THE ROLE OF GEOSCIENTISTS IN PROMOTING GROUNDWATER PROTECTION AND MANAGEMENT THROUGH INFORMING AND EDUCATING CITIZENS, COMMUNITIES AND DECISION MAKERS

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ABSTRACT
Technical contributions by the geoscience and engineering communities are the building blocks of effective ground water management and protection. However, community support and political will have also become fundamental elements. These elements are enhanced by heightened public understanding and awareness of groundwater issues. Hydrogeologists have an important role to play in raising this awareness. Drawing on the authors' experiences, this review examines the roles hydrogeologists have played in various outreach and education programmes both at the local and provincial level. These include programmes associated with a wide range of projects such as: private well stewardship; environmental farm planning; regional groundwater management; communal wellhead protection; and representations on behalf of a professional association and expert panels. The technical context, the role of the geoscientists and their impact are discussed. Experience to date underlines the importance of having hydrogeologists take an active role early on in the groundwater protection and management processes.

RÉSUMÉ
Le soutien communautaire et la volonté politique sont des éléments nécessaires à la gestion efficace et à la protection des eaux souterraines. Ces éléments sont rehaussés par la compréhension ainsi que la sensibilisation accrues du public en matière des questions des eaux souterraines. Les hydrogéologues ont un rôle important à jouer dans l'accroissement de cette sensibilisation. En s'appuyant sur les expériences des auteurs, cette revue examine les rôles joués par les hydrogéologues dans les divers programmes de diffusion et d'éducation aux niveaux locaux et provinciaux. Parmi ces programmes on retrouve ceux qui sont reliés à une vaste gamme de projets tels que: l'intendance des puits privés; la planification environnementale agricole; la gestion régionale des eaux souterraines; la protection communale des têtes du puits; et les plaidoiries au nom d'une association professionnelle et des groupes d'experts. Le contexte technique, le rôle des géoscientifiques ainsi que leur influence y sont discutés. L'expérience acquise à de jour souligne l'importance du rôle actif que doivent assumer les hydrogéologues dans les processus de la protection et de la gestion des eaux souterraines.

1. INTRODUCTION

Groundwater protection and management is multifaceted and can involve many agencies, organizations and individuals. The approaches and needs vary. Many protection and management strategies now identify communication and public education as major components. Advances have been made by hydrogeologists in conveying clear concise groundwater related information to other professionals, land use decision makers and to the public. As well, groundwater geoscientists have recognized that key management problems are often socio-political rather than technical. In particular, securing co-operation between those using and affecting the groundwater resource, and those attempting to manage it and plan for its protection, is essential.

The purpose of this paper is two-fold. The first purpose is to briefly examine why the involvement of groundwater geoscientists in informing and educating is critical to the success of groundwater protection and management initiatives. The second purpose is to describe the roles groundwater geoscientists are playing in various outreach and education programmes, at both the local and provincial levels in Ontario. The latter includes a range of projects: private well stewardship; environmental farm plans; regional groundwater management; participation on a provincial well expert panel; and representations on behalf of a professional association.

2. IMPORTANCE OF EDUCATING AND INFORMING CITIZENS, COMMUNITIES AND DECISION MAKERS

Educating and informing communities, decision makers and individual citizens about groundwater for its protection and management is important because:

- Community support influences a local government's capacity to protect groundwater. If the citizens in a community understand and support a groundwater protection programme, then they are more likely to become actively involved (Giantomasso et al, 1998; Environment Canada, 1995). Low public awareness reduces community participation in groundwater protection, as is often witnessed by the professional

geoscience community when there is low turn-out to scheduled public meetings. Conversely, the public turns out when there is a perceived crisis.

- Political support and commitment to groundwater protection and management is reflected in the policies, laws, regulations and by-laws that are in place, and the vigour with which they are promoted and enforced. Political support is considered to be a function of community support and the level of awareness amongst both the general citizenry and the decision makers (Giantomasso et al., 1998).

- Many water management situations cannot be, or are poorly addressed, by the "command and control" legislative and regulatory approach. Groundwater management involves the regulation of water wells, and thus regulating the actions of thousands of individual well owners (Rivera, 2000). These situations require the whole community to become better informed about the potential environmental and health impacts of their land and water use practices and to voluntarily make changes where necessary (Appleyard, 2000).

