PROMOTING PRIVATE WATER SYSTEMS BEST MANAGEMENT PRACTICES

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ABSTRACT
Groundwater drawn from private wells is usually the only drinking water supply for farm and other rural use, such as rural non-farm and cottagers, and is also a significant water supply source in municipal areas. Private well owners have a personal interest and valuable role in ensuring that their actions and land use activities within their property boundaries do not impair the quality or quantity of recharge to their water supplies. They may be unaware of this interest and role, and often need user-friendly information that helps them to understand, assess and mitigate threats associated with their groundwater supplies.
A broad-based private water system information package (PWSIP) has been produced. The PWSIP materials include an introductory poster, four information sheets and a disinfection fact sheet. It also includes the revised Water Wells Best Management Practices Book (BMP), which continues to be a key reference document for public health unit staff and private well owners. The purpose of the PWSIP materials is to raise the awareness of the private well owners concerning the importance of undertaking regular water sampling and testing, proper siting and best practices for well construction, maintenance and decommissioning, and appropriate well disinfection techniques and water treatment options where needed.
Approximately 220,000 copies of the PWSIP materials have been printed and will be distributed in three ways. First, 600 hard cover kits will be prepared containing the PWSIP materials, as well as an OMAF video and a MOE video concerning proper well construction, maintenance and decommissioning. The hard cover kits will be distributed to groups that receive public water quality inquiries such as public health units, government, conservation authorities, and public libraries. Second, 110,000 soft cover kits containing the PWSIP materials Water Wells BMP Book will be prepared and shipped directly to public health units for distribution to clients that experience adverse water quality test results. Finally, the remaining PWSIP materials will be distributed broadly by government offices, public health units, conservation authorities, and other agencies and organizations.
This paper describes the background and content of the PWSIP materials, and the status of an Ontario-wide outreach strategy for promoting private water system BMPs across Ontario that features these materials.

RÉSUMÉ
Les eaux souterraines puisées d'un puits privé sont habituellement la seule source d'eau potable pour l'agriculture et d'autres utilisations en milieu rural (chalets et utilisations non agricoles). Elles sont aussi une source importante d'eau potable dans de nombreuses zones municipales. Les propriétaires d'un puits privé ont donc un intérêt personnel à veiller à ce que les activités qui ont lieu sur leur terrain ne réduisent ni la quantité ni la qualité des eaux souterraines. Outre leur intérêt personnel, ils ont aussi un rôle important à jouer pour garantir la quantité et la qualité des eaux souterraines. Toutefois, ils ne sont pas toujours conscients de leur intérêt et de leur rôle à cet égard. Ils ont donc souvent besoin de renseignements conviviaux, qui les aident à comprendre les risques, à les évaluer et à les atténuer.
On a réalisé une trousse d'information générale sur les réseaux d'eau privés. La trousse renferme une affiche introductive, quatre feuilles d'information et une fiche technique sur la désinfection. Elle renferme aussi la version révisée du livret intitulé *Pratiques de gestion optimales : les puits*. Le livret continue d'être un document de référence d'une importance clé pour le personnel des circonscriptions sanitaires et les propriétaires d'un puits privé. La trousse d'information a pour but de conscientiser les propriétaires d'un puits privé, pour qu'ils comprennent bien l'importance de prélever régulièrement des échantillons d'eau et de les faire analyser, de bien situer leur puits et, enfin, d'en assurer l'entretien et de le mettre hors service correctement. Les documents traitent également des techniques de désinfection d'un puits et des appareils de traitement de l'eau qui existent sur le marché.
Environ 220 000 exemplaires ont été imprimés et seront distribués de trois façons. On préparera d'abord 600 exemplaires reliés, qui renfermeront la trousse d'information sur les puits privés, ainsi qu'une vidéocassette du ministère de l'Agriculture et de l'Alimentation et une du ministère de l'Environnement. Les vidéocassettes expliquent les façons de bien construire un puits, de bien l'entretenir et de le mettre hors service correctement quand il n'est plus utilisé. Les exemplaires reliés seront remis aux organismes qui reçoivent des demandes de renseignements au sujet de la qualité de l'eau potable distribuée par une municipalité. Ce seront entre autres les bureaux de santé publique, le gouvernement, les offices de protection de la nature et les bibliothèques publiques. Deuxièmement, on préparera 110 000 exemplaires à couverture souple, qui renfermeront la trousse d'information sur les puits privés et le livret intitulé *Pratiques de gestion optimales : les puits*. Ces exemplaires seront expédiés aux bureaux de santé publique, qui les remettront à leurs clients dont l'analyse de l'eau a donné des résultats insatisfaisants. Enfin, les autres documents seront distribués librement par les bureaux gouvernementaux, les bureaux de santé publique, les offices de protection de la nature et divers autres organismes.

