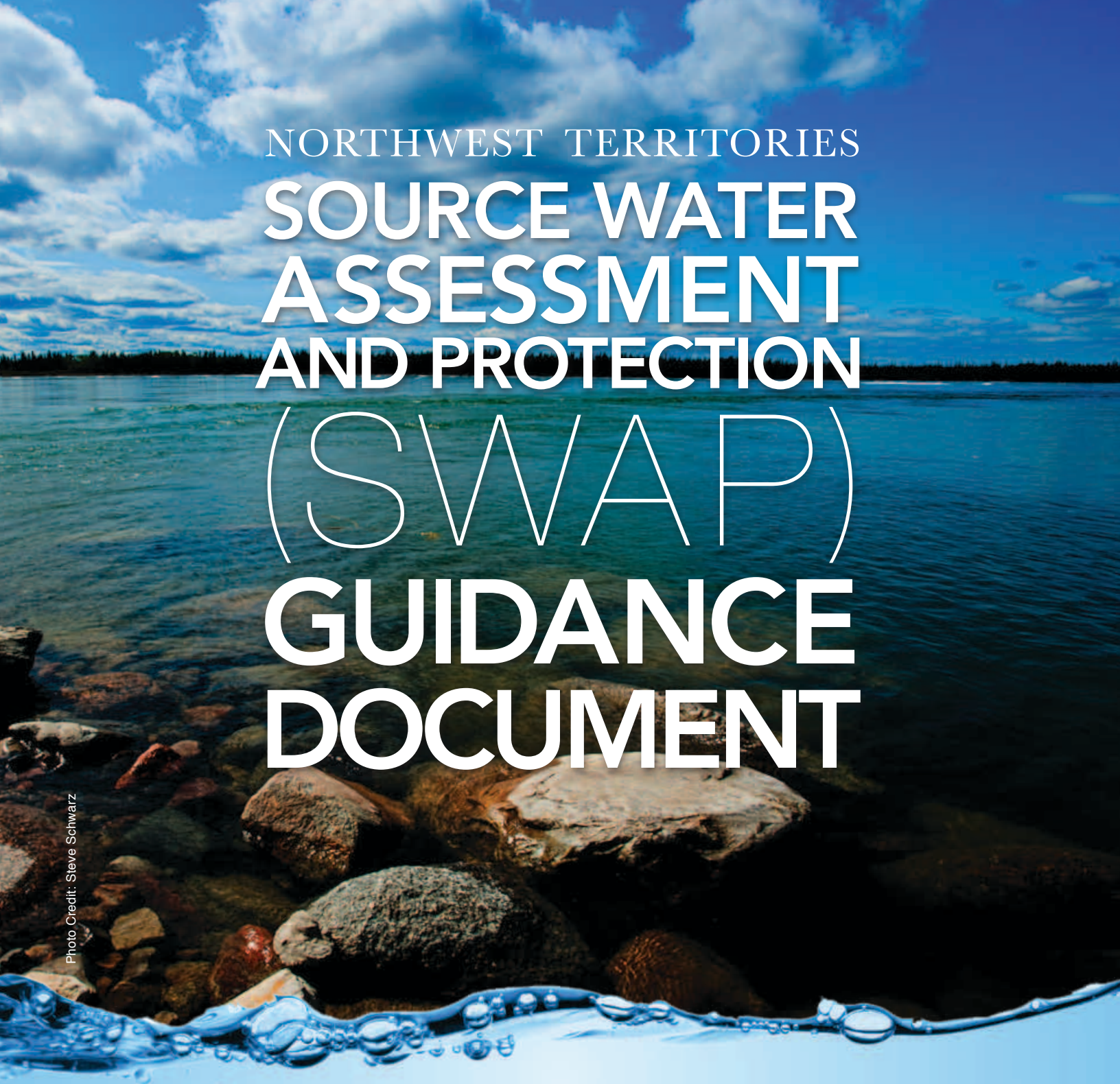

NORTHWEST TERRITORIES

SOURCE WATER ASSESSMENT AND PROTECTION (SWAP) GUIDANCE DOCUMENT

Photo Credit: Steve Schwarz

"The first barrier to the contamination of drinking water involves protecting the sources of drinking water."

- Justice Dennis O'Connor, Walkerton Inquiry 2002

Northwest Territories Environment and Natural Resources

NOTE: The SWAP Guidance Document is a living document. This February 2012 version is intended to assist with source water protection planning at the community and regional level in the Northwest Territories as part of the NWT Water Stewardship Strategy and Action Plan.

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Photo Credit: Christin Tondeur

SUMMARY

The NWT Water Stewardship Strategy *Northern Voices, Northern Waters: the NWT Water Stewardship Strategy* (NWT Water Stewardship Strategy) was released in May 2010. The NWT Water Stewardship Strategy is a made in the north strategy intended to guide effective, long-term stewardship of NWT water resources. One of the "Keys to Success" in the NWT Water Stewardship Strategy is the establishment of "a pilot study for community source water protection planning that links aquatic ecosystem indicator development and community-based monitoring." In response to this "Key to Success", the Government of the Northwest Territories (GNWT) initiated a document to assist communities in the preparation of source water protection planning. This Source Water Assessment and Protection (SWAP) program document is the outcome.

The SWAP program document is for voluntary use by communities interested in source water protection planning. The SWAP program is intended to guide source water protection planning at the community or regional level, recognizing the uniqueness of each community (and region) with regards to land use activities and source water conditions.

Source water is raw water from aquifers, streams or lakes that supplies drinking water systems. Protecting source water is a vital first step in the multi-barrier approach to safe drinking water. The goal of this SWAP program document is to assist communities and regions in the protection of source water for both human and ecosystem health.

The intent of this program is for local community members to come together with watershed interest groups, government staff, volunteers, Aboriginal groups, Elders and industry to form a Steering Committee to inventory and plan for source water protection.

The Steering Committee will find direction through a five (5) stage process. Stage 1 provides guidance for the formation of the Steering Committee. Stage 2 identifies the information necessary for inclusion into a source water assessment report. The third stage, Stage 3, instructs on the development of a source water protection plan. Stage 4 provides tools and ideas to help implement the source water protection plan. The final stage, Stage 5, explains the process of plan review.