- Proactive education and outreach increases groundwater protection by prevention since increased awareness and conscientious behaviours go hand in hand with prevention of contamination. Groundwater professionals are more aware than most that once groundwater is contaminated, remediation is a very costly and lengthy process. The most cost-effective means of ensuring a safe groundwater supply is to protect the source and prevent groundwater contamination from occurring in the first place. This is the first barrier in a multi-barrier approach to source water protection.

The challenge of providing information on groundwater issues in a clear and understandable manner is exacerbated by the public's general lack of exposure to basic geosciences and groundwater in the school system. The result is a low level of awareness of geology, groundwater and groundwater systems amongst the public in general, groundwater users and decision makers alike. In addition, society may too often focus on the impact of the individual when looking at a negative situation – fish kill from spills or leakage, purposeful dumping of pollutants, negligent or fraudulent behaviour. Instead, we can focus on the positive impact the individual can have if informed and provided with incentives.

3. PUBLIC EDUCATION AND THE ROLE OF GEOSCIENTISTS

Geoscientists provide the necessary technical knowledge to manage groundwater resources. They also have a professional duty, as per Ontario's Professional Geoscientist's Act, 2000, to participate in public education on geoscience and the geoscience profession. To increase the effectiveness of those activities in terms of groundwater management and protection, hydrogeologists need to consider how technical knowledge and information is conveyed, in what form, to whom and with what approach.

For example, Holysh et al. (2000) suggested that hydrogeologists have been largely ineffective in conveying clear concise groundwater related information to land-use decision makers. Regional groundwater studies result in maps which may be useful in elucidating the regional hydrogeology but are insufficient for guiding land use planning decisions. The direct result: groundwater has not been properly considered in the land use decisions. What is required is proactive mapping of groundwater features, at a scale that can incorporate groundwater into the planning process in a timely manner. In their review of local implementation of groundwater source protection in Ontario, and the role of the groundwater studies carried out under the provincial water protection fund, de Loë et al. (2003) stressed that effective implementation was more often linked with having the key local people involved with the study from the outset. Hydrogeologists must be involved in educating and informing these key local people early on.

In terms of follow-up, hydrogeolgists can also provide a key link for lessons learned. Neufeld (1998) observed that municipalities in Ontario do not lack for groundwater planning and management tools. He suggests what is lacking is the direct experience in applying the land use planning and other measures to groundwater management. Hydrogeologists can assist in advancing this aspect of implementation by facilitating the transfer of information and appropriate methods across the jurisdictions in which they work. This will not fill the void left, for example, by the paucity of follow-up monitoring which should be done to evaluate the success of implemented best management techniques (Holysh et al., 2000). Nevertheless the relaying of lessons learned would help dispel some of the isolation that currently exists between the various agents working in groundwater management, protection and research (Rivera, 2000).

For the thousands of private well owners tasked with properly managing and protecting their well water supply, technical information in a meaningful and accessible form is required (Simpson et al., 2002; GCA, 2002). The basic information should be supplemented with clear directions on what actions individual well owners need to take to protect their water supply. If people cannot access reliable information and expert guidance easily, nor understand it and feel comfortable on how to apply it, the message is undermined. The audience's confusion and diminished confidence become barriers to action (Pearse et al., 1985; GCA, 2002). Geoscientists must convey our complex and unseen science in a clear and useful fashion, often a daunting task for scientists who have little formal training in public communication skills.

4. INVOLVEMENT OF GROUNDWATER GEOSCIENTISTS IN CERTAIN PROGRAMMES IN ONTARIO

The following summaries describe roles groundwater geoscientists have played in various outreach and education programmes both at the local and provincial level. The technical context, the role of the geoscientists involved and the impacts are discussed for all of these.

4.1 Private well stewardship and groundwater protection

In Ontario, approximately 500,000 private wells serve about a quarter of the province's population. As many as 100,000 of these wells may no longer be in use and may require proper decommissioning (GCA, 2002). In 2001 Ontario's Ministry of the Environment (MOE) funded the development and implementation of Well Aware, a social marketing and community outreach programme. This programme was designed to improve and enhance private well owner knowledge of their wells and their legal responsibilities.

Well Aware is a project of the Green Communities Association in partnership with the Ontario Groundwater Association. The Association of Professional Geoscientists of Ontario participated by recruiting member hydrogeologists to provide the groundwater education component of the community forums.