Cet article décrit le contexte et en quoi consiste la trousse d'information sur les réseaux d'eau privés et l'état d'avancement des activités mises en œuvre partout en Ontario pour favoriser des « pratiques de gestion optimales »

1. INTRODUCTION

The most common source of water for persons living in rural areas is groundwater pumped from private water wells. Groundwater is also a significant water supply source for many persons living in municipal areas, including a number of larger urban communities. In Ontario, approximately 23% of the overall water supply comes from groundwater (AAFC and OMAF, 2003).

The most common threat to the integrity of a private water well is contamination resulting from the entry of surface water either directly into or down the outside of the well casing because of poor construction or maintenance (U.S. EPA, 1993). The Ontario Farm Groundwater Quality Surveys (Goss et al., 1992), which included water sampling of 1208 rural domestic wells for bacteria. It was observed that a greater proportion of shallow (sand point, dug or bored) wells had bacteria samples that exceeded the maximum acceptable concentration than drilled wells. It was also noted that older wells tended to have bacteria samples that exceeded the maximum acceptable concentration than younger wells, and that this correlation tended to decrease with increasing depth.

A well can also become contaminated if the groundwater supply for the well is affected by point and non-point sources, naturally occurring or human in source, both near and at some considerable distance. With private water wells, the responsibility for providing a safe water supply lies with the well owner. In most cases, this can be achieved using proper water well best management practices. Best management practices enable the well owner to ensure an adequate quantity of water, and prevent the well and underlying aquifer from becoming contaminated through poor well construction and maintenance, or improper actions around the well (Simpson et. al., 2002).

The above information underlines the importance of well construction in maintaining a secure water supply. The need for a comprehensive package of awareness and education materials for private well owners that would provide accessible and consistent information was recognized by a number of provincial and local public health unit staff working with private well owners. A Private Water System (PWS) technical working group was formed by staff from three ministries and three public health units (PHUs) from across Ontario. The ministries included: the Ministry of Health and Long-Term Care, which has a mandate for implementing the Safe Water Program, including promoting the sampling of water quality by private well owners, through 37 local public health units under the authority of the Health Promotion and Protection Act; the Ministry of the Environment, which has a mandate to ensure the proper construction, maintenance and decommissioning of wells through Regulation 903 under the Ontario Water Resources Act; and, the Ontario Ministry of Agriculture and Food which has an interest and expertise promoting water wells best management practices, and a mandate for developing and implementing technology transfer programs for the farm and broader rural community. The PHUs that participated in the PWS technical working group included the District of Algoma Health Unit, Leeds, Grenville and Lanark District Health Unit, and the Waterloo Regional Health Unit. These PHUs have a history of developing and implementing progressive private well owner awareness and education programs.

This paper summarizes the background information and process that was used to by the PWS technical working group to design an awareness and education program for private well owners, and describes the content of the materials that were developed. The status of a province-wide program to raise the awareness and education private well owners is provided.

2. EDUCATING PRIVATE WELL OWNERS

Despite this important role and responsibility of private well owners, many [especially those who are transient or recent rural residents (e.g., cottagers, persons who moved to a rural area from the city recently)], are not aware that their water supply comes from a private well. As a result many rural residents are not aware that they are responsible for maintaining their well while it is in use, and must properly decommission it when it is no longer in use. They may also be unaware that testing their water supply for indicator bacteria is a important means to ensure that water supply is potable. This is significant because a properly constructed and maintained well, that is tested regularly, is the first and best line of defense for protecting their water supply.

To address this concern, the objective of the PWS technical working group was to produce a series of information materials in English and French that would raise awareness of the private well owners about the importance of undertaking a regular water sampling and testing program, practice proper siting and best practices for well construction, maintenance and decommissioning, and use appropriate well disinfection techniques and water treatment options where needed. The group concluded that a series of awareness and information materials, rather a single document, should be prepared to lead the reader through the awareness to action spectrum - from the point of becoming aware of the concern ,though an increasing level of understanding, to implementing private water well best management practices.