Photo Credit: Holly Norris

INTRODUCTION

This source water assessment and protection planning document has been prepared by the Government of the Northwest Territories (GNWT) for voluntary use by communities interested in source water protection planning. This document is intended to guide source water protection planning at the community or regional level, recognizing the uniqueness of each community with regards to land use activities and source water conditions.

Source water is raw water from aquifers, streams or lakes supplying drinking water systems. Protecting source water is a vital first step in the multi-barrier approach to safe drinking water. A source water protection plan is developed from information collected in a source water protection assessment report. The assessment report collects relevant technical information specific to water quality, quantity, land use activities and general watershed characteristics. Regulatory and non-regulatory tools and activities are available for inclusion in a source protection plan. Bylaw regulations and zoning are examples of a regulatory approach. A non-regulatory approach might include education and monitoring.

Photo Credit: Steve Schwarz

NWT WATER STEWARDSHIP STRATEGY

The NWT Water Stewardship Strategy *Northern Voices, Northern Waters: The NWT Water Stewardship Strategy* (NWT Water Stewardship Strategy) was released in May 2010. The NWT Water Stewardship Strategy is a made in the north strategy intended to guide effective, long-term stewardship of NWT water resources. One of the "Keys to Success" in the NWT Water Stewardship Strategy is the establishment of "a pilot study for community source water protection planning that links aquatic ecosystem indicator development and community-based monitoring."

What is Source Water?

Source water is raw (untreated) surface or groundwater used for private and public drinking water systems. Source water contained in surface water supplies includes water found in wetlands, streams, lakes or rivers. The term watershed includes all the surface water within an area's natural drainage. Groundwater is another source of raw water. Groundwater is water found beneath the earth's surface. Approximately 70 percent of Canadians are supplied with drinking water originating from surface sources; the remaining 30 percent are reliant on groundwater sources. According to Environment Canada, approximately 25 percent of the NWT population is reliant on groundwater.

What is Source Water Protection?

Source water protection aims to protect sources of raw (untreated) water for human consumption and ecosystem function, today and into the future. Preventing contaminants from reaching water sources is an important first step in protecting our drinking water. Increasingly, source water protection has become an important component of water management. Sources of drinking water can be protected using a variety of management approaches and tools. The practice of source water protection has grown in importance in Canada as a result of significant water contamination events at Walkerton, ON (April 2000) and North Battleford, SK (May 2001), increased pressure on water resources generally, and the uncertainty of climate variability into the future.

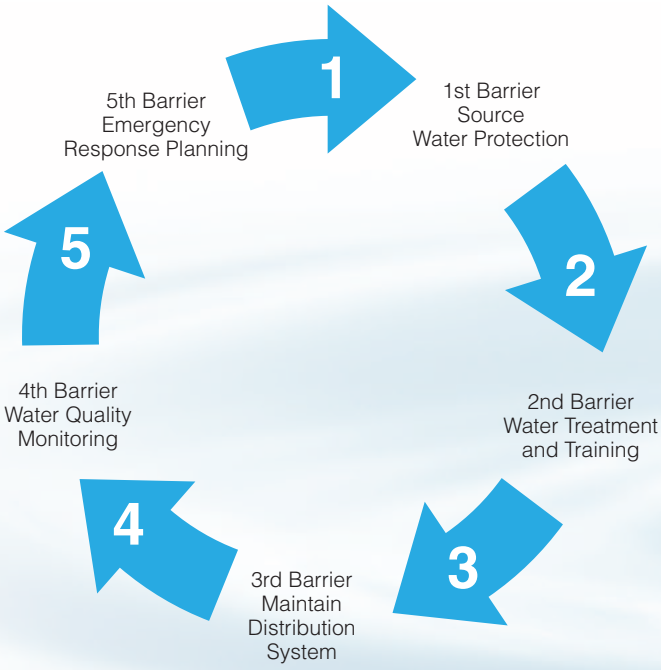
Why is Source Water Protection Important?

Source water protection works to keep water safe at the source. Source protection is important for at least four reasons. First, it is less expensive to protect a water source from contamination than it is to remediate after contamination. Second, it has been shown to be more cost-effective to invest in natural capital, such as land acquisition within a watershed, than to invest solely in physical capital, such as water treatment technologies. Third, source water protection significantly reduces water treatment challenges and costs. Last, source water protection contributes to improved ecosystem health and integrity. Source water protection is just one of the many barriers used in a "multi-barrier approach" to ensuring safe drinking water.

The Multi-barrier Approach

The Canadian Council of Ministers of the Environment (CCME) defines the multi-barrier approach as "an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water from 'source-to-tap' in order to reduce risks to public health." The goal of the multi-barrier approach in drinking water management is to reduce the risk of drinking water contamination through the presence of system redundancies, or barriers, built into the water system. Source water protection is the first barrier in the multi-barrier approach to safe drinking water. The other barriers include water treatment and operator training, system maintenance, water quality monitoring and emergency response planning (Figure 1).

Figure 1: Multi-Barrier Approach to Safe Drinking Water



Sources of Contamination

Point source pollution is something that you can point to, like an outfall pipe. Non-point source pollution originates from multiple areas, is less obvious and more difficult to trace.

Natural and human factors influence the quality of a water source. Table 1 provides examples of contamination originating from natural factors and human factors. Natural factors are often unpredictable and may occur very suddenly, such as flooding or streamside bank failure, impacting water quality. At other times, natural factors may be long-term, such as sediment loading causing high turbidity. Climate change introduces further uncertainty and challenges respecting watershed management. Human-related factors contributing to pollution are often divided into two categories: *point source* and *non-point source* pollution. *Point source* pollution can be traced to a fixed point, such as an effluent pipe, a smoke stack or a leaking fuel tank. It is something an individual can 'point a finger at' and say "there is the pollution source". *Non-point source* pollution can not be traced to a fixed point, such as recreation activity, roads and urban runoff. In this situation it is not possible for someone to 'point' to a specific pollution source. *Point source* pollution discharge has been moderated using technological innovation. Non-point sources of pollution are recognized as a significant challenge. Land use change and the intensity of development over large areas have produced a new set of challenges to environmental planning, particularly to source water protection.

