WQ-1341 (revised)

It's All In Your Water
2010 EDITION

Drinking Water Quality:
Testing and Interpreting Your Results

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Public water systems in North Dakota cooperate with the Department of Health to ensure compliance with safe water guidelines the Environmental Protection Agency's (EPA) Safe Drinking Water Act sets. These rules do not cover private wells, however, and the owner is responsible for testing, interpreting the results and making necessary changes to the system. Although the EPA cannot force private well owners to comply with the EPA guidelines, the agency's maximum contaminant levels will serve as a reference to provide you with safe drinking water. An unacceptable water sample may be based on bacterial analysis, chemical characteristics of the water (such as chlorides, iron and hardness) or physical characteristics (such as odor, taste and color).

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This publication will answer the following questions:

- What should your water be tested for?
- What samples do I need?
- Where do I have my water tested?
- How do I interpret my results?
- How do I correct my problem?

The following chart will give you a quick overview of acceptable levels for drinking water. A more detailed explanation is on pages 4-6 of this publication.

A Quick Look at Safe Levels in Drinking Water

Coliform bacteria	**No coliform bacteria is acceptable**
pH	6.5 – 8.5
Nitrates	< 10 mg/l as NO_3–N < 45 mg/l as NO_3
Total dissolved solids (TDS)	< 500 mg/l
Chloride	< 250 mg/l
Fluoride	0.7 – 1.2 mg/l
Calcium and magnesium	Calcium – limits not set by EPA Magnesium > 125 mg/l may show laxative effects
Iron and manganese	Iron < 0.3 mg/l Manganese < 0.05 mg/l
Sodium	< 100 mg/l
Sulfates	< 250 mg/l
Arsenic	< 10 ppb
Conductivity	0.4-0.85 micromoles per centimeter
Total hardness	< 270 mg/l
Turbidity	1 turbidity unit (TU). Note: > 5 TUs are detectable easily in a glass of water and usually objectionable for aesthetic reasons.
Potassium	No maximum limit has been set
Color	< 10 color units

< means less than
> means greater than

What Should My Water Be Tested For?

New wells or homes

- Bacteria
- Routine water analysis, including:
  - Conductivity
  - Magnesium
  - Manganese (total)
  - Sodium absorption ratio (SAR)
  - pH
  - Sodium
  - Nitrates
  - Total dissolved solids (TDS)
  - Calcium
  - Iron (total)
  - Hardness

Existing wells: Annual testing

- Each year, general indicators, including:
  - Bacteria, pH, nitrate and total dissolved solids
  - Any constituents that were at or near the drinking water standard in previous years

Existing wells: Every five years or if you notice a change in water quality

- Comprehensive water analysis
- Routine water analysis, plus:
  - Potassium
  - Alkalinity
  - Chloride
  - Fluoride
  - Sulfate

Note: Keep copies of ALL results so you can track changes in your water quality through time.

How Do I Collect a Sample?

To determine how to collect a sample, you need to know what type of analysis you will conduct.

Bacterial Analysis

A sterile container the laboratory provides is required for these tests. Check with the laboratory for sampling and timing instructions because samples must reach the lab within 36 hours. Do not to rinse containers because most contain preservatives.

Mineral or Chemical Analysis

A "raw" water sample is preferred. Bypass water treatment units, such as water softeners, reverse osmosis (RO) systems and iron removal systems, if possible. A second sample taken after the treatment equipment will enable you to see if your equipment is functioning as expected.

Give special attention to contaminants that have tested high in the past or when concerns arise from health issues. Use a clean plastic or glass container to collect a 1-quart sample. Containers previously used for bleach, soap or other substances will contaminate the water sample. Rinse the container three times with the water that will be tested. Laboratories recommend samples reach them within two weeks.

For more information:

U.S. Environmental Protection Agency,
Safe Drinking Water Act
www.epa.gov/safewater/sdwa/index.html

North Dakota State University
Water Quality Interpretive Tool
www.ndsu.edu/waterquality

North Dakota State Health Department
www.health.state.nd.us/WQ/

Where Do I Have My Water Tested?

A list of laboratories in North Dakota can be found on the last page of this publication, on the Internet at *www.ndsu.edu/waterquality*, at your local Extension office or at the North Dakota Department of Health at (701) 328-6140. To select a lab, consider convenience, services offered and quality.

Now That I Have the Results, What Do These Numbers Mean?

Figures 1 and 2 are examples of water analyses reports. The report will contain a list of contaminants tested and the measured concentration of each, and sometimes will highlight any problems.