Intuitive learning models are useful tools for identifying and understanding the information needs of the rural community, and assist them to understand and adopt actions that would protect their private water supply (Simpson and Hodgins, 2002) In this instance, the learning model selected was based on the collective experience from the development of several initiatives in Ontario to help rural landowners to select environmentally sustainable farming practices for their property. These included the Ontario Best Management Practices (BMP) Program, which was developed to support the development of a series of BMP publications (factsheets, books, videotapes) and the Environmental Farm Plan[1] program (Taylor, 1996). The intuitive learning model for the Ontario BMP Program includes the following three learning levels:

Level I - Initial Awareness Building Stage: During this stage the attention of the community needs to be caught through a series of short and frequent messages, and promoted in areas where the community has the greatest concern about groundwater quality. These projects are aimed at providing an overview of the issues and the respective remedial measures associated with a concern;

Level II - Awareness-Education Transition Stage: During this stage the community needs to be provided with examples of how to protect groundwater around the home and farm. These projects are aimed at helping landowers to select appropriate practices when planning environmental improvement around their home or farm; and

Level III – Education-Empowerment Transition Stage: During this stage the community moves from needing information about the need and means for groundwater protection to actively seeking information and involvement in groundwater protection efforts. These projects are intended to help the landowner to effectively implement BMPs, and more tips, costs and research results are included in these materials.

The above information was considered when developing awareness and education programs both in terms of the level of writing and manner in which material was presented . For instance, frequent, short and snappy messages reinforced with highly visual material are important during for Level I materials to catch a person's awareness. For the Level III materials, however, logic becomes more useful because this provides concrete examples of how a person can take action.

2.1 PWSIP Materials Content

Based on the above information, the PWS technical working group developed two primary messages that would be based directly on the mandates and interests of the ministries and PHUs. The first was to educate private well owners about the importance of regular sampling of water quality by private well owners. The second was to promote the proper construction, maintenance and decommissioning of wells. The PWS technical working group concluded that these messages should be communicated using all three levels of awareness and educational materials described above.

2.1.1 Level I Materials

An introductory information sheet and a poster were written at a Level I content. The introductory sheet introduced the two primary messages, provided an outline of the Level II materials, and presented a well safety checklist that a well owner should take to protect their water supply (PWS, 2003a).

The poster includes a diagram showing the different parts of a well with which a well owner should be familiar, repeats the well safety checklist, presents a table that summarizes of the different well types (dug or bored, drilled), and states which organization that you can turn to for assistance with different private water system concerns (PWS, 2003b).

Also, two videotapes were produced independently of each other that helped to support the principle messages. The second videotape consisted of three six-minute segments prepared for the OMAF Town and Country Ontario television show. Development of the content for the segments was assisted by the PWS technical working group, and had a focus on owners of existing private wells (Clark, 2002a; Clark, 2002b; Clark, 2002c;). The second videotape consists of a single 20-segment prepared by the MOE as a general awareness and education material with a focus on persons constructing new wells. In both cases, the videotapes emphasized the importance of proper construction, maintenance and decommissioning of private water wells (Neufeld, 2002). The Town and Country Ontario videotape, however, also emphasized the importance of a regular sampling and testing program for private wells. A fourth six minute Town and Country Ontario segment was produced and aired recently that demonstrated the importance of a regular sampling and testing program, discussed how to disinfect a private well with adverse test results, and provided an overview of water treatment technologies (Clark, 2004).

2.1.2 Level II Materials

A series of four information sheets and one instruction sheet were written at Level II content. These were designed to catch the attention of the reader with a series

[1] The EFP is a risk assessment tool and an educational process that encourages farmers to incorporate best environmental practices in all their farming activities. The risk assessment helps farmers evaluate potential environmental impacts specific to their individual farms using worksheets that address 23 key environmental issues. To date over 26,000 farms (the principal stakeholders**)** or approximately 1/3 of the 56,000 registered farm businesses in Ontario have voluntarily participated in EFP workshops or completed a home study package.

of short messages, and also providing some detailed information about how the community can protect its water supply. In this way the materials are flexible because they can both make the reader aware of the importance of the messages, while also provide the more detailed information that is desired by the aware reader. The content of the introductory materials is described in the following section.

2.2.1 Get Acquainted With Your Well

The first information sheet is entitled "Get Acquainted With Your Well Choosing a Water Treatment System" (PWS, 2003c). The most common threat to the integrity of a private water well is contamination resulting from the entry of surface water either directly into or down the outside of the well casing because of poor construction or maintenance (U.S. EPA, 1993). As a consequence, the first line of defence with a private well is to ensure that it is properly constructed and maintained. A secure lid prevents direct entry of surface water and vermin, mounded up soil directs water away from the base of the well casing, and watertight grout prevents surface water from infiltrating and moving down through the well annular space.

Private well owners need to be aware of the different types of wells, how each is constructed, and how each type operates. For the purposes of wellhead protection, there are two common types of water systems. These include drilled small diameter wells, and dug and bored large diameter wells.