Table 1: Sources of Contaminants (examples only)

Natural Factors	Human-related Factors	
	Point Sources	Non-point Sources
Climate Topography Geology Soils Vegetation Wildlife Spring thaw	Sewage lagoon effluent pipe Industrial pipe discharge Road crossings	Land clearing Urban runoff Forest management Mining Recreation Etc.

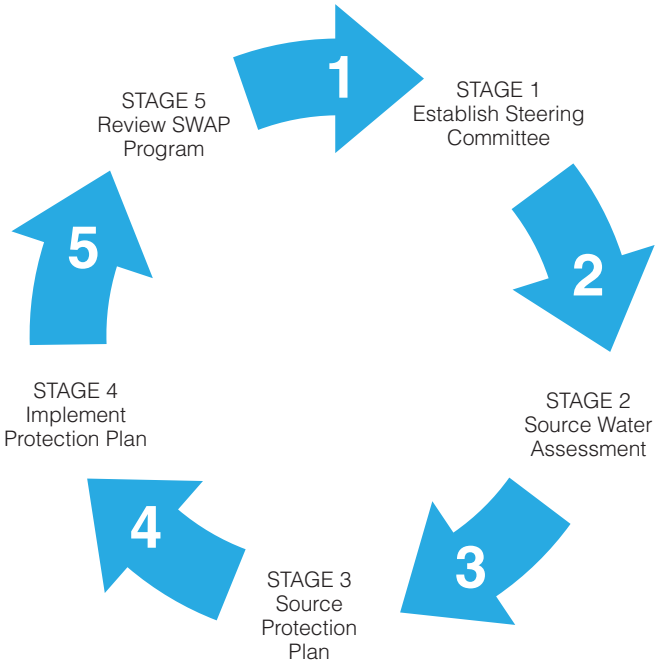
Photo Credit: Holly Norris

NWT SOURCE WATER ASSESSMENT AND PROTECTION (SWAP) PROGRAM

The importance of source water protection in the NWT is identified in the NWT Water Stewardship Strategy. The SWAP program is a multi-stage planning process (Figure 2) designed to assist public water systems in preventing contamination of their source water supplies, while minimizing water treatment challenges, saving financial resources and ensuring environmental stewardship though ecosystem science and traditional knowledge. The five stages include: establishing a steering committee; developing a source water assessment report; producing a source protection plan; implementing the plan; and reviewing the plan every five years or as needed. The SWAP program is meant to be completed in sequence, beginning at Stage 1 and ending at Stage 5. To be at Stage 3 means that you have completed Stage 2. "Stage jumping" is not allowed – such practice will not facilitate effective plan making! How long it will take to reach Stage 5 depends on many variables. Generally, it will take one year at a minimum.

The SWAP program is meant to be completed in sequence, beginning at Stage 1 and ending at Stage 5.

Figure 2: Source Water Assessment and Protection (SWAP) Program



STAGE 1: Establishing a Steering Committee

Public participation is important to the overall success of the NWT Water Stewardship Strategy. Source water protection assumes informed citizens, equipped with fundamental knowledge about their drinking water source and the threats to it, will be the most effective advocates for protecting source water.

1.1 Goal

In the earliest stage of source water protection planning it will be necessary to assemble a broad base of community and territorial partners in the form of a local community steering committee (Steering Committee). These partners should encompass a wide spectrum of interests and concerns, and strive for broad, inclusive membership. Representation should include community members, Aboriginal peoples, government, non-government organizations, academia and industry. Additional names may be added at anytime. The Steering Committee will decide the rules of membership, including a member's length of term, frequency of meeting, adoption of rules, etc. Representation from local and traditional knowledge keepers will be important.

1.2 Objectives

i) Establish a Steering Committee with broad stakeholder representation.
ii) Steering Committee to be consensus driven, operating in collaboration with as many stakeholders as possible.
iii) Steering Committee to be accountable to the community, to hold open meetings, to maintain accurate records and make available agendas and minutes of meetings.

1.3 Required Action

To establish a Steering Committee with broad stakeholder representation from sectors and groups, including: environmental organizations; forestry; mining; other industry; land owners; water boards; Aboriginal groups; recreation interests; community associations; local and territorial government; and federal government agencies. Table 2 provides an example of public record for membership on the Steering Committee. To ensure work consistency and commitment to process, the Steering Committee may wish to consider minimum time limits for membership.

Table 2: Steering Committee Membership (example only)

Name	Steering Committee Position	Affiliation	Contact Info	Membership Start Date
eg. S. Smith	Committee Chair	Elder	123 4th Street T: 222-3333 Email:	Jan. 1, 2012
		ENGO		
		Industry		
		Water Board		
		AANDC		
Etc.	Etc.	Etc.	Etc.	Etc.

Once the Steering Committee is created and rules of operation established, the next order of business is to begin development of a Source Water Assessment Report.

STAGE 2: Source Water Assessment Report

The Source Water Assessment Report is intended to be either a community specific assessment of the community's immediate surrounding land, describing potential threats to water quality, or a much broader watershed specific assessment of potential threats over a much larger area upstream of the water intake. Smaller communities may lack capacity to undertake a broader, watershed specific assessment. In such cases, a community assessment will provide important base information. A larger, full watershed assessment may be possible in future, where local capacity to conduct such a study develops over time.

2.1 Goal

The goal of Stage 2 is to develop a Source Water Assessment Report (Assessment Report). The Assessment Report is intended to provide a *water system inventory* of existing and potential sources of contaminants and a *risk assessment* to interpret the inventory data. There are two kinds of Assessment Reports. The first is a community source water assessment. The second is a regional source water assessment. Depending upon local capacity to undertake source protection planning and local water quality concerns, a community may choose a community-level approach or a broader, regional approach. A community may wish to start with the community approach to address immediate source water concerns, to be followed afterward with a more regional approach.

A community source water assessment provides a *community-level water system inventory* and a *risk assessment* to identify the amounts and types of contaminants that may be entering the water supply source. The *community-level water system inventory* should include a land use inventory of land uses and activities, such as the landfill, residential development, roads, fuel storage and industrial sites. The *risk assessment* will identify all potential risks to the water system and the natural environment resulting from any activities or facilities identified in the community-level water system inventory. The community source water assessment is intended to be completed by local residents, with assistance from environmental groups, local government, Elders, band councils and territorial agencies.