The concentration is the amount of a given substance (weight) in a specific amount of water (volume). The most common concentration unit used is milligrams per liter (mg/l), which, in water, is approximately equal to one part per million (ppm).

Many compounds are measured in smaller concentrations, such as micrograms per liter or parts per billion (ppb). Some contaminants have units that are specific to the test and others are expressed as an index number and not in terms of concentration, and therefore have no units.

Analytical Laboratory Report

Client: Client Name
Project: Analytical Laboratory Services
Date Collected: 1/5/08
Sample Identification: Kitchen tap

Collected by: KM
Project Number: CL000001
Time Collected: 7:35 a.m.
Lab Number: 01000

Analysis	Results	Units
Total coliform bacteria	50	#/100ml
Nitrate-nitrogen	4.55	mg/l
pH	7.50	
Iron	0.55	mg/l
Hardness as CaCo3	280	mg/l
Sulfate-sulfur	32.0	mg/l
Chloride	25.4	mg/l
Specific conductance	344	umhos/cc

The test results indicate this water sample does not meet EPA drinking water standards.

The following notes apply to this sample:

The total coliform bacteria exceeded the acceptable level of no bacteria.
The iron level exceeded the limit of 0.3 mg/l.

Submitted by: _____ Laboratory Manager

Figure 1. Sample Analytical Laboratory Report

Your City Public Health Environmental Laboratory

John Doe
1234 West Drive
Great Town, ND 58000

Order Number: 03-659
Sample Number: 03-1230

Phone: 701-222-2222
Fax:

ReceiveDate: 9/11/2006
ReceiveTime: 9:30 AM

Owner: John Doe
Collection Site: North Well Crete Area
Collection Date: 9/10/2006
Collection Time: 2:30 PM

Collected by: John Doe
Source: Water

Analyte	Result	Analysis Date	Time	Analyst
Total Coliform	Absent	9/11/2006	1:45 PM	D. Johnson
E. coli	Absent	9/11/2006	1:45 PM	D. Johnson
Nitrate-Nitrate as N	<2.0 mg/L	9/11/2006	1:45 PM	D. Johnson

Interpretation of Results

A total coliform bacteria and E. coli bacteria result of "Absent" indicates that none of these bacterium were detected in the sample. The water may be considered safe for human consumption.

A total coliform bacteria result of "Present" indicates that bacteria was detected in the sample. This water should not be consumed until corrective action is taken. If you need instructions on ways to correct this problem, call (701) 222-2222.

The maximum contaminate level for Nitrate-Nitrite as N in drinking water, as determined by the E.P.A., is 10 mg/L (or parts per million (ppm)). Water with Nitrate-itrite as N less than 10 mg/L is considered safe for human consumption. I the level is higher than 10 mg/L, the water should not be consumed until corrective action is taken. If you need instructions on ways to correct this problem, call (701) 222-2222.

Figure 2. Sample Bacteriological Testing Report

Interpreting a Bacteriological Test

The laboratory commonly will report the bacteriological test as positive or negative (absent), indicating the presence or absence of coliform bacteria. A satisfactory (negative) rating would mean the water is safe for human consumption from a bacteriological standpoint.

Coliform bacteria are present in the intestinal tract of warm-blooded animals, including humans. While not a cause of disease by itself, its presence indicates probable contamination of the water supply and possible presence of disease organisms. This can lead to more serious problems for people with weakened immune systems, such as the very young, elderly or immuno-compromised individuals.

A positive test (or greater than 1 per 100 milliliters of water) suggests further testing is necessary to include fecal coliform or E. coli bacteria testing. If such bacteria are present, the test confirms sewage or animal waste is contaminating the water and shock chlorination should be performed. Refer to NDSU publication AE-1046 for more information on chlorination. Testing of this water should be repeated to confirm the effectiveness of this treatment.

Interpreting a Mineral Analysis

Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemicals present in natural waters are carbonates, bicarbonates and hydroxides. The bicarbonate ion is usually prevalent. However, the ratio of these ions is a function of pH, mineral composition, temperature and ionic strength. Water may have a low alkalinity rating but a relatively high pH or vice versa, so alkalinity alone is not of major importance as a measure of water quality.

Alkalinity is not considered detrimental to humans but generally is associated with high pH values, hardness and excess dissolved solids. High alkalinity waters also may have a distinctly flat, unpleasant taste. Treatment is an ion exchange via the addition of a tank media or reverse osmosis. This process is explained in NDSU publication AE-1047.

Arsenic

Arsenic is a semimetal element in the periodic table. It is odorless and tasteless. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices.

