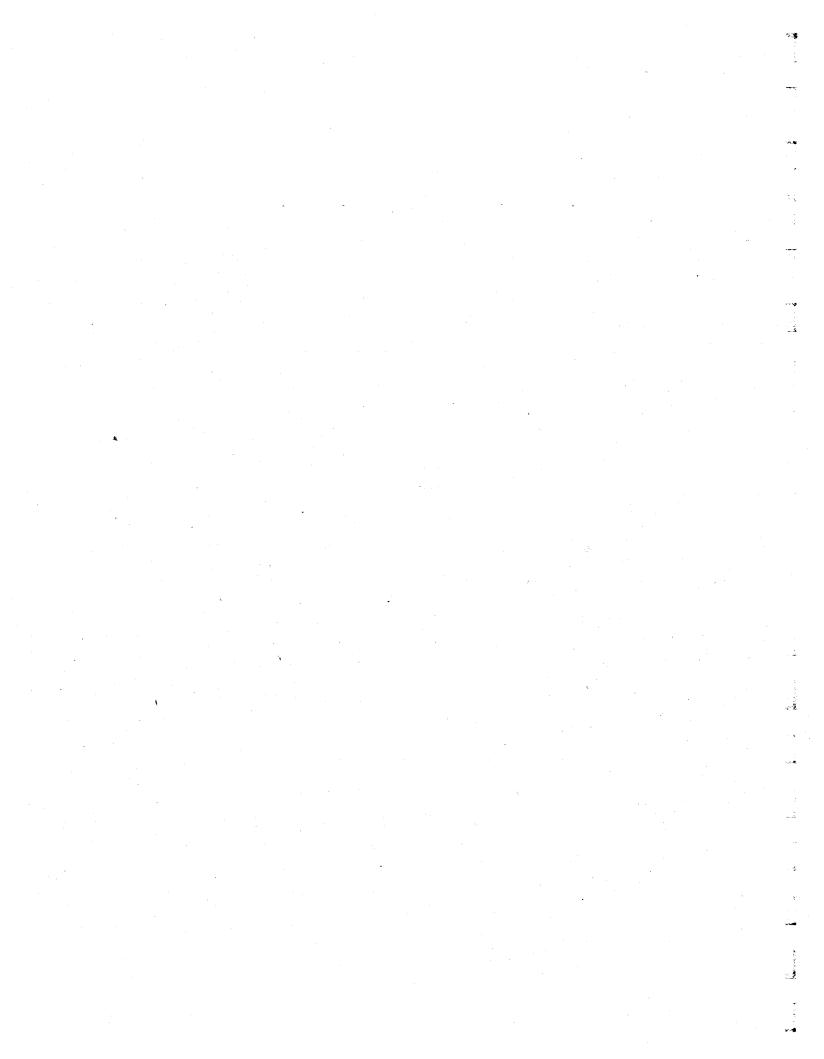
SITE CLASSIFICATION

Class: ____1 __X 2 ____3 ____N ____I

Score: <u>61 + 4.3</u> Total Estimated Score

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:



SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

			No	Yes		Reference Attached
	1	 a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? 	X X		→ Class 1 → Class 1	
	1	Contaminant(s) Characteristics				
		2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?		Ø		
	·	 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha 		ι,		
		 distributed or placed in such a manner as to have the potential to cause significant off-site contamination 				
	11	Pathways				
		4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	D			
<u></u>	111	Receptors	<u>, </u>			
	•	 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); c. exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); c. caused vegetative stress or other known environmental impairment? 				
•	14 37	answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	Ø			

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
Contaminant(s) Characteristics	 A. Degree of hazard High concern contaminants - high concentration High concern contaminants - high concentration Medium concern contaminants - low concentration Low concern contaminants 	14 8 3 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other iandfill gares). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	 Hish Concern Contaminants Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) Institutional waste (lab, schools hospitals, etc.) Pathological wastes and animal carcasses 	Transport Dangerous Goc Act; Provinci Territorial Hazardous Was lists; regulatio under Canadi Environmental Protection Ac Canadian Environmental Quality Criteria i Contaminated Sites; etc.
	 B. Contaminant Quantity (area/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	10 6 2	the quantity of wastes at abandoned	Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	97 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes for more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
· · ·	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SCORE

SITE CLASSIFICATION WORDSIEE. (Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

::

• Degree of Hazard A.

	List possible contaminants and	ENERGETIC MATERIALS FOUND IN ANNUNITION (TNT. HMK,
	estimated concentrations:	ROX) FOSSIBILITY OF HEAVY METAL CONTAMINATION
	<u></u>	
	Scoring Rationale & Information Source	ce:
٠	Contaminant Quantity	
	Estimated or measured areal volume of contaminated zone:	NO REGISTÉR OF UNEXPLODED SHELLS BEFORE 1995 AREA < 1 Km ²
		QUANTITY ESTIMATED WITH AREA OF THE RADGE
	Scoring Rationale & Information Source	CE: CHRIS HOGAN / SEAN MOYLES
•	Physical State of Contaminant	
	Does the site contain: a) Predominantly liquids/gases	
	b) Primarily sludgesc) Primarily solids	ENERGETIC MATERIALS (TNT. RDX. HMX)
	Scoring Rationale & Information Source	ce:
•	Special Considerations	
• .	Document any other important contaminant characteristics not	
	addressed above:	

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINB	RATIONALB	METHOD OF EVALUATION	SOURCES OF
II. Exposure Pathwaya	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Quality Guidelines; Provincial/ Territorial Water
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	@ 2 0	potential for pollution. Potential	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this-factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over squifer(s) of concern 3 m or less 3 to 10 m >10 m 		(e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
•	 (c) Hydraulic conductivity of the confining layer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	1.5 1.5 0.5	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and other

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Barrier of

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SCORE

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II. I	EXF	POSURE PATHWAYS		
Α.		Groundwater		
1.	•	Known Groundwater Contaminat	ion	
		Document information on known groundwater contamination:	NO RECORD	
		Scoring Rationale & Information Source	2	
2.a	•	Engineered Subsurface Containm	ent	
		Document engineered systems protecting groundwater:	NO ENGINEERED SYSTEM	
		Scoring Rationale & Information Source		
2.b	•	Thickness of Confining Layer Ov Document local geological conditions:	BEOROCK (LIMESTONE, DOLOSTONE, SHALE, SAMETONE, MIN DRIFT COVER) OVERLAIN BY TILL (POORLY SORTED DIAM	
	•	Identify water-bearing zones used for water supply:	NO CONFINING LAYER	, ,
		Scoring Rationale & Information Source	8:	
2.c	•	Hydraulic Conductivity of the Co	onfining Layer	
		Estimate hydraulic conductivity of any confining layer:	NO CONFINING LAYER	
		Scoring Rationale & Information Source	B;	
•				
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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	1 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	 (e) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻²-10⁻⁴ cm/sec <10⁻⁴ cm/sec 	3 1.5 (8.3)	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 10 +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :				
18	Solubility (S) :Iow(S/standard = 101)medium(S/standard = 102)high(S/standard = 103)	-4/3* 0 (4/3)*	* The weighting suggested is valid if there are no points affected to other special considerations.		
	Retardation factor (R) :(R / $R_{Cl} \approx 10^2$) or (Kd = 12,51)• delayed(R / $R_{Cl} \approx 10^1$) or (Kd = 12,51)• little or no delay(R / $R_{Cl} \approx 10^0$) or (Kd = 0)	-4/3* 0 4/3*	N.B. : the R calculation was done using $n = 0.33$ et $p_b = 1.75$ g/cm ³ ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et p_b change. ($R_{Cl} = 1$)		
	 Biodegradation (μ): observed non observed non biodegradable 	-4/3* 0 4/3*			
	Other special considerations	(-4 à 4)	weighting of the special consider	tant elements have been neglected, he can change the internal ttions and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

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II. EXPOSURE PATHWAYS (cont'd)

- A. Groundwater (cont'd)
- 2.d Annual Rainfall

Document rainfall data:

BETWEEN 1951 AND 1980 -> = 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

> Estimate hydraulic conductivity of <u>TILL HAS A HYDROLIC CONDUCTIVITY RANGING FROM</u> relevant aquifer(s): <u>10⁻¹⁰ to 10⁻⁴ cm (s</u>

Scoring Rationale & Information Source:

Special Considerations

3.

10

Document any other important ground water issues not addressed above:

SOLUBILITY (S / STANDARD = 130/0.12) => 4/3 RETARDATION FACTOR (K) = 4.5) => -0.5 BIO DEGRO 04TION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ARBITARY SCORE FOR RETARDATION FACTOR

SCORE

0.1

0.5

5/6

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
<u> </u>		1	Transford		
II. Bxposure Pathways (cont'd)	 B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	jurisdictions is not to contaminate	Quality Guidelines (select appropriate guidelines based on	CCMB Canadiar Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	 2. Potential for surface water contamination a) Surface Containment No containment Partial containment Full containment 	(5) 3 0.5	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	reports, air photos,
•	 b) Distance to perennial surface water 0 to <100 m 100 to 300 m >300 m 	7 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.		
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.5 1.2 0.8 ©	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

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٠	Surface Water		·
•	• Observed or Measured Contamin	ation	
	Document information on surface water contamination:	HO RECORD	
		e:	
.a	• Surface Containment		
	Review and document engineered or natural systems protecting surface water:	NO SURFACE CONTAINMENT	
	Scoring Rationale & Information Sourc	e:	5
.b	• Distance to Perennial Surface Wa	ater	
	Estimate distance from site to nearest stream or other water body:	BIGGAR LAFE BESIDE THE AREA, BARON RIVER TO THE SOUTH	
	Scoring Rationale & Information Sourc	e:	3
. C	• Topography		
·.	Document terrain conditions:	FLAT SLOPE	
	Document position of contaminants (are they above ground or buried?)	CONTAMINANTS AT OR BELOW GROUND LEVEL	
	Scoring Rationale & Information Source	:e: MAP MCE 132 EN B TR 99	0
• •	Scoring Ranonale & Information bowle		

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE *	SOURCES OF INFORMATION					
II. Baposure Pathways (cont'd)	 B. 2. C. C. A. Standard C. S. /li>	1 0.6 0.2	into water bodies. Water run-off is a function of precipitation and the	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	of Canada (Fisherie				
	 e) Flood potential 1 in 2 years 1 in 10 years 1 in 50 years 	0.5 0.3 0.1	and concentrations of contaminants to be released to surface water	of nearby water courses both up and down gradient. Rate	Bstablished flood plain guidelines maps; provincial territorial soi survey maps.				
•	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.					
	 3. Special considerations (detailed) : Solubility (S) : low (S/standard ~ 10¹) medium (S/standard ~ 10²) high (S/standard ~ 10³) 	-2* 0 2*	* The weighting suggested is valid if	there are no points affected to other special considerations.					
	 Biodegradation (μ) : observed non observed non biodegradable Other special considerations 	-2* (-4 à 4)	 N.B.: if the user believes that important elements have been neglected, he can change the inter weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allow 						

II. EXPOSURE PATHWAYS (cont'd)

B. Surface Water (cont'd)

- 2.d Run-off Potential
 - Document geological and rainfall conditions:

PERMEABILITY RANGING FROM

10-10 cm

m-4 cm 3

AVERAGE VALUÉ

TO

Scoring Rationale & Information Source:____

2.e • Flood Potential

23

Estimate flood frequency of nearby water courses or water bodies:

Scoring Rationale & Information Source: ARBITRARY SCORE

UNKNOWN

3. • Special Considerations

Document any other important surface water conditions not addressed above:

SOLUBILITY (S/STANDARD = 10 3) =>2 RIODEGRADATION (NON OBSERVED) =>0

Scoring Rationale & Information Source:_

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALB	METHOD OF BYALUATION	SOURCES OF
II. Exposure Pathwayz (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). Strongly suspected contamination of media off-site No contamination of media off-site 	11 6 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	 Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) b) Known or suspected airborne emissions impacting on neighbouring properties a) Airborne emissions generally restricted to site b) No airborne emissions 	5 3.55	contamination of neighbouring blota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	 b) Accessibility of Site (ability to contact materials) Limited or no barriers to prevent site access; contaminants not covered Moderate accessibility or intervening barriers; contaminants are covered Controlled access or remote location and contaminants are covered 	4 3 @ 0	site and to contaminants, the greater the chance for	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
•	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 ·	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text) .	Technical judgment.	
	 3. Special considerations (detailed) : Vapor pressure : < 0,1 kPa 0,1 à 0,5 kPa 0,5 à 1,5 kPa > 1,5 kPa 	(2) -2/3* 2/3* 2*	(N.B. : vapor pressure limits are valid a * The weighting suggested is valid if t		
	Powderiness : • <0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other ial con	-2* -2/3* 2* (-4 à 4)	weighting of the special considera	45 μm) tant elements have been neglected, he can change the internal tions and assign a score to the section "Other special ant the new weighting. However, the total of points allowed	s (

II. EXPOSURE PATHWAYS (cont'd) SCORE Direct Contact C. • Known Contamination Off-site: 1. Document reports of off-site RECORD contamination due to contact with contaminated soil, dust, air, etc.: Scoring Rationale & Information Source:_ • Airborne Emissions 2.8 Document incidents or complaints POSSIBLE BUT UNKNOWN about fumes, gases, dust, odours, etc.: 25 Scoring Rationale & Information Source:_ Accessibility of Site 2.b Review and document avenues of REMOTE LOCATION AND CONTAMINANTS NOT COVERED site access by humans and animals: 2 Scoring Rationale & Information Source:____ • Hazardous Soil Gas Migration 2.c NO PUTRESCIBLE CONTAMINANTS Review potential for hazardous soil gas production and migration from site: 0 Scoring Rationale & Information Source:___ • Special Considerations 3. Document any other conditions whereby UAPOR PRESSURE (= 1. 49 × 10 - 9 atm) humans/animals could contact contamination: POWDERINESS => 3/3 ARBITRARY VALUE Scoring Rationale & Information Source: <u>SEE</u> ρ , 36

Site Identification:

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
		y			·
III. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site Known adverse effect on humans or domestic animals Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination, from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: 1) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 Potential for impact on humans or animals Drinking water supply Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination Known contamination of drinking water supply to levels above CDWG Strongly suspected contamination of drinking water supply Drinking water supply is known not to be contaminated 	9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above. Guidelines for Canadian Drinking Water Quality or applicable provincial/ territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Canadian Drinking Water Quality; other drinking water guidelines
	 ii) Potential for impact on drinking water supply Proximity to drinking water supply 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	७ ५ द जि	to a contaminant source, the greater	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.		

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III. RECEPTORS

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SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

1	Record known or suspected	NO RECORD	
	adverse effects on humans or domestic animals:	· · · · · · · · · · · · · · · · · · ·	
			
	Scoring Rationale & Information Sourc	e:	
2.a.i •	Known Contamination of Drinkin	ng Water Supply	
	Record known or suspected incidents of contamination of drinking water:		
	Scoring Rationale & Information Source	e:	
2.a.ii.°•	Distance to Nearest Drinking Wa	iter Supply(s)	
	Identify nearest drinking water well and measure distance to site:	SOME CABINS BESIDE BARRON RIVER	
	Scoring Rationale & Information Source	۶. <u></u>	3
2.a.ii.°°	Availability of Alternate Drinking	Water Supply	•
	Document availabiilty of alternate sources of drinking water and ease of implementation:	OTHER WATER SUPPLY WOULD BE AVAILABLE (LAKES, STREAMS AND RIVERS) BUT THE QUALITY IS NOT KNOWN	. 4
•	Scoring Rationale & Information Sourc	8:	1.5
	;		
Cite Ider	nification:		

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE -	METHOD OF BVALUATION	SOURCES OF
· · · · · · · · · · · · · · · · · · ·		•			
III. Receptors (cont'd)	 A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated 	4 3 0	(groundwater or surface water)	Review documentation for reported or suspected contamination of water used for recreation or food chain ures, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	Water Quality Guidelines; provincial/
	 ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	2 1.5 1 0.3	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	 Use of water resources - if multiple uses, give highest score (use following table) Prequency of Use Water Use Prequent_Occasional 	0.2 ②	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.		
	Recreational (swinning, fishing)21Commercial food preparation1.50.8Livestock watering10.5Irrigation10.5Other domestic or food chain uses0.50.3Not currently used but likely future use0.50.2				

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III. RECEPTORS (cont'd)

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SCORE

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

	Record information on water	NO is	PF CC	2RD					<u>.</u>			<u> </u>	
	resource that is or is potentially affected by site contamination:												-
	Scoring Rationale & Information Source:	·							· · ·	<u></u>			[_]
2.b.ii.°•	Proximity of Water Resources to							•			·		
	Locate and measure nearest water resource areas to site:	BARRO	<u></u>	RIUER	1.5 Km	SOUT	H			•			••
	Scoring Rationale & Information Source:	•		•				•				······································	0.3
2.b.ii.°°•	• Water Uses	· · · · ·											
	Record uses of nearby water resources:	EISHIN SWIMMI		?									-
	Scoring Rationale & Information Source:	•		•									[2]

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF			
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkiand/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) 0-300m 300m - 1km 1 - 5km Residential 5 4.5 3 Agricultural 5 4 2.5 Parkland/School 4 3 1.5 Commercial/Industrial 3 1 0.5	5 3.5 0 0.5 • 5	contamination are directly related to land use. Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and		Environmental			
	3. Special Considerations	-5 10 +5	(See 3.7.3 in text)	Technical judgment.				
	 3. Special considerations (detailed) : People affected by contamination : ≤ 250 250 à 1000 > 1000 	© 1,5* 3*	* The weighting suggested is valid if	f there are no points affected to other special considerations.				
	Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	(-5 à 5)	weighting of the special consider	N.B.: if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit				

SCORE

III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.c.i • Known Contamination of Land Used by Humans

	Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site:									
	Scoring Rationale & Information Source.		-			<u> </u>				
2.c.ii •	Land Use at and Adjacent to the Site		•							
	Document land uses (current and proposed) for up to 5 km from the site:	MILITARY	EFERCISES							
	<u> </u>		I AREA B	E IMPACT AREA THIS AREA	S IMPICT AREA B	W IMDYCTAREA 8				
•	<u>I km - 5 km</u> Scoring Rationale & Information Source	•				0				
3. •	Special Considerations	•	•							
	Document any other important human or animal use information, including details of air contamination if known:		· ·	> 4 250 =>0. BY MILITARY ISEOP	<u>رچ</u>					
	Scoring Rationale & Information Source	•				0				

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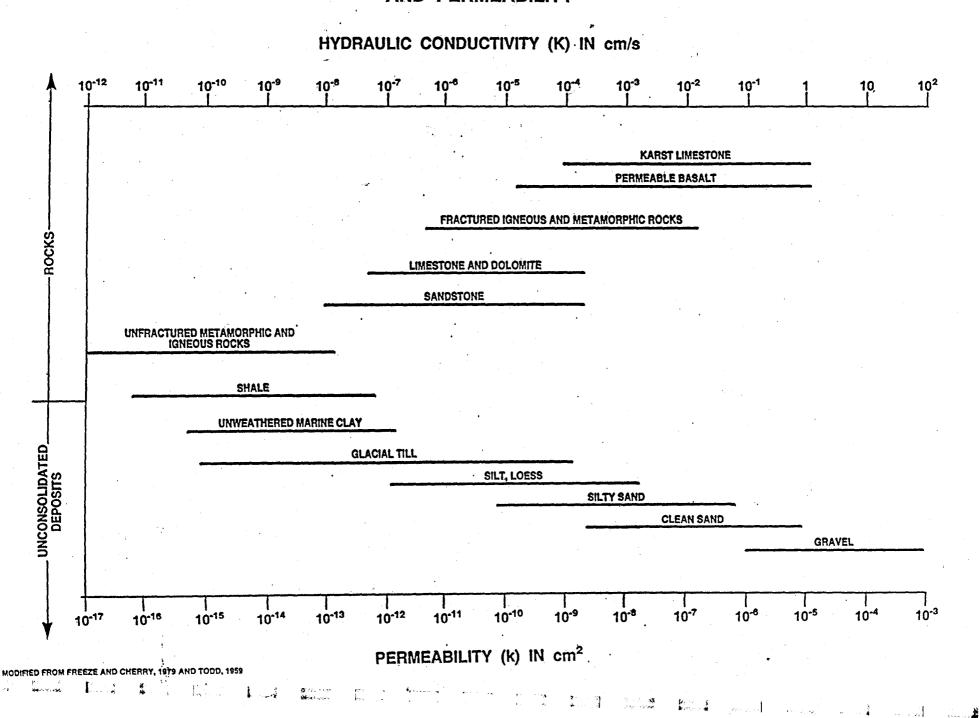
CATEGORY	EVALUATION FACTOR		RATIONALE	METHOD OF EVALUATION	SOURCES OF	
III. Receptors (cont'd)	 B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	16 14 12	protected against site contamination. Bvidence of	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).		
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	(1) 6 2 0.5	approximately 1 km of the site there is immediate concern for		Relevant provincial /territorial and federal maps of sensitive environments.	
•	 b) Groundwater - distance to important or susceptible groundwater resource(s) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	& 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.		

III. RECEPTORS (cont'd)

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SCORE

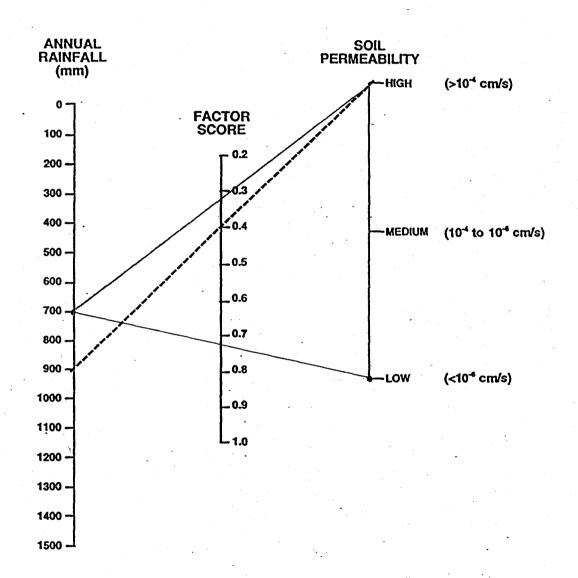
Da	and known impact(a) on any	NO RECORD
sei	cord known impact(s) on any nsitive biological environment and/or around the site:	
Sco	oring Rationale & Information Source:	
• Di	stance from Site to Nearest Sens	sitive Environment
an	cument location, distance, type d details of any nearby sensitive vironments or habitats:	SOME MARSHES WITHIN THE AREA #B
Sco	oring Rationale & Information Source:_	
• Gi	roundwater	
	easure distance to major	RECHARGE WITHIN THE AIREA (MOUNTAINS, ONTEROPS)
Sci	oring Rationale & Information Source:_	
• Sp	ecial Considerations	
Do on	cument any other important impacts the environment not addressed above:	
	oring Rationale & Information Source:	



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RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY

RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	. Т	Vápour pressure	т	Degradation	Degra	dation constan	its (mu)	Kđ	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								1
Units		(mg/L)	(C)	(atm)	(C)		(/ħr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	1
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
	1 B. 19	150	25	9,49E-09	25					l				l			(3)
		130	20	4,61E-09	20				l								(3)
				1,66E-09	20			Ĺ	l			·					(4)
							3,20E-03	1,40E-01	8,30E-02		1						(5)
										Ottawa sand: 1,	5	1					(6)
									İ	Siit: 4,5							(6)
									1	Clay: 10							(6)
									·				0,12*		· ·		(7)
2,4 dinitrototuene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17É-08	25		~										(3)
		270	20	1,61E-08	-20												(3)
								·					1,10E-04		,		(7)
2,6 dinitrotojuene	2,8 DNT	208	25	7,46E-07	25	Aerobic and anaerobic	-						•				(1)
		206	25	7,46E-07	20									5		1	(2)
				1					1				0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1			i .		(1)
		42	20	5,53E-12	20				}					2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine,		50	20	2,58E-12	20	· ·							. I.				(3)
or																L	
			ļ	<u> </u>			0	6,50E-03	1,40E-02	0.1 à 13.26	+						(5)
						<u> </u>			1	0,1 8 13,26	ļ	1				ļ	(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	НМХ	5	. 25	4,38E-17	25	Anaerobique					1.	nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 -		5	25	4,34E-17	20					1	1	1					(2)
tetranitro - 1,3,5,7 -										0,2 8 4,2							(6)
tetrazocine)			•				0	3,60E-03	3,20E-02							1	(5)

McGrath, 1995
 Thiboutot *et al.*, 1998
 Pheelan and Webb, 1997
 Hayes, 1992
 Myers *et al.*, 1996
 Townsend *et al.*, 1996
 Townsend *et al.*, 1996
 http://www.mel.gouv.qc.ca/tr/environn/criteres_eau

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te serves Arrentes No. 19

* Provisory criteria for aquatic life (surface water)

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Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

1

	Sections	Score for potential impacts	known and/or potential impacts			?	Comments
	CONTAMINANT(S) CHARACTERISTICS		· · · ·				
)	DEGREE OF HAZARD	11	11	/14	1	0	Energetic materials found in ordnances.
<u> </u>	CONTAMINANT QUANTITY	10	10	/10		0	All areas: 77,99877 km ³ , no register before 1995
	PHYSICAL STATE OF CONTAMINANTS	3	3	/9		0	Energetic materials.
	Special considerations TOTAL	0 24	0 24	/6 /33		0	N.B.: If the total is < 0 or > 33, the score assigned to special consideration must be changed in order to respect the limits for the corresponding sect (i.e. between 0 and 33).
<u>,</u>	EXPOSURE PATHWAYS GROUNDWATER	Sec. 1				1.1.1.1.1.	<u> 1995 - Constantino de Constantino de Constantino de Constantino de Constantino de Constantino de Constantino d</u>
. <u>,</u>	Known contamination at or beyond property boundary		-100	/11	-		
	Engineered subsurface containment	4	4	/4		0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1,5	1,5	/1.5	1	ő	No confining layer.
	Hydraulic conductivity of the confining layer	1,5	1,5	11.5		Ö	No confining layer.
	Annual rainfall	0,7	0,7	/1	1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	1,5	1,5	/3		1,5	Ranging from 10E-08 cm/s to 10E02 cm/s.
	Special considerations	1,3	1,3	/4	1		Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
	TOTAL	10,5	10,5	/11		1,5	N.B.: If the total is < 0 or > 11 , the score assigned to special considerati must be changed in order to respect the limits for the corresponding sec
		Į					(i.e. between 0 and 11).
<u>}</u>	SURFACE WATER		-100	/11			
	Observed or mesured contamination of water/effluent discharged from site Surface containment	4	-100.	/5		0	No surface containment.
	Distance to perennial surface water	3	3	/3		0	Petawawa River, Barron River, Montgomery Lake, etc.
	Topography	1,2	1,2	/1,5	1	0	Mostly flat with some hills, contaminants are at or below ground level.
	Run-off potential (see nomograph)	0,52	0,52	11		0	Average value.
	Flood potential	0,25	0,25	/0,5		0,25	No flood in the last 50 years but local floods might occur.
	Special considerations	2,0	2,0	/4	10		Solubility: 2
	TOTAL	11,0	11,0	/11		0,3	N.B.: If the total is < 0 or > 11, the score assigned to special consideration must be changed in order to respect the limits for the corresponding sect (i.e. between 0 and 11).
1	DIRECT CONTACT	1					
	Known contamination of media off-site	I	-100	/11			
	Airborne emissions (gases, vapour, dust, etc.)	2,5	2,5	/5		2,5	Possible but unknown.
	Accessibility of site (ability to contact materials)	3	3	/4	<i></i>	0	Moderate access by boat, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	-	0	No putrescible contaminants.
	Special considerations TOTAL	-1,3 4,2	-1,3 4,2	/4 /11		2,5	Vapor pressure: -2, powderiness: $2/3$ N.B.: If the total is <0 or > 11, the score assigned to special consideration must be changed in order to respect the limits for the corresponding sec G.e. between 0 and 11).
	RECEPTORS	34 C. A.M.			29,6	Nes, let	
)	HUMANS AND ANIMALS	<u> </u>			1		
	Known adverse impact on living things as a result of the contaminated site		-100	/18			
	Known impact on drinking water supply	1.201.011	-100	/9		~ 10	
	Proximity to drinking water supply	4	4	/6		0	Houses south of area 3 <1 km south and intake of water plant 3 km east.
	"A vailability" of alternate drinking water supply	1,5	1,5	/3	12	1,5	Unknown but possible.
	Known impact on used water resource		-100	/4	100		
	Proximity to water resources used for activities	1	1	/2		0	Petawawa River between areas 3, 4, 5 and 6.
	Use of water resources	2	2	12	1	0	Boating, fishing and swimming.
	Known contamination of land used by humans		-100	15		<u></u>	
	Use of land at and surrounding site '	4,5	4,5 0,0	/5 /5	1	0	Military exercises, residential uses,
	Special considerations TOTAL		13,0	/18		1,5	People affected lower than 250, military people.
		13,0				د، 	N.B.: If the total is < 0 or > 18, the score assigned to special considerat must be changed in order to respect the limits for the corresponding sec (i.e. between 0 and 18).
	ENVIRONMENT	1				·····	·
	Known adverse impact on sensitive environment as a result of the contaminated size	<u> </u>	-100	/16			
	Distance from site to nearest sensitive environment	10	10	/10	1	0	Some marshes within areas 2, 4, 5 and 6.
	Distance to important or susceptible groundwater resource(s) Special considerations	6	<u>6</u> 0	/6 /5		0	Hills within areas, outcrops: recharge areas, watercourses: discharge areas
	TOTAL	16	16	/16		0	N.B.: If the total is < 0 or > 16 , the score assigned to special considerat
							must be changed in order to respect the limits for the corresponding sec (i.e. between 0 and 16).
	ore (potential impacts)	76,7 +	2,0	/100			

 2,0
 /100
 +/ 5,8

 2.0
 /100
 +/ 5,8

 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class 1 (for insufficient information).

 N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Score	Class	Risk potential	Action required	
70-100	1	High	Yes	
50-69	2	Medium	Likely	
38-49	3	Medium low	May be	
<=37	N	Low	Not likely	

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	nzio Area 1 Date: 06-27-2000 User (s):	Marc-André	LAVIGUE		1000		
	Sections	Score for potential impacts	known and/or potential impacte			7	Comments
	CONTAMINANT(S) CHARACTERISTICS				***		
	REE OF HAZARD	1 11	11	/14	**	0	Energetic materials found in ordnances.
	AMINANT QUANTITY	10	10	/10	***	0	Area = 5.44656 km ³ , no register before 1995
PHYS	ICAL STATE OF CONTAMINANTS	3	. 3	19	***	0	Energetic materials.
	Special considerations	0	0	/6	*		
TOTA		24	24	/33		0.	N.B.: If the total is < 0 or > 33 , the score assigned to special conside must be changed in order to respect the limits for the corresponding section between 0 and 13)
	EXPOSURE PATHWAYS				***		
GROU	INDWATER				**		· · · · · · · · · · · · · · · · · · ·
	Enown continuention at or beyond property boundary		309	- // 1	***		
	Engineered subsurface containment	4	4	/4	.	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5		0	No confining layer.
	Hydraulic conductivity of the confining layer	1.5	1.5	/1,5		0	No confining layer.
	Annual rainfall	0.7	0.7	/1		0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	1.5	1.5	ß	1	Ő	Fine sand: from 10E-02 cm/s to 10E-04 cm/s.
	Special considerations	0.8	0.8	14			Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
TOTA		10.0	10.0	/1		0.0	N.B.: If the total is < 0 or > 11 , the score assigned to special consider
		10,0		/11		0.0	must be changed in order to respect the limits for the corresponding sections of and 11).
SURF.	ACE WATER	1			88 B		
	Observed or mesured contamination of water/effigent ductarged from site		-100	- 111	22		
	Surface containment	5	5	/5	**	0	No surface containment.
	Distance to perennial surface water	2	2	13	***	0	Tucker Creek approx. 250 m west of the site.
	Topography	1 1	1	/1.5		0	Mostly flat with some hills, contaminants are at or below ground level.
	Ran-off potential (see nomograph)	0.73	0,73	1	8	0	
	Flood potential	0.1	0.1	10,5			No flood in the last 50 years.
	Special considerations	2.0	2.0	/4			Solubility: 2
TOTA		10.8	10.8	/11		0.1	N.B.: If the total is < 0 or > 11 , the score assigned to special consider
			10.0	<i>/</i> 11			must be changed in order to respect the limits for the corresponding secti between 0 and 11).
DIRE	CT CONTACT	1					
	Known contamination of media off-sue		-300	્યા			
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5			Possible but unknown.
	Accessibility of site (ability to contact materials)	2	2	/4		0	There is a fence, contaminants not totally covered.
	Hazardous soil gas migration	0	0	2	**	0	No putrescible contaminants.
	Special considerations	-1.3	-1.3	/4	***		Vapor pressure: -2, powderiness: 2/3
TOTA		3.2	3.2	/11		2.5	N.B.: If the total is < 0 or > 11 , the score assigned to special conside must be changed in order to respect the limits for the corresponding section totuces 0 and 11)
	RECEPTORS						
HUM	ANS AND ANIMALS	1					
	Known adverse impact on living things as a reast of the contaminated site	1	+100	/18 /5			
	Knows impaction drinking water supply		100				
	Proximity to drinking water supply	3	3	/6		0	Water plant southwest of the site.
	"Availability" of alternate drinking water supply	1.5	1.5	ß		1.5	Unknown but possible.
	Known impact on used water resource	1	-100				
	Proximity to water resources used for activities	0.5	0.5	2		0	Ottawa River 3 km west.
	Use of water resources	2	2	12		0	Boating, fishing and swimming.
	Known contemination of land need by humans		108	3 5			
	Use of land at and surrounding site	0	0	/5		0	Military exercises.
•	Special considerations	0.0	0.0	/5			People affected lower than 250, military people.
TOTA		7.0	7.0	/18			N.B.: If the total is < 0 or > 18, the score assigned to special considemust be changed in order to respect the limits for the corresponding sectibetween 0 and 18).
ENVI	RONMENT	1			*		CONTEMN & Milli LEL
	Ranwo advores impact on sonsitive caviconneus as a track of the contaminated site		-108	A6	w t		
	Distance from site to nearest sensitive environment	10	10	/10		0	Some marshes along Tucker Creek.
		6	6	- 16	1		250m to Tucker Creek.
	Distance to important or susceptible groundwater resource(s)	0	0	/5			2.JUR IU I HUNGI LIUCE.
TOTA	Special considerations			 	-	0	
IOTA		16	16	10			N.B.: If the total is < 0 or > 16, the score assigned to special conside must be changed in order to respect the limits for the corresponding secti

· · · · · · · · · · · · · · · · · · ·		_	_		
Total score (potential impacts)	69.5	+	1.5	/100 +/-	4.1
Total score (known impacts or potential impacts if the former is not known)	69.5	+	1.5	/100 +/-	4.1

Score	Class	Risk potential	Action required	
70-100	1	High	Yes	
50-69	2	Medium	Likely	
38-49	3	Medium low	May be	
<=37	N	Low	Not likely	

 1.5
 /100
 77
 7.1

 1.5
 /100
 1/4
 4.1
 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

 N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

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R. Kenner

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Easting Northing Legal Land L Provincial Po Completed E	Longitude: Description: arcel No.: EM Site Classification I	anager:F DND deg deg Information:	B_PE7AL	sec. sec.
Easting Northing Legal Land L Provincial Po Completed E	Site Owner: Latitude: Longitude: Description: arcel No.: EM Site Classification I	deg deg deg Information:	min min	sec. sec.
Custodian Dept.: DND Facility Name: CEB_PETA WAWA Site Ope Type of Site: IMPACT_AREA Site Ow Zone: UTM Coordinates: Easting Latitude Location: Legal Land Description. Northing Longitud Address Provincial Parcel No.: Brief Description of Site: SAUDY AREA I FLAT WITH SOME HILLS Site Land Use: Current: MULITARY TRAINING Proposed: INEM Comments: Summary of Site Classif Completed Evaluation F Site Score: 71.3 Contact Name: CHRIS HOGANJ /SEAD HOYLES Notes: Proposition: Motes: Phone No.: Fax No.: Site Classified by above or MARC - ANDRE /KARIDE CHAMPAGNE Degree of Familiarity with Site: Very familiar Moderately familiar Indirectly familiar	Latitude: Longitude: Description: arcel No.: EM Site Classification I	deg deg Information:	min min	sec.
Northing Legal Land E Provincial Po Cos red: Summary of S Completed E	Longitude:	deg Information:	min	sec.
Provincial Po	arcel No.:	Information:		
ed: Summary of Summary of S	EM Site Classification I	Information:	······································	
red: ne Summary of S Completed E	EM Site Classification I	Information:		
red: ne Summary of S Completed E	EM Site Classification I	Information:		
Completed E			led x Sh	
Completed E			led x Sh	
•			$cu \underline{/} onc$	ort
Site Score:	<u>. 71.3</u> Total ±			
• • •	3, N, or I)	Risk:	НІĞН	
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	Date of Complete	ed Classificatio	on:	
	Notes:	Notes:	Notes:	Notes:

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APPENDIX B

National Classification System Process Checklist

USER'S GUIDE REVIEWED

- MINIMUM DATA REQUIREMENTS MET

 - Description of site location Type of contaminants or materials likely to be present at site (and/or description of
 - historical activities)
 - Approximate size of site and quantity of contaminants
 - Approximate depth to water table
 - Geologic map or survey information (soil, overburden, and bedrock information) Annual rainfall data (can be inferred from rainfall map of Canada)
 - Surface cover information
 - Proximity to surface water
 - **Topographic information** Flood potential of site
 - Proximity to drinking water supply
 - Uses of adjacent water resources
 - Land use information (on-site and surrounding)
- FACILITY/SITE DESCRIPTION COMPLETED

Detailed Form

- SITE CLASSIFICATION WORKSHEET COMPLETED
- **REFERENCES ATTACHED/CITED**
- **EVALUATION FORM COMPLETED**

Short Form

- SCORE SHEET COMPLETED
- SITE CLASSIFICATION

Class: <u>1</u> 1 ____ 2 ____ 3 ____ N

Score: $\frac{71.3}{\text{Total}} + \frac{4.3}{\text{Estimated Score}}$

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:

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SHORT EVALUATION FORM

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Instructions for Use

1

Site Identification:

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

	No	Yes	Refere Attac
 a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? 			$ \rightarrow Class 1 \qquad \square \\ \rightarrow Class 1 \qquad \square $
Contaminant(s) Characteristics			
2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?			
 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha 			
• distributed or placed in such a manner as to have the potential to cause significant off-site contamination			
Pathways			
4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)		. 0	
Receptors			194 H F (g B B) a - 15
 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? 			τ (), ¥ () , κ () ,
answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	۵		
	 or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? Contaminant(s) Characteristics 2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site? 3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha distributed or placed in such a manner as to have the potential to cause significant off-site contamination Pathways 4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide) Receptors 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or applicable provincial/territorial guidelines or applicable provincial/territorial guidelines or applicable provincial/territorial guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or RP values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or 	or sensitive environments? (see User's Guide)	or sensitive environments? (see User's Guide) □ b) Is the site a fire or explosion hazard as it currently exists? □ Contaminant(s) Characteristics □ 2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site? □ 3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • Ilquid (as disposed/spilled) • in quantity >1,000 m ³ • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination Pathways 4 4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide) □ Receptors 5 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkiand purposes (i.e., exceeds the AG or RP values of Canadian E

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

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1. 1.

ATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
Contaminant(*) Characteristics	 A. Degrees of hazard High concern contaminants - high concentration High concern contaminants - high concentration Medium concern contaminants - low concentration Low concern contaminants 	14 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	 concentrations: <u>Hish Concern Contaminants</u> Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) Institutional waste (lab, schools hospitals, etc.) Pathological wastes and animal carcasses 	Transport of Dangerous Goods Act; Provincial, Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	 B. Contaminant Quantity (area/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	6 2	the quantity of wastes at abandoned	Note: Any number of drums abandoned or disposed is considered a high concern.	
	 C. Physical State of Contaminants Liquid/gas Sludge Solid 	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.		
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SCORE

SITE CLASSIFICATION VOR JANEE. (Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

Dennes of Honord Α.

	List possible contaminants and estimated concentrations:	ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, ROK, H	(WX)
		POSSIBILITY OF CONTAMINATION BY HEAVY METAL	
	Scoring Rationale & Information Source	ce:	_[
•	Contaminant Quantity		
	Estimated or measured areal volume of contaminated zone:	NO RECORD OF UXO AND ORDNANCE FIRED BEFORE 1995 AREA 5.44656 Km ²	
		CONTAMINATION ESTIMATED WITH THE AREA OF THE SITE	
	Scoring Rationale & Information Source	ce:	[
٠	Physical State of Contaminant		
	Does the site contain: a) Predominantly liquids/gases		
	b) Primarily sludges c) Primarily solids	TNT, RDK, HMK	
	Scoring Rationale & Information Source	ce:	[
٠	Special Considerations		
•	Document any other important contaminant characteristics not addressed above:		
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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
II. Baposure Pathways	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if	Canadian Water Quality Guidelines Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	() 2 0	potential for pollution. Potential	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over squifer(s) of concern 3 m or less 3 to 10 m >10 m 	0	(e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	 (c) Hydraulie conductivity of the confining layer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	1.5 0.5	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and other

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II. EXPOSURE PATHWAYS

A. Groundwater

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1. • Known Groundwater Contamination

		Document information on known groundwater contamination:	DO RECORD	
		Convine Devianala & Information Sour	10.01	-
		Scoring Rationale & Information Sour	ce	- 7
2.a	٠	Engineered Subsurface Contain	ment	
		Document engineered systems protecting groundwater:	NO ENGINEERED SYSTEM	
		Scoring Rationale & Information Sour	rce:	4
2.b	٠	Thickness of Confining Layer (Over Aquifer(s) of Concern	
		Document local geological conditions:	BEDROCK (LIMESTONE, DOLOSTONE, SHALE, SANDSTONE, MINDR DRIET COUER)	
	•	Identify water-bearing zones used for water supply:	NO CONFINING LAYER	
		Scoring Rationale & Information Sour	·ce:	1.5
2.c	٠	Hydraulic Conductivity of the		
		Estimate hydraulic conductivity of any confining layer:	NO CONFINING LAYER	
			•	1.5
		Scoring Rationale & Information Sour		
•				

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF	
· · · · ·						
l. Exposure Pathways (cont'd)	A.2. (d) Annusi Rainfali • >1000 mm • 600 mm • 400 mm • 200 mm	1 (5.7) 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	areas. Use 30-year average rainfall for evaluation purposes.	Hydrological Atl of Canada (Fisheri and Environme: Canada, 1978).	
	 (e) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻²-10⁻⁴ cm/sec <10⁻⁴ cm/sec 	3 (15) 0.5	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherr, 1979.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.		
	 3. Special considerations (detailed) : Solubility (S) : low (S/standard = 10¹) medium (S/standard = 10²) high (S/standard = 10³) 	-4/3* Q (4/3*)	* The weighting suggested is valid if	there are no points affected to other special considerations.	• • •	
	Retardation factor (R):• important delay $(R / R_{CI} = 10^2)$ or $(K_d = 12,51)$ • delayed $(R / R_{CI} = 10^1)$ or $(K_d = 1,14)$ • little or no delay $(R / R_{CI} = 10^0)$ or $(K_d = 0)$	-4/3* © 4/3*		sing $n = 0.33$ et $\rho_b = 1.75$ g/cm ³ ; if the studied soil is neither e recalculated because n et ρ_b change. ($R_{Cl} = 1$)		
	 Biodegradation (μ): observed non observed non biodegradable 	-4/3* © 4/3*		ortant elements have been neglected, he can change the internal		
Other special considerations (-4 à 4				rations and assign a score to the section "Other special bunt the new weighting. However, the total of points allowed		

II. EXPOSURE PATHWAYS (cont'd)

- A. <u>Groundwater</u> (cont'd)
- 2.d Annual Rainfall

Document rainfall data:

BETWEEN 1950 AND 1981 - 700 m

Scoring Rationale & Information Source: CLIMATIC. ATLAS - CAURDA

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

> Estimate hydraulic conductivity of <u>Hydraulic conductivity</u> OF FINE SAND VARIES FROM relevant aquifer(s): 1×10^{-2} TO 1×10^{-4}

Scoring Rationale & Information Source:_

Special Considerations

3.

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Document any other important ground water issues not addressed above:

130/0.12) => 4/3 SOLDBULTY Ka) = 4.5 RETARDATION FACTOR - 1/2 RIODEGRADATION (NON OBSERVED) =>0

Scoring Rationale & Information Source: ARBITRARY VALUE FOR RETARDATION FACTOR

5/6

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
11. Exposure Pathways (cont'd)	 B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	jurisdictions is not to contaminate	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	Water Quality Guidelines:
	 2. Potential for surface water contamination a) Surface Containment No containment Partial containment Full containment 	@ 3 0.5	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	reports, air photos,
	 b) Distance to peremial surface water 0 to <100 m 100 to 300 m >300 m 	3 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	•	
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.5 1.2 © 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater case from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

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II. EXPOSURE PATHWAYS (cont'd)

B. Surface Water

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1. • Observed or Measured Contamination

		Document information on surface	NO RECORD	-
		Scoring Rationale & Information Source:		
2.a •	•	Surface Containment		
		Review and document engineered or natural systems protecting surface water:	NO SURFACE CONTHINMENT	-
		Scoring Rationale & Information Source:_		5
2.b	•	Distance to Perennial Surface Wate	r	ĸ
		Estimate distance from site to nearest stream or other water body:	TUCKER STREAM 250 M WEST OF THE SITE	-
		Scoring Rationale & Information Source:_		2
2.c	•	Topography Document terrain conditions:	MOSTLY FLAT WITH SOME HILLS	- -
		Document position of contaminants	AT OR BELOW GROUND LEVEL	-
		Scoring Rationale & Information Source:		

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE +	METHOD OF EVALUATION	SOURCES OF
			•		
II. Exposure Pathways (cont'd)	 B. 2. d) Run-off potential (see nomograph, end of Appendix D) >1000 mm rainfall and low permeability surface material 500 to 1000 mm rainfall and moderately permeable surface material <500 mm rainfall and highly permeable surface material 	0.6 0.2	into water bodies. Water run-off is a function of precipitation and the	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	 e) Flood potential 1 in 2 years 1 in 10 years 1 in 50 years 	0.5 0.3 0.1	and concentrations of contaminants to be released to surface water	Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate	plain guidelines/ maps; provincial/
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :				
• • • •	Solubility (S) :•low(S/standard = 101)•medium(S/standard = 102)•high(S/standard = 103)	-2* 0 2	* The weighting suggested is valid if there are no points affected to other special considerations.		
	 Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-2* 0 2* (-4 à 4)	weighting of the special consider	rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special bunt the new weighting. However, the total of points allowed	

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SCORE

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II. EXPOSURE PATHWAYS (cont'd)

B. <u>Surface Water</u> (cont'd)

2.d • Run-off Potential

2.e

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	Document geological and rainfall conditions:	RAINFALLS - 200 PERMEABILITY VARIE	PROM 10-4 CH/S	5 TO 10-2 cm/	· · · · · · · · · · · · · · · · · · · ·	
	Scoring Rationale & Information Source	e: <u>SEE P.35</u>				0, 3
•	Flood Potential		•			•

Estimate flood frequency of nearby <u>NO FLOOD OCCURS IN THE LAST SO YEARS</u> water courses or water bodies:

Scoring Rationale & Information Source: CHRIS HOGAN

• Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (5/STANDARD > 03) => 2 BIODEGREDATION (NON OBSERVED) =>0

Scoring Rationale & Information Source: SEE P. 36

Site Identification:____

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
	· · · · · · · · · · · · · · · · · · ·				
I. Exposure Pathways (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). Strongly suspected contamination of media off-site No contamination of media off-site 	11 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	 Potential for direct human and/or animal contact Airborne Emissions (gases, vapours, dust, etc.) Known or suspected airborne emissions impacting on neighbouring properties 	5 3 <i>G</i> 3 0	there is a great hazard for direct	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	 b) Accessibility of Site (ability to contact materials) Limited or no barriers to prevent site access; contaminants not covered Moderate accessibility or intervening barriers; contaminents are covered Controlled access or remote location and contaminants are covered 	4 3 (2) 0	greater the chance for	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	·
	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 ·	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider présence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text) .	Technical judgment.	
A	3. Special considerations (detailed) :				
	Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa	273* 2/3* 2*	(N.B. : vapor pressure limits are valid at * The weighting suggested is valid if t	at a 20°C temperature)	
	Powderiness : • < 0,1 % • 0,1 & 1 % • 1 & 10 % • > 10 % Other special considerations	-2* -2/3* (2/3*) 2* (-4 à 4)	weighting of the special considera	tant elements have been neglected, he can change the internal tions and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

II. EXPOSURE PATHWAYS (cont'd) C. <u>Direct Contact</u>

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SCORE

1.	٠	Known Contamination Off-site:		
		Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.:	NO RECORD	
		Scoring Rationale & Information Source.	•	-
2.a	٠	Airborne Emissions		
		Document incidents or complaints about fumes, gases, dust, odours, etc.:	POSSIBLE BUT UNENOUN	
		Scoring Rationale & Information Source.	•	2.5
2.b	٠	Accessibility of Site		
		Review and document avenues of site access by humans and animals:	THERE A FEWE WHICH RESTRAINS THE ACCESS BUT CONTAMINA	<u>JA</u> NTS
		Scoring Rationale & Information Source	•	2
2.c	•	Hazardous Soil Gas Migration		
		Review potential for hazardous soil gas production and migration from site:	NO PUTRESCIBLE CONTAMINANTS	
		Scoring Rationale & Information Source	•	0
3.		Special Considerations Document any other conditions whereby humans/animals could contact contaminu	VAPOR PRESCURE: 1.45 X10 ⁻⁹ atm AT 30°C =>-2 ation: <u>POWDERINESS: SOIL IS MOSTLY SAND => 2/3</u> ? => ARBITRARY VALUE	
Site 1	Iden	Scoring Rationale & Information Source	<u>SEE P. 36</u>	7/3

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF
			·		
III. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site Known adverse effect on humans or domestic animals Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination. from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (a.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural	
			•	environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination Known contamination of drinking water supply to levels above CDWG Strongly suspected contamination of drinking water supply Drinking water supply is known not to be contaminated 	9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/ territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines fo Canadian Drinking Water Quality; othe drinking wate guidelines developed by recognized agencie (e.g., other Healti and Welfare Canad guidelines, U.S EPA, etc.).
	 ii) Potential for impact on drinking water supply Proximity to drinking water supply 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	6 5 4 3	to a contaminant source, the greater the potential for contamination. Well water used for irrigation/	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

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III. RECEPTORS

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A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

	Record known or suspected adverse effects on humans or	NO RECORD	••••••••••••••••••••••••••••••••••••••
	domestic animals:		-
	Scoring Rationale & Information Source	e:	
2.a.i •	Known Contamination of Drinkin	ng Water Supply	
	Record known or suspected incidents of contamination of drinking water:	NO_RECORD	-
	Scoring Rationale & Information Source	e:	-
2.a.ii.°•	Distance to Nearest Drinking Wa	iter Supply(s)	
,	Identify nearest drinking water well and measure distance to site:	WATER PLANT -5 Km SOUTHWEST OF THE SITE	-
	Scoring Rationale & Information Source	B;	3
2.a.ii.°°•	Availability of Alternate Drinking	Water Supply	
	Document availabiilty of alternate sources of drinking water and ease of implementation:	ANOTHER WATER SUPPLY WOULD BE DIFFICULT TO FIND (CHALE RIVER ?)	-
	Scoring Rationale & Information Source	8:	1.5
Site Ideni	tification:		

CATEGORY	EVALUATION FACTOR	SCORING GUIDBLINE	RATIONALE +	METHOD OF EVALUATION	SOURCES OF INFORMATION
		•			
III. Receptors (cont'd)	 A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated 	4 3 0	(groundwater or surface water)	Review documentation for reported or suspected contamination of water used for recreation or food chain ures, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	Water Quality Guidelines; provincial/
	 ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	2 1.5 1 3	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	 Use of water resources - if multiple uses, give highest score (use following table) <u>Prequency of Use</u> <u>Water Use</u> <u>Water Use</u> <u>Prequent</u> <u>Occasional</u> Recreational (swimming, fishing) 2 1 Commercial food preparation 1.5 0.8 Livestock watering 1 0.5 Irrigation Other domestic or food chain uses 0.5 0.3 Not currently used but likely future use 0.5 	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.		

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III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

	Record information on water resource that is or is potentially affected by site contamination:	<u>NO RECORD</u>							
	Scoring Rationale & Information Source:								
2.b.ii.°•	Proximity of Water Resources to	Site							
	Locate and measure nearest water resource areas to site:	OTTAWA RIVER -3 KM WEST	•						
	Scoring Rationale & Information Source:		0.5						
2.b.ii.°°	• Water Uses								
	Record uses of nearby water resources:	BOATING FISHING SWIMMING	•						
	Scoring Rationale & Information Source:		2						

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
				· · · · · · · · · · · · · · · · · · ·	
III. Receptors (cont'd)	 A. 2. c) Direct human exposure Known contamination of land used by humans Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values Known contamination of land used for commercial or industrial purposes above C/I EQC values Land is known not to be contaminated 	5 3.5 0	contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of, soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	Environmental
	 ii) Potential human exposure through land use Use of land at and surrounding site (use following table; give highest score to worst case scenario) <u>Distance from Site</u> Land Use (current or future) 0-300m 300m - 1km 1 - 5km Residential 5 4.5 3 Agricultural 5 4 2.5 Parkland/School 4 3 1.5 Commercial/Industrial 3 1 0.5 	0.5 - 5	contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	
· · · · · · · · · · · · · · · · · · ·	3. Special considerations (detailed) :				1
	 3. Special considerations (detailed) : People affected by contamination : ≤ 250 250 à 1000 > 1000 		* The weighting suggested is valid if	f there are no points affected to other special considerations.	
•	Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	① 1* 2* (-5 à 5)	weighting of the special consider	ortant elements have been neglected, he can change the internal rations and assign a score to the section "Other special ount the new weighting. However, the total of points allowed	

SCORE

III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.c.i • Known Contamination of Land Used by Humans

	Record land use type (current or	NO RECORD				•
	proposed) and level of contamination for land known to be contaminated due to site:					•
			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	······		
	Scoring Rationale & Information Source.	•				
2.c.ii •	Land Use at and Adjacent to the Site	• • •	•			
	Document land uses (current and proposed) for up to 5 km from the site:	MULITARY EXER		j		
	0 - <300 m	N TRAINING AREA	E HIGHWAU 17	S I MPACT	W	
•	300 m - <1 km	0	CP_RAILEOAD	AREA 2	AREA 4	• •
	<u>1 km - 5 km</u>					,
	Scoring Rationale & Information Source.	•				0
3. •	Special Considerations		•	•		
	Document any other important human or animal use information,	PEOPLE AFFECTE	0 < 250 =>0			
	including details of air contamination if known:	SITE IS USED B	Y MILITARY PEOPLE			· ·
	Scoring Rationale & Information Source	•				0
	Scoring Rationale & Hyormation bource	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
•			•			•

Site Identification:

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CATEGORY	EVALUATION FACTOR	SCORING GUIDBLINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF	
III. Receptors (cont'd)	 B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	16 14 12	The environment should be protected against site contamination. Bvidence of impact(s) shows that protection is lacking.	sensitive environment is defined as a sensitive aquatic		
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km 	() 6 2 0.5	approximately 1 km of the site		/territorial and	
•	 b) Groundwater - distance to important or susceptible groundwater resource(s) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.		

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III. RECEPTORS (cont'd)

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Site Identification:

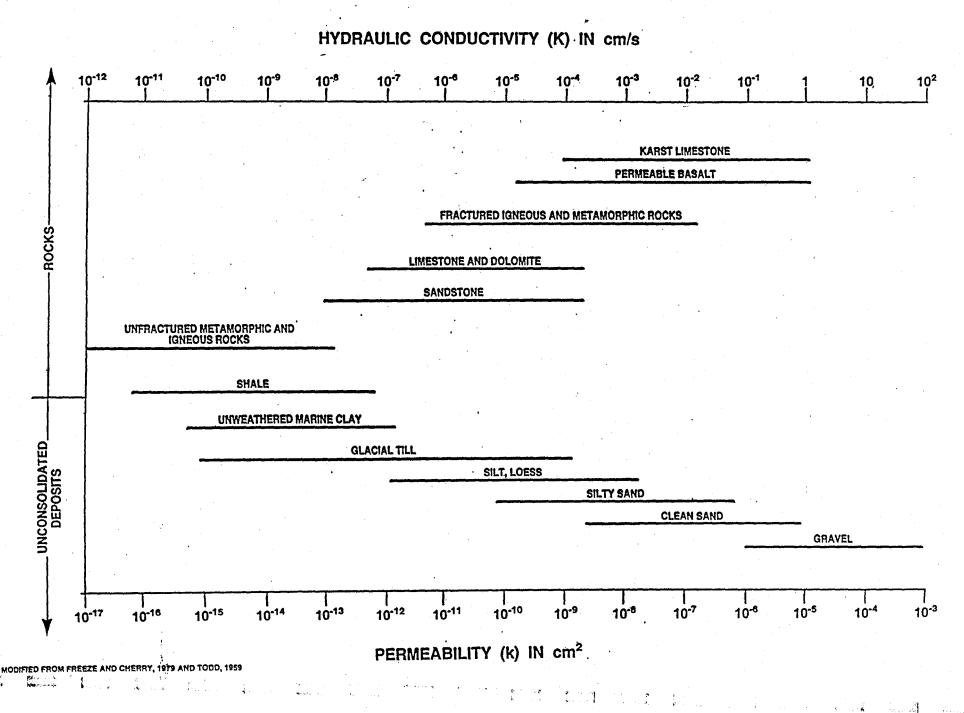
SCORE

B. Environment

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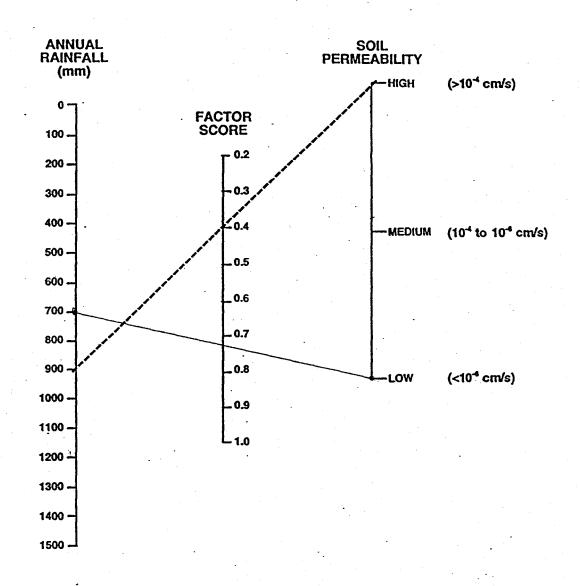
1. • Known Adverse Impact(s) on Sensitive Environment

		Record known impact(s) on any	
		Scoring Rationale & Information Source:	
2.a	٠	Distance from Site to Nearest Sensitive Environment	
		Document location, distance, type <u>SOME MARSHES ALOUG TUCKER CREEK</u> and details of any nearby sensitive environments or habitats:	
		•	- 10
		Scoring Rationale & Information Source:	
2.b	•	Groundwater	
		Measure distance to major <u>TUCHER CREEK SEEMS TO BE A DISCHARGE ZOWE</u> recharge or discharge area:	
•		Scoring Rationale & Information Source:	
3.	•	Special Considerations	•
		Document any other important impacts	·
		Scoring Rationale & Information Source:	



RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY

RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	Ť	Vapour pressure	Ť	Degradation	Degra	dation constan	ts (mu)	Kđ	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Şand	Sitt	Ciay	1							
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic	•				Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25	· · · · · · · · · · · · · · · · · · ·		1.1									(3)
·		130	20	4,61E-09	20			•									(3)
				1,66E-09	20												(4)
· ·							3,20E-03	1,40E-01	8,30E-02		l						(5)
1										Ottawa sand: 1,	5						(6)
			· · · ·		· · · · · · · · · · · · · · · · · · ·					Silt: 4,5	<u> </u>	L					(6)
										Clay: 10		 					(6)
	4								· · · ·				0,12*				(7)
2,4 dinitrôtoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic				•	Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	- 20		1										(3)
									1 ·				1,10È-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
				1.		1				1			0.93*			1	(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1			:		(1)
		42	20	5,53E-12	20					1				2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine,		50	20	2,56E-12	20												(3)
or						· · · · · ·				ļ	ļ						
· · · · · · · · · · · · · · · · ·				44			0	6,50E-03	1,40E-02	1				ļ			(5)
								ļ		0,1 à 13,26						ļ	(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	нмх	5	25	4,38E-17	25	Anaerobique						nd	·	400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 -		5	25	4,34E-17	20				1		I						(2)
tetranitro - 1,3,5,7 -										0,2 8 4,2							(6)
tetrazocine)							0	3,60E-03	3,20E-02								(5)