A regional source water assessment provides a *watershed-level water system inventory* and a *risk assessment* to identify the amounts and types of contaminants that may be entering the water supply source. A regional source water assessment covers a much larger area than a community source water assessment, taking into consideration existing and potential contaminants affecting the water supply source. This includes upstream industrial activities, airborne contaminants and upstream residential and recreation generated waste. Because of the larger area covered by the regional source water assessment, it will be necessary for more involvement of water boards, territorial and federal agencies to assemble information. These details, from the community source water assessment or the regional source water assessment, will be essential to, and inform the content of, the source protection plan that follows in Stage 3 of the SWAP program. The regional source water assessment takes in the full watershed area to include all water source areas; the community source water assessment is confined to the community-specific land uses and activities with potential to impact water quality.

2.2 Community Source Water Assessment Objectives

i) Map boundary of community watershed area.
ii) Inventory all community land uses and activities with potential to degrade water quality. Local and traditional knowledge will be an important source of information.
iii) Undertake a risk assessment of the inventory data to estimate risk of potential contamination to the water source.

2.3 Regional Source Water Assessment Objectives

i) Map boundary of regional watershed area.
ii) Inventory all watershed land uses and activities with potential to degrade water quality. Local and traditional knowledge will be an important source of information.
ii) Undertake a risk assessment of the inventory data to estimate risk of potential contamination to the water source.

2.4 Required Action

The Steering Committee must determine its capacity and expertise to conduct a community source water assessment or a regional source water assessment. Factors determining community capacity can include financial resources, technical knowledge and human resources, and legal and jurisdictional access.

2.4.1 Community Source Water Assessment

i) Community water system inventory

A community water system inventory should include an inventory of land use that occurs in your community boundary. The boundaries of any community land use inventory area will need to be determined and mapped by the Steering Committee. This is a critical first step and may require additional expertise outside the Steering Committee. This could include Elders, band members, local residents, non-government specialists, local knowledge holders, government, industry and academics. The inventory includes physical and land use characteristics of the area under study. Maps from local or territorial government sources will be necessary. Map sources include the GNWT Department of Municipal and Community Affairs (MACA), an Atlas and Google maps. Once a community boundary is determined, an inventory of existing and potential sources of contaminants, both natural and human, can be completed and shown on the map. The purpose of the inventory is to: ensure all land uses, activities or natural processes that could degrade water quality are identified; estimate the extent of the resulting contaminants; and rank the sources in terms of their priority for control. Local and traditional knowledge will be an important source of information.

As a general rule, it will be important to determine the exact location of the water system intake(s). Community land uses, activities and natural conditions posing potential risk to the public water system should be inventoried and mapped. These land uses and activities can include: road networks; stream crossings; oil and gasoline usage; fuel "cache" storage for hunting and exploration; local landfill; residential heating fuel storage; commercial and industrial fuel transportation and storage; sewage lagoon; industrial wastes; natural streamside erosion; and airborne contaminants. The land use activity of concern should be noted, along with its location and community concern ranking (Table 3).

Table 3: Community Land Use Inventory of Potential Contaminants (example only)

Land Use/Activity/ Natural Condition	Location of Activity	Community Concern
Natural streambank erosion	Upstream of intake	High
Landfill seepage	Downstream of intake	Medium
Oil and gasoline uses	>600 metres from intake	High
Road network, stream crossings	Upstream of intake	High
Recreation: ATV, boats, snowmobile	Lakes and streams	High
Spring thaw	Source water lake	Medium
Etc.	Etc.	Etc.

The inventory should make some assessment of the type and extent or intensity of future land uses and activities posing a threat to water quality. Updating land uses and activities for the inventory could take place every five to ten years depending on the level of development intensity in the community/region.

ii) Community risk assessment

The purpose of the community risk assessment is to interpret the land use inventory data to estimate the different types and amounts of contaminants entering the water supply source (Table 4). The water system inventory and risk assessment should also be used to identify and estimate the water quality impacts of natural sources (see Table 1: Sources of Contaminants). This estimate should further be refined through on-site assessment and/or water quality monitoring.

Table 4: Community Land Use and Pollutant Analysis Matrix (example only)

Land Use	Turbidity	pH	Nitrogen Phosphate	Viruses	Bacteria	THM Precursors	Heavy Metals	Iron, Mangan
Recreation				X	X			
Landfill		X	X		X		X	X
Roads	X	X	X			X		X
Bulk fuel storage, transport						X	X	X
Oil and gas uses							X	X
Sewage lagoons	X	X	X	X	X	X	X	X
Household septic		X	X	X	X	X		
Household fuel storage, transport								

Source: Modified from Triton 2006

Table 5 is intended to provide a community "snap shot" of existing conditions and protection measures being undertaken for the water system. The objective is to provide a list of potential protection measures to help ensure safe access to drinking water. This list is not exclusive; other protection measures may be added. The presence, or absence, of factors listed in Table 4 will allow the Steering Committee to make more informed decisions respecting source protection and water system vulnerability. The public will also be better informed by this information.

Table 5: Protection Measures

Factors Considered	Yes/No	Comments
Does the water supplier control all activities in the source area?	No	Comments
Are source protection plans in place?		
Is watershed use limited, regulated and designated to certain areas only?		
Is there a backup water intake in place?		
Is there a backup source available?		
Are water users in the community aware of the impact of human activity on source water quality and quantity?		
Is the raw water source monitored?		
Does the intake ensure the best quality source water is captured?		
Are contaminant sources present in the catchment area?		
Etc.		

2.4.2 Regional Source Water Assessment

i) Regional water system inventory

The Regional Source Water Assessment should include all items covered by the Community Source Water Assessment, plus additional information specific to the larger watershed region (Table 6). The additional information may include land tenure, land use and bio-physical aspects mapped and defining the source area as best as possible. The land ownership and land use regime as well as local climate, soils, bedrock, hydrogeology studies and area hydrology will provide useful technical information in the plan development phase.