Drilled wells can be constructed in both bedrock and overburden (e.g., unconsolidated sand and gravel) aquifers. Drilled wells consist of a small diameter casing ranging in size from 10 to 20 centimetres (4 to 8 inches) of steel or plastic casing with watertight joints. Large diameter wells are typically constructed in overburden aquifers using prefabricated concrete tile or corrugated galvanized steel pipe ranging in diameter from 60 to 120 centimetres (24 to 48 inches). Older large diameter wells may be constructed of brick, stone or even wood cribbing and need to be inspected for undesirable seepage.

Well owners are responsible for ensuring that their well is properly maintained to prevent surface water and materials from moving into the well. This ensures optimum well water quality, and prevents the well from acting as a pathway for contaminants into underlying aquifer(s) and neighbouring wells. Simpson (2003) provides a checklist of well safety items that should be implemented as part of a thorough private well risk assessment.

There are a number of factors that can make a water supply highly vulnerable to contamination. These include an inadequate depth of soil protecting the aquifer, direct movement of water from the ground surface into the well casing and aquifer, groundwater under the influence of surface water, location of a well at a lower elevation than the surrounding land, or location of a well near or downgradient from a potential contaminant source(s). Highly vulnerable supplies include extremely shallow (e.g., less than 3 metres or 10 feet deep), below-grade wells (including well pits, buried wells, drilled wells constructed in old large-diameter wells), shallow well (or sand) points, cisterns, springs, spring boxes and surface water sources (e.g., infiltration wells). In general, water drawn from these sources should not be considered safe to drink and should not be used without appropriate testing and treatment.

Unused or improperly abandoned wells are another significant potential source of contamination. These wells should be properly decommissioned (plugged and sealed) to prevent the direct entry of surface water and contaminants into the well and aquifer, prevent the exchange of water and contaminants between aquifers, and eliminate a safety hazard.

2.1.2.1 Pathogens and Your Well Water

The second information sheet is entitled Pathogens and Your Well Water" (PWS, 2003d). The public is increasingly aware of the risks that harmful organisms can pose in drinking water. Water may also contain health-related (hazardous/toxic) dissolved chemicals that can cause illness. Well owners should be aware of different organisms and chemicals that can impair their water quality, how they move through soil and water, and why it's important to test well water to ensure that it is safe.

The primary micro-organisms of concern with private water supplies are bacteria, viruses and parasites. Pathogens are micro-organisms that can cause disease and/or illness in humans. Bacteria are single-cell micro-organisms that occur naturally in soil and water. Bacteria come in many forms and are for the most part essential to life on Earth. However, certain bacteria can cause food spoilage and serious illness in humans. Protozoa are single-celled organisms. Some can live in animals and humans, and are excreted in feces. Protozoa are capable of surviving for long periods of time in the aquatic environment as dormant cysts. Viruses are tiny organisms that reproduce by infecting living cells.

2.1.2.2 Putting Your Well Water to the Test

The second information sheet is entitled Pathogens and Your Well Water" (PWS, 2003e). The best way for a well owner to protect themselves and their family from illness or disease causing pathogens is to monitor their water supply for indicator bacteria. Total coliform and Escherichia coli (E. coli) are indicator bacteria that can act as early warning signals of health risks related to well water. Total coliform are a general family of bacteria that are found in vegetation, surface soils and animal wastes. Their presence in a water sample indicates possible surface water contamination of well water, and provides an early warning signal that there may be a problem with the water supply. E. coli are group of bacteria that live in the intestines of warm-blooded animals. Their presence in a water sample indicates recent fecal contamination

such as sewage, and indicates there is a problem with the water supply.

Water can also contain dissolved chemicals that can cause illness. The dissolved chemicals may come from naturally occurring minerals or from spills of human-made substances. There can also be changes in "aesthetic parameters" (the appearance, taste, colour or odour of your water) that may signal a change in water quality and should prompt the well owner to test the water. If the well owner suspects that there may be problems with the water quality, a water sample should be submitted to an accredited laboratory for analysis.

2.1.2.3 Choosing a Water Treatment System

The fourth information sheet is entitled "Choosing a Water Treatment System" (PWS, 2003f). As described above, water may contain pathogens from waste materials, and chemicals from naturally-occurring minerals or human activity (such as industrial spills). Water may also contain aesthetic materials that affect its appearance, taste or smell.

Treatment systems can be used to treat water from any source to make it suitable or more palatable for drinking. Treating highly vulnerable water sources described above can be expensive, difficult and will require a great deal of time to ensure that the equipment is looked after properly. These types of treatment systems will require skill and knowledge to design, construct and operate. It is recommended that the owner contact your local public health unit and/or a water treatment professional when selecting, installing and operating a treatment system.