McGrath, 1995
 Thiboutot et al, 1998
 Pheelan and Webb, 1997
 Hayes, 1992
 Myers et al, 1996
 Townsend et al, 1996
 http://www.mef.gouv.qc.ca/it/environn/criteres_eau

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* Provisory criteria for aquatic life (surface water)

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Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Sections Image: Sections <thimage: sections<="" th=""> Image: Sections<th></th><th></th><th></th><th>1.55</th><th></th><th>ré Lavigne</th><th>Warc-Aud</th><th>Impact Area A Date: 06-27-2000 User (s):</th></thimage:>				1.55		ré Lavigne	Warc-Aud	Impact Area A Date: 06-27-2000 User (s):
CIVE Addition111<		Comments	7		mpacts	cnown and/or potential	Score for potential mpacts	Sections
CONTAMINAT QUANTY 10 10 0								CONTAMINANT(S) CHARACTERISTICS
PHYSICAL STATE OF CONTAMENANTS 3 3 9 0 PT, RDX, RDX, Getz Sector contactions 0 0 6 NB. If die inal is < 0 or > 33, die score assigned to special number designed for projects for company Account of the store of the stor								
Special considerations 0 0 6 TOTAL 24 25 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
TOTAL 24 24 73 0 NB. If the total is < 0 or > 33, the score stagged to sequel insume to example to sequel insume to example to insume to example to insume to example to insume to example to exa		TNT, RDX, HMX, etc	0					
GROUNDWATER		must be changed in order to respect the limits for the corre	0.					TOTAL
Server constantants are by two for process containants 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1								
Engineer anthruffice containants 4 6 No Erd for a part of a state of a s								
The lates of confining layer and price of a confining layer 1.5 1.5 1.5 1.5 1.5 Anamal an infull 0.7 <td></td> <td>Na analisi sa danatan</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>		Na analisi sa danatan						
Hydraulic conductivity of the confining layer 1.5 1.5 1.5 0. No confining layer. Anaual minfall 0.7 0.7 0.7 0.7 Hydraulic conductivity of the spatial(r) of concern 1.3 1.3 0.7 0.7 Special considerations 1.3 1.3 1.3 0.7 TOTAL 10.5 1.0 1.0 1.0 1.0 Supervised readmanness of sourceTheore discharged from pills 0.00 N.8: If the soil is < 0 or > 11, the score sarged of special matrix to charge in order to respecible limits for the correspond between 0 and 11. Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.00 10.8 Supervised readmanness of sourceTheore discharged from pills 0.01 0.11 0.11 Supervised readmannessource discharged to piplication 0.02 0.								
Anault minfail 0.7								
Hydraulic conductivity of the sequifact() of concern 1.5 1.5 1.5 1.6 0 From 102-01 cm/s to 10080 (cm/s). TOTAL 10.5 10.5 10.5 11 0 N.B.: If the seal is < 0 or > 11, the score assigned to special considerations react on a characterized contransmits. 00 N.B.: If the seal is < 0 or > 11, the score assigned to special considerations of one or respect the limits for the correspond between 0 and 11. StrFACE WATER. 0 0.00 0.01 0 N.B.: If the seal is < 0 or > 11, the score assigned to special consideration of one or respect the limits for the correspond between 0 and 11. Observed or memory of the store of continuents at observer/liced discharged from site 0.00 0.01 0 Interes encounding the firing ranges and almost all over the area. Distance to presental parface water 2 2 0 0 Interes encounding the firing ranges and almost all over the area. TOTAL 0.11 0.11 1.5 0.11 1.5 0.11 0.11 TOTAL 0.20 2.0 A 0 Interes encounding the firing ranges and almost all over the area. DIRECT CONTACT 8.6 1.6 1.11 0.11 0.11 0.11 Katewe constansation of and is of or set in the correspond to the present diminist and totally covered. 1.3 .1.3 1.4 DIRECT CO								
Special considerations 1.3 1.3 1.4 Selectify: 4.7, Retardation Prector: 1.7, Biolographiance. roth of a special naute to changed in order to respond in order to respond to special naute to changed in order to respect the limits for the correspond to thereas (and 10. SUBFACE WATER. 10.5 10.5 10.5 10.5 Sector of oncinence contanuous of oncinence contanuous of once or respect the limits for the correspond to t								
TOTAL 10.5 10.5 11.5 10.5 11.1 0.0 NB: If the total is < 0 or > 11, the score saringsed to operate the limits for the correspond is between 0 and 11. SUFFACE WATER. 3 5.5 0 Trees arrounding the firing ranges and almost all over the area. Observed 0 and 11.1 2 2.0 0 0 Trees arrounding the firing ranges and almost all over the area. Topgraphy 1 1 1.5 0 Trees arrounding the firing ranges and almost all over the area. Topgraphy 0.1 0.1 1.1 1.5 0 Statuse to premise the area. Topgraphy 0.1 0.1 0.1 0.1 0.1 0.1 0.1 Topgraphy 0.1			<u> </u>					
SUPFACE WATER and the changed in order to respect the limits for the corresponding of the sense of an analysis o								
Observed or meaned operations of conserved/liced discharged from all? 3 3 6 Surgeon Lake within the area. 2 2 7 Operating operating purpose water 2 2 7 Topggraphy 1 1 1 Picod potential (see nanograph) 0.31 0.31 7 Operating operations 2.0 2.0 7 Picod potential (see nanograph) 0.23 0.25 No flot whom of hat areas, contaminants at or below ground leve Special considerations 2.0 2.0 7 1 TOTAL 8.6 8.6 711 0 DIRECT CONTACT 2.6 2.5 7.5 7.5 Arborne emissions (gases, rayour, dust, etc.) 2.5 2.5 7.5 7.5 Arborne emissions (gases, rayour, dust, etc.) 2.5 2.5 7.5 7.5 You prescrible or allow off with -1.3 7.1 7.4 7.4 Maxwee contaminants and training 0 0 7.2 7.4 Arborne emissions (gases, rayour, dust, etc.) 2.5 2.5 7.5 7.5 Special considerations -1.3 7.1 7.4 7.4 7.4 Maxwee contaminants not totally covered. -1.3	d to special conside corresponding sect	must be changed in order to respect the limits for the corre-	0.0				10.5	
Surface containancet 3 3 // 0 Trees arrowning the firing ranges and almost all over the area. Topography 1 // 0 0 Surgeon Lake within the area. Topography 1 // 0 Hills with some flat areas, contaminants at or below ground level Ren-off potential (see non-ograph) 0.1 0.1 0 Hills with some flat areas, contaminants at or below ground level Prode potential 2.0 0.4 0 Special considerations 0.2 TOTAL 8.6 8.6 // 0 N E: If the total is < 0 or > 11, the some assigned to special instance to respect the limits for the correspond between 0 and 111 Macanow contamination of meals offnee 2 2.6 // 0 Arborne emission (grace, vapour, durf, etc.) 2 2.5 // 2.5 // Arborne emission (grace, vapour, durf, etc.) 2 2.5 // 2.5 // // Arborne emission (grace, vapour, durf, etc.) 2 2.5 // // 0 Net: If the total is < 0 or > 11, the some assigned to special numbers Macanow solid gramma (grace, vapour, durf, etc.) 2 2.5 // 1.5 // 1.6 // Net: If the total is < 0 or > 11, the some assigned to special numath to the stat some al								
Distance to percendial performance in the series. 2 2 0 Surgeon Lake within the area. Topperphy 1 1 1 1 0 Prood potential (see nanograph) 0.31 0.31 0 0 Special considerations 2.0 2.0 0.4 0 TOTAL 8.6 6 11 0 0 DIRECT CONTACT 8.6 6 10 0.3 NB:: If the total is < 0 or> >11 (the score assigned to special names on surged to spe								
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			0		/16	16	16	TOTAL
	corresponding secti							
				100	:			
					2			
score (potential impacts) $67.8 + 2.0 / 100 + \frac{1}{4} - \frac{4.3}{3}$ score (known impacts or potential impacts if the former is not known) $67.8 + 2.0 / 100 + \frac{1}{4} - \frac{4.3}{3}$ NB if the uncertainty exceeds 15 we consider								ore (potential impacts)

Score 70-100 50-69 38-49 <=37 Risk potential High Medium Medium low Low Action required Yes Likely May be Not likely Class 1 2 3 N

2.0 /100 17/ 4.3 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class 1 (for insufficient information). N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

Site No.:	RA 614		. •	8	ny: ONTARIO
Custodian	Dept.: DND	Facility Name: <u>CFB</u> P	ETAWAWA	Site Operator/Mo	anager: <u>CFB_PFTAWAW</u>
Type of Si	te: IMPACT	ARFA	*	Site Owner:	NO
Zone:		UTM-Coordinates:	Easting Northing		deg min se deg min se
Location:		•	Legal Land	i Description:	·····
Address	<u></u>		Provincial	Parcel No.:	
Brief Desc	ription of Site:				
Site Land	Use: Current:_	MILITARY TRAINING	Proposed:	DE M	
Comments	•		Summary o	of Site Classification I	Information:
			· · ·	-	\times Detailed \times Short
			Site Score:		<u>4.3</u> Estimated Score
Contract N	CILDIS	HOGAN SEAN MOVILES	Class: (1, Notes:	2, 3, N, or I)	Risk: MEDUAM
			<i>Ivoles</i> .		TO HIGH
				<u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>	
	The state Duran Tram	Parent Cadas		,	
		_: CNTPostal Code: Fax No.:			· · · · · · · · · · · · · · · · · · ·
	fied by above	or MARC- HNORE LA	IVIGNE/KARINE CHA	AMPAGNE	
Degree of I Visited site	Familiarity with Site:	Very familiar Moderat	ely familiar Ind	lirectly familiar	Unfamiliar
	RESEARCH ASSIST		(g) 654-2647		

APPENDIX B

National Classification System Process Checklist

USER'S GUIDE REVIEWED

MINIMUM DATA REQUIREMENTS MET

- Description of site location Type of contaminants or materials likely to be present at site (and/or description of historical activities) Approximate size of site and quantity of contaminants Approximate depth to water table Geologic map or survey information (soil, overburden, and bedrock information) Annual rainfall data (can be inferred from rainfall map of Canada) Surface cover information Proximity to surface water Topographic information Flood potential of site Proximity to drinking water supply Uses of adjacent water resources Land use information (on-site and surrounding)
- FACILITY/SITE DESCRIPTION COMPLETED
- SITE CLASSIFICATION WORKSHEET COMPLETED
- **REFERENCES ATTACHED/CITED**
- **EVALUATION FORM COMPLETED**

Detailed Form * Short Form

SCORE SHEET COMPLETED

SITE CLASSIFICATION

Class: \underline{x} 1 \underline{x} 2 \underline{x} 3 \underline{N}

Score: $\underline{69.8} \pm \underline{4.3}$ Total Estimated Score

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:

SHORT EVALUATION FORM

1.5.0

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes	Reference Attache
1	 a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? 	B	$\Box \rightarrow Class \\ \Box \rightarrow Class$	
1	Contaminant(s) Characteristics		••••••••••••••••••••••••••••••••••••••	
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?		ß	
	 3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha distributed or placed in such a manner as to have the potential to cause significant off-site contamination 	ı D	ß	
II	Pathways			
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	M		
111	Receptors			
	 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); c) caused vegetative stress or other known environmental impairment? 			
(A Yes a	nswer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	ଷ		

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
. Contaminant(s) Characteristics	 A. Degree of hazard High concern contaminants - high concentration High concern contaminants - low concentration Medium concern contaminants - high concentration Medium concern contaminants - low concentration Low concern contaminants 	14 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. There are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other iandfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	 concentrations: Hish Concern Contaminants Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) Materials regulated by the Canadian Environmental Protoction Act (e.g., PCBs) Institutional waste (lab, schools hospitals, etc.) Pathological wastes and animal carcasses Radioactive wastes 	Dangerous Goods Act; Provincial Territorial Hazardous Wastes lists; regulations under Canadian
				 Liquid wasts not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers Pood processing wastes Non-hazardous incinerator residues Municipal solid (household) wastes Organic and vegetable wastes Mining residues Low Concern Contaminants Industrial and commercial solid wastes, (e.g., 	
				 Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) Other nearly inert wastes (e.g., foundry sands) <u>High Concentration of Contaminants</u> contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm) 	
	 B. Contaminant Quantity (area/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	(1) 0 2	the quantity of wastes at abandoned	Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.		
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SCORE

SITE CLASSIFICATION WORNSTIEL: (Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

• Degree of Hazard Α.

Β.

	estimated concentrations:	HMX) POSSIBILITY OF HEAVY METAL CONTAMINATION	•
	Scoring Rationale & Information Source:		Π
٠	Contaminant Quantity		
	Estimated or measured areal volume of contaminated zone:	NO REGISTER OF UNEXPLODED SHELLS OR AMMUNITION FIRED AREA ~ 22.5900 Km ² QUANTITY ESTIMATED WITH THE AREA OF THE RANGE	BEFOR
	Scoring Rationale & Information Source:		10
•	Physical State of Contaminant		
	Does the site contain: a) Predominantly liquids/gases b) Primarily sludges c) Primarily solids	TNT, RDX, HMK (EVERGETIC HATERIALS)	•
	Scoring Rationale & Information Source:		3
• .	Special Considerations		
	Document any other important contaminant characteristics not addressed above:		
	Scoring Rationale & Information Source:		

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALB	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guldelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	©2 0	potential for pollution. Potential	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over squifer(s) of concern 3 m or less 3 to 10 m >10 m 	(1) 0	(e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the amenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	maps, well records, government hydrogeologist or
	 (c) Hydraulic conductivity of the confining layer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	(1.5) 0.5	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and other

II. EXPOSURE PATHWAYS

A. Groundwater

1. • Known Groundwater Contamination

		Document information on known	NO RECORD	-
		groundwater contamination:		-
				-
		Scoring Rationale & Information Source	e:	-
2.a	•	Engineered Subsurface Containm	ient	
		Document engineered systems protecting groundwater:	NO ENGINEERED SYSTEM	•
		Scoring Rationale & Information Source	e:	4
2.b	٠	Thickness of Confining Layer Or	ver Aquifer(s) of Concern	
•		Document local geological conditions:	BEDROCK (LIMESTONE, MINDR DOLOSTONE, SHALE, SANDSTONE) OVERLA BY THIN TAND DISCONTINUOUS DRIET COVER, GLACIOFLUVIAL OUT WA	
	•	Identify water-bearing zones used for water supply:	AND DELTAIC DEPOSITS (GRAVEL, GRAVELLY SAND, SAND,) NO CONFINING I AYER	-
		Scoring Rationale & Information Source	e:	1.5
2.c	•	Hydraulic Conductivity of the Co	onfining Layer	
		Estimate hydraulic conductivity of any confining layer:	NO CONFINING LAYER	•
		Scoring Rationale & Information Sourc	e.	1.5
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Site Identification

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE *	METHOD OF BVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	1 0.6 0.4 0.2	quantity of leachate produced.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	 (e) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻²-10⁻⁴ cm/sec <10⁻⁴ cm/sec 	3 1.5 0.5	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 10 +4	(See 3.7.3 in text)	Technical judgment.	
â	 3. Special considerations (detailed) : Solubility (S) : low (S/standard = 10¹) medium (S/standard = 10²) high (S/standard = 10³) 	-4/3* 0 4/3*	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	Retardation factor (R) :• important delay $(R / R_{CI} = 10^2)$ or $(K_d = 12,51)$ • delayed $(R / R_{CI} = 10^1)$ or $(K_d = 1,14)$ • little or no delay $(R / R_{CI} = 10^0)$ or $(K_d = 0)$	-4/3* 0 4/3*		ing $n = 0.33$ et $\rho_b = 1.75$ g/cm ³ ; if the studied soil is neither recalculated because n et ρ_b change. ($R_C \approx 1$)	
	 Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-4/3* 0 4/3* (-4 2 4)	weighting of the special consider	tant elements have been neglected, he can change the internal ations and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

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II. E	EXP	OSURE PATHWAYS (cont'd)		SCORE
A.	G	roundwater (cont'd)		
2.d	•	Annual Rainfall		
		Document rainfall data:	BETWEEN 1950 AND 1980 - 700 mm	
		Scoring Rationale & Information Source	CLIMATIC ATLAS - CANADA	0.7
2.e	•	Hydraulic Conductivity of Aquife of Concern	er(s)	
		Estimate hydraulic conductivity of relevant aquifer(s):	T <u>RANGES FROM 10⁻² cm/s to 10' cm/s</u>	
		Scoring Rationale & Information Source	*	3
3.	٠	Special Considerations		
		Document any other important ground water issues not addressed above:	SOUBILITY (5/STANDARD = 130/0.12) => 4/3 RETARDATION FACTOR => -1/2 (20 = 4.5) BIODEGRADATION - NON ORSERVED => 0	
		Scoring Rationale & Information Source	ARBITRARY VALUE FOR RETARDATION FACTOR	5/6

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
			r		
l. Exposure Pathways (cont'd)	 B. Surface Water Observed or measured contamination of water/effluent discharged from sita Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	local water use, e.g., recreational, irrigation, freshwater	Water Quali Guidelines;
	 Potential for surface water contamination surface Containment No containment Partial containment Full containment 	3 (3) (3) (3)	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	reports, air photo
•	 b) Distance to peremital surface water 0 to <100 m 100 to 300 m >300 m 	(3) 22 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.		
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.5 1.2 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

II. I	EXF	OSURE PATHWAYS (cont'd)		SCORE
Β.	S	urface Water		
1.	٠	Observed or Measured Contaminat	tion	
		Document information on surface water contamination:	Lo RECORD	
		Scoring Rationale & Information Source:		_ [-]
2.a	•	Surface Containment		
		Review and document engineered or natural systems protecting surface water:	THEREARE TREES ALMOST ALL OVER THE AREA AND THEY SURROUND THE FIRING RANGES	
		Scoring Rationale & Information Source:	•	3
2.b	٠	Distance to Perennial Surface Wat	er	
		Estimate distance from site to nearest stream or other water body:	STURGEON LAKE WITHIN THE AREA	
		Scoring Rationale & Information Source:	•	3
2.c	· · •	Topography		
		Document terrain conditions:	MOSTLY HILLS WITH FLAT ZONES	
		Document position of contaminants (are they above ground or buried?)	AT OR BELOW GROUND LEVEL	
	•	Scoring Rationale & Information Source.	•	
Site	Ider	ntification:		

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE *	METHOD OF EVALUATION	SOURCES OF
			•		
II. Exposure Pathways (cont'd)	 B. 2. d) Run-off potential (see nomograph, end of Appendix D) >1000 mm rainfall and low permeability surface material 500 to 1000 mm rainfall and moderately permeable surface material <500 mm rainfall and highly permeable surface material 	1 0.6 0.2	into water bodies. Water run-off is a function of precipitation and the	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	of Canada (Fisheries
	 e) Flood potential 1 in 2 years 1 in 10 years 1 in 50 years 	0.5 0.3 0.1	and concentrations of contaminants to be released to surface water	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Bstablished flood plain guidelines, maps; provincial territorial soil survey maps.
•	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :				
	Solubility (S) :•low(S/standard ~ 10^1)•medium(S/standard ~ 10^2)•high(S/standard ~ 10^3)	-2* 0 2*	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	 Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-2* 0 2* (-4 à 4)	weighting of the special consider	rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special ount the new weighting. However, the total of points allowed	

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Sec. 12

II. EXPOSURE PATHWAYS (cont'd)

- B. <u>Surface Water</u> (cont'd)
- 2.d Run-off Potential
 - Document geological and rainfall conditions:

ANDRAL RAIDFALLS = 100 mm PERMEABLICTY VARIES FROM (0-3

Scoring Rationale & Information Source: SEE P. 35

2.e • Flood Potential

23

Estimate flood frequency of nearby NO FLOOD IN THE LAST SO YEARS BUT STURGEOW LAKE water courses or water bodies: INCREASES THE PROBABILITY

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TO

Scoring Rationale & Information Source:

3. • Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (S/STANDARO = 130/0.12) => BIODEGRADATION (NON OBSERVED) =>0

Scoring Rationale & Information Source:

0.31

	CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
-			•		•	

II. Exposure Pathways (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). Strongly suspected contamination of media off-site No contamination of media off-site 	11 6 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	 Potential for direct human and/or animal contact Airborne Emissions (gases, vapours, dust, etc.) Known or suspected airborne emissions impacting on neighbouring properties Airborne emissions generally restricted to site No airborne emissions 	5 3 0	there is a great hazard for direct	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	 b) Accessibility of Site (ability to contact materials) Limited or no barriers to prevent site access; contaminants not covered Moderate accessibility or intervening barriers; contaminants are covered Controlled access or remote location and contaminants are covered 	4 3 0	site and to contaminants, the greater the chance for	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 (1)	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 10 +4	(See 3.7.3 in text) .	Technical judgment.	_
	 3. Special considerations (detailed) : Vapor pressure : < 0,1 kPa 0,1 à 0,5 kPa 0,5 à 1,5 kPa > 1,5 kPa 	(2) -2/3* 2/3* 2*	(N.B. : vapor pressure limits are valid * The weighting suggested is valid if t	at a 20°C temperature) there are no points affected to other special considerations.	
	Powderiness : • < 0,1 % • 0,1 & 1 % • 1 & 10 % • > 10 % Other special considerations	-2* -2/3* ©]3* 2* (-4 à 4)	weighting of the special considera	tant elements have been neglected, he can change the internal tions and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

•	XPOSURE PATHWAYS (cont'd) <u>Direct Contact</u>	
•	• Known Contamination Off-site:	
	Document reports of off-site contamination due to contact with	NO RECORD
	contaminated soil, dust, air, etc.:	
	Scoring Rationale & Information Source	
1	• Airborne Emissions	
	Document incidents or complaints about fumes, gases, dust, odours, etc.:	POSSIBLE, BUT VUKNOWN
	Scoring Rationale & Information Source	•
b	• Accessibility of Site	
·	Review and document avenues of site access by humans and animals:	THERE IS A FENCE THAT SURROUND THE AREA, BUT THE CONTAMINANTS ARE NOT TOTALLY COVERED
		CONTAMINANTS ARE NOT TOTALLY COVERED
c	site access by humans and animals:	CONTAMINANTS ARE NOT TOTALLY COVERED
C	site access by humans and animals: Scoring Rationale & Information Source	CONTAMINANTS ARE NOT TOTALLY COVERED
С	site access by humans and animals: Scoring Rationale & Information Source • Hazardous Soil Gas Migration Review potential for hazardous soil	LONTHMINANTS ARE NOT TOTALLY COVERED
	site access by humans and animals: Scoring Rationale & Information Source • Hazardous Soil Gas Migration Review potential for hazardous soil gas production and migration from site: Scoring Rationale & Information Source • Special Considerations Document any other conditions whereby	UD PUTRESCIBLE CONTAMINANTS
C	site access by humans and animals: Scoring Rationale & Information Source • Hazardous Soil Gas Migration Review potential for hazardous soil gas production and migration from site: Scoring Rationale & Information Source	UD PUTRESCIBLE CONTAMINANTS

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE *	METHOD OF BVALUATION	SOURCES OF INFORMATION
11. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination, from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: 1) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply b) Drinking water supply is known to be adversely affected as a result of site contamination c) Known contamination of drinking water supply to levels above CDWG c) Strongly suspected contamination of drinking water supply c) Drinking water supply is known not to be contaminated 	9 7 0	Water used for drinking should be protected against contamination from any site.	known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/ territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking	Canadian Drinki Water Quality; oth drinking wat guidelines
	 ii) Potential for impact on drinking water supply Proximity to drinking water supply 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	0 n a	to a contaminant source, the greater		
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	3 2 6.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

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Record known or suspected adverse effects on humans or domestic animals: NO	•	Known Adverse Impact on Human	ns or Domestic Animals
adverse effects on humans or domestic animals: Scoring Rationale & Information Source: .a.i · Known Contamination of Drinking Water Supply Record known or suspected incidents of contamination of drinking water: Scoring Rationale & Information Source: .a.ii.° · Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well and measure distance to site: Scoring Rationale & Information Source: .a.ii.° · Availability of Alternate Drinking Water Supply Document availability of alternate UNENDWN, RUT, FOSSIRCE	•	Million Auverse impact on Muma	
domestic animals: Scoring Rationale & Information Source: a.i Known Contamination of Drinking Water Supply Record known or suspected NO RECORD inclients of contamination of MO RECORD inclients of contamination of MO RECORD a.ii.** Scoring Rationale & Information Source: a.ii.* Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well CHALK RIVER 2 KM WEST AND SOME CABINS 2 KM NO Scoring Rationale & Information Source: Scoring Rationale & Information Source: a.ii.* Scoring Rationale & Information Source: Document availability of Alternate Drinking Water Supply Document availability of alternate UNKNOWN, RUT, POSSIBLE	•		
Scoring Rationale & Information Source: a.i · Known Contamination of Drinking Water Supply Record known or suspected incidents of contamination of drinking water: Scoring Rationale & Information Source: a.ii.° · Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well and measure distance to site: Scoring Rationale & Information Source: a.ii.° · Availability of Alternate Drinking Water Supply Document availability of alternate		domestic animals:	• • • • • • • • • • • • • • • • • • • •
A.i. • Known Contamination of Drinking Water Supply Record known or suspected incidents of contamination of drinking water: Scoring Rationale & Information Source: a.ii.°• Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well and measure distance to site: Scoring Rationale & Information Source: a.ii.°• Availability of Alternate Drinking Water Supply Document availability of alternate			
a.i Known Contamination of Drinking Water Supply Record known or suspected incidents of contamination of drinking water: NO_RECORD drinking water: Scoring Rationale & Information Source: a.ii.°• Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well and measure distance to site: Scoring Rationale & Information Source: Scoring Rationale & Information Source: a.ii.°• Availability of Alternate Drinking Water Supply Document availability of alternate			
Record known or suspected incidents of contamination of drinking water:		Scoring Rationale & Information Source)* * <u></u>
incidents of contamination of drinking water: Scoring Rationale & Information Source: .a.ii.°• Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well and measure distance to site: Scoring Rationale & Information Source: .a.ii.°• Availability of Alternate Drinking Water Supply Document availability of alternate	.a.i •	Known Contamination of Drinking	g Water Supply
incidents of contamination of drinking water: Scoring Rationale & Information Source: Scoring Rationale & Information Source: Identify nearest drinking water well and measure distance to site: Scoring Rationale & Information Source: a.ii.°°-Availability of Alternate Drinking Water Supply Document availability of alternate		Record known or suspected	NO RECORD
Scoring Rationale & Information Source: a.ii.°• Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well <u>CHALK RIVER 2 KM WEST AND SOME CABINS 2 Km NO</u> and measure distance to site: Scoring Rationale & Information Source: a.ii.°• Availability of Alternate Drinking Water Supply Document availability of alternate <u>UNKNOWN BUT POSSIBLE</u>		incidents of contamination of	
a.ii.°• Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well CHALK RIVER 2 KM WEST AND SOME CABINS 2 Km NO and measure distance to site: Scoring Rationale & Information Source: a.ii.°••Availability of Alternate Drinking Water Supply Document availability of alternate		drinking water:	
a.ii.°• Distance to Nearest Drinking Water Supply(s) Identify nearest drinking water well CHALK RIVER 2 KM WEST AND SOME CABINS 2 Km NO and measure distance to site: Scoring Rationale & Information Source: a.ii.°••Availability of Alternate Drinking Water Supply Document availability of alternate			
Identify nearest drinking water well <u>CHALK RIVER 2 KM WEST AND SOME CABINS 2 KM NO</u> and measure distance to site: Scoring Rationale & Information Source: a.ii. ^{oo} •Availability of Alternate Drinking Water Supply Document availability of alternate <u>UNKNOWN BUT POSSIBLE</u>		Scoring Rationale & Information Source	þ.
Identify nearest drinking water well <u>CHALK RIVER 2 KM WEST AND SOME CABINS 2 KM NO</u> and measure distance to site: Scoring Rationale & Information Source: .a.ii. ^{oo} •Availability of Alternate Drinking Water Supply Document availability of alternate <u>UNKNOWN BUT POSSIBLE</u>		Distance to Nearest Drinking West	ter Sunnly(s)
and measure distance to site: Scoring Rationale & Information Source: a.ii.°°•Availability of Alternate Drinking Water Supply Document availability of alternate	.a.11.*•		
Scoring Rationale & Information Source: a.ii.°°•Availability of Alternate Drinking Water Supply Document availability of alternate			CHALK RIVER 2 KM WEST AND SOME CABINS 3 KM NORT
a.ii.°°•Availability of Alternate Drinking Water Supply Document availability of alternate <u>UNKNOWN BUT POSSIBLE</u>	•		
a.ii.°°•Availability of Alternate Drinking Water Supply Document availability of alternate <u>UNKNOWN BUT POSSIBLE</u>		Scoring Rationale & Information Source.	
Document availabiilty of alternate		•	
Document availabiilty of alternate UNKNOWN BUT POSSIBLE	a.ii.°°•	Availability of Alternate Drinking	Water Supply
active of driving water and pase	•	Document availabiilty of alternate	
of implementation:	•	sources of drinking water and ease	
		of implementation.	