As part of the development phase of Well Aware, an assessment was completed to determine why there was an apparent lack of transference of existing water well stewardship information to the private well owner and what new publications or tools could or should be developed. This first phase also included pilot testing of a "Well Discovery Campaign" and a well tag system for existing private water wells. The pilot project concentrated on locating existing private wells, used and unused.

The needs assessment determined that the requirements of well stewardship are in sharp contrast to the actual level of knowledge and involvement of many private well owners in Ontario. For example, in the survey of 400 well owners, only 58% of the respondents agreed "that in time surface water seeps down and becomes groundwater, and groundwater moves into surface waters", while 42% disagreed or did not know. About half of the respondents incorrectly believed that "well water comes from large underground rivers" (GCA, 2002). In the Well Discovery pilot, even the approximate locations of 10% of the wells were unknown. Just 70% of the wells were visible, and for 16% of the wells the user and/or owner did not know what type of well it was (Wilson, 2002).

Phase 2 of Well Aware was the implementation of the major public education outreach initiative targeting private well owners and their communities. The strategies used have been applied in groundwater education in other parts of the world and are common to what is referred to as "community based social marketing" and to "public education and outreach" programmes. The reader is referred to the following website and reference for more in-depth information on these terms and concepts: www.cbsm.com and McKenzie-Mohr and Smith (1999).

The overall communication strategy follows a hierarchy of activities ranging from broad-based and relatively widely disseminated information materials, through to group interactions, such as presentations and workshops, and then face-to-face interactions. The most powerful form of communication in terms of inducing behavioural change is face-to-face interaction (Clacherty, 2000). The more multifaceted education and information programmes, utilizing all the formats noted above, are considered to be most effective (Clacherty, 2000; Potter, 2000). In all cases, the technical information must be presented in a clear, concise and credible manner to solicit the greatest response from individuals.

Hydrogeologists played several key roles in the Well Aware outreach programme. They worked with community groups, well contractors, and others in four of the Well Aware elements and made the following contributions:

- Technical review of the Well Aware Booklet, over 72,000 of which have been distributed to well owners across the province. This easily read guide to private well owners was designed to provide well stewardship information and links to additional information and assistance.

- Presentations on groundwater basics at Community Forums, complementing presentations from other experts on key groundwater and well issues. These evening events were community-level public forums in which experts address the key issues and well owners had the opportunity to ask questions. Over 30 professional geoscientists participated in 62 of these Forums across the province, reaching over 2,000 well owners.

- Participation in a number of Information Provider Workshops on the basics of groundwater science, well stewardship best management practices, and the roles and responsibilities of the provincial and municipal government in private water well management. The Workshops were held in communities across the province for a wide range of well information providers. The purpose of the Workshops was to ensure that private well owners across the province are provided with accurate, consistent, and mutually reinforcing information from multiple government and non-government sources.

- The technical training of and support to the "Water Guides" who guide well owners through on-site assessments during a home visit. Water Guides are instructed on groundwater basics, water well regulations, upgrading and construction. Water Guides are not intended to take the place of licensed well contractors or play the role of groundwater specialists. Rather the Guides' increased knowledge,

skill and awareness in water well stewardship represent the abilities Well Aware strives to instil in all well owners. The Water Guides are catalysts encouraging change in well owner behaviour through face-to-face sessions so that the well owner can and will act in accordance with the four key Well Aware messages: regular well water testing; well maintenance; have unused and unmaintained wells properly plugged and sealed; and hire licensed well contractors.

The full impact of the hydrogeologists' contribution to Well Aware will be discerned over time. The programme's evaluation will provide more information on the intermediate and longer term influence beyond the few thousand well owners reached directly by the programme. However the more immediate impacts from the hydrogeologists' involvement are readily apparent:

- Increased accuracy in the depiction of the groundwater environment in the four Well Aware elements noted above;

- For individual well owners who attended the Community Forums, an increase in the accessibility to expertise: In the words of a Forum participant, the information provided by a P.Geo. "answered many of my questions and definitely gave us something to think about"; the information provided by the P.Geo. was "new to us"; and the Community Forum "was very worthwhile";

- Enriched "classroom experience" at the Workshops: "Having a professional [geoscientist] in the room gave people a comfort level with the knowledge and information and encouraged them to ask questions beyond the session." (Keating, 2004); and

- Fifteen trained Water Guides, operating in five communities across the province from Thunder Bay to eastern Ontario, are inspired and knowledgeable agents, willing and able to promote well stewardship, increasing the level of understanding of the groundwater environment.

By providing technical expertise and pertinent information through these venues, hydrogeologists helped residential well owners better understand the impacts of human activities on the groundwater environment, including the owner's well water supply. It was important to dispel certain myths such as underground rivers or lakes, and provide the clear scientific facts that govern groundwater and wells in a manner that was understandable to the non-expert public. The Well Aware Booklet and presentations were designed to increase the well owners' knowledge of rudimentary hydrogeology and the vulnerability of groundwater to contamination. Part of the geoscientists' role was to stimulate rural well owners' interest and sense of responsibility for the groundwater environment and to motivate and empower them to take positive action to protect their groundwater resource.

For more information on current Well Aware activities please see www.wellaware.ca.

4.2 Healthy Futures Well Upgrading and Decommissioning Project and Environmental Farm Plan

Presently a serious deficit exists in private well source protection. Wells are in various states of disrepair and are often located adjacent to obvious sources of contamination, others are buried beneath driveways, roads or manure piles. Private wells are not maintained proactively. One of the barrier's to proper well maintenance is cost. Ontario Ministry of Agriculture and Food (OMAF) invested $5 million in the Healthy Futures, a well upgrade and decommissioning programme designed to subsidize work done on private wells. This project was extremely successful in repairing or decommissioning high risk wells. There were a total of 2576 wells upgraded and 835 wells decommissioned under the programme. One barrier addressed is the lack of understanding by well owners of what a good well looks like and the associated risks that could affect a well. Part of the Healthy Futures programme was the requirement for an Environmental Farm Plan for farmers and a self assessment for non-farm residents. The non-farm assessment form was adapted from the Environmental Farm plan by a geoscientist. Participants improved the security of their wells, reduced risks to local groundwater resources, and increased their knowledge of good well stewardship.

Steps towards groundwater protection in rural areas are being taken through the Environmental Farm Plan (EFP). Fitzgibbons (2000a; 2000b) estimates that half the threats to groundwater due to wellhead exposure, spills of stored fuel and the use and storage of pesticides as well as septic systems have already been remedied as a result of this programme. Potential threats were likely prevented through the enhanced knowledge the participant gained through the EFP process. Rural Water Quality programmes are being developed and implemented to address rural water quality issues with some areas targeting specific projects for reduction in specific substances, (e.g. South Nations Phosphorous Trading Program).

The geoscientist working with the Healthy Futures programme developed a protocol for auditing well projects, trained 3 other auditors, supervised, managed and analyzed results from all of the over 500 projects audited. The audit process was designed to assess whether the project objective of improving groundwater quality was achieved. To increase the likelihood of improved groundwater quality, the upgrading or decommissioning of wells were required to be done according to "Best Practices." This may have involved measures which went beyond the minimum required by the regulations that existed at that time.

The audits were completed between July and the end of October 2003. There were 102 decommissioning projects and 401 well upgrades. The bulk of the well upgrades were on drilled wells finished below ground, with or

without well pits. The projects assessed through the audit process were distributed throughout Southern Ontario with different auditors generally focusing on different geographical locations. Forty % of the audited wells were upgraded or decommissioned using "Best Practices". Twenty three % of the wells were ranked as causing major concern to the auditor observing the well. The variation in ranking reflected regional differences in well construction and contractor practices.

One of the most common problems observed in drilled well upgrades was the absence of sealants, and the subsequent use of local soil, sand or gravel to fill excavated holes around a well that had been extended. Vermin-proof well caps seemed to be contractor or regionally influenced. A large diameter well is inherently more vulnerable to surface water contamination because it is challenging to maintain a watertight casing with the materials that have traditionally been used for lining dug or bored wells. Well upgrades for this type of well should aim to ensure longevity of watertight seals to the casing and cap. The quality observed in large diameter upgrades varied greatly. Some contractors seemed to have the expertise to reconstruct the well in a fashion that would ensure long-term water tight casing while it appeared others did not.