In contrast, treating water from properly constructed and maintained wells is generally easier but the technology used must be selected carefully to ensure that it is effective for each specific situation. An awareness of the potential shortcomings of each treatment method should be kept in mind. It is prudent to make use of local expertise such as the public health unit and/or a water treatment professional for assistance in selecting, installing and operating a treatment system.

Long-term treatment options should be selected carefully because each technology is effective for a particular purpose. Specific treatment methods, water quality parameters for which they are suited, limitations of the methods, and comments on the application and maintenance of these methods are discussed in Simpson (2003).

It is important to remember that water treatment should not be used to compensate for a high vulnerability water supply when an alternate and more secure supply is available, or as a substitute for good water supply construction and maintenance practices. It is also recommended that the local public health unit and/or a water treatment professional be consulted for assistance when selecting, installing and operating a treatment system.

2.1.2.4 Disinfection Instruction Sheet

The fifth level II material is an instruction sheet (PWS, 2003g) that provides a step-by-step approach for disinfecting a private well. The first step where there are repeat adverse water quality tests is to look at the condition of the well, and the surrounding area, for an indication of the source of contamination.

There may be some situations where a well will require disinfection, however, this may not be a permanent solution and may not eliminate the source of bacteria. In this situation the well may have to be replaced by a more secure water source such as a deeper well. In situations where an alternate water source is not available, it may be necessary to use a home treatment device.

2.1.3 Level III Material

It was concluded that an existing Level III material, the Water Wells BMP Book (Agriculture and Agri-Food Canada & OMAFRA, 1997) should be updated by the PWS technical working group. The original book was developed and published as a direct response to the educational reference needs of participants in the Environmental Farm Plan program, and to alarming results (regarding nitrates and pathogen levels) from rural well water quality studies (Goss et. al., 2002). The Water Wells BMP book received a Blue Ribbon Award from the American Society of Agricultural Engineers, and was out of print by 2001

The revised Water Wells BMP Book (Agriculture and Agri-Food Canada & OMAFRA, 2003) continues to be a detailed educational resource that is intended to help readers effectively implement BMPs and provides tips, associated costs and research results concerning the construction, maintenance, upgrading and decommissioning (plugging and sealing) of wells. The subject matter in the Level II information sheets and disinfection instruction sheet is included in the book. This detailed best management practice information is provided within a broader context of groundwater flow, quantity and contamination, and how specific actions can minimize individual, family and community health and environmental risk.. The book has also been revised to be consistent with the requirements of the provincial water well regulations, and contains new information concerning the sampling and analysis of private water wells for indicator bacteria.

3. STATUS OF A PROVINCE WIDE AWARENESS AND EDUCATIONAL PROGRAM

Approximately 220,000 copies of the PWS information materials (English and French) were printed in early 2003, and are being distributed in three ways. First, 600 hard cover kits have been prepared containing the PWSIP materials, as well as a copy of the OMAF videotape and a MOE videotape. The hard cover kits have been

distributed to groups that receive public water quality inquiries such as public health units, OMAF and MOE offices, conservation authorities and public libraries. Second, approximately 110,000 soft cover kits were prepared that contain the PWS information materials, and have been shipped directly to public health units and provincial government offices for distribution to clients with adverse water quality test results. The remaining PWSIP materials are being distributed broadly by MOHLTC, OMAF, MOE and other agencies. The distribution of the materials is being coordinated by the Regional Municipality of Waterloo Community Health Department.

At a meeting of the PWS technical working group in May 2003, it was concluded that the demand for PWS information kits is significantly greater than anticipated. In addition, Health Canada has learned about the soft cover kits, and has acquired and distributed approximately 500 copies to its First Nations clients. It was also decided that at least 60,000 copies of the kit may be required to meet current PHU needs for 2004. All outstanding copies of the kits, such as those shipped to ministry offices, are being redirected to PHU offices to meet this demand. The working group is currently looking for additional resources to meet demand for the kits beyond the end of the calendar year.

4. ACKNOWLEDGEMENTS

The authors would like to acknowledge the contributions of the following persons that were invaluable in the preparation of this paper: Alison Lane; Maxine Kingston, Ontario Ministry of Agriculture and Food; Kim Yee, Tony Edmonds, Robert Bruce, Caroline Cosco and Paul Froese, Ontario Ministry of the Environment; Fred Ruf and Bill Hunter, Ontario Ministry of Health and Long-Term Care; Bill O-Donnell and Sherri Cleaves, District of Algoma Health Unit; Henry Garcia, Leeds, Grenville and Lanark District Health Unit; Shawn Zentner, Waterloo Regional Health Unit.

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