Studies have linked long-term exposure to arsenic in drinking water to cancer of the bladder, lungs, skin, kidney, nasal passages, liver and prostate. Noncancerous effects of ingesting arsenic include cardiovascular, pulmonary, immunological, neurological and endocrine (e.g., diabetes) effects. Short-term exposure to high doses of arsenic can cause other adverse health effects, but such effects are unlikely to occur from U.S. public water supplies that are in compliance with the existing arsenic standard of 10 ppb.

Treatment depends on the level of contamination. Typical recommendations include the addition of an anion filter or tank media. This process is explained in NDSU publication AE-1029.

Calcium and Magnesium

Calcium and magnesium are the main contributors to water hardness. When water is heated, calcium breaks down and precipitates out of the solution, forming scale. Maximum limits have not been established for calcium. Magnesium concentrations greater than 125 mg/l may have a laxative effect on some people. Treatment for calcium includes ion exchange through tank media and reverse osmosis. Magnesium levels can be controlled through distillation. This process is explained in NDSU publication AE-1032.

Chloride

High concentrations of chloride ions can cause water to have an objectionable salty taste and corrode hot-water plumbing systems. High-chloride waters have a laxative effect for some people. An upper limit of 250 mg/l has been set for chloride ions, although noticing the taste at this level is difficult and even higher concentrations do not appear to cause adverse health effects. An increase in the normal chloride content of water may indicate possible pollution from human sewage, animal manure or industrial wastes. Treatment includes reverse osmosis. This process is explained in NDSU publication AE-1047.

Color

Color may be indicative of dissolved organic material, inadequate treatment, high disinfectant demand and the potential for the production of excess amounts of disinfectant byproducts. Inorganic contaminants, such as metals, are also common causes of color. In general, the point of consumer complaint is variable in a range from 5 to 30 color units, though most people find color

objectionable in excess of 10 color units. Standards related to color: aluminum, color, copper, foaming agents, iron, manganese and total dissolved solids.

Conductivity

Conductivity is a measure of the conductance of an electric current in water. This is an easy measurement to make and relates closely to the total dissolved solids (mineral) content of water. The total dissolved solid is approximately 70 percent of the conductivity measured in microsiemens per centimeter. Maximum contaminant level (MCL) is 0.4 to 0.85 microsiemens per centimeter. Treatment with reverse osmosis is effective for drinking water purposes. This process is explained in NDSU publication AE-1047.

Fluoride

Concentrations of 0.7 to 1.2 mg/l fluoride will reduce the incidence of dental cavities. Low levels of fluoride are common in most groundwater. At concentrations of more than 1.5mg/l, fluorosis (mottling) of teeth may occur. This occurs only in developing teeth, before they push through the gums. Children under 9 should not drink water that has more than 2 mg/l of fluoride. Municipalities add fluoride to the water if it is not naturally occurring.

Unless specified, bottled water does not contain fluoride; therefore, fluoride must be supplemented if consumption of water is limited to this source. Treatment of excess amounts includes reverse osmosis, activated alumina filters, deionization and/or distillation. This process is explained in NDSU publications AE-1032 and AE-1047.

Iron and Manganese

Iron in concentrations greater than 0.3 mg/l and manganese in concentrations greater than 0.05 mg/l may cause brown and black stains on laundry, plumbing fixtures and sinks. A metallic taste also may be present and it may affect the taste of beverages made from the water. High concentrations of iron and manganese do not appear to present a health hazard. Treatment includes a water softener or iron filter for iron and reverse osmosis for manganese. This process is explained in NDSU publications AE-1031, AE-1030 and AE-1047.

Nitrates

Nitrate (NO_3) levels should not be higher than 10 mg/L if reported as nitrogen (N) or nitrate-nitrogen (NO_3-N) or higher than 45mg/l if reported as nitrate (NO_3). High nitrate levels may cause methemoglobanemia (infant cyanosis or "blue baby disease") in infants who drink water or formula made from water containing nitrate levels higher than recommended.

Adults can drink water with considerably higher concentrations than infants without adverse effects. Livestock water can contain up to 100 mg/l of nitrate-nitrogen, but young monogastric animals, such as swine, may be affected at nitrate levels of considerably less than 100 mg/l. Treatment of such water includes anionic ion exchange, reverse osmosis, distillation and/or deionization. These processes are explained in NDSU publications AE-1031, AE-1047 and AE-1032.

pH

pH is a measure of the hydrogen ion concentration in water. A pH of 7 is neutral. pH under 7 indicates acidity; higher than 7 indicates alkalinity. Drinking water with a pH between 6.5 and 8.5 generally is considered satisfactory. Acidic waters are corrosive to plumbing and faucets, particularly if the pH is below 6. Waters with a pH above 8.5 may have a bitter or sodalike taste. The pH of water can affect the treatment of water and should be considered if the water is used for field application of pesticides. Water with a pH of 7.0 to 8.5 requires more chlorine for the destruction of pathogens (disease organisms) than water that is slightly acidic. Treatment is a neutralizer filter.

Potassium

Potassium concentrations in water are generally very small. Although excessive amounts may have a laxative effect, public health authorities have not established a maximum limit. Potassium (chloride) is used as a replacement for salt in water softeners when dietary sodium intake is a health issue.

SAR

The sodium adsorption ratio (SAR) is a measure of the relative proportion of the concentration of sodium ions to calcium and magnesium ions in the water. Excess sodium in irrigation water in relation to calcium and magnesium levels, plus the impact of the total salt content, can affect soil structure adversely and reduce the infiltration rate and soil aeration. An SAR of less than 6 is appropriate for lawn and garden irrigation, 6 to 9 may cause some problems in clay and silt loam soils, and any result over 9 will create problems with many soil types.

Sodium

Sodium is a very active metal that does not occur naturally in a free state. It always is combined with other substances. In the human body, sodium helps maintain the water balance. Human intake of sodium mainly is influenced by the consumption of sodium as sodium chloride or table salt. The contribution of drinking water is normally small, compared with other sources.

The treatment for certain heart conditions, circulatory or kidney diseases or cirrhosis of the liver may include sodium restriction. Diets for these people should be designed with the sodium content of their drinking water taken into account.

The National Academy of Sciences has suggested a standard for public water allowing no more than 100 mg/l of sodium. This would ensure that the water supply adds no more than 10 percent of the average person's total sodium intake.

The American Health Association recommends a more conservative standard of 20 mg/l to protect heart and kidney patients.

Softening by ion exchange or lime-soda ash increases the sodium content approximately 8 mg/l for each gr/gal (grain per gallon) of hardness removed Treatment includes the use of potassium chloride instead of sodium chloride softener pellets (softener salt) or alternatively, restrict drinking water from this source.

Sulfates

Water containing high levels of sulfates, particularly magnesium sulfate (Epson salts) and sodium sulfates (Glauber's salt), may have a laxative effect on people unaccustomed to the water. These effects vary among individuals and appear to last only until they become accustomed to using the water. High sulfate content also affects the taste of water and forms a hard scale in boilers and heat exchangers. The upper limit recommended for sulfates is 250 mg/l. Treatment includes reverse osmosis. This process is explained in NDSU publication AE-1047.

Total Dissolved Solids (TDS)

High concentrations of TDS may affect taste adversely and deteriorate plumbing and appliances. The EPA recommends that water containing more than 500 mg/l of dissolved solids not be used if other less mineralized supplies are available. However, water containing more than 500 mg/l TDS is not dangerous to drink. Exclusive of most treated public water supplies, the Missouri River, a few freshwater lakes and scattered wells, very few water supplies in North Dakota contain less than the recommended 500mg/L concentration of total dissolved solids. Many households in the state use drinking water supplies with concentrations of 2,000 mg/l and greater. Treatment for household use is reverse osmosis. This process is explained in NDSU publication AE-1047.

Total Hardness

Hardness is the property that makes water form an insoluble curd with soap and primarily is due to the presence of calcium and magnesium. Waters that are very hard have no known adverse health effects and may be more palatable than soft waters. Hard water is primarily of concern because it requires more soap for effective cleaning, forms scum and curd, causes yellowing of fabrics, toughens vegetables cooked in the water and forms scale in boilers, water heaters, pipes and cooking utensils. The hardness of good-quality water should not exceed 270 mg/l (15.5 grains per gallon) measured as calcium carbonate. Waters softer than 30 to 50 mg/l may be corrosive to piping, depending on pH, alkalinity and dissolved oxygen. A water softener will correct hard water (more than 270mg/l) in this situation. This process is explained in NDSU publication AE-1031.

Turbidity

Turbidity is a measure of suspended minerals, bacteria, plankton, and dissolved organic and inorganic substances. Turbidity often is associated with surface water sources. Treatment includes mixing with a substance such as alum that causes coagulation of the suspended materials followed by sand filter filtration.

Certified Labs in North Dakota

The EPA certifies the North Dakota Department of Health (NDDH) in certain parameters of drinking water testing and also authorizes the department to certify other labs within the state for specific tests. This certification is necessary for public water sources only. Private wells do not have to follow these guidelines and can use any lab.

The following chart lists laboratories in North Dakota that are certified in some aspect of testing drinking water. An asterisk following the test indicates the laboratory follows certain testing procedures required by the EPA.

Lab Information

Also available on: www.ndsu.edu/waterquality

***Certified by the N.D. Department of Health or EPA**

Pricing is subject to change. Verify prices with laboratory.

Lab Name	Phone Number	Address	Bacteria and Nitrate	Price	Chemistries
Astro Chem Lab Inc.	(701) 572-7355	4102 2nd Ave. W. P.O. Box 972 Williston, ND 58802	Bacteria: 2-4 day $15 18 hr Colilert method $25	$50	Conductivity, Residual Sodium Carbonate, Sodium Adsorption Ratio (SAR), Hardness, Total Dissolved Solids (TDS), Sodium Chloride, Calcium*, Magnesium, Sodium, Iron*, Potassium, Chloride, Carbonate, Bicarbonate, Sulfate, Nitrate*, pH*
			Nitrates $15		***Others:** Alkalinity, filterable residue, copper, manganese, nickel, silver, zinc, barium, arsenic, cadmium, chromium, lead and selenium
				$17	Fluoride*
Fargo Cass Public Health Environmental Laboratory	(701) 298-6986 (701) 298-6997	435 14th Ave. S. Fargo, ND 58103	Coliform bacteria $14	$55	**Complete Potable Water:** Coliform bacteria*, Nitrates*, Calcium, Sodium*, Potassium, Iron, Manganese*, Magnesium, Total hardness*
			Nitrates $13 Both for $27	$40	**Partial Water Chemistry:** Calcium, Sodium*, Magnesium, Potassium, Manganese*, Iron, Total hardness*
				$75	**Complete Water Chemistry:** pH*, Conductivity, Total Dissolved Solids, Turbidity*, Iron, Calcium, Sodium*, Magnesium, Potassium, Manganese*, Total hardness*, Chloride*, Fluoride*, Nitrate*, Sulfate, P&M alkalinity
				$40	**Irrigation Series:** Calcium, Magnesium*, Sodium*, Sodium Absorption Ratio (SAR), Conductivity
				Lead and Copper $25 Arsenic $20	**Trace Minerals:** Lead*, Arsenic*, Copper*, etc.
					***Others:** Alkalinity, dissolved organic carbon, total organic carbon, UV 254, barium, beryllium, cadmium, chromium, nickel, zinc, antimony, selenium, thallium, mercury, bromide, orthophosphate, sulfate, bromoform, chloroform, dibromochloromethane, dichlorobromomethane, bromoacetic acid, bromochloroacetic acid, chloroacetic acid, dibromoacetic acid, dichloroacetic acid, trichloroacetic acid
First District Health Unit Laboratory *www.fdhu.org*	(701) 852-1376	801 11th Ave. S.W. P.O. Box 1268 Minot, ND 58702	$18*	$20	**Chemical Analysis:** Conductivity, Total Dissolved Solids, Total Hardness, Iron, Manganese, Sodium, Nitrate
				$20	**Irrigation Water Quality:** Specific Conductance @ 25 F. Total Dissolved Solids, Hardness, Iron, Sodium, Nitrates, pH
City of Grand Forks Environmental Laboratory *http://www.grandforksgov.com/gfgov/home.nsf/Pages/Water-Potable+Departments*	(701) 746-2594	503 4th St. S. Grand Forks, ND 58201	$26* Bacteria only		No chemistries at this location.
Minnesota Valley Testing Laboratories Inc. (MVTL) *www.mvtl.com*	(701) 258-9720	1411 12th St. S. Bismarck, ND 58504	$33*	$55	**Routine Water Analysis:** Conductivity, Sodium*, Hardness, pH*, Iron (Total), Calcium*, Manganese (Total)*, Magnesium, Nitrates*, Sodium Absorption Ratio (SAR), total Dissolved Solids (TDS)
				$89	**Comprehensive Water Analysis:** Routine water analysis plus Potassium, Alkalinity*, Chloride, Fluoride*, Sulfate

continued

Lab Name	Phone Number	Address	Bacteria and Nitrate	Price	Chemistries
Minnesota Valley Testing – continued				$40	**Stock Pond Series:** Conductivity, Sulfate, Total Dissolved solids (TDS), Nitrate*
				$40	**Irrigation Series:** Conductivity, Sodