DRAFT REPORT

MICROBIAL CONTAMINATION CONTROL PLAN (INTERIM WELLHEAD PROTECTION MEASURES PLAN)

FOR
TOWNSHIP OF NORTH STORMONT
VILLAGE OF CRYSLER
MUNICIPAL GROUNDWATER SUPPLY WELLS

PREPARED FOR:

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WESA

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Prepared for:

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EXECUTIVE SUMMARY

Water and Earth Science Associates Ltd. (WESA) was retained by the Township of North Stormont to develop a Microbial Contamination Control Plan (MCCP) for the Village of Crysler production well site. The MCCP is a requirement of Certificate of Approval 6160-62VLJG, dated August 27, 2004 for the Township of North Stormont -Village of Crysler water supply system. The study area for this project encompasses a 2 kilometre radius of the Municipal well site. The primary focus of the study is on an area with a 900 m radius (approximate) around the Municipal wells, as well as key areas north-northeast and south-southwest of the municipal well site along the esker deposit that is the primary recharge area of the well water supply.

A GUDI (groundwater under direct influence of surface water) assessment, completed between 2001 and 2003, determined that the municipal wells were GUDI wells though with adequate effective in situ filtration. The wells are considered GUDI wells due to the potential for surface water impacts based on the vulnerability of the sand and gravel aquifer from which they draw their water.

The Village of Crysler municipal well site is bordered by operating licensed aggregate sand pits to the south, rural land to the north, rural/agricultural and a private sand pit to the east, and a tree farm to the west. Neighbouring land use within the extent of the broader study area consists primarily of farmland and rural land with some aggregate extraction areas. ,

The Village of Crysler production well site lies over a buried esker ridge consisting of melt water derived glaciofluvial sand and gravel deposits that coarsen toward the core of the esker body. The esker complex has a north-south trending axis. Groundwater flow in the aquifer is to the north and therefore recharge is derived from the largest part of the sand and gravel esker complex located south of the Crysler well site.

A second local aquifer is found below the esker complex aquifer. A Municipal Groundwater Study for the Township of North Stormont was prepared by Robinson Consultants et al. in October, 2003 (EOWRC Report), in which they modelled the regional 'Contact Zone Aquifer'. The 'Contact Zone Aquifer' is comprised of the basal glacial sediment layer and the weathered shaley limestone bedrock of the Verulam Formation (Williams, 1991). . At a March 10, 2004 meeting between WESA, OCWA and the MOE it was decided that WESA would supplement the regional information modeled in the EOWRC report for the Crysler Municipal supply wells, with site specific geological and hydrogeological data for the local esker complex.

For the purpose of developing the microbial plan, WESA reviewed and refined the hydraulic parameters defining the esker complex, and thus those parameters used to model the area of primary recharge south of the municipal well(s). WESA used an analytical equation, Bear and Jacobs (Hydrology, 1965) to develop microbial risk management zones (MRMZs) within the boundaries of the esker complex. WESA deferred to the regional modeling conducted as part of the EOWRC Report for the remaining microbial risk management zones outside the esker complex, having no site specific hydrogeological information for those areas.

WESA inventoried and ranked the risk of existing and potential activities that might affect both microbial risks and risks to the *in situ* filtration capability of the aquifer. The risks identified consisted primarily of aggregate extraction activities, dug and drilled wells, manure lagoons and spreading activities, septic systems and lagoons, ponds, swales and drains. WESA summarized these risks in an inventory and ranked the risk of existing and potential sources based on aquifer intrinsic susceptibility, location within MRMZs, and activity type.

A risk avoidance, management and awareness program was developed in response to the identified risks, prioritizing actions to target activities with the highest potential to affect either the in situ filtration capability or microbial quality of the source aquifer supplying the Crysler Municipal wells.

Risk awareness is recommended to target everyone within the Microbial Risk Management Zones. Risk awareness includes, identifying key activities of concern, and providing workshops to address these activities; presenting BMPs, including implementation strategies, cost considerations, information and support sources; creation of an area on the Township website with key information on the Microbial Risk Management Zones, contacts and BMPs; targeting potential contaminant sources through mail outs that outline specific BMPs; and design and posting of public signs indicating the boundaries of the MRMZ, and the risk ranking of each MRM zone.

Risk avoidance, management and awareness steps were further outlined specific to the highest risk activities present within the MRMZ zones, observed by WESA. These include undertaking meetings with the MOE, MNR, OCWA, WESA and aggregate operation owners to develop a strategy to reduce the risk imposed by the surrounding aggregate operations; promotion of the creation of farm management and nutrient management plans; inventory and proper care of private wells and septic systems; regular microbiological testing of private water supply wells in the MRMZs and response and reporting of adverse results.

Further contingency measures included the evaluation of particle count data for trends with respect to changes in environmental conditions, pumping flow rates and adverse results that could indicate inadequate in situ filtration; the addition of three sentry wells surrounding the municipal supply wells to forewarn of any impact before it could reach the municipal wells; and an evaluation of raw water bacteriological results in association with pump flow rate data.

This report was prepared as per the requirements outlined in the MOE's document "*Development of Microbial Contamination Control Plans for Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective In situ Filtration, January 2004,*, including a contamination source inventory list; plans delineating the well head protection areas; detailed description of all proposed microbial contamination control measures; and a proposal for the implementation of the Microbial Contamination Control Plan.

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1.0 INTRODUCTION

Water and Earth Science Associates Ltd. (WESA) was retained by the Township of North Stormont to develop a Microbial Contamination Control Plan (MCCP) for the Village of Crysler production well site. The requirement for a MCCP was originally specified in the Ministry of Environment (MOE) Municipal Drinking Water Systems Certificate of Approval Number 5599-5MSH8W and is reiterated in the most recent Certificate of Approval 6160-62VLJG, dated August 27, 2004 (herein referred to as 'the C of A') for the Township of North Stormont -Village of Crysler water supply system.

1.1 BACKGROUND

The Village of Crysler is located within the Township of North Stormont, United Counties of Stormont, Dundas and Glengarry, in Southeastern Ontario (Figure 1). The Village of Crysler municipal well site is located on the south side of County Road 13 approximately 5 kilometres east of the Village. The study area for this project encompasses a 2 kilometre radius of the Municipal well site. The primary focus of the study is on an area with a 900 m radius (approximate) around the Municipal wells, as well as key areas north-northeast and south-southwest of the municipal well site along the esker deposit that is the primary source and recharge area of the well water supply. A plan showing the study area and the municipal well site is provided as Figure 1.

Between 1984 and 1993 a number of investigations were completed for the Village of Crysler production well site characterizing the physical and chemical hydrogeology of the sand and gravel aquifer and to design and construct two production wells at the site. The findings of these investigations are provided in the following reports:

- WESA, June 1993; Construction and Testing of a Production Well for the Village of Crysler, Township of Finch, Ontario. Prepared for Kostuch Engineering Ltd.
- WESA, September 1986: Crysler Water Supply Test Drilling Program. Prepared for Kostuch Engineering Ltd. Herein referred to as the WESA 1986 report.

Between 2001 and 2003 a GUDI (groundwater under direct influence of surface water) assessment was completed for the well site to determine if the site wells were GUDI and if there is effective in situ filtration for the removal of suspended particulate matter. These studies did not identify any 'existing' influence from surface water. The production wells have been declared GUDI wells due to the potential for surface water impacts based on the vulnerability of the sand and gravel aquifer in which they are located. At this time they have adequate in situ filtration, however with a neighbouring sand and gravel pit operation licensed to extract beneath the water table within 60 metres of the production wells there is a potential for surface water influence/impact in the future. The GUDI assessment findings are provided in the following reports:

- WESA, April 2002: GUDI Well Assessment of Village of Crysler Well Supply, Township of North Stormont, Ontario. Prepared for the Township of North Stormont.
- WESA, January 8, 2003 letter: Evaluation of the Effectiveness of In Situ Filtration, Village of Crysler Well Supply, Township of North Stormont, MOE Reference Number 3306-5ASGNF.

The Ministry's document "*Development of Microbial Contamination Control Plans for Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective In situ Filtration, January 2004*", herein referred to as the 'Guidance Document', outlines the required components of a MCCP. The objective of a MCCP is to minimize aquifer disturbance and microbial contaminant loading to an aquifer in close proximity to GUDI wells relying on *in situ* filtration for the removal of suspended particulate matter. This is required in the absence of chemically assisted filtration. The requirements outlined in the Guidance Document are considered interim wellhead protection measures, as it is anticipated that over the long term a province wide groundwater protection program will be implemented addressing all potential sources of contamination. The Guidance Document lists the following requirements for the MCCP:

1. Delineate microbial risk management zones.
2. Inventory and rank the risk of existing and potential activities that might affect the *in situ* filtration capability of the aquifer.
3. Inventory and rank the risk of existing and potential sources of microbial contamination.
4. Identify measures to protect well(s) from microbial contamination and to protect the *in situ* filtration capability of the aquifer.

5. Develop appropriate monitoring and contingency plans.
6. Establish a schedule for the implementation of the microbial contamination control measures.

In addition to the information sources listed above, a program to implement wellhead protection strategies for the United Counties of Stormont, Dundas and Glengarry, the United Counties of Prescott & Russell, and the City of Ottawa was carried out for the Eastern Ontario Water Resources Committee (EOWRC). The definition of Wellhead Protection Areas (WHPAs) for the Village of Crysler Municipal wells and recommended measures for a wellhead protection strategy for the defined areas are provided in the following report:

- Robinson Consultants Inc. et al. Municipal Groundwater Study, Township of North Stormont, dated October 2003.

This Municipal Groundwater Study report is herein referred to as the 'EOWRC Report'. The WHPAs and Aquifer Intrinsic Susceptibility Map for the Crysler Municipal Wells as determined in the *EOWRC report* are provided in Appendix A for reference.

At the outset of this project, on March 10, 2004, WESA met with Mr. Bob Putzlocker (Regional Hydrogeologist, Technical Support Section, MOE Kingston) and Mr. Jan Frassen (District Drinking Water Inspector, MOE District office Cornwall) of the MOE as well as OCWA representatives to tour the Crylser facility. Following the site visit WESA and the MOE discussed an acceptable approach for developing a microbial control plan to protect the water supply at Crysler. This included establishing the 50 day, 2 year and >2 year TOT zone boundaries to be used in the Crylser Microbial Contamination Control Plan. It was decided that it would be unnecessary to conduct detailed hydrogeological modelling on the well site, as this had been completed in the EOWRC report. At the time, the EOWCR report MODFLOW model was undergoing a peer review. Therefore, the parties agreed that since the groundwater source for the Crysler Site was the overburden aquifer and not the Contact Zone Aquifer modelled in the EOWRC report, WESA should apply a common sense approach to establish the TOT zones for the esker complex. Prime importance was therefore given to assessment and maintenance of effective in-situ aquifer filtration and monitoring plans and contingency measures for the site.

2.0 SITE DESCRIPTION, GEOLOGY, HYDROGEOLOGY & WELL CONSTRUCTION DETAILS

2.1 SITE DESCRIPTION

The Village of Crysler municipal well site is located along County Road 13 about 5 kilometres east of the Village of Crysler and approximately 2.25 kilometres east of the Payne River. The Site is bordered by operating licensed aggregate sand pits to the south, rural land to the north, rural/agricultural and a private sand pit to the east and a tree farm to the west. Neighbouring land use within the extent of the broader study area consists primarily of farmland and rural land with some aggregate extraction areas.

Access to the municipal well site is obtained by a dirt road running south from County Road 13. The municipal wells and treatment system are operated by Ontario Clean Water Agency (OCWA) and are contained in a chain linked fenced property which is securely locked when OCWA staff are not present. Municipal Well #1 is the main supply well and is located inside the treatment facility building. Municipal Well #2 is a standby well, regularly flushed and equipped with piping and a control system, however has never been used for the potable water supply. Municipal Well #2 is located outside the building within the secured area.

From the 2001 Engineering Report, and a design report prepared by Genivar Consulting Group, the total design capacity for the Crysler Water Treatment Plant and Distribution System is 1,685 cubic metres per day at 85 metres total dynamic head. However, the systems actual daily operation rate only averages 175 cubic metres. This system services a population of 600 residents (according to 2001 census data). Groundwater is pumped from the main municipal Well #1 and is treated by chlorination and fluoridation. Continuous analysing monitoring equipment for flow, chlorine residual, turbidity and fluoride provide real-time data.

Treatment system upgrades will include the addition of two Trojan Technologies UVSwift SC Model B06 ultraviolet light units in parallel for system redundancy. Each unit is rated at 19.5 L/s (matching the incoming water flowrate) and has mechanical wipers, an NSF 055 Class A design dose, automatic alarms and automatic system shut-off. A single particle counter will be installed to continuously monitor the raw water flow and includes data logging

capabilities. An infiltration trench is proposed for drainage of the potable water discharged from the chlorine residual analyzers, turbidity meter and particle counter. Subject to Ministry approval, upgrades will be installed by November, 2004. The existing water system was designed by Kostuch Engineering Ltd., and has been in service since 1996.

2.2 GEOLOGY

The Village of Crysler production well site lies over a buried esker ridge consisting of melt water derived glaciofluvial sand and gravel deposits that coarsen toward the core of the esker body. The esker complex has a north-south trending axis that has been traced in varying forms to the south at the Village of Finch, a distance of some 16 kilometres. In the study area, the esker complex is up to 700 metres wide and has an average thickness of 12.7 metres, ranging from 8.1 metres to 18.9 metres. Offshore Marine deposits of blue-grey clay and silt are located to the east and west of the esker deposit. The clay and silt deposits overly the flanks of the buried esker ridge, thinning out toward the esker complex core. Between 1983 and 1986, a total of 32 test pits and 26 test holes were drilled to refusal and completed in the study area to map the sand and gravel esker deposit. The geological cross-sections of the Crysler esker complex taken from WESA's, September 1986 report are described below and presented in Appendix B.

The lines of cross sections are presented on Figure 5 of the WESA, September 1986 report. Cross section A-B (Figure 6 of WESA, September 1986 report) extends along the central north-south axis of the esker for approximately 1.4 kilometres. Cross section A-B indicates that the sand and gravel is exposed along the core of the esker deposit. Cross sections C-D (Figure 7 of WESA, September 1986 report), E-F (Figure 8 of WESA, September 1986 report), G-H (Figure 9 of WESA, September 1986 report), and I-J (Figure 10 of WESA, September 1986 report) all bisect the core of the esker deposit from west to east. Cross section C-D indicates that the sand and gravel unit is overlain by a 2.5 metre to 7 metre thick clay deposit along County Road 13. The clay is also evident in cross sections G-H and I-J, overlying the western flank of the esker deposit. An isopach thickness map of the sand and gravel aquifer is provided as Figure 5 in the WESA, September 1986 report. The isopach thickness map shows that the aquifer thickness is greatest along the core of the esker and that the complex thins out to the east and to the west. The interpreted boundary to the esker complex in the study area was taken from the EOWRC report findings (see Figure 5.3, Appendix A).

Underlying the buried esker ridge deposit is a thin (0 to 2.5 metres thick) discontinuous calcareous, silty, compact till. The till directly overlies the grey shaley limestone bedrock of the Verulam Formation (Williams, 1991).

2.3 LOCAL HYDROGEOLOGY

Fifteen of the 26 test holes were instrumented with groundwater monitoring wells. Additional piezometers include those installed in March 1993 by Trow for Kostuch Engineering Ltd. for geotechnical purposes (BH 112(GT1) and BH 111(GT2)), and the production well installed in May 1993 by WESA (Well #1).

Natural groundwater flow conditions of the sand and gravel aquifer were assessed from the WESA 1993 report and the historical report data. Static hydraulic head data collected from the site monitoring well network is plotted on Figure 11 of the WESA, September 1986 report. The information shows that groundwater flow in the aquifer is to the north and therefore recharge is derived from the largest part of the sand and gravel esker complex located south of the Crysler well site. The measured natural hydraulic gradient on the site is very shallow on the order of 0.0002 to 0.002. A low hydraulic gradient is characteristic of a highly transmissive aquifer. The average linear velocity for groundwater flow under natural gradient conditions was calculated at 0.52 m/day in the WESA GWA report. This velocity equates to a travel distance of 15.6 metres in 30 days, 26 metres in 50 days, and 52 metres in 100 days.

For the purpose of developing the microbial plan, WESA reviewed and refined the hydraulic parameters defining the esker complex, and thus those parameters used to model the area of primary recharge south of the municipal well(s). The measured natural hydraulic gradient within the recharge zone is very shallow on the order of 0.0002 to the south of the well field. The initial saturated thickness of the screened water-bearing unit varied from 8.00 m – 12.66 m in this area. A representative saturated thickness was assumed to be 11.00 m. The calculated average linear velocity for groundwater flow under the redefined natural gradient conditions was calculated at 0.05 m/day (calculation provided in Appendix C). This velocity calculated from the straightforward formula $v = Ki/n$, equates to a travel distance of 2.47 metres in 50 days, 36.00 metres in 2 years 179.98 metres in 10 years and 449.95 metres in 25 years. The hydraulic conductivity of the esker complex was calculated to be 61.64 m/day (Appendix C). This value equates to an aquifer transmissivity of 678.04 m^2/day. The conservative transmissivity estimate recommended in the WESA 1993 hydrogeological report was 678 m^2/day.

A second local aquifer is found below the esker complex aquifer. As identified in the EOWRC report the basal glacial sediment layer and the weathered shaley limestone bedrock of the Verulam Formation (Williams, 1991) formulate the 'Contact Zone Aquifer'. For hydrogeological properties of the 'Contact Zone Aquifer' the reader is invited to review Section 4.5 of the EOWRC report. The utilization of a deep bedrock water bearing zone is not common. Characteristically, wells completed in the local bedrock aquifer produce low yields and poor water quality.

2.4 WELL CONSTRUCTION

The geologic and well completion logs for Well #1 and Well #2 (formerly TW27) are provided in Appendix D. Although the wells are situated only 19 metres apart, the dissimilar layering of sand and gravel materials at the two well locations is evidence of extensive cross-bedding within the esker ridge. In general, the subsurface stratigraphy at the main pumping well, Well #1, is as follows:

Depth	Description
0 to 4.6 metres	Medium to fine grained sand
4.6 to 7.6 metres	Sand with varying amounts of gravel, some cobbles
7.6 to 8.5 metres	Medium grained sand
8.5 to 12.5 metres	Gravel with some coarse grained sand
12.5 to 12.8 metres	Till with silty sand matrix

3.0 DELINEATION OF MICROBIAL RISK MANAGEMENT ZONES (MRMZS)

The first task addressed under this requirement was the delineation of time of travel (TOT) zones in accordance with the *Protocol for Delineation of Wellhead Protection Areas for Municipal Groundwater Supply Wells Under Direct Influence of Surface Water* (MOE, 2001). For the microbial contamination control plan the Microbial Risk Management Zones (MRMZ)s of greatest concern to be delineated are i) the 0 to 50 day TOT and ii) the 50 day to 2 year TOT. Undertaking this task required a good understanding of the local hydrogeological conditions and water well construction.

3.1 WESA GUDI Well Assessment Report (GWA Report, 2002)

In the GUDI Well Assessment of the Village of Crysler Well Supply, Township of North Stormont, Ontario undertaken by WESA in April 2002 the 'calculated fixed radius method' was used to assess the capture zone radius of the Crysler production wells. Details on the limitations and results of this method were provided in the GWA report.

Since bacteria have a limited life span, (E. Coli for instance less than 50 days), the delineation of a 50-day TOT area for the Crysler well site was considered the most important. Using the maximum pumping capacity of 1685 m^3/day for the well water supply system, a potential capture radius of 187.5 metres and 716.6 metres were indicated for the 50 day and 2 year TOT zones, respectively.

3.2 Robinson Consultants Municipal Groundwater Study Report (EOWRC Report, October 2003)

A Municipal Groundwater Study for the Township of North Stormont was prepared by Robinson Consultants et al. in October, 2003 (EOWRC Report), in which they modelled the regional 'Contact Zone Aquifer'. The 'Contact Zone Aquifer' is comprised of the basal glacial sediment layer and the weathered shaley limestone bedrock of the Verulam Formation (Williams, 1991). Originally, as part of WESA's proposal for the scope of work for this report, WESA was to confirm the results of the EOWRC Report, specifically in regards to the Crysler municipal well site However, a peer review, contracted out by the Raisin River Conservation Authority, concluded that the MODFLOW modelling for the regional 'Contact Zone Aquifer' from the recently completed "Municipal Groundwater Study, North Stormont" was acceptable.

A point of key interest for the Crylser Site is that the EOWRC report clearly indicates that less than one percent of the regional water wells are tapped into the "overburden aquifer". Section 4.9.2.9 of the EOWRC report recommends local-scale refinement of hyrogeological data to improve the knowledge of groundwater flow around the Crysler wells. At a March 10, 2004 meeting between WESA, OCWA and the MOE it was decided that WESA would supplement the information with site specific geological and hydrogeological data for the local esker complex. The MOE agreed that WESA was not required to redo the MODFLOW modelling for the site but

should apply a common sense approach to estimate the expected changes to site conditions as the neighbouring sand and gravel pit expands to its' licensed boundaries. WESA used an analytical equation, Bear and Jacobs (Hydrology, 1965) to develop microbial risk management zones (MRMZs) within the boundaries of the esker complex. The results of the WESA analytical modelling exercise is discussed in Section 3.3 below.

The simulated WHPAs for the Crysler Municipal wells were delineated by Robinson Consultants Inc. et al. and are depicted in the EOWRC report, Figure 5.3. This figure is provided in Appendix A of this report. The EOWRC assessment indicates that the 50-day WHPA area for the 'Contact Zone Aquifer' at the Municipal well site is situated within 200 metre in the southeast direction from the well site. To the northwest, north and south of the well site the approximate distance to the 50-day TOT is 100 m, 125 m and 125 m, respectively. The 2-year WHPA has an elliptical shape in which the elongated side of the WHPA extends approximately 1,375 metres southeast beyond the boundaries of the Municipal well site, encompassing land zoned for aggregate extraction and agricultural/rural. The 10-year and 25-year WHPA extend several kilometres (11.5 kilometres and 12.7 kilometres, respectively) to the east/southeast.

From WESA's experience with numerical models such as 'MODFLOW' it is known that many parameters are highly sensitive. The modeling results presented in the EOWRC report was based on regional data collected over a 30 year period, and modeled primarily for the 'Contact Zone Aquifer'. Although the EOWRC model for the Crysler area took into account four geological layers, in the discussion of the model results (Section 4.9.2.7 of the EOWRC report, 2003) it was stated that:

"local groundwater flow gradient from east to west in the vicinity of the wells supplies the wells with water through the interconnected and underlying 'Contact Zone Aquifer'. It is easier for the wells to pull water from the upgradient sources than from distal cross-gradient and downgradient sources within the esker deposit."

WESA is not in agreement with this statement. WESA acknowledges that the Robinson et. al. team did not have sufficient local data to accurately portray, in the EOWRC simulation, the conditions with regards to the "Overburden Aquifer" or esker complex at the Crylser site. Through geological drilling and hydrogeological testing WESA has an understanding of the site specific hydrogeological conditions.

3.3 LOCAL MUNICIPAL WELL HEAD MICROBIAL RISK MANAGEMENT ZONES (MRMZ)

WESA's first step in delineating the microbial risk management zones (MRMZ) was to verify the reasonableness of the shape of the EOWRC report well head protection areas, especially with respect to the 50 day and 2 year protection zones.

The Crysler municipal supply wells are instrumented in a coarse sand and gravel esker deposit overlying a till confining unit, which, in turn, overlies the 'Contact Zone Aquifer'. The esker is bounded to the east and west by a clay unit that would act as a confining boundary to any surface source of contamination on the flanks of the geological feature. WESA's investigation as presented in their 1986 report, included an analysis of natural groundwater gradient fields and consequentially the recharge/discharge regime of the glacio-fluvial complex. At the time of the study the following conclusions were reached which were adopted as assumptions for this microbial contamination control plan:

- the esker complex is the source of groundwater for the Crysler municipal well field;
- the esker body appeared to be hydraulically continuous;
- groundwater flow in the aquifer was determined to be generally to the north-northeast and therefore recharge was found to be derived from the largest part of the sand and gravel esker complex located south of the well site;
- an impermeable till unit underlies the esker sand and gravels in the area of the well field. This till unit was found to be 2-2.5m thick in the north end of the study area in the vicinity of the municipal wells;
- Transmissivity within the aquifer was very high, oriented in a north south direction with a highly permeable esker core;
- The drawdown cone for the aquifer was very wide and shallow, characteristic of a very high transmissivity, high specific yield situation;
- Negative boundaries existed along the esker ridge where the sand and gravels gave way to relatively semi-confining silty sands then a confining clay unit;
- Positive boundaries may exist south of the well field where excavation ponds exist within the aggregate pit operation; and
- Hydraulic conductivity of the aquifer was determined to be: 61.64 m/day (derived from transmissivity and initial saturated thickness calculated by WESA in hydrogeolgical investigations in 1986 and 1993).

Therefore recharge for the Crysler municipal wells comes primarily from within the permeable and highly transmissive esker deposit itself and not the 'Contact Zone Aquifer'. WESA refined the WHPAs within the esker complex to reflect the local verses regional hydrogeological conditions. The protection areas within the esker complex are referred to as Microbial Risk Management Zones (MRMZ)

For all areas outside the defined esker complex, WESA assumed that the prime aquifer of concern was the "Contact Zone Aquifer", and adopted the well head protection areas (WHPAs) from the EOWRC report.

To determine the 50 day, 2 year and >2 year microbial risk management zones (MRMZs) for within the esker complex itself, WESA used an analytical equation derived by Bear and Jacobs (Hydrology, 1965), and compared this to the "fixed radius" method, to calculate a linear distance of travel associated with a time of travel (TOT).

The Bear and Jacobs equation assumed a constant pumping rate, a confined aquifer of infinite areal extent, with uniform flow in a linear direction. Verification of the applicability of the model was undertaken. As with all analytical models assumptions were made that are not exactly representative of the aquifer, however the error associated with the assumptions was considered acceptable. The Bear and Jacobs (Hydrology, 1965) method results, closely match the fixed radius model along the upgradient direction of groundwater flow. An outline of the calculations and model results are presented in Appendix C.

Figure 2 depicts the 50 day, 2 year and the > 2 year MRMZs , as well as the 2 year, 10 year and 25 year WHPAs for the Crysler municipal well field using this approach.

3.4 SYSTEM DESIGN CONSIDERATIONS

Future projected activities that might affect water demand are unknown in the study area at this time and therefore, a specific engineering evaluation has not been completed for this report. A brief assessment is presented below for discussion purposes.

The Crysler water treatment system was designed based on a 20 year projected population. A comparison of the design values and the actual 2001 measured values is outlined in Table 1. The 2001 census for Crysler indicated 225 households. Assuming there are 2.67 people/household (2001 census for Ontario) would yield 601 people. From a 1982 WESA report, a home sampling program was undertaken in Crysler and indicated that the village had 210 households. Therefore in 19 years the household numbers in the Village of Crysler increased by only 15. Assuming 2.67 people per household (2001 census for Ontario) this would equate to a population increase of 40 people over a 19 year period, approximately 2.1 persons/year. Assuming this same rate of growth, in 2024 the population of the Village of Crysler will be 649 people.

Table 1: Current Actual vs. Design Water Demand Values

Parameter	**Design Value (Engineer's Report, 2001)**	**Actual Highest Recorded Value (1999 to 2003 OCWA WPPA reports)**	**Difference**
Population	1500	600 (Township, 2004)	900
Average Daily Demand (m^3/day)	674	294	380
Maximum Daily Demand/(m^3/day)	1685 (current design flow)	507	1178

Table 2 below presents average day and maximum day demands recorded. Using an assumed average day water demand of 300 litres/pers/day, would equate to an average daily demand of 194,700 litres/day (194.7 cubic metres/day) for domestic use in 2024. Assuming domestic use is 60% of the total use in the village, the projected average water use would be close to 324.5 cubic metres/day in 2024. From 1999 to 2003, the maximum day demand factor ranged from 1.4 to 1.9 times the average day demand. From McGhee (1991) maximum day factors are estimated to range from 1.8 to 2 times average day demands. Based on the aforementioned, to estimate an average maximum daily demand, a maximum day factor of 2 is

presumed to be a reasonable value. Using this relationship the maximum use assumed for the year 2024 would be (2 * 324.5) or 649 cubic metres/day. This is still only 39% of the designed maximum use of 1685 cubic metres/day. For comparison purposes, please note that from 1999 to 2003 the highest recorded maximum daily demand was 507 cubic metres/day.

Table 2: Average Day and Maximum Day Demands Recorded (1999 to 2003 OCWA WPPA reports)

Year	Highest Recorded Average Day Demand (m^3/day)	Highest Recorded Maximum Day Demand (m^3/day)	Observations
2003	285 (in June)	450 (in May) (695* in October)	The 695 value was as a result of a water main break
2002	244 (in September)	419 (in October)	
2001	269 (in July	507 (in August)	
2000	294 (in September)	399 (in September)	
1999	262 (in May)	408 (in May)	
Overall	294	507	

4.0 INTRINSIC SUSCEPTIBILITY AND CONTAMINANT SOURCE INVENTORY WITHIN THE MRMZ

As per the MOE Reference Document (Jan. 2004), groundwater intrinsic susceptibility can be inferred from the well geology, water table position, vertical gradients, water bearing zones and where applicable, well screen location. Proximity to surface water should be noted. For microbial management plans the Intrinsic Susceptibility Index must be conducted to 500 m outside the 2 year TOT zone unless the total extent of the aquifer is less.

Within the EOWRC report, the entire coarse sand and gravel esker is ranked as 'high' aquifer susceptibility (EOWRC report, Figure 5.3). Further to the south, southwest and northeast, the areas are characterized by medium vulnerability (EOWRC report, 2003). The GwIS results

are presented in Section 5.0 of the EOWRC report and state that overburden thickness and the groundwater table were the deciding parameters in assigning aquifer intrinsic susceptibility (GwIS). WESA adopted the groundwater intrinsic susceptibility presented in the EOWRC report (Figure 5.3) for this study.

4.1 INVENTORY AND RANK THE RISK OF EXISTING AND POTENTIAL ACTIVITIES THAT MIGHT AFFECT THE *IN SITU* FILTRATION CAPABILITY OF THE AQUIFER & POTENTIAL SOURCES OF MICROBIAL CONTAMINATION

The requirement to inventory and rank the risk of existing and potential activities that might affect the *in situ* filtration capability of the aquifer involved assessing land use activities within the identified capture zones to determine whether any current or future land use could affect the *in situ* filtration capability of the aquifer. In particular, land uses causing significant ground vibration, or which involve subsurface excavation, drilling or boring were carefully evaluated to determine what effect if any they may have on elevated particle counts in the well water. Once identified, each risk was ranked based on WESA's professional judgement and a common sense approach.

The requirement to inventory and rank the risk of existing and potential sources of microbial contamination involved assessing land use activities within the identified capture zones to determine whether any current or future land use could be a potential microbial contaminant source. For the purposes of this task, the Guideline outlines that it is acceptable to focus on the activities within the 2 year MRMZ, with the exception of high risk activities which should be identified even if beyond the extent of the 2 year MRMZ.

This inventory is required to identify any sites where there is an existing or potential source of pathogenic microbial activity including commercial/industrial, agricultural/rural and residential/municipal activities. The risk inventory involved collection of as much of the following information as possible for description of the potential source:

- Source name and name of owner/operator;
- Identification of whether it is an existing or potential source;
- Source type;
- Approximate areal size of source; and
- If the source is permanent or intermittent.

Where possible the location of the source included:

- Address;
- Geo-reference (field based GPS for high risk areas), desktop location for low risk areas
- Approximate saturated horizontal TOT to the well/well field;
- Current municipal zoning and land use type
- Source risk rank (based on degree of aquifer susceptibility, likelihood of the sources release of contaminants, amount of contaminant generated, use of best management practices, and monitoring of groundwater quality downgradient)

A site visit was conducted on April 29, 2004 by WESA to ground truth existing and potential activities that could affect the aquifer's capabilities of *in situ* filtration, and potential sources of microbial contamination. All potential and existing sources are summarized in a Microbial Risk Inventory attached as Table 3 and are mapped on Figure 3. Figure 4 identifies municipal zones and land use designations. A description of these activities is included herein. Where local residents and farmers were present, they were consulted for permission to ground truth their site and activities. As outlined on Figure 3, residents that agreed to WESA's investigation are shown with a number on the map and are detailed in the microbial inventory (Table 3). It should be clearly noted that the activities and point sources shown on these specific properties are not unique to these properties, but are indicative of activities undertaken in the area. Additional, similar potential point sources were observed from the road, and confirmed in aerial photographs and in review of the topographical map of the area where possible. WESA would like to thank those residents who willingly and kindly participated in this portion of the work program.

4.1.1 Mineral Aggregate Extraction

Mineral aggregate extraction activities might affect the *in situ* filtration effectiveness of the aquifer, as well as act as a potential source of contamination. Mineral aggregate extraction land-use involves subsurface excavation, and in this case excavation below the ground water table. Two aggregate extraction operations are present in close vicinity to the municipal water supply wells, these are;

- Provost Sand Pit (Raymond Provost Cartage Company Ltd.) and,
- Gagne Pit (Claude Gagne and Alice Gagne).

The Provost Sand Pit is located on lots 20 and 21 in Concession 9 of the Township of North Stormont and is depicted in Figures 3 and 4. The operation immediately borders the municipal supply well site to the east, west and south. The Raymond Provost Cartage Company Ltd. holds a Class A licence allowing more than 20,000 tonnes of aggregates to be extracted per year up to a maximum of 200,000 tonnes/year, and for extraction to take place up to 5.4 m below the water table. The water table is indicated on the aggregate license to be at 97.4 masl and the approved basal limit of excavation is 92.0 masl. The permitted extraction area limits are located at a distance of 60 m from the municipal supply well site as per the license agreement. The Provost Sand Pit occupies a 26.3 hectare area. At the time of the April 29, 2004 site visit, 5 ponds were noted to the east, west and south of the municipal wells site property. These same ponds had an areal extent of approximately 3,500 m^2 as measured during a 2002 visit of the property, and are expected to have increased in size, and it is expected they will continue to increase in extent over time. The operation plan for the Provost Sand Pit outlines an extraction plan which requires that the operator extract all licensed material from Quadrant 1 or 2 before proceeding to Quadrant 3 or 4. Rehabilitation should proceed in each quadrant as the second lifts are being completed. Therefore, Quadrant 1 and Quadrant 2 should begin rehabilitation before activity begins in Quadrant 3 or 4. Appendix E outlines the quadrant boundaries and extraction operation plan.

The Gagne Pit is located in Lot 20, Concessions 8 and 9 in the Township of North Stormont, further to the south of the Provost Sand Pit, within the same sand and gravel esker complex as the municipals wells. The Gagne Pit is divided into a north and south section, north and south of Concession Road 8-9/Beeler Road. The north section is closest to the Crysler wells at a distance of approximately 500 m to the south of the well site. The Gagne Pit is presented on Figures 3 and 4. Gagne Pit is licensed for an approximate 38.9 hectare area and is located outside of the 2 year MRMZ. A request to amend Gagne Pit's permit was made in 2000 to allow extraction below the groundwater table. It is WESA's understanding however that currently the pit licence remains as a Class B, enforcing that extraction be limited to elevations above the groundwater table.

The mineral aggregate extraction activities have been ranked as 'high' risk activities with respect to their potential to affect *in situ* filtration capability of the aquifer. With respect to microbial risk, risk ranking is assigned based on TOT as outlined in Table 3.

4.1.2 Dug and Drilled Wells

The installation of new domestic and commercial water supply wells is considered a risk to the aquifer's capabilities of *in situ* filtration and also a potential source of microbial contamination. The risk arises from the well construction which involves drilling or boring into the subsurface to an elevation below the groundwater table. It should be noted that groundwater wells located within the sand and gravel esker offer a direct pathway to the aquifer. Even deeper wells, screened within a lower groundwater unit, may offer a pathway to the sand and gravel esker if the well is not properly sealed or grouted.

A dug well was noted on a property to the northeast of the municipal well site at a distance of approximately 300 m. This site is identified as # 6 in the microbial risk inventory (Table 3). The dug well was no longer in use and had been replaced by a drilled well, but it had not been abandoned. Though no other dug wells were observed, the ground truthing conducted on April 29, 2004 was done while driving along main roads. It is speculated that more dug wells may exist in the vicinity of other drilled wells. Drilled wells were observed on many residential and farm properties. Figure 3 depicts residential and farm locations. These locations were identified using a topographical map and aerial photographs. Most of the drilled wells that were inspected during the April 29, 2004 field visit 'appeared' to be of recent construction and in good condition. It is possible that others are present that require repairs or upgrades as the MOE well records for the area include wells constructed as early as the 1950's with the majority constructed in the 1970's.

With respect to the ability of wells to affect the aquifer's intrinsic susceptibility, dug wells were ranked as 'high' risk. Improperly constructed or unsealed drilled wells were similarly ranked as 'high' risk. Properly constructed and sealed drilled wells were ranked as 'low' risk. With respect to microbial risk, risk ranking is assigned based on MRMZ area as outlined in Table 3.

4.1.3 Manure Lagoons & Spreading Activities

Manure lagoons often are excavated into the subsurface and have only recommended standards, so their construction can range from an earthen pit to an earthen floor with concrete walls. For these reasons these structures represent a risk to the aquifer's *in situ* filtration capability and are potential sources for microbial contamination.

During the ground truthing undertaken on April 29, 2004 many large (approximately 40 m diameter) constructed circular lagoons were observed on farm properties. The lagoons were located in the vicinity of barns, and are speculated to contain liquid manure for spreading on farms where the manure is generated. The circular pits appeared to be dug into the ground, and were enclosed by fence structures. Figure 3 outlines the farm locations where manure lagoons were observed from the road, or where they were identified by review of aerial photographs, or the EOWRC report. It is speculated that most of the farms in the area have similarily constructed manure lagoons. The manure lagoon construction has been ranked as a 'moderate' risk activity with respect to its' potential to affect *in situ* filtration capability of the aquifer, assuming excavation activities will not cause significant ground vibration, and assuming a shallow subsurface excavation. With respect to microbial risk, risk ranking is assigned based on MRMZ area as outlined in 3.

Application of liquid manure to farm fields, and/or biosolids is assigned a microbial risk rating based on MRMZ area as outlined in Table 3. This activity is not anticipated to present a risk to the aquifer's *in situ* filtration capabilities, as it is not anticipated to involve any significant ground vibration or any subsurface excavation. If manure storage and application activities are properly controlled through development of Environmental Farm Plans (EFPs) for small farms (less than 300 nutrient units (NUs)) or regulated through the Nutrient Management Act of the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) this risk can be controlled.

4.1.4 Septic systems

Septic systems are either excavated into the subsurface or constructed on the existing ground surface depending on the natural materials in place. For this reason septic beds represent a low to moderate risk to the aquifer's *in situ* filtration capabilities. Septic systems represent a microbial contaminant risk.

All residents within the microbial risk management zones have private septic systems. Residential and farm locations are indicated on Figure 3. Proper construction, care and maintenance of these systems is required to mitigate microbial contamination risks. Septic tile fields involve the subsurface distribution of microbial contaminants. With respect to microbial risk, risk ranking is assigned based on TOT areas as outlined in Table 3.

4.1.5 Lagoons/Ponds/Swales & drains

A large lagoon was noted approximately 2 km to the northwest of the Crysler municipal supply wells. Local residents speculated that the lagoon may have been associated with a cheese factory in St. Albert. This lagoon is identified as No. 26 in the microbial risk inventory (Table 3) and on Figure 3. As mentioned in Section 4.1.1 ponds were also associated with the local aggregate extraction operations. A large pond to the south of the Site was also noted on the south side of the north section of the Gagne Pit. This pond was not shown to the extent observed, on the topographical map of the area, and is speculated to alter in extent seasonally. Lagoons and deep ponds are assigned a 'high' risk ranking with respect to the aquifers *in situ* filtration capabilities and potential microbial contaminant source.

Swales, drains and naturally occurring shallow ponds are smaller water bodies, and likely of limited depth. New construction or repairs of these features have been assigned a 'moderate' risk ranking with respect to their ability to affect the aquifer's in –situ filtration capabilities. However, existing swales and drains and naturally occurring shallow ponds do not pose an *in situ* filtration risk.

With respect to microbial risk, risk ranking is assigned to these features based on MRMZ as outlined in Table 3.

4.1.6 Summary

The location of all the identified potential sources of contamination is shown on Figure 2 along with the Microbial Risk Management Zones (MRMZ). A summary of the potential contaminant sources for each Microbial Risk Management Zones (MRMZ) are given below.

0-50 Day MRMZ

The first MRMZ (0-50 day) extends approximately 75 metres to the north, 100 metres to the west, east and south from the Crysler Well Site. This area includes two (2) potential contaminant sources, the Provost Sand Pit licensed operational area and the swale located just north of the well site which flow EW and acts as a drainage path for site surface water. The aggregate operation is rated as having a high hazard potential for both the *in situ* filtration and microbial contamination. The swales hazard potential is moderate for microbial contamination.

50 day to 2 year MRMZ

The second MRMZ (50 day to 2 year) extends 401 metres to the south, 354 metres to the north and 375 metres to the east and west of the Crysler Well Site. There are five (5) potential contaminant sources within this MRMZ; the southern extent of the Raymond Provost Cartage Company Ltd. operation; drainage ditches (swales); the P. Laroque residence which has a drilled well, septic bed, gas AST, and a depleted manure pile; manure spreading in fields just east of the well site; and a farm just across CR13 north of the well site. The *in situ* filtration hazard rating and the microbial contamination rating are listed in Table 3.

>2 year MRMZ

The third MRMZ (> 2 year) extends 500 metres in all directions from the outer limits of the 2 year MRMZ boundary. Within this area there are six (6) points of potential source contamination, these are; farm operation northwest of well site; farm operation northeast of well site; A. Richer residence northeast of well site; Gagne Pit; swales and ditching; and surface water ponds within aggregate pits. For the *in situ* filtration hazard rating and the microbial contamination rating for these point sources refer to Table 3

4.2 Chemical Contamination Source Considerations

During the April 29, 2004 ground truthing visit, several potential chemical sources were identified. Although identification of potential sources of chemical contaminants is outside the scope of the work requirements for this report, WESA felt it was important to provide this information, for consideration purposes, and for future development of a more comprehensive wellhead protection plan. The following features were identified and are outlined in Table 3:

- Above ground storage tanks (ASTs) for fueling were observed, primarily on agricultural properties, speculated to be used for fueling farming equipment. Other farm equipment maintenance products may also be stored on these sites;
- Farming practices would include the use of pesticides and fertilizers. Since the types of pesticides used are commonly crop specific, WESA noted crop types and locations in their April 29, 2004 ground truthing. Figure 5 identifies agricultural crops observed in the area on that date;
- Household hazardous waste are always a consideration, including items such as paints, solvents, cleaners, oils/greases/lubricants, fuels, batteries, etc.;
- An old dump/waste disposal site was observed, located approximately 3 km to the southeast of the wellheads and is identified as No. 14 on Figure 3 and in Table 3. No groundwater monitoring wells were visible in association with this site, and it is unknown if chemical contaminants leaching from historically buried wastes are an associated concern with this property;
- A sign for a motor repair shop was observed, and the estimated location of this shop is shown on Figure 3 and Table 3 as No. 17 ;
- A welding and lubricating location was identified as well, and is shown on Figure 3 and Table 3 as No. 22 ;
- A sign indicating land application was seen east of the 'dump' location and is shown on Figure 3 and Table 3 as No. 15.

5.0 IDENTIFIED MEASURES TO PROTECT WELL(S) FROM MICROBIAL CONTAMINATION AND TO PROTECT THE *IN SITU* FILTRATION CAPABILITY OF THE AQUIFER

Identifying measures to protect wells from microbial contamination and to protect the *in situ* filtration capability of the aquifer involves developing a plan to manage the risk of contaminant release to the groundwater, and making recommendations for allowable activities in new developments. This aspect would involve partnerships with local business, industry and the agricultural community focussing on educational/training programs, pollution prevention and best management practices. On a regulatory level, recommendations would be made regarding regulatory permitting and land use controls/restrictions. Section 5 of MOE Reference Document (2004) outlines microbial contamination control measures. Tables 5-2 and 5-3 of that document

outline priority microbial contamination control measures and management of activities that might affect *in situ* filtration effectiveness of the aquifer, respectively. A copy of Section 5 of the MOE Reference Document (2004) is included as G. This document was heavily referenced for development of this section of the report.

5.1 LAND-USE RISK RATING

To evaluate all of the data collected during this study in terms of planning for the future, and managing present land development, a two matrix system was used to integrate the results of the GwIS index and the analysis. To determine the land-use microbial risk rating only, Time of Travel zones and groundwater intrinsic susceptibility factor into the ranking system.

For areas greater than 500 m outside the 2 year TOT zone the MOE rating scheme recommended in the *MOE Terms of Reference* was used and is presented in Table 4 below:

Table 4: Land Use Risk Rating Matrix

Saturated Zone Time of Travel	Groundwater Intrinsic Susceptibility (GwIS) Index		
	< 30	30 to 80	> 80
<50 day	High	High	High
50 day to 2 years	High	High	High/Moderate
2 to 10 years	High	Moderate	Low
10 to 25 years	Moderate	Low	Low

For areas outside the 25 year TOT zone a rating of Low Risk was assigned.

For all other areas closer than the above stated distance the MOE rating scheme recommended in the *Reference Document – Model Microbial Contamination Control Plan for Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective In situ filtration* was used as presented in Table 5 below:

Table 5: Microbial Risk Management Rating Matrix

Saturated Zone Time of Travel	Groundwater Intrinsic Susceptibility (GwIS) Index		
	< 30	30 to 80	> 80
<50 day	High	High	High/Moderate
50 day to 2 years	High	Moderate	Low
> 2 years	Moderate	Low	Low

Areas within the Esker Complex

Based on the matrices shown above all of the area falling within the 0-50 day Microbial Risk Management Zones (MRMZ) should be considered high risk as well as the entire 2-year Microbial Risk Management Zones (MRMZ). This is primarily due to the high permeability of the sand and gravel unit, depth of water table (<30 m), unconfined nature of the esker core area, which provides little natural protection from potential contamination sources, and time of travel. In addition the highly transmissive nature of the esker complex permits a strong migrational pathway for microbial contaminants. No areas of the 50 day and 2 year Microbial Risk Management Zones (MRMZ) lie outside the geological boundaries of the esker complex.

For the > 2 year MRMZ, those areas along the esker complex with no or minimal clay cover (< 4m) are rated as moderate risk. This is primarily due to the increase in travel time and the potential for remediation over this distance. The Land-Use Risk Rating (LURR) for Crylser Microbial Contamination Control Plan referred to as the Microbial Risk Management Ranking (MRMR) is shown in Figure 6.

Special attention is drawn to that area within the esker complex, between the WESA 2 year MRMZ and the esker complex geological boundary southeast of the well site. This area was originally ranked as moderate risk due to the distance from the well site, however, as a conservative approach to well head protection and for practical application of the plan it has been upgraded to high risk to correlate with the high risk ranking of the 50 day to 2 year WHPA just outside the esker complex (see Figures 2 and 6).

Areas outside the Esker Complex

The GwIS rating (EOWRC report) is high to medium for this area and therefore the land-use rating assigned for this area ranks from low to high depending on the thickness of the clay unit and distance from the Crysler municipal well site. The area outside the esker complex that is located within the EOWRC report's 50 day to 2 year WHPA to the southeast of the well site has been ranked a high risk land use zone. All other areas outside the esker complex lie outside the 2 year WHPA zone boundary and have been given a rating of Moderate to Low risk (see Figures 2 and 6).

5.2 RISK MANAGEMENT STRATEGIES

To reduce risk within the Microbial Risk Management Zones (MRMZ)s a number of approaches can be applied. In general the most beneficial approach is *risk avoidance*, followed by *risk management* and *awareness*. These three approaches are very different with regards to implementation.

Risk avoidance requires the removal of risk. In the context of municipal well head protection, this would be achieved by removing from the area those potential sources that are of greatest risk of causing an adverse impact to the underlying groundwater. Of the three strategies, risk avoidance is generally considered to be the most problematic to implement (methods of implementation are discussed in the Appendix G).

Risk management would not be as effective because the potential source of contamination would remain at its current location. However stringent programs would be implemented to manage risks on the property, and if implemented properly are very effective.

The third strategy is *awareness*. By informing people that they are located near the municipal groundwater wells and instructing them of the potential hazards of adversely impacting the groundwater, there will be an increased level of interest to implement risk management practices.

5.3 RISK RANKING & ASSOCIATED RISK MANAGEMENT STRATEGIES

As defined in the MOE *Reference,* there were three designations for Aquifer Microbial Risk Ranking derived from an estimate of time of travel and intrinsic susceptibility. In the zone rated High for Aquifer Microbial Risk Ranking, the objective is one of risk avoidance (no significant potential sources of microbial contaminants should be permitted). It is within this zone that the greatest care must be taken to encourage stringent measures to manage any current sources of microbial contaminants and timely effective contingency plans must be established. In the zone rated Moderate for Aquifer Microbial Risk Ranking, the objective should be one of risk management and monitoring. Within the areas rated Low with respect to Aquifer Microbial Risk Ranking, the emphasis should be on awareness, education and minimal controls, necessary to ensure protection of the well site.

5.4 IMPLEMENTATION OF WELL HEAD PROTECTION STRATEGY

The suggested strategies presented above identify different activities to be implemented within different Aquifer Microbial Risk Ranking zones. The implementation of any of these strategies depends on whether the site is a greenfield site (as yet undeveloped) or a site that is already developed. In the case of a greenfield site, requirements can much more easily be imposed during the planning stages prior to someone purchasing or developing the property. In the case where the property is currently developed, it is much more difficult to impose requirements.

5.4.1 Risk Avoidance

In the High and Moderate aquifer microbial risk zones the greatest care must be taken to manage any current risks, and avoid the addition of any moderate to high risk sources.

In Tables 5-2 and 5-3 of the MOE Reference Document (copied in Appendix F of this report), a ranking system was developed to evaluate potential land-use activities and sources that might affect microbial contamination and *in situ* filtration of the aquifer. This ranking system, is

recommended to be used to define which operations should be excluded from establishing themselves within a High or Moderate Microbial Risk Management Ranking area. The current zoning for the area is provided in Figure 4.

Surrounding the Crysler municipal well site, licensed aggregate pits and farm operations are already present within the Microbial Risk Management Zones (MRMZ)s, and forcing a change of land-use is difficult. Changing current zoning of greenfield sites to limit development of high and moderate risk contaminant sources should be strongly considered for those areas ranked High and Moderate in the Microbial Risk Management Ranking. Other risk avoidance measures used by other municipalities in Ontario are discussed in Appendix G.

In summary the tasks Associated with Risk Avoidance are the Following:

- Task 1: Use the ranking system which evaluates potential contaminant sources (Tables 5-2 and 5-3) and use this to define which operations and activities in the future should be excluded from establishing themselves within a High or Moderate Microbial Risk Management Ranking area.

- Task 2: Through land-use planning, change zoning such that certain activities are not permitted. This includes amending the Official Plan and creating By-laws to restrict the type of land-uses in Microbial Risk Management Zones (MRMZ)s with restrictions being more stringent closer to the well head itself.

5.4.2 Risk Management

Where high or moderate risk activities are already present in a high or moderate risk area, stringent initiatives need to be put in place to ensure that best management practices are being maintained and to limit expansion.

5.4.2.1 Discouraging Expansion

In cases where there are existing moderate or high risk operations and it is too difficult or costly to move them out of the Microbial Risk Management Zones (MRMZ)s, limited expansion/development should be permitted within the high risk land-use areas. In the moderate risk land-use areas, a permitting program could be implemented requiring approval before any new operation/expansion/development is undertaken. The permitting program would include agreements placing restrictions on the types and quantities of potential microbial contaminants based on their potential to impact the groundwater. Permitting would serve to monitor and direct expansion/development and restrict any activities that could negatively affect the aquifer's effective in-situ capabilities. Expansion can be discouraged by implementing land securement or protection mechanisms.

5.4.2.2 Implementing Best Management Practices

Best Management Practices (BMP's) identify specific actions that lead to prevention of groundwater impacts.

To ensure the implementation of Best Management Practices, the Municipality could also encourage/ require the implementation of the following through by-law creation:

- BMPs for aggregate extraction: The current pit operation licence for Provost Sand Pit allows extraction beneath the water table at a distance of approximately 60 m from the wellheads. A meeting should be undertaken with the MNR, MOE, Township and WESA to discuss, in light of the new Safe Drinking Water Act, the best approach to encourage extraction at a distance as far away from the wells as possible. Once an approach has been decided Raymond Provost Cartage Company Ltd. should be invited to a similar meeting in an attempt to reach an agreement. Options to consider in order of preference include seeking a larger buffer area where no extraction is allowed (the 50 day time of travel zone); seeking no extraction beneath the water table within a certain setback distance from the wellheads (again the 50 day time of travel zone); encouraging that extraction be completed in quadrants 1 or 2 before any work is undertaken in quadrants 3 or 4; also seeking an alternate rehabilitation plan for the Provost Sand Pit and not leaving the Site as a lake as per the current license agreement. Permission should also be

requested for collecting water samples on a quarterly basis from Provost Sand Pit Ponds (Pond 1 and Pond 2) as per the contingency measures outlined in Section 6.2 below.

- BMPs for Farm owners: work with farmers to develop Environmental Farm Plans. Recommend construction standards and BMPs for sewage/manure/biosolid storage, handling and spreading in accordance with the Nutrient Management Act (NMA). The regulation and protocols for manure storage/handling and spreading is very prescribed and can be found and reviewed at the following websites;
    - http://www.gov.on.ca/OMAFRA/english/agops/index.html.
    - http://www.gov.on.ca/OMAFRA/english/environment/water/clean_water_incentives.htm) (for funding opportunities)
    - (http://www.gov.on.ca/OMAFRA/english/nm/cert.html) (for certification and training programs offered).
- Farmers should be strongly encouraged to attend a training course, and be supported in the implementation of NMA requirements, and Environmental Farm Plans.
- BMPs for proper well care, construction and abandonment should be provided;
- BMPs for septic system care, construction and abandonment should be provided;
- The municipality could strongly encourage people who have potential medium and high risk contaminant sources to attend a workshop(s) for BMP implementation.

By having such systems in place, it would ensure that the Best Management Practices are being implemented on a continual basis. Sample BMP fact sheets, including some developed by the Region of Waterloo, could be used as templates for the business sectors identified in the Crysler study area. These are provided in Appendix H of this report.

To ensure the implementation of Best Management Practices, the Municipality could also encourage the implementation of the following for residents/farmers/commercial operators through creation of a task force (volunteer or otherwise):

- Perform a survey to verify the existence, construction and use of private water wells. All unused wells should be properly abandoned beginning in the high risk ranked areas of the study area. Construction and integrity of existing wells should be evaluated, and where required maintenance or upgrades should be undertaken to ensure a proper seal; Private water well owners should be encouraged to regularly verify the microbiological quality of their water supply by collecting and submitting samples free of charge to the local Health unit for analysis, sampling frequency should be coordinated with the local Health unit (depending on the Health unit's

capability, quarterly sampling is recommended). Residents within the 50 day MRMZ should be encouraged to report adverse results to the task force, and follow up with a summary of corrective actions taken and final water quality results.

- Verification of the proper decommissioning of any unused private septic systems is strongly recommended beginning in the high risk ranked areas. A program should be undertaken to ensure all tanks have been properly emptied and abandoned, and septic fields decommissioned. Active septic systems should be inspected to ensure they are being properly maintained, and a regularly scheduled inspection/maintenance program implemented.
- Assist farmers in understanding the requirement of Environmental Farm Plans and the Nutrient Management Act. Coordinate with the Ministry of Agriculture and Food, for provision of a response to questions/concerns with respect to understanding and implementing the requirements. Consideration should be given to hiring a consultant to help farmers implement these tasks.

In summary the tasks Associated with Risk Management are the following:

Task 1: Restrict any new expansion/development within the high risk land use areas.

Task 2: In the medium land use risk areas implement a permitting program that will require approval prior to expansion or development. Include additional restrictions on activities that could potentially impact the groundwater.

Task 3: Encourage the implementation of best management practices for activities within the Microbial Risk Management Zones (MRMZ)s through By-law creation.

Task 4: Encourage the implementation of best management practices through creation of a task force, and programs/workshops for implementation.

5.4.3 Awareness (Education and Training)

The objective of any awareness campaign is to target an audience, and inform as many of the target audience as possible. In this case, the targeted audience is everyone within the Microbial Risk Management Zones (MRMZs). It should be noted that people residing/working outside the WHPA would also benefit from this training.

There are various methods used to inform the target audience. Given the technical nature of the topic, it is strongly suggested that the material be presented in an interactive manner. Workshops are a very effective educational tool that can reach a large number of people at one time. For example, a one-day workshop could be held for up to 50 attendees to present the concepts of groundwater protection, to introduce the concepts of risk management in terms of environmental impact, and to present some Best Management Practices. The workshop would explain how they could potentially impact the groundwater and what measures need to be taken to prevent this from occurring.

Materials to be presented in the workshop could include the BMP's included in Appendix H. Some appropriate BMPs should be presented and reviewed in detail to demonstrate their applicability and usefulness. Implementation of such BMP's should be discussed so that participants have a concrete notion of the steps required to implement the components of the BMP. And to ensure continued awareness and implementation of the BMP's, the workshop could also mention the use of Environmental Management Systems, Pollution Prevention Plans, Environmental Farm Plans, and Spill Response Plans. The workshop should provide a list of references and web sites that participants could consult to develop their own plans.

To reach a broader audience, mail-outs included with municipal correspondence can be an effective means of raising awareness. Public signage indicating the boundaries of the Microbial Risk Management Zones (MRMZ)s on major routes around the Crysler Village and well site would provide a strong visual message to local residents. Mailouts could include the following materials:

- General information regarding the importance of protecting their groundwater resources.
- A summary of the results of groundwater study including illustrations showing the location of the municipal wells and the groundwater capture areas.
- General information about potential microbial contaminants and activities that affect the *in situ* filtration capabilities of the aquifer and how these could impact the groundwater.
- Suggestions regarding prevention of potential groundwater impacts.
- What actions one should take in the event of a spill (reporting, cleaning-up, use of spill kits).

In summary, the tasks Associated with Awareness (Education and Training) are the following:

Task 1: Identify key activities of concern and target audience, and provide workshops to address these activities. Present BMPs, including implementation strategies, cost considerations, where more information can be found, who can help, etc.

Task 2: Create an area on the Township website with key information on the Microbial Risk Management Zones (MRMZ)s, contacts and BMPs

Task 3: Target potential contaminant sources through mail outs that outline specific BMPs;

Task 4: Design and post public signs indicating the boundaries of the MRMZ, and the risk ranking of each MRM zone.

A few general management tools available for microbial protection that the municipality may want to consider and implement are included in Table 5-1 of the MOE Reference Document attached as Appendix F.

6.0 MONITORING PLAN AND CONTINGENCY MEASURES

In addition to the aforementioned risk avoidance, risk management and risk awareness strategies the following monitoring and contingency plans are also recommended. Please note further microbial protection requirements as outlined in the Certificate of Approval #6160-62VLJG, Provincial Officer's Order No. 4802-5T9M2R and the March 2001 Engineer's Report, have not been duplicated herein. These aforementioned documents should be further consulted and followed as outlined within their respective text.

6.1 *IN SITU* FILTRATION ASSESSMENT

Particle count data should be used to evaluate trends with respect to changes in environmental conditions and pumping flow rates. Correlations between particle count data and weather events, flow rates, or changes to extraction or other activities in the Provost Sand Pit and

area surrounding the well heads should be recorded. These observations should include any observations of other potential sources of impact as well. The particle count values recorded over time, should also include a description of the size of particles being detected. A checklist for the particle counter should be created to record observations of weather, pumping flow rate, surrounding site activities and other potential sources of impact in addition to particle count numbers and particle sizes. Regular review of the continuous particle count data (within 72 hours) for adverse results should be undertaken as outlined in Ontario Regulation 170/03 for continuous monitoring equipment (as already undertaken for chlorine residual and turbidity data). Results of the program should be evaluated on a quarterly basis for the first year by a qualified person in conjunction with other data collected and assessed for changes and trends.

Verification of the proper functioning of the particle counter installed, and a regular operation and maintenance protocol for the particle counter should be incorporated into the current operation and maintenance program and checklists at the Crysler Water Treatment Plant. Operation and maintenance should be conducted as per the manufacturer's recommendations or as specified by a professional engineer, and scheduled in compliance with the requirements of Ontario Regulation 170/03 under the Safe Drinking Water Act. The operation and maintenance program should include calibration and replacement of required parts. Any parts requiring frequent replacement should be kept on hand in the Water Treatment Plant, again as per the requirements of Ontario Regulation 170/03.

As per the *in situ* filtration assessment outlined in Section 3 of the MOE Guidance Document (January, 2004), in order for a well to be characterized as having "effective *in situ* filtration", the following conditions must be met:

a) Particle count data must show that the water consistently contains significantly less than 100 particles per mL in the size range of 10 microns and greater;
b) Particle counts must remain constantly low during storm, seasonal or other regular environmental changes. This is required to ensure that embedded microbes are not shielded from effective UV or chlorine disinfection.
c) Raw water does not contain significant microbial loadings; to ensure the disinfection process is not overwhelmed.

Any result that does not result in a conclusion of 'effective *in situ* filtration' as described above should be treated as an 'Adverse Result' and be reported as per the Ontario Ministry of the Environment (MOE) Regulation 170/03 reporting protocols. A copy of the reporting form and instructions can be found on the MOE website at the following link: http://www.ene.gov.on.ca/environet/dwis/forms.htm.

Corrective actions should be determined in consultation with the MOE Spills Action Centre (SAC) at 1-800-268-6060 or 416-325-3000, the local Medical Officer of Health (MOH), and the Ontario Clean Water Agency (OCWA). It is anticipated that corrective actions would include: immediately shutting off the raw water intake, immediately verifying the quality of the treated water to be supplied, re-testing the raw water, verifying the particle counter is functioning properly, shock chlorination of the water supply well, use of the standby well, and/or possibly issuance of a 'boil water advisory'.

If consistent adverse results are encountered indicating that inadequate *in situ* filtration is present within the aquifer, actions to address the activities that correlate to the adverse results should be undertaken. Ultimately, the safest solutions would be the addition of chemically assisted filtration to the treatment process.

Due to the costs associated with chemically assisted filtration, WESA strongly encourages that the preventative approach within this document be adopted. Should chemically assisted filtration become the only viable solution, funding through government programs to undertake the required filtration upgrade should be sought to minimize the financial impact on the Township. Where consistent adverse results are encountered indicating inadequate *in situ* filtration the Crysler water supply would be considered a GUDI Site without adequate in situ filtration and would then qualify for funding. Funding opportunities should be sought in consultation with the Ontario Ministry of the Environment and the local South Nation Conservation Authority, funding opportunities may potentially still also exist through OSTAR provided by the Ministry of Agriculture and Food.

6.2 GROUNDWATER MONITORING NETWORK

Monitoring of groundwater quality at wells located between the municipal production well and closest potential sources of microbial contamination and aquifer disturbance is recommended. At the Crysler Site, the closest potential source of microbial contamination and aquifer disturbance is the Provost Sand Pit, whose permitted extraction areas are within 60 m to the east, west and south of the wellhead. In response it is recommended that three, two inch monitoring wells be installed on the north (for background data), southeast and southwest sides of the Water Treatment Plant. The proposed approximate locations of these monitoring wells are illustrated on Figure 7. The monitoring wells can be located within, and along the boundaries of the fenced area of the water treatment plant. Alternatively, the north well could be located outside the fence between the Site and the north ditch used for water discharge.

These three wells are recommended to be drilled by truck mounted hollow stem auger technique down to the same elevation as the production well screen. Drilling and instrumentation of the wells should be undertaken using the guidelines outlined in Ontario Regulation 903 as amended by 128/03 under the Ontario Water Resources Act related to the prevention of the introduction of any potential contaminants to the aquifer. These precautions would ensure only new materials are used, that they are clean and free of contamination, and will not impair the quality of water with which it comes in contact. Hollow stem auger equipment should be thoroughly decontaminated before being brought to the Site by pressure washing equipment using hot water and an acceptable cleaning agent, in an appropriate wash/rinse cycle. All downhole materials should also be disinfected by means of a chlorine solution before introduction to the bored hole. The borehole should be chlorinated upon completion, by a methodology that will not impart any impact to the raw water quality at the potable water supply well heads. Specifications on appropriate materials, disinfection protocols, well instrumentation/construction, and precautions to ensure that no potential contaminants are introduced to the Site should be outlined in a specification document before the work proceeds, and closely monitored during construction.

The purpose of the three monitoring wells is for advanced warning of a surface water impact, before impacted water can reach the Municipal supply wells. In development of the indicator parameter list WESA considered microscopic particulate analysis (MPA). MPA verifies the presence of a broad range of surface water indicators including vegetative parts,

insects or insect parts, microorganisms, algae, or large diameter protozoa pathogens. Through discussions with two analytical laboratories that specialize in MPA, it was discovered that to have a representative sample, 1,000 gallons of water were recommended to pass through the required collection filter. Collection of this volume of water by the recommended methodology was felt to be prohibitively costly, and operatively infeasible at these monitoring well locations. Alternatively, WESA recommends continuous turbidity monitoring, with quarterly monitoring for other surface water indicators as outlined below.

Continuous turbidity monitoring is recommended in the southeast and southwest monitoring well locations. The turbidity data can be collected by means of a sensor in the monitoring wells, connected to the existing SCADA datalogging system. This data, similar to other continuous monitoring data should be reviewed on a 72 hour basis, similar to the municipal supply well data. With respect to turbidity, groundwater should be relatively stable. Shifts in the turbidity data should be seen as an indicator of potential introduction of surface water to the groundwater supply. The advantage to this monitoring approach is that continuous data will be available, for monitoring trends in water quality, upgradient of the supply wells.

Based on the current microbiological trends observed (please refer to section 6.3 below), it appears that the highest microbial impacts occur in late fall (October). WESA recommends that the following quarterly monitoring program, as outlined in Table 6 below, be implemented;

Table 6: Surface Water Ponds and Sentry Wells Monitoring Program

Sampling Year	Location	Frequency	Parameter
2005	Two surface water locations in the Provost Sand Pit (Pond 1, Pond 2) and the three proposed monitoring wells	Quarterly: January, April, July and October	Microbiological parameters (E.Coli, Faecal Coliforms, Faecal Streptococci, Heterotrophic Plate Count, Total Coliforms), colour, dissolved organic carbon (DOC), tannins and lignins, temperature, conductivity and pH. Water levels are to be taken at each sampling event.
2006 and beyond (please note: depending on the results of the 2005 monitoring event, it is likely that subsequent monitoring can be scaled back to the frequency outlined herein for 2006 and beyond)	Two surface water locations in the Provost Sand Pit (Pond 1, Pond 2) and the three proposed monitoring wells	Semi-annually	Microbiological parameters (E.Coli, Faecal Coliforms, Faecal Streptococci, Heterotrophic Plate Count, Total Coliforms), colour, dissolved organic carbon (DOC), tannins and lignins, temperature, conductivity and pH. Water levels are to be taken at each sampling event.

Appropriate sampling protocols should be used and sampling equipment should be decontaminated. All samples should be submitted to an analytical laboratory certified in the analysis of each parameter of concern. Results of the program should be evaluated on a quarterly basis by a qualified person and assessed for changes, trends, groundwater flow direction, in conjunction with other data, to best identify any results of concern.

6.3 WATER WELL FLOW RATE CONSIDERATIONS:

A review of the microbiological results for the raw water quality from 2001 to 2004 was undertaken and compared to flow rate data. No Escherichia Coli (E.Coli) counts were reported. Since 2002, total reported coliform counts ranging from 1 to 8 counts per 100 ml (with a count of up to 51 counts per 100 ml reported in October 2002) were recorded in the months of October to December (sometimes extending from September and to January). The total coliform counts appear to correlate with the background counts being reported. It is likely that the bacterial counts observed especially in the fall/winter months are, at least in part, a result of seasonal influences. Generally, average day flows appear to be highest in the summer months May to August (please refer to Table 2 above).

Though, from 2001 to 2004, no trend is apparent between the highest average and maximum day flows and reported bacteria incidences in the raw water, further comparison of flow rates recorded and reported bacteria incidences in the raw water is recommended to be undertaken to accurately determine if there is a trend or direct correlation. This recommendation is based on concerns that elevated flow rates would increase the capture area of the wells and could result in pulling groundwater in from a further capture radius. This could be a concern especially considering the proximal distance of the surface water ponds on the Provost Sand Pit Site.

7.0 MICROBIAL CONTAMINATION CONTROL MEASURES ACTION PLAN

The objective of this study was to provide a framework for the Township of North Stormont to ensure protection of their Crysler Municipal Well Field groundwater resources. It is important that the following recommendations be implemented to promote awareness of groundwater protection, and to implement programs that will ensure long-term protection of this resource. The following is a draft Action Plan, proposed for discussion purposes. Once the Action Plan Strategies are finalized an implementation schedule can be developed.

A practical and chronological approach to the Crylser Municipal Well Head Protection Plan is provided below;

1. The Township of North Stormont should create a Groundwater Task Force (GTF) to implement this plan. It is recommended that the general well head protection strategies of risk avoidance, risk management and awareness be implemented by the GTF as per the tasks and schedule outlined in Table 7 in consultation with Council and Planning Department at the Municipality.

Table 7: Well Head Protection Strategy and Implementation Schedule

MCCM Strategy	Timeframe for Implementation
Risk Avoidance	
Task 1: Use the ranking system which evaluates potential contaminant sources (Tables 5-2 and 5-3) –to define which operations and activities in the future should be excluded from establishing themselves within a High or Moderate Microbial Risk Management Ranking area.	Implement as soon as possible
Task 2: Through land-use planning, change zoning such that certain activities are not permitted. This includes amending the Official Plan and creating By-laws to restrict the type of land-uses in high ranked Microbial Risk Management Zones (MRMZ) with restrictions being more stringent closer to the well head itself.	October 2005
Risk Management	
Task 1: Restrict any new expansion/development within the high risk land use areas. The municipality also needs to manage those activities that are presently within the high risk areas.	Implement as soon as possible
Task 3: In the medium land use risk areas develop a permitting program to implement requirements for any new expansion/development. Place restrictions for activities that could potentially impact the groundwater.	July 2005
Task 4: Encourage the implementation of best management practices for activities within the moderate ranked Microbial Risk Management Zones (MRMZs) through By-law creation.	October 2005

MCCM Strategy	Timeframe for Implementation
Task 5: Encourage the implementation of best management practices through creation of a task force, and programs/workshops for implementation.	Implement as soon as possible
Awareness (Education and Training)	Coordinate all with Management strategy initiatives. Education initiatives should commence immediately and be on-going throughout execution of the WHPP.
Task 1: Identify key activities of concern and target audiences, and present workshops inviting potential contaminant sources. Present BMPs, including implementation strategies, cost considerations, where more information can be found, who can help, etc.	Implement as soon as possible
Task 2: Create an area on the Township website with key information on the Microbial Risk Management Zones (MRMZ)s, contacts and BMPs	Website creation by July 2005
Task 3: Target potential polluters through mail outs that outline specific BMPs.	Coordinate with mail – out activities conducted for other purposes
Task 4: Design and post public signs indicating the boundaries of the MRMZ, and the risk ranking of each MRM zone.	By March 2006

2. It is recommended the following tasks associated be addressed as soon as possible and before August 2005, as listed in order from high to low priority.

A. A meeting between the Township of North Stormont Planning Department, Council and GTF; MOE; MNR; Genivar and WESA should be scheduled as soon as possible in order to address the Provost Sand Pit operations issue and the following recommended actions;

i. For the mineral aggregate extraction Provost Sand Pit, Raymond Provost Cartage Company Ltd., should be encouraged to adhere to the operation and rehabilitation plan outlined in the aggregate license # P623598 dated November 1990. In doing so the operator will extract as far away from municipal supply wells as possible for as long as possible. Raymond Provost Cartage Company Ltd. should be reminded of the potential effects of its operation on the municipal water supply.

ii. An amendment to the Raymond Provost Cartage Company Ltd. MNR Licence in regards to buffer zones should be sought by the Township in cooperation with the MNR and the MOE under their existing MOU (memorandum of understanding) and in light of the current Ontario government health and safety concerns for the protection of public drinking water supplies under the new *Safe Drinking Water Act,* passed by the Ontario government in December 2002.

B. Monitoring of groundwater quality at wells located between the municipal production well and closest potential sources of microbial contamination and aquifer disturbance is recommended. Currently the site has an inadequate monitoring network, it is recommended that the following action be completed before August 2005;

i. Three two inch monitoring wells are recommended to be installed on the north (background), east, southwest sides of the Water Treatment Plant compound. Drilling and instrumentation of the wells should be undertaken using the guidelines outlined in Ontario Regulation 903 as amended by 128/03 under the Ontario Water Resources Act related to the prevention of the introduction of any potential contaminants to the aquifer.

ii. The southeast and southwest monitoring wells should be instrumented with continuous turbidity monitoring equipment, tied into the existing SCADA datalogging network.

iii. For 2005, on a quarterly basis it is recommended that these three monitoring wells and Provost Sand Pit surface water ponds (Pond 1 and Pond 2) be measured for water levels, and sampled for surface water indicators. Results of the program should be evaluated on a quarterly basis by a qualified person and assessed for changes, trends, groundwater flow direction and issues of concern.

iv. For 2006 and beyond the monitoring program frequency can likely be scaled back to a semi-annual basis. This should be further assessed after the 2005 data is reviewed by a professional, qualified in that determination.

C. An *in situ* filtration assessment should be undertaken as of November 2004 by continuously monitoring particle count data in the raw water. Weekly microbiological raw water quality results are also collected. Results should be used to evaluate trends with respect to changes in environmental conditions and pumping flow rates by a qualified person on a quarterly basis in conjunction with the water quality evaluation (item B). A checklist for the particle counter is recommended to be created. Review of the particle count data, operation and maintenance of equipment, reporting of adverse results and supply of spare parts should be undertaken as outlined in Ontario Regulation 170/03. Particle count data must be examined within 72 hours after data is collected by a certified operator to verify for adverse results.

D. If consistent adverse results are encountered indicating that inadequate *in situ* filtration is present within the aquifer, actions to address the activities that correlate to the adverse results should be undertaken. Ultimately, the safest solutions would be the addition of chemically assisted filtration to the treatment process. Should chemically assisted filtration become the only viable solution, funding through government programs to undertake the required filtration upgrade should be sought under GUDI programs and local Conservation Authority grants to minimize the financial impact on the Township.

3. It is recommended the following tasks associated be addressed as soon as possible and before October 2005, as listed in order from high to low priority.

   A. Regular microbiogical testing of potable water supply wells within the 50 day (and 2 year MRMZ) should be encouraged. Sample bottles and testing are provided free of charge through the local Health unit. The Health unit should be consulted to verify their capabilities and if possible, a minimum quarterly sampling program should be established. Residents especially within the 50 day MRMZ should be encouraged to report adverse results to the GTF, including follow-up corrective actions undertaken and final groundwater quality results.

B. Farms should strongly be encouraged through incentives and awareness programs to develop Environmental Farm Plans (EFPs) or Nutrient Management Strategies utilizing the program developed by the Ontario Ministry of Agriculture Food and Rural Associations (OMAFRA). Development and use of these strategies can control the risk represented by the construction and use of manure storage lagoons and application of liquid manure/biosolids to farming fields.

   Information on the Nutrient Management Act can be found at the following link:

   http://www.gov.on.ca/OMAFRA/english/agops/index.html.

   A link to available funding programs is the following:

   http://www.gov.on.ca/OMAFRA/english/environment/water/clean_water_incentives.htm.

   A link to best management practice information and a nutrient management workbook is the following:

   http://www.gov.on.ca/OMAFRA/english/nm/resource.html

4. It is recommended the following tasks associated be addressed as soon as possible and before March 2006, as listed in order from high to low priority.

   A. With respect to general groundwater protection and potential chemical contaminants, it is strongly recommended that for any mineral aggregate extraction activities, any oils, hydraulic fluids and fuels used for heavy equipment operation should be stored outside of the active pit areas, in proper secondary containment and that any accidental spills be reported to the MOE Spills Centre and dealt with immediately.

   B. The GTF should conduct an inventory of groundwater source water supplies within the High, Moderate and Low microbial risk management ranked (MRMR) areas.

i. It is recommended that all dug wells no longer be used for water supply and be properly abandoned. Where owners decide to keep using dug wells for potable water supply in high risk areas, they should be encouraged to ensure that their dug well is properly maintained, secured, and tested on a regular basis to ensure acceptable potability.

ii. Any drilled groundwater wells not used for water supply should be properly abandoned. Groundwater well construction for any drilled wells should be evaluated to ensure proper grouting, and that no pathway by means of an unsealed casing exists. Improperly constructed wells should either be abandoned, re-drilled in accordance with Ontario Regulation 903 as amended by O. Reg. 128/03, or upgraded to Regulatory standards (eg. over-drilled and properly sealed, installation of a secure vermin proof well cap,…).

C. The GTF should conduct an inventory of septic systems within the High, Moderate and Low microbial risk management ranked (MRMR) areas. Proper decommissioning of any unused private septic systems should be verified beginning in the high risk ranked areas. A program should be undertaken to ensure all tanks have been properly emptied and abandoned, and septic fields decommissioned. Active septic systems should be inspected to ensure they are being properly maintained, and a regularly scheduled inspection/maintenance program implemented. Provision of best management practices, and assistance should be provided by the GTF.

The suggested actions outlined above provide a framework within which stakeholders can provide input and recommendations. Successful implementation requires co-operation from the general population. By starting a dialogue involving participation and input by the public, a more sustainable program will be achieved in the long term. Once the municipality has compiled a list of options regarding implementation of environmental management strategies, these should be presented and discussed with the public to incorporate their comments and ideas. Implementation of any such policies would require input and co-operation from the public.

This strategy is a proposed plan that can be discussed with stakeholders and interested parties. The details of the specific components as well as an implementation schedule should be developed in consultation with these groups.

8.0 CONCLUSIONS

The investigation to date allows the following conclusions and recommendations to be formulated:

1. The Crylser municipal well(s) groundwater source is an overburden aquifer located within a buried esker complex.

2. Local hydrogeological data suggests that recharge for the Crysler municipal wells comes primarily from within the permeable and highly transmissive esker deposit to the south of the well field. The protection areas within the esker complex are referred to as Microbial Risk Management Zones (MRMZs).

3. As a conservative approach to groundwater protection WESA has adopted the EOWRC report's well head protection areas (WHPAs) for all areas outside the defined esker complex.

4. To determine the 50 day, 2 year and >2 year microbial risk management zones (MRMZs) for within the esker complex itself, WESA used an analytical equation derived by Bear and Jacobs (Hydrology, 1965). The 50 day and 2 year MRMZs are contained within the esker complex at approximate distances of 100 and 400 metres, respectively, from the municipal well(s).

5. The 2 year WHPA for the area outside the boundaries of the esker complex was adopted from the EOWRC report. The boundary of this WHPA extends in a southeast downgradient direction for a distance of 1,375 metres from the municipal well(s).

6. For the purpose of this plan WESA adopted the groundwater intrinsic susceptibility ratings as presented in the EOWRC report.

7. Based on the intrinsic susceptibility of the municipal well field and surrounding areas combined with the established MRMZs and WHPAs a microbial land use risk rating was established for the Crysler municipal well field.

8. Within the limitations of the study, most potential and existing sources of microbial contamination to the aquifers were identified and documented.

9. A draft schedule to promote awareness of groundwater protection, and strategies to implement programs that will ensure long-term protection of the Crysler well site water resource were provided for each identified source of microbial contamination risk.

10. An assessment of the effective in-situ aquifer filtration was completed between 2001 and 2003 that determined that adequate effective in situ filtration is occurring within the aquifer.

11. Maintenance of the in-situ filtration system involves the following tasks;
    - undertaking meetings with the MOE, MNR, OCWA, WESA and aggregate operation owners to develop a strategy to reduce the risk imposed by the surrounding aggregate operations;
    - promotion of the creation of farm management and nutrient management plans;
    - inventory and proper care of private wells and septic systems;
    - regular microbiological testing of private water supply wells in the MRMZs and
    - response and reporting of adverse results.

12. Further contingency measures included;
    - the evaluation of particle count data for trends with respect to changes in environmental conditions, pumping flow rates and adverse results that could indicate inadequate in situ filtration;
    - the addition of three sentry wells surrounding the municipal supply wells to forewarn of any microbial impact before it could reach the municipal wells; and
    - an evaluation of raw water bacteriological results in association with pump flow rate data.

9.0 LIMITING CONDITIONS

This report was prepared as per the requirements outlined in the Guidance, including the following items:

- Contamination source inventory list, including geo-referenced coordinates where appropriate;
- Map delineating the well head protection areas;
- Detailed description of all proposed microbial contamination control measures; and
- Proposal for the implementation of the Microbial Contamination Control Plan.

The observations and results obtained during this investigation are representative of the observations gathered on March 10, 2004 and on the April 29, 2004 ground truthing event, and information collected from topographical maps, historical aerial photographs, the EOWRC report, historical Site reports, correspondence with OCWA, and Genivar Consulting Ltd. The statements made in this report are based solely on the information obtained to date as part of the above referenced investigation.

The Bear and Jacobs equation used to model Microbial Risk Management Zones (MRMZs) has inherent assumptions that differ from the exact attributes of the investigated aquifer, however the error associated with these assumptions was considered acceptable.

WESA has used its professional judgment in analyzing this information and formulating its conclusions. No other warranty or representation, expressed or implied, as to the accuracy of the information or recommendations is included or intended in this report.

Respectfully submitted,

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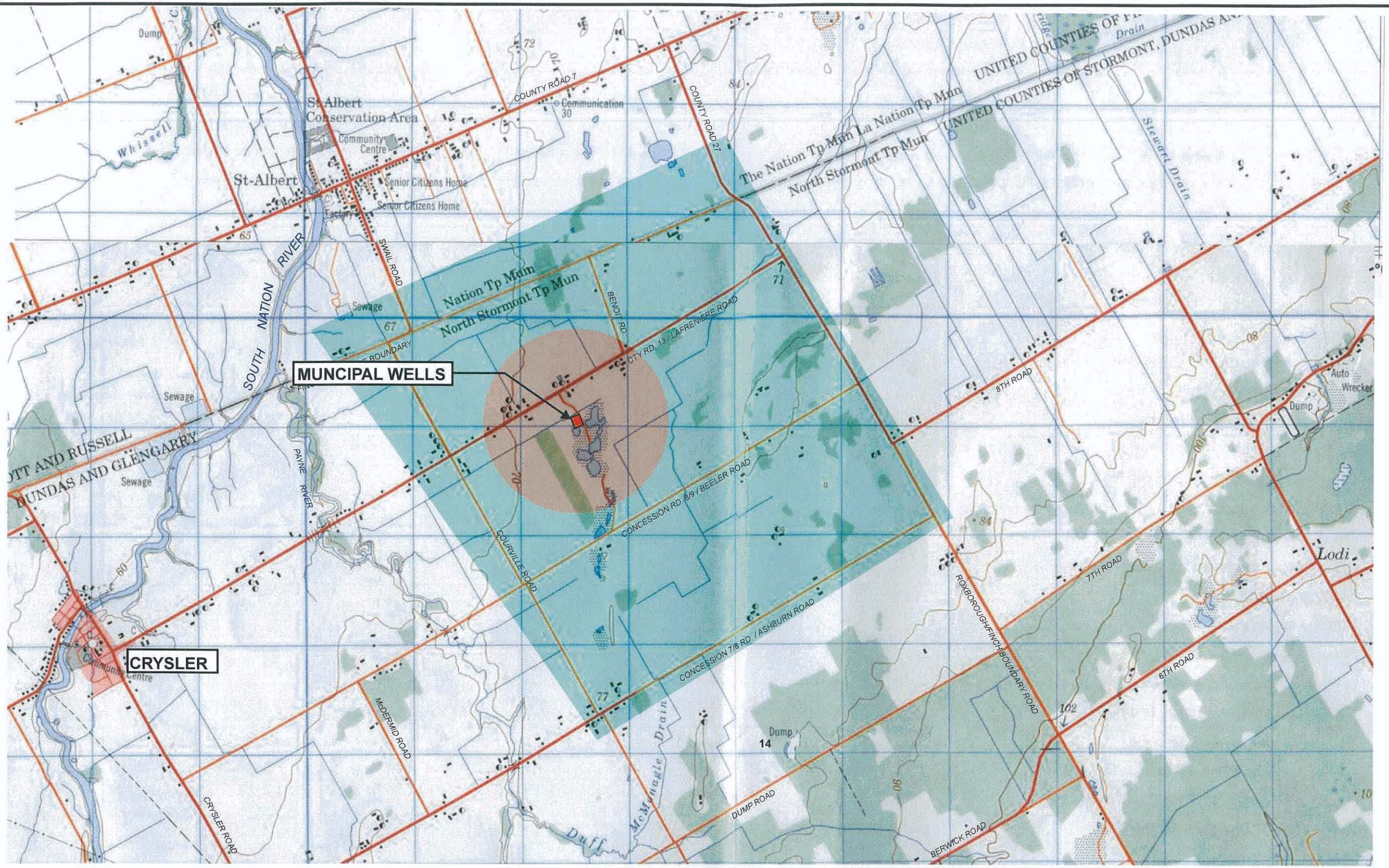

FIGURE: 1
PLAN STUDY AREA
VILLAGE OF CRYSLER

CONCENTRATED STUDY AREA - 900m RADIUS AROUND WELL SITE
GENERAL STUDY AREA - 2km. NORTHEAST AND SOUTH

0 1000 2000
(METRES)

REFERENCE: NRC TOPOGRAPHIC MAPS
WINCHESTER 31 G/3 - ED 6

B2730-FIGURE 1

WESA
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MUNICIPAL WELLS

SWAIL ROAD

BENOIT ROAD

COUNTY ROAD 13/LAFRENIERE ROAD

COURVILLE ROAD

BEELER ROAD/CONCESSION 8/9 ROAD

ASBURN ROAD/ CONCESSION 7/8 RD./ ASHBURN ROAD

DUMP ROAD

FOXBOROUGH/FINCH BOUNDARY ROAD

7TH ROAD

6TH ROAD

Nation Tp Mun

North Stormont Tp Mun

Sewage

Dump

Auto Wrecker

Lodi

McMenemie Drain

Duff

MRMZ ZONES

- 50 DAY
- 2 YEAR
- >2 YEAR (REF.: SECTION 4.2 & 4.3 OF MOE REFERENCE DOCUMENT, JAN.2004)
- APPROXIMATE BOUNDARIES OF ESKER BASED ON GEOLOGICAL DRILLING RECORDS AND REFERENCES
- 500 METRE OUTSIDE THE TWO YEAR TIME OF TRAVEL ZONE (SECTION 4.2 MOE REFERENCE, JAN.2004)

WHPA (REFERENCE: E.O.W.R.C. REPORT–OCT. 2003)

- 2 YEAR WELL HEAD PROTECTION AREA
- 10 YEAR WELL HEAD PROTECTION AREA
- 25 YEAR WELL HEAD PROTECTION AREA

④ IDENTIFIED POTENTIAL POINT SOURCES AS PER APRIL 29, 2004 VISIT

0 1000 2000

(metres)

PROJECT NUMBER: B2730	DRAWN BY: C.M.R.	DESIGNED BY: L.D'C.
DATE: 16 SEPTEMBER 2004	CHECKED BY: R.H.	
SCALE: AS SHOWN	CAD FILE NO.: B2730–SP	

FIGURE: 2

MRMZ ZONES

CRYSLER MUNICIPAL WELL FIELD
TOWNSHIP OF NORTH STORMONT

WESA
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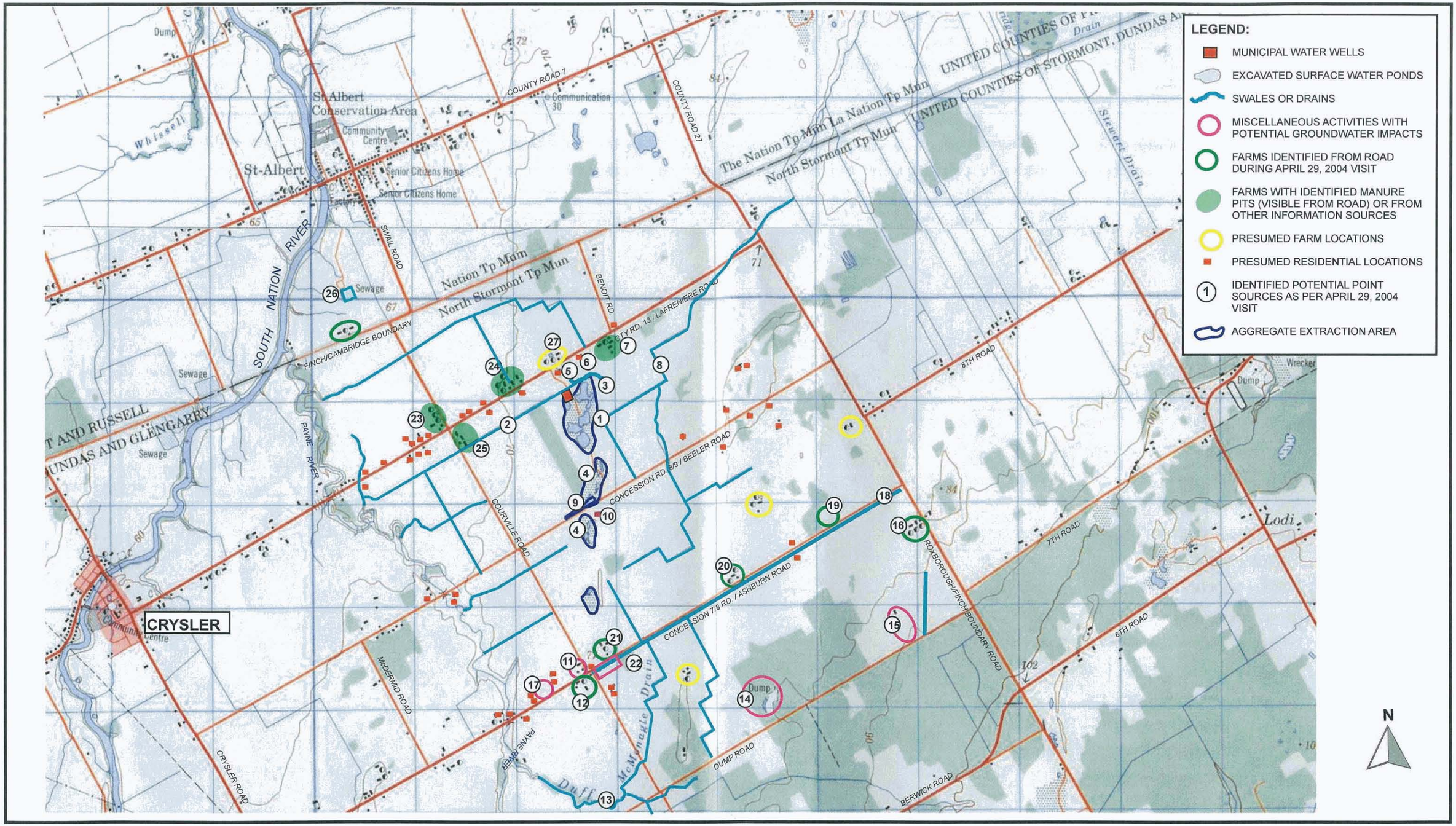


FIGURE: 3

MICROBIAL RISK MAP

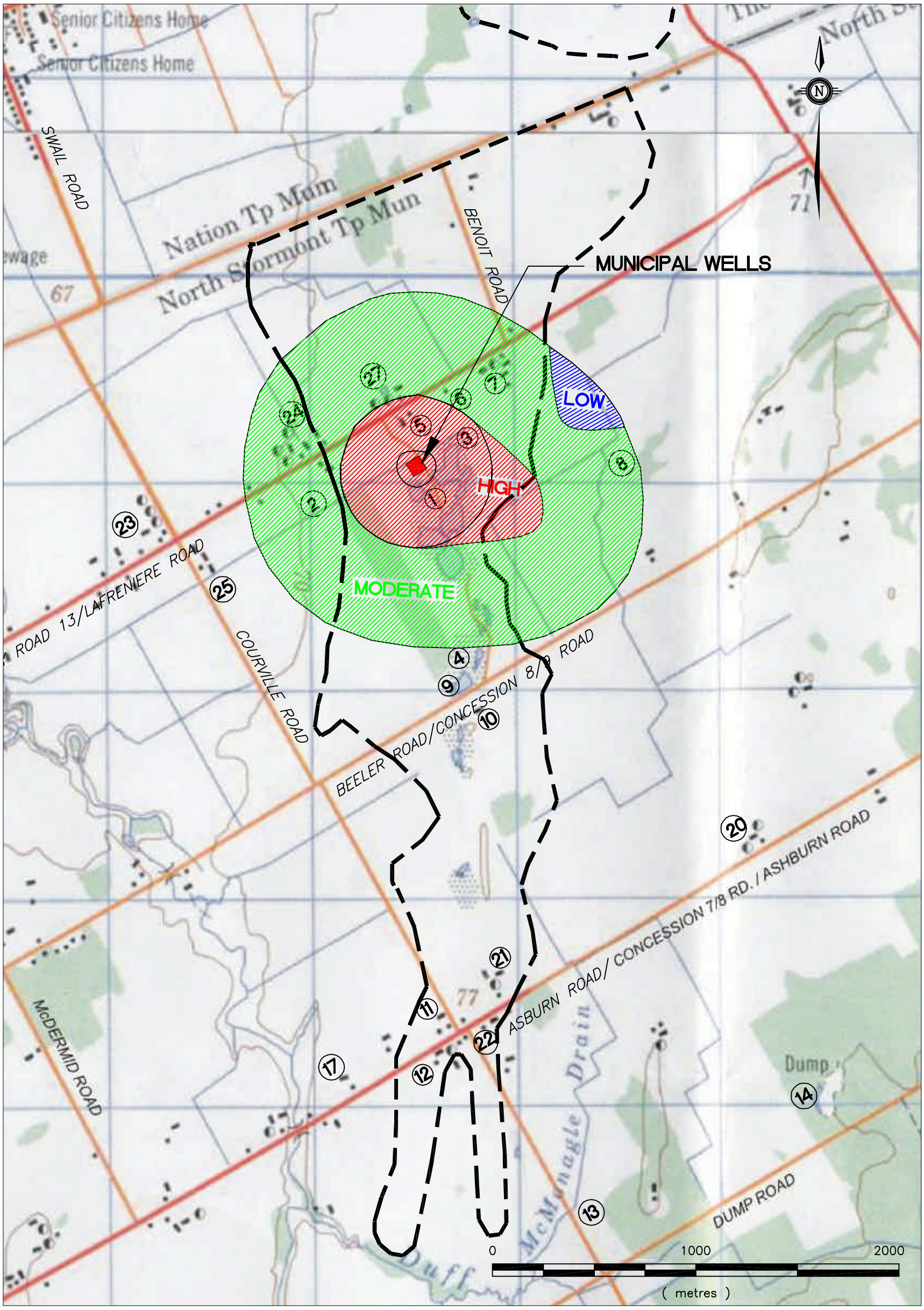
VILLAGE OF CRYSLER

0 1000 2000
(METRES)

REFERENCE: NRC TOPOGRAPHIC MAPS
WINCHESTER 31 G/3 - ED 6

B2730-PPS

WESA
A Better Environment For Business



MICROBIAL RISK MANAGEMENT RANKING

- HIGH RISK
- MODERATE RISK
- LOW RISK
- APPROXIMATE BOUNDARIES OF ESKER BASED ON GEOLOGICAL DRILLING RECORDS AND REFERENCES
- 500 METRE OUTSIDE THE TWO YEAR TIME OF TRAVEL ZONE (SECTION 4.2 MOE REFERENCE, JAN.2004)
- ④ IDENTIFIED POTENTIAL POINT SOURCES AS PER APRIL 29, 2004 VISIT

PROJECT NUMBER: B2730	DRAWN BY: C.M.R.	DESIGNED BY: L.D'C.;T.S.
DATE: 17 SEPTEMBER 2004	CHECKED BY:	
SCALE: AS SHOWN	CAD FILE NO.: B2730-RISK	

FIGURE: 6

MICROBIAL RISK MANAGEMENT RANKING (MRMR) MAP

CRYSLER MUNICIPAL WELL FIELD
TOWNSHIP OF NORTH STORMONT

WESA
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FIGURE: 4
MUNICIPAL ZONES AND LAND USE DESIGNATION

REFERENCE: MAY 4, 1994 AERIAL PHOTO (A28051-15)

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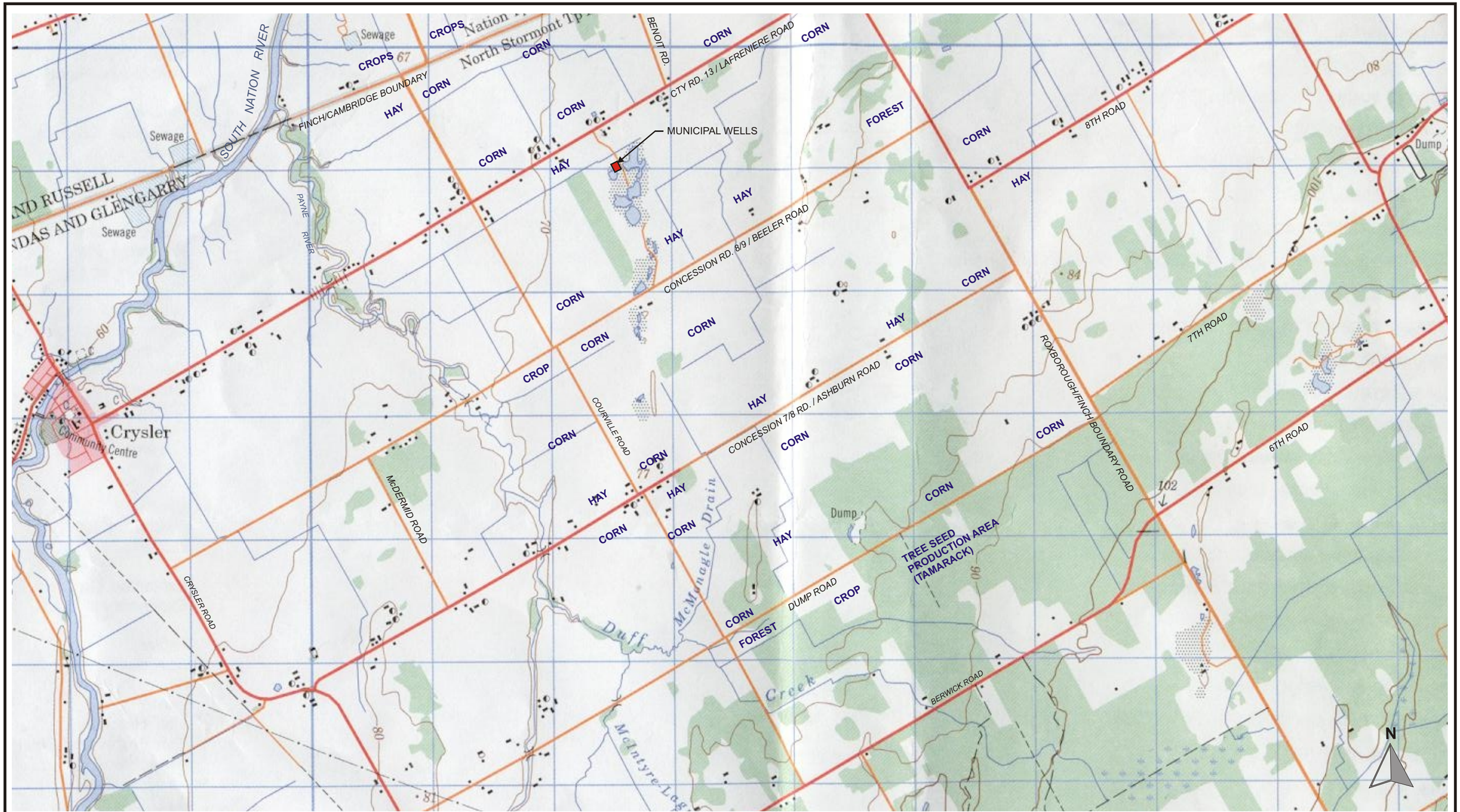

FIGURE: 5

AGRICULTURAL LAND USE - OBSERVED CROPS - APRIL 29, 2004

0 1000 2000
(METRES)

REFERENCE: NRC TOPOGRAPHIC MAPS
WINCHESTER 31 G/3 - ED 6

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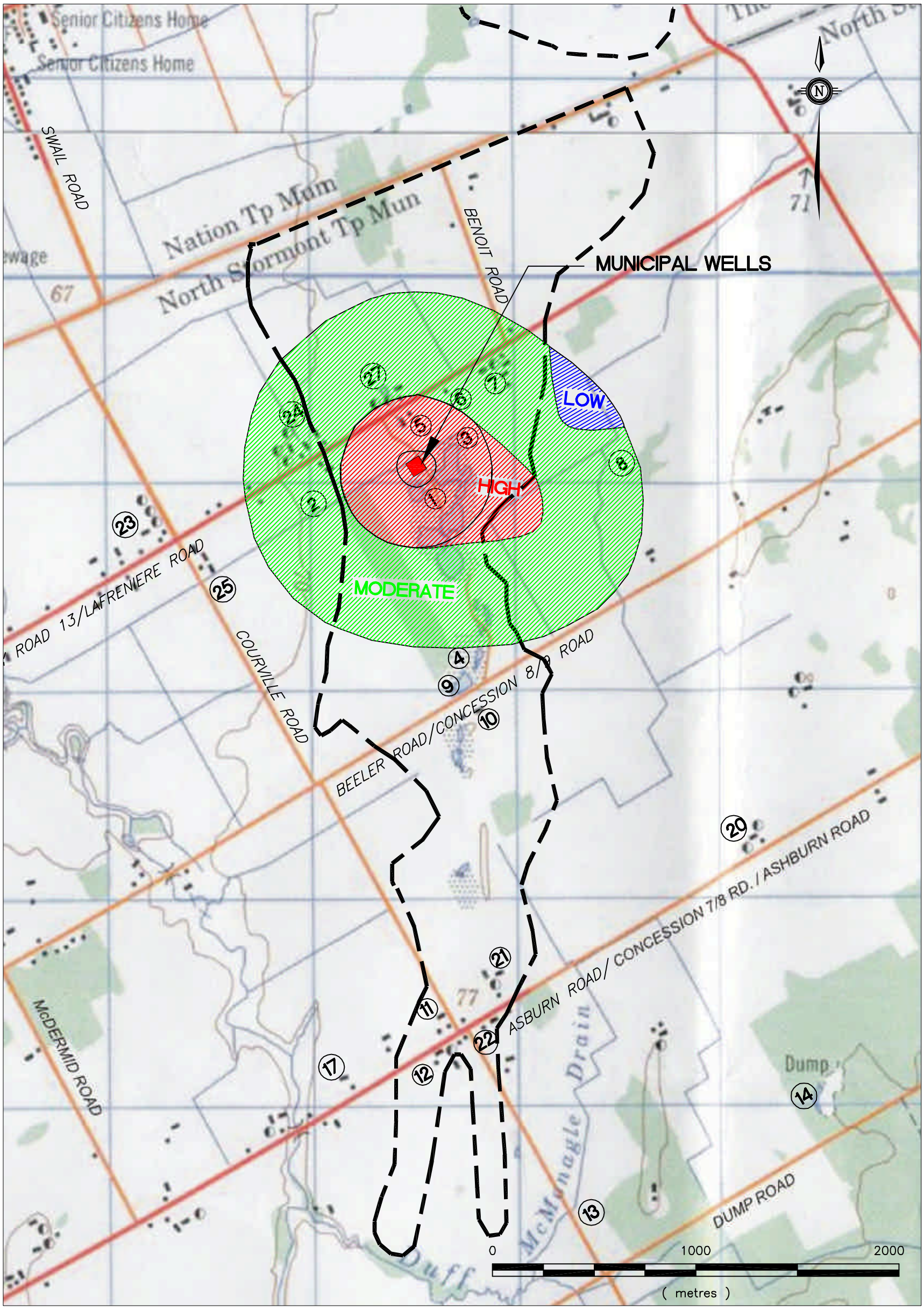


MICROBIAL RISK MANAGEMENT RANKING

- HIGH RISK
- MODERATE RISK
- LOW RISK
- APPROXIMATE BOUNDARIES OF ESKER BASED ON GEOLOGICAL DRILLING RECORDS AND REFERENCES
- 500 METRE OUTSIDE THE TWO YEAR TIME OF TRAVEL ZONE (SECTION 4.2 MOE REFERENCE, JAN.2004)
- ④ IDENTIFIED POTENTIAL POINT SOURCES AS PER APRIL 29, 2004 VISIT

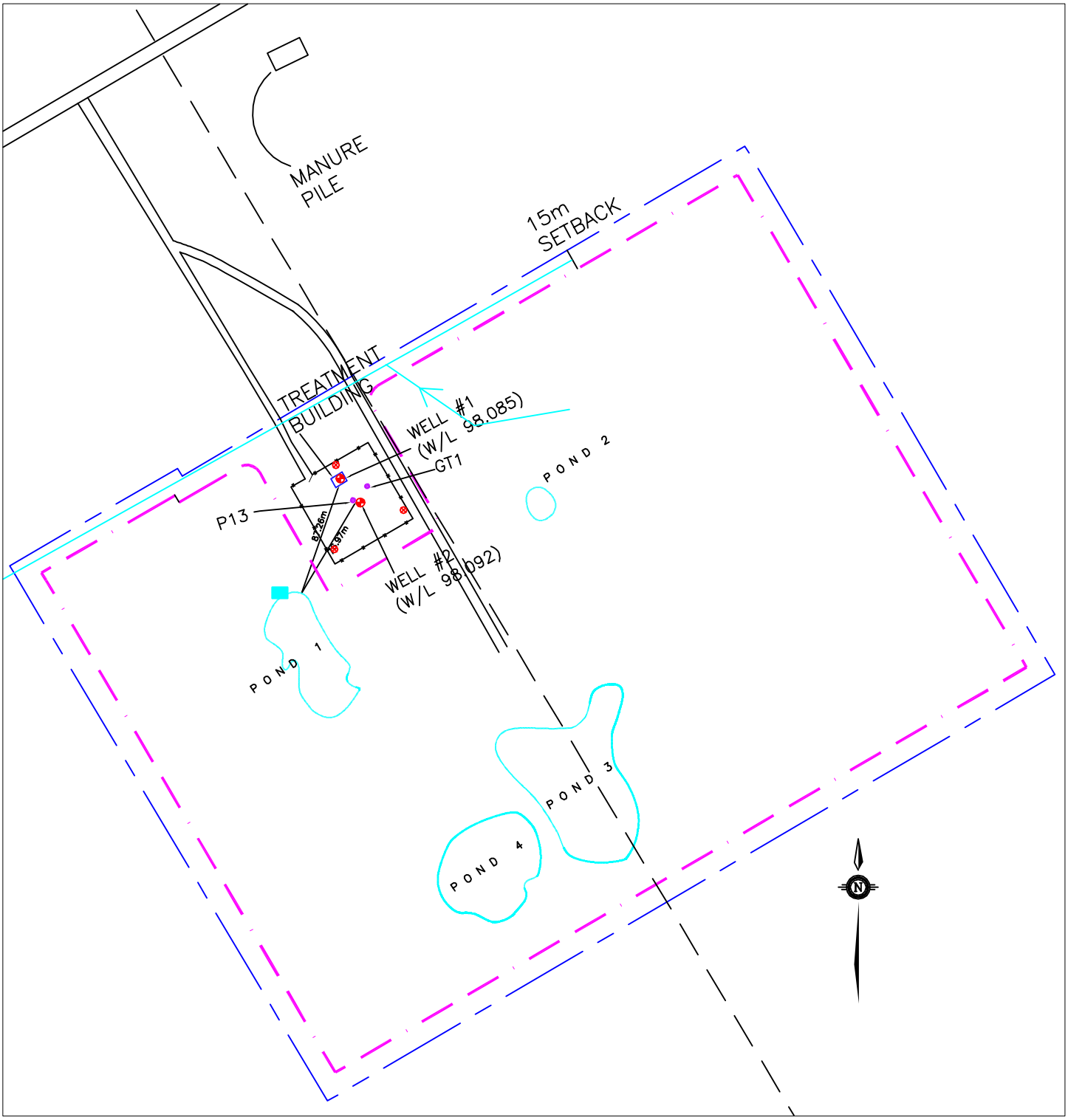
PROJECT NUMBER: B2730	DRAWN BY: C.M.R.	DESIGNED BY: L.D'C.;T.S.
DATE: 17 SEPTEMBER 2004	CHECKED BY:	
SCALE: AS SHOWN	CAD FILE NO.: B2730-RISK	

FIGURE: 6

MICROBIAL RISK MANAGEMENT RANKING (MRMR) MAP

CRYSLER MUNICIPAL WELL FIELD
TOWNSHIP OF NORTH STORMONT

WESA
A Better Environment For Business



LEGEND:

- DENOTES WELL SITE BOUNDARY (FENCED)
- DENOTES LICENSED PIT AREA
- DENOTES PROPERTY BOUNDARY
- DENOTES SURFACE WATER SAMPLE LOCATION
- DENOTES PUMPING WELL AND NAME
- DENOTES MONITORING WELL AND NAME
- DENOTES LIMITS TO PONDED AREAS, NOVEMBER 22, 2001
- DENOTES PROPOSED MONITORING WELL LOCATIONS

PROJECT NUMBER:	B2730	DRAWN BY: C.M.R.	DESIGNED BY: R.H.
DATE:	23 SEPTEMBER 2004	CHECKED BY:	R.H.
SCALE:	1:5000	CAD FILE NO.:	B2730-MWL

FIGURE: 7

PROPOSED SENTRY MONITORING WELL LOCATIONS

CRYSLER WELLS
PART OF LOT 20, CONCESSION 9
TOWNSHIP OF FINCH

WESA
A Better Environment For Business

Table 3: Village of Crysler Microbial Risk Inventory

No.	Name	Owner/Operator	Address	Existing or Potential	Permanent/ Intermittent	Type	Observations
1	Provost aggregate extraction pit	Raymond Provost Cartage Company Ltd.	P.O. Box 35, Crysler, Ontario K0A 1R0 Lot 20, 21, Concession 9, Municipality of Finch, County of Stormont	existing	Intermittent - extraction areas change, and rehabilitation is to be done in accordance with the license agreement	Commercial (Mineral Aggregate Extraction)	Class A licence allows 200,000 tonnes of extraction/year - up to 5.4 m below the water table
1a	Provost Pond 1 NE corner NW corner SW corner SE corner			existing			04/29/04 - dog, deer and bird tracks noted
1b	Provost Pond 2 NW corner NW corner of little inlet SW corner of little inlet NE corner of little inlet SE corner of little inlet			existing			04/29/04 - 2 ducks observed in pond
1c	Provost Pond 3/4 NW corner northside			existing			
1d	Provost Pond 5 SW corner Western extent eastern extent			existing			
2	Swale EW at corner of east road outlet to flushing of water Well 2	unknown	NA	existing	Intermittent based on seasonal and local conditions	Agricultural/rural	2 m deep and drains west (in 2002) 04/29/04 flowing towards west 2.5 m wide approximately runs along N side of WTP
3	Swale N to SE Point along swale Point 2 along swale	unknown	NA	existing	Intermittent based on seasonal and local conditions	Agricultural/rural	04/29/04 approximately 2 m in diameter stagnant at time observed (no observable flow direction) ends at second road on east side of WTP heads along N side of Pond 2
4	Gagne aggregate extraction pit	Claude and Alice Gagne	Lot 20, Concession 8 and 9, Township of North Stormont	existing	Intermittent - extraction areas change, and rehabilitation is to be done in accordance with the license agreement	Commercial (Mineral Aggregate Extraction)	
5	Residence drilled well to NE Swale/ditch at front manure pile Gas AST for refueling raised septic tile field	Paul Laroque	County Road 13/Lafreniere Road	existing existing existing existing existing existing	Permanent Permanent Intermittent Intermittent Permanent Permanent	Agricultural/rural	 Well is approximately 20 m deep, water contains sulfur, likely advanced into bedrock drainage observed towards roadside ditch along County Rd. 13 only 2 loads left, quite small, ~ 1.5 m high, 5 m diameter on SW corner of property small ~250 litres at back of house
6	Residence dug well drilled well	Andre Richer	County Road 13/Lafreniere Road	existing existing existing	Permanent Permanent Permanent	Agricultural/rural	 dug well went dry, not yet abandoned Gilles Bourgeois Well Drilling Ltd. St. Albert 613-987-5291, appears well constructed
7	Farm manure lagoon manure spreading	unknown	County Road 13/Lafreniere Road	existing	Permanent	Agricultural/rural	Manure lagoon visible from aerial located in MA zone which is likely esker deposit Property is believed to extend to the south of Residences 5 and 6

Table 3: Village of Crysler Microbial Risk Inventory

No.	Name	Owner/Operator	Address	Existing or Potential	Permanent/ Intermittent	Type	Observations
8	NS ditch	unknown	NA	existing	Intermittent based on seasonal and local conditions	Agricultural/rural	4 m across, flow to north
9	large pond	unknown - may be part of Gagne Pit?	NA	existing	Permanent - extent likely changes with seasonal/local conditions	Agricultural/rural or Commercial/Industrial	Could be associated with north Gagne pit. All coordinates were estimated from south side
	SE corner						extends approximately 100-150 ft N from this point
	narrowing point						narrows to approximately 50 ft across
	pond end						
10	Farm Property between Gagne Pits	unknown	15586 Concession Road 8/9 -Beeler Road	existing	permanent	Agricultural/rural	
	drilled well			existing	permanent		between Gagne pits
	large pond			existing	Permanent - extent likely fluctuates with seasonal local conditions		Does not appear active
11	Residence diesel AST ~ 2,000 litres	unknown	2120 Courville Rd	existing	Permanent	Agricultural/rural	GPS is for Property from Road (no on Site permission)
12	Dairy Farm	Zueger (presumed)	Concession Road 7/8 - Ashburn Road	existing	Permanent	Agricultural/rural	
	3 ASTs			existing	Permanent		
	manure spreading						
13	McMonagal Drain	NA	NA	existing	Permanent	Agricultural/rural	Runs EW, water flow observed to west, ~ 0.6 to 1.5 m across
14	Closed Dump southern end at gate	unknown	Dump Road	existing	Permanent	Unknown	extent unknown, closed, no monitoring wells observed
15	Land Application Program	Domtar (based on sign)	Dump Road	existing	Intermittent (presumed)	Commercial/Industrial	
	NS swale/ditch		NA	existing	Intermittent - likely fluctuates with seasonal/local conditions		water flow N
16	Farm	Ken Matten (presumed)	2172 Boundary Rd.	existing	Permanent	Agricultural/rural	
	3 ASTs for fueling			existing	Permanent		
	manure lagoon observed			existing	Permanent		NW of silos west side of cattle barn
	manure spreading						
17	Behler Motor Repair Led.	Behler (presumed)	4.5 km W of Boundary and Conc. 7-8, 987-5484	existing	unknown	Commercial/Industrial	Only the sign was observed, location estimated
18	Swale W-E	NA	south side of Ashburn Road	existing	Intermittent - likely fluctuates with seasonal/local conditions	Agricultural/rural	water flow towards the east
19	Hobby Farm	unknown	15845 Ashburn Road, GPS coordinates from Road	existing	Permanent	Agricultural/rural	
	drilled well			existing	Permanent		
	little AST			existing	Permanent		
	manure spreading						
20	Farm	unknown	15793 Ashburn Road, ~ 1,000 gallon visible from Road	existing	Permanent	Agricultural rural	
	Fuel AST						
21	Farm	Rodena (presumed)	15509 Ashburn Road	existing	Permanent	Agricultural/rural	sand/topsoil north side of road
	Propane & ASTs	Rodena (presumed)		existing	Permanent	Agricultural/rural	
	manure spreading						

Table 3: Village of Crysler Microbial Risk Inventory

No.	Name	Owner/Operator	Address	Existing or Potential	Permanent/ Intermittent	Type	Observations
22	Berny's Welding & Fabricating	unknown		existing	Permanent	Commercial/Industrial	south side of road, bus. # 987-2747, Res. 346-2351
23	Farm	Nick & Jo-Anne Dirven (presumed)	15490 corner of County Rd. 13 & Courville	existing	Permanent	Agricultural/rural	
	manure lagoon			existing	Permanent		large circular pit ~ 30 m diameter W-E extent georeferenced from Road
	manure spreading						Approximately 18 m from Rd edge
24	Farm	Gilles Sabourin (presumed)	tel. #: 987-5468	existing	Permanent	Agricultural/rural	Appears to own and farm a large amount of property to N & S of road
	large circular pit			existing	Permanent		Maybe manure pit, visible from Rd. EW extent GPS
	manure spreading						
25	Farm	unknown	15479 Cty. Rd. 13	existing	Permanent	Agricultural/rural	Corner Courville Rd. & Cty. Rd. 13
	manure spreading						large visible circular pit - manure lagoon? GPS from road
26	Lagoon	St. Albert Cheese Factory (presumed)	N side of Finch/Cambridge Boundary Rd, W of St. Paul S Street	existing	Permanent	Commercial/Industrial	Spoke with a resident who believed Property crop land and lagoon belonged to cheese factory. Located just east of the Payne and South Nation River Junction
	lagoon SE corner						coordinate ~ 15 m to south of point
	lagoon SW corner						coordinate ~ 15 m to south of point
	drilled well			existing	Permanent		~ 6 " well with above ground casing
	drilled well			existing	Permanent		~ 6" well - well tag A001717
27	Farm	Unknown	Cty. Rd. 13/LaFreniere	existing	Permanent	Agricultural/rural	
	manure spreading						

Table 3: Village of Crysler Microbial Risk Inventory

No.	Name	Current municipal zone or land use type	Current land use	Geo-Reference		Direction From well	Estimated Areal Size [1] (m^2)	Approximate Linear distance to well / well field (m)	Approximate Saturated horizontal TOT to the well/well field	Intrinsic Susceptibility	In-Situ Filtration Risk	Microbial Risk	Overall Land Use Risk rank or category [2]
				Northing Latitude dd.mm.sss	Easting Longitude dd.mm.sss								
1	Provost aggregate extraction pit	MP, RU	MP			south, east, west	263,000 (licensed area)	60 m	50 day and 2 year	High	High	High	High
1a	Provost Pond 1					south-west	3,000 (in 2002)	77 m (in 2002)	50 day				
	NE corner			45.14050	75.05741								
	NW corner			45.14033	75.05762								
	SW corner			45.13984	75.05722								
	SE corner			45.14002	75.05704								
1b	Provost Pond 2					east and south-east	400 (in 2002)		50 day				
	NW corner			45.14096	75.05657								
	NW corner of little inlet			45.14111	75.05657								
	SW corner of little inlet			45.14106	75.05652								
	NE corner of little inlet			45.14114	75.05658								
	SE corner of little inlet			45.14112	75.05646								
1c	Provost Pond 3/4					south		200 m (in 2002)	2 year				
	NW corner			45.13954	75.05683								
	northside			45.13997	75.05612								
1d	Provost Pond 5					south west		200 m (in 2002)	2 year				
	SW corner			45.14053	75.05613								
	Western extent			45.14057	75.05626								
	eastern extent			45.13957	75.05763								
2	Swale EW	MP, A	MP, A			north		60 m	50 day	High	Moderate	Moderate	High
	at corner of east road			45.14135	75.05712								
	outlet to flushing of water Well 2			45.14116	75.05748								
3	Swale N to SE	MP, MA, A	MP, A			east and southeast		340 m	2 year	High	Moderate	Moderate	High
	Point along swale			45.14117	75.05645								
	Point 2 along swale			45.14119	75.05669								
4	Gagne aggregate extraction pit	RU, MP and MA	MP			south	389,000 (licensed area)	670 m	> 2 year	High	High	Low	Moderate
5	Residence	A	RU, A			north west	4,000	250 m	2 year	High			High
	drilled well to NE			45.14247	75.05736						Moderate	Low	
	Swale/ditch at front										Moderate	Moderate	
	manure pile			45.14208	75.05786						Low	Moderate	
	Gas AST for refueling			45.14222	75.05769						NA	NA	
	raised septic tile field			45.14236	75.05742						Moderate	High	
6	Residence	A	RU, A			north-east	4,000	380 m	>2 year	High			Moderate
	dug well			45.14316	75.05603						High	High	
	drilled well			45.14314	75.05599						Moderate	Low	
7	Farm	A, MA, MP	A			north east	100,000	120-564 m	>2 year	High			Moderate
	manure lagoon									High	Moderate	High	Moderate
	manure spreading								2 year	High	Low	High	High

Table 3: Village of Crysler Microbial Risk Inventory

No.	Name	Current municipal zone or land use type	Current land use	Geo-Reference Northing Latitude dd.mm.sss	Geo-Reference Easting Longitude dd.mm.sss	Direction From well	Estimated Areal Size [1] (m^2)	Approximate Linear distance to well / well field (m)	Approximate Saturated horizontal TOT to the well/well field	Intrinsic Susceptibility	In-Situ Filtration Risk	Microbial Risk	Overall Land Use Risk rank or category [2]
8	NS ditch	A	A, RU	45.13757	75.04956	east		415 m	> 2 year	Moderate-High	Moderate	Moderate	Moderate
9	large pond	RU, A	RU, A			south west	6,000	830 m	> 2 year	High	High	Moderate	Moderate
	SE corner			45.13759	75.04960								
	narrowing point			45.13513	75.05555								
	pond end			45.13501	75.05580								
10	Farm Property between Gagne Pits	A	A			south	20,000	1,200 m	> 2 year	High			Moderate
	drilled well			45.13457	75.05544						Moderate	Low	
	large pond			45.13442	75.05524						Moderate	Moderate	
11	Residence diesel AST ~ 2,000 litres	A	A	45.12649	75.05623	south	15,000	2,725 m	> 2 year	High			Moderate
12	Dairy Farm	A	A			south	70,000	2,900 m	> 2 year	High			Moderate
	3 ASTs			45.12633	75.05572								
	manure spreading						400,000				Low	High	
13	McMonagal Drain	A	A	45.12166	75.05163	south		1,875 m	> 2 year	Moderate-High	Moderate	Moderate	Low
14	Closed Dump	WD	WD			south east	75,000	3,560 m	> 2 year	High	Low	Moderate	Low
	southern end at gate			45.12380	75.04106								
15	Land Application Program	A	A			south east to east of dump	70,000	4,000 m	> 2 year	High	Low	High	Low
	NS swale/ditch			45.12851	75.02945						Moderate	Moderate	
16	Farm	A	A	45.13444	75.03013	south east	70,000	3,700 m	> 2 year	High			Low
	3 ASTs for fueling												
	manure lagoon observed										Moderate	High	
	manure spreading						400,000				Low	High	
17	Behler Motor Repair Led.	A-1	A-1			south west	12,000	3,000 m	> 2 year	Moderate			Low
18	Swale W-E	A	A			south - south east		2,500 m	> 2 year	High	Moderate	Moderate	Moderate
19	Hobby Farm	RU	RU, A	45.13385	75.03749	south east	50,000	2,800 m	> 2 year	High			Moderate
	drilled well										Moderate	Low	
	little AST												
	manure spreading										Low	High	
20	Farm	A	A	45.13097	75.04450	south east	70,000-400,000	2,500 m	> 2 year	High			Low
	Fuel AST												
21	Farm	A, MA	A	45.12716	75.05388	south	70,000	2,650 m	> 2 year	High			Moderate
	Propane & ASTs												
	manure spreading										Low	High	

Table 3: Village of Crysler Microbial Risk Inventory

No.	Name	Current municipal zone or land use type	Current land use	Geo-Reference Northing Latitude dd.mm.sss	Geo-Reference Easting Longitude dd.mm.sss	Direction From well	Estimated Areal Size [1] (m^2)	Approximate Linear distance to well / well field (m)	Approximate Saturated horizontal TOT to the well/well field	Intrinsic Susceptibility	In-Situ Filtration Risk	Microbial Risk	Overall Land Use Risk rank or category [2]
22	Berny's Welding & Fabricating	A	Commercial			south	20,000	2,725 m	> 2 year	High			Moderate
23	Farm	A	A	45.13938	75.06563	north west	70,000	1,300 m	> 2 year	Moderate			Low
	manure lagoon			45.13934	75.06568						Moderate	High	
				45.13946	75.06537								
	manure spreading						400,000				Low	High	
24	Farm	A	A			north west	70,000	600 m	> 2 year	High			Moderate
	large circular pit			45.14085	75.06191						Moderate	High	
				45.14095	75.06169								
	manure spreading						400,000				Low	High	
25	Farm	A	A	45.13983	75.06661	west	70,000	1,100 m	> 2 year	Moderate			Low
	manure spreading						400,000				Low	High	
26	Lagoon	RA	Commercial			north west	20,000	2,300 m	> 2 year	Moderate	Moderate	Moderate	Low
	lagoon SE corner			45.14466	75.07180								
	lagoon SW corner			45.14574	75.07391								
	drilled well			45.14500	75.07124								
	drilled well			45.14513	75.07083								
27	Farm	A	A, RU			north	70,000	300 m	2 year	High			High
	manure spreading						400,000				Low	High	

Notes:

A Land Use Designations are detailed in the legend of Figure 4

1 Areal size was estimated from topographical and aerial features, and may not be representative of actual property extent

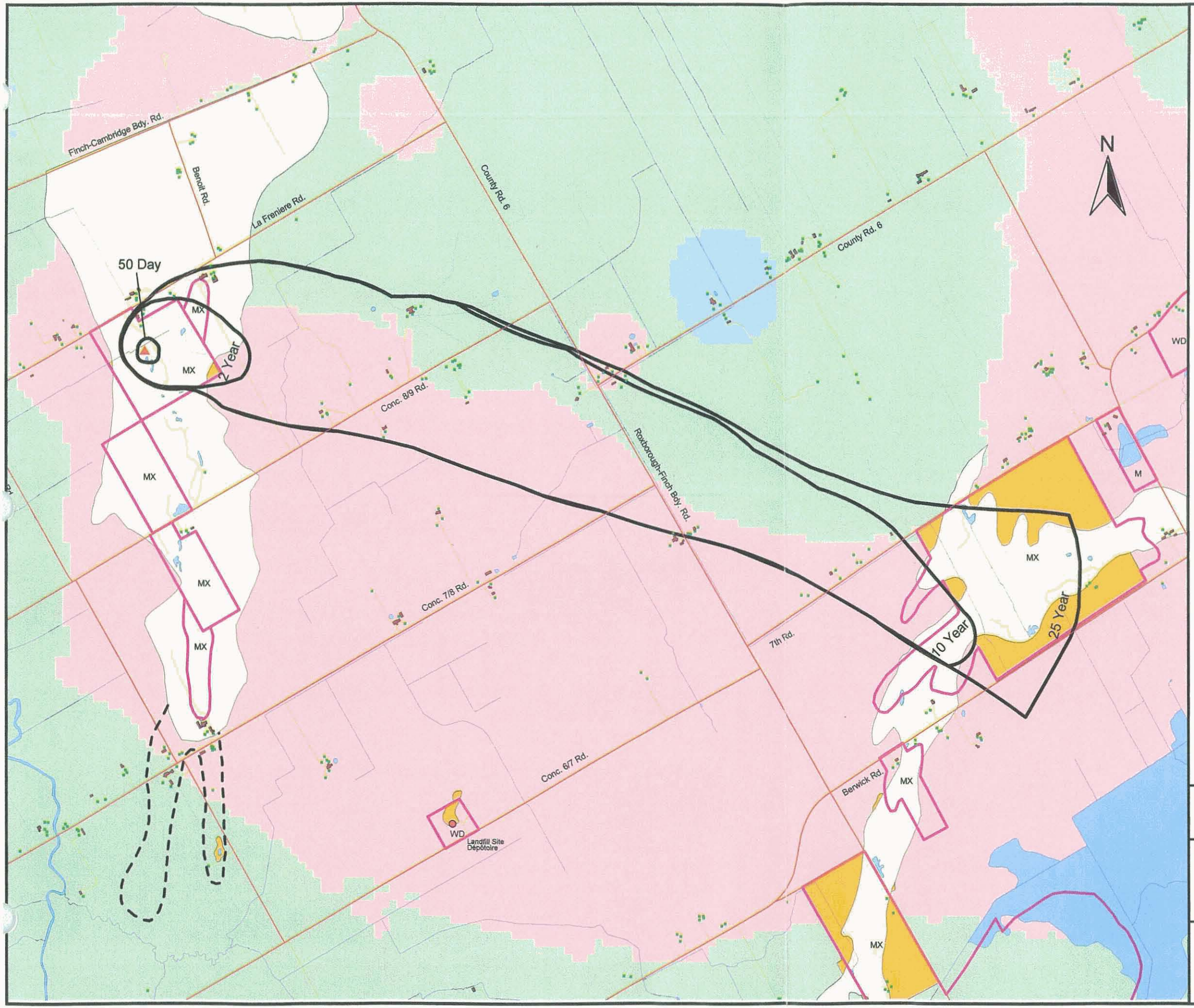
2 From MOE Reference (2004) Intrinsic Susceptibility Index (ISI) mapping must be conducted to 500 m outside of the 2 year TOT zone. Outside of this distance (~1 km from wells) all identified point sources of contamination were assigned a risk ranking of low outside of the esker, and moderate inside of the esker. From the MOE Guidance (2004) the risk of microbial contamination of wells is normally limited to contaminant sources in proximity to the wellhead , usually within the 0 to 2 year TOT zones.

APPENDIX A

EOWRC 2003 Report: Figure 5.3, Wellhead Protection Areas And Aquifer Intrinsic Susceptibility Map

Figure 5.3
Wellhead Protection Area
Aquifer Intrinsic Susceptibility
Crysler Municipal Wells

Périmetre de Protection de Tête de Puits
Sensibilité Intrinsèque D'eau Souterraine



Legend/Légende

- Municipal Water Well / Puits Municipal
- Water Use Permit / Permis de Puiser de l'Eau
- 50 Day — Wellhead Protection Area Groundwater Time of Travel / Périmetre de Protection de Tête de Puits Temps de Migration de l'Eau Souterraine
- Esker Deposits / Dépôt D'Esker
- Buried Esker Deposits / Dépôt D'Esker Enterré
- Pits and Quarries / Sablières et Carrières
- Point Contaminant Source / Pollutant de Source Ponctuelle

Zoning/Zonage

WD	Waste Disposal/Dépôtoir
WY	Wrecking Yard/Aire de Démolition
M	Industrial/Industriel
MX	Mineral Extraction/Sources Extractives
CH	Highway Commercial/Commerciale Routier

Intrinsic Susceptibility Index/Index de Sensibilité Intrinsèque

- High/Elévé
- Medium/Moyen
- Low/Bas

Scale 1:25,000 Echelle

0.5 0 0.5 1 1.5

Kilometers/Kilomètres

RAISIN REGION CONSERVATION AUTHORITY
OFFICE DE PROTECTION DE LA NATURE DE LA RÉGION DE RAISIN

Prescott Russell | United Counties Stormont Dundas Glengarry | Ottawa

Aquafor Beech Limited | Robinson Consultants | Horsley & Witten Inc.

APPENDIX B

Cross-Sectional Maps from WESA 1986 report (Figures 5-11)

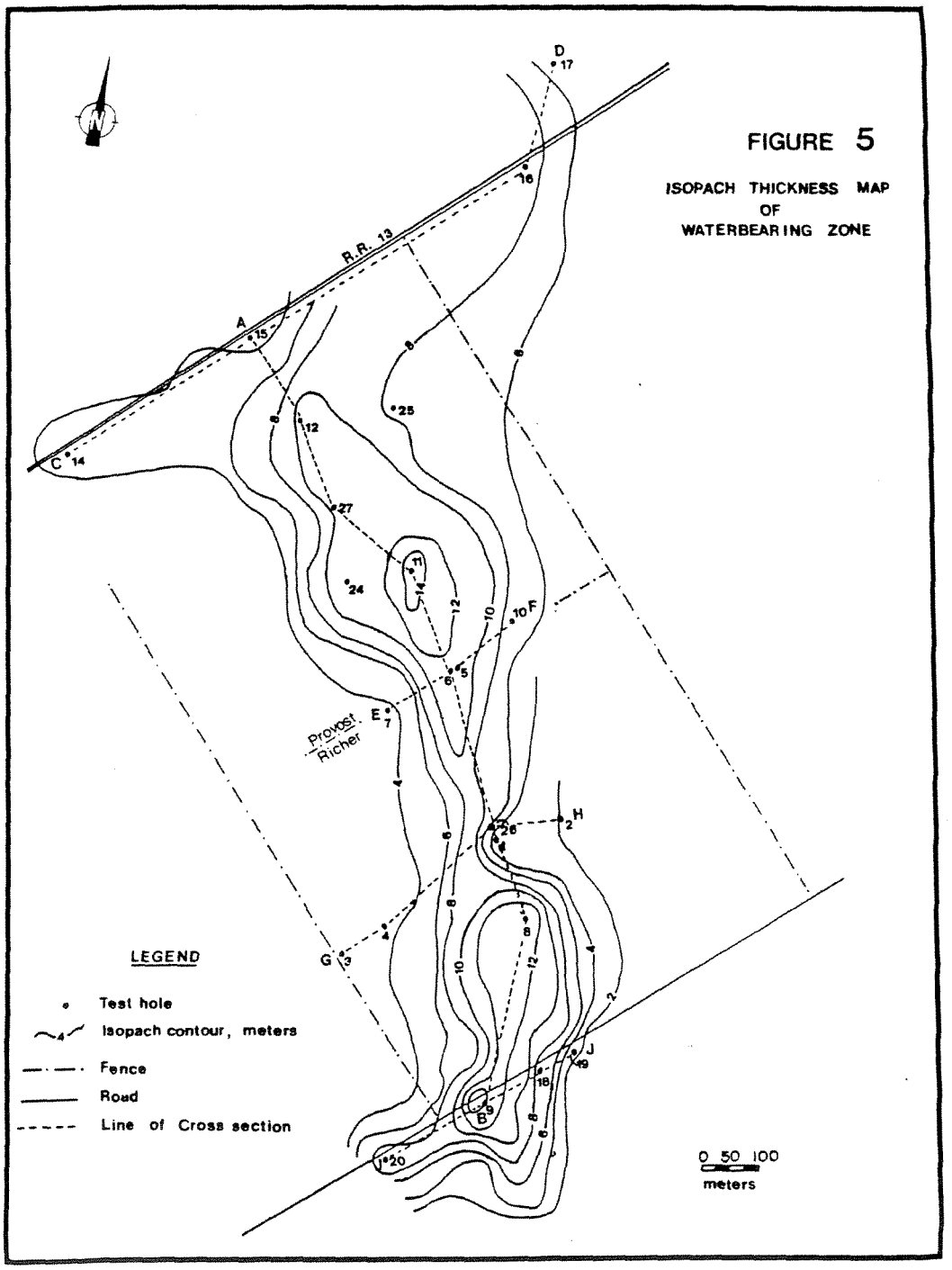


FIGURE 5
ISOPACH THICKNESS MAP
OF
WATERBEARING ZONE
R.R. 13
Provost
Richer
A
B
C
D
E
F
G
H
J
LEGEND
Test hole
Isopach contour, meters
Fence
Road
Line of Cross section
0 50 100
meters

FIGURE 6

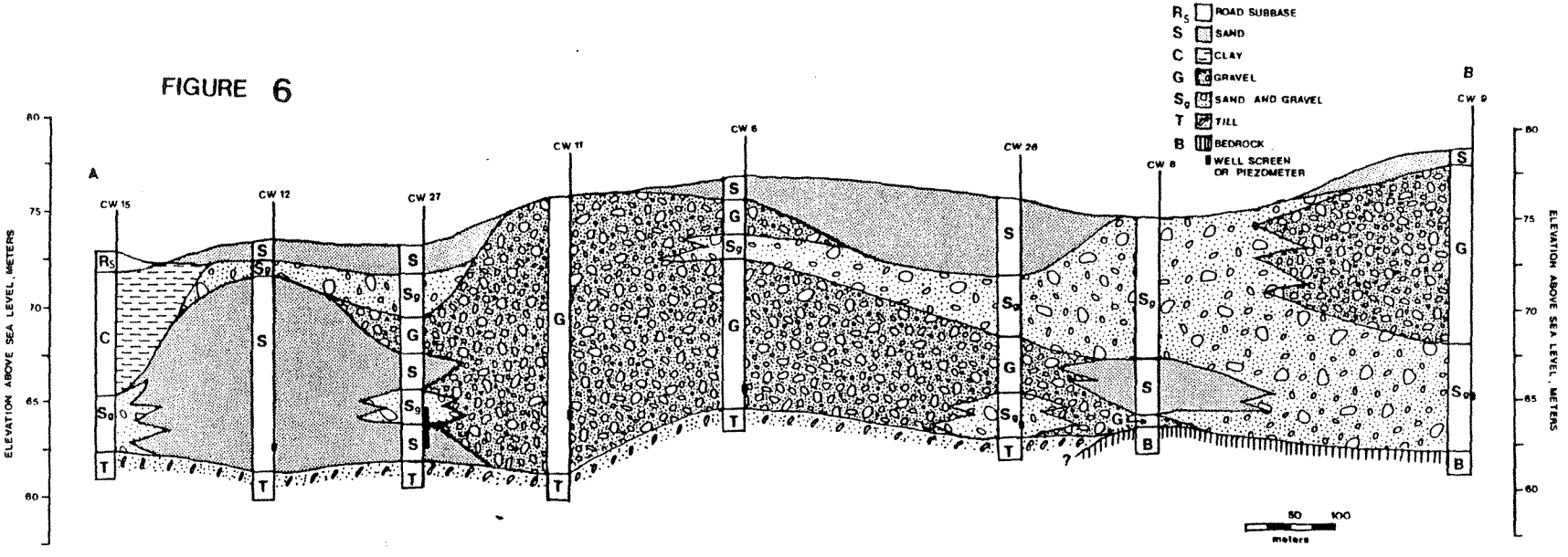

A
B
CW 15
CW 12
CW 27
CW 11
CW 6
CW 26
CW 8
CW 9
R_S ROAD SUBBASE
S SAND
C CLAY
G GRAVEL
S_g SAND AND GRAVEL
T TILL
B BEDROCK
WELL SCREEN OR PIEZOMETER
ELEVATION ABOVE SEA LEVEL, METERS
80
75
70
65
60
50
100
meters

FIGURE 7

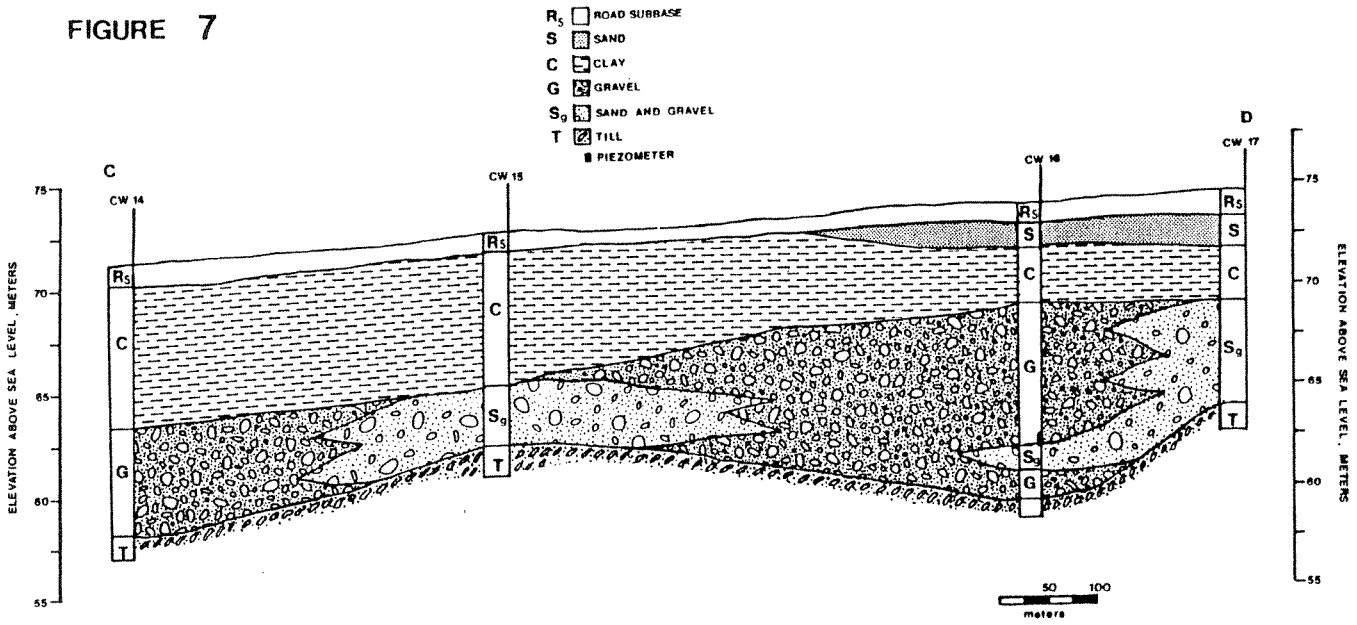

R5 ROAD SUBBASE
S SAND
C CLAY
G GRAVEL
Sg SAND AND GRAVEL
T TILL
PIEZOMETER
C
D
CW 14
CW 15
CW 16
CW 17
ELEVATION ABOVE SEA LEVEL, METERS
75
70
65
60
55
50 100
meters

FIGURE 8

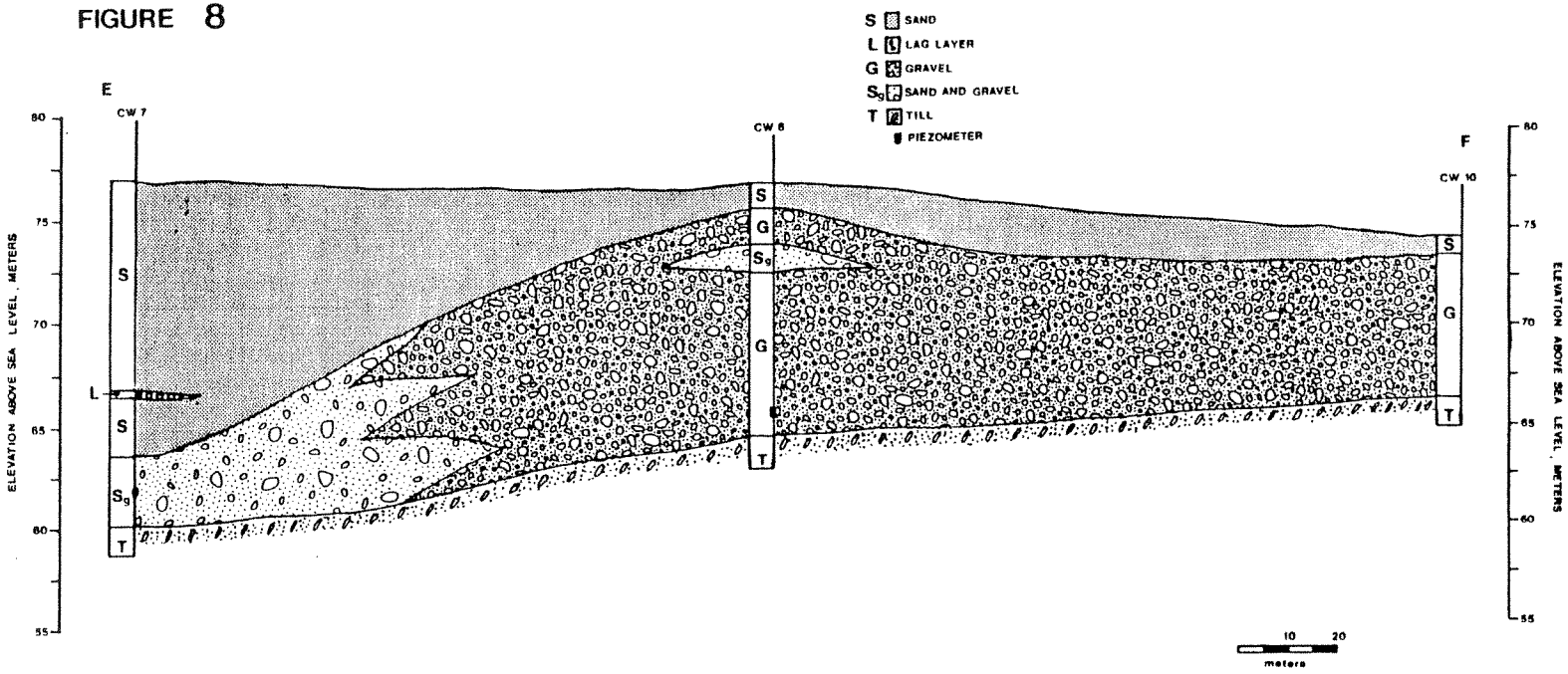

S SAND
L LAG LAYER
G GRAVEL
Sg SAND AND GRAVEL
T TILL
PIEZOMETER
E
F
CW 7
CW 8
CW 10
ELEVATION ABOVE SEA LEVEL, METERS
80
75
70
65
60
55
10
20
meters

FIGURE 9

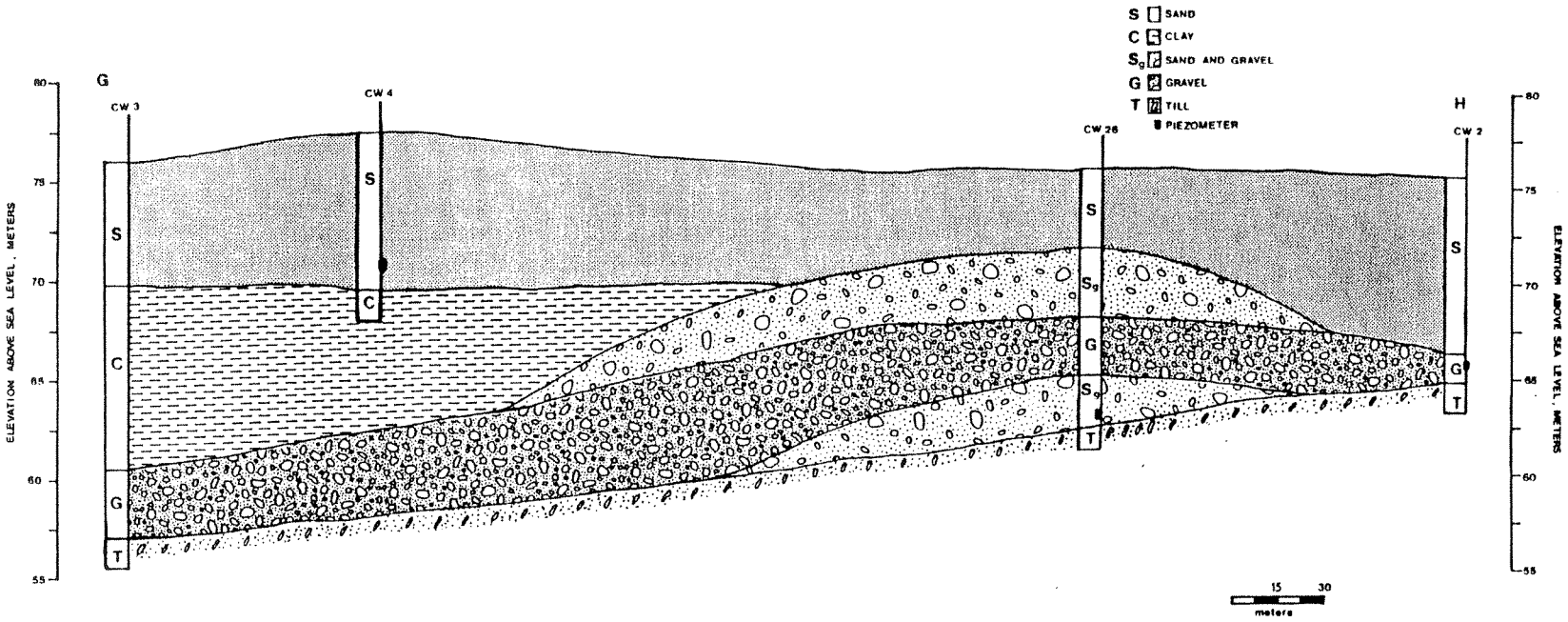
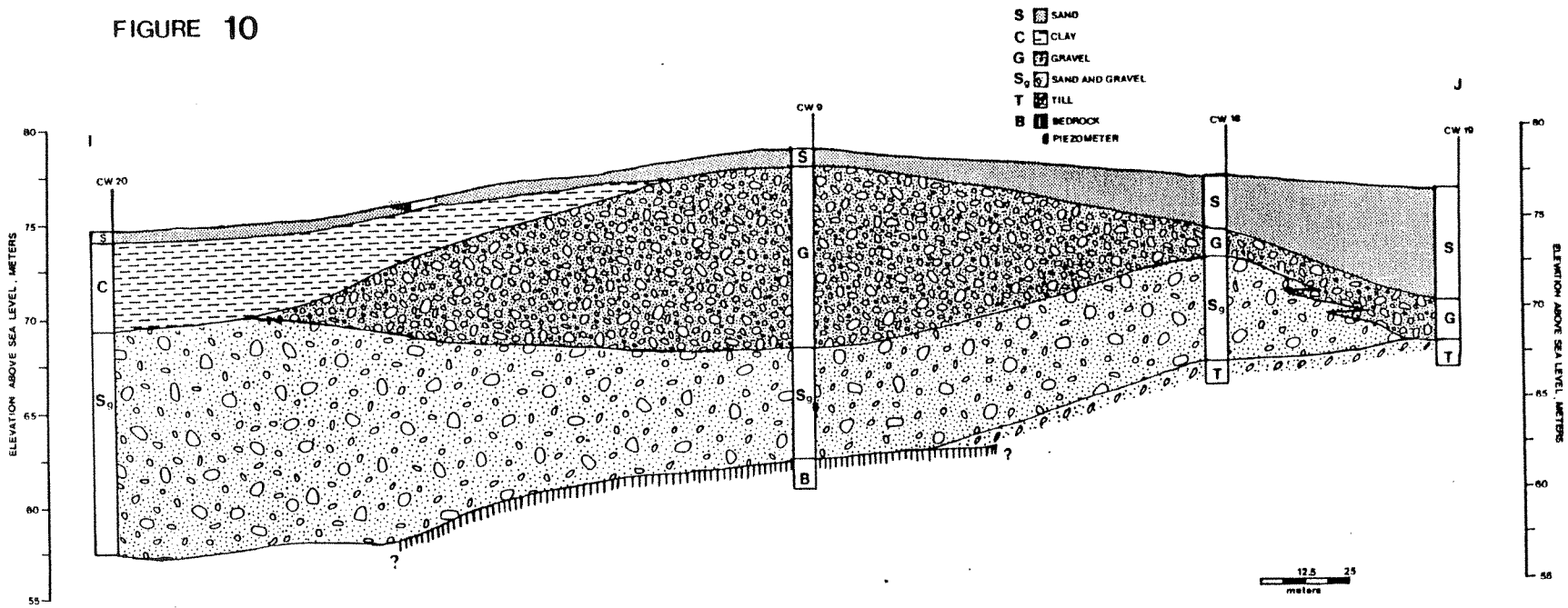

S SAND
C CLAY
Sg SAND AND GRAVEL
G GRAVEL
T TILL
PIEZOMETER
G
H
CW 3
CW 4
CW 26
CW 2
S
C
Sg
G
T
80
75
70
65
60
55
ELEVATION ABOVE SEA LEVEL, METERS
15
30
meters

FIGURE 10


S SAND
C CLAY
G GRAVEL
S_g SAND AND GRAVEL
T TILL
B BEDROCK
PIEZOMETER
I
J
CW 20
CW 9
CW 18
CW 19
S
C
G
S_g
T
B
?
ELEVATION ABOVE SEA LEVEL, METERS
80
75
70
65
60
55
12.5
25
meters

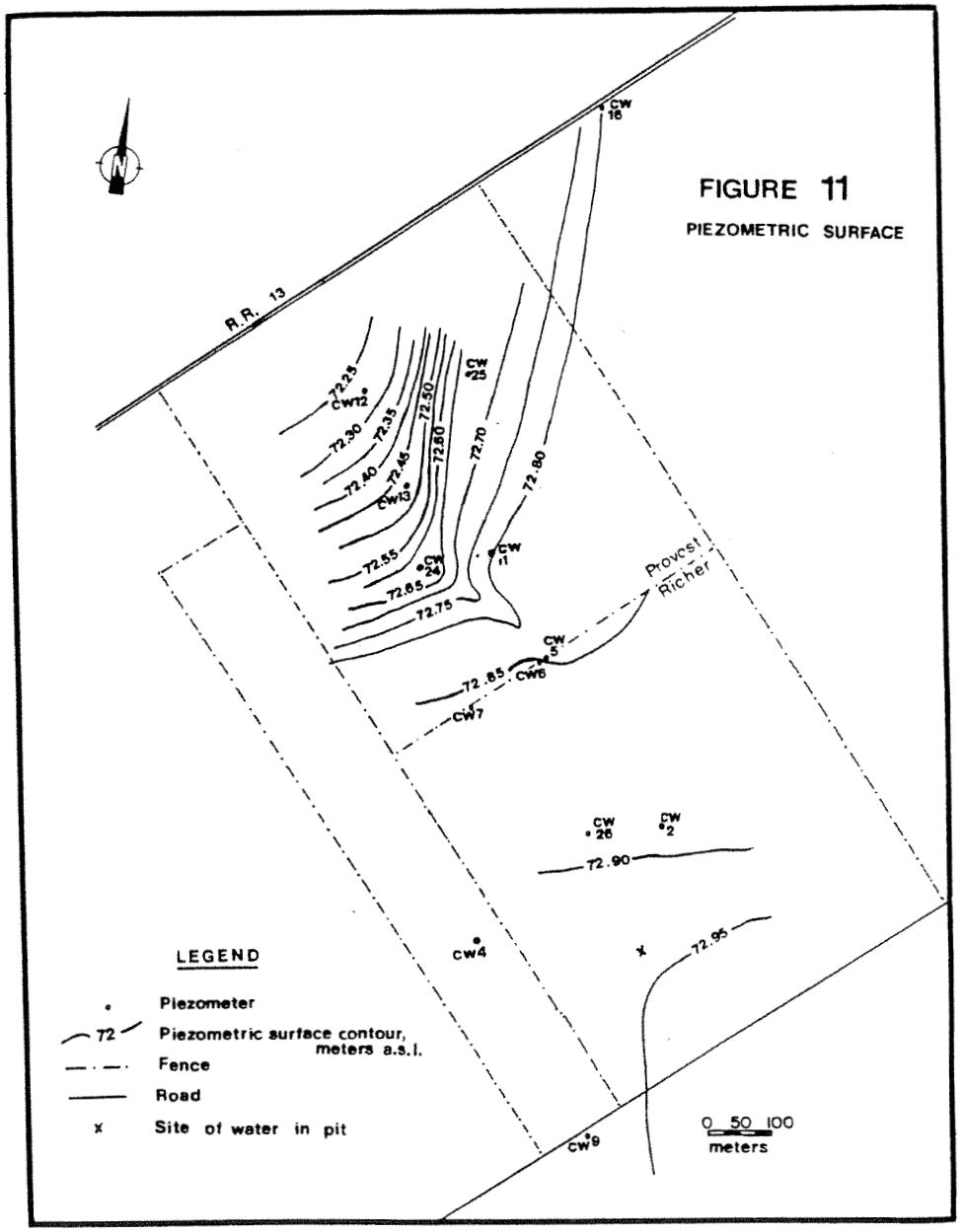


FIGURE 11
PIEZOMETRIC SURFACE
R.R. 13
CW 16
CW 25
CW12
CW13
CW 24
CW 11
CW 5
CW6
CW7
CW 26
CW 2
cw4
CW9
72.25
72.30
72.35
72.40
72.45
72.50
72.55
72.60
72.65
72.70
72.75
72.80
72.85
72.90
72.95
Provost
Richer
LEGEND
Piezometer
72 Piezometric surface contour, meters a.s.l.
Fence
Road
x Site of water in pit
0 50 100
meters

APPENDIX C

MRMZ (TOT) Calculations

CB2730

Microbial Control Plan for the Village of Crysler
Microbial Risk Management Zones (MRMZs) Calculation Summary

	Hydraulic Conductivity (m/day)	Natural hydraulic gradient (m/m)	Pumping flow rate (m^3/day)	b-saturated thickness of screened interval (m)	Porosity	Bear and Jacobs Distance in the x direction for varying travel times (m)	
Bear & Jacobs	**K**	**i**	**Q**	**b**	**n**	**50 day**	**2 year**
upgradient direction	61.64	0.0002	1685	11	0.25	100	402
downgradient direction	61.64	0.0002	1685	11	0.25	-75	-354
Fixed Radius							
WESA GUDI-Fixed Radius Calculation	61.64	0.0002	1685	11	0.25	98.8	377.3

Culmination Point of the Depression Cone	
Kruseman and Ridder	Sloping Unconfined Aquifer -Steady State Flow
POI =	$Q / 2 \pi K b i$
POI =	1978

POI = Point of Impingement

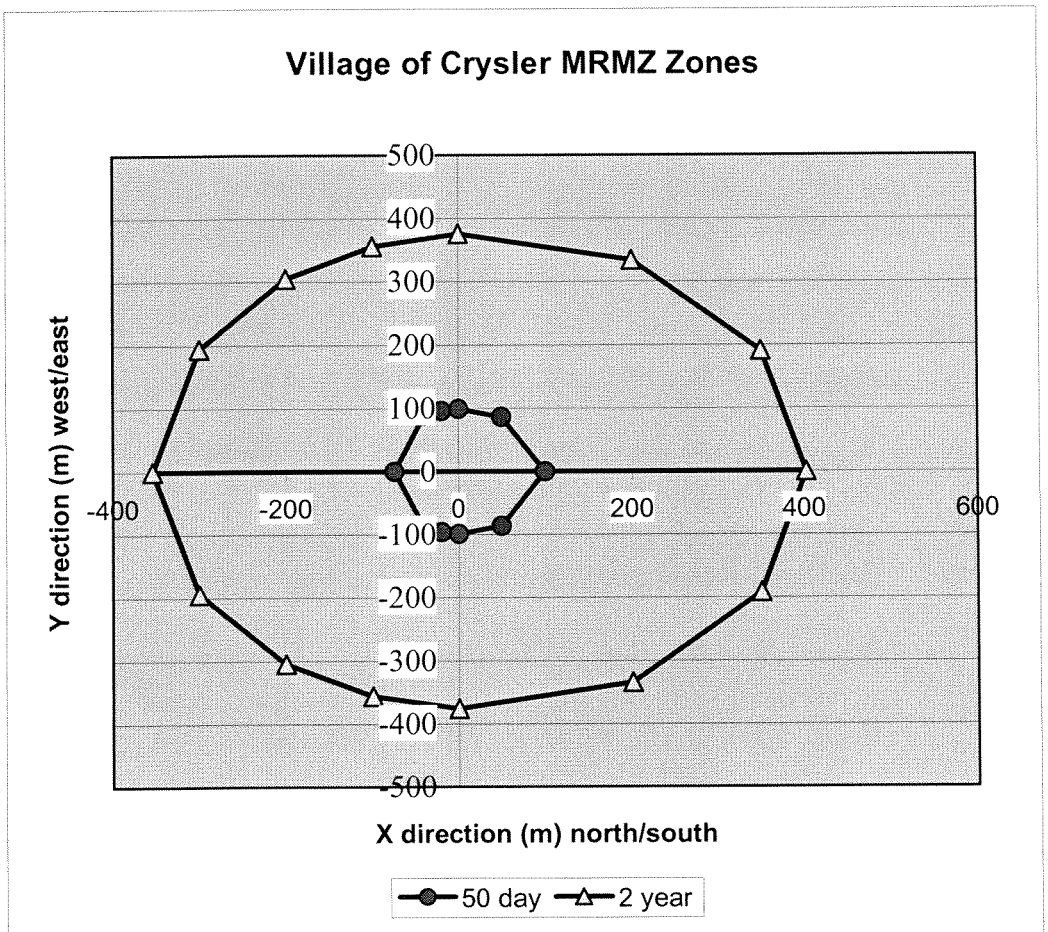
Calcuation of distance in the y direction (m) (Bear & Jacobs)	**t = 50 days**		**t = 2 years**	
	x	**y**	**x**	**y**
	100	1E-09	402	0
	50	86	350	191
	0	99	200	334
	-20	96	0	376
	-40	89	-100	356
	-75	1E-09	-200	305
			-300	194
			-354	0

Notes:

Journal of Hydrology, Jacob Bear and Martin Jacobs 1965, pages 37-57, *'On the movement of water bodies injected into aquifers'* volume 3, Issue 1, May.

WESA, April 2002: GUDI Well Assessment of Village of Crysler Well Supply, Township of North Stormont, Ontario.

Analysis and Evaluation of Pumping Test Data, Kruseman and Ridder, ILRI, Netherlands 1991, Section 7.2.1, pg. 127-128



t = 50 days		t = 2 years	
x	y	x	y
100	1E-09	402	0
50	86	350	191
0	99	200	334
-20	96	0	376
-40	89	-100	356
-75	1E-09	-200	305
100	-1E-09	-300	194
50	-86	-354	0
0	-99	402	0
-20	-96	350	-191
-40	-89	200	-334
-75	-1E-09	0	-376
		-100	-356
		-200	-305
		-300	-194
		-354	0

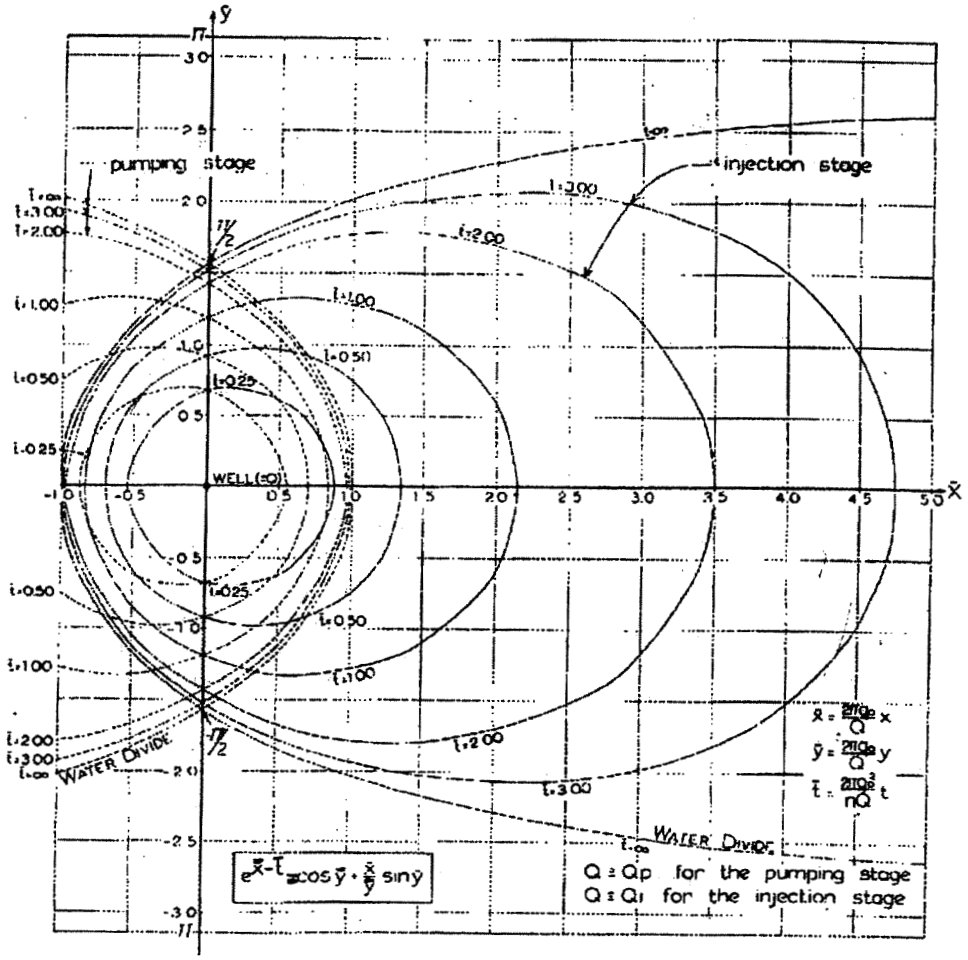


Fig. 1. Front positions for a single well in uniform flow.

Bear and Jacobs, 1965

CB2730 Microbial Control Plan for the Village of Crysler
Microbial Risk Management Zones (MRMZs) Calculation Summary

Input Parameters			**units**
K	61.64	hydraulic conductivity	m/day
i	0.0002	natural hydraulic gradient of the aquifer	none
Q	1685	pumping flow rate	m3/day
b	11	saturated thickness of the aquifer	m

Source: *On the Movement of Water Bodies Injected Into Aquifers' Jacob Bear and Martin Jacobs,* Journal of Hydrology, Volume 3, Issue 1, May 1965, pg. 37-57

Theory: Steady flow from a single well in uniform flow - estimating shape of front symmetric in the x direction (time t at which front reaches point x)

Inherent Assumptions:

a confined aquifer of infinite areal extent (underestimates TOT distances close to the well)
average constant specific discharge (q°) in the x direction.
uniform transmissivity
steady state flow
symmetric front in the x direction

Equation: $((2 \pi q°2)/(nQ))\, t + \ln [1 + (2 \pi q° x)/(Q)] = ((2 \pi q°)/(Q))\, x$

Upgradient 50 day

q°	0.012328	constant specific discharge in the x direction	m/day	= Ki
Q	153.1818	flowrate per unit thickness	m2/day	=Q/b
x	**100**	**distance**	**m**	iterative
n	0.25	porosity (Range from Freeze & Cherry, 1979)		0.25 -0.4
t	50	time of travel	days	
LS	0.050577	$((2 \pi q°2)/(nQ))\, t + \ln [1 + (2 \pi q° x)/(Q)]$		
RS	0.050567	$((2 \pi q°)/(Q))\, x$		

Upgradient 2 year

q°	0.012328	constant specific discharge in the x direction	m/day	= Ki
Q	153.1818	flowrate per unit thickness	m2/day	=Q/b
x	**402**	**distance**	**m**	iterative
n	0.25	porosity (Range from Freeze & Cherry, 1979)		0.25 -0.4
t	730	time of travel	days	
LS	0.203253	$((2 \pi q°2)/(nQ))\, t + \ln [1 + (2 \pi q° x)/(Q)]$		
RS	0.203278	$((2 \pi q°)/(Q))\, x$		

CB2730 Microbial Control Plan for the Village of Crysler
Microbial Risk Management Zones (MRMZs) Calculation Summary

Input Parameters			**units**
K	61.64	hydraulic conductivity	m/day
i	0.0002	natural hydraulic gradient of the aquifer	none
Q	1685	pumping flow rate	m3/day
b	11	saturated thickness of the aquifer	m

Source: *On the Movement of Water Bodies Injected Into Aquifers' Jacob Bear and Martin Jacobs,* Journal of Hydrology, Volume 3, Issue 1, May 1965, pg. 37-57

Theory: Steady flow from a single well in uniform flow - estimating shape of front symmetric in the x direction (time t at which front reaches point x)

Inherent Assumptions:

a confined aquifer of infinite areal extent (underestimates TOT distances close to the well)
average constant specific discharge (q°) in the x direction.
uniform transmissivity
steady state flow
symmetric front in the x direction

Equation: $((2 \pi q°2)/(nQ)) t + \ln [1 + (2 \pi q° x)/(Q)] = ((2 \pi q°)/(Q)) x$

Downgradient 50 day

q°	0.012328	constant specific discharge in the x direction	m/day	= Ki
Q	153.1818	flowrate per unit thickness	m2/day	=Q/b
x	**-75**	**distance**	**m**	iterative
n	0.25	porosity (Range from Freeze & Cherry, 1979)		0.25 -0.4
t	50	time of travel	days	

LS	-0.037416	$((2 \pi q°2)/(nQ)) t + \ln [1 + (2 \pi q° x)/(Q)]$
RS	-0.037925	$((2 \pi q°)/(Q)) x$

Downgradient 2 year

q°	0.012328	constant specific discharge in the x direction	m/day	= Ki
Q	153.1818	flowrate per unit thickness	m2/day	=Q/b
x	**-354**	**distance**	**m**	iterative
n	0.25	porosity (Range from Freeze & Cherry, 1979)		0.25 -0.4
t	730	time of travel	days	

LS	-0.179037	$((2 \pi q°2)/(nQ)) t + \ln [1 + (2 \pi q° x)/(Q)]$
RS	-0.179006	$((2 \pi q°)/(Q)) x$

Bear and Jacobs Calculations for Y

Upgradient

As y approaches 0, X is at the front for t = 50 days (verification of formula)

x =	100		t =	50		y =	0.000000001
x bar =	0.05056678	((2 π q°)/(Q)) x	t bar =	0.001247	((2 π q°2)/(nQ)) t	y bar =	5.05668E-13 ((2 π q°)/(Q)) y

x bar - t bar =	0.04932	
cos y bar =	1	
x bar/y bar =	1E+11	
sin y bar =	5.0567E-13	
LS	1.05055648	e ^ (x bar - t bar)
RS	1.05056678	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be between 0 and the front (0 to 100 m), for t = 50 days

x =	50		t =	50		y =	86
x bar =	0.02528339	((2 π q°)/(Q)) x	t bar =	0.001247	((2 π q°2)/(nQ)) t	y bar =	0.043487428 ((2 π q°)/(Q)) y

x bar - t bar =	0.02403661	
cos y bar =	0.99905457	
x bar/y bar =	0.58139535	
sin y bar =	0.04347372	
LS	1.02432782	e ^ (x bar - t bar)
RS	1.02432999	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be 0 m, for t = 50 days

x =	0		t =	50		y =	99
x bar =	0	((2 π q°)/(Q)) x	t bar =	0.001247	((2 π q°2)/(nQ)) t	y bar =	0.050061109 ((2 π q°)/(Q)) y

x bar - t bar =	-0.0012468	
cos y bar =	0.9987472	
x bar/y bar =	0	
sin y bar =	0.0500402	
LS	0.998754	e ^ (x bar - t bar)
RS	0.998747	cos y bar + (x bar/ y bar)* sin y bar

50 day MRMZ

Downgradient

Solve for y, Let X be between 0 and the downgradient front (0 to -75 m), for t = 50 days

x =	-20		t =	50		y =	96
x bar =	-0.0101134	((2 π q°)/(Q)) x	t bar =	0.001247	((2 π q°2)/(nQ)) t	y bar =	0.048544106 ((2 π q°)/(Q)) y

x bar - t bar =	-0.0113601	
cos y bar =	0.99882197	
x bar/y bar =	-0.2083333	
sin y bar =	0.04852504	
LS	0.98870415	e ^ (x bar - t bar)
RS	0.98871258	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be between 0 and the front (0 to -75 m), for t = 50 days

x =	-40		t =	50		y =	89
x bar =	-0.0202267	((2 π q°)/(Q)) x	t bar =	0.001247	((2 π q°2)/(nQ)) t	y bar =	0.045004432 ((2 π q°)/(Q)) y

x bar - t bar =	-0.0214735	
cos y bar =	0.99898747	
x bar/y bar =	-0.4494382	
sin y bar =	0.04498924	
LS	0.97875543	e ^ (x bar - t bar)
RS	0.97876759	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be at the front (-75 m), for t = 50 days

x =	-75		t =	50		y =	0.000000001
x bar =	-0.0379251	((2 π q°)/(Q)) x	t bar =	0.001247	((2 π q°2)/(nQ)) t	y bar =	5.05668E-13 ((2 π q°)/(Q)) y

x bar - t bar =	-0.0391719	
cos y bar =	1	
x bar/y bar =	-7.5E+10	
sin y bar =	5.0567E-13	
LS	0.96158544	e ^ (x bar - t bar)
RS	0.96207492	cos y bar + (x bar/ y bar)* sin y bar

2 Year MRMZ

Upgradient

Solve for y, Let X be 350, for t = 2 years

x =	350		t =	730		y =	191
x bar =	0.17698372	((2 π q°)/(Q)) x	t bar =	0.018203	((2 π q°2)/(nQ)) t	y bar =	0.096582544 ((2 π q°)/(Q)) y

x bar - t bar =	0.15878081	
cos y bar =	0.99533953	
x bar/y bar =	1.83246073	
sin y bar =	0.09643246	
LS	1.17208101	e ^ (x bar - t bar)
RS	1.17204822	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be between 0 and the front (0 to 402 m), for t = 2 years

x =	200		t =	730		y =	334
x bar =	0.10113355	((2 π q°)/(Q)) x	t bar =	0.018203	((2 π q°2)/(nQ)) t	y bar =	0.168893035 ((2 π q°)/(Q)) y

x bar - t bar =	0.08293065	
cos y bar =	0.98577144	
x bar/y bar =	0.5988024	
sin y bar =	0.16809124	
LS	1.08646646	e ^ (x bar - t bar)
RS	1.08642488	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be 0, for t = 2 years

x =	0		t =	730		y =	376
x bar =	0	((2 π q°)/(Q)) x	t bar =	0.018203	((2 π q°2)/(nQ)) t	y bar =	0.190131082 ((2 π q°)/(Q)) y

x bar - t bar =	-0.0182029	
cos y bar =	0.98197947	
x bar/y bar =	0	
sin y bar =	0.18898762	
LS	0.98196177	e ^ (x bar - t bar)
RS	0.98197947	cos y bar + (x bar/ y bar)* sin y bar

2 Year MRMZ

Downgradient

Solve for y, Let X be between 0 and the front (-354 m), for t = 2 years

x =	-100		t =	730		y =	356
x bar =	-0.0505668	((2 π q°)/(Q)) x	t bar =	0.018203	((2 π q°2)/(nQ)) t	y bar =	0.180017726 ((2 π q°)/(Q)) y

x bar - t bar =	-0.0687697	
cos y bar =	0.98384052	
x bar/y bar =	-0.2808989	
sin y bar =	0.17904701	
LS	0.93354166	e ^ (x bar - t bar)
RS	0.93354641	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be between 0 and the front (-354 m), for t = 2 years

x =	-200		t =	730		y =	305
x bar =	-0.1011336	((2 π q°)/(Q)) x	t bar =	0.018203	((2 π q°2)/(nQ)) t	y bar =	0.15422867 ((2 π q°)/(Q)) y

x bar - t bar =	-0.1193365	
cos y bar =	0.98813031	
x bar/y bar =	-0.6557377	
sin y bar =	0.15361797	
LS	0.88750914	e ^ (x bar - t bar)
RS	0.88739722	cos y bar + (x bar/ y bar)* sin y bar

Solve for y, Let X be - 300, for t = 2 years

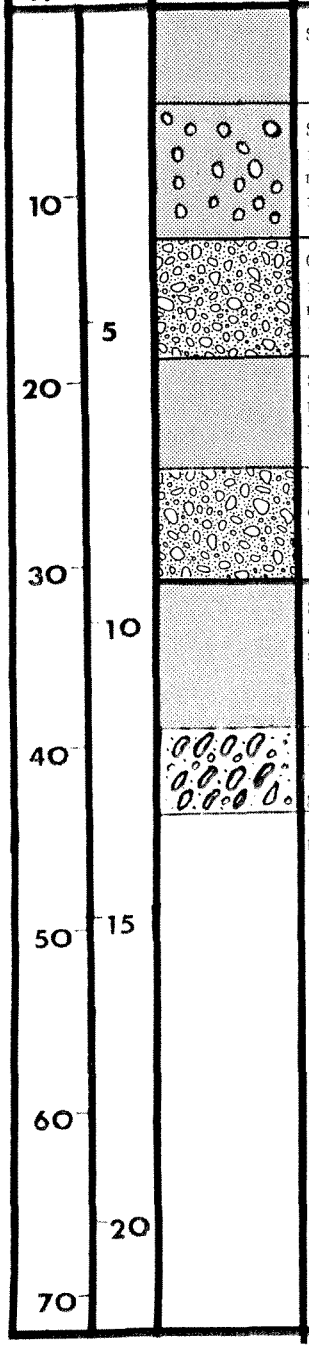
x =	-300		t =	730		y =	194
x bar =	-0.1517003	((2 π q°)/(Q)) x	t bar =	0.018203	((2 π q°2)/(nQ)) t	y bar =	0.098099547 ((2 π q°)/(Q)) y

x bar - t bar =	-0.1699032	
cos y bar =	0.9951921	
x bar/y bar =	-1.5463918	
sin y bar =	0.09794228	
LS	0.84374646	e ^ (x bar - t bar)
RS	0.84373496	cos y bar + (x bar/ y bar)* sin y bar

APPENDIX D

Municipal Wells – Well Records

FIGURE 4.3	RECORD OF TEST HOLE	ELEVATION 73.31 m	CW-27 T.W.



DRILL LOG	GEOLOGIC DESCRIPTION	OBSERVATION DURING DRILLING
	Sand: med. to cr. grd.; brown; immature. 1.5 m	Hole completed with cable-tool percussion drilling. No circulating fluid was used. Stable hole. Samples were obtained by both dart and suction bailers. Hole was dry for the first 9 ft. (2.7 m) and therefore water was added to the hole to form a slurry which aided the bailing process. Water was found at 10 feet (3.0 m).
	Sand and Gravel: pebble gravel ranging in size from 0.5 cm to 3.0 cm; sand is med. to cr. grd. consisting of quartz, feldspar, and rock fragments. 3.8 m	
	Gravel: pebble gravel ranging in size from 0.75 cm to 1.25 cm; very little sand matrix; sand is coarse grd. (0.1-0.3 cm). Interbedded are layers of cobble gravel. 5.8 m	
	Sand: med. to cr. grd. sand with no pebbles. Sand tends to have a heaving nature. 7.6 m	
	Sand and Gravel: med. grd. sand with cobble and pebble gravel (0.5-6.0 cm). Fine grained sand interbed occurs at 29 feet (8.8 m). 9.4 m	Plenty of water. Slow yet smooth drilling.
	Sand: fine to medium grained, immature quartz grains abundant; fairly unimodal. smooth drilling; no pebbles. 11.4 m	Plenty of water.
	Till: granules and pebbles with the occasional boulder; silty sand matrix; gray-green colouring. 13.4 m	Loss of water.
	End of hole at 44 feet (13.4 m).	Hole refilled to 39 feet (11.9 m).

FIGURE: 3

AS-BUILT DIAGRAM

DESIGNATION	COMPLETION DATE
PW1	May 19, 1993

PROJECT: Crysler Production Well

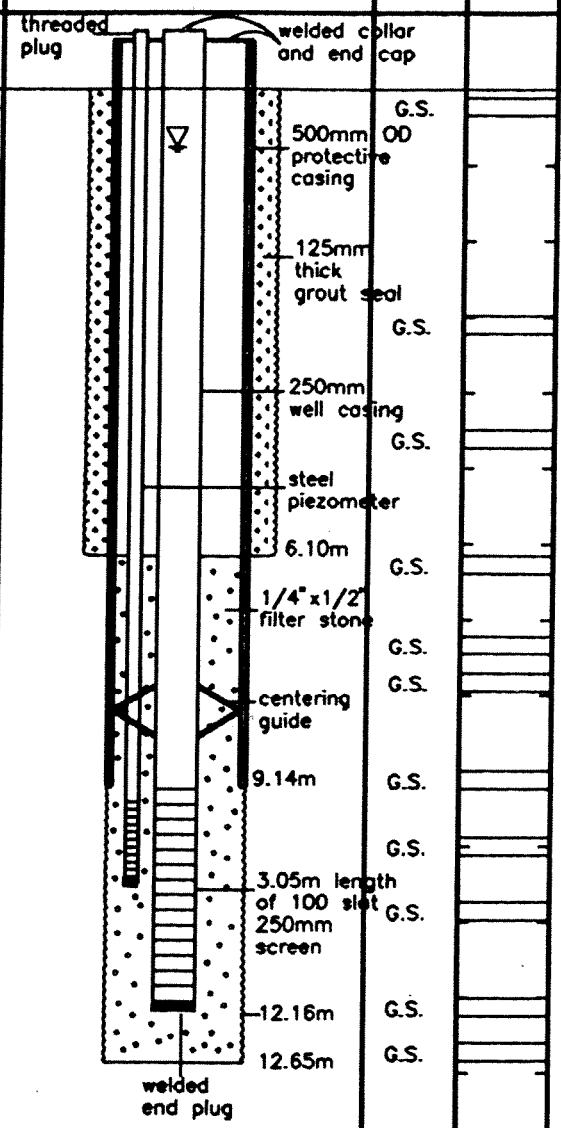
PROJECT NO.: 3013

DRILLING METHODS: Cable Tool (Churn Drill)

SUPERVISOR: R. Hillier

DRILLING CONTRACTOR: Olympic Drilling Co. Ltd.

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY
0	72.89 masl	
1–3		0 – 3.0m Sand – light brown medium to fine grained
3–4.6		3.0 – 4.6m Sand – minor clay layer
4.6–6.1		4.6 – 6.1m Grey Sand – pebbles & cobbles
6.1–7.6		6.1 – 7.6m Sand, gravel, stones
7.6–8.5		7.6 – 8.5m Sand, medium grained
8.5–12.5		8.5 – 12.5m Gravel – stones, some coarse sand
12.5–12.8		12.5 – 12.8m Till – silty sand matrix
12.8		12.8m End of Hole



LOG	INSTRUMENTATION	TYPE	INTERVAL	N VALUE

WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O. BOX 430 CARP, ONTARIO. KOA 1L0

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

STORMONT | 1. PRINT ONLY IN SPACES PROVIDED 2. CHECK ☒ CORRECT BOX WHERE APPLICABLE | 11 | 5803704 | MUNICIP 58002 | CON. CON | LOT 09

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON	BLOCK	TRACT	SURVEY	ETC	LOT
Stormont, Dundas & Glengarry	Crysler, Ontario					9	10

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Village of Crysler Ont.	CRYSLER, Ontario	DAY 19 MO 05 YR 93

21 | 1 PRODUCTION WATER WELL | ZONE | EASTING | NORTHING | RC | ELEVATION | RC | BASIN CODE | II | III | IV

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	Sand		Packed	0'	5'
Brown	Sand		Packed	5'	10'
Brown	Sand	Some Clay	Packed	10'	15'
Grey	Gravel	Pebbles, Cobbles	Packed	15'	20'
Grey	Gravel	Sand, Gravel, Stones	Loose	20'	28'
Grey	Gravel	Stones, Cobbles	Loose	28'	40'

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
30-40'	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH FEET FROM	DEPTH FEET TO
30"	1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE ☒ 5 PLASTIC		0'	24' 28'
20"	☒ 1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC	.375	+2'	30'
10"	☒ 1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC	.375	+3'	30'
10"	☒ 1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC Screen		30'	40'

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
100	10" INCHES	10' FEET

MATERIAL AND TYPE: Stainless Steel

DEPTH TO TOP OF SCREEN: 30' FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD, PACKER, ETC.)
0'	24'	Cement Grout
		28 sacks of High
		Early Cement

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☒ 1 PUMP ☐ 2 BAILER	300 GPM	72 HOURS MINS

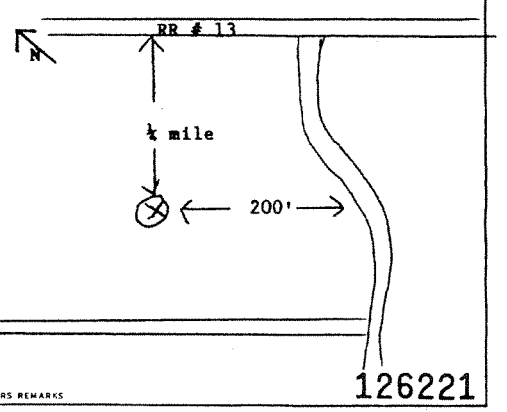
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: ☐ 1 PUMPING ☐ 2 RECOVERY	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
5' FEET	11.93' FEET		8.2' FEET	8.7' FEET	9.1' FEET	9.4' FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	25' FEET	☒ 1 CLEAR ☐ 2 CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☒ SHALLOW ☐ DEEP	25' FEET	300 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW



DRILLERS REMARKS: 126221

FINAL STATUS OF WELL
1 ☐ WATER SUPPLY 2 ☒ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED ☐ DEWATERING

WATER USE
1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☒ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF CONSTRUCTION
1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING ☐ DIGGING ☐ OTHER

CONTRACTOR

NAME OF WELL CONTRACTOR: OLYMPIC DRILLING CO.LIMITED
WELL CONTRACTOR'S LICENCE NUMBER: 4006
ADDRESS: Box 9180 OTTAWA, Ontario K1G 3T9
NAME OF WELL TECHNICIAN: Jodie Renwick
WELL TECHNICIAN'S LICENCE NUMBER: TO 460
SIGNATURE OF TECHNICIAN/CONTRACTOR: (Sec.)
SUBMISSION DATE: DAY 25 MO 05 YR 93

OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 4006 | DATE RECEIVED JUN 11 1993
DATE OF INSPECTION | INSPECTOR
REMARKS

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

APPENDIX E

Provost Sand Pit Operational Plan

Ontario

Ministry of Natural Resources

Ministère des Richesses naturelles

The Aggregate Resources Act

Loi de 1989 sur les ressources en agrégats

Application for a Licen((/ Demande de permis

Application for a:
Demande concernant :

- [X] Pit / un puits d'extraction
- [ ] Quarry / une carrière

- The site plan required under section 8 of the Act must accompany this application.
  Le plan du site exigé aux termes de l'article 8 de la Loi doit être joint à la présente demande.
- For Class A licences the report required under section 9 of the Act must accompany this application.
  Pour les demandes de permis de classe A, le rapport exigé aux termes de l'article 9 de la Loi doit être joint à la présente demande.
- Personal information required on this form is collected under the authority of the Aggregate Resources Act, s.7(1) and will be used for the administration of the Act.
  Les renseignements personnels contenus dans cette formule sont demandés en vertu de la *Loi de 1989 sur les ressources en agrégats*, par. 7(1) et seront utilisés à des fins d'application de la Loi.
- Questions about this information should be directed to the District Manager of the Ministry of Natural Resources district in which the site is located.
  Adresser toute question sur cette demande au chef du district du ministère des Richesses naturelles dans lequel se trouve la carrière ou le puits d'extraction.
- All information submitted in respect of this application is available for public review.
  Tous les renseignements donnés relativement à cette demande peuvent être examinés par le public.

1. Type of Application: / Type de demande :

- [X] Class 'A' Licence - more than 20,000 tonnes per year
  Permis de classe 'A' - plus de 20 000 tonnes métriques per année
- [ ] Class 'B' Licence - 20,000 tonnes or less per year
  Permis de class 'B' - 20 000 tonnes métriques par année ou moins

2. Applicant: / Requérant :

Name / Nom: RAYMOND PROVOST CARTAGE COMPANY LTD.

Address / Adresse: P.O. Box 35, Crysler, Ontario K0A 1R0

Phone No. / N° de tél.: 987-2118

Postal Code / Code postal: K0A 1R0

3. Landowner: (If different from Applicant) Propriétaire : (S'il est différent du requérant)

Name / Nom: same

Address / Adresse: same

Phone No. / N° de tél.:

Postal Code / Code postal:

Type of Tenure / Type de bail:
- [ ] Lease / Location — Expiry Date / Date d'expiration:
- [ ] Extraction Agreement / Entente d'extraction — Expiry Date / Date d'expiration:

4. Site Location: / Emplacement :

Lot	Concession	Geographic Township / Canton géographique	Local Municipality / Municipalité locale	County / Regional Municipality / District / Comté / municipalité régionale / district
20,21	IX(9)	FINCH	--	STORMONT

5. Site History: / Historique de l'emplacement :

(Complete i), ii) or iii) as appropriate) (Remplissez la section i), ii) ou iii), selon le cas)

i) [ ] Licence under Pits and Quarries Control Act / Permis aux termes de la *Loi sur les puits d'extraction et les carrières*

Licence No. / Permis n° P623598

ii) [X] Established pit / quarry in newly designated area / Puits d'extraction / carrière existant dans une zone nouvellement désignée

a) When previously operated / Période d'activités précédente: 1989

* B classification now going to an "A"

b) Tonnage removed within previous 2 years / Quantité extraite pendant les deux dernières années:

c) Area disturbed / Région perturbée:

d) Present zoning of site and adjacent lands on site plan / Zonage actuel de l'emplacement et des terrains adjacents indiqués sur le plan du site

* [illegible]

iii) [ ] New Pit / Quarry / Nouveau puits d'extraction / nouvelle carrière

Present zoning of site and adjacent lands on site plan / Zonage actuel de l'emplacement et des terrains adjacents indiqués sur le plan du site

6. Pit / Quarry Operation: / Activités au puits / à la carrière

Estimated amount of aggregate to be excavated annually / Quantité approximative d'agrégats à extraire chaque année	Licenced Area / Région touchée par le permis	Extraction Area / Zone d'extraction	Is this an expansion to an existing pit / quarry? / S'agit-il de l'expansion d'un puits d'extraction ou d'une carrière existant ?
200,000 tonnes métriques	26.3 hectares	23.6 hectares	

7. Corporation Use Only: / Réservé à la compagnie :

I have authority to bind the herein-named Corporation / Je suis habilité à prendre des engagements au nom de la compagnie ci-après mentionnée

Initials and Surname of Corporation Official (Please Print) / Initiales et nom de famille du représentant de la société (en charactères d'imprimerie)	Signature of Corporation Official / Signature du représentant de la société	Position / Fonctions
		President

8.

Signature of Applicant / Signature du requérant:

Dated this / Ce 14 day of / jour de July, 19 90

For Office Use Only / Réservé au bureau

Ci-joint	copies of the site plan included as per Section 8 of the Act / exemplaires du plan du site, conformément à l'article 8 de la Loi.	Ci-joint	copies of report included as per Section 9 of the Act / exemplaires du rapport, conformément à l'article 9 de la Loi.	$ Ci-joint le droit de	application fee included as per Section 5 of the Regulations / $ exigé pour la demande, conformément à l'article 5 des règlements. Receipt No. / Reçu n° 0001 CHEQUE $200.00

0029 (89/07)

REPORT FOR A CLASS A LICENCE

Raymond Provost Pit

Lots 20 and 21, Concession 9

in

Finch Township - Stormont County

a) Suitability of Rehabilitation

The rehabilitated site will be beneficial to the adjacent lands. At the present time the site provides water for agricultural and municipal purposes.

b) Environmental Effects

The environment will not be affected in any negative fashion. The site will be a wildlife fish sancturary as well as a place for swimming. Motor boats will not be allowed on this lake.

c) Economic Benefits

This pit provides employment to approximately 5 men. Also the high quality aggregate is not available in the area. The quanlity products include mortar sand and high quality gravel.

d) Quality and Quantity

The site has been tested to 20' depth. There is good quality sand on the west half and very good quality gravel on the east half. Also, when the Municipal well was drilled good gravel was found to at least 45'feet.

e) Truck Routes

The concession 10 County Road will be used. It is of suitable construction to handle our truck traffic.

f) Hydrology

The site is an excellent water producing area. There will be no pumping for drainage, no diversion or point of discharge to the surface.

g) Product Stockpiles

The pit operations will be portable and temporary. There will not be any permanent product stockpiles. The topsoil will be transferred to the rehabilitated areas in a progressive fashion.

h) Planning

The Township of Finch has been approched on this matter, (October 1989). They agreed in principal, however, they wanted to wait until the plans are officially circulated by Ministry of Natural Resources for their review and comment.

i) Self explanatory

j) Other Necessary Information

The municipal water well will not interfere with the pit operations. The Municipality of Finch agreed to this in writing at the time of the well construction (1985).

Prepared by: les ingénieurs
DESJARDINS/LASCELLES
engineering limited

per: André E. Desjardins, P.Eng.

Ontario

Ministry of Natural Resources

Ministère des Richesses naturelles

Aggregate Resources Act

Loi de 1989 sur les ressources en agrégats

Licence

Permis

Licence No. / N° de permis P623598

Pursuant to the Aggregate Resources Act and Regulations, and subject to the limitations thereof and to the conditions of the licence and the requirements of the site plan.

Conformément à la *Loi de 1989 sur les ressources en agrégats* et à ses règlements, et sujet aux restrictions qu'ils comportent, aux conditions d'octroi du permis et aux exigences du plan du site,

this Class A licence is issued to:
nous délivrons ce permis de classe A à :

RAYMOND PROVOST CARTAGE COMPANY LTD.
P.O. BOX 35
CRYSLER, ONTARIO
K0A 1R0

FEED FAX THIS END

FAX

To: Vim Johnston
Dept: Kostuch Env. Ltd
Fax No.: 744-8877
No. of Pages: 3
From: Butch Martelock
Date: 93-03-25
Company: MNR Cornwall
Fax No.: Attn. 933-1774
Comments: As discussed

to operate a PIT pour exploiter un/une

on a 26.3 sur le terrain de

hectare site in: hectares situé à l'endroit suivant :

20 & 21 Lot

IX (9) Concession

FINCH Local Municipality / Municipalité locale

STORMONT County / Regional Municipality / Comté / municipalité régionale

The licence is subject to the following conditions:
Ce permis est assujetti aux conditions suivantes :

SEE ATTACHED SCHEDULE "A"

Effective the 16 day of November, 19 90
En vigueur le jour d

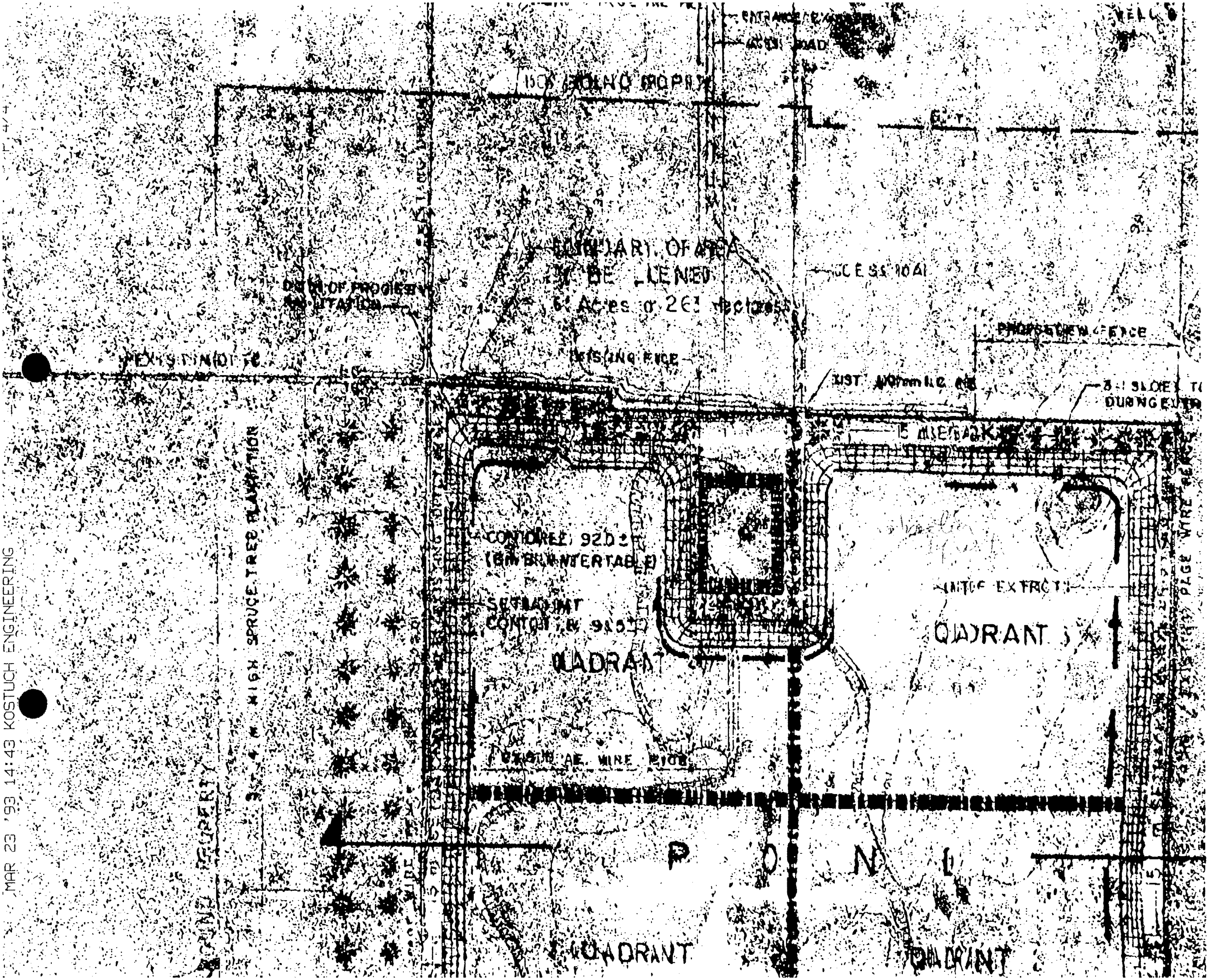
Bud Wildman
Minister of Natural Resources
Ministre des Richesses naturelles

SCHEDULE "A"
P623598

1) REFUELLING OF EQUIPMENT MUST BE RESTRICTED TO AREAS UNDERLAIN BY SILT AND CLAYS OUTSIDE OF THE EXCAVATION AREA SO AS TO PREVENT WATER QUALITY DEGRADATION.

2) ONLY WATER CAN BE USED TO CONTROL DUST ON THE SITE.

3) NOT MORE THAN 200,000 TONNES MAY BE REMOVED IN ANY CALENDAR YEAR.


ENTRANCE/EXIT
ACCESS ROAD
BOUNDARY OF AREA
TO BE LICENED
ACCESS ROAD
PROPOSED NEW FENCE
EXISTING FENCE
EXISTING DITCH
3-4 m HIGH SPRUCE TREE PLANTATION
CONTOUR 92.0±
SETBACK
PAGE WIRE FENCE
QUADRANT
QUADRANT
P O N D
QUADRANT
QUADRANT

APPENDIX F

Section 5 of the MOE Reference Document Hazard Ratings For Potential

Microbial Risk Management Rating

Saturated Zone Time of Travel	Intrinsic Susceptibility Index		
	<30	30 to 80	>80
0 - 50 days *	HIGH	HIGH	HIGH/MOD*
50 days - 2 years	HIGH	MODERATE	LOW
>2 years **	MODERATE	LOW	LOW

* NOTE: Where this zone is not well defined by a calibrated hydrogeological model, a distance of 100 metres for overburden flow systems and 500 metres for bedrock flow systems should be used.

** NOTE: Land use activities beyond the 2-year boundary need to be considered where it is necessary to allow for increased future pumping rates, where there is significant uncertainty regarding boundary placement or where there are high risk activities that may be impacted directly or through surface water flows.

Three risk ratings (High, Moderate and Low) have been defined below:

High Risk: In the areas defined as high risk, microbial contaminants can rapidly infiltrate into the water supply aquifer and begin migrating toward the well(s). Ideally, no **significant potential sources of microbial contaminants** should be permitted in High Risk areas. Where it is not practical to eliminate existing potential significant contaminant sources in this area, stringent measures to manage the risk posed by these sources must be developed and timely, effective contingency plans established.

** To ensure adequate protection in the immediate vicinity of the well(s), it is recommended that the 50 day time of travel zone be defined as a high risk area regardless of the Intrinsic Susceptibility Index (ISI) rating. Exceptions which result in a Moderate Risk rating may be made only in cases where:*

1) the ISI significantly exceeds 80, AND

2) it can be clearly demonstrated that contaminant short-circuiting pathways are not present in the confining layer, AND

3) policies are put in place to prohibit the creation of such pathways within the 50-day time of travel zone.

Moderate Risk: The moderate risk areas require the development of a plan to manage and monitor risks posed to the well supply by potential microbial contaminant sources.

Low Risk: Low Risk areas are those in which minimal controls are necessary to ensure effective protection of the well from microbial contamination.

5. POTENTIAL MICROBIAL CONTAMINATION MANAGEMENT

5.1 Contents of the inventory of contamination sources

Information on each of the identified existing and potential sources of contamination should be compiled in a list including:

a) description of the contamination source
   - source name (if applicable), and name of owner/operator
   - indication if it is an existing or potential source
   - type of the source (see Table 5.2)
   - approximate areal size of the source
   - permanent/intermittent

b) location of the source
   - address (if applicable)
   - geo-reference information based on NAD83 (North American Datum 1983). Field-based GPS coordinates are mandatory for major potential contaminant sources in high risk areas; desktop analysis may be sufficient in low risk areas.
   - approximate saturated horizontal TOT to the well/well field
   - linear distance to the well/well field
   - current municipal land use zoning and land use designation for the location
   - current land use
   - source risk rank or category (see below)

In addition to the inventory list, all identified existing and potential sources of microbial contamination must be accurately plotted and identified (existing/potential, name and type) on a copy of the to-scale TOT delineation map prepared in accordance with the Delineation Protocol. This copy of the TOT delineation map must also identify the current municipal zoning and land use designations.

5.2 Risk Ranking/Categorization of the Contaminant Sources

Any identified source of microbial contamination within the delineated time of travel zones can pose a risk of contamination and possible loss of the water supply. Due to limited resources, however, it may be necessary for the municipality to focus efforts on the sources which pose the most significant risks.

In order to establish priorities for the plan of implementation of microbial contamination control measures, it is necessary to evaluate the relative degree of risk that the individual contamination sources identified in the inventory pose to the water supply.

Where a potential contamination source has been identified, and the individual business owners and agricultural operators are using established BMPs for groundwater protection , the contamination source will not generally need any additional attention at the present time.

Similarly, a potential contamination source may be considered a low hazard source, and not require any immediate remedial action, where the owner of the facility in question, under conditions of its approval/permit, was required to install a network of monitoring wells upgradient and downgradient from its site, and it has been determined that the monitoring program and remedial action plan in place are adequate.

As noted above, the risk rank or category of each source must be noted in the source inventory list. In a preamble to the source inventory list, the criteria used in the risk ranking must be identified, including reasons for the choice of the criteria.

5.3 Microbial Contamination Control Measures

Although some of the microbial contamination management tools identified here refer to regulatory programs, it is generally accepted that groundwater protection within specific time of travel zones of the microbial contamination control areas can be accomplished most effectively and at the least cost by developing partnerships with local business, industry and

the agricultural community, and focussing on educational/training and pollution prevention or best management practices concepts.

Since groundwater can be affected by a wide variety of human activities and sources, a comprehensive groundwater protection program would need to incorporate various types of measures. The various microbial contamination control measures may be categorized into three general areas:

- pollution prevention/best management practices (BMPs),
- regulatory permitting/environmental assessment, and
- land use controls or restrictions.

5.3.1 General microbial contamination control measures

Components of the plan should include, but not necessarily be limited to:

1) identification of the potential risks,
2) recommendations to reduce and manage the risk of contaminant release to the environment, and
3) recommendations for control of new development and specific activities within the area

Microbial contamination control measures that may apply to all activities that may result in microbial contamination of groundwater include the following tools:

- Public Education;
- Installation of Signs;
- Water Conservation;
- Public/Private Partnerships;
- Zoning By-laws;
- Groundwater Monitoring;
- Property Purchases;
- Septic System Upgrades;
- Potential Source Restrictions.
- Certificates of Approval
- Farm Management Plans (Nutrient Management Act)

The tools listed above are applicable to all types of potential contamination (not only microbial contamination). However, the list does not include tools that are otherwise very useful in preventing groundwater contamination, but are not applicable to sources of microbial contamination (e.g.,hazardous waste collection programs, spill response plans, or special chemical use and transportation prohibition). Table 5-1 provides a brief discussion of the contamination control tools that may be relevant to potential microbial contamination.

Table 5-1: General Management Tools Available for Microbial Protection

1. **Public Education/Notification:** This option is highly recommended for implementation within the entire microbial contamination control area. Every effort should be made to contact all property owners within the microbial contamination control area so they are aware of the need for protection measures. One of the tools in accomplishing this may be organizing one or more workshops where information would be available and presentations would be made to inform local residents of the connection between drinking water quality and activities on the land surface. The focus of such an educational effort should include: – basic information about groundwater and the relationship between surface activities and groundwater quality, – familiarity with the location of the protected area, – basic information on sources of contamination, and – effective strategies for safe management of all potential contaminants.
2. **Sign Installation:** Information signs should be placed adjacent to all roadways entering the microbial contamination control area. The signs should include the name of the water system or jurisdiction along with a phone number where callers can obtain more information.
3. **Water Conservation Program:** Implementing water conservation measures in your community can significantly benefit microbial contamination control efforts. Reductions in pumping rates may reduce flow rates within the aquifer and the associated risk of transporting any contamination within the aquifer. Conserving water may also help reduce the need for additional water sources in the near future. Water conservation can be accomplished through steps such as distribution of flow control devices, retrofitting high-flow toilets and washing machines.
4. **Public/Private Partnerships:** It is highly recommended that the public authority having jurisdiction over the water supply system seek partnerships with the private business, commercial, and industrial communities within the microbial contamination control area. These public/private partnerships can involve setting up a process for collaboration and finding common goals, such as maintaining low cost clean drinking water, encouraging best management practice applications, and continued economic prosperity in the region. Mutual benefits may include maximizing pollution prevention implementation in the community, public recognition of "green businesses", etc.
5. **Zoning and Other By-laws:** The existing municipal zoning within the microbial contamination control area may be reviewed, and were feasible, the zoning could be adjusted to restrict certain types of developments and land uses. By-laws may also be introduced to restrict certain activities within the area or impose special permitting requirements for new building applicants or impose requirements for implementation of measures that minimize the risk of contaminating the public water supply.
6. **Groundwater Monitoring Program:** Collecting data from existing monitoring and water supply wells and installation of dedicated monitoring may help your community detect any contaminants that could threaten the water supply in the near future. This is especially useful in locations down-gradient from any high risk contamination sources in the microbial contamination control area.

7. **Property Purchase/Donation Program:**
Community ownership of as much as possible of the land within the microbial contamination control area obviously provides some of the best assurances of long-term protection of the public water supply. Protection could be provided by ownership accomplished through methods such as capital or bond fund programs, or through easements and deed restrictions.

8. **Septic System Upgrades/Maintenance Program:**
Septic systems are very common sources of contamination in groundwater. If the microbial contamination control area contains high-density septic system areas (more than one septic system per acre), it would be prudent to initiate an effort to upgrade these systems, or at least implement a voluntary or mandatory program for maintenance (e.g., septic systems should be pumped out every 2-3 years for proper functioning). The community may also consider implementing a septic tank cleaner ban or prohibition within the microbial contamination control area. Most septic system cleaners contain solvents which not only contaminate groundwater as chemicals but also increase transportation of other pollutants through facilitating their release from solid state. Any such ban or prohibition is difficult to enforce, and would need to have an educational component associated with it. In fact, the community may need to count on voluntary compliance.

9. **Potential Source Restrictions:**
The community may also want to consider establishing and implementing restrictions on the placement of some high-risk potential contaminant sources such as underground storage tanks, dry wells, sumps, injection wells, lagoons, biosolids spreading,, manure spreading and landfills within the microbial contamination control area.

Some of these microbial contamination control measures may be applied to the entire microbial contamination control area and others only to its specific zones of influence established in the process of the required delineation of the wellhead protection area. For example, different measures may need to be applied to the 50-day and 2-year time-of-travel (TOT) zones within the wellhead protection area.

5.3.2 Measures for commercial and industrial sources of contamination

The commercial and industrial facilities in the microbial contamination control area are generally the most highly regulated of any land uses. However, even facilities that are required to have permits/approvals for building, material storage or waste discharge cannot be assumed to pose no risks to groundwater. In many such cases there is much that can be done in prevention of groundwater contamination, and this is where the community's efforts in working with the commercial and industrial facilities should be focussed.

In dealing with owners of commercial and industrial sources of contamination, the municipality may consider the following actions or measures:

- encourage participation in pollution prevention and waste reduction programs that may be offered by the federal and provincial governments,
- distribute information on general best management practices related to groundwater,
- protection applicable to the majority of the potential commercial/industrial sources within the microbial contamination control area,
- send individual letters with information on resources available to identify best management practices for specific facilities,
- host informative meetings with the leaders of the local business community to raise awareness of the need for groundwater protection,
- establish a recognition program for businesses that take voluntary actions to protect groundwater,

- facilitate employee training workshops to raise awareness of groundwater and potential impacts from mismanagement of hazardous wastes, and
- introduce basic training in prevention of groundwater contamination as part of grade school curricula

Apart from these actions geared towards encouraging voluntary implementation of groundwater protection measures, where applicable, the municipality should review and/or inspect all locally regulated/permitted facilities for adequacy and compliance with permit requirements. Such inspections may also serve to verify that any provincially approved/permitted operations associated with those facilities (e.g., wastewater treatment and disposal facilities) have valid approvals or permits.

5.3.3 Measures for agricultural and rural sources of contamination

The overall objectives that agricultural lands within the microbial contamination control area would be expected to meet are:

- proper handling and application of agricultural chemicals, and other controlled substances;
- proper manure storage and spreading,
- proper biosolids storage and spreading
- proper siting, installation, and maintenance of septic systems, wells, storage tanks, wastewater lagoons, and solid waste sites;
- proper management of irrigation and wastewater disposal; and
- proper siting and management of dairies and feedlots facilities.

The uniqueness of the approach that needs to be taken in the development of a management plan for addressing potential sources of contamination related to agricultural lands and activities lies in two facts. One is that during the inventory of the microbial contamination control area, it would not be possible to assess specific activities or practices on each farm (only the most obvious and visible types of agricultural activity would be identified in the inventory). The other fact is that implementation of any improvements to the existing agricultural activities may only be accomplished through voluntary efforts of the farmer because, in Ontario, any management alternative that would seek to regulate farming practices may only be developed and implemented by the Ontario Ministry of Agriculture and Food. This situation is changing with the introduction of the Nutrient Management Act. The MOE regulates the spreading of non-farm biosolids through application of Part V of the EPA.

For these reasons, the development of any microbial contamination control measures related to agricultural activities must include two main steps:

- an on-farm assessment to identify those sources that pose the most significant risks to the groundwater; and
- identification and selection of the most appropriate management tools or measures to apply to the potential sources of contamination with the participation of the individual farmers and taking into account site-specific conditions.

Also, prior to undertaking any on-farm assessment, the municipality should verify existence of any OMAF developed or endorsed best management practices (BMPs) applicable to the types of agricultural activities in the microbial contamination control area, and refer to those BMPs both in the process of on-farm assessment and in the development of measures intended for implementation.

5.3.4 Measures for residential and municipal sources of contamination

Residential areas are not typically thought of as being potential sources of groundwater contamination, however, it is now well recognized that these areas can be significant sources of groundwater pollutants.

Municipal contaminant sources are grouped with residential because many of contamination sources associated with municipal activities are found in the same areas as the residential land uses.

Although the tools for managing many of the potential sources of the "municipal" type may be the same as for those of the "commercial/industrial" type, usually, a different approach in managing these sources needs to be taken as these sources are often associated with publicly-owned facilities. Reference to the suggested tools for the "commercial/industrial" sources should be made especially to address sources such as sewage treatment and disposal facilities and waste transfer stations.

For the identified contamination sources associated with facilities owned by the municipality responsible for the development of this microbial contamination control program, the approach is obvious; the municipality must identify the improvements it intends to undertake at those facilities in order to reduce potential for contamination of the groundwater.

Microbial contamination control measures specific to residential/municipal contamination sources, and not already addressed in the "general" or "commercial/industrial" categories of measures above, are those associated with urban runoff/storm water, waste disposal landfills and dumps.

In order to reduce potential for groundwater contamination that may be associated with urban runoff (storm water), the municipality should encourage the use of best management practices (BMPs) to improve the quality of storm water that my find its way into the groundwater aquifer, such as:

- use of Detention Ponds - earthen embankments or excavated ponds intended for the temporary detention of storm water to control peak runoff rates and for the settlement of particulate pollutants;
- use of Retention Ponds - earthen embankments or excavated ponds that usually contain a permanent pool intended for the retention of storm water runoff and for the settlement of particulate pollutants;
- use of Vegetated Swales - grassed water courses that retard or impound concentrated runoff to induce infiltration and decreased velocities;
- use of Vegetated Filter Strips - areas of vegetated cover through which runoff containing sediments and other pollutants must flow before leaving a site or entering a storm water management practice;
- use of Urban Forestry - protection of trees and forest land during the construction phase of development; planting of trees after the site has been cleared; or homeowner landscaping after the site has been fully developed;
- use of Sand Filters - self-contained bed of sand underlain with pipe that is designed to treat the first flush of storm water runoff, and may be enhanced by layers of peat, limestone and/or topsoil, and may be planted with grass.
- application of the Stormwater Management Manual (MOE)
- maintenance of trees and shrubs for a specified distance back from top of stream bank or ravine or bank of any other water body
- establishment of conservation easements (tax incentives) to retain rural streambanks, valleys and flood plains in forest cover with no agricultural intrusion (e.g., wandering livestock)

For areas where the municipality is the responsible authority, the municipality should identify the groundwater protection BMP's it intends to use.

For any waste disposal landfills or dumps operating within the microbial contamination control area, the municipality should verify that they valid provincial approval and that adequate groundwater monitoring is in place to prevent contamination.

5.4 Priority Microbial Contamination Control Measures

Table 5-2 included at the end of this document lists land use activities and sources that have the potential to increase microbial loadings in raw water pumped from the production wells. Land use activities and sources are grouped into high, moderate and low risk activities based on the amount of contamination generated and the potential for it to reach the water supply aquifer. Immediate and continuing action measures are listed separately for aquifer zones classified as high, moderate and low risk of being impacted by microbial contaminants released at ground surface.

5.5 Management of Activities that Might Affect *in situ* Filtration Effectiveness of the Aquifer

Table 5-3 included at the end of this document lists land use activities and sources that have the potential to increase particle counts in raw water pumped from the production wells. Immediate and continuing action measures are listed for high, moderate and low risk aquifer zones.

TABLE 5-2 PRIORITY MICROBIAL CONTAMINATION CONTROL MEASURES

LAND-USE ACTIVITIES & SOURCES*	Associated Land-Use Hazard	AQUIFER MICROBIAL RISK RANKING					
		High		Moderate		Low	
		Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure
COMMERCIAL/INDUSTRIAL - Large subsurface sewage disposal systems - Sewage lagoons - Wastewater treatment / disposal facilities - Land application of treated waste / sludge - Meat processing & rendering plants - Food processing/disposal lagoons - Dairy processing **AGRICULTURAL/RURAL** - Manure cesspools, agricultural liquid waste lagoons and drainage wells - Unsealed abandoned wells and test holes - Manure storage pits and spreading areas - Manure piles - Confined animal feeding operations (feedlots) - Dairy operations - Auction lots/boarding stables - Spray irrigation (of sewage effluent) - Land application of sewage and non-sewage biosolids - Storage facilities for biosolids **RESIDENTIAL/MUNICIPAL** - High density development on septics - Unsealed abandoned wells and test holes - Stormwater infiltration basins and galleries - Sewage treatment/disposal facilities - Land application of treated waste / sludge	**High**	Restrict/remove current or potential activities generating significant sources of microbial contaminants Abandonment of unsealed/unused wells and any other potential point contaminant source Use alternative technologies to improve effluent quality before discharge Modify existing works to accommodate treatment Site specific monitoring where applicable Proper abandonment of unsealed/unused wells and any other potential point source of contamination	Property Purchase/Donation Program Zoning and Other By-laws Groundwater Monitoring Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices	Restrict disposal of untreated liquid manure, sewage and/or liquid waste through lagoons, trenches and drainage wells Strict control through land acquisitions, zoning, bylaws, and/or easements Pollution prevention Implement site-specific monitoring programs where applicable	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships GW Monitoring Program Property Purchase / Donation Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices	General monitoring at wellhead Control measures via municipal acquisitions, zoning by-laws, and easements	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships Groundwater Monitoring Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices

COMMERCIAL/INDUSTRIAL - Cemeteries or graveyards - Animal burial grounds - Funeral, veterinary and taxidermy services - Stormwater runoff swales, ditches, ponds **AGRICULTURAL/RURAL** - Wildlife feeding and migration areas - Veterinary services - Aquaculture operations (fish farming) - Stormwater surface runoff swales, ditches, and ponds - Waste disposal landfills and dumps - Septic systems - Campgrounds and trailer parks **RESIDENTIAL/MUNICIPAL** - Stormwater runoff swales, ditches, ponds - Waste disposal landfills and dumps - Waste transfer and recycling stations - Septic systems, sewage lagoons - Campgrounds and trailer parks - Sewer lines	**Moderate**	Strict control through land acquisitions, zoning, bylaws, and/or easements Pollution prevention Site specific assessment and monitoring Site specific monitoring where applicable Priority maintenance of stormwater and sewer pipelines and other works	Public Education / Notification Water Conservation Program Public/Private Partnerships GW Monitoring Program Property Purchase / Donation Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices	Pollution prevention Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway Implement site specific monitoring programs	Sign Installation Water Conservation Program Public/Private Partnerships GW Monitoring Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices		Sign Installation Water Conservation Program Follow Best Management Practices
COMMERCIAL/INDUSTRIAL **AGRICULTURAL/RURAL** - Grazing lands - Ponds, creeks, streams - Rural homesteads **RESIDENTIAL/MUNICIPAL** - Low density privately serviced developments - Apartment and condominium buildings - Housing developments - Snow Dumps	**Low**	General monitoring at wellhead Land-use controls / restrictions Prohibit specified products within the time of travel zone	Water Conservation Program Septic Upgrades / Maintenance Program Follow Best Management Practices		Public Education / Notification Water Conservation Program Follow Best Management Practices	No special additional action required	No special additional action required

TABLE 5-3 MANAGEMENT OF ACTIVITIES THAT MIGHT AFFECT *IN SITU* FILTRATION EFFECTIVENESS OF THE AQUIFER

ACTIVITIES & SOURCES*	AQUIFER DISTURBANCE AS A POTENTIAL FOR AN INCREASE IN PARTICLE COUNT - RISK RANKING					
	High		Moderate		Low	
	Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure
Blasting Operations Drilling new wells Quarries Aggregate Extraction Pond Construction Utility Trenching Rupture of Stormwater pipe Highway and roadway construction	Restrict/remove activities with significant potential for increase of particle counts Use alternative technologies to limit stress on the hydrogeologic regime Modify existing works to accommodate monitoring /contingency measures Site specific monitoring where applicable Priority maintenance of stormwater and sewer pipelines and other works Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway Pollution Prevention	Public/Private Partnerships Zoning and Other By-laws Groundwater Monitoring Program Property Purchase/Donation Program Potential Land-Use Restrictions Follow Best Management Practices Regular Maintenance Program	Strict control through land acquisitions, zoning, bylaws, and/or easements Pollution prevention Implement site-specific monitoring programs where applicable Priority maintenance of stormwater and sewer pipelines and other works Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships GW Monitoring Program Property Purchase / Donation Program Regular Maintenance Program Potential Land-Use Restrictions Follow Best Management Practices	Priority maintenance of stormwater and sewer pipelines and other works Control measures via municipal acquisitions, zoning by-laws, and easements Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships Groundwater Monitoring Program Regular Maintenance Program Potential Land-Use Restrictions Follow Best Management Practices

Appendix A

GSC Geomaterial Protocol

The GSC Geomaterial Protocol provides the basis for a standardized approach to material descriptions for all borehole information used in a groundwater study. The protocol is best applied at the outset of a project and directly to borehole data sets received from various agencies. The coding routine is best used within a relational database structure (e.g SiteFx software). Use of a relational database facilitates the standardizing of a large number of boreholes and information such as the 212 fields in the MOE water well records.

The coding protocol was developed by geologists who re-coded material descriptions found in provincial water well records. The records allow for the use of three fields for drillers to enter material descriptions; however, only one field was used in most records. To partly compensate for this problem, the geologists linked re-coding rules to the many thousands of field sites they observed during geological mapping studies. In 1998, the GSC published the results of their extensive testing program as part of database developed through the Oak Ridges Moraine Hydrogeology Project. One conclusion of the re-coding and field testing was that the "clay" descriptions are over represented compared to their occurrence in the field, by a factor of 10. This is a significant finding because "clay" material is often used as a key factor in determining groundwater vulnerability.

A description of the geomaterial protocol is found in the following reference:

Standardization and assessment of geological descriptions from water well records: Greater Toronto and Oak Ridges Moraine Areas, southern Ontario, Russell, H. A. J., Brennand, T. A., Logan, C., and Sharpe, D. R., 1998, Current Research 1998-E: Ottawa, Geological Survey of Canada, p. 89-102.

The Ontario Ministries of the Environment, Natural Resources, Mines and Northern Development contribution have been acknowledged in the reference. The reference is available through the internet site at: http://sts.gsc.nrcan.gc.ca/orm/acrobat_data.asp.

The abstract and tables 1, 3 4. and 5 are presented here, followed by the suggested method for documenting the Metadata for the GSC Geomaterial Protocol.

Abstract

Archival drilling records from water wells, geotechnical, mineral exploration, and hydrogeologic studies provide subsurface information for regional geologic and hydrogeologic investigations. This paper evaluates methods by which water well material descriptions may be standardized. In Ontario, material descriptions are reported in three attribute fields using 82 terms, thus theoretically permitting over 500,000 permutations. Materials descriptions are rationalized to 10 classes then reclassified according to two methods: (i) First-Attribute Method (FAM), and (ii) Rule-Based Method (RBM). The first-attribute method is presently applied by hydrogeologists in southern Ontario and uses only the first attribute field; it is a simple, effective method able to broadly delimit aquifers and non-aquifers. The rule-based method applies conditional rules developed from regional geologic models. This method is more geologically accurate, and is recommended where water well data are to be integrated into geologic and hydrogeologic investigations. Successful applications are summarized and general recommendations made.

APPENDIX G

Risk Strategies Implemented By Other Ontario Municipalities

RISK AVOIDANCE

The following paragraphs summarize some of the risk avoidance strategies implemented in other municipalities in North America.

The majority of groundwater protection plans implemented to date in Canada and the United States use legislative changes to by-laws, official plans and zoning regulations. This method provides the municipality with the legislative authority to enforce the required changes that is not offered through voluntary programs. For example, Regina, Saskatchewan restricts any industrial land uses in WHPA's that use hazardous chemicals. New Brunswick regulates the quantities and types of chemicals that can be stored or used by new or existing businesses in WHPA's. Existing businesses that cannot meet the restrictions must move, some businesses being granted up to 15 years for this move. In Dayton, Ohio, companies within WHPA's had to compile an inventory of the type and quantity of chemicals they had on site at the time the regulation was passed. The companies are not allowed to increase the inventory, type and quantity, even if production increased or the company wished to expand. Because of the economic impact that this imposed on industrial facilities, the municipality of Dayton spent tens of millions of dollars over the last 20 years to assist up to 80% of the businesses in WHPA's to move to other locations. All of these examples can be classified as avoidance, or chemical restriction methods.

The Regional Municipality of Waterloo (Waterloo) has been addressing this issue of greenfield vs. developed property dilemma. In their case, proposed changes to greenfield sites have largely been accepted by the community and industry, although the by-laws have not yet been revised. For those properties that are currently developed they had intended to stipulate that these businesses did not meet the new by-laws and they would be deemed legal, but classified as non-conforming. The intent was to allow for increased flexibility for the existing industries however the business community rejected the stigma attached to the property especially if a property were to be sold.

The County of Oxford in southern Ontario is reportedly close to implementing groundwater protection policies. Land-use restrictions are being proposed for WHPA's similar to that proposed for Waterloo. Components of their policies for WHPA's include:

- prohibiting the use of underground storage tanks
- prohibiting any new development based on private wells or septic systems
- very stringent protocols for intense livestock operations
- development agreements could have more stringent storm water runoff requirements including the feasibility of at-source infiltration, increased design criteria, impact analysis and mitigation measures

The Oxford policies are a good example that groundwater protection should not be limited just to well head protection areas. Their policies will restrict land-uses in Environment Protection Areas (EPA) (such as Provincially Significant Wetlands) or require an Environmental Impact Study on lands contiguous to an EPA. There will be permitted, banned and conditional land-uses in recharge areas. In these areas, current businesses or new businesses would have to submit a disclosure report (i.e. essentially a chemical inventory with operational procedures). The County may also require a contingency plan in the event of a spill, site plan approval with a view on groundwater protection measures (i.e. BMPs) and groundwater monitoring programs. The policies also include measures for the redevelopment of contaminated or potentially contaminated land including historical review, soil and groundwater investigation, remedial action plans and MOE approval of those plans. Oxford's legal counsel has reviewed the policies and has the opinion that although they could be challenged, they are defendable at the Ontario Municipal Board (OMB) level.

RISK MANAGEMENT

To better control *future* activities on *developed* properties within the WHPA, Waterloo is proposing the use of a Development Permit System (DPS) that would only apply to existing businesses in WHPA's that wish to expand beyond their current boundaries or when a site is to be re-used. In this way, current businesses could proceed with current operations, but when they want to expand, or sell the property, the DPS would require the business to implement best management practices to ensure that the land-use is of equal or less risk than the existing land-use. The DPS cannot be implemented at this time since the Ministry of Municipal Affairs and Housing, which originally approved its use on a pilot basis, has acknowledged that new provincial legislation has to be implemented in order for the DPS to work effectively. It is not known when or if this legislation will be introduced.

COSTS TO IMPLEMENT WELL HEAD PROTECTION STRATEGIES

The cost to change By-laws to restrict land-use of greenfield properties is an internal cost for the Municipality. Such activities will have to be integrated into the Municipality's action items. Public Meetings and consultation will be part of the process as with any other changes to the existing By-laws.

In cases where there are existing industries, incentives could be provided to encourage them to move out of the WHPA. Incentives could include subsidies to businesses that are to move out of the area or subsidies to landowners whose property is devalued due to change of land-use. This can be very costly as seen in the Dayton, Ohio example mentioned above. If the municipality decides it is too costly and/or difficult to move high risk activities out of the WHPA, chemical restriction policies could be required. The municipality must decide whether such a program will be a voluntary one, or if it intends to enforce such an activity. As mentioned earlier different implementation strategies have been tried in Ontario. It appears the permitting option may be most easily

implemented. Unfortunately, this would only include those establishments that are undergoing some change to trigger the permitting. For those that do not fall under the permitting obligations, they may be encouraged to participate through incentive programs.

The cost to implement the restriction of chemical use lies primarily in the monitoring and enforcement of the restrictions. These additional costs would be incurred primarily through the hiring of additional staff to ensure implementation of the program is followed.

Workshops are also very effective educational tools that can reach a large number of businesses at one time. The Municipality could subsidize the information Workshops. Participants could be asked to pay a nominal fee, such as $50, to ensure attendance. The municipality would, therefore, have to subsidize the event to include the costs of the presenters, room rental, food and audiovisual equipment. The costs of a typical workshop would be approximately $5000. Detailed training for all applicable employees at a specific business on items such as Transportation of Dangerous Goods and Emergency Response typically range from $2000 to $5000 per facility.

The Business Water Quality Program (BWQP) in the Region of Waterloo provides financial and technical assistance to businesses to implement BMPs that prevent water pollution. The first step in the Program is a Facility Review and Assessment completed by a pre-qualified consultant (including WESA) who assesses the potential for spills to groundwater, surface water or sewer systems and then recommends procedural and/or capital BMPs. Procedural BMPs include employee training, spill prevention or pollution prevention plans and Environmental Management Systems (EMSs). Capital BMPs include facility and structural improvements, equipment purchases or process changes. In Waterloo, the program pays 50% of the initial assessment costs up to a maximum of $4000. None of the assessments conducted to date have exceeded $8000. The program also provides grants to implement the BMPs on a 50% cost share basis up to a maximum of $14,000. The Region has committed $1.5 million over the 5 years of the Program with additional funding being provided by the MOE and Environment Canada. The Program is administered by an outside agency (OCETA – Ontario Centre for Environmental Technology Advancement). This is an example of the type of incentive program that could be established for the study area. The level of environmental awareness is greatly increased for each business participating in the BWQP in the Region of Waterloo.

APPENDIX H

Examples of Best Management Practices for Industry and Commercial Establishments

Preventing Well Water Contamination

How well water gets contaminated

Your well water can be contaminated by:

- openings in the well seal
- improperly installed well casing
- well casing not deep enough
- well casing not sealed
- a source of contamination not related to well construction (e.g. your septic system waste or livestock waste, agricultural or road chemicals)

Preventing contamination

- do not allow liquids or wastes from garbage and manure piles to drain towards the casing
- do not locate dog runs around the well casing
- do not treat the area around the well with pesticides or fertilizer
- do not flush oils, detergents, paints, solvents or other chemicals down the toilet

Proper installation and maintenance

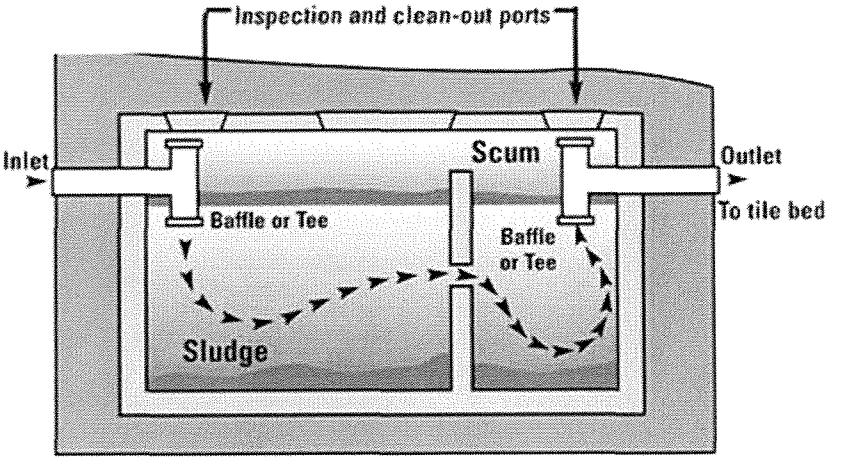
- sanitary seal or well cap is securely in place and watertight
- cap is at least 30 cm above the ground
- joints, cracks and connections in the well casing are sealed
- surface drainage near the well is directed away from the well casing
- surface water does not pond near the well
- well pump and distribution systems are checked regularly
- changes in the quantity and quality of water are investigated immediately
- well water is tested for bacteria three times a year and after major plumbing work
- wells are chlorinated and tested after any major repairs

Abandoned wells should be carefully sealed to prevent pollution of groundwater and any hazards. Hiring a qualified well contractor to seal the well is strongly recommended.

All About Wells and Septic Systems

Septic System Problems

How septic systems work



When septic systems don't work

If the tank is not pumped out regularly, the sludge and/or scum layers will be drawn into wastewater distributed to the tile bed, eventually overloading the system. After sufficient time, the tile bed will no longer be capable of distributing the wastewater into the ground, "breakouts".

These are direct discharges of partially treated wastewater onto the ground surface. Sew its associated wastes will filter into the soil, contaminating everything it reaches - your we neighbour's well, the underground water supply, and local streams and rivers.

If too much water is dumped in the tank, the tile bed will be overloaded with the same re well as the possibility of it backing up into your house.

If excess household chemicals, soaps and detergents are washed into the septic tank, th bacterial action may be slowed or killed.

All About Wells and Septic Systems

- Water and Your Well
- City-owned Wells
- Septic Systems and Your Well
  - Septic System Problems
  - Managing Your Septic System
- Well and Septic System Log
- New Well or Septic System? Buying a Home?
- Related Links

Drinking Water

Who We Are, What We Do

About Water Quality

All About Wells and Septic Systems

Understanding Your Water Bill

On-going Projects and Programs

FAQs

Education

Links

Contact Us

Water Efficiency

Managing Your Septic System

Signs of trouble

- Grass over the tile bed is unusually green or spongy to walk on.
- Plumbing takes longer to drain.
- You can smell sewage.
- Grey or black liquids surface in yards.
- A test of your or a neighbour's well water shows contamination.

Septic system care - DO THIS!

DO know where the tank is located and keep a maintenance record.

DO make sure you hire a licensed septic tank servicing company for regular inspect and that they take care not to damage inlet or outlet baffles or tees during pump

DO get the tank pumped to remove the accumulated scum and sludge. Pumping int should be based on regular inspections (including measurement of scum and sl levels in your tank).

DO plant grass over the leaching field; it will help prevent erosion and absorb exces water.

DO divert surface runoff water from roofs, patios, driveways, and other areas away f the leaching field.

DO conserve water to avoid overloading the system.

Septic system care - DON'T!

DON'T use your toilet as a trash can.

DON'T use more soap or detergents than you need to.

DON'T install a garbage disposal without checking whether your septic tank can han added volume.

DON'T poison your septic system and the groundwater by pouring harmful chemicals cleaners such as chlorine bleach, toilet bowl cleaners, borax and drain opene down the drain.

DON'T drive over or park cars, trucks or heavy equipment on the tile bed.

DON'T plant trees or shrubbery in or near the tile bed, because the roots will grow int lines and plug them.

DON'T pave the tile bed with concrete or asphalt.

DON'T drain your water softener backwashes into the septic tank. Use a class-2 leac pit (dry well) or the sump hole in your basement.

DON'T add "starters" or "conditioners"; some will interfere with normal operations; otl (particularly degreasers) contain cancer-causing substances that could conta the groundwater.

Septic system care - NEVER!

NEVER flush these items into the tank (they cannot be broken down by bacteria or will d bacterial action):

- loose hair
- cigarette butts
- coffee grounds
- fat, grease, or oil
- dental floss
- paper towels
- disposable diapers
- sanitary napkins, tampons or condoms
- kitty litter
- gauze bandages
-

NEVER flush chemicals into the tank (they could contaminate surface and groundwater)

- paints
- varnishes
- thinners
- waste oils
- photographic solutions
- pesticides or herbicides

All About Wells and Septic Systems

- Water and Your Well
- City-owned Wells
- Septic Systems and Your Well
    - Septic System Problems
    - Managing Your Septic System
- Well and Septic System Log
- New Well or Septic System? Buying a Home?
- Related Links
- Contact Numbers

Preparing a Nutrient Management Strategy/Nutrient Management Plan

Author: OMAF Staff
Creation Date: July 2003
Last Reviewed: 13 May 2004

Nutrient Management Act Regulation
July 2003

Table of Contents:

Getting Started

The key message for farmers to understand is that every new and every large livestock farm will be developing a nutrient management strategy document (NMS), a nutrient management plan (NMP), or both, and that having and using these documents will become a standard operating practice. The benefits of doing NMS documents and NMPs are:

- reduce the risk that nutrients will cause environmental contamination;
- demonstrate that best management practices are being used;
- create efficiencies in fertilizer use, which saves money; and
- demonstrate that operators value good stewardship and appreciate natural resources.

Farmers with less than 300 nutrient units will not have to complete nutrient management strategies and plans unless they are new farms. The new farms that are less than 150 NU will have to complete a strategy and plan, but do not have to have their documents (NMS and NMP) provincially approved. They can simply keep them on the farm for reference and inspection.

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Nutrient Management Strategy (NMS)

A NMS is a document that is prepared for a farm that shows how much prescribed material(s) is going to be produced, as well as how it will be stored and where it will be used. If your farm *generates* prescribed materials then you need to complete a NMS. Whether you are using the nutrients yourself or are transferring them to someone else, your NMS will document it. The five options for how the material will be used are:

1. used on your farm for land application
2. used by someone else on their farm for land application
3. used by another operation in a process (e.g., mushroom-growing medium)
4. transferred to a broker
5. used for non-nutrient purposes (e.g., incinerated).

The components of a NMS are:

- identifier number (provided by OMAF on application)
- description of the type of operation and status of the NMS (i.e. new or renewal)
- a farm unit declaration and sketch
- a list of all prescribed materials and the calculated amount that is generated annually
- a description of nutrient storage (type, capacity, dimensions, etc)
- analysis of nutrient content (nitrogen, phosphorous, potassium and total solids) of prescribed materials
- a list of nutrient uses (from 5 options above) with the appropriate agreements that accounts for the total nutrients generated
- storage facilities – yearly amount
- contingency plan for times when the NMS cannot be followed (e.g. storage structural failure)
- Certification form (signed by the farmer, the person who prepared the strategy, and if applicable, the Nutrient Management Strategy Certifier)

The duration of a nutrient management strategy is five years, unless there is a major change in the amount of nutrients produced, or the destination of the nutrients. In this case, a new nutrient management strategy will need to be prepared.

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Nutrient Management Plan (NMP)

A NMP is a document prepared for the farm that gives an assessment of what application rate is appropriate for the land base and what other land application standards must be followed. All farmers that are subject to the regulation and where nutrients are applied on agricultural land will need to have a completed nutrient management plan (NMP). Remember that when the regulation refers to nutrients it means all prescribed materials as well as commercial fertilizers. The NMP is based on specifics: what is the nutrient source and what is in that material, what crop is grown, what are the characteristics of the field, etc. The idea is to strike the right balance between maximum nutrient uptake by crops and minimal environmental impact. The components of a NMP are:

- description of the type of operation and status of the NMP (i.e. new or renewal)*
- farm unit declaration and sketch*
- analysis of nitrogen, phosphorous, potassium and total solids in the manure or other material *
- storage information (if applicable)*
- contingency plan* for when the NMP can't be followed, for example when weather prevents application and storage gets too full
- certification form*
- list of nutrients to be applied and the total quantity (generated and received)
- field information, cropping practices and application rates
- setback information from surface water and wells
- landowner agreements that show adequate land base for application.

*Livestock farmers who also grow crops will need to complete a NMS and NMP. Their NMP won't need to repeat the "farm unit declaration and sketch" or any other information that is common to both the NMS and the NMP. The duration of a nutrient management plan is five years, unless there is a major change in the amount of nutrients taken up by crops. In this case, a new nutrient management plan will need to be prepared.

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Short Version NMS/NMP For Low Risk Farms

A short form NMS/NMP will be available. It is an alternative to doing a full nutrient management strategy or plan for farmers who have relatively low risk operations with respect to water resources. It should be kept on the farm so that it is available for the farmer's reference and must be available at all times for provincial inspection officers. Is the short form an option for your farm operation? Farms can use the short form NMS/NMP if they have less than 150 NU. The following farms cannot use the short form NMS/MP:

- Larger livestock operations with 150 nutrient units or more

- Operations that generate or receive liquid manure
- Farms that use biosolids

These farms must complete a full NMP to submit to OMAF for review and approval.
The short version NMS/NMP consists of 8 questions and a summary listing of the amount and destination of the nutrients that are produced or applied on the farm and the documentation of their activity. A farmer must be managing his/her operation such that they are able to answer YES to all the questions, or will have to complete a full NMS or NMP.

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How Do I Prepare A NMS Or NMP?

OMAF has developed a computer program for preparing NMS documents and NMP's, as well as a paper workbook. This resource will guide you through the development of your NMS or NMP. NMAN is the name of the software program, and it will do all the necessary calculations in your NMS or NMP for you. The workbook is a pen and paper format that outlines all the same steps as the software but you do the calculations yourself.

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When Do I Need To Complete A NMS Or NMP?

The date (either September 30, 2003 or July 1, 2005) by which you need to prepare a NMS or NMP for your farm is determined by whether you meet that new and expanding livestock or existing large livestock definition.

Category	Phase-in date
All New greater than 5 NU	September 30, 2003
All expanding equal to or greater than 300 NU	September 30, 2003
All existing large livestock equal to or greater than 300 NU	July 1, 2005

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Approvals

The following chart outlines the required approvals of nutrient management strategies and plans.

Operation Type	Who in that category needs approval	What documents need approval		Who approves them
		NMS	NMP	
New Operations > 5 NU and <150 NU	No provincial approval required*			
New Operations ≥ 150 NU and < 300 NU	Requires approval of NMS/NMP	Yes	Yes	OMAF
All Operations ≥300 NU	Requires approval of NMS/NMP, as well as terms of reference of site characterization where appropriate**	Yes	Yes	OMAF

A new approval for either a NMS or NMP is required every 5 years when the NMS or NMP is renewed. A

new approval is required sooner if there is a significant change in the operation that affects the applicability of the current NMS or NMP. * Farms >5 NU and < 150 NU can simply keep their NMS or NMP documents on the farm for the farmer's reference and to be available for inspection purposes. The farmer can also choose to have the NMS or NMP certified by an accredited certifier but this is not mandatory.

** For more information on the Site Characterization see the Siting and Construction Protocol.

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For more information on Nutrient Management
Toll Free: 1-866-242-4460
Email: nman@omaf.gov.on.ca

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How Many Nutrient Units Do I Have? Dairy Operations

Author: OMAF Staff
Creation Date: July 2003
Last Reviewed: July 2003

Nutrient Management Act Regulations

July 1, 2003

If you own a dairy operation, the regulations of the *Nutrient Management Act, 2002* may apply to you.

The implementation date of **September 30th, 2003** applies:

- if you apply for a building permit for a barn **on or after** September 30th, 2003, and
- your operation will generate manure, and
- your operation generates greater than 5 nutrient units, and
- the barn is on a separately deeded property, on land which the person who owns or controls the site has not previously carried out an agricultural operation that generated manure.

OR

- you are **expanding an existing** operation and will generate 300 or more nutrient units.

The implementation date of **July 1st, 2005** applies to your dairy operation if:

- you have an existing dairy operation and generate 300 or more nutrient units.

Farms which do not fit the definition of "new" and which are smaller than 300 NU will not be subject to the *Nutrient Management Act 2002* regulations until 2008 at the earliest. The issue of when the proposed regulation would apply to all types of livestock and non-livestock farms except new livestock farms, existing large livestock farms and those expanding into and within the large livestock category will be referred to the provincial advisory committee. Implementation dates for the regulation for all categories except for new and expanding livestock farms have also been tied to the availability of cost-shared funding.

The *Nutrient Management Act 2002* will apply to new livestock farms, large livestock farms (>300 NU) and those farms expanding into or within the large category. Existing livestock farms and expanding livestock farms that are less than 300 nutrient units may be subject to municipal by-laws where they exist.

If you own a dairy operation and keep no other livestock on your farm, you can use the following chart to easily determine the nutrient units for your farm operation.

Determine Total Nutrient Units for Your Farm

Cow Type	Enter # of Animals	Nutrient Unit Conversion	Divide # of Animals by Nutrient Unit

			Factor	Conversion Factor
Large Frame (e.g. Holstein)	**Cows***		0.55 animal/NU	
	Cows 545-636 kgs (1200-1400 lbs)		0.7 animal/NU	
	Heifers 182-523 kgs (400-1200 lbs)		2 animals/NU	
	Calves 45-182 kgs (100-400 lbs)		6 animals/NU	
Medium Frame (e.g. Guernsey)	**Cows***		0.66 animal/NU	
	Cows 455-545 kgs (1000-1200 lbs)		0.85 animal/NU	
	Heifers 148-455 kgs (325-1000 lbs)		2.4 animals/NU	
	Calves 39-148 kgs (85-325 lbs)		7 animals/NU	
Small Frame (e.g. Jersey)	**Cows***		0.77 animal/NU	
	Cows 364-455 kgs (800-1000 lbs)		1 animal/NU	
	Heifers 125-364 kgs (275-800 lbs)		2.9 animals/NU	
	Calves 30-125 kgs (65-275 lbs)		8.5 animals/NU	
			Total Nutrient Units on Farm	

*Note this row automatically makes nutrient unit adjustments for the entire herd including calves and heifers. If housed on separate farm units, do separate calculations using the individual number of cows, heifers or calves per Nutrient Unit. There could be very slight discrepancies in the resulting number of NU because of the rounding of numbers.

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For more information:
Toll Free: 1-877-424-1300
Local: (519) 826-4047
Email: ag.info@omaf.gov.on.ca

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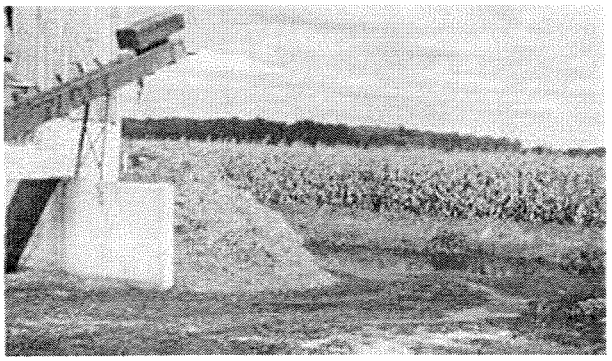
Manure Run-off and Tile Discharge

Livestock are important to production agriculture in Ontario. They convert locally grown grains and forages to meat, egg and dairy products. Cattle, horses and sheep require hay and pasture (forages). The resulting crop rotation of grains with hay and pasture is good for Ontario's productive soils.



Manure spills and contaminated run-off are prime sources of agricultural pollution.

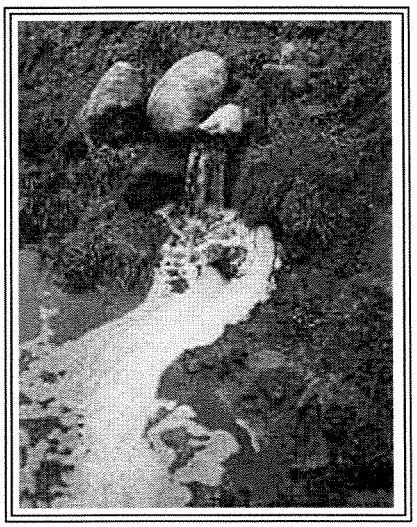
To avoid problems, liquid and solid manure have to be stored properly to contain nutrients and prevent run-off. Manure storage must be large enough to handle the volume of wastes generated until weather and crop conditions allow spreading.

Some milkhouse wastes enter watercourses through illegally connected tile drains. Studies have suggested that milkhouse wastes are a source of pollution. Potential pollutants include phosphates and bacteria.

However, with livestock production comes the challenge of managing wastes and by-products. When managed effectively these materials can be essential farm resources. But when managed improperly, they can pollute nearby waterways.

The two critical features of manure storage design are:

- adequate sizing, and
- personal safety



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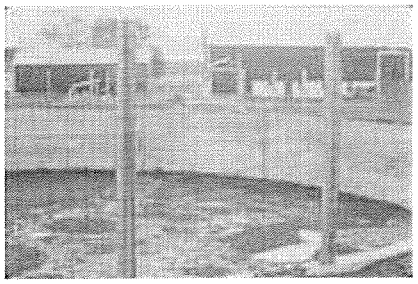
Manure and Milkhouse Washwater Storage and Handling



A properly size concrete tank with safety fencing is an acceptable was to store liquid manure and other waste waters.

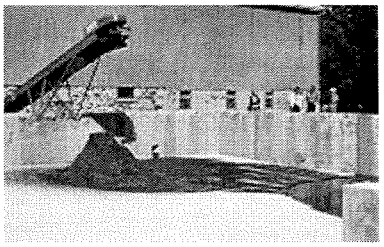
Where problems exist, farm managers must clearly identify the resources and options that are available to correct them. The next step is to choose the appropriate best management practice. Setting priorities involves striking a balance between production goals, economic costs and environmental protection. If a new system is needed, here are a few ideas to consider.

Manure can be stored and handled as a solid or as a liquid. Snow melt and rain water can be diverted from the manure storage by eavestroughs or with a roofed structure.

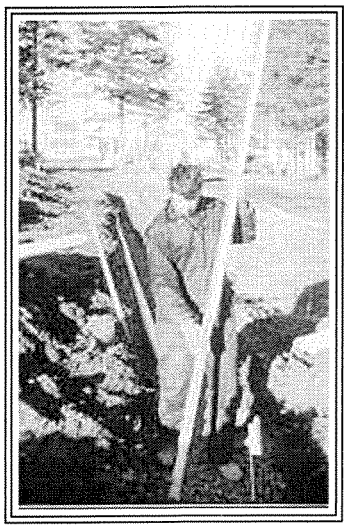
Contaminated waters and milkhouse washwater can be contained with curbs and walls or stored in a separate earthen pond.

Be sure to satisfy all current regulations in the design and placement of the structure.

Another option for milkhouse washwater is to treat the waste in properly-designed and managed sediment tank and treatment trench system.



A concrete-walled storage area with a sloped floor will store solid manure and divert contaminated liquids to a separate storage.



A well-managed sediment tank and treatment trench system, similar to a household septic system, will provide years of service for most dairy operations. For the best results, locate treatment in a protected area with good drainage and no equipment traffic. To prolong the life of the system, remove milk solids before releasing the washwater to the sediment tank.

Refer to the following BMP books for further information:

- Livestock and Poultry Management
- Nutrient Management
- Nutrient Management Planning

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Ontario

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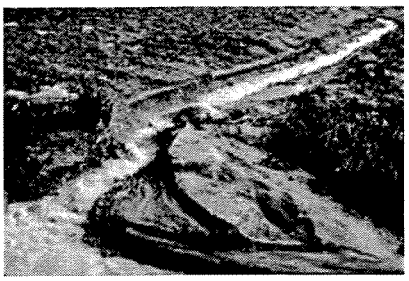
Last Updated: October 16, 2002

Manure Application Mismanagement

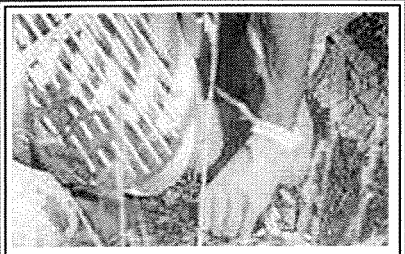


Manure applied to frozen ground can run off with spring meltwaters.

Manure contains organic matter and nutrients. Both of these resources are important to sustain crop yields. Manure can supply crops with all the nutrients necessary for high yields. However, it comes with its own risks. If run-off from manure applied to fields enters than a growing crop can use, some of the excess nutrients may be leached into groundwaters.

Timing and location are two of the most critical factors to effective manure management. In ideal situations, manure is tilled into the soil as it is applied, or right after spreading. Manure spread on pasture or forage fields near streams can also run off.

Well-timed applications of manure can provide both nutrients and moisture for crop growth. Since roots need air to breathe, too much manure can hinder crop vigour. When excessive rate are combined with poor timing, surface and groundwater may be polluted.



Studies suggest that under some conditions, liquid manure can move through the soil and enter tile drains.

Some field trials show unacceptable traces of manure entering ditches through tile outlets. The results vary with manure type, rates, timing and soil conditions. The problems are worse when broken tiles intercept the run-off directly from the soil surface. Careful consideration of crop needs and soil conditions followed by frequent monitoring can prevent this situation.

Too much manure can lead to poor crop performance, water pollution and create excessive odours.

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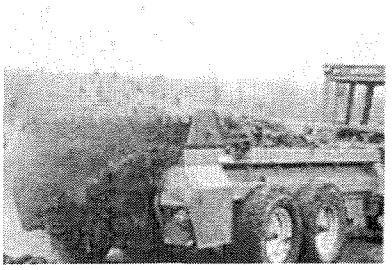
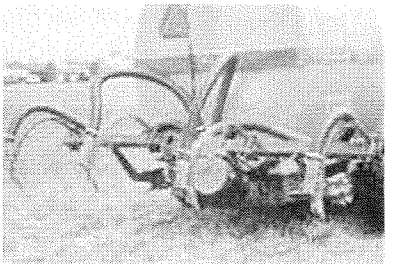
Effective Manure Application

If crop needs and soil conditions are properly considered, manure becomes a valuable resource. Producers should start by testing cropland soil and manure regularly for nutrient content. Factors to consider when determining application rates include: soil type, acreage, the crop to be grown and the type of manure. The key is to never apply more than is needed. It is also important that manure be applied as closely as possible to the time when the crop can best use the nutrients.

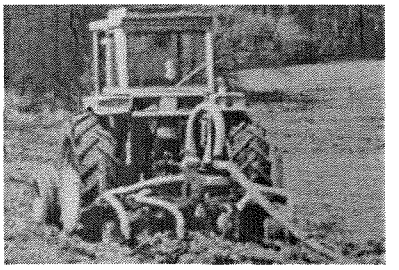
Solid manure should be spread when the soil is dry and completely thawed. In ideal situations, tilling should follow within 24 hours.



By following the above advice, producers ensure maximum benefit and minimum pollution. Keep the neighbours happy - spread at times that are acceptable to everyone.



Liquid manure can also be injected into the soil through units mounted on a bulk tank. Where possible, pre-till tile drained lands before applying liquid manure.



Liquid manure can be injected into the root zone with a flexible-hose system to provide crop needs and reduce risk of run-off. Manure is pumped directly from a liquid storage tank to the manure injector. One advantage of this system is that it is tankless, which can translate into a lower risk of soil compaction.

For further information refer to the following BMP books:

- Livestock and Poultry Management
- Nutrient Management
- Nutrient Management Planning

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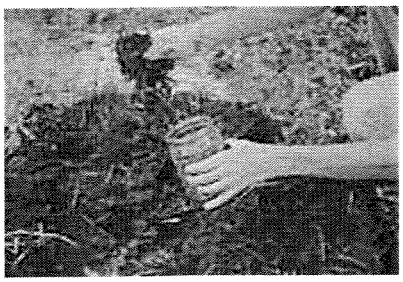
Nutrient Management Planning

Nutrient management planning involves the careful attention to meeting crop nutrient needs, using cost-effective and environmentally responsible management practices.

To produce a plan, you need to:

- understand the principles of nutrient management
- know your soil and landscape features
- know your soil fertility reserves
- know what you should be applying
- calibrate application equipment to know how much you're applying
- implement best management practices for application of nutrients
- adopt best management practices for soil management and soil and water conservation
- implement best management practices for monitoring and emergencies.



There are at least 3 good reasons why you should develop a nutrient management plan. A good plan will help you: achieve optimal crop yields and product quality; manage input costs and protect soil and water resources.

Manure testing will help you determine how much to apply.

An integral part of Nutrient Management Planning - calibration of application equipment - works in combination with soil and manure testing to ensure proper application rates of manure and commercial fertilizers.

To expedite control measures and minimize environmental risk, farmers should have written contingency plans for manure spills and other emergencies.

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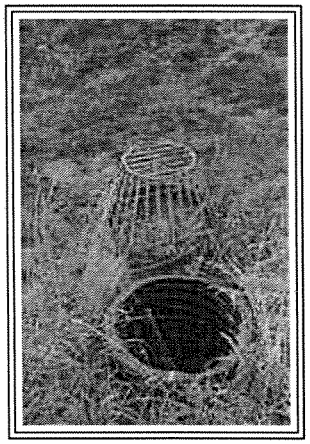
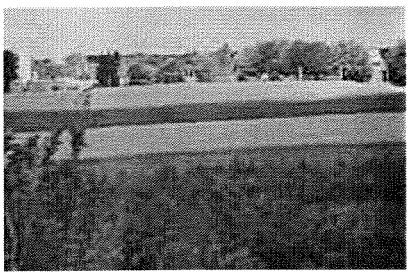
Protecting Surface Water

Protecting surface water is a best management strategy. By using Best Management Practices for soil and water conservation, manure management and natural habitats, agricultural impact on water quality is reduced. Remember, it IS a water cycle - you're always 'upstream' and 'downstream' from somebody else.



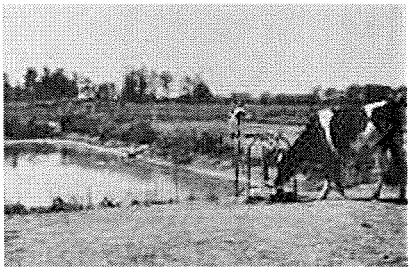
Manure runoff can be prevented by avoiding or reducing application near surface waters. Separation distances for application can be calculated using information about soil nutrient levels, soil infiltration and runoff potential, field topography, manure nutrient levels and commercial fertilizer application rates. Separation distances must also take the proximity to surface water inlets into account.



Soil and water conservation Best Management Practices such as strip cropping will help protect surface waters by increasing field roughness and infiltration rates plus reducing runoff potential.

Soil conservation structures such as this series of terraces and drop inlet structures contain runoff in ponding areas as that sediments can settle out before entering surface waters.

Buffer strips along watercourses can curb surface water contamination by reducing field runoff and maintaining separation distances for nutrient and pesticide application.



A fenced pond to restrict access can provide livestock with a clean water source.

Refer to the following Best Management Practices for further information:

- Field Crop Production
- Horticultural Crops
- No-Till: Making it Work
- Water Management
- Soil Management
- Nutrient Management
- Fish and Wildlife Habitat Management

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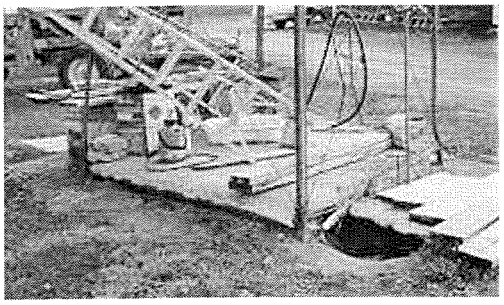
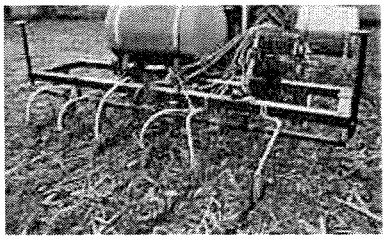
Risk to Groundwater

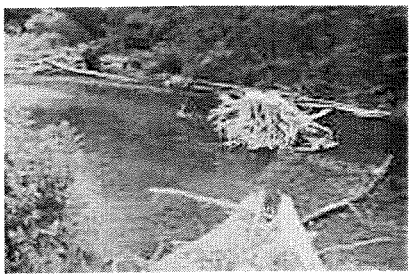
An adequate water supply is a necessity for any home. It must provide quality water at a constant and dependable rate. Groundwater supplies 90 per cent of water in rural areas for both domestic use and livestock watering. Harmful bacteria, nitrate, and crop protection chemicals have been detected in some groundwater wells.



Pesticide contamination of groundwater is primarily due to carelessness around the farm well.

Application rates for nutrients, both commercial fertilizer and manure, must be determined with more than just crop yield in mind. Equal consideration should be given to possible damage to both groundwater and surface water from leaching and run-off.





Many streams and wetlands are fed by groundwater. Taking large amounts of groundwater for irrigation or livestock facilities can lower water levels in watercourses, wetlands and water wells.

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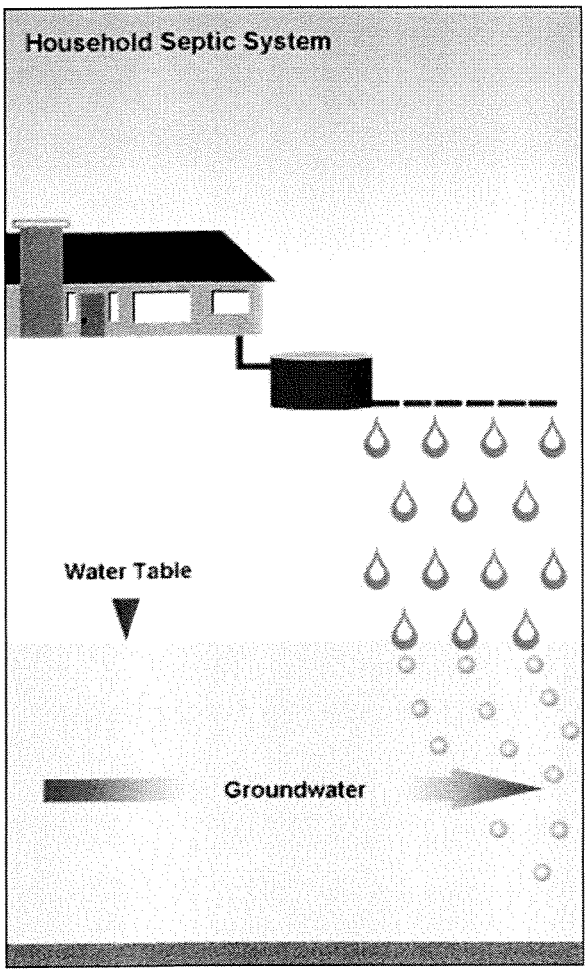
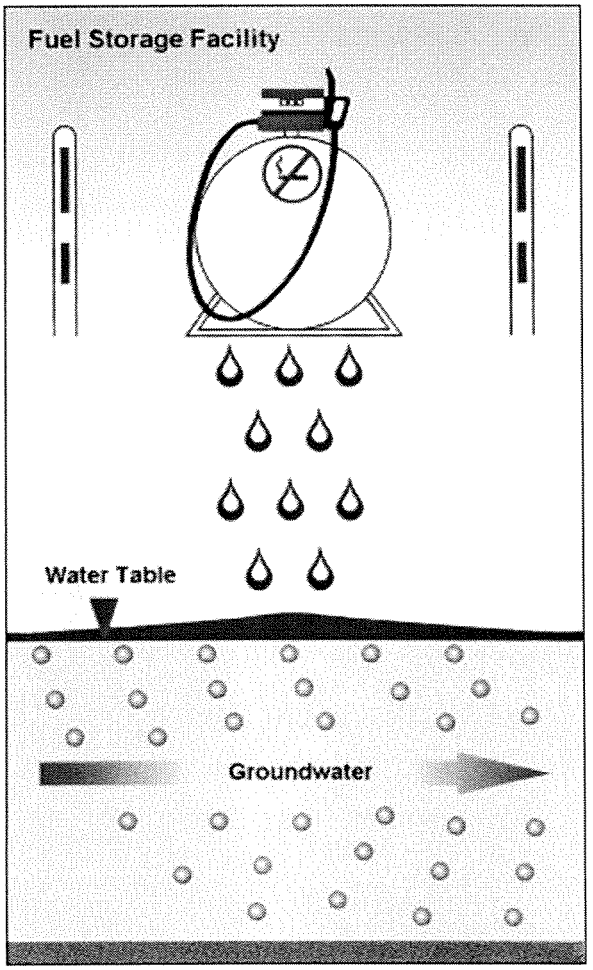
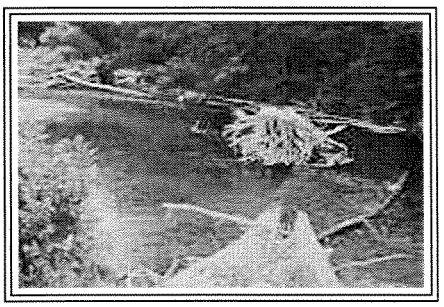
Water Wells

Substances that dissolve in groundwater such as fertilizers, road salts, water soluble pesticides and septic-based nitrates will move with recharge water to the aquifer. Once they reach the aquifer, they move in the direction of groundwater flow.

Generally, oil products and water don't mix, although some of this material does "dissolve" in the water. If spills or leaks occur, small amounts may make an entire aquifer unfit to drink. Such materials are lighter than water and will remain near the top of the aquifer.







Taking large amounts of water from ground water can lower levels in wetlands, small streams and nearby wells.

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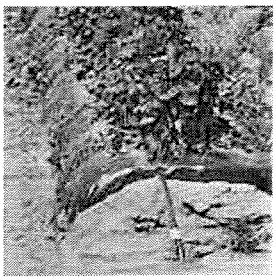
Protecting Groundwater

To protect groundwater in the well head area, there are many Best Management Practices to choose from. Start with proper siting and locations of wells and potential contaminants such as manure storages, fertilizer, fuel and pesticide storages, septic systems and maintenance shops. Proper maintenance of these facilities and management of the nutrients, pesticides and fuels will help reduce groundwater contamination. Wells need managing too - they may require repair, upgrading, replacement or proper abandonment.



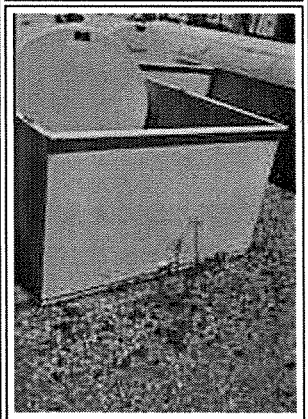
Drip or trickle irrigation technology plus mulching is very water efficient combination: only the root zone of growing crop is watered and the mulch reduces evaporation.

Unused wells are safety hazard and pose a risk to groundwater quality. They should be properly plugged and sealed. Here, water well technicians are adding grout materials to plug the well cavity and seal the potential path of surface and subsurface pathogens.

For further information refer to the following Best Management Practices books:

- Water Wells
- Irrigation
- Water Management
- Fish and Wildlife Habitat

Septic systems require maintenance - they should be cleaned out every 3 years.



To prevent leaks and spills, fuel tanks should be diked and sized to contain 110% of the total volume stored in the tank.

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Water Pollution Prevention Fact Sheet

- Quarry and Sand Pit -

Everyday business practices can pollute our groundwater, rivers and lakes. There are many Pollution Prevention Practices that we can use to prevent water pollution. Many of these Pollution Prevention Practices are simple to do, yet are very effective in keeping chemicals and wastes from harming our environment. Pollution prevention can be inexpensive, while pollution cleanup can cost thousands of dollars. Some of the Pollution Prevention Practices that were developed by people in your industry are listed below.

- Sand and gravel pits make groundwater especially vulnerable to contamination due to the permeable nature of their deposits. Mining activities should be located away from recharge areas of aquifers needed for public water supplies.
- Quickly stabilize disturbed areas by restoring overburden, replacing topsoil, avoiding steep slopes, reproducing natural drainage patterns, and replacing vegetation.
- Topsoil and subsoil should be stripped from the operation area and kept for restoration of the area.
- Incorporate appropriate drainage systems to prevent ground and surface water contamination. Drainage should not lead directly into streams or ponds.
- Limit active gravel removal to a total of five acres at any one time to minimize the amount of surface area susceptible to erosion.
- Ensure that access roads are constructed and maintained properly so as to prevent or control erosion.
- Maintain an adequate vertical separation between the deepest depth of excavation and the maximum high water table elevation.
- Liquid Storage areas must have secondary containment to hold any spills or leaks at 10% of the total volume of the containers, or 110% of the volume of the largest container, whichever is larger.
- Perform preventative maintenance and manage equipment and materials to minimize opportunities for leaks, spills, evaporative losses and other releases of potentially toxic chemicals.
- New and waste material storage areas should be roofed, isolated from floor drains, have sealed surfaces, and be accessible to authorized personnel only.
- Underground storage tanks (USTs) should not be used, unless required by fire codes or other regulations. Above ground storage tanks (ASTs) are preferred. Tanks should have visual gauges to monitor fluid levels. Routinely check all ASTs and USTs for leaks. Nozzles used for filling tanks should have automatic shutoff valves.
- If USTs must be used, they require secondary containment monitoring, high level and leak sensing audio/visual alarms, level indicators and overfill protection. A protective plate should be placed at the tank bottom if a dip stick is used.
- Dry wells should be eliminated. All unused wells must be abandoned (Ontario Regulation 903).
- Consider a bulletin board solely for environmental concerns.
- Employees must have WHMIS training. Train all staff on proper handling, storage and transportation procedures for WHMIS materials to reduce the risk of spills and accidents.
- Keep track of where and why spills have occurred to prevent future spills.
- An operator should be on-site at all times to monitor the filling of tanks and drums.
- Drip pans should be used under spigots of chemical and oil containers to catch spills. Empty

Regional Municipality of Waterloo – Water Services Division
Website:
www.region.waterloo.on.ca/water/docs/wateresouc.html
Version 1.1, November, 1998

Water
Ours to Protect

them regularly for recycling, reuse or proper disposal.

- Develop a spill prevention and clean-up plan. Include notification procedures, site plans with storm water flow directions, and potential spill sources. Clean spills promptly and report as required. The Region's Spills reporting number is (519) 650-8200; Ontario's is 1-800-268-6060.
- Use emergency spill kits and equipment. Locate them in storage areas, loading and unloading areas, dispensing areas, and work areas.

The Regional Municipality of Waterloo has a Water Resources Protection Strategy to limit the risk of contamination of our water resources. The Region has compiled a list of Pollution Prevention Practices for most businesses in the Region. For additional information on pollution prevention and Pollution Prevention Practices contact the following:

Regional Municipality of Waterloo – Water Services Division
150 Frederick Street
7th Floor
Kitchener, ON N2G 4J3
Phone: 519-575-4426
Fax: 519-575-4424
www.region.waterloo.on.ca/water/docs/wateresouc.html

Environmental Business Source (CTT)
437-150 Frederick Street
Kitchener, ON, N2G 4J3
Phone: 519-579-4795
Fax: 519-575-4542
Email: ebsctt@oceta.on.ca

Canadian Centre for Pollution Prevention (C2P2)
100 Charlotte Street
Sarnia, ON, N7T 4R2
Phone: 1-800-667-9790
Fax: 519-337-3486
Email: c2p2@sarnia.com
http://c2p2.sarnia.com

Environment Canada Green Lane
Web page:
www.cciw.ca/green-lane/or-home.html

NOTES ON YOUR POLLUTION PREVENTION OR BEST MANAGEMENT PRACTICES...

Water Pollution Prevention Fact Sheet

- Automotive Vehicles, Parts & Accessories - Sales-

Everyday business practices can pollute our groundwater, rivers and lakes. There are many Pollution Prevention Practices that we can use to prevent water pollution. Many of these Pollution Prevention Practices are simple to do, yet are very effective in keeping chemicals and wastes from harming our environment. Pollution prevention can be inexpensive, while pollution cleanup can cost thousands of dollars. Some of the Pollution Prevention Practices that were developed by people in your industry are listed below.

- Each service bay should be provided with a waste collection station which include labeled containers for each type of waste liquid or labeled sinks which lead to an appropriate waste holding tank.
- Service pits should have spill containment such as a sump which discharges to a holding tank.
- Store large quantities of lead-acid batteries in covered, isolated areas with no floor drains, acid resistant flooring, and secondary containment. Small quantities can be stored in acid-resistant tubs.
- Each car wash facility should maximize the recycling/reuse of rinse water.
- Floor drains should connect to an oil/water separator system.
- Service pits should have impervious, concrete floors. Old earthen floors should be checked for historical contamination and remediated as necessary.
- Check hydraulic lifts regularly for leaks.
- Vehicle storage and repair areas must have an impermeable surface and some form of containment in case of spills or leaks.
- Use above ground hydraulic lift systems whenever possible
- Dedicate service bays to a specific operation such as parts cleaning, degreasing, engine steam cleaning, vehicle washing etc. This will make waste handling more efficient.
- Do not use antifreeze as a de-icing agent. Antifreeze can be recovered on-site or off-site.
- Do not use waste oil as a dust suppressant.
- Waste paints, thinners, paint sludges and solids should be collected, drummed, labeled and disposed by a licensed waste hauler.
- Waste from the collection tank of an oil/water separator should be emptied every 6 to 12 months by a licensed waste hauler.
- Send waste solvent to a waste exchange for further reuse and recycling.
- If no floor drains are installed, there should be no vehicle washing and there should be no discharges to environment of any kind.
- Install a drying rack and/or drip pan to collect solvents dripping off of washed parts. Reuse the collected solvent.
- Use high performance oils to reduce the frequency of changes and the amount of waste produced.
- Used oil filters should be recycled for their scrap metal content. Drain (for at least 24 hrs.) and collect the residual oil prior to recycling.
- Untreated rinse waters or floor drains should not discharge to a sanitary sewer, septic system, storm drain or surface water.
- Liquid Storage areas must have secondary containment to hold any spills or leaks at 10% of the total volume of the containers, or 110% of the volume of the largest container, whichever is larger.
- Underground storage tanks (USTs) should not be used, unless required by fire codes or other regulations. Above ground storage tanks (ASTs) are preferred. Tanks should have visual gauges to monitor fluid levels. Routinely check all ASTs and USTs for leaks. Nozzles used for filling tanks should have automatic shutoff valves.

Regional Municipality of Waterloo – Water Services Division
Website:
www.region.waterloo.on.ca/water/docs/wateresouc.html
Version 1.1, November, 1998

Water
Ours to Protect

- Consider a bulletin board solely for environmental concerns.
- Employees must have WHMIS training. Train all staff on proper handling, storage and transportation procedures for WHMIS materials to reduce the risk of spills and accidents.
- Keep track of where and why spills have occurred to prevent future spills.
- Use dry cleanup methods and mopping, and avoid flooding with water. Absorbent material saturated with oil is a hazardous waste and should be disposed properly.
- Recycle cleaning rags or rags contaminated with paint, solvents, grease or oil, and have them cleaned by an industrial launderer.
- Purchase products in refillable, reusable or at least recyclable containers. Ask suppliers to take back containers.
- Use spigots, pumps or funnels for the transfer of materials to reduce spillage.
- Whenever possible, use environmentally friendly materials.
- Perform preventative maintenance and manage equipment and materials to minimize opportunities for leaks, spills, evaporative losses and other releases of potentially toxic chemicals.
- An operator should be on-site at all times to monitor the filling of tanks and drums.
- Develop a spill prevention and clean-up plan. Clean spills promptly and report as required. The Region's Spills reporting number is (519) 650-8200; Ontario's is 1-800-268-6060.
- Hazardous materials are not permitted in the sanitary or storm sewers (Sewer Use By-Law 1-90). Call (519)650-8260 for information on Regional By-Law 1-90.

The Regional Municipality of Waterloo has a Water Resources Protection Strategy to limit the risk of contamination of our water resources. The Region has compiled a list of Pollution Prevention Practices for most businesses in the Region. For additional information on pollution prevention and Pollution Prevention Practices contact the following:

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Phone: 519-575-4426
Fax: 519-575-4424
www.region.waterloo.on.ca/water/docs/wateresouc.html

Environmental Business Source (CTT)
437-150 Frederick Street
Kitchener, ON, N2G 4J3
Phone: 519-579-4795
Fax: 519-575-4542
Email: ebsctt@oceta.on.ca

Canadian Centre for Pollution Prevention (C2P2)
100 Charlotte Street
Sarnia, ON, N7T 4R2
Phone: 1-800-667-9790
Fax: 519-337-3486
Email: c2p2@sarnia.com
http://c2p2.sarnia.com

Environment Canada Green Lane
Web page:
www.cciw.ca/green-lane/or-home.html

Water
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Water Pollution Prevention Fact Sheet

- *Wholesale Motor Vehicle, Parts and Accessories-*

Everyday business practices can pollute our groundwater, rivers and lakes. There are many Pollution Prevention Practices that we can use to prevent water pollution. Many of these Pollution Prevention Practices are simple to do, yet are very effective in keeping chemicals and wastes from harming our environment. Pollution prevention can be inexpensive, while pollution cleanup can cost thousands of dollars. Some of the Pollution Prevention Practices that were developed by people in your industry are listed below.

- Untreated rinse waters or floor drains should not discharge to a sanitary sewer, septic system, storm drain or surface water.
- Liquid Storage areas must have secondary containment to hold any spills or leaks at 10% of the total volume of the containers, or 110% of the volume of the largest container, whichever is larger.
- New and waste material storage areas should be roofed, isolated from floor drains, have sealed surfaces, and be accessible to authorized personnel only.
- Tanks and pipe fittings should be leak tested periodically for structural integrity. Annual testing of unprotected steel tanks and piping systems should be performed, especially for those aged 15 years or more.
- Waste collection stations, with labeled containers for each kind of waste, should be provided throughout work areas for spent chemicals, soiled rags, etc.
- Underground storage tanks (USTs) should not be used, unless required by fire codes or other regulations. Above ground storage tanks (ASTs) are preferred. Tanks should have visual gauges to monitor fluid levels. Routinely check all ASTs and USTs for leaks. Nozzles used for filling tanks should have automatic shutoff valves.
- If USTs must be used, they require secondary containment monitoring, high level and leak sensing audio/visual alarms, level indicators and overfill protection. A protective plate should be placed at the tank bottom if a dip stick is used.
- Uncovered receiving areas should be designed with a spill sump to catch and store any spilled chemicals with manual operation for emptying.
- Do not let rainwater runoff come into contact with materials and wastes.
- Find out where your water drains. Drainage should not lead directly into streams or ponds. Cross-connections, such as sanitary discharges to storm sewers or floor drain discharges to storm sewer systems should be identified and eliminated. Install backflow preventors on water supply lines.
- Dry wells should be eliminated. All unused wells must be abandoned (Ontario Regulation 903).
- Consider a bulletin board solely for environmental concerns.
- Employees must have WHMIS training. Train all staff on proper handling, storage and transportation procedures for WHMIS materials to reduce the risk of spills and accidents.
- Keep track of where and why spills have occurred to prevent future spills.
- Use dry cleanup methods and mopping, and avoid flooding with water. Absorbent material saturated with oil is a hazardous waste and should be disposed properly.
- Recycle cleaning rags or rags contaminated with paint, solvents, grease or oil, and have them cleaned by an industrial launderer.
- Purchase products in refillable, reusable or at least recyclable containers. Ask suppliers to take back containers.
- Minimize the use of materials such as road salts and lawn-care chemicals.
- Recycle materials such as used oil, spent degreaser, and mineral spirits.
- Drip pans should be used under spigots of chemical and oil containers to catch spills. Empty

Regional Municipality of Waterloo – Water Services Division
Website:
www.region.waterloo.on.ca/water/docs/wateresouc.html
Version 1.1, November, 1998

Water
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them regularly for recycling, reuse or proper disposal.

- Use spigots, pumps or funnels for the transfer of materials to reduce spillage.
- Ordinary drums may have to be handled as hazardous waste unless they are properly cleaned before disposal. Discharge cleaning residues properly.
- Whenever possible, use environmentally friendly materials.
- Perform preventative maintenance and manage equipment and materials to minimize opportunities for leaks, spills, evaporative losses and other releases of potentially toxic chemicals.
- An operator should be on-site at all times to monitor the filling of tanks and drums.
- Develop a spill prevention and clean-up plan. Include notification procedures, site plans with storm water flow directions, and potential spill sources. Clean spills promptly and report as required. The Region's Spills reporting number is (519) 650-8200; Ontario's is 1-800-268-6060.
- Use emergency spill kits and equipment. Locate them in storage areas, loading and unloading areas, dispensing areas, and work areas.
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Water
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Water Pollution Prevention Fact Sheet

- *All Industries and Businesses* -

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- Dry wells should be eliminated. All unused wells must be abandoned (Ontario Regulation 903).
- Closed-loop cooling systems should be used to save water and costs.
- Consider a bulletin board solely for environmental concerns.
- Employees must have WHMIS training. Train all staff on proper handling, storage and transportation procedures for WHMIS materials to reduce the risk of spills and accidents.
- Keep track of where and why spills have occurred to prevent future spills.
- Use dry cleanup methods and mopping, and avoid flooding with water. Absorbent material saturated with oil is a hazardous waste and should be disposed properly.
- Recycle cleaning rags or rags contaminated with paint, solvents, grease or oil, and have them cleaned by an industrial launderer.
- Purchase products in refillable, reusable or at least recyclable containers. Ask suppliers to take back containers.
- Minimize the use of materials such as road salts and lawn-care chemicals.

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Water
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- Recycle materials such as used oil, spent degreaser, and mineral spirits.
- Drip pans should be used under spigots of chemical and oil containers to catch spills. Empty them regularly for recycling, reuse or proper disposal.
- Use spigots, pumps or funnels for the transfer of materials to reduce spillage.
- Ordinary drums may have to be handled as hazardous waste unless they are properly cleaned before disposal. Discharge cleaning residues properly.
- Whenever possible, use environmentally friendly materials.
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Fuels

TRANSPORTATION FUELS
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REGULATIONS & UPDATES
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FIELD APPROVALS
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FUELS HOME

Reporting a fuels incident

Information Bulletin

New Safety Laws To Prevent Fuel Oil Leaks and Spills

(November 2002) The Technical Standards and Safety Authority (TSSA) is advising all owners of fuel oil heating systems of the requirement to have their heating systems inspected by qualified oil burner technicians, and the need to register their underground (buried) fuel oil storage tanks with TSSA. New requirements were introduced in October 2001 to reduce the number of fuel oil leaks and spills that occur throughout the province each year.

TSSA investigation statistics show that old, rusting underground tanks and poorly maintained and defective heating systems are the leading sources of fuel oil leaks and spills. These leaks and spills can result in serious environmental damage and costly clean-up repairs for homeowners.

The new regulations require fuel oil distributors to conduct inspections on all fuel oil heating systems. This includes all underground and aboveground tanks, associated piping, venting and heating appliances such as furnaces, boilers and water heaters. The fuel oil distributor must inspect all equipment to which they deliver fuel, whether it is located above or below ground, initially and at least once every 10 years. **Fuel oil cannot be delivered to equipment that poses an immediate hazard.**

Most fuel oil spills are preventable by a simple inspection during regular maintenance and by replacing agein or defective components. Please contact your local fuel oil supplier for more information about the inspection requirements for your heating system.

If you own a buried fuel oil tank, it must be upgraded with leak and spill-protection equipment or removed. Your first step is to register your tank, free of charge, with the Technical Standards and Safety Authority (TSSA). **Your fuel supplier may refuse to fill your underground tank if it is not registered with TSSA** This does not include oil tanks in basements and aboveground fuel storage tanks. The provincial regulations include a phased-in, multi-year program to upgrade or remove these tanks. If your underground fuel tank wa: installed:

- **25 or more years ago?** the tank must be upgraded or removed by **October 1, 2006**
- **20 to 24 years ago?** the tank must be upgraded or removed by **October 1, 2007**
- **10 to 19 years ago?** the tank must be upgraded or removed by **October 1, 2008**
- **Less than a year to 9 years ago?** the tank must be upgraded or removed by **October 1, 2009**

To register your underground tank and find out more about the new inspection requirements, please call TSSA's Fuels Safety program at (416) 734-3300 / toll-free at 1-877-682-TSSA (8772).

New Fuel Oil Requirements (Frequently Asked Questions)

FUEL OIL DISTRIBUTOR INSPECTIONS

Why were the new inspection requirements introduced?
The new requirements were introduced in 2001 to address safety and environmental concerns with fuel oil installations. Many fuel oil leaks and spills are attributed to equipment failure that may have been preventabl with an inspection.

A fuel oil user whose fuel oil installation leaks also faces substantial costs to clean up the resulting environmental contamination, not to mention the risk of liability in the event of an accident. The potential for personal injury and environmental harm resulting from improperly maintained or inappropriately used fuel oil installations is both unacceptable and avoidable. Fuel oil users have a responsiblity to ensure that their equipment is in compliance with safety regulations to minimize these risks wherever they live.

Can you provide details about these new requirements?
The new regulations require that the entire fuel oil system (associated piping, venting and heating appliance: such as furnaces, boilers and water heaters) must be inspected by distributors before they can receive fuel. Periodic inspections - at least once every 10 years - must be performed by distributors on each fuel oil system.

What exactly is on the tank inspection checklist?
First, it is important to realize your fuel oil system consists of more thena storage tank. It includes a fill and vent pipe for oil supply and an outlet line with a valve and filter to supply the oil to your furnace. So when we discuss the oil system, we are really talking about all of these components. Keep in mind any one of these components can fail causing a leak or spill.

Some of the things your fuel dealer will be looking at during the inspection include:

- verifying the tank has a proper gauge and an overfill protection device
- checking whether the tank is leaning over and may topple
- checking whether there are signs of leakage at the tank bottom
- ensuring that the fill and vent are piped outside.

What happens if the fuel oil supplier finds an unsafe installation?
Depending on the danger from the unsafe installation, a fuel supplier can specify a time period up to 90 days for corrective action or the delivery of fuel oil will cease. If the unsafe installation is very dangerous, then the distributor must immediately stop the supply of fuel oil to the installation.

Who can fix my appliance and make it safe again?
All heating contractors working on fuel oil equipment are required to be registered with TSSA. When calling a heating contractor, ask for the contractor's TSSA registration number and request that only a TSSA certified Oil Burner Technician work on the appliance. To check if thecontractor is registered with TSSA call 1-877-682-TSSA (8772).

I don't agree with my fuel supplier and I think that my equipment is safe. What can I do?
Tank owners can get a second opinion from other Oil Burner Technicians and other Fuel Oil Suppliers to confirm whether or not there is an unsafe installation.

I have a natural gas/propane furnace, does this apply to me?
No. While natural gas and propane-fuelled appliances have similar requirements, they are governed under different regulations. For more information on regulations governing natural gas and propane appliances, vis our Web site at www.tssa.org.

What regulation governs fuel oil and where can I get a copy?
Fuel oil is governed under the Technical Standards and Safety Act, and Ontario Regulation, 213/01. You car obtain a copy from the TSSA Web site at www.tssa.org or order a copy from the Ontario Government Bookstore at 1-800-668-9938.

UNDERGROUND FUEL OIL TANKS

What are the new requirements?
In October 2001, new fuel oil regulations administered by TSSA came into effect. The new regulations requir registration of all underground fuel tanks in Ontario by May 2002.

Why were they introduced?
The new requirements were introduced to address safety and environmental concerns with underground fue oil installations. Fuel tank leaks can lead to environmental hazards.

A fuel oil user whose tank leaks also faces substantial costs to clean up the resulting contamination, not to mention the risk of liability in the event of an accident. The potential for personal injury and environmental harm resulting from improperly maintained or inappropriately used tanks is both unacceptable and avoidable Fuel oil users have a responsibility to ensure that their equipment is in compliance with safety regulations to minimize these risks wherever they live.

What's the problem with underground fuel tanks?
Many underground oil tanks in Ontario are 25 years old and older, or of an unknown age. These tanks are nc specially protected from corrosion, as newer tanks are. As a result they may be leaking and should be upgraded or removed.

Leaking fuel oil tanks will contaminate soil and groundwater. The cost of cleaning up contamination from a leaking underground tank can range from $5,000 to over $1,000,000.

Why weren't these new fuel oil requirements introduced before?
No attention was paid to fuel oil leaks and spills for years before the hazards were fully understood. Once th nature of the hazards were apparent, the new requirements were introduced to correct existing problems anc to prevent spills and leaks in the future.

Why do I have to register my underground tank?
By registering the tank, TSSA will be able to keep track of the location and condition of underground fuel oil tanks in Ontario. These new regulations will help to protect Ontario's environment from possible fuel oil leaks by creating a registry of the location and condition of each underground tank in the province and by ensuring that fuel oil tanks that are in danger of leaking do not receive fuel oil.

How do I register?
An Underground Fuel Oil Application Form must be completed and filed with TSSA. The application forms ar available on our Web site at www.tssa.org or from our Fuels Safety program at 1-877-682-8772. A registratic number will be assigned to your tank that you can give to your fuel distributor to ensure uninterrupted fuel supply.

How can I tell if my underground tank is leaking?
Because they are buried, it is difficult to tell if the tank is leaking. Some underground tanks may leak for year without owners realizing it. However, if your oil consumption suddenly goes up your tank may have sprung a large leak.

There are companies that test underground tanks for leaks. Call the Ontario Petroleum Contractors Association at (705) 735-9437 to help you find underground tank testing companies.

What do I do if my underground tank is leaking?
Call a TSSA registered fuel oil contractor to help you find and stop the leak and clean up any leaked fuel oil. You are also required to call the Spills Action Centre of the Ministry of Environment at 1-800 -268-6060 to report the leak. Your insurance company may also be able to assist you.

How do I remove my underground tank?
Underground tanks are required to be removed by TSSA registered fuel oil contractors. A certified Petroleum Equipment Mechanic Two "PM2" is required to perform the removal. When you call a contractor, ask for the TSSA registration number. When an underground tank is removed, the soil around the tank must be assesse for contamination and all contamination cleaned. The costs associated with the removal of underground fuel oil storage tanks will vary depending on the location of the tank. Owners are encouraged to attain competitiv quotes for the removal of their underground storage tank.

I have an underground tank that I am no longer using, what should I do?
Once an underground tank stops being used, or where it hasn't been used in two years the underground tan is required to be removed and all contaminated soil cleaned. The removal is to be performed by a Petroleum Equipment Mechanic Two "PM2".

Who are TSSA Registered Contractors?
By law, all contractors working on fuel oil equipment such as underground tanks are required to be registere with TSSA. Persons repairing, installing, removing and servicing fuel oil underground tanks are also required

to be trained and certified as a "Petroleum Equipment Mechanic 2." The Ontario Petroleum Contractors Association may be able to refer you to some good TSSA registered fuel oil contractors.

Who pays for the upgrading or removing of underground tanks?
Owners of underground tanks are responsible for the costs of maintaining, upgrading, and removing their underground tank.

While we are concerned with the economic burden this may place on homeowners, the investment in these environmental upgrades will reduce the incidence of fuel spills, and offset the much higher potential costs for the clean-up of contaminated sites. The environmental hazards from spills are too great to ignore. Unfortunately, there has been a number of spills which have occurred as a result of defective fuel oil installations.

How much time do I have to upgrade or remove my tank?
TSSA has established a phased-in approach for fuel oil tank removal or upgrade over several years to assist owners in managing the associated costs.

The schedule guidelines call for tanks older than 25 years by October 2001(including tanks whose age cannot be determined) must be replaced or upgraded by October 2006. Owners of tanks between 20 and 24 years old have an additional year to do this work, while tanks between 10 and19 years must be replaced or upgraded by October 2008. Tanks less than nine years old in 2001 must be replaced or upgraded by October 2009.

My insurance company wants my buried tank removed within 30 days, who is right TSSA or my insurance company?
An insurance company can set their standards higher than what the regulations require. For example, they may determine they will not insure tanks of a certain age, as each insurance company is able to make its own determination of the liability they are willing to assume.

What do the regulations say about upgrading basement or above ground tanks?
There are no requirements in the regulations or Code that make upgrading of these tanks mandatory. Some insurance companies set their standards higher than TSSA and may require these tanks to be upgraded as well.

Variance Applications for Abandonment of Underground Storage Tanks in Place

Background
Under the Liquid Fuels Handling Code and the Fuel Oil Code all underground storage tanks (UST's) must be removed within two years of disuse. This code requirement is for safety purposes as old steel tanks may corrode and leave a void in the ground that may cause the ground to collapse. Secondly, abandoned USTs left with product in them may leak and cause an environmental impact. Under the TSS Act, an applicant may make application to seek a variance from this code requirement provided they give alternative actions that meet the intended safety requirements. More...

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