



PRAIRIE WATER QUALITY PROBLEMS

December 1997

SWQI INITIATIVE

The *Surface Water Quality Initiative (SWQI)* was funded by the Canada-Saskatchewan Agriculture Green Plan Agreement (CSAGPA). Its purpose was to seek affordable and dependable solutions to surface water quality problems encountered on Prairie farms. This **Water Quality Matters** publication summarizes this research. This fact sheet provides background material for the other sheets in the series. It outlines the water quality issues prevalent on Prairie farms but is not meant to be a comprehensive description of all water quality issues.

- livestock watering, and,
- farm production activities such as mixing chemicals for field application.

The SWQI focused on surface water supplies, specifically dugouts, which are small on-farm reservoirs, for several reasons:

- surface water supplies usually experience poorer water quality than ground water supplies;
- dugouts are plentiful across the Prairies and pose many water quality management problems;
- dugouts are easy to isolate and study in the field, which makes them good field laboratories; and
- water quality solutions for dugouts or for water drawn from dugouts are applicable to other surface water sources and with some modification are also relevant for some ground water sources.



A typical Prairie farm

Farms either draw water from a surface water source such as a river, lake or reservoir, or pump water from a shallow or deep ground water source. Water is required on farms for:

- domestic purposes, including
 - potable water for drinking and cooking, and
 - non-potable water for bathing, washing and toilets,



A dugout is a common water supply for many farms



TYPICAL WATER QUALITY PROBLEMS FOR FARM USE

High quality drinking water can be achieved only when the water is free from microbiological, chemical and physical problems. Water that is aesthetically pleasing for washing and bathing must also meet certain standards for parameters such as odour, clarity, colour and hardness. Water quality problems can be generated by both natural and man-made causes.

MICROBIOLOGICAL PROBLEMS

Typical microbiological problems common to surface and ground water supplies include bacteria and viruses, although their occurrence is usually higher in surface water. Protozoa in water, such as parasites, can also pose problems. Parasites are transferred to water supplies by warm-blooded animals through human or animal wastes. Common parasites include *Giardia* (which may cause giardiasis, often referred to as "Beaver Fever") and *Cryptosporidium*.

The presence of microbiological contaminants in water can cause negative health impacts for humans and animals consuming polluted water. They include diarrhoea, gastro-intestinal problems and other illnesses. Animals may also experience reduced weight gain.

Water from surface water supplies MUST be treated and disinfected to achieve safe drinking water which is free of microbiological contamination. Common forms of disinfection include:

- chlorination,
- ozonation, and
- ultraviolet (UV) light disinfection.

CHEMICAL PROBLEMS

Chemical problems with water quality occur when the concentrations of certain natural or man-made chemicals are elevated. Some chemicals occur naturally, including iron, manganese, sulphate, calcium and magnesium (hardness), arsenic, nitrates, sodium, uranium, hydrocarbons and phosphorus. Some chemicals are man-made including waste products, gasoline, oil or pesticides which may enter into a water supply from human activities. These products can create serious water quality problems if they are mishandled, spilled,

improperly stored, discarded or, in the case of pesticides or fertilizers, over-applied.

Chemicals can cause various problems, ranging from human and animal health issues to aesthetic concerns. Chemical problems are unique to each parameter and its concentration. Some potential problems are described below.

- Ingesting arsenic can cause skin and nervous system problems in humans.
- Ingesting nitrates can cause blue-baby syndrome in infants and can affect animal health.
- Plant nutrients including phosphate and nitrate can cause algae problems in water supplies.
- Chemicals such as iron and manganese at high enough concentrations may create aesthetic problems such as staining of fixtures and clothes, or taste and odour problems in water supplies.
- Some chemicals may negatively affect animal weight gain or affect human health.
- Calcium and magnesium (hardness) can cause scaling of appliances and fixtures.

Chemical problems in water require very specific treatment processes, often custom-designed, to address the issue. In the case of man-made chemicals, the best policy is to protect the source water quality by limiting the potential for pollution caused by human activities.