An audit, where work done is verified against the invoice, would not have identified the inherent problems noted above had a geoscientist not been involved. The involvement of a geoscientist in this audit process allowed more questions regarding the quality of the workmanship and impact on the environment to also be answered. This information was documented and provided to the OMAF. This information may assist in identifying and addressing deficits in private wells and in designing future funding programmes. The technical specifications of the audit, designed by a licensed geoscientist, assured that the assessment and documentation addressed the potential impacts on groundwater quality.

4.3 Regional Groundwater and Wellhead Protection Area Studies

Prior to the tragedy in Walkerton in 2000, there were a handful of Ontario municipalities who were looking to understand and manage their groundwater resources in a more rigorous fashion. For example, the Town of Orangeville carried out its own independent Groundwater Management Plan (Gartner Lee Limited, 1998), prior to the availability of provincial funding assistance. This first step was a technical study that had no public awareness component, save presentation to the Town Council. It did however recommend that a public awareness campaign, targeting private residences and commercial and industrial facilities (within designated wellhead protection areas) be undertaken (Usher and Tupling, 1998). The Town carried out a subsequent groundwater modelling exercise and more detailed contaminant inventory to more accurately determine wellhead protection areas (Burnside et al., 2001). The public forums it carried out were poorly attended despite extensive advertising. Individual industrial facilities have been subsequently spoken to on a one-on-one basis.

Ontario's Provincial Water Protection Fund initiated Groundwater Management Studies in 1997. To date these regional groundwater and wellhead protection area studies have involved 97 projects including all of southern Ontario (south of the Muskokas) and certain communities in the northern Ontario which rely on communal municipal groundwater supplies (Talyor, 2004). The studies were considered to be the first phase of groundwater source protection, and were intended to assist in developing future environmental policy, and to support the development of local and regional groundwater protection (Ontario Ministry of Environment, 2001) .

Hydrogeologists are the main authors of these studies and have also participated on associated technical advisory committees. Many of the studies' final reports recommend public education or awareness programmes. The main goal of these programmes is to increase the public's understanding of how their actions can affect the quantity and quality of the water supply, whether the supply is from a communal system or an individual well. In this regard the hydrogeologists involved in the Groundwater Management Studies have tried to promote education and awareness as the foundation of a successful groundwater management plans.

In many cases the recommended programmes are not acted upon nor are they given the priority, scope and/or profile required to make them effective. To change this, informing and educating the decision makers may need to take place first. If there is a perceived lack of groundwater quality and/or quantity problems in an area, then interest may be low and a more proactive approach may need to be taken to gain political and community support. In such situations the potential consequences of not implementing groundwater management and protection measures needs to be explained (Environment Canada, 1995).

4.4 Communication with Decision Makers

The Centre for Research in Earth and Space Technology (CRESTech) created an independent expert panel in support of an Ontario provincial programme to improve sustainable water well infrastructure. The objectives of the panel are to document knowledge gaps and opportunities for improving water well infrastructure in Ontario as well as identify emerging threats to water well sustainability and assess Ontario's capacity to mitigate these threats. The panel had its first meeting in September 2003 and has been working on a state of the knowledge document that will be presented to Ontario's Minister of the Environment during 2004. The panel is made up of a number of geoscientists and engineers with varying expertise related to water wells.

The panel was struck under the Royal Society of Canada's guidelines and the first meeting was held in a public forum to allow members of the public an

opportunity to comment on the terms of reference. Initially this process had a limited time-frame for exploration of the issues. During the first meetings held over two days, the panel met with members of the public, well drillers, municipal water work engineers, Ontario MOE staff and quickly realized that the task was substantial. Each member of the panel undertook several writing assignments which drew upon their expertise but also required literature review and analysis from the panel member. The final 4 chapters were written by the group as a whole, after all other chapters were assembled.

The resulting document (in preparation at press time) focused more on private wells than municipal wells because there is little legislation governing private wells. Lack of inspection or enforcement of private water wells creates a situation where there are many deteriorating water wells that will affect the quality of our groundwater on a broader scale if not addressed. The regulation governing private wells has recently been revised. The Ontario MOE held a number of outreach sessions for well contractors to educate them on new requirements. Concerns over lack of inspection and education to the drilling industry were noted time and time again at these sessions. Other programmes have revealed an area for opportunity in well rehabilitation and decommissioning, as many clients looking for a contractor were unable to find a contractor with time and expertise to perform this type of work.

The government has chosen to involve outside experts or stakeholder representatives in a number of committees and expert panels to address concerns. Stakeholder groups and geoscientific experts have been brought in to advise on Nutrient Management and Source Protection. These are both technical issues defining vulnerable areas and levels of risk. These geoscientists, among others, are expected to also advise on implementation issues and tools. There have also been a number of expert panels formed surrounding specific issues (e.g. Sustainable Water Well Infrastructure). The provincial government is now supplementing in-house geoscientific expertise. The use of outside parties is relatively new, but shows a government concerned about answering challenging questions and interest in facilitating acceptance of new policies and legislation. The use of credible professionals such as geoscientists is critical to assuring sound advice and adequate background to provide direction to government leaders.

4.5 Professional Associations

In Ontario, the Professional Geoscientist's Act (2000) became fully in force in 2003 after a three year transition period establishing the Association of Professional Geoscientists of Ontario (APGO). Sections of the Act, Regulations and Bylaws require APGO members to participate in public education of geoscience. The academic geoscience community is however strongly centred in the universities, there being 13 different geoscience departments in Ontario alone. In the past 5 years Ontario has transitioned from 13 grades to 12, finally eliminating grade 13 in 2003. To achieve this geology was initially dropped. However, in response to opinions expressed by the geoscience community, it was reintroduced as part of an earth and space sciences elective. Only 77 secondary schools in Ontario carry this course with an average class size of 22 students. Some geoscience remains in the physical geography programmes at the secondary school level but is seldom taught by geoscientists. Given that geoscience forms the very basis for all society's needs, this situation is difficult to comprehend. A very real danger exists that if interest is not kindled at an early enough point in the education system, then the raw materials (students) will not be available for the university programmes, and our society will have too few informed geoscientists on which to rely.

The response of the Ontario provincial government to the circumstances of the Walkerton tragedy included many new regulations on municipal water supply safety, as well as small and communal systems. The APGO and the Professional Engineers of Ontario (PEO) have relied on their respective Environment Committees, both separately and in cooperation, to respond to these regulations, as the regulations call on both professions to implement compliance. Most recently the Ontario Government introduced a white paper on Source Water Protection Planning. In this proposed policy calls for watershed based science to be used to determine actual water resources, water use, and groundwater vulnerability. Geoscientists will be at the fore in the source planning process, which is expected to be carried out by the Conservation Authorities. Both the PEO and the APGO responded strongly to this White Paper, calling for participation of geoscientists and geological engineers at the decision making level and not just in a support role.

5. DISCUSSION

The role of the geoscientist varies greatly from consultant on a municipal groundwater study, to a technical lead in a provincial public awareness campaign, to a creative force behind an auditing of water well projects. In each of these roles the geoscientist interacts with individuals and may also have the ability to reach larger or more influential audiences to achieve real change. In the past, groups of experts tended to retain their knowledge, sharing their findings only with those as highly trained as they are. In our society the press or sales personnel often educate the public on a host of issues including the environment. Seldom does the public get the full story, as can be told impartially by a professional geoscientist or engineer. It is a significant responsibility for our profession to ensure that geoscientific information is conveyed in a factual, understandable and impartial manner in all matters. By regulation in Ontario, geoscientists must follow their Code of Ethics. We must avoid being cast in an advocacy role. We must also become better trained in communication of our methods and results to the lay public.

There have been many campaigns in the last ten years that have adapted complicated subjects to something that

a large portion of the general population can clearly understand. A few examples in the public realm are: the transmission of AIDS, the link between cancer and tobacco, the impact of alcohol on driving, and the importance of wearing seatbelts. Understanding the basic concepts, that is, the things the public need to know to protect themselves, can result in a positive change in their behaviour. Geoscientists have the opportunity to provide credible technical information to members of the public and decision makers, fostering enhanced knowledge, which could lead to many individual actions accumulating into significant environmental improvements.

6. CONCLUSIONS

It is clear that the success of many groundwater management and protection initiatives depends on groundwater geoscience professionals communicating effectively with the public and decision makers. Experience to date underlines the importance of the involvement of groundwater geoscientists in informing and educating early on in the groundwater protection and management process. The public needs to have access to reliable information and expert guidance. Groundwater professionals can provide credible and unbiased information for the betterment of groundwater protection. Today's professional geoscientist needs to step forward and take a more vocal and active role in educating our society on the important role to be played by the citizens in the protection of their groundwater resources.

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