Table 6: Regional Land Use Inventory of Potential Contaminants (example only)

Land Use/Activity/ Natural Condition	Location of Activity	Community Concern
Natural streambank erosion	Upstream of intake	Medium
Industrial discharge (Oil sands, AB)	Upstream of intake	High
Forest fires	Throughout watershed area	Medium
Oil and gas uses	Throughout watershed	High
River crossings by roads	Upstream of community	High
Fuel (oil and gas) cache storage	Throughout watershed area	High
Etc.	Etc.	Etc.

The inventory should make some assessment on the type and extent or intensity of future land uses and activities posing a threat to water quality. Land uses and activities for the inventory should be updated every five to ten years depending on the level of development intensity in the community/region.

ii) Regional risk assessment

The purpose of the risk assessment is to interpret the inventory data to estimate the different types and amounts of contaminants entering the water supply source. The inventory and risk assessment should be used to identify and estimate the water quality impacts from natural sources (see Table 1: Sources of Contaminants). The initial risk assessment from human-related sources may be taken from Table 7 below. This estimate should be refined through on-site assessment. It may be necessary to employ experienced personnel (environmental engineer/toxicologist) for on-site assessments to confirm presence/absence of contaminants listed in Table 7. Grab samples and lab testing may be required.

Table 7: Regional Land Use and Pollutant Analysis Matrix (example only)

Land Use	Turbidity	pH	Nitrogen Phosphate	Viruses	Bacteria	THM Precursors	Heavy Metals	Iron, Mangan
Recreation				X	X			
Landfill		X	X		X		X	X
Roads	X	X				X		X
Mining	X	X					X	X
Oil and gas uses		X					X	X
Industrial discharge	X	X	X		X	X	X	X
Sewage lagoons	X	X	X	X	X	X	X	X
Bulk fuel storage, transport		X					X	X
Oil sands		X					X	X

Source: Modified from Triton 2006

2.5 Community or Regional Risk Assessment

The following table is intended to provide the Steering Committee with a practical means of itemizing contaminants based on a community or a regional source water assessment. Table 8 provides information related to jurisdiction, proximity of contaminant to water intake, name of contaminant and transport mechanism.

Table 8: Community or Regional Contaminant Source Inventory (example only)

Hazard #	Contaminant Source	Owner/ Jurisdiction	Distance to Source	Contaminants of Concern	Transport Mechanism
POINT SOURCE					
1	Bulk fuel storage	Town A	X metres west of intake	Metals, gases, pathogens, nutrients	Runoff groundwater
2	Sewage lagoon overflow	Town B	X kilometres north of intake	Nutrients, pathogens, ecoli, pharmaceuticals	Overland flow
3	Road crossings	Land claim	Varying	Sediment, organics	Runoff
NON-POINT SOURCE					
1	Recreation	Crown	Varying	Sediment, ecoli	Runoff
2	Mining	Land claim	Varying	Sediment, metals	Runoff
3	Etc.				
NATURAL FACTORS					
1	Streambank erosion	Crown	50 metres	Sediment, turbidity	Runoff

iii) Potential risks

The potential risk associated with each identified hazard can be qualitatively characterized as the likelihood of occurrence multiplied by the consequence if the hazard occurred (WHO, 2004). This means it is necessary to determine the likelihood and consequence of each hazard before characterizing the risk as high, moderate or low.

Table 9 shows the rankings (high, possible, unlikely) and associated criteria used to determine the likelihood of a hazard based on a fixed likelihood descriptor. The likelihood descriptor for the purposes of this SWAP program is the probability of a hazard occurring in the next ten-year period. For example, the Steering Committee has identified outdoor recreation (boating and ATV activity) as a potential contaminant source (Table 3) to a community water supply. As a result, the Steering Committee determines that this activity presents a "high" (>70% chance) likelihood of becoming a hazard in the next ten years. Conversely, the Steering Committee has determined that the likelihood of streambank erosion becoming a hazard is "unlikely" (<30% chance).

Table 9: Likelihood Determination

Likelihood Descriptor	Likelihood		
	High	Possible	Unlikely
Likelihood of hazard to occur in next 10 years (probability of occurrence)	Probably will occur (>70% chance)	Possible to occur (30-70% chance)	Could occur at some time (<30% chance)

Source: Adapted from Triton (2006)

Table 10 shows the rankings (high, moderate, low) and the criteria for each consequence descriptor. The consequence of a hazard was defined as high if at least one of the four descriptors was ranked as high. If no descriptors were ranked as high and at least one was ranked as moderate, the consequence was defined as moderate. If all descriptors were ranked as low, the consequence was defined as low.

Table 10: Consequence Determination

Hazard	Consequence Descriptors	High	Moderate	Low
1	Is the contaminant linked to health concerns?	Yes	Indirect	No
2	What is significance of potential health effects?	Serious	Limited	No effect
3	What is effect on aesthetic quality of drinking water?	High	Moderate	Low
4	Could the hazard compromise water quality?	Yes	-	No

Source: Adapted from Triton (2006)

Table 11 provides the actual risk level of a particular hazard using a qualitative risk analysis matrix based on the likelihood determination and the consequence descriptors. The risk level of any potential hazard will be determined to fall within a range of very high to low depending on the likelihood ranking and the consequence descriptor ranking.

Table 11: Qualitative Risk Analysis Matrix

Likelihood	Consequence Descriptors		
	High	Moderate	Low
	RISK LEVEL		
Likely	Very high	High	Moderate
Possible	High	Moderate	Low
Unlikely	Moderate	Low	Low

iv) Vulnerability assessment

The potential risk associated with each identified hazard can be qualitatively characterized as the likelihood of hazard occurrence (Table 9) multiplied by the consequence of the hazard (Table 10). The risk level is then indicated based on the rankings provided in Table 11 ranging from very high to low. The risk level for specific drinking water hazards are shown in Table 12.

Table 12: Risk Characterization (examples only)

Hazard #	Drinking Water Hazard	Likelihood Level	Consequence Level	RISK LEVEL (Likelihood x Consequence)
1	High precip.	Likely	High	Very high
2	Sewage lagoon	Possible	High	High
3	Landfill	Possible	Moderate	Moderate
4	Recreation	Likely	Low	Moderate

STAGE 3: Source Water Protection Plan

Upon completion of the Source Water Assessment Report (Stage 2), development of the Source Water Protection Plan (SWPP) may begin. The Steering Committee will take the lead in developing the SWPP. Like any land use plan, this SWPP should be thought of as a living document, something that evolves and changes over time as new knowledge and information becomes accessible and as new concern surface.

3.1 Goal

Establishing program goals and objectives will help to clarify direction for the plan. The goals and objectives should be designed to match the challenges identified in Stage 2, namely the watershed characterization and contaminant source inventory indicated by the land use and pollutant analysis matrix (Tables 4 and 7). The primary goal of a watershed protection plan should be to provide an adequate supply of high quality water for current and future generations. Specific objectives will vary between different watersheds and the particular priorities of communities as identified by the efforts of the Steering Committee.

> Local commitment and political support for source protection is critical to the success of watershed management plans.

3.2 Objectives

Examples of types of objectives include:

i) Identify existing and recommended source protection management actions.
ii) Use traditional and local knowledge, when appropriate, to form management actions.
iii) Make use of existing science-based monitoring data and programs to form management actions.

3.3 Management Actions

The source water assessment summary itemizes the identified hazard, risk level, existing measures taken to address the hazard, and recommended action (Table 13). Watershed management actions will need to be established with careful consideration of natural and human impact risks identified. Table 13 introduces land and water management actions to help address the hazards prioritized based on risk levels determined in Table 12. Existing measures may also be listed in this table as a means of providing a history of management actions.

Table 13: Source Protection Management Actions (examples only)

Hazard #	Drinking Water Hazard	RISK LEVEL	Existing Measures	Recommended Actions
1	Spring thaw, break-up	Very high	- Rehabilitation of existing sediment sources	- New rehab measures - Bank stabilization
2	Sewage lagoon	High	- Maintenance - Monitoring	- Identify future lagoon location - Source funding
3	Landfill	Moderate	- Waste separation	- Monitor - Increase waste separation - Install security gate
4	Recreation	Moderate	- Some signage	- Improve signage - Public education
Etc.				

3.4 Watershed Management Measures

Specific watershed management measures should be designed to match potential contaminant challenges identified in Stage 2. These measures are watershed specific and will vary between different watersheds. Land use practices and regulations, education activities and structural controls recommended by the Steering Committee will form the building blocks for the SWPP.

Structural and non-structural control measures implemented by water utilities, other agencies, or a combination of agencies, in a watershed make up the building blocks of a watershed protection program. A list of structural and non-structural control measures is provided in Table 14.

Table 14: Structural and Non-structural Measures (examples only)

Structural	Non-structural
Stormwater collection and treatment	Land use planning
Sewage lagoon restoration	Vegetation buffer
Intake pipe repair	Signage
Road culverts	Education
Landfill relocation	Enforcement, inspection

3.4.1 Structural Controls

Structural controls are comprised of infrastructure (pipes, pumps, constructed retention ponds) or a fixed land alteration (retention walls, stream bank restoration). Examples include:

i) Road/stream crossings

- Inspections
- Road repair
- Culvert replacement or repair

ii) Landfill

- Landfill relocation
- Waste separation at landfill
- More permanent containment of materials

iii) Lagoon

- Repair outlet, relocation of lagoon
- Installation of pumps, repairs

iv) Fuel storage

- Replacement of aging tanks
- Relocation of bulk fuel depot away from source water

3.4.2 Non-structural Controls

Non-structural controls do not require infrastructure or land alteration. This could include education programs, regulations and enforcement, signage and/or water stewardship workshops. Implementation of these protection measures is determined in part by availability of funding, legal jurisdiction, and priority in SWPP. Examples include:

i) Buffer zone protection

> "The most sensitive portions of water supply watersheds are the areas immediately adjacent to streams and reservoirs."
> - AWWA, 1991

Development activity within and adjacent to watercourses can degrade water quality by increasing the availability and transport of pollutants. Retaining vegetation along watercourses is one of the most effective, and least costly, practices used to protect water supplies. These vegetation protection areas are commonly called *buffer zones, riparian zones or set-back areas*. Buffer zones may have a *fixed-width buffer* or a *variable-width buffer*.

ii) Land acquisition

Land ownership by a water utility or municipality has shown to be an effective way to protect water supplies. Land acquisition may become effective in instances where regulatory controls imposed by the water operator are not possible or when voluntary measures by the land owner are not practiced. Through land acquisition by the water operator (municipality, water board, community, etc.) the jurisdiction over a watershed, or portion thereof, will enable self-imposed regulations for the purpose of source protection. Land prices may be prohibitive and there may be political opposition to the fee simple purchase of privately held land. To help plan for future land purchases, local government and water operators may create a special fund for such purposes.

A conservation easement over sensitive watershed areas may be possible where land is sold to the water operator (municipality) at a reduced cost in exchange for special development rights going to the seller. In land claim areas of the NWT, greater control over land use is possible by the group holding land title. Restrictive covenants may also be registered on sensitive lands by the local government at the time of private land development (subdivision or building permit) to protect habitat and water quality.

iii) Signage

Signs can be used in watershed areas to convey regulatory requirements or simply to advise the public of the need to respect water supplies. Signage may advise the public against unauthorized trespass over private lands held by the water operator. In other instances, signage may be an educational instrument reminding the public of sensitive streamside habitat or the presence of a public water reservoir.

iv) Public education

Citizens are often not aware of watershed boundaries, water system operations and watershed protection programs. Without awareness, the public likely will not know that certain actions they take may be negatively impacting their own water quality. As a result, public education has become an important component of source protection planning. Public education can include: access to the Source Water Protection Plan (SWPP) online; newsletters; water-related information, including water service area maps and in-school programs on watershed protection; mail-out material on source protection; practical information on residential best management practices, such as the proper disposal of paints, cleaners, household hazardous waste, crankcase oil, solid and liquid waste disposal and pharmaceutical products; and fuel storage.

> Public education and community involvement activities can play a valuable role in a watershed protection program.

v) Watershed inspections

Routine inspections to identify sources of contaminants both in the immediate community and in the wider watershed area are critical to water quality. Watershed inspections may be done by members of the SWPP Steering Committee or members of the community. Local understanding of watershed characteristics such as natural processes and land use practices, will be an asset to those conducting watershed inspections. General recommendations for developing an effective watershed inspection program include:

- Develop and use a formal inspection checklist to help guide the program. Data entry should be standardized to build a long-term database.
- Identify and assign priorities for inspecting areas or activities that present the greatest risk to source water.

- Establish good working relationships with landowners, water boards, local government, territorial agencies, industry, etc.
- Solicit volunteers from the community to conduct inspections, become long-term stewards of the watershed, and be willing to report unauthorized access and violators.

iv) Density restrictions

Figure 3: Cluster Development

Density restrictions are often used as a type of land use control to protect watersheds. Density may be used to limit the size and number of land parcels in a particular area; or to limit the number of dwelling units in a particular area (see Figure 3). Emphasis on low density rural land use (large land parcels) is common in un-sewered areas. Minimum land parcel sizes of five acres (two hectares) are common in un-sewered areas with onsite sewage disposal. In the NWT, sewage lagoons operating as community sewage systems will enable smaller parcel sizes, thereby supporting a more dense form of settlement. A more dense settlement pattern (one acre or smaller) can help protect rural lands from unwanted sprawl, land clearing and road development. Cluster development, or multiple buildings on a single parcel of land, is another means of densifying land use. This practice may be a more efficient use of land and protect vegetation on adjacent lands. The concept of increasing density to protect watersheds may run counter to popular understanding of rural livelihoods and lifestyle.

v) Prohibited land uses

Certain land uses in a watershed pose a potential for contamination to water quality. For example, sewage lagoons or landfills tend to concentrate hazardous materials, posing a serious threat to surface and groundwater quality. Industrial development may also pose a threat to water quality. Point source discharge from an industrial or commercial operation may harm water quality. Land use zoning to prohibit certain land use activities, or to restrict the size or location of an operation, are options open to local government. Site development restrictions, such as the requirement for retention of vegetation buffer strips, may also be applied. The creation of impervious land area may contribute unwanted pollutants to a water source. The development of parking areas and removal of vegetation cover will increase overland peak flows, providing a major source of pollutants in stormwater runoff.

vi) Monitoring program

A source protection monitoring program is necessary to gauge the effectiveness of the source protection measures put in place to address concerns identified in the SWPP. Without long-term monitoring of the source protection measures it will be impossible to quantify any positive or negative changes in the area. A monitoring program must determine appropriate monitoring criteria to be used in the program. How the information collected is reported and who is responsible for taking necessary action must be clearly identified.

STAGE 4: Plan Implementation

Plan implementation is when policies described in the plan are put into action. Implementation means include: legal and institutional arrangements; public education; and financial programs.

4.1 Goal

The goal of plan implementation is to bring action to the recommendations in the SWPP. In a land use planning document there will be numerous programs and activities identified requiring action. The Steering Committee must prioritize the most pressing programs and activities for implementation. Cost restrictions, political will and availability of resources are all factors that may influence the choice of implementation priorities. Strategies to help implement SWP plans are identified below (see Required Action).

4.2 Objectives

i) Prioritize recommended actions from the plan.
ii) Set timelines for recommended actions in the plan.
iii) Identify funding sources, partners.

4.3 Required Action (examples only)

Often a mix of implementation strategies is required to implement any plan.

Table 15: Implementation Strategy (example only)

Hazard #	Drinking Water Hazard	RISK LEVEL	Recommended Actions	Implementation Strategy
1	Spring thaw	Very high	- New rehab measures - Bank stabilization	Liaison with relevant gov't agencies
2	Landfill	Very high	- Begin separation of wastes	Hire consultant
3	Stream crossing by roads	Very high	- Inventory crossing	Liaison with other agencies
Etc.				

4.3.1 Legal and Institutional Arrangements

Legal actions include development of zoning bylaws, building bylaws, subdivision regulations, and enforcement of territorial licenses and other legal instruments. Institutional arrangements include agreements between land owners, inter-jurisdictional arrangements and commitments from individuals and organizations to protect source waters. In the case of a local, community-based SWPP, the local jurisdiction holds many decision-making powers around land use controls. Local government, in consultation with territorial agencies, water boards and the community-at-large, is encouraged to become active in setting land use controls and regulations.

In the case of a larger, watershed-based SWPP, the local jurisdiction and water operator likely does not have jurisdiction over the entire source water area. In this case, the local jurisdiction will have very little, if any, legal powers. Institutional arrangements will become important to support land use agreements, partnerships and other voluntary activities to protect source water.

4.3.2 Public Education

> "Public education and voluntary action are important components of watershed protection programs."
> – AWWA, 1991

Public education is critical to successful plan implementation. The public, including land owners, need to understand the objectives of the watershed protection program, the benefits to the community and ways to contribute to the success of the plan. Public education is best achieved early in the planning process (in Stage 2). In this way, community members are more likely to take ownership of the plan during its formative stages. Conversely, the public may react negatively if they are excluded from the planning process (especially Stages 2 and 3). In many cases, public education may be the strongest tool available to local jurisdictions intent on developing a SWPP. Media attention to the plan-making process, the goals and objectives of the plan and the implementation strategy will further engage public support for watershed protection efforts.

4.3.3 Financial Programs

The cost associated with watershed management planning should be shared across multiple levels. This strategy draws more stakeholders into the process as well as lessens the burden of cost. Revenue to support a SWAP program should be sought from a wide range of sources. These sources may include:

- Grants to community-based, non-government organizations. Grants are competitive, often in high demand. Advantages are that this is new monies, repayment not required. *RBC Blue Water Project* is one such organization. Viewable at http://bluewater.rbc.com/
- Property Tax can be source of revenue. This may be politically unfavoured and not all contributors benefit directly. Advantage is ease to administer.
- Land development fees
- Watershed improvement district
- Potable water use fees
- Recreation fees
- Water license fees
- Fuel tax

Table 16: Implementation Timeline (example only)

Hazard #	Drinking Water Hazard	RISK LEVEL	Recommended Actions	Implementation Strategy	Timeline	Funding/ Partners
1	Spring thaw	Very high	- New rehab measures - Bank stabilization	Liaison with relevant gov't agencies	Next 12 months	GNWT
2	Landfill	Very high	- Begin separation of wastes	Hire consultant	Next 5 years	AANDC EC
3	Stream crossing by roads	Very high	- Inventory crossing	Liaison with other agencies	Next 12 months	GNWT
Etc.						

4.3.4 Emergency Response Action Plan

In the event of contamination of a water supply with potential to affect human or ecosystem health (eg. fuel spill, forest fire, land slippage), the public, Aboriginal officials, GNWT, the local government, and local media must be notified. The Steering Committee must develop an Emergency Response Action Plan (ERAP) with a full list of names and contact information. These contacts will include water treatment operators, mayor's office, public health officials, Administrative Officer, Circuit Rider, Medical Health Office and the NWT Spill Report Line. The ERAP will outline the steps to efficiently notify the public of a water contamination event and safety steps to be followed (boil water, do not consume, etc.). Appropriate levels of action will be determined by officials acting in authority. Each SWPP should identify a lead person, and an alternate, to take the lead in reporting a water contamination event.

STAGE 5: Review SWAP Program

5.1 Goal

The goal of the SWAP review is to assess implementation progress and ensure any new issues and concerns are captured in the SWAP program.

5.2 Objectives

i) Assess and report the rate of implementation progress (Table 15) in the current SWPP.
ii) Review issues and concerns either at the community scale or the watershed scale.
iii) Determine the need for full SWAP program review.

5.3 Required Action

The SWAP program review should occur on a five year interval, beginning with the establishment of a Steering Committee (Stage 1). Stage 2 should produce a revised Source Water Assessment Report; based on the revised assessment, an updated SWPP may be developed to address any new developments or problems in the SWPP area.

The intention of the SWAP program review is to ensure: the SWPP is addressing the main risk priorities identified in the initial assessment; the source protection measures are appropriately matched to the main risks; and to make note of results of the source protection measures, both positive and negative.

Based on this review, the Steering Committee will make the necessary changes to the existing SWPP in consultation with the community and broad stakeholder interests. Local and traditional knowledge will be an important source of information.

Photo Credit: Mike Vassal

CONCLUSION

The aim of this program is to assist NWT communities in the development of source water protection plans. Source water protection planning in the NWT is voluntary. The SWAP program is based on a five stage process beginning with the formation of a Steering Committee followed by a source water assessment report, development of a source protection plan, a strategy for plan implementation and, lastly, a review process of the SWAP program.

The development of source water protection plans will require participation of Aboriginal governments and organizations, environmental groups, local and regional associations, and various levels of agencies. Industry is another important stakeholder. Local and traditional knowledge will be an important source of information.

The SWAP program recognizes all watersheds and water supply systems are unique. Similarly, the Steering Committee structure will also be different across the SWAP program. In some instances, Aboriginal leadership may guide a SWAP program. In other instances, a local government council or community group may guide a SWAP program.

The intention of this SWAP program is to be flexible and adaptive to local and regional political structures and source water concerns.

Photo Credit: Jennifer Skelton

ABBREVIATIONS AND ACRONYMS

AANDC – Aboriginal Affairs and Northern Development Canada (formerly INAC)

CCME – Canadian Council of Ministers of the Environment

ENGO – Environmental Non-government Organization

ERAP – Emergency Response Action Plan

GNWT – Government of the Northwest Territories

NGO – Non-government Organization

NWT – Northwest Territories

SWAP – Source Water Assessment and Protection

SWP – Source Water Protection

SWPP – Source Water Protection Program

Aklavik Water Treatment Plant

March 2011

DEFINITIONS

Multi-barrier Approach – As applied to water resource management, a system of redundancies to protect against potable water contamination. These redundancies include source water protection, water treatment, distribution system maintenance, monitoring and an emergency response system.

Non-point source – A source of pollution that originates from distributed sources such as airborne contaminants.

Point Source – A localized or stationary source of pollution, such as a sewage outfall.

Source Water – The origin, or source, of a potable water supply such as groundwater, or surface water including a stream, river, lake or other water body.

Source Water Protection – The practice of managing land uses and water activities for the protection against contamination of the aquatic environment and potable water supplier.

Watershed – An area or region drained by a river, river system or other body of water.

NOTE: This document is intended to assist with source water protection planning at the community and regional level in the Northwest Territories.

Photo Credit: Maik Tondeur-Zetzmann

REFERENCES

AWWA (American Water Works Association). 1991. Effective Watershed Management for Surface Water Supplies. Robbins, Richard W.; Glicker, Joseph L.; Bloem, Douglas M.; Niss, Bruce M.

British Columbia Ministry of Environment, Lands and Parks (MELP). 1999. Ambient Water Quality Guidelines for Organic Carbon. Overview Report prepared for the Water Management Branch. Updated August 7, 2001.

Canadian Council of Ministers of the Environment. 2004. Source to Tap. The multi-barrier approach to safe drinking water. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water.

Environment Canada. Groundwater. Available at: http://ec.gc.ca/eau-water/default.asp?lang=En&n=300688DC-1#sub5 [Last accessed January 27, 2012]

Health Canada. 2003. Guidelines for Canadian Drinking Water Quality: Supporting Documentation – Turbidity. Water Quality and Health Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

National Health and Medical Research Council (NHMRC). 2003. Australian Drinking Water Guidelines.

Nova Scotia Environment and Labour. 2002. Developing a Source Water protection Plan: A guide for water utilities and municipalities.

Nova Scotia Environment. 2009. Developing a Municipal Source Water Protection Plan. Step 2; Step 3.

Royal Bank of Canada Blue Water Project. Viewable at: http://bluewater.rbc.com/ [Accessed July 15, 2011]

Triton Environmental Consultants Limited. 2006. Chapman Creek Watershed Drinking Water Source Assessment. Prepared for the Sunshine Coast Regional District, BC, Canada. Available at: http://www.scrd.ca/Reports [Accessed October 11, 2011]

World Health Organization (WHO). 2004. Guidelines for drinking water quality, Third Edition.