PHYSICAL AND ORGANIC PROBLEMS

Physical and organic problems in water are the result of dissolved or particulate matter that causes chemical and/or physical problems, including unacceptable taste, odour and colour. Typical problems include:

- high turbidity, caused by inorganic particles like sand and silt and living and dead organic matter (including algae, plants and other organisms),
- toxins such as those produced by blue-green algae (cyanobacteria),
- increased dissolved organic carbon (DOC),
- taste and odour problems from algae and organisms, and
- highly coloured water that is aesthetically unpleasant, or that stains clothing and fixtures.
- difficult to safely disinfect the water (Trihalomethanes - THMs)

High levels of organic matter in water cause problems that may affect the performance of water treatment systems and may compromise disinfection processes, negatively affecting the quality of the final water product.

Turbidity

For treated drinking water, turbidity must be kept below 1.0 NTU (nephelometric turbidity units) to ensure water safety for human consumption is not compromised. Ideally, turbidity of drinking water should be less than 0.1 NTU. Levels higher than this may allow particles to 'shield' or 'clump' around the microbiological contamination, preventing the disinfectant chemical, such as chlorine, from reaching and destroying the bacteria, viruses or parasites. Therefore, in turbid water, even though large amounts of chlorine may be added, and even though residual levels of chlorine may be detected, the water can not be assumed to be safe to drink. Only good quality water can be safely disinfected for human drinking water.

Fortunately, in a well designed and maintained treatment system, turbidity caused by high levels of inorganic suspended sediment or particulate organic matter such as algae can usually be reduced by filtering, if the particles are large enough.

Algae

Another potential problem associated with increased levels of nutrients in water is the growth of algae. The presence of algae is indicated by the concentration of chlorophyll *a* in the water. Green algae can break through treatment systems, causing taste and odour problems. Blue-green algae (cyanobacteria) can produce lethal toxins. When humans or animals consume water containing these toxins, they can become sick; animal deaths have occurred after consuming blue-green algal toxins.

Water from a dugout that has experienced a blue-green algae bloom and subsequent collapse (die-off) should not be consumed by humans or animals for at least two weeks following the collapse, since the dead algae could potentially release large doses of toxins. When blue-green algae are present, it is especially important that the treatment system be well designed, operated and maintained in order to supply safe drinking water. Blue-green algae in a dugout can be limited by reducing the

nutrients present in the water, through watershed or reservoir management techniques (see the **Water Quality Matters** publication "Protecting Your Water").



Algae blooms are common, and can cause serious water quality problems as shown here

Trihalomethanes (THMs)

Dissolved organic carbon will react with the chlorine that is added for disinfection purposes to form 'disinfection by-products' such as trihalomethanes (THMs). High THM levels in water consumed over a long period of time can increase the risk of acquiring cancer. The *Guidelines for Canadian Drinking Water Quality* recommend a THM level below 100 µg/L, to minimize the carcinogenic risk in drinking water.

Therefore, it is important to minimize the formation of THMs in drinking water. Although this could be accomplished by limiting the amount of chlorine used to disinfect water, it would result in an increased risk of illness from microbial contamination. Therefore, an effective way to minimize the formation of THMs is to reduce the concentrations of DOC in the water *BEFORE* it is disinfected. DOC can be reduced by membranes or carbon filters (e.g. reducing chlorine dosage below recommended levels).

Reducing the formation of THMs should never be done to the extent of compromising safe disinfection.

TYPICAL PRAIRIE DUGOUT WATER QUALITY PROBLEMS

Prairie dugouts experience several water quality problems, including:

- elevated levels of dissolved organic matter;
- the presence of micro-organisms including algae (both green and potentially toxic blue-green algae);
- elevated turbidity levels, which vary and are generally related to organic matter and the amount of sediment in runoff; and
- levels of dissolved organic carbon (DOC) in dugouts which are about five times higher than in most surface water supplies used by urban communities across North America.

The guideline for THMs states that the concentration should not exceed 100 µg/L. Currently no guideline exists for DOC levels. However, to achieve THM levels less than the guideline value of 100 µg/L, the water (before chlorine treatment) should have a DOC concentration below 5 mg/L. Table 1 shows the concentration of DOC in Prairie dugouts is significantly higher than in the water sources used by Regina and Saskatoon, and is well above the recommended level of 5 mg/L. The DOC of Prairie dugout water is much too high to be safely disinfected by chlorination without preliminary treatment. Special water treatment measures must be incorporated to deal with the problem.

TYPICAL PRAIRIE GROUND WATER QUALITY PROBLEMS

Common naturally-occurring problems in Prairie ground water include micro-biological contamination (such as sulphate-reducing bacteria or iron bacteria), dissolved organic carbon, and inorganic parameters such as iron, manganese, arsenic, sulphate, calcium and magnesium (hardness) and sodium. Other problems can occur such as parasites or man-made chemical contamination (usually caused by pollution from improper siting or maintenance of the well). In some areas, special problems may result from the presence of naturally-occurring hydrocarbons or uranium. Each of these problems requires special treatment considerations.

Shallow ground water supplies (25 m deep or less) may be susceptible to the same water quality problems as surface water supplies because the contaminants are not filtered out by the soil and in some cases, may accumulate over time (e.g. nitrates). Therefore, these shallow wells may experience water quality problems common to both surface and ground water supplies.

DRINKING WATER QUALITY GUIDELINES

The SWQI research focused on ways to provide high quality and aesthetically pleasing water for on-farm domestic uses. Potable (drinkable) water must meet

Table 1: DOC Concentrations in Various Prairie Water Sources

COMMUNITY	WATER SOURCE	DOC (mg/L)	MAXIMUM ACCEPTABLE DOC
Regina	Buffalo Pound Lake	6-8	5
Saskatoon	South Saskatchewan River	2-4	5
Rural Saskatchewan	Dugouts studied in SWQI	12.8	5

certain standards for health-related parameters, and should also be aesthetically pleasing with respect to taste, odour and colour. For other domestic uses, non-potable water must be of sufficient quality to ensure it does not negatively affect quality of life. For instance, water should not cause staining of fixtures or clothing.

Drinking water quality guidelines are stated as a goal for the *maximum* acceptable concentrations of certain parameters. Good quality drinking water therefore will have parameters in concentrations *less* than the guideline levels.

The SWQI project adopted Canadian Drinking Water Quality Guidelines where they existed, and established guidelines for DOC, phosphorus, and chlorophyll *a* which are not included in the national guidelines. The main parameters studied under the SWQI are presented in Table 2 along with the goals.

Table 2: SWQI Water Quality Goals

PARAMETER	SWQI GOAL
DOC	<5 mg/L
Colour	<15 TCU*
Turbidity	<1.0 NTU*
Phosphorus	<0.010 mg/L
Chlorophyll <i>a</i>	<0.010 mg/L
Iron	<0.3 mg/L*
Manganese	<0.050 mg/L*
Arsenic	<0.025 mg/L*
Coliform Bacteria	0 count per 100 mL*

Note: * guideline drawn from the Canadian Drinking Water Quality Guidelines

CONCLUSION

This issue describes some of the water quality problems experienced by on-farm users of Prairie water supplies and presents the guidelines used to judge good quality water. It provides the necessary background to the Surface Water Quality Initiative research conducted under the Canada-Saskatchewan Agriculture Green Plan Agreement. The other publications in the series **Water Quality Matters** deal with specific dugout and in-house water treatment methods that may provide solutions to rural Prairie water quality issues.

For further information on rural Prairie water quality and treatment technology:

- contact your local Prairie Farm Rehabilitation Administration office (PFRA is a branch of Agriculture and Agri-Food Canada);
- read the other publications in PFRA's **Water Quality Matters** series;
- get a copy of "Rural Prairie Water Quality: Searching for Solutions for On-farm Users" available from PFRA; or
- read Prairie Water News, available from PFRA, or on the Internet at www.quantumlynx.com/water

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FUNDING: This publication was funded in part by the Canada-Saskatchewan Agriculture Green Plan Agreement and the Canada-Saskatchewan Agri-Food Innovation Fund.

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