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE *	METHOD OF EVALUATION	SOURCES OF
III. Receptors (cont'd)	 A.2. b) Other Water Resources Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km Use of water resources - if multiple uses, give highest score (use following table) Prequency of Use Water Use 	4 3 0 1.5 1 0.5 0.2 (2)	(groundwater or surface water) should be protected against contamination. The nearcr a water resource is to a site, the greater the risk of contamination.	Assess water users adjacent to the site from maps and directories.	Water Quality Guidelines; provincial/ territorial water quality guidelines and objectives; etc.
	Recreational (swimming, fishing)(2)1Commercial food preparation1.50.8Livestock watering10.5Irrigation10.5Other domestic or food chain uses0.50.3Not currently used but likely future use0.50.2				

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III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

	Record information on water resource that is or is potentially affected by site contamination:		
	Scoring Rationale & Information Sour	°ce:	
2.b.ii.°•	Proximity of Water Resources	to Site	
	Locate and measure nearest water resource areas to site:	STURGEON LAKE WITHIN THE AREA MASKINONGE LAKE I KM NORTH	
	Scoring Rationale & Information Sou	·ce:	Ð
2.b.ii.°°	• Water Uses		
	Record uses of nearby water resources:	FISHING Swimming ?	
	Scoring Rationale & Information Sou	•ce:	_ _

III. RECEPTORS (cont'd)

SCORE

A. Human and Ammal Oses (com	Α.	Human and Animal Use	s (cont'd
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2.c.i • Known Contamination of Land Used by Humans

	Record land use type (current or	NO RECORD			
	proposed) and level of contamination for land known to be			·····	
	contaminated due to site:				
	Scoring Rationale & Information Source.	•			
2.c.ii •	Land Use at and Adjacent to the Site				
	Document land uses (current and proposed) for up to 5 km from the site:	MILITARY EVERCISE	5		
		N	E	S	W
	<u> </u>		TRAINING AREA B	AREAS DIC	LICHWAY R CP RAILROHD
	1 km - 5 km			·····	
	Scoring Rationale & Information Source.	•			0.5
3. •	Special Considerations			•	
	Document any other important	PEOPLE AFFECTED	< 250 =>0		
	human or animal use information, including details of air contamination if known:	THE SITES ARE USED	> Ву милтару	PEOPLÉ	
				·····	
	Scoring Rationale & Information Source	٠ •			

<u>3</u> ·

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
III. Receptors (cont'd)	 B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	16 14 12	protected against site contamination. Evidence of	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: I) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normat conduct of business (from Ontario Environmental Protection Act, 1980).	
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km 	(19 6 2 0.5	approximately 1 km of the site		/territorial and
	 b) Groundwater - distance to important or susceptible groundwater resource(s) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	(8) 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

1.1

III. RECEPTORS (cont'd)

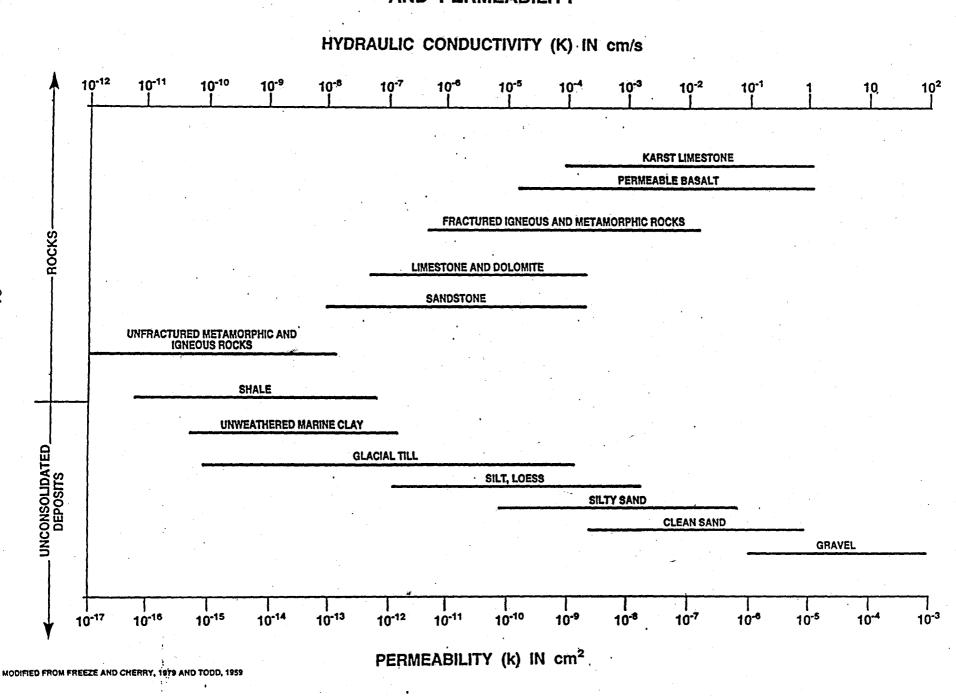
SCORE

B. Environment

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1. • Known Adverse Impact(s) on Sensitive Environment

1.		Record known impact(s) on any sensitive biological environment	NO RECORD	
		at and/or around the site:		
				- - -
		Scoring Rationale & Information Source	•	
2.a	٠	Distance from Site to Nearest Ser	sitive Environment	
		Document location, distance, type and details of any nearby sensitive environments or habitats:	SOME MARSHES IN THE SOUTHERN AND NORTHEASTERN PART OF THE AREA	-
		Scoring Rationale & Information Source		,10
2.b	٠	Groundwater		
		Measure distance to major recharge or discharge area:	STURGEON LAKE IS A DISCHARGE ZONE	
•		Scoring Rationale & Information Source	•	6
3.	٠	Special Considerations		
		Document any other important impacts on the environment not addressed above	•	~
				- -
		Scoring Rationale & Information Source	•	
Site	Iden	tification:		•



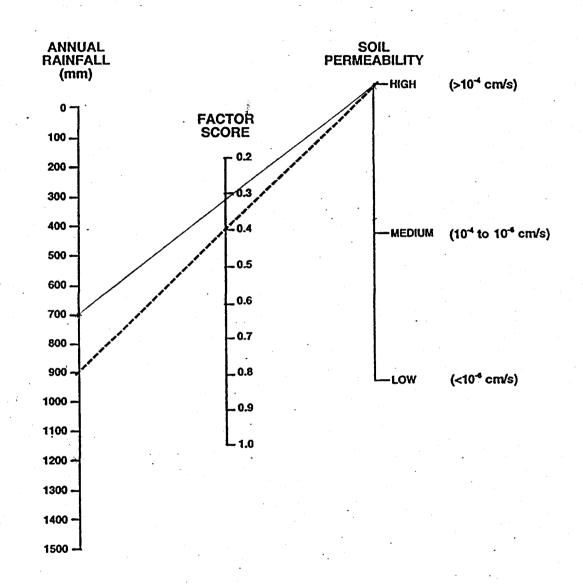
RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY

1 * 1

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RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T.	Vapour pressure	т	Degradation	Degra	dation constan	ts (mu)	Kd #	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Danieis)	Danger criteria (Rouisse)	Referenc
							Sand	Silt	Clay	1	·····	1					<u> </u>
Units		(mg/L)	(C)	(atm)	(C)	1	(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	1
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic			· · ·	· • .	Possibly toxic	0,02					(1)
	1. 1. 1. 1. 1. T.	130 .	20	1,45E-09	20					1	· · · ·	1		1	0,3	0,024	(2)
		150	25	9,49E-09	25			1			1. J.						(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20											·	(4)
							3,20E-03	1,40E-01	8,3QE-02					1			(5)
	•							1		Ottawa sand: 1,	5						(6)
										Silt: 4,5							(6)
										Clay: 10			1 ¹ 2.				(6)
			1										·0,12*				(7)
2,4 dinitrotoluene	2.4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic			• •		Possibly carconogenous						(1)
		270	22	2,89E-07	20			1		1				5			(2)
		· · · · · ·	•	3.17E-08	25					1							(3)
		270	20	1.61E-08	- 20												(3)
· · · · · ·				T									1,10E-04				(7)
2,6 dinitrotojuene	2,6 DNT	208	25	7,46E-07	25 ·	Aerobic and anaerobic	1 A 1 4										(1)
		206	25	7;46E-07	20									5			(2)
													0,93*		· · · · · · · · · · · · · · · · · · ·		(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	· 25	Anaerobique					Possibly carconogenous	0,1					(1)
UNING INCO		42	20	5,53E-12	20									2	0.3	0.00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine,		50	20	2,56E-12	20		·				•						(3)
or the L					<u></u>		· 0	6.50E-03	1,40E-02	· · · · · · · · · · · · · · · · · · ·					ł		
				++		<u> · · · · </u>		0,002-03	1,40E-02	0,1 à 13,26					<u> </u>		(5)
				++	_	<u> </u>				0,1413,20		<u> </u>				<u> </u>	+le
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	нмх	5	25	4,38E-17	25	Anaeroblque						nd		400	1,7	2,2	(1
(or octahydro - 1,3,5,7 -		5	25	4,34E-17	20												(2
tetranitro - 1,3,5,7 -										0,2 à 4,2	I						(6)
tetrazocine)			•				0	3,60E-03	3.20E-02								(5)

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McGrath, 1995
 Thiboutot et al, 1998
 Pheelan and Webb, 1997
 Hayes, 1992
 Myers et al, 1996
 Townsend et al, 1996
 http://www.mef.gouv.qc.ca/ir/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Site classification computerised worksheet

e: Impact Area B Date: 06-27-2000 User (s):	Marc-Andr	é Lavigne				·
Sections	ore for tential pacts	cnown and/or ootential	mpacts		- 2	Comments
	1.6 %	<u> </u>	Ē			
CONTAMINANTISI CHARACTERISTICS		11	<u></u>			
DEGREE OF HAZARD	10	11	/14 /10		0	Energetic materials found in ordnances.
CONTAMINANT QUANTITY	3	3	/10	- 68	0	Area = 14.6681 km ³ , no register before 1995 TNT, RDX, HMX, etc
PHYSICAL STATE OF CONTAMINANTS	0	0	//	-	·	INT, KDX, HMX, etc
Special considerations TOTAL	24	24	/33		0.	N.B.: If the total is < 0 or > 33 , the score assigned to special consideration must be changed in order to respect the limits for the corresponding section (i.e.
EXFOSURE FATHWAYS						
) GROUNDWATER					L	
Known contamination at or beyond property boundary		-100				
Engineered subsurface containment	4	4	/4		0	No engineered system.
Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5		0	No confining layer.
Hydraulic conductivity of the confining layer	1.5	1.5			0	No confining layer.
Annual rainfall	0.7	0.7	/1		0	700 mm between 1950 and 1981.
Hydraulic conductivity of the aquifer(s) of concern	2.5	2.5	ß		0	From 10E-03 cm/s to 1 cm/s.
Special considerations	0.8	0.8	/4			Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
TOTAL	11.0	11.0	/11		0.0	N.B.: If the total is < 0 or > 11, the score assigned to special consideration must be changed in order to respect the limits for the corresponding section (i. between 0 and 11).
SURFACE WATER						USAYISSIL 9. AULIALIA
Observed or mesored continuanton of water/efficient discharged from siz		100	<i></i>			
Surface containment	5	5	/5	100	0	Trees all over the area but no particular surface containment.
Distance to perennial surface water	3	<u>-</u>	ß		0	Chalk Bay south, Ottawa River east and Mason Lake within the area
			/1.5		0	Mountains with flat zones, contaminants at or below ground level.
Topography Burn of a standal (see a second b)	0.31	0,31	/1_5	- 88	0	Mountains with that zones, contain mains at or below ground level.
Run-off potential (see nomograph)	0.25	0.31	/0,5			
Flood potential		1.4	/4	-	0.25	No flood in the last 50 years but Sturgeon Lake increases the possibilities.
Special considerations	1.4					Solubility: 2
TOTAL	11.0	11.0	/11		0.3	N.B.: If the total is < 0 or > 11 , the score assigned to special consideration
					[]	must be changed in order to respect the limits for the corresponding section (i.
						between 0 and 11).
DIRECT CONTACT				-		
Known contamination of airdin off-site	<u></u>	-100				
Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5		2.5	Possible but unknown.
Accessibility of site (ability to contact materials)	3.5	3.5	/4		0	People come by boat, contaminants not totally covered.
Hazardous soil gas migration	0	0	12		0	No putrescible contaminants.
Special considerations	-1.3	-1.3	/4			Vapor pressure: -2, powderiness: 2/3
TOTAL	4.7	4.7	/11		2.5	N.B.: If the total is < 0 or > 11 , the score assigned to special consideration must be changed in order to respect the limits for the corresponding section (i. between 0 and 11)
BECEPTORS						
HUMANS AND ANIMALS	T					
Known adverse impact on hving things as a result of the outlaminated size		+198	- 118			
Knows unpactor draking water supply		100	A			
Proximity to drinking water supply	2	2	/6		0	Water plant approx. 7 km south.
"Availability" of alternate drinking water supply	1.5	1.5	/3		1.5	Unknown but possible.
Kriswit impact on used water resource.						
Proximity to water resources used for activities	2	2	/2		0	Chalk Bay and Ottawa River
Use of water resources	2	2	2	t÷	Ö	Fishing, swimming
	a anta an					I BRING SWINDING
Kapiya contemposition of land parti by humans	0,5	0.5	<u>/////////////////////////////////////</u>		0	Military exercises,
Use of land at and surrounding site	0.0	0.0	/5	100		People affected lower than 250, military people.
Special considerations TOTAL			/18		1.5	
IOTAL	8.0	8.0	. /18		1.3	N.B.: If the total is < 0 or > 18, the score assigned to special consideration must be changed in order to respect the limits for the corresponding section (i. between 0 and 18).
ENVIRONMENT						
Kanvan advorse impact on sonslave environment as a trault of the contaminated sit	æ			8		
Distance from site to nearest sensitive environment	10	10	/10		0	Some marshes within the area.
Distance to important or susceptible groundwater resource(s)	6	6	/6	***	0	Mountains and outcrops act as recharge zones
Special considerations	0	0	15			
TOTAL	16	16	/16		.0	N.B.: If the total is < 0 or > 16, the score assigned to special consideration
						must be changed in order to respect the limits for the corresponding section (i.
				_		
tal score (potential impacts)	73.8	+ 0,9	/100		4.3	
tal score (known impacts or potential impacts if the former is not known)	73.8	+ 0.9	/100	+/-	4.3	N.B. : If the uncertainty exceeds 15, we consider that there i
						· · · · · · · · · · · · · · · · · · ·

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

Site No.:	RA 684			EA B		DNTA	
Custodian Dept.:				WAWA		anager: <u>CFB</u>	
Type of Site:	APACT AREA	NOW TRAIL	ING AREA	*	Site Owner:	NO	<u></u>
Zone:		UTM Coordinate	•	Easting		deg	
					•	deg	min se
Location:	<u> </u>	· · · · · · · · · · · · · · · · · · ·	*** ,		nd Description:		
Address				Provincia	al Parcel No.:		
Brief Description of S	Site:						
Site Land Use:	Current: M	ILITARY. TRAI	NING	Proposed:	1DEM		· · ·
Comments:		· · · · · ·			of Site Classification	•	
	•				ed Evaluation Form: _		> Short
				• -	e: <u>74.7</u> Total :		
				Dic DCOI		<u> </u>	SLOTE
				Class: (?	1, 2, 3, N, or I)	Risk: <u> </u>	IIGH
Contact Name:	HRIS HOGA	N/SEAN MO	YLES	Notes:			
Position:						<u> </u>	
Address:				·			
City: PETAWAWA	Prov./Terr.: c	DNT. Postal Co	de:				
Phone No.:		Fax No.:				· · ·	
Site Classified by abo	ove	or MARC-AN	DRE LAVIGN	E /KARINE CHAL	IPAGNE		
Degree of Familiarity Visited site: $\underline{\times}$	with Site: Yes	_ Very familiar No	×Moderately	familiar I	ndirectly familiar	Unfamiliar	•
Position: <u>RÉSEARC</u> Address: <u>880</u> CH City: QUEB	EMIN Ste-		none No.: <u>(418)</u> 40, <u>CP 7500</u> 20 FBEC Post	654 - 2647 al Code: 61V 4C7	Date of Complete	ed Classification:	
Site Identification:		I TOY I GIT OU		<u>,</u>		crooground //.	<u></u>

APPENDIX B

National Classification System Process Checklist

USER'S GUIDE REVIEWED

MINIMUM DATA REQUIREMENTS MET

Description of site location

Type of contaminants or materials likely to be present at site (and/or description of historical activities) Approximate size of site and quantity of contaminants Approximate depth to water table Geologic map or survey information (soil, overburden, and bedrock information) Annual rainfall data (can be inferred from rainfall map of Canada) Surface cover information Proximity to surface water Topographic information

Flood potential of site

Proximity to drinking water supply

Uses of adjacent water resources

Land use information (on-site and surrounding)

FACILITY/SITE DESCRIPTION COMPLETED

SITE CLASSIFICATION WORKSHEET COMPLETED

- **REFERENCES ATTACHED/CITED**
- **EVALUATION FORM COMPLETED**

___ Detailed Form V. * Short Form

SCORE SHEET COMPLETED

SITE CLASSIFICATION

Class: <u>1</u> 2 3 N 1

Score: 74.7 + 4.3Total Estimated Score

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:

<u>si</u> i i

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

	No	Yes	Refere Attacl
ination known to have caused adverse impacts on humans avironments? (see User's Guide) re or explosion hazard as it currently exists?	53 52	□ → Cla □ → Cla	
Characteristics			
ants that can be classified as 'high concern' (as defined in the User's Guide) site?		X	
oncern contaminants known to be present in large quantities? Answer yes if contaminant is: disposed/spilled) y >1,000 m ³ of contamination >10 ha d or placed in such a manner as to have the potential to cause significant off-site contamination		图	
wn to have caused contamination (above national or applicable provincial/territorial guidelines off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? ide)	53		
amination known to have the quality of local drinking water or other water resources eds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines ble provincial/territorial guidelines or policies); ited lands used for agricultural, residential or parkland purposes eds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites ble provincial/territorial guidelines or policies); or getative stress or other known environmental impairment?			•
ven if the impact has made the water, land, environment, or air unacceptable for use.)	Ø		
ven if the	impact has made the water, land, environment, or air unacceptable for use.)	impact has made the water, land, environment, or air unacceptable for use.)	

Site Identification:

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF BVALUATION	SOURCES OF
I. Contaminent(s) Characteristics	 A. Degree of hazard High concern contaminants - high concentration High concern contaminants - low concentration Medium concern contaminants - high concentration Medium concern contaminants - low concentration Low concern contaminants 	14 0 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature	 concentrations: Hish Concern Contaminants Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) 	Dangerous Good Act: Provincia Territorial Hazardous Waste lists: regulation
			(production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Protection Act (e.g., PCBs) • Institutional warte (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes Medium Concern Contaminants	Environmental Quality Criteria for Contaminated Sites; etc.
				 Liquid wasts not referred to in above, petroleum products septie tank pumpings, agricultural and chemical containers Pood processing wastes Non-hazardous incinerator residues Municipal solid (household) wastes Organic and vegetable wastes Mining residues Low Concern Contaminants 	
				 Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) Other nearly inert wastes (e.g., foundry sands) Hish Concentration of Contaminants contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm) 	
	 B. Contaminant Quantity (area/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	6 2	the quantity of wastes at abandoned	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Studge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

SCORE

A. • Degree of Hazard

List possible contaminants and EVERGETIC MATERIALS FOUND IN AMMUNITION (TNT. HAX. ROX) estimated concentrations: POSSIBILITY OF NEAUY METAL CONTAMINATION Scoring Rationale & Information Source:_ • Contaminant Quantity Estimated or measured areal NO REGISTER OF UNEXPLODED SHELLS BEFORE 1995 volume of contaminated zone: 2 AREA = 14. 6681 Km QUANTITY ESTIMATED WITH AREA OF THE RANGE 10 Scoring Rationale & Information Source:____ CHRIS HOGAN SEAN MOVLES • Physical State of Contaminant Does the site contain: a) Predominantly liquids/gases b) Primarily sludges c) Primarily solids ENERGETIC MATERIALS ARE PRESENT IN A SOLID STATE Scoring Rationale & Information Source: • Special Considerations Document any other important contaminant characteristics not addressed above: Scoring Rationale & Information Source:_

C.

Site Identification:

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF BYALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Quality Guidelines; Provincial/
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	© 2 0	potential for pollution. Potential	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over aquifer(s) of concern 3 m or less 3 to 10 m >10 m 	G 1 0	(e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	maps, well records, government hydrogeologist or
•	 (c) Hydraulic conductivity of the confining layer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	() 1 0.5	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and other

II. EXPOSURE PATHWAYS

SCORE

- A. <u>Groundwater</u>
- 1. Known Groundwater Contamination

		Document information on known	NO. RECORD	-
		groundwater contamination:		-
				-
	•	Scoring Rationale & Information Sour	ce:	
2.a	. •	Engineered Subsurface Contains	nent	•
		Document engineered systems protecting groundwater:	NO ENGINEERED SUSTEM	•
		Scoring Rationale & Information Source	ce:	4
2.b	٠	Thickness of Confining Layer O	over Aquifer(s) of Concern	
	•	Document local geological conditions:	NO CONFINING LAVER BEOROCK (PRECAMBRIAN ROCKS - INTRUSILIE AND METAMORPHIC)	-
	•	Identify water-bearing zones used for water supply:	OVERLAIN BY OLDER: ALLUVIUM IN TERRACE REMUNNTS: SAND, GRAVELLY SAND	-
		Scoring Rationale & Information Sour	CC: THICK NESS VARIES BETWEEN 65 AND 95 FEET	1.5
2.c	•	Hydraulic Conductivity of the C	Confining Layer	• .
		Estimate hydraulic conductivity of any confining layer:	IT RANGES FROM 10 TO 1	-
		Scoring Rationale & Information Sour	CP:	1.5
		Dealing randing of right manale some		

Site Identification:

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	. RATIONALE *	METHOD OF EVALUATION	SOURCES OF
	· · · · · · · · · · · · · · · · · · ·	1		r	
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	0.4 0.2	quantity of leachate produced.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., $667 \text{ mm} = 0.7 \text{ score}$)	Hydrological Atl of Canada (Fisheri and Environme: Canada, 1978).
	 (e) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻² 10⁻⁴ cm/sec <10⁻⁴ cm/sec 	3 1.5 0.5	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Preeze and Cherry 1979.
	3. Special Considerations	-4 10 +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :				
	Solubility (S) :•low(S/standard = 10 ¹)•medium(S/standard = 10 ²)•high(S/standard = 10 ³)	-4/3* Q (4/3*)	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	Retardation factor (R) :• important delay $(R / R_{CI} = 10^2)$ or $(K_d = 12,51)$ • delayed $(R / R_{CI} = 10^1)$ or $(K_d = 1,14)$ • little or no delay $(R / R_{CI} = 10^0)$ or $(K_d = 0)$	-4/3*		ing $n = 0.33$ et $\rho_b = 1.75$ g/cm ³ ; if the studied soil is neither recalculated because n et ρ_b change. ($R_{Cl} = 1$)	
	 Biodegradation (μ): observed non observed non biodegradable 	-4/3* 4/3*			
	Other special considerations	(-4 à 4)	weighting of the special consider	tant elements have been neglected, he can change the internal ations and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	•

;:

1.

II. EXPOSURE PATHWAYS (cont'd)

- A. <u>Groundwater</u> (cont'd)
- 2.d Annual Rainfall

Document rainfall data:

BETWEEN 1951 AND 1980 -> - YOC

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADR

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

> Estimate hydraulic conductivity of <u>SAND AND GRAVELLY SAND HAVE A HYDROLIC CONDUCTIVITY</u> relevant aquifer(s): <u>RANGING FROM 10⁻³¹ TO 1</u>

Scoring Rationale & Information Source:

3. • Special Considerations

5

HIGH SOLUBILITY OF ENFRGETIC MATERIALS (130/0.12 = 5/STANDARD) => 4/3 RETARDATION FACTOR (K) ~ 4.5) => -0.5 BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ARBITRARY SCORE FOR RETARDATION FACTOR

SCORE

0.7

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
					·
 Bxposure Pathways (cont'd) 	 B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	jurisdictions is not to contaminate		Water Quality
	 Potential for surface water contamination Surface Containment No containment Partial containment Full containment 	(5) 3 0.5	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	reports, air photos,
•	 b) Distance to perennial surface water 0 to <100 m 100 to 300 m >300 m 	(3) 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Brwironment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.		
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.5 1.2 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

SCORE

II. EXPOSURE PATHWAYS (cont'd)

B. Surface Water

1. • Observed or Measured Contamination

		Document information on surface water contamination:	NO RECORD	-
:				•
		Scoring Rationale & Information Source	۱ ۲	2
2.a	•	Surface Containment		
		Review and document engineered or natural systems protecting surface water:	NO SURFACE CONTAINMENT	•
		Scoring Rationale & Information Source	*	.5
2.b	٠	Distance to Perennial Surface Wa	ter	
· ,		Estimate distance from site to nearest stream or other water body:	OTTAWA RIVER TO THE EAST, CHALE BAY TO THE SOUTH AND MASON LAKE WITHIN THE AREA	
		Scoring Rationale & Information Source	3	3
2.c	•	Topography		
		Document terrain conditions:	FLAT SLOPE TO STEEP SLOPE	•
		Document position of contaminants (are they above ground or buried?)	CONTAMINANTS AT OR BELOW CROUND LEVEL	
		Scoring Rationale & Information Source	e: MAP MCE 132 Ed 8 TR 99	
Site	Ider	ntification:		•

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF EVALUATION	SOURCES OF
		•	•		
I. Bxposure Pathways (cont'd)	 B. 2. c) Run-off potential (see nomograph, end of Appendix D) >1000 mm rainfall and low permeability surface material 500 to 1000 mm rainfall and moderately permeable surface material <500 mm rainfall and highly permeable surface material 	1 ©.© 0.2	into water bodies. Water run-off is a function of precipitation and the	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nornograph" figure at end of Appendix D.	of Canada (Fisherie
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	0.5 0.3	and concentrations of contaminants to be released to surface water	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Bstablished floo plain guidelines maps; provincial territorial soi survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
<u></u>	3. Special considerations (detailed) :	I			
•	Solubility (S) : low (S/standard = 10 ¹) medium (S/standard = 10 ²) high (S/standard = 10 ³)	-2* 0 2	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	Biodegradation (µ) : • observed • non observed • non biodegradable Other special considerations :	-2* © 2* (-4 à 4)	weighting of the special consider	rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special nunt the new weighting. However, the total of points allowed	

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II. EXPOSURE PATHWAYS (cont'd)

B. <u>Surface Water</u> (cont'd)

2.d • Run-off Potential

Document geological and rainfall conditions:

PRECIPITATION = 700 mg + PERMEABLE SURFACE MATERIALS

NO FLOOD

MAPPENS IN THE LAST

=>

50

VEARS

Scoring Rationale & Information Source:

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies:

Scoring Rationale & Information Source:

3. • Special Considerations

23

Document any other important surface water conditions not addressed above: HIGH SOLUBILITY (S/STANDARD $\approx \frac{130}{0.12}$) RIDOFERADATION (NON DESERVED)

Scoring Rationale & Information Source:

0.6

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF BYALUATION	SOURCES OF
		•	·	•	
I. Exposure Pathways (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered), Strongly suspected contamination of media off-site No contamination of media off-site 	11 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	 Potential for direct human and/or animal contact Airborne Emissions (gases, vapours, dust, etc.) Known or suppected airborne emissions impacting on neighbouring properties Airborne emissions generally restricted to site No airborne emissions 	5 (5) (6) (5)	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring blota and/or resources.	been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous	Site inspecti reports, etc.
			•	emissions or otherwise reduce or eliminate exposure.	
	 b) Accessibility of Site (ability to contact materials) Limited or no barriers to prevent site access; contaminants not covered Moderate accessibility or intervening barriers; contaminants are covered Controlled access or remote location and contaminants are covered 	4 ₃ 5 0	site and to contaminants, the greater the chance for	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 ·	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text) .	Technical judgment.	
	2. Securit appridentions (datailed) :				
	 3. Special considerations (detailed) : Vapor pressure : <0,1 kPa 0,1 à 0,5 kPa 0,5 à 1,5 kPa >1,5 kPa 	27 -2/3* 2/3* 2*	(N.B. : vapor pressure limits are valid * The weighting suggested is valid if	at a 20°C temperature)	
	Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	-2* -23* (3) 2* (-4 à 4)	weighting of the special considera	5 45 μm) tant elements have been neglected, he can change the internal titons and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

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II. EXPOSURE PATHWAYS (cont'd) C. <u>Direct Contact</u>

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SCORE

1.	• Known Contamination Off-site:		· .
	Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.:	NO RECORD	
	Scoring Rationale & Information Source	e:	E
2. a	• Airborne Emissions		
	Document incidents or complaints about fumes, gases, dust, odours, etc.:	POSSIBLE BUT UNKNOWN	-
	Scoring Rationale & Information Sourc	e:	3
2.b	• Accessibility of Site		
	Review and document avenues of site access by humans and animals:	THE ACCESS IS CONTROLED BUT PEOPLE COMING BY BOAT	
	Scoring Rationale & Information Sourc	e: <u>SEAN MOYLES</u>	3 ?
2.c	• Hazardous Soil Gas Migration		
	Review potential for hazardous soil gas production and migration from site:	NO PIJTRESCIBLE CONTAMINANTS	
	Scoring Rationale & Information Sourc	e:	0
3.	• Special Considerations Document any other conditions where the humans/animals could contact contaminations and the second contact contamination of the second contact contamination of the second contact co	$\frac{1}{1} \frac{1}{1} \frac{1}$	- -
	Scoring Rationale & Information Sourc		-2
Site 1	Identification:		

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE *	METHOD OF EVALUATION	SOURCES OF
• •	· · · · · · · · · · · · · · · · · · ·	T	T	· · · · · · · · · · · · · · · · · · ·	<u> </u>
III. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site Known adverse effect on humans or domestic animals Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural	
				environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 Potential for impact on humans or animals Drinking water supply Known impact on drinking water supply Known impact on drinking water supply Drinking water supply is known to be adversely	9 7 0	Water used for drinking should be protected against contamination from any site.		Canadian Drinking Water Quality; othe drinking wate
	 ii) Potential for impact on drinking water supply Proximity to drinking water supply 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	6543	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/ agricultural purposes should also be included as it may be used for human consumption.	and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use	
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	(f) 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	•	

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III. RECEPTORS

Site Identification:_

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SCORE

Α.	H	uman_and_Animal_Uses							
1.	٠	Known Adverse Impact on Human	ns or Domestic Animals						
		Record known or suspected adverse effects on humans or domestic animals:	LO RECORD						
		Scoring Rationale & Information Source:	[
2.a.i	٠	· Known Contamination of Drinking Water Supply							
		Record known or suspected incidents of contamination of drinking water:	NO RECORO						
		Scoring Rationale & Information Source:							
2.a.ii.	•	Distance to Nearest Drinking Wat	er Supply(s)						
		Identify nearest drinking water well and measure distance to site:	THE WATER WELL, WHICE PROVIDE WATER FOR PETAWAWA VILLAGE AND THE BASE IS LOCATED 7 KM SOUTH FROM THE SITE (DOWNSTREAM)						
		Scoring Rationale & Information Source:	L						
2.a.ii. ^c	00 <u>.</u>	Availability of Alternate Drinking	Water Supply						
		Document availabiilty of alternate sources of drinking water and ease of implementation:	OTHER WATER SUPPLY WOULD BE DIFFICULT TO OBTAIN (PEMBROKE DEEP RIVER)						
		Scoring Rationale & Information Source:							
· .		, }							

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALB *	METHOD OF EVALUATION	SOURCES OF INFORMATION
					•
III. Receptors (cont'd)	 A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated 	4 3 0	(groundwater or surface water)	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other- relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	Water Quality
	 ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	② 1.5 1 0.5	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	 Use of water resources - if multiple uses, give highest score (use following table) <u>Prequency of Use</u> <u>Water Use</u> <u>Recreational</u> (swimming, fishing) 	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	
·	Recreational (swimming, fishing)(2)1Commercial food preparation1.50.8Livestock watering10.5Irrigation10.5Other domestic or food chain uses0.50.3Not currently used but likely future use0.50.2				

SITE (CLASSIFICATION	WORKSHEET		cont'd
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SCORE

III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

	Record information on water	NO RECORD			/
	affected by site contamination:				
•	Scoring Rationale & Information Source:	•			
2.b.ii.°•	Proximity of Water Resources to	Site			
	Locate and measure nearest water resource areas to site:	CHAL	E BAY AND OTTAWA	RIVER	
	Scoring Rationale & Information Source:	·			2
2.b.ii.°°	• Water Uses			•	
	Record uses of nearby water resources:	RECRE	ATIONAL FISHING + SW	<i>импы</i>	
	Scoring Rationale & Information Source:	•			2

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
		· · ·		· · · · · · · · · · · · · · · · · · ·	
III. Receptors (cont ⁱ d)	 A. 2. c) Direct human exposure Known contamination of land used by humans Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values Known contamination of land used for commercial or industrial purposes above C/I EQC values Land is known not to be contaminated 	5 3.5 0	Hazards associated with soll contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Bvaluate levels of soil contamination against Canadian Bnvironmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; CI = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCMB Canadia Environmental Quality Criteria fo Contaminated Sites
	 ii) Potential human exposure through land use Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) 0 - 300m 300m - 1km 1 - 5km Residential 5 4.5 3 Agricultural 5 4 2.5 Parkland/School 4 3 1.5 Commercial/Industrial 3 1 0.5 	0.5 . 5	contamination are directly related to land use and distance of the used land from the site. Residential and	that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :	1			
	People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000	@ 1,5* 3*	* The weighting suggested is valid if	f there are no points affected to other special considerations.	
	Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	(-5 à 5)	N.B.: if the user believes that impo weighting of the special consider considerations" that will take in accommust not exceed the prescribed limit.		

III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.c.i • Known Contamination of Land Used by Humans

	Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site:	NO RECORD				• • •
	Scoring Rationale & Information Source.			·	:	
2.c.ii •	Land Use at and Adjacent to the Site					
	Document land uses (current and proposed) for up to 5 km from the site: 0 - <300 m	NILITARY EXERCISES N OTTAWA RIVER	E STIAWA RIVER	S	W	•
	300 m - <1 km	OILAWA RIVER 2	•	CHALK BAY	TRAINING AREA A	•
	<u>1 km - 5 km</u> Scoring Rationale & Information Source:					3
3. •	Special Considerations	•		•		
	Document any other important human or animal use information,	PEOPLE AFFECTED =	=> < 250 =>0			
	including details of air contamination if known:	THE SITE IS USED BY	MILITARY PEDP	bie		
	Scoring Rationale & Information Source.					0

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
III. Receptors (cont'd)	 B. Environment Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Bvidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	sensitive environment is defined as a sensitive aquatic	
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km b) Groundwater - distance to important or susceptible 	0.5	approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review groundwater contour maps, if available, and other	/territorial and federal maps of sensitive environments.
	 of conditional considerations of to <500 m of to <500 m 2 to <5 km 5 to 10 km 	€ 4 2 1 -5 to +5	recharge area, the greater the potential for contamination of a groundwater or surface water resource. (See 3.7.3 in text)	available reports. Otherwise use established hydrogeologic principles.	maps, etc.

III. RECEPTORS (cont'd)

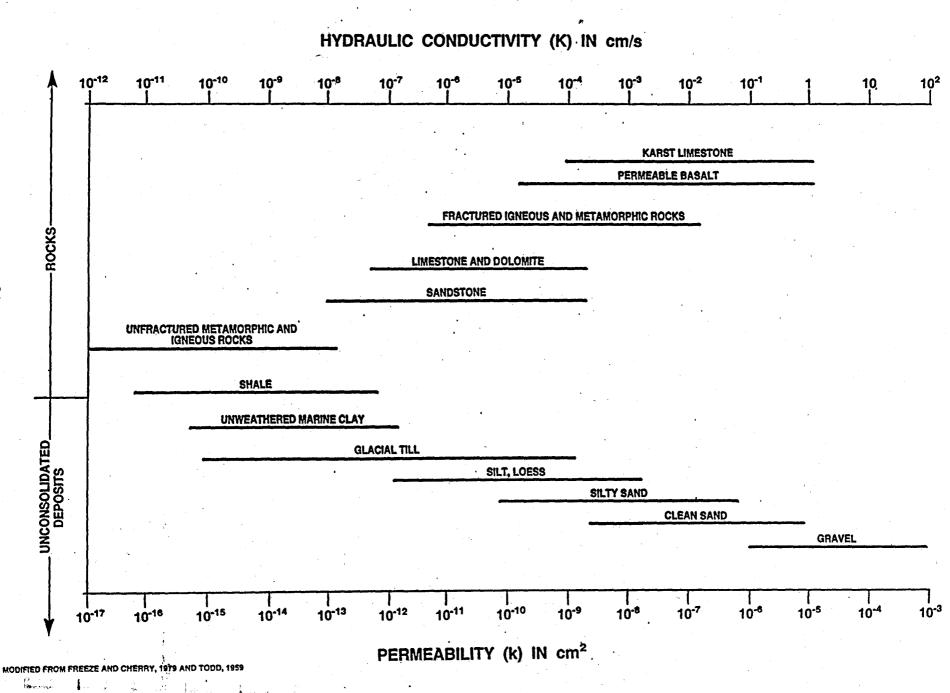
SCORE

B. Environment

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1. • Known Adverse Impact(s) on Sensitive Environment

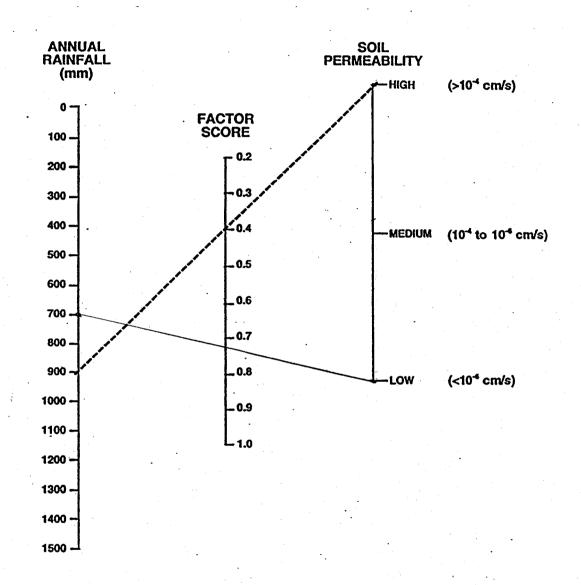
		Record known impact(s) on any sensitive biological environment	LO RECORD	
		at and/or around the site:		
		Security Device ale & Information Source	•	
2.a	•	Distance from Site to Nearest Sen	sitive Environment	
		Document location, distance, type	SOME MARSHES WITHIN THE AREA	
		and details of any nearby sensitive environments or habitats:		
				- [
		Scoring Rationale & Information Source	•	10
2.b	•	Groundwater		
		Measure distance to major recharge or discharge area:	RECHAGE AREA WITHIN THE SITE (MOUNTAINS OUTCROP)	·
		recharge of awardinge area.		
		Scoring Rationale & Information Source	•	6
3.	•	Special Considerations		
		Document any other important impacts on the environment not addressed above		• ••••
				_
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		Scoring Rationale & Information Source	•	L _{anne}
Site I	den	ntification:		•



RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY

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RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	т	Degradation	Degra	dation constan	. ,	Kđ	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Danleis)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay		i	1					
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20					<i>.</i>				1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20					[·				(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,	5						(6)
	· · · · · · · · · · · · · · · · · · ·			1		· · · · · · · · · · · · · · · · · · ·			· · · · · · · · · · · · · · · · · · ·	Sik: 4,5							(6)
· · · · ·				<u> </u>						Ciay: 10							(6)
						· ·							0,12*	•			(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						· (1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	- 20												(3)
													1,10E-04	1			(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic						1					(1)
		206	25	7,46E-07	20							1		5			(2)
												1.	0.93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20							1		2	0.3	0.00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine,		50	20	2,56E-12	20												(3)
or .												ł		<u> </u>			
L				ļ			0	6,50E-03	1,40E-02	l	l	L					(5)
								L		0,1 & 13,26	L	ļ					(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	НМХ	5	25	4,38E-17	25	Anaerobique	-					nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5.7 -		5	25	4,34E-17	20							1					(2)
tetranitro - 1,3,5,7 - tetrazocine)						-	0	3.60E-03	3,20E-02	0,2 4 4,2							(6)

(1) McGrath, 1995 (2) Thiboutot *et al*, 1998 (3) Pheelan and Webb, 1997 (4) Hayes, 1992 (5) Myers *et al*, 1996 (6) Townsend *et al*, 1996 (7) http://www.mef.gouv.qc.ca/ir/environn/criteres_eau

Provisory criteria for aquatic life (surface water)

د. ملاحقه

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	· 1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	• 1

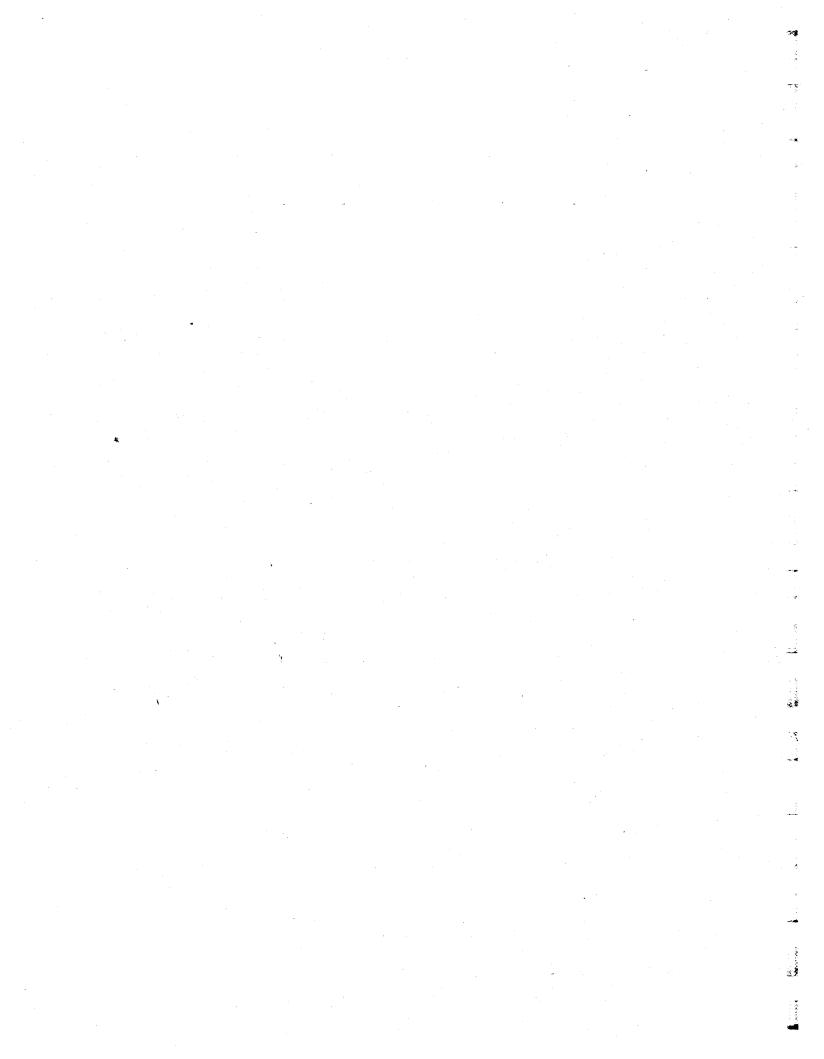
Site: Petawawa Grenade Range Date: 06-27-2000 User (s):	Marc-Andr	ré Lavigne			_	
		5		×		
		o/pd		×		
Sections	5 4 5	ă I s		8	2	Comments
	score for ootential mpacts	nown au otential npacts		×		
	lå å E	<u> </u>		×.		
CONTAMINANT(S) CHARACTERISTICS		<u></u>		***	****	
A) DEGREE OF HAZARD B) CONTAMINANT QUANTITY	11		/14	-	0	Energetic materials found in ordnances.
C) PHYSICAL STATE OF CONTAMINANTS	3		/10	<u>-</u>	0	Area < 1 km ³ , no register before 1995. TNT, RDX, HMX, etc.
Special considerations	0		16	<u> -</u>	-	INI, KDA, IIMA, CC.
TOTAL	16	16	/33	*	0.	N.B.: If the total is < 0 or > 33, the score assigned to special considerations
				8		must be changed in order to respect the limits for the corresponding section (i.e
	_		1	×.		hotseen () and 33)
EXPOSURE FATHWAYS	<u>a aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa</u>				*****	
A) GROUNDWATER			m	*	anda	
Engineered subsurface containment	4	4	/4		0	No engineered system.
Thickness of confining layer over aquifer(s) of concern	1 15	1.5	1,5	<u>-</u>	ŏ	No confining layer.
Hydraulic conductivity of the confining layer	2	2	11.5	8		No confining layer.
Annual rainfall	0.7	0,7	/1			700 mm between 1950 and 1981.
Hydraulic conductivity of the aquifer(s) of concern	1.5	1.5	ß	×	0	From 10E-04 cm/s to 10E-01 cm/s.
Special considerations	1.3	1.3	/4			Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
TOTAL	11.0	11.0	/11	*		N.B.: If the total is < 0 or > 11 , the score assigned to special considerations
	1			**		must be changed in order to respect the limits for the corresponding section (i.e
B) SURFACE WATER				÷-		between 0 and 11).
Observed or mesared contamination of water efficient ductarized from siz		-108	SAI .	ž.		
Surface containment	5	5	/5		0	No surface containment.
Distance to perennial surface water	0.5	0.5	ß		0	Ottawa River 3 km east.
Topography	0	0	/1,5		0	Flat, contaminants are at or below ground level.
Run-off potential (see nomograph)	0.31	0.31	<u></u>	×.	0	
Flood potential	0.1	0.1	10,5	× -	0.1	No flood in the last 50 years.
Special considerations TOTAL	2.0	2.0	14	× -		Solubility: 2
IUIAL	7.9	7.9	/11	8		N.B.: If the total is < 0 or > 11 , the score assigned to special consideration:
				2		must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C) DIRECT CONTACT			ŝ	1 1		CONTROL V. WINE A.L.
 Kaowo contamination of media off-site 		~300	3318			
Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	8		Possible but unknown.
Accessibility of site (ability to contact materials)	2	2	-/4	<u> </u>	0	Access controled, contaminants not totally covered.
Hazardous soil gas migration Special considerations	-1.3	-1.3	12 /4	×	0	No putrescible contaminants.
TOTAL	3.2	3.2	11	<u>-</u>	2.5	Vapor pressure: -2, powderiness: $2/3$ N.B.: If the total is < 0 or > 11, the score assigned to special considerations
TOTAL	3.2	5.2	- *** B	*		must be changed in order to respect the limits for the corresponding section (i.e.
				× 1		between 0 and 11)
RECEPTORS				**		
A) HUMANS AND ANIMALS				<u></u>		
Known adverse impact on hype things as a result of the centeminated sur-	4	-190	11# 70			
Known impact on drinking water supply	4		<u></u>	<u> </u>	ų.	W
Proximity to drinking water supply "Availability" of alternate drinking water supply	1.5	3	/6 /3	ä-	1.5	Water plant southwest of the site.
Known impact on used water remarks	d dia dia dia dia dia dia dia dia dia di	1.5	-	8 (x) (x)		Unknown but possible.
Proximity to water resources used for activities	0.5	0.5	2	*	0	Ottawa River 3 km west.
Use of water resources	2	2	2	×	ŏ	Boating, fishing and swimming.
Known contamination of land most by humans		+100	. 6			R. 2
Use of land at and surrounding site	0	0	/5	*	0	Military exercises.
Special considerations	0.0	0.0	/5	ä		People affected lower than 250, military people.
TOTAL	7.0	7.0	/18	*		N.B.: If the total is < 0 or > 18 , the score assigned to special consideration:
				*		must be changed in order to respect the limits for the corresponding section (i.e
B) ENVIRONMENT	+			÷		between 0 and 18).
Rawn advorate unpatt on somblive coveronment as a ment of the contaminator of	.	-100	A6	Í.		
Distance from site to nearest sensitive environment	2	2	/10	Ĩ	0	Some marshes along Tucker Creek and Jorgens Lake.
Distance to important or susceptible groundwater resource(s)	2	2	/6			Jorgens Lake: recharge area.
Special considerations	0	0	15			n
TOTAL	4	4	/16	8		N.B.: If the total is < 0 or > 16 , the score assigned to special considerations
	1			8		must be changed in order to respect the limits for the corresponding section (i.e
	.1		10	<u>.</u>		hetween () and (6)
Total score (potential impacts)	47.1	+ 2.0	/100 +	7.	4.1	
Total score (known impacts)		+ 2.0	/100 +		4.1	N.B. : If the uncertainty exceeds 15, we consider that there if
		<u> </u>		÷		N.D. : If the uncertainty exceeds 15, we consider that there is

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	Ň	Low	Not likely

 2.0
 7100
 +/4
 4.1

 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

 N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.



Appendix C

Facility/Site Description

Document site information as completely as possible:	
Site No.: RAGII Site Name: PETAWAWA GRENAT	DE RGE Province/Territory: ONTARIO
Custodian Dept.: DND Facility Name: CEB PETAWAWA	Site Operator/Manager: CFB PETAWAWA
Type of Site: <u>GRENADE</u> RANGE	* Site Owner:
Zone: UTM Coordinates: 3188000 5088300	EastingLatitude: deg min sec.NorthingLongitude: deg min sec.
Location:	Legal Land Description:
Address	Provincial Parcel No.:
Brief Description of Site:	
Site Land Use: Current: <u>MILITARY TRAINING</u> Propos	sed:DEM
Comments:	Summary of Site Classification Information:
	Completed Evaluation Form: $\underline{\times}$ Detailed $\underline{\times}$ Short
	Site Score: <u>49.1</u> Total \pm <u>4.1</u> Estimated Score
Contact Name: CHRIS HOGAN / SEAN MOYLES	Class: (1, 2, 3, N, or I) Risk: MEDIUM LOW Notes: TO MEDIUM
Position:	DESPITE ITS LOW MARK, A MORE PRECISE
Address:	STUDY INCLUDING SOIL AND WATER
City: PETAWAWA Prov. Terr.: ONT. Postal Code:	SAMPLING WOULD BE NECESSARY IN ORDER
Phone No.: Fax No.:	TO KNOW THE INFLUENCE OF THE MILITARY
Site Classified by above or MARC-ANDRÉ LAUIGNE /	TRAININGS . KARINE CHAMPAGNE
Degree of Familiarity with Site: Very familiar Moderately familiar Visited site: Yes No	<u> </u>
Position: <u>RESEARCH ASSISTANT</u> Phone No.: <u>(418)</u> 654 - Address: <u>ABO CHEMIN STE-FOY</u> , BUR B40, CP 7500 <u>City: QUEBEC</u> Prov.Terr.: QUEBEC Postal Code: C Site Identification: <u>1</u>	
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FACILITY/SITE DESCRIPTION

APPENDIX R

National Classification System Process Checklist

USER'S GUIDE REVIEWED

X

MINIMUM DATA REQUIREMENTS MET

- Description of site location
 - Type of contaminants or materials likely to be present at site (and/or description of historical activities) Approximate size of site and quantity of contaminants
- Approximate depth to water table
 - Geologic map or survey information (soil, overburden, and bedrock information)
 - Annual rainfall data (can be inferred from rainfall map of Canada)
- Surface cover information
 - Proximity to surface water
 - Topographic information
 - Flood potential of site
 - Proximity to drinking water supply Uses of adjacent water resources
 - Land use information (on-site and surrounding)
- FACILITY/SITE DESCRIPTION COMPLETED
- SITE CLASSIFICATION WORKSHEET COMPLETED

REFERENCES ATTACHED/CITED

EVALUATION FORM COMPLETED

___ Detailed Form

____X ___ Short Form

SCORE SHEET COMPLETED

SITE CLASSIFICATION

Class: ____1 __X _2 __X _3 ____N _

Score: <u>49.1</u> + <u>4.1</u> Total Estimated Score

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:

4 jalo - Jana Jakar Arak

SHORT EVALUATION FORMA

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

			No	Yes	Reference <u>Attached</u>
	1	 a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? 	R		
-	I	Contaminant(s) Characteristics			
		2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?			
	•	 3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha distributed or placed in such a manner as to have the potential to cause significant off-site contamination 			
		Pathways			
		4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)			
	111	Receptors			
		 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); caused vegetative stress or other known environmental impairment? 		•	: .
	(A Yes a	answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	Ø		
	······································	If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. C	Check bo	ox if Class 1 rat	ing. 🗆

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF BVALUATION	SOURCES OF
Contaminant(s) Characteristics	 A. Degree of hazard High concern contaminants - high concentration High concern contaminants - low concentration Medium concern contaminants - high concentration Medium concern contaminants - low concentration Low concern contaminants 	14 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wartes may contain hazardous materials	 concentrations: High Concern Contaminants Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) Institutional waste (lab, schools hospitals, etc.) 	Dangerous Goods Act: Provincial, Territorial Hazardous Wastes lists; regulations under Canadian
			(6.g., batteries, medical wastes, paints, etc).		Sites; etc.
				 Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) Other nearly inert wastes (e.g., foundry sands) Hish Concentration of Contaminants contaminant concentrations in soli, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/ industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm) 	
	 B. Contaminant Quantity (arca/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	10 6 Ø	the quantity of wastes at abandoned	Note: Any number of drums abandoned or disposed is	
	 C. Physical State of Contaminants Liquid/gas Sludge Solid 	97 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SCORE

SITE CLASSIFICATION WORKSHEET (Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

• Degree of Hazard Α.

•	na sense a su construir e la construir e la construir de la construir e la construir e la construir e la constr L'arte de la construir e	--	---
oring Rationale & Information Source:			
ontaminant Quantity			
lume of contaminated zone:	NO RECORD DE UNEXPLODED SHELLS AND OPDNANCES FIRED BEFO AREA < 2 ha		
······································	WILLIME OF CONTAMINANTS ESTIMATED BY AREA OF THE SITE		
oring Rationale & Information Source:			
ysical State of Contaminant			
Primarily sludges			
Primarity solids	TNT, RDK, HMX. etc		
oring Rationale & Information Source:			
ecial Considerations			
cument any other important			
	lume of contaminated zone: oring Rationale & Information Source: hysical State of Contaminant pes the site contain: Predominantly liquids/gases Primarily sludges		

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALB	METHOD OF EVALUATION	SOURCES OF
il. Exposure Pathways	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.		Canadian Wate Quality Guidelines Provincial/ Territorial Wate Quality Guidelines or policies Guidelines for Canadian Drinking Water Quality.
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	a 2 0	potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminanus. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over aquifer(s) of concern 3 m or less 3 to 10 m >10 m 	(j) - 0	(e.g., clay, shale, etc.) between contaminants and any squifers of concern will affect the attenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	maps, well records government
	 (c) Hydraulic conductivity of the confining layer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	0.5	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and othe

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II. EXPOSURE PATHWAYS

SCORE

A. <u>Groundwater</u>

2.a

2.b

1. • Known Groundwater Contamination

Identify water-bearing zones used for water supply:

Scoring Rationale & Information Source:____

2.c • Hydraulic Conductivity of the Confining Layer

estimate hydraulic conductivity NO CONFINING LAYER

CONFINING LAVER

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Scoring Rationale & Information Source:____

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	. RATIONALE 🗶	METHOD OF EVALUATION	SOURCES OF
			· · · · · ·		
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfail • >1000 mm • 600 mm • 400 mm • 200 mm	1 0.6 0.4 0.2	quantity of leachate produced.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	 (e) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻² 10⁻⁴ cm/sec <10⁻⁴ cm/sec 	3 1.5 0.5	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :	I			
1 0	Solubility (S) :Iow(S/standard = 101)medium(S/standard = 102)high(S/standard = 103)	-4/3*	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	Retardation factor (R) :• important delay $(R / R_Q = 10^2)$ or $(K_d = 12,51)$ • delayed $(R / R_Q = 10^1)$ or $(K_d = 1,14)$ • little or no delay $(R / R_Q = 10^0)$ or $(K_d = 0)$	-4/3* 00 4/3*		ing $n = 0.33$ et $\rho_b = 1.75$ g/cm ³ ; if the studied soil is neither recalculated because n et ρ_b change. ($R_{\rm CI} \approx 1$)	
	 Biodegradation (μ): observed non observed non biodegradable 	-4/3* © 4/3*			· ·
	Other special considerations	(-4 à 4)	weighting of the special considera	rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

R.

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II. EXPOSURE PATHWAYS (cont'd)

- A. <u>Groundwater</u> (cont'd)
- 2.d Annual Rainfall

Document rainfall data:

BETWEEN 1950 AND 1981 : 700 m

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of

MARIES FROM 10-4 cm/s to 10-1 cm/s

Scoring Rationale & Information Source:_

• Special Considerations

3.

5

relevant aquifer(s):

Document any other important ground water issues not addressed above:

130/2 12) =2 4/3 (.S/STILLIDURN SOUDRILITY =>0 RE tion BIODEGRADATION (NOT OBSERVED = 20

Scoring Rationale & Information Source:_

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0.7

4/3

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF BVALUATION	SOURCES OF
		r	·····		<u> </u>
ll. Exposure Pathways (cont'd)	 B. Surface Water Observed or measured contamination of water/effluent discharged from site Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	jurisdictions is not to contaminate	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	Water Qualit Guidelines; Relevant provincis
	 2. Potential for surface water contamination a) Surface Containment No containment Partial containment Full containment 	(5) 3 0.5	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspectio reports, air photos etc.
•	 b) Distance to peremial surface water 0 to <100 m 100 to 300 m >300 m 	3 2 5.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.		
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.5 1.2 0.8 Ø	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

II. E	XPOSURE PATHWAYS (cont'd)		SCORE
В.	Surface Water	ж. Алагана (1997)	
1.	• Observed or Measured Contamin	ation	
	Document information on surface water contamination:	40 RECORD	······································
	Scoring Rationale & Information Sourc	e:	
2.a	• Surface Containment		
	Review.and document engineered or natural systems protecting surface water:	NO SURFACE CONTAINHENT	
•	Scoring Rationale & Information Source	e:	5
2.b	• Distance to Perennial Surface Wa	ater	
	Estimate distance from site to nearest stream or other water body:	OTTAWA RIVER 3 km WEST JORGENS LAKE 2 Km SOUTH	
	Scoring Rationale & Information Source	е:	05
2.c	 Topography 		
	Document terrain conditions:	FLAT. TERRAIN	
	Document position of contaminants (are they above ground or buried?)	AT OR BELOW GROUND LEVEL	
	Scoring Rationale & Information Source	:e:	0
Site T	lentification:		

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE *	METHOD OF EVALUATION	SOURCES OF
_			a		
II. Exposure Pathways (cont'd)	 B. 2. d) Run-off potential (see nomograph, end of Appendix D) >1000 mm rainfall and low permeability surface material 500 to 1000 mm rainfall and moderately permeable surface material <500 mm rainfall and highly permeable surface material 	1 0.6 (31) 0.2	into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	of Canada (Fisherie: and Environmen Canada, 1978).
	 e) Flood potential 1 in 2 years 1 in 10 years 1 in 50 years 	0.5 0.60 75 0.1	and concentrations of contaminants to be released to surface water	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	plain guidelines, maps: provincial
•	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	 3. Special considerations (detailed) : Solubility (S) : low (S/standard = 10¹) medium (S/standard = 10²) high (S/standard = 10³) 	-2* 0 2*	* The weighting suggested is valid if there are no points affected to other special considerations. N.B.: if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		
	 Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-2* 0 2* (-4 à 4)			

II. EXPOSURE PATHWAYS (cont'd)

B. Surface Water (cont'd)

2.d • Run-off Potential

 Document geological and rainfall
 ANUUAL RAIDFALLS: 700 mm

 conditions:
 MUDRADLIC
 CONDUCTIVITY: FROM 10⁻⁴ cm/s 70 10⁻⁴ cm/s

P. 35

Scoring Rationale & Information Source: <u>SEE</u>

2.e • Flood Potential

Estimate flood frequency of nearby <u>NO FLOOD IN THE LAST 50 VEARS</u> water courses or water bodies:

Scoring Rationale & Information Source:

• Special Considerations

Document any other important surface water conditions not addressed above:

= 130/0 S/ STANDARD ミン SOLUBILITU =>.o BIODEGRADATION RSERVED

Scoring Rationale & Information Source:

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SCORE

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
		•		•	
I. Exposure Pathways (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soll, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). Strongly suspected contamination of media off-site No contamination of media off-site 	11 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	 Potential for direct human and/or animal contact Airborne Emissions (gases, vapours, dust, etc.) Known or suspected airborne emissions impacting on neighbouring properties Airborne emissions generally restricted to site No airborne emissions 	5 3 0	there is a great hazard for direct	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Sita inspection reports, etc.
	 b) Accessibility of Site (ability to contact materials) Limited or no barriers to prevent site access; contaminants not covered Moderate accessibility or intervening barriers; contaminants are covered Controlled access or remote location and contaminants are covered 	4 3 (b) 0	site and to contaminants, the greater the chance for	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low-rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 (0)	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
Ì	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
I	3. Special considerations (detailed) :				
	Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa	-2/3* -2/3* 2/3* 2*	(N.B. : vapor pressure limits are valid a* The weighting suggested is valid if t	at a 20°C temperature)	на на селоти По селоти По селоти
Powderiness : • < 0,1 % • 0,1 à 1 % • /1 à 10 % • > 10 %		-2* -2/3* -2/3* 2* (-4 à 4)	weighting of the special considera	45 μm) tant elements have been neglected, he can change the internal tions and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

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II. E C.	KPOSURE PATHWAYS (cont'd) Direct_Contact		SCORE
1.	• Known Contamination Off-site:		
	Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.:	NO RECORD	
	Scoring Rationale & Information Source	• • • • • • • • • • • • • • • • • • •	-
2. a	• Airborne Emissions		
	Document incidents or complaints about fumes, gases, dust, odours, etc.:	UNKNOWN BUT POSSIBLÉ.	
	Scoring Rationale & Information Source	•	2.5
2.b	• Accessibility of Site		
	Review and document avenues of site access by humans and animals:	ACESS LIMITED, CONTAMINANTS NOT TOTALLY CON	<u>ERED</u> .
	Scoring Rationale & Information Source	•	<u>ر</u>
2.c	• Hazardous Soil Gas Migration		
	Review potential for hazardous soil gas production and migration from site:	NO PUTRESCIBLE CONTAMINANTS	
	Scoring Rationale & Information Source	•	6
3.	• Special Considerations Document any other conditions whereby hymonylanimals could contact contamin	<u>VAROR PRESSURE: 1,49 × 10- ⁹ a Cro AT 30 °C => 2</u> ation: <u>POWDERINESS: ²/3 -> ARRITRARY VALUE</u>	

Site Identification:

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALE	METHOD OF BYALUATION	SOURCES OF
·			•		
III. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site Known adverse effect on humans or domestic animals Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination. from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 Potential for impact on humans or animals Drinking water supply Known impact on drinking water supply Known impact on drinking water supply Drinking water supply is known to be adversely	9 7 0	Water used for drinking should be protected against contamination from any site.		Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	 ii) Potential for impact on drinking water supply Proximity to drinking water supply 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/ agricultural purposes should also be included as it may be used for human consumption.	and measure the distance to the nearest resident or drinking	ם ה, שבו.
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of atternate drinking water supply or distance to alternate source.	

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III. RECEPTORS

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SCORE

A. 👘	Human_	and A	nimal	Uses

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1. • Known Adverse Impact on Humans or Domestic Animals

	Record known or suspected	UN RECORD	-
	adverse effects on humans or domestic animals:		••••
			-
	Scoring Rationale & Information Sour	ce:	
2.a.i •	Known Contamination of Drinki	ng Water Supply	
	Record known or suspected incidents of contamination of drinking water:	UD RECORD	1995
			- -
	Scoring Rationale & Information Sour	ce:	-
2.a.ii.°•	Distance to Nearest Drinking W	ater Supply(s)	
•	Identify nearest drinking water well and measure distance to site:	WATER PLANT INTAKE 4 Km EAST	
	Scoring Rationale & Information Source	ce:	3
2.a.ii.°°•	Availability of Alternate Drinkin	g Water Supply	•
·	Document availabiilty of alternate sources of drinking water and ease of implementation:	UNKDOWN	-
	Scoring Rationale & Information Sour		1.5
Site Iden	tification:		

1.1

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE *	METHOD OF EVALUATION	SOURCES OF INFORMATION
		· ·			· · · · · · · · · · · · · · · · · · ·
III. Receptors (contd)	 A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated 		(groundwater or surface water)	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other- relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	Water Quality Guidelines; provincial/
	 ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	2 1.5 (1.3)	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	 Use of water resources - if multiple uses, give highest score (use following table) <u>Prequency of Use</u> <u>Water Use</u> <u>Prequent</u> Occasional Recreational (swimming, fishing) 1 Commercial food preparation 1.5 0.8 	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.		
	Commercial food preparation1.50.6Livestock watering10.5Irrigation10.5Other domestic or food chain uses0.50.3Not currently used but likely future use0.50.2				

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III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

	Record information on water resource that is or is potentially	NO RECORD			<u> </u>		
	affected by site contamination:			•			
	Scoring Rationale & Information Source:						
2.b.ii.°•	Proximity of Water Resources to	Site					
	Locate and measure nearest water resource areas to site:	OTTAWA RIVER	3 Km EAST	• <u>••••</u> •••••••••••••••••••••••••••••••			
	Scoring Rationale & Information Source.			••	· · · · · · · · · · · · · · · · · · ·	0.5	
2.b.ii.°°	• Water Uses						
	Record uses of nearby water resources:	SWIMMING FISHING BOATING	: 				
	Scoring Rationale & Information Source:			•		2	Ì

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CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF
					· · ·
III. Receptors (cont'd)	 A. 2. c) Direct human exposure Known contamination of land used by humans Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values Known contamination of land used for commercial or industrial purposes above C/I EQC values Land is known not to be contaminated 	5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Bvaluate levels of soll contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; CI = commercial/industrial level). If soll is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadi Environmental Quality Criteria Contaminated Sit
	 ii) Potential human exposure through land use Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) 0-300m 300m - 1km 1 - 5km Residential 5 4.5 3 Agricultural 5 4.5 3 Agricultural 5 4 2.5 Parkland/School 4 3 1.5 Commercial/Industrial 3 1 0.5 	0.5 - 5	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :	1			
	People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000	(D) 1,5* 3*	* The weighting suggested is valid in	f there are no points affected to other special considerations.	
· · ·	Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	(-5 à 5)	weighting of the special consider	ortant elements have been neglected, he can change the internal rations and assign a score to the section "Other special sount the new weighting. However, the total of points allowed	

III. RECEPTORS (cont'd)

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SCORE

- Human and Animal Uses (cont'd) Α.
- 2.c.i Known Contamination of Land Used by Humans

	Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site:	<u>NO_RECORO</u>	
	Scoring Rationale & Information Source	•	
2.c.ii •	Land Use at and Adjacent to the Site		
	Document land uses (current and proposed) for up to 5 km from the site:	MILITARY EXERCISES	
	<u> </u>		
	<u> </u>		
3. •	Scoring Rationale & Information Source Special Considerations	•	6
	Document any other important	PEOPLE AFFECTED 4250 =>0	
	human or animal use information, including details of air contamination if known:	SITE USED BY MILITARY PEOPLE	
	Scoring Rationale & Information Source)6 *	0
Site Ider	tification:		•••

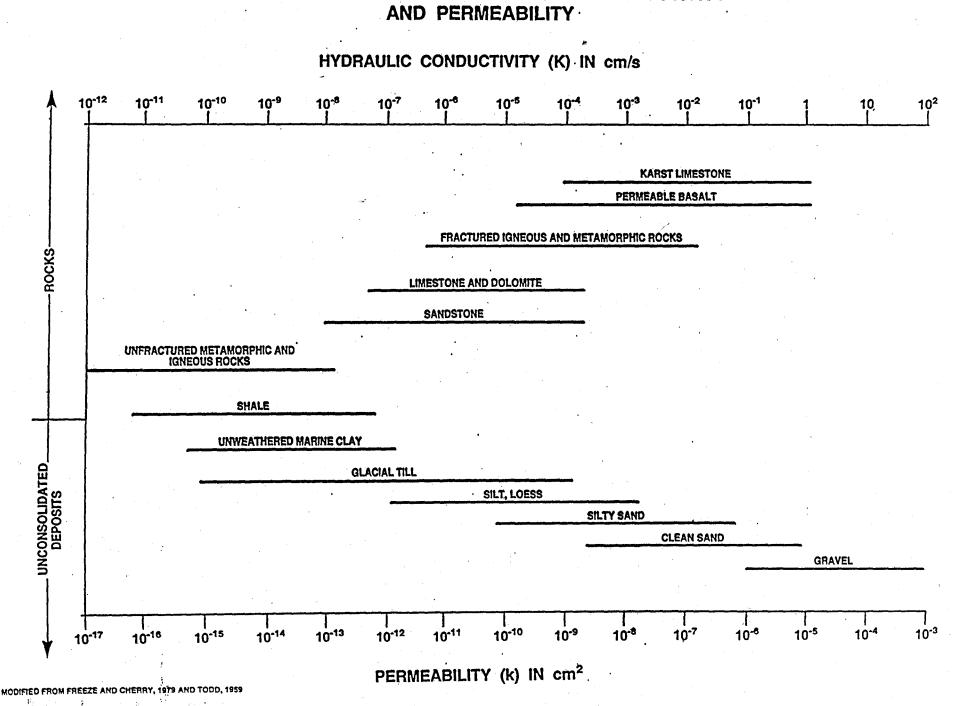
CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	 B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Evidence of stress on squatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	, 16 14 12			
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	10 5 0.5	approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.		/territorial and federal maps of sensitive environments.
	 b) Groundwater - distance to important or susceptible groundwater resource(s) 0 to <500 m 500 m to <2 km 2 to <5 km 5 to 10 km 	6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

III. RECEPTORS (cont'd)

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SCORE

	Known Adverse Impact(s) on S			
	Record known impact(s) on any sensitive biological environment at and/or around the site:	NO RECORD		
	Scoring Rationale & Information Sout	rce:		
٠	• Distance from Site to Nearest Sensitive Environment			
	Document location, distance, type and details of any nearby sensitive environments or habitats:	DO RECORD		
	Scoring Rationale & Information Sour	rce:		
•	Groundwater			
٠	•			
	Measure distance to major recharge or discharge area:	SOME MARSHES ABOUND JORGENS LAKE		
	Scoring Rationale & Information Sour	ce:		
٠	Special Considerations			
	Document any other important impacts on the environment not addressed above	S JORDEN LAKES : DISCHARGE AREA . SAKIN SOUTH		
)Ve:		
	۵۰ - ۲۰۰۹ ۲۹ - ۲۰۰۹ - ۲۰۰۹ ۲۹ - ۲۰۰۹ ۲۹ - ۲۰۰۹ ۲۰۰۹			
	Scoring Rationale & Information Sou			



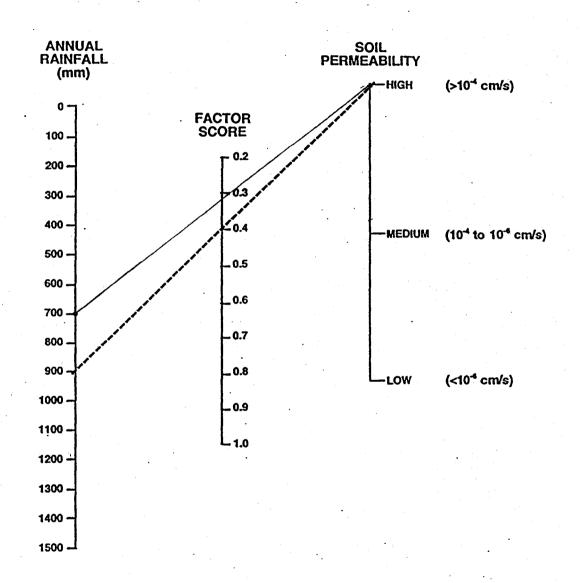
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RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY

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RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	т	Vapour pressure	·· †·	Degradation	Degra	dation constan	ts (mu)	Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay			1				1	1
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	1
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20					I		· ·		1	0,3	0,024	(2)
		150	25	9,49E-09	25							l				[(3)
	•	130	20	4,61E-09	20												(3)
		·		1,66E-09	20				L	L	L					L	(4)
							3,20E-03	1,40E-01	8,30E-02	1						L	(5)
		· · ·		Į						Ottawa sand: 1,	5	· · ·				L	(6)
			<u></u>	ļ		1				Silt: 4,5							(6)
										Clay: 10							(6)
				<u> </u>		1				[0,12*				(7)
2,4 dinitrotoluene	2,4.DNT	280	25	2,86E-07	25	Aerobic and anaerobic		· .			Possibly carconogenous						(1)
		270	22	2,89E-07	. 20				l				5	5			(2)
				3,17E-08	25		-			·					· · · ·		(3)
		270	20	1,61E-08	-20												(3)
									· · ·				1,10E-04		,	· · · ·	(7)
2,6 dinitrotojuene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic	•			·							(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthytene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1			÷		(1)
		42	20	5,53E-12	20	1		· ·		1		1		2	0.3	0,00024	(2)
or hexahydro - 1,3,5 - rinitro - 1,3,5 - triazine,		50	20	2,56E-12	20						· .						(3)
or .							0	6.50E-03	1.40E-02								
				<u> </u>			<u> </u>	0,000-03	1,405-02	0,1 & 13,26						+	(5)
				<u> </u>						0,1 4 19,20				<u> </u>		<u> </u>	<u>↓ · · · · · · · · · · · · · · · · · · ·</u>
cycio - 1,3,5,7 - etramethylene - 2,4,6,8 - tetranitramine	нмх	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
or octahydro - 1,3,5,7 -		5	- 25	4,34E-17	20				ľ								(2)
tetranitro - 1,3,5,7 -										0,2 à 4,2							(6)
tetrazocine)							0	3,60E-03	3,20E-02								(5)

McGrath, 1995
 Thiboutot et al, 1998
 Pheelan and Webb, 1997
 Hayes, 1992
 Myers et al, 1996
 Townsend et al, 1996
 http://www.mef.gouv.qc.ca/ir/environn/criteres_eau

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- E Davis - Age Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

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Site classification computerised worksheet

Impact Areas 7 and 8 Date: 06-27-2000 User (s):	Marc-Andr	ré Lavigne				
		er.		*		
Sections	5 7	ai ai			,	Comments
Sector Marka	a cuti fo	tnown an ootential mneete			•	Communa
		ĔĔ				
CONTAMINANT(S) CHARACTERISTICS DEGREE OF HAZARD	11	11	/14	***	0	Energetic materials found in ordnances.
CONTAMINANT QUANTITY	10	10	/10		ō	Area $7 = 26,2074$ km ² and Area $8 = 30,1715$ km ² , no register before 1995
PHYSICAL STATE OF CONTAMINANTS	3	3	19		0	TNT, RDX, HMX, etc
Special considerations TOTAL	0 24	24	/6 /33		0.	N.B.: If the total is < 0 or > 33 , the score assigned to special consideration
	-					must be changed in order to respect the limits for the corresponding section (
EXPOSURE PATHWAYS				***		hetuveen () and 33)
GROUNDWATER						
Known contamination at or beyond property boundary		-100	<u></u>	繎		
Engineered subsurface containment Thickness of confining layer over aquifer(s) of concern	4	4	/4	*	0	No engineered system. No confining layer.
Hydraulic conductivity of the confining layer	1.5	1.5	11,5	*	Ō	No confining layer.
Annual rainfall	0.7	0.7	/	22	0	700 mm between 1950 and 1981.
Hydraulic conductivity of the aquifer(s) of concern Special considerations	3	3	<u></u> 	*	0	From 10E-02 cm/s to 10E02 cm/s.
TOTAL	11.0	11.0	/11	*	0.0	Solubility: $4/3$, Retardation Factor: 0, Biodegradation: not observed N.B.: If the total is < 0 or > 11, the score assigned to special consideration
	1		~~~	*	0.0	must be changed in order to respect the limits for the corresponding section (
	Į					between 0 and 11).
SURFACE WATER Observed or mesared contamination of waterellivest discharged from site		-100		***		
Surface containment	4	4	/5		0	Trees surrounding the major impact zones.
Distance to perennial surface water	3	3	ß		0	Numerous lakes, rivers and creeks within the areas
Topography Pure of Contraction (one name and the second s	1.2 0.31	0.31	/1,5 /1	*	0	Small mountains, contaminants at or below ground level.
Run-off potential (see nomograph) Flood potential	0.25	0.31	10,5	*		No major flood in tha last 50 years but local flood are possible.
Special considerations	2.0	2.0	/4	**		Solubility: 2
TOTAL	10.8	10.8	/11	*	0.3	N.B.: If the total is < 0 or > 11 , the score assigned to special consideration
	Í					must be changed in order to respect the limits for the corresponding section (i between 0 and 11).
DIRECT CONTACT						
K. KNOWO contamination of media off-site		-300	AL.	88		
Airborne emissions (gases, vapour, dust, etc.) Accessibility of site (ability to contact materials)	2.5	2.5	/5 /4	.	2.5	Possible but unknown. Moderate access by Petawawa River, contaminants not covered.
Hazardous soil gas migration	6	0	12		0	No putrescible contaminants.
Special considerations ·	-1.3	-1.3	/4			Vapor pressure: -2, powderiness: 2/3
TOTAL	4.2	4.2	/11			N.B.: If the total is < 0 or > 11 , the score assigned to special consideration
	(1			must be changed in order to respect the limits for the corresponding section between () and (1)
BECEPTORS				**		
HUMANS AND ANIMALS				4		
Ranny advance impact on living things as a result of the contaminated atte Known impact on drieding water supply		+160 186	/15 /5			
Proximity to drinking water supply	3	3	/6		0	Some cabins beside Barron River.
"Availability" of alternate drinking water supply	1.5	1.5	/3		1.5	Other water supply available (lakes, rivers, etc), but quality not known.
Rational impact on used water response	2	<u>+100</u> 2	//////////////////////////////////////			Barron River, Petawawa River and Montgomery Lake.
Proximity to water resources used for activities Use of water resources	2	2	12	**	ŏ	Fishing, swimming
Known contempation of land need by humans		+108	/5			
Use of land at and surrounding site	3	3		×	0	Military exercises, bivouac area (west).
Special considerations TOTAL	0.0	0.0	/5		1.5	People affected lower than 250, military people. N.B.: If the total is < 0 or > 18 , the score assigned to special considerat
IUIAL	11.5	11.5	/18		1.5	must be changed in order to respect the limits for the corresponding section
						between 0 and 18).
ENVIRONMENT			A6			
Reput adverse impact on sonsidive environment as a result of the postaminated sub	10	10	/10		0	Some marshes within the area 8.
Distance from site to pearest sensitive environment	6	6	16			Petawawa River: discharge zone, outcrops and mountains: recharge zones.
Distance from site to nearest sensitive environment Distance to important or susceptible groundwater resource(s)			/5	88 F		1
Distance to important or susceptible groundwater resource(s) Special considerations	0	0				
Distance to important or susceptible groundwater resource(s)		16	/16			
Distance to important or susceptible groundwater resource(s) Special considerations	0					
Distance to important or susceptible groundwater resource(s) Special considerations	0					N.B.: If the total is < 0 or > 16 , the score assigned to special consideration must be changed in order to respect the limits for the corresponding section (between 0 and 16).

Risk potential High Medium Medium low Low Action required Yes Likely May be Not likely Score 70-100 50-69 38-49 <=37 Class ł 3 N

 1.0
 10
 174
 4.3

 1.0
 100
 142
 4.3

 N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

 N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

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Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Site No.:	•	•	Province [Territo	TY: ONTARIO
Custodian Dept.:0	C Facility Name: CFB PE	TAWAWA	Site Operator/Ma	anager: <u>CFB PETAWA</u>
Type of Site:MPAC	T_AREA	¢	Site Owner:	DND
Zone:		Easting		deg min deg min
Location:		Legal Land L	Description:	
Address	· · · · · · · · · · · · · · · · · · ·	Provincial Po	arcel No.:	
Brief Description of Site:				·
			Le.	
Site Land Use: Cur	rent: MILITARY TRAINING	Proposed:	IDEM	
Comments:		Summary of	Site Classification I	information:
		Completed E	valuation Form:	\times Detailed \times Sh
		Site Score:	<u>77.5</u> Total ±	<u>4.3</u> Estimated Score
Contact Name: <u>SEAN</u>	NOYLES / CHRIS HOGAN	Class: (1, 2, Notes:	3, N, or I)	Risk: <u>HigH</u>
Position:				
Address:				
City: PETAWAWA Pro	v.Terr.: ONT. Postal Code:		· ·	······································
Phone No.:	Fax No.:			
Site Classified by above	OF MARC-ANDRE LAVIGNE	KARINE CHAMPAGN	J.	
Degree of Familiarity with Visited site: $\underline{\qquad} \times \underline{\qquad} Yes$	Site: Very familiar Moderate	ly familiar Indir	ectly familiar	Unfamiliar
Position: <u>RESEARCH</u> A Address: <u>880 CHEMIA</u> <u>City: OUEBEC</u>	STE-FON, BUR 840 CP 7500		Date of Complete	d Classification:

APPENDIX B

National Classification System Process Checklist

USER'S GUIDE REVIEWED ✓ _____ MINIMUM DATA REQUIREMENTS MET

- Description of site location Type of contaminants or materials likely to be present at site (and/or description of historical activities) Approximate size of site and quantity of contaminants Approximate depth to water table Geologic map or survey information (soil, overburden, and bedrock information) Annual rainfall data (can be inferred from rainfall map of Canada) Surface cover information Proximity to surface water Topographic information Flood potential of site Proximity to drinking water supply Uses of adjacent water resources ò Land use information (on-site and surrounding) X
- **FACILITY/SITE DESCRIPTION COMPLETED**

Detailed Form

- SITE CLASSIFICATION WORKSHEET COMPLETED
- KEFERENCES ATTACHED/CITED
- ____ EVALUATION FORM COMPLETED

 \rightarrow

____ Short Form

SCORE SHEET COMPLETED

SITE CLASSIFICATION

Class: $X_1 = 2 = 3 = N$ Score: 77.5 + 4.3Total Estimated Score

SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification:

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SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached. To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Y	les	Reference Attached
1	 a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide) b) Is the site a fire or explosion hazard as it currently exists? 	2	(□ → Class 1 □ → Class 1	
]	Contaminant(s) Characteristics				
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?			8	
•	 3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: liquid (as disposed/spilled) in quantity >1,000 m³ in an area of contamination >10 ha distributed or placed in such a manner as to have the potential to cause significant off-site contamination 		S	2	
11	Pathways		······································		
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	۲ کی	E	ב	a,
111	Receptors				
•	 5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); 	•	•	· ·	, J
(A Yes	nswer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	Ø	C	ן	

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Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF BVALUATION	SOURCES OF
Contaminant(s) Characteristics	 A. Degree of hazard High concern contaminants - high concentration High concern contaminants - low concentration Medium concern contaminants - low concentration Low concern contaminants 		In determining the degree of hazard	 concentrations: <u>High Concern Contaminants</u> Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations Materials identified by Province as hazardous waste (perticides, herbicides, paint sludge, acid and alkaline' solutions, solvents, etc.) Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) Institutional waste (lab, schools hospitals, etc.) Pathological wartes and animal carcasses 	Transport Dangerous Goo Act; Provincia Territorial Hazardous Wast lists; regulatio under Canadia Brvironmental Protection Ac Canadian Environmental Quality Criteria f Contaminated Sites; etc.
	 B. Contaminant Quantity (area/volume of site contamination) >10 ha, or >1000 m³, or drums of liquid 2 to 10 ha, or 100 to 1000 m³ <2 ha, or <100 m³ 	@ 8 2	the quantity of wastes at abandoned	Note: Any number of drums abandoned or disposed is considered a high concern.	
	 C. Physical State of Contaminants Liquid/gas Sludge Solid 	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case- by-case basis.		
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	·

SCORE

SITE CLASSIFICALON VIJRESAEE'. (Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

::

• Degree of Hazard Α.

	List possible contaminants and estimated concentrations:	-> ENERGETIC HATERIALS	
•	Scoring Rationale & Information Sourc	e:	Ę
•	Contaminant Quantity		
	Estimated or measured areal volume of contaminated zone:	NO RECORD. OF UNEXPLODED SHELLS OR ORDANCES BEFORE 1995 AREA 7 : 26, 2074 KM ² AREA 8: 30.1715 KM ² NOLUME DE CONTAMIMANTS ESTIMATED BY THE AREA OF THE RANGE	-
	Scoring Rationale & Information Sourc		- [
•	Physical State of Contaminant		
	Does the site contain: a) Predominantly liquids/gases b) Primarily sludges		-
	c) Primarily solids	TNT, ROX . HMY	- - г
	Scoring Rationale & Information Sourc	e:	Ļ
•	Special Considerations		05
•	Document any other important contaminant characteristics not addressed above:		
			- - -

CATEGORY	BVALUATION FACTOR	SCORING GUIDELINE	RATIONALB	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	 A. Groundwater 1. Known contamination at or beyond property boundary Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater Between 1 and 2x CDWG or probable contact with groundwater Meets Canadian Drinking Water Guidelines 	11 6 0	The logislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Quality Guidelines; Provincial/ Territorial Water
	 Potential for groundwater contamination (a) Engineered subsurface containment No containment Partial containment Full containment 	@ 2 0	potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	 (b) Thickness of confining layer over squifer(s) of concern 3 m or less 3 to 10 m >10 m 	(3) 0	(e.g., clay, shale, etc.) between contaminants and any squifers of concern will affect the attenuation of contaminants and hence the quantity and quality of	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	maps, well records,
	 (c) Hydraulic conductivity of the confining fayer >10⁻⁴ cm/sec 10⁻⁴ to 10⁻⁶ cm/sec <10⁻⁶ cm/sec 	(5) 1 0.5	migrate through the confining layer will affect attenuation and the	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	1979, and other

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II. EXPOSURE PATHWAYS

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DEPOSITS AND DELTAID DEPOSITS

- Groundwater Α.
- Known Groundwater Contamination 1.

Document information on known groundwater contamination:

Scoring Rationale & Information Source:_

• Engineered Subsurface Containment 2.a

> Document engineered systems protecting groundwater:

Scoring Rationale & Information Source:

• Thickness of Confining Layer Over Aquifer(s) of Concern 2.b

> Document local geological BEOROCK (LIMESTONE, MINOR, DOLOSTONE, SHALE, SANDSTONE) EXPOSURES conditions: OVERLAIN AT SOME PLACE BY THIN AND DISCONTINUOUS DRIFT COVER

SUSTEM

ENGINEERED

Identify water-bearing zones GRAVEL, GRAVELLY SAND AND SAND, (GLAGOFLUVIAL ICE-CONTACT used for water supply: NO CONFINING LAVER

Scoring Rationale & Information Source:_

• Hydraulic Conductivity of the Confining Layer 2.c

Estimate hydraulic conductivity	NO COUFINING LAYER	
of any confining layer:		

Scoring Rationale & Information Source:

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	. RATIONALE *	METHOD OF EVALUATION	SOURCES OF
II. Exposure Pathways (cont'd)	A.2. (d) Annusi Rainfali • >1000 mm • 600 mm • 400 mm • 200 mm	1 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	 (e) Hydraulic conductivity of aquifer(s) of concern >10⁻² cm/sec 10⁻²_10⁻⁴ cm/sec <10⁻⁴ cm/sec 	(3) 1.5 0.5	conductivity can transport contaminants at high velocity over	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
1	 3. Special considerations (detailed): Solubility (S): low (S/standard = 10¹) medium (S/standard = 10²) high (S/standard = 10³) Retardation factor (R): important delay (R / R_Q = 10²) or (K_d = 12,51) delayed (R / R_Q = 10¹) or (K_d = 1,14) little or no delay (R / R_Q = 10⁰) or (K_d = 0) Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-4/3* (43* -4/3* (-4 à 4)	N.B. : the R calculation was done us sand, silt or clay, the R factor must be N.B. : if the user believes that impor weighting of the special consider	there are no points affected to other special considerations. ing $n = 0.33$ et $\rho_b = 1.75$ g/cm ³ ; if the studied soil is neither recalculated because n et ρ_b change. ($R_{CI} = 1$) retant elements have been neglected, he can change the internal ations and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

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II. EXPOSURE PATHWAYS (cont'd)

- A. <u>Groundwater</u> (cont'd)
- 2.d Annual Rainfall

Document rainfall data:

BETWEEN 1950 AND 1981 = 100 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of ______

HYDRADLIC CONDUCTIVITY RANGING FROM 10 - CM/S TO 10 - CM/S

Scoring Rationale & Information Source:

3. • Special Considerations

5

Document any other important ground water issues not addressed above:

SCLUBILITY (S/STANDARD = 130/0.12) => 4/3 RETARDATION FACTOR (50=1.5) => 0

BIODEGRADATION (NOT OBSERVED) =>0

Scoring Rationale & Information Source:_



3

4/3

0.7

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
11. Exposure	B. Surface Water		l	<u> </u>	[
Pathways (cont'd)	 Observed or measured contamination of water/effluent discharged from site Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x Known or strongly suspected to be between 1 - 2x CWQG Meets Canadian Water Quality Guidelines 	- 11 6 0	jurisdictions is not to contaminate	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Ouidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	Water Quality Guidelines;
	 Potential for surface water contamination Surface Containment No containment Partial containment Full containment 	5 3 0.5	containment will affect the	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	reports, air photos,
•	 b) Distance to perennial surface water 0 to <100 m 100 to 300 m >300 m 	(3) 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.		
	 c) Topography Contaminants above ground level and slope is steep Contaminants at or below ground level and slope is steep Contaminants above ground level and slope is flat Contaminants at or below ground level and slope is flat 	1.3 () 0.8 0	Water can run off (and therefora potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope =>50% • flat slope =<5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

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	Surface Wat	er		
ι.	• Observed	or Measured Contamin	ation	
	Document in water contar	nformation on surface nination:	UO RECORD	
	•	· · · · · · · · · · · · · · · · · · ·		·
	Scoring Rat	ionale & Information Sourc	re:	
.a	• Surface C	ontainment		
		document engineered or ems protecting surface	THERE ARE TREES SURROUNDING THE MAJOR IMPACT 200	<u>ES</u>
		ionale & Information Sourc	:e:	3
.b	• Distance t	o Perennial Surface Wa	ater	
	Estimate dis			
		stance from site to am or other water body:	<u>PETAWAWA RIVER BETWEEN BOTH AREAS, BIGGAR LAKE, SURV</u> (OLIN LAKE WITHIN AREAB, MILITARY LAKE, CENTRE LAKE AND LONG	7
	nearest stree		COLIN LAKE WITHIN AREA B, MILITARY LAKE, CENTRE LAKE AND LONG WITHIN AREA 7, THERE ARE ALSO MANY CREEKS AND MARSHES	7
.c	nearest stree	am or other water body: ionale & Information Sourc	COLIN LAKE WITHIN AREA B, MILITARY LAKE, CENTRE LAKE AND LONG WITHIN AREA 7, THERE ARE ALSO MANY CREEKS AND MARSHES	7
.c	nearest stree Scoring Rat • Topograp	am or other water body: ionale & Information Sourc	COLIN LAKE WITHIN AREA B, MILITARY LAKE, CENTRE LAKE AND LONG WITHIN AREA 7, THERE ARE ALSO MANY CREEKS AND MARSHES	
.C	nearest stree Scoring Rat • Topograp Document to Document p	am or other water body: ionale & Information Sourc hy errain conditions: position of contaminants	(OLIN LAKE WITHIN AREA B, MILITARY LAKE, CENTRE LAKE AND LONG WITHIN AREA 7, THERE ARE ALSO MANY CREEKS AND MARSHES CC:	
.c	nearest stree Scoring Rat • Topograp Document to Document p (are they at	am or other water body: ionale & Information Sourc hy errain conditions: position of contaminants bove ground or buried?)	(OLIN LAKE WITHIN AREA B, MILITARY LAKE, CENTRE LAKE AND LONG WITHIN AREA 7. THRRE ARE ALSO MANY CREEKS AND MARSHES CE:	
.c	nearest stree Scoring Rat • Topograp Document to Document p (are they at	am or other water body: ionale & Information Sourc hy errain conditions: position of contaminants bove ground or buried?)	COUN LAKE WITHIN AREA B. MILITARY LAKE, CENTRE LAKE AND LONG WITHIN AREA 7. THRRE ARE ALSO MANY CREEKS AND MARSHES CO:	7

CATEGORY	EVALUATION FACTOR	SCORING	RATIONALB +	METHOD OF EVALUATION	SOURCES OF	
			•			
II. Exposure Pathways (cont'd)	 B. 2. d) Run-off potential (see nomograph, end of Appendix D) >1000 mm rainfall and low permeability surface material 500 to 1000 mm rainfall and moderately permeable surface material <500 mm rainfall and highly permeable surface material 	1 (0.52) 0.6 0.2	into water bodies. Water run-off is a function of precipitation and the	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).	
	 e) Flood potential 1 in 2 years 1 in 10 years 1 in 50 years 	0.5 0.3©3 0.1		potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate	plain guidelines maps; provincial	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	· · ·	
	3. Special considerations (detailed) :					
•	Solubility (S) : Iow (S/standard = 10 ¹) medium (S/standard = 10 ²) high (S/standard = 10 ³)	-2* 0 2*	* The weighting suggested is valid if	there are no points affected to other special considerations.		
· · ·	 Biodegradation (μ): observed non observed non biodegradable Other special considerations 	-2* (-4 à 4)	weighting of the special consider	rtant elements have been neglected, he can change the internal ations and assign a score to the section "Other special bunt the new weighting. However, the total of points allowed		

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and and

II. EXPOSURE PATHWAYS (cont'd)

B. <u>Surface Water</u> (cont'd)

- 2.d Run-off Potential
 - Document geological and rainfall conditions:

AUDUAL RAINFALLS = 100 pm PERHEABILITY : 10-2 cm ? TO 10+2 cm?

Scoring Rationale & Information Source: SEE P. 35

2.e • Flood Potential

23

Estimate flood frequency of nearby to HATR FLOOD IN THE LAST 50 YEARS BUT RIVERS, LAKES AND CREEKS MIGHT water courses or water bodies: <u>LOCALLY INVODATE</u>

Scoring Rationale & Information Source:

3. • Special Considerations

Document any other important surface water conditions not addressed above:

SOLUBILITY (100/0.12) => 2 BIODSCRADHTION (NOT OBSERVED) => 0

Scoring Rationale & Information Source:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALB	METHOD OF EVALUATION	SOURCES OF INFORMATION
11. Exposure Pathways (cont'd)	 C. Direct Contact 1. Known contamination of media off-site Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). Strongly suspected contamination of media off-site No contamination of media off-site 	11 6 0	off-site is an important	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	 Potential for direct human and/or animal contact Airborne Emissions (gases, vapours, dust, etc.) Known or suspected airborne emissions impacting on neighbouring properties Airborne emissions generally restricted to site No airborne emissions 	\$ 3 0	there is a great hazard for direct	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	 b) Accessibility of Site (ability to contact materials) Limited or no barriers to prevent site access; contaminants not covered Moderate accessibility or intervening barriers; contaminants are covered Controlled access or remote location and contaminants are covered 	4 (3) 0	site and to contaminants, the greater the chance for	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	 c) Hazardous soil gas migration Contaminants are putrescible and soil permeability is high Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface No putrescible contaminants at the site. 	2 1 ·	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text) .	Technical judgment.	
	3. Special considerations (detailed) :				· · · · · · · · · · · · · · · · · · ·
	Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa		(N.B. : vapor pressure limits are valid a* The weighting suggested is valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid if the valid is valid if the valid if the valid if the valid is valid if the valid if the valid is valid if the valid is valid if the valid is valid if the valid if the valid if the valid is valid is valid if the valid is valid is valid if the valid is valid is valid is valid if the valid is va	at a 20°C temperature)	
	Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 %	-2* -2/3* 2* (-4 à 4)	weighting of the special considera	tant elements have been neglected, he can change the internal tions and assign a score to the section "Other special unt the new weighting. However, the total of points allowed	

II E	KPOSURE PATHWAYS (cont'd)		SCORE
Ĉ.	Direct Contact		
1.	• Known Contamination Off-site:		
	Document reports of off-site contamination due to contact with	MO RECORD	
	contaminated soil, dust, air, etc.:		
	Scoring Rationale & Information Source	*	
2.a	• Airborne Emissions		
	Document incidents or complaints about fumes, gases, dust, odours, etc.:	POSSIBLE BUT UNKNOWN	······
	Scoring Rationale & Information Source	• •	2.5 2
2.b	• Accessibility of Site		
•	Review and document avenues of site access by humans and animals:	HODERATE ACCESS BY PETAWAWA RIVER	
	Scoring Rationale & Information Source	k <u></u>	3
2.c	• Hazardous Soil Gas Migration		
	Review potential for hazardous soil gas production and migration from site:	NO PUTRESCIBLE CONTANINANTS	
	Scoring Rationale & Information Source	2. <u></u>	0
3.	• Special Considerations Document any other conditions whereb	Y VAPOR PRESSURE : 1,49 × 10 - 9 ATM AT 30 °C => -2	
	humans/animals could contact contamin	ation:_ POWDERINESS \$2/3 + ARBITRARY VALUE	
	Scoring Rationale & Information Source	**	- 3
Site Id	entification:		

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CATEGORY	EVALUATION FACTOR	SCORING	RATIONALB *	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	 A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site Known adverse effect on humans or domestic animals Strongly suspected adverse effect on humans or domestic animals 	18 15	Contamination, from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: 1) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	 Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply b) Trinking water supply is known to be adversely affected as a result of site contamination c) Known contamination of drinking water supply to levels above CDWG c) Strongly suspected contamination of drinking water supply c) Drinking water supply is known not to be contaminated 	9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/ territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Canadian Drinkir Water Quality; oth drinking wate guidelines developed the recognized agencie (e.g., other Heal and Welfare Canadia guidelines, U.3
	 ii) Potential for impact on drinking water supply Proximity to drinking water supply 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	0 N 43	to a contaminant source, the greater the potential for contamination.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	EPA, etc.).
	 "Availability" of alternate drinking water supply Alternate drinking water supply is not available Alternate drinking water supply would be difficult to obtain Alternate drinking water supply available 	3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

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III. RECEPTORS

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A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

	Record known or suspected	NO RECORD	_
	adverse effects on humans or domestic animals:		-
			• ·
	Scoring Rationale & Information Source	At <u></u>	-
2.a.i •	Known Contamination of Drinkin	g Water Supply	
· .	Record known or suspected incidents of contamination of	NO RECORD	-
	drinking water:		•
. ·	Scoring Rationale & Information Source	*	
2.a.ii.°•	Distance to Nearest Drinking Wa		
•	Identify nearest drinking water well and measure distance to site:	SOME CABINS I KM SOUTH OF IMPACT AREA B	•
	Scoring Rationale & Information Source	•	3
2.a.ii.°°•	Availability of Alternate Drinking	Water Supply	
	Document availabiilty of alternate sources of drinking water and ease of implementation:	LINKNOWN, RUT QUANTITY OF WATERCOURSE	•
	Scoring Rationale & Information Source	*	1.5 ?
•	, , ,		

Site Identification:____

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CATEGORY	BYALUATION FACTOR	SCORING GUIDELINE	RATIONALE *	METHOD OF EVALUATION	SOURCES OF
III. Receptors (cont'd)	 A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination Water resource is known to be contaminated above CWQG Water resource is strongly suspected to be contaminated above CWQG Water resource is known not to be contaminated 	4 3	(groundwater or surface water)	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other- relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	Water Quality Guidelines;
	 Water resource is known not to be contaminated ii) Potential for impact on water resources Proximity to water resources used for activities listed above 0 to <100 m 100 to <300 m 300 m to <1 km 1 to 5 km 	2 1.5 1 0.5	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	 Use of water resources - if multiple uses, give highest score (use following table) <u>Prequency of Use</u> <u>Water Use</u> <u>Prequent Occasional</u> 	0.2 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	
	Recreational (swimming, fishing)Image: Constraint of the system1Commercial food preparation1.50.8Livestock watering10.5Irrigation10.5Other domestic or food chain uses0.50.3Not currently used but likely future use0.50.2				

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SCORE

III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

•	Record information on water resource that is or is potentially affected by site contamination:	MO RECORD	
	Scoring Rationale & Information Source	2:	
2.b.ii.°•	Proximity of Water Resources to	o Site	
·	Locate and measure nearest water resource areas to site:	PETHUHWA RIVER. BETWEEN BOTH SITES MONTGOMERY LAKE RERRON RIVER	
	Scoring Rationale & Information Source	8:	2
2.b.ii.°°	• Water Uses		
	Record uses of nearby water resources:	EISHIKG SWIMMING	
	Scoring Rationale & Information Source	e;	2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES O
		r	r <u></u>	·····	1
Receptors	A. 2.				
(cont'd)	 c) Direct human exposure i) Known contamination of land used by humans 		Hazarda associated with soil	Review zoning and land use maps for lands adjacent the site.	CCMB Canad
	Known contamination of land used for agricultural or	5	contamination are directly related	Byaluate levels of soil contamination against Canadian	
	residential/parkland/school purposes above AG or		to land use.	Bnvironmental Quality Criteria (EQC) for Contaminated	Quality Criteria
	R/P EQC values			Sites (AG = agricultural level; R/P = residential/parkland	Contaminated Si
	 Known contamination of land used for commercial or industrial purposes above C/I EQC values 	3.5		level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly	
	 Land is known not to be contaminated 	· 0		endangering public health, some immediate action (e.g.,	
		- · ·	us.	fencing the area, limiting public access, etc.) should be	
		1		initiated to reduce or eliminate the exposure.	
			·		
	ii) Potential human exposure through land use		Hazards associated with soil	Review zoning and land use maps over the distances	
	 Use of land at and surrounding site (use following 	0.5 - 5	contamination are directly related	indicated. If the proposed future land use is more "sensitive"	
	table; give highest score to worst case scenario)		to land use and distance of the used	than the current land use, evaluate this factor assuming the	
	Distance from Site	I	land from the site. Residential and	proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land	
	Land Use (current or future) 0 - 300m 300m - 1km 1 - Skm	Ŭ,	concern because humans are situated		
			at these locations for longer	to the productive capability of the land or facility (e.g.,	
	Residential 5 4.5 (3) Agricultural 5 4 2.5	•	periods.	greenhouse) and are agricultural in nature, or activities	
	Agricultural 5 4 2.5			related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on	}
•	Parkland/School 4 3 1.5 Commercial/Industrial 3 1 0.5			which dwelling on a permanent, temporary, or seasonal	
	Commercial/Industrial 3 1 0.5			basis is the activity (residential), as well as uses on which	
-				the activities are recreational in nature and require the natural	1
		·• ·		or human designed capability of the land to sustain that	
				activity (parkland). Commercial/industrial land uses are defined as land on which the activities are related to the	
				buying, selling, or trading of merchandise or services	
				(commercial), as well as land uses which are related to the	
				production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :		· · · · · · · · · · · · · · · · · · ·	•	
					· .
•	People affected by contamination : • ≤ 250	0	•		
	• 250 à 1000	1.5*	* The weighting suggested is valid if	there are no points affected to other special considerations.	
	 > 1000 	3*	0 0 00	•	
		Ì			}
	Type of person using the site :				
	Workers		N.P. , if the year believes that impo	mont elements have been necleated be can abarre the interest	
	• Adults	2*		ortant elements have been neglected, he can change the internal rations and assign a score to the section "Other special	
	Children and seniors			ount the new weighting. However, the total of points allowed	
	Other special considerations	(-5à5)	must not exceed the prescribed limit.		

SCORE

III. RECEPTORS (cont'd)

A. <u>Human and Animal Uses</u> (cont'd)

2.c.i • Known Contamination of Land Used by Humans

	Record land use type (current or	NO RECORD			
	proposed) and level of				
	contamination for land known to be				
	contaminated due to site:			······································	
	•		•		-
	Scoring Rationale & Information Source:				
2.c.ii •	Land Use at and Adjacent to the Site	• •			
	Do sum and land uses (summent and	HILITARY EXER	2 1 CM C		
	Document land uses (current and proposed) for up to 5 km from the site:	BIVOUAL AREA			
		N	E	S	W
	<u>0 - <300 m</u>	PETAWAWA	INPACT AREAS	TRANING AREA	TRAINING
	<u> </u>	RESEARCH FOREST	5.4.6	R	AREA
	<u>1 km - 5 km</u>				PEQ
	Scoring Rationale & Information Source:				1
3. •	Special Considerations	•		•	
	Document any other important	PEOPLE AFFECTED	< 250 => O		·
· .	including details of air contamination if known:	SITE IS USED BY	MILITARY PEOPLE		
					<u></u>
	Scoring Rationale & Information Source:			· · · · · · · · · · · · · · · · · · ·	
					•
•			•	,	

Site Identification:

CATEGORY	EVALUATION FACTOR		RATIONALE	METHOD OF EVALUATION	SOURCES OF
III. Receptors (cont'd)	 B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site Known adverse impact on sensitive environment Bvidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site Strongly suspected adverse impact on sensitive environment 	16 14 12			
	 2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatle environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km 	۹ د م ه د م ه د م	approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted. The closer a site is to a discharge or	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic	/territorial and federal maps of sensitive environments.
	 2 to <5 km 5 to 10 km 3. Special Considerations 	2 1 -5 to +5	(See 3.7.3 in text)	Technical judgment.	

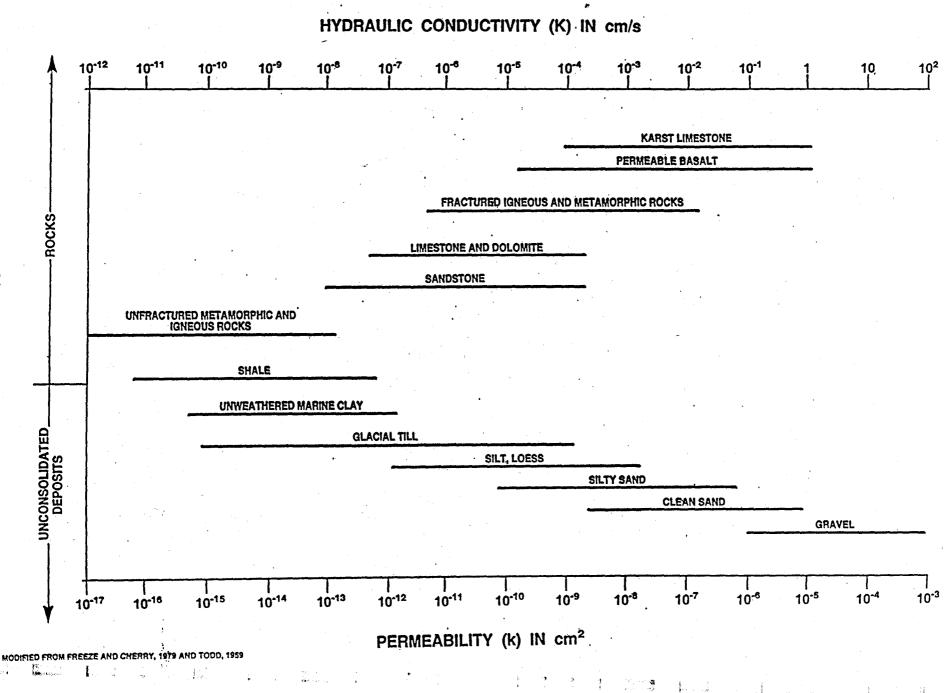
SCORE

III. RECEPTORS (cont'd)

Environment Β.

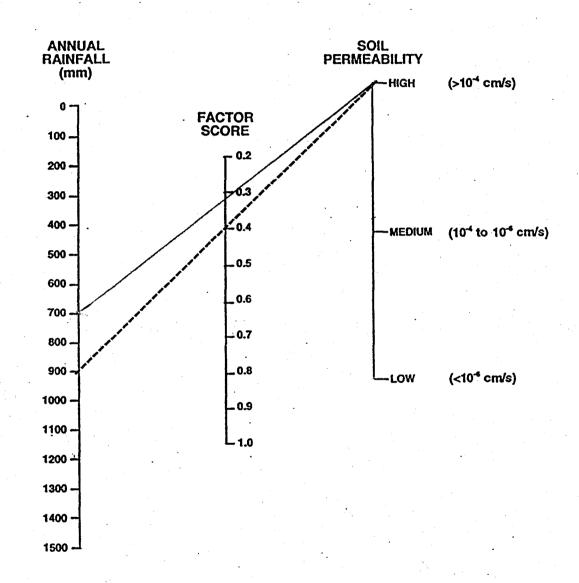
• Known Adverse Impact(s) on Sensitive Environment 1.

		Record known impact(s) on any sensitive biological environment at and/or around the site:	NO RECORD	
		Scoring Rationale & Information Source	۲۰	_
2.a	•	Distance from Site to Nearest Ser	nsitive Environment	
		Document location, distance, type and details of any nearby sensitive environments or habitats:	WUMEROUS MARSHES WITHIN AREA 8	
		Scoring Rationale & Information Source	}• <u>•</u>	10
2.b	٠	Groundwater		
		Measure distance to major recharge or discharge area:	MOUTAWS AND MUTCROPS -> RECHARGE ZONE PRTAWAWA RIVER-2 DISCHARGE ZONE	
		Scoring Rationale & Information Source	*	6
3.	٠	Special Considerations		
		Document any other important impacts on the environment not addressed above	8:	
		Scoring Rationale & Information Source		
Site I	den	tification:		



RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY

RUN-OFF POTENTIAL NOMOGRAPH (FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	т	Vapour pressure	T	Degradation	Degrad	dation constan	ts (mu)	Kđ	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
						1	Sand	Sitt	Clay			1		•			t
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	1
2,4,6 trinitrotoluene	2,4,6 TNT	150	- 25	7,25E-09	25	Mostly anaerobic		×3.			Possibly toxic	0,02					(1)
	- N	130	20	1,45E-09	20	\								1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20				·								(4)
							3,20E-03	1,40E-01	8,30E-02	ļ	<u></u>						(5)
									<u> </u>	Ottawa sand: 1,	5 .					·	(6)
										Silt: 4,5						· · ·	(6)
	·	,	ļ							Clay: 10			0.12*				(6)
						A crabic and				l	Dessible		0,12		·		(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	. 25	Aerobic and anaerobic		1			Possibly carconogenous						(1)
		270	22	2,89E-07	20					·				5			(2)
				3,17E-08	25						<u></u>						(3)
		270	20	1,61E-08	20	·····			· · · · · · · · ·	<u> </u>						L	(3)
													1,10E-04				(7)
2,6 dinitrotojuene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
											l		0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1			•		(1)
		42	20	5,53E-12	20							1		2	0.3	0.00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine,		50	20	2,56E-12	20		· ,										(3)
or							0	6.50E-03	1,40E-02		ļ		· · · ·				<u> </u>
			·	<mark>-}</mark> }		<u> </u>		0,50E-03	1,40E-02	0.1 à 13.26						<u> </u>	(5)
cyclo - 1,3,5,7 -			· · · · · · · · · · · · · · · · · · ·				<u> </u>			0,14 13,20							(6)
tetramethylene - 2,4,6,8 tetranitramine	НМХ	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 -		5	25	4,34E-17	20												(2)
tetranitro - 1,3,5,7 -										0,2 à 4,2							(6)
tetrazocine)			15.6 T				0	3,60E-03	3,20E-02								(5)

 $\dot{\mathbb{C}}_{1,q}$

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Sec. 2

роні. Рознатах,

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McGrath, 1995
 Thiboutot et al, 1998
 Pheelan and Webb, 1997
 Hayes, 1992
 Myers et al, 1996
 Townsend et al, 1996
 Townsend et al, 1996
 http://www.mef.gouv.qc.ca/tr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

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302-

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Appendix C – Physical and chemical properties and environmental criteria related to energetic materials

Compounds Abbreviations Sol		Solubility	т	Vapour pressure	т	Degradation	Degradation constants (mu)		Ка			Toxicity	EPA drinking water standard	MEF water quality criteria	Drinkab#ity criteria	Danger criterla ² (Daniels)	Danger criteria ² (Bouisse)	References	
	· · · · ·						Sand	Silt	Clay	Sand	Silt	Clay							
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(i_/kg)	(L/kg)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7.25E-09	25	Mostly anaerobic							Possibly toxic and carcinogenic	0.02					(1)
		130	20	1.45E-09	20					[0.3	0.024	(2)
		150	25	9.49E-09	25														(3)
		130	20	4.61E-09	20							1							(3)
				1.66E-09	20				L										(4)
							3.20E-03	1.40E-01	8.30E-02			1						L	(5)
									L	1,5 3	4.5	10							(6)
			ļ							0.47	2.23								(6)
				·						6,8 4	2.8	11	····						(6)
									ļ						0,12 1				(7)
									<u> </u>							1			(8)
2,4 dinitrotoluene	2,4 DNT	280	25	2.86E-07	25	Aerobic et anaerobic							Possibly carcinogenic						¹ (1)
		270	22	2.89E-07	20														(2)
				3.17E-08	25														(3)
		270	20	1.61E-08	20														(3)
															1.10E-04				(7)
													L			5			(8)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic et anaerobic													(1)
		206	25	7.46E-07	20														(2)
															0.93 1				(7)
										· · · · · ·						5			(8)
cyclo - 1,3,5 - trimethylene - 2,4,6 - trinitramine	RDX	45	25	5.30E-12	25	Anaerobic							Possibly carcinogenic	0,1					(1)
(or hexahydro - 1,3,5 -		42	20	5.53E-12	20												0,3	0.00024	(2)
trinitro - 1,3,5 - triazine		50	20	2.56E-12	20														(3)
			_				0	6.50E-03	1.40E-02										(5)
											0,1 à 13,26	0,1 à 13,26							(6)
_									1	0.29	1.20								
										· · · ·		[2			(8)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	нмх	5	25	4.38E-17	25	Anaerobic								nd			1.7	2.2	(1)
(ou octahydro - 1,3,5,7		5	25	4.34E-17	20														(2)
tetranitro - 1,3,5,7 -										0,2 à 4,2	0,2 à 4,2	0,2 à 4,2							(6)
tetrazocine)							0	3.60E-03	3.20E-02										(5)
											0.12 5	12.1 ⁶							
																400			(8)

McGrath, 1995
 Thiboutot *et al.*, 1998
 Pheelan and Webb, 1997
 Hayes, 1992
 Myers *et al.*, 1996
 Tompsend *et al.*, 1996
 Thip://www.mef.gouv.qc.ca/ft/environn/criteres_eau
 Walsh *et al.*, 1992
 Brannon and *al.*, 1992
 Pennington and Patrick, 1990
 Brannon and *al.*, 1999

¹ Temporary criteria for aquatic life (surface water) ² Human health danger criteria

³ Ottawa sand

4 Joliet sand

⁸ Grange Hall silt

⁴ Yokena clay

Conversion table for pressure units

·	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101.3	1.013250274
1 mm Hg =	0.001316	1	1	0.133289	0.001333224
1 torr =	0.001316	1	1	0.133289	0.001333224
1 kPa ≖	0.009872	7.502467917	7.5024679	1	0.010002471
1 bar =	0.986923	750.06148	750.06148	99.9753	1

Appendix D – Training Area authorisation forms

*

Code de secteur:

Range Id:

RA697

MINISTERE DE LA DEFENSE NATIONALE DEPARTMENT OF NATIONAL DEFENCE Gouvernement du Canada / Government of Canada

SISEFC

FORMULAIRE D'AUTORISATION DE SECTEUR **RANGE / TRAINING AREA AUTHORIZATION FORM**

Nom de secteur: ROCKET LAUNCHER RGE

CFRIS

1

Page:

	CFB PETAWAWA CFB PETAWAWA	Type / Type: ANTI-AI	RMOUR
Commandement / Command:	Director Land Forces Read	liness	
État / Status:	Actif Active	Grandeur / Size:	1,000.00 Metres
Feuille de carte / Map Sheet:	MCE132 TR 89 ED 7	GR157953	Allées / Lanes:
MES	WEAPONS	MUNITIONS	AMMUNITI
RIFLE (SNIPER) C3 7.62	nm	CTG 7.62mm	
LAW M72		CTG 7.62mm Match	
MAW GUN 84mm (CG)		RKT 66mm HEAT(M72)
		CTG 84mm HEAT FFV	551
		CTG 84mm HEPD FFV	/ 502
		CTG 84mm TP/T	

RESTREINTS:

RESTRICTIONS

Sécurité / Safety: No movement forward of the firing points without authorization from CFB Petawawa.

Autre / Other: None

Date autorisé / Authorized Date: 18/06/1998	Autorisé par: MWO G.H. BERGERON
Commandement / Command: Director Land Forces Readiness	Authorized By: DLFR6-6-3
Date inspectée / Inspected Date: 17/11/1997 Central Area	Par / By: LFCA MWO RD

MINISTERE DE LA DEFENSE NATIONALE DEPARTMENT OF NATIONAL DEFENCE Gouvernement du Canada / Government of Canada

SISEFC

FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

1

Code de secteur: Range Id:	Nom de secteur: DE Range Name:	MOLITION RANGE	
Locale / Location: CFB P	ETAWAWA	Type / Type: DEMOL	ITION
Base / Base: CFB P	ETAWAWA		
Commandement / Command: Directo	or Land Forces Readi	ness	
État / Status: Actif	Active	Grandeur / Size:	1,000.00 Metres
Feuille de carte / Map Sheet: MCE1	32 TR 89 ED 7	GR057833	Allées / Lanes: 0
ARMES	WEAPONS	MUNITIONS	AMMUNITION
		EXPLOSIVES	
RESTREINTS:			RESTRICTIONS
Sécurité / Safety: None			
Autre / Other: None			
Date autorisé / Authorized Date: 22/	06/1998	Autorisé par: MW	O G.H. BERGERON
Commandement / Command: Dir	ector Land Forces Rea	diness Authorized By: DLF	R6-6-3
Date inspectée / Inspected Date: 18/	11/1997 Central Ar	ea Par/By: LFC	A MWO RD

MINISTERE DE LA DEFENSE NATIONALE DEPARTMENT OF NATIONAL DEFENCE Gouvernement du Canada / Government of Canada

SISEFC

FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

1

Locale / Location: CFB PE Base / Base: CFB PE Commandement / Command: Directo	AWAWA	Type / Type: GRENAI	DE RANGE
État / Status: Actif	Active	Grandeur / Size:	200.00 Metres
Feuille de carte / Map Sheet: MCE13	2 TR 89 ED 7	GR188883	Allées / Lanes: 4
RMES	WEAPONS	MUNITIONS	AMMUNITIO
GRENADES FRAG		GREN FRAG M67	· · · · · · · · · · · · · · · · · · ·
PYROTECHNICS		GREN FRAG M61	
	·	PYROTECHNICS	
ESTREINTS:		•	RESTRICTION
Sécurité / Safety: None			
Autre / Other: None	· · ·		
Date autorisé / Authorized Date: 18/0	06/1998	Autorisé par: MWC	O G.H. BERGERON
Commandement / Command: Dire	ector Land Forces Rea	adiness Authorized By: DLFI	R6-6-3
Date inspectée / Inspected Date: 18/1	11/1997 Central Ar	ea Par / By: LFC	A MWO RD

MINISTERE DE LA DEFENSE NATIONALE DEPARTMENT OF NATIONAL DEFENCE Gouvernement du Canada / Government of Canada

SISEFC

FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

_

Code de secteur: Range Id: RA614	Nom de secteur: Range Name:	ACT AREA A	
Locale / Location: CFB		Type / Type: IMPACT ARE	EA
Base / Base: CFB			
Commandement / Command: Direc	tor Land Forces Reading	ess	
État / Status: Actif	Active	Grandeur / Size:	5.00 Acres
Feuille de carte / Map Sheet: MCE	132 TR 89 ED 7		Allées / Lanes: 0
ARMES	WEAPONS	MUNITIONS	AMMUNITIO
MG .50in		CTG .38	
MG C5 7.62mm		CTG 5.56mm	
MG C6 7.62mm		CTG 9mm	
MAW GUN 84mm (CG)		CTG 7.62mm	
RIFLE C7 5.56mm		CTG .50	
RIFLE (CARABIN) C8 5.56mm	1	CTG 60mm MOR HE	
MG C9 5.56mm		CTG 60mm MOR SMK WP	
MORTAR 60mm		CTG 60mm MORIII	
MORTAR 81mm		CTG 81mm MOR HE	
GUN 105mm TK		CTG 81mm MOR SMK WP	
GUN 105mm HOW		CTG 81mm MOR III	
GUN 40mm BOFFIN		RKT 66mm HEAT(M72)	
GUN 106mm		CTG 84mm HEAT FFV 551	
GUN 76mm (COUGAR)		CTG 84mm TP/T	
PISTOL 9mm		CTG 105mm HE PD (HOW)	ł .
RIOT GUN 38mm		CTG 105mm ILL (HOW)	
PYROTECHNICS		CTG 105mm SMK (HOW)	
PISTOL .38		PROJ 155mm HE M107	
		PROJ 155mm ILL	
		PROJ 155mm SMK	
		PROJ 155mm SMK WP	
		CTG 76mm HESH	
		CTG 76mm SH/P	
		CTG 38mm SPEDEHETE C	S
		CTG 38mm FLITERITE CS	
		PYROTECHNICS	

RESTRICTIONS

Sécurité / Safety: None Autre / Other: None

Imprimé / Printed: 07/04/1999 15:11:02

RESTREINTS:

Imprimé par / Printed by: MWO BERGERON, GILLES G

Page:

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MINISTERE DE LA DEFENSE NATIONALE DEPARTMENT OF NATIONAL DEFENCE Gouvernement du Canada / Government of Canada

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FORMULAIRE D'AUTORISATION DE SECTEUR **RANGE / TRAINING AREA AUTHORIZATION FORM**

Code de secteur: Range Id:	RA614	Nom de secteur: Range Name:	IMPACT	AREA A	

Date autorisé / Authorized Date:	18/06/1998		Autorisé par:	MWO G.H. BERGERON	
Commandement / Command:	Director Land F	Forces Readiness	Authorized By:	DLFR6-6-3	
Date inspectée / Inspected Date:	20/11/1997	Central Area	Par / By:	LFCA MWO RD	

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

Locale / Location: CFB	PETAWAWA	Type / Type: IMPACT A	RFA	
Base / Base: CFB				
Commandement / Command: Direc	tor I and Forces Readin	229		
État / Status: Actif		Grandeur / Size:	5.00 Acres	
• • • • • • • • • • • • • • • • •		Glaideur / Size.		_
Feuille de carte / Map Sheet: MCE	132 TR 89 ED 7		Allées / Lanes:	0
ARMES	WEAPONS	MUNITIONS	AMMUN	ΙΤΙΟΙ
GUN 105mm TK		CTG 105mm HE PD (HO	w)	
GUN 105mm HOW		CTG 105mm HE PLGD (I	HOW)	
GUN 155mm HOW		CTG 105mm MTSQ (HO)	N)	
GUN 76mm (COUGAR)		CTG 105mm ILL (HOW)		
-		CTG 105mm HESH L43A	(1 (HOW)	
		CTG 105mm SH\P (HOW	0	•
		CTG 105mm SMK WP (H	IOW)	
		CTG 105mm SMK (HOW)	
		PROJ 155mm HE M107		
		PROJ 155mm ILL		
n an an Araba an Araba an Araba an Araba an Araba an Araba an Araba an Araba an Araba an Araba an Araba an Arab		PROJ 155mm SMK		
		PROJ 155mm SMK WP	•	
		CTG 76mm HESH		
		CTG 76mm SH/P		
		CTG 76mm SMK BE		
		CTG 105mm HESH (TK)	• • • • • •	
		CTG 105mm APCS/T (TI	K)	
		CTG 105mm APFSDS (1	ГК)	
		CTG 105mm SMK HCBE	E (TK)	•
		CTG 105mm SMK WP (1	ГК)	
		CTG 105mm TPFSDS/T	• •	
		CTG 105mm SH/PT C10	9 (TK)	

RESTREINTS:

RESTRICTIONS

Sécurité / Safety: Ricochet area for area 2 and small arms ranges Q, X, and Y.

Autre / Other: None

Date autorisé / Authorized Date:	18/06/1998	
Commandement / Command:	Director Land F	Forces Readiness
Date inspectée / Inspected Date:	20/11/1997	Central Area

Autorisé par: MWO G.H. BERGERON Authorized By: DLFR6-6-3 Par / By: LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

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Locale / Location: CFB PETAWAWA	Type / Type: IMPACT AREA
Base / Base: CFB PETAWAWA	
Commandement / Command: Director Land Forces Rea	diness
État / Status: Actif Active	Grandeur / Size: 5,000.00 Metres
Feuille de carte / Map Sheet: MCE132 TR 89 ED 7	Allées / Lanes:
MES WEAPONS	MUNITIONS AMMUNITIC
RIFLE C1 7.62mm	CTG 5.56mm
MG .50in	CTG 9mm
MG C5 7.62mm	CTG 7.62mm
MG C6 7.62mm	CTG .50
RIFLE C7 5.56mm	CTG 38mm SPEDEHETE CS
RIFLE (CARABIN) C8 5.56mm	CTG 38mm FLITERITE CS
MG C9 5.56mm	PYROTECHNICS
PISTOL 9mm	BLANK AMMUNITION
RIOT GUN 38mm	CS Riot Gas
PYROTECHNICS	
ESTREINTS:	RESTRICTIO
Sécurité / Safety: 1. No vehicle movement off road	S.
2. No impact of dud producing a	mmunition.
3. Ricochet area for arty and arn	nd wpns subject to clearance.
Autre / Other: None	
Date autorisé / Authorized Date: 18/06/1998	Autorisé par: MWO G.H. BERGERON
Commandement / Command: Director Land Forces R	Readiness Authorized By: DLFR6-6-3
Date inspectée / Inspected Date: 18/11/1997 Central	Area Par / By: LFCA MWO RD
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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

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Code de secteur:	RA683
Range Id:	104003

Nom de secteur: Range Name: IMPACT AREA D

Locale / Location: CFB PETAWAWA Base / Base: CFB PETAWAWA		Type / Type: IMPACT A	REA
Commandement / Command: Director			
État / Status: Actif	Active	Grandeur / Size:	5.00 Acres
Feuille de carte / Map Sheet: MCE132	2 TR 89 ED 7		Allées / Lanes: 0
ARMES	WEAPONS	MUNITIONS	AMMUNITIO
RIFLE C1 7.62mm		CTG .38	
RIFLE (SNIPER) C3 7.62mm		CTG 5.56mm	
MG .50in		CTG 9mm	· •
Rockets 2.75in		CTG 7.62mm	
MG C5 7.62mm		CTG .50	
MG C6 7.62mm		CTG 60mm MOR HE	
LAW M72		CTG 60mm MOR SMK W	I P
MAW GUN 84mm (CG)		CTG 60mm MORIII	
RIFLE C7 5.56mm		CTG 81mm MOR HE	
RIFLE (CARABIN) C8 5.56mm		CTG 81mm MOR SMK W	P.
MG C9 5.56mm		CTG 81mm MOR III	· · ·
MORTAR 60mm		RKT 21mm SUB-CAL(M7	/2)
MORTAR 81mm		CTG 84mm HEAT FFV 5	51
GUN 105mm TK		ATGM BGM 71AE HE (T	ow)
GUN 105mm HOW		CTG 84mm TP/T	
GUN 155mm HOW		CTG 105mm HE PD (HO	W)
GUN 40mm BOFFIN		CTG 105mm ILL (HOW)	
GUN 106mm		CTG 105mm SMK WP (H	łow)
GUN 76mm (COUGAR)		CTG 105mm SMK (HOW	0
PISTOL 9mm		PROJ 155mm HE M107	
RIOT GUN 38mm		PROJ 155mm ILL	
MISSILE TOW		PROJ 155mm SMK	· ·
MISSILE BLOWPIPE		PROJ 155mm SMK WP	
PYROTECHNICS		CTG 76mm HESH	
PISTOL .38		CTG 76mm SH/P	
		CTG 76mm SMK BE	
		CTG 105mm SMK HCBE	Ξ (ΤΚ)
		CTG 105mm SMK WP (• •
		CTG 38mm SPEDEHET	•

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

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Code	de	secteur:	
	R	lange Id:	

RA683

Nom de secteur: Range Name: IMPACT AREA D

> CTG 38mm FLITERITE CS RKT 2.75in HE PYROTECHNICS MISSILE BLOWPIPE BLANK AMMUNITION CS Riot Gas

RESTREINTS:

RESTRICTIONS

Sécurité / Safety: DZ dives crossing in area D, UXO producing ammunition fired only on authority of Comd CFB Petawawa.

Autre / Other: None

Date autorisé / Authorized Date:	18/06/1998	· · · ·	Autorisé par:	MWO G.H. BERGERON
Commandement / Command:	Director Land F	Forces Readiness	Authorized By:	DLFR6-6-3
Date inspectée / Inspected Date:	20/11/1997	Central Area	Par / By:	LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

Locale / Location: CFB PETAWAWA Base / Base: CFB PETAWAWA	Type / Type: IMPACT AREA
Commandement / Command: Director Land Forces	Readiness
État / Status: Actif Act	tive Grandeur / Size: 5,000.00 Metres
Feuille de carte / Map Sheet: MCE132 TR 89 ED 7	Allées / Lanes: 0
ARMES WEAPONS	S MUNITIONS AMMUNITION
RIFLE C1 7.62mm	CTG .38
RIFLE (SNIPER) C3 7.62mm	CTG 5.56mm
MG .50in	CTG 9mm
MG C5 7.62mm	CTG 7.62mm
MG C6 7.62mm	CTG .50
LAW M72	CTG 60mm MOR HE
MAW GUN 84mm (CG)	CTG 60mm MOR SMK WP
RIFLE C7 5.56mm	CTG 60mm MORIII
RIFLE (CARABIN) C8 5.56mm	CTG 81mm MOR HE
MG C9 5.56mm	CTG 81mm MOR SMK WP
MORTAR 60mm	CTG 81mm MOR III
MORTAR 81mm	RKT 21mm SUB-CAL(M72)
GUN 105mm TK	CTG 84mm TP/T
GUN 105mm HOW	CTG 105mm HE PD (HOW)
GUN 155mm HOW	CTG 105mm HE PLGD (HOW)
GUN 40mm BOFFIN	CTG 105mm ILL (HOW)
GUN 106mm	CTG 105mm SMK WP (HOW)
GUN 76mm (COUGAR)	CTG 105mm SMK (HOW)
PISTOL 9mm	PROJ 155mm HE M107
RIOT GUN 38mm	PROJ 155mm ILL
PYROTECHNICS	PROJ 155mm SMK
PISTOL .38	PROJ 155mm SMK WP
	CTG 105mm SMK HCBE (TK)
	CTG 105mm SMK WP (TK)
	CTG 38mm SPEDEHETE CS
	CTG 38mm FLITERITE CS
	PYROTECHNICS
	BLANK AMMUNITION
	CTG 105mm HE M1

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: Range Id: RA684	Nom de secteur: Range Name: IMPAC	T AREA B	
		CS Riot Gas	
RESTREINTS:		· · · · · · · · · · · · · · · · · · ·	RESTRICTIONS
Sécurité / Safety: None		•	
Autre / Other: None			
Date autorisé / Authorized Date: 18	8/06/1998	Autorisé par: N	WO G.H. BERGERON
Commandement / Command: D	irector Land Forces Readiness	Authorized By: [DLFR6-6-3
Date inspectée / Inspected Date: 17	7/11/1997 Central Area	Par / By: L	FCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

	de secteur: . Range Id:	RA60	D Nom d Ran	e secteur: ge Name:	BURWASH GRENADE	RANGE
	Locale	e / Location:	CFTA BURWAS	SH ON	Type / Type: GRE	
	8	ase / Base:	CFB PETAWAV	VA		
Com	mandement /	Command:	Director Land F	⁻ orces Re	adiness	
	É	tat / Status:	Actif	Active	Grandeur / Size:	300.00 Metres
Feui	ille de carte /	Map Sheet:	DELAWARE 4-	1/2 CONIS	STON GR139232	Allées / Lanes: 0
ARMES	<u></u>		WE	APONS	MUNITIONS	AMMUNITION
GRE	ENADES F	RAG			GREN FRAG M67 ,GREN LAUNCHER	40mm PRAC
RESTRE	EINTS:					RESTRICTIONS
Sécur	rité / Safet	- · ·	es to be installed unicationwith Rai		32322,13482279,13602314. Sentr	ies must have
Αι	utre / Othe	r: None				
Da	ate autorisé /	Authorized [Date: 18/06/1998	<u></u>	Autorisé par: N	MWO G.H. BERGERON
	Commanden	ent / Comm	and: Director Lan	d Forces	Readiness Authorized By: [DLFR6-6-3
Dat	te inspectée /	Inspected E	Date: 23/10/1997	Centra	l Area Par / By: l	FCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

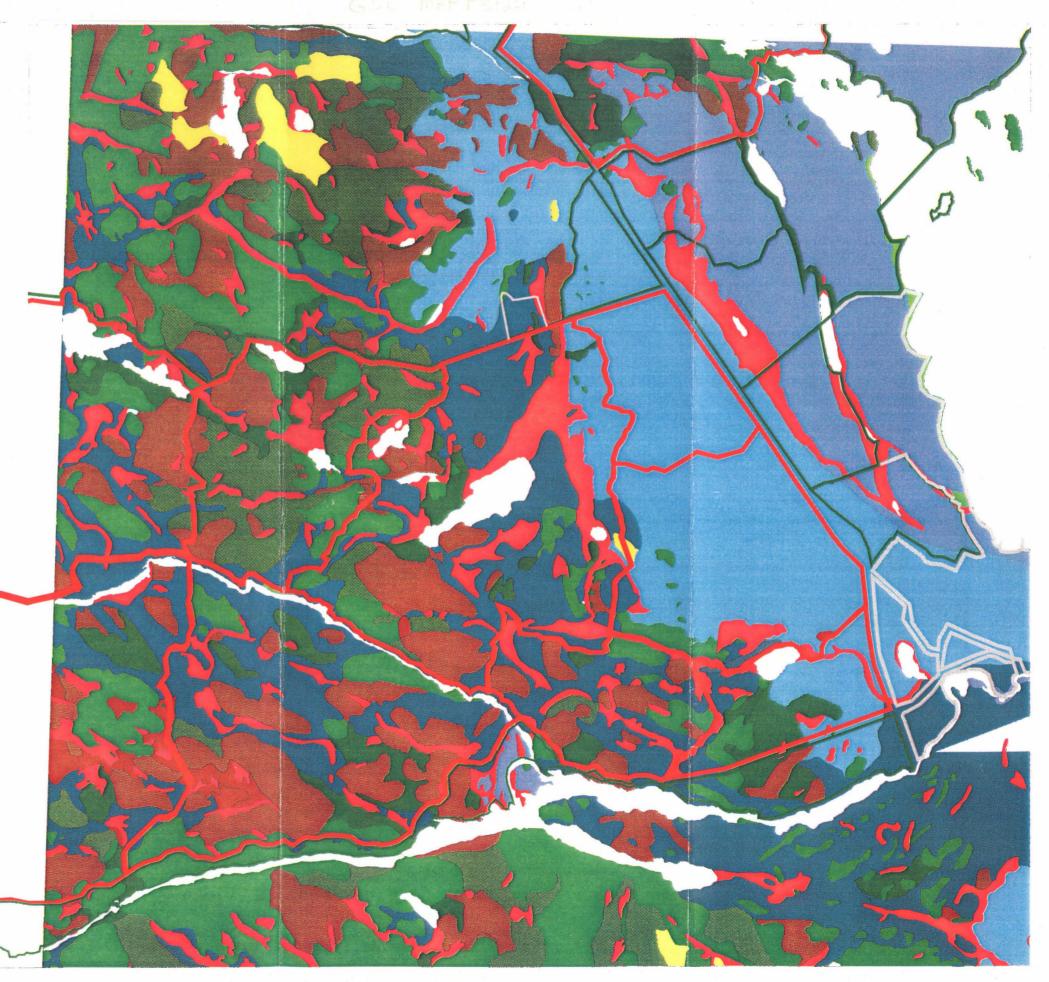
1

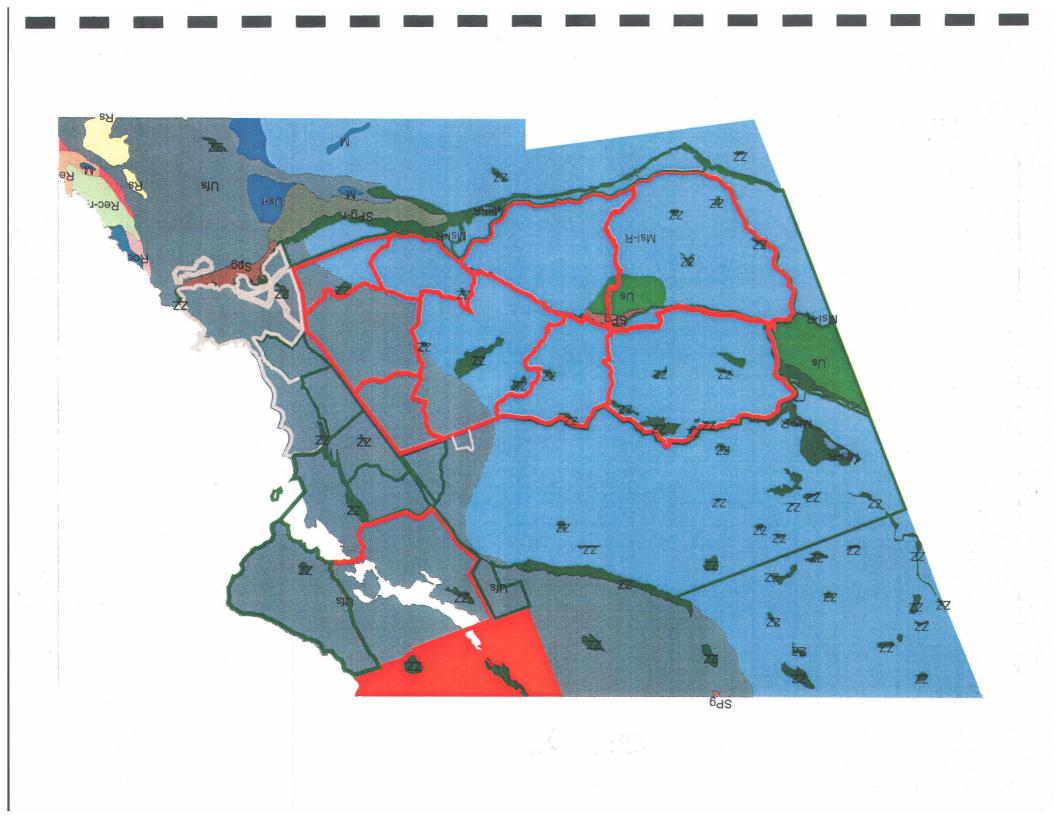
Code de secteur: RA613 Nom de secteur: Range Id: Range Name:	BLOWPIPE RGE
Locale / Location: CFB PETAWAWA, ONT	
Base / Base: CFB PETAWAWA Commandement / Command: Director Land Forces R	eadiness
État / Status: Actif Activ	Grandeur / Size: 5,000.00 Metres
Feuille de carte / Map Sheet: MCE132 TR 89 ED 7	GR063919 Allées / Lanes: 0
ARMES WEAPONS	MUNITIONS AMMUNITION
MISSILE BLOWPIPE MISSILE JAVELIN	Missile Javelin S15 MISSILE BLOWPIPE
RESTREINTS:	RESTRICTIONS
Sécurité / Safety: None	
Autre / Other: None	
Date autorisé / Authorized Date: 14/08/1992 Commandement / Command: Director Land Forces Date inspectée / Inspected Date: 11/02/1997 Centu	Autorisé par: MWO JA LARADE Readiness Authorized By: DLFR6-6-3 al Area Par / By: LFCA HQ WO DEVEREA

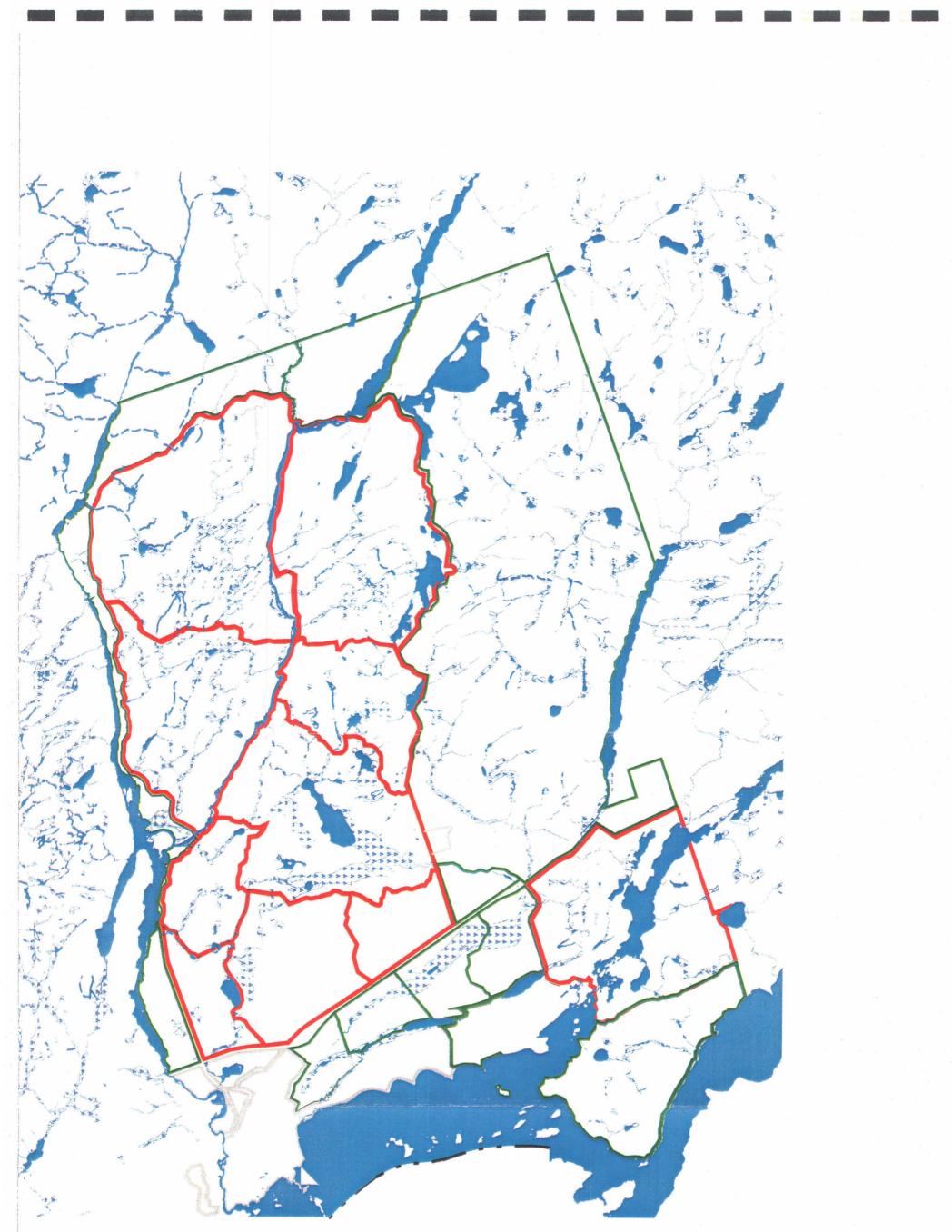
Appendix E – Topographic and surface deposits maps

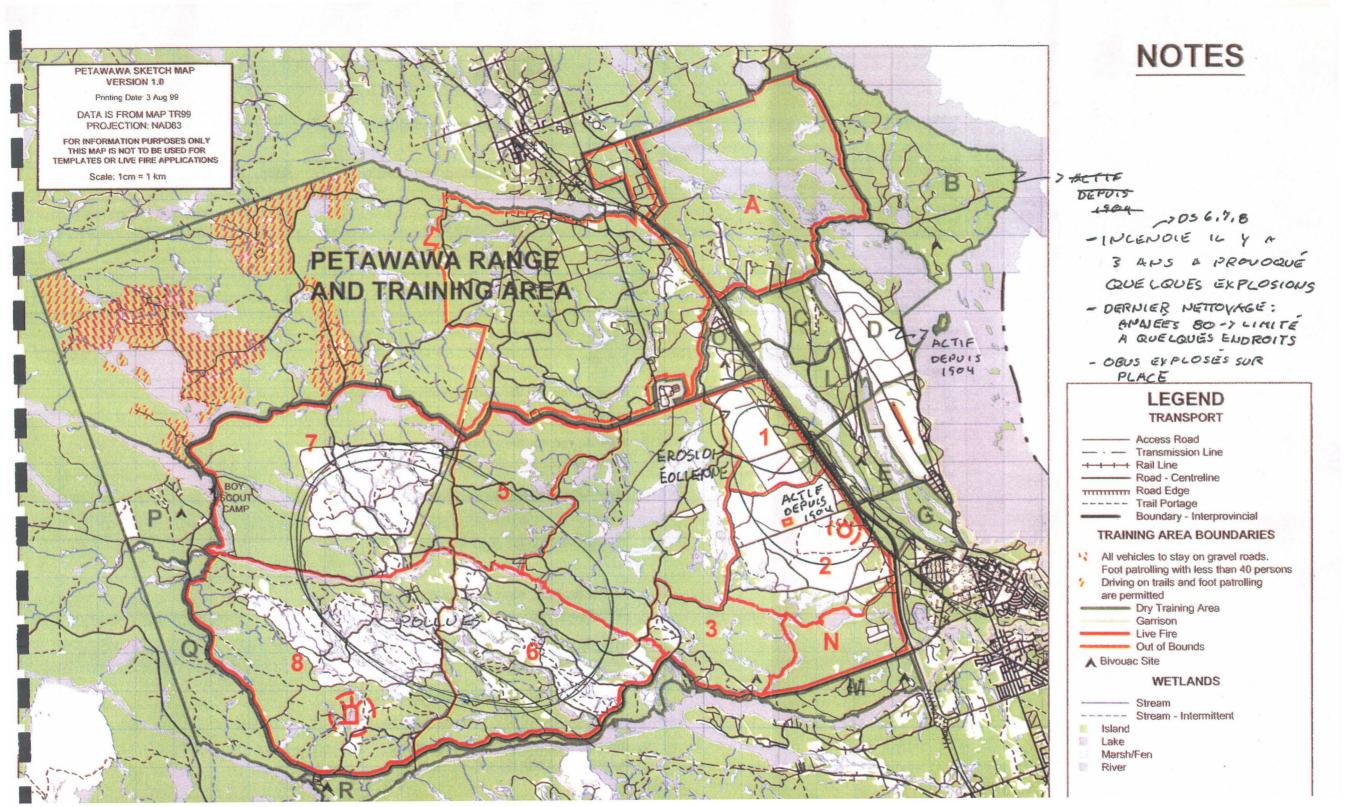
Surficial_Geology by Description

	(2)
Abundant bedrock exposure with thin drift cover	(542)
Bedrock: limestone, minor dolostone, shale, sandstone, minor drift cover	(7)
Bog and swamp: muck, peat, marl	(529)
Clay, silty clay, clayey silt	(10)
Fine to medium grained sand	(11)
Glaciofluvial ice-contact stratified deposits: gravel, gravelly sand, sand,	(70)
Glaciofluvial outwash and deltaid deposits: gravel, fravelly sand, sand+	(111)
Gravel, gravelly sand, sand	(205)
Lacustrine	(4)
Landslide debris: highly contorted clay, silt, sand	(3)
Marine beach, bar or near shore deposits: gravel, gravelly sand, minor clay, fos	(14)
Marine fine-grained deposites: silt, clay	(20)
Modern alluvium: unsubdivided - clay, silt, sand, gravel, muck	(19)
Older alluvium in terrace remnants: sand, gravelly sand	(34)
Silt dominant	(1)
Subglacial till: sandy to silty, stony	(40)
Surface modified by wind	(21)
Thin and discontinuous drift cover, in places sufficiently thick to locally subd	(210)
Till: poorly sorted diamicton	(67)
Till: Very stony and sandy, usually associated with humocky topography	(19)
unclassed	(18)
all others	(35)









Training and the Environment CFB Petawawa / CFTA Burwash

NOTE: This guide does not replace Range Standing Orders

TRAINING AREAS

- $\sqrt{}$ Authorisation for any tree cutting must be obtained from BCE Natural Resources through Range Control. - Use Camouflage netting instead of branches
- Use branches from logging slash piles whenever possible
- Police all garbage and trash on a regular basis. On-base users will return garbage and recyclables to their unit lines. Off base users must arrange access to garbage and recycling facilities through Range Control.
- Do not burn or bury any trash.
- An inspection by Range Control is REQUIRED for training area/range clearance.
- Remove all wire, trash and tactical obstacles
- Collect spent shell casings to the extent practical

- Fill in and mound ALL excavations

VEHICLE MOVEMENT

- Speed limit in the Training Area is 50 km/hr
- Stick to trails if the ground is saturated with water
- Wheeled vehicles are to have tire air pressures lowered to off-road settings before leaving hard packed trails.
- Off road traffic on DZ Anzio will stick to established trails unless permitted by Range Control.

CFTA BURWASH - SPECIAL PROCEDURES

- Range Control MUST be contacted in advance and advised of unit identity, nature of training, number of personnel and departure time. Units MUST have an operating cellular telephone while at Burwash.
- FIRE Between 1 April and 1 October. Units MUST advise Ontario Ministry of Natural Resources Fire Operations Centerat (705) 564-6000 of deployment, departure date and time before starting training. Call them for any fire fighting assistance.

CFB PETAWAWA - PETAWAWA RESEARCH FOREST

This is Canada's oldest research forest. Some experiments have been ongoing for over eighty years. Disturbance of any experiments will harm our national heritage and carry severe consequences.

- Dry training only, live fire is not permitted.
- No travel through PRF townsite at any time.
- No off-road vehicle movement without authorisation from Range Control
- See sketch map (reverse side) for special restrictions
- ALL ACCESS TO THE AREA including recces, must be cleared through Range Control in advance. Range Control will liase with Research Forest Manager.

POL & HAZMAT - SPILL PREVENTION & RESPONSE

- $\sqrt{1}$ For any group activity involving five vehicles or more, the group must have spill response capability in the amount of one spill kit for every five vehicles.
- ✓ POL pts and field refuelling operations will not occur closer than

- V Action in event of spill - prevent spill from entering water and cleanup.
- V Contaminated materiel must be disposed of through Base Supply R&D during normal hours, or 2 Svc Bn after hours.
- √ Spills beyond Unit capability slow, divert or contain the discharge, call for assistance through Range Control. Range Control will activate Base Spill team through the Fire Hall and notify Base Environmental Officer.
- √ Report all spills through Range Control with the following information:
 - Any injuries,
 - Assistance required (Y/N)
 - Identity and amount of materiel spilled, - Location of spill (Grid Ref).
 - Name and contact person for the unit.
 - Did spill enter water?

CONTACT NUMBERS (613) 687-5511

- Base Operations Training Coordination loc 6403/6762 Range Control - RCO and RSO loc 5181/5477
- Range Control Duty NCO loc 5203
- Base Environmental loc 6572
- Base Duty Center loc 5439/5611
- BCE Fire Hall loc 5222 or (613)687-2222
- Base General Safety loc 6385
- Base Ammunition Section loc 5429
- Base Accommodation loc 5937/5153 Base Hospital loc 7056/5392 (24hrs)
- Base Military Police loc 5444 or 687-4444 (24hrs)

Range Control Customer Survey

Please help us improve our services by completing the following survey.

Please rate the services received for each question (on a scale 0 to 5)

	0 = Not at all satisfied
	5 = Very satisfied
	NA = Not assessed
(Optional)	
Rank	
Name	
Unit	-

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- 1. How do you rate the services received overall?
- 2. How do you rate the procedure for range bookings?
- 3. How do you rate the march off procedures?
- 4. How do you rate the range standing orders?
- 5. Do the facilities allow you to achieve your training goals?
- 6. How do you rate the deportment of the Range Control Staff?
- 7. Are you satisfied with the communications in the field (Safety net)?
- 8. Are you satisfied that the training can be achieved in a safe manner?

9. Please feel free to add any comments that could help the quality of services offered:

OBUS	VIEUK	DE	whit	
		- /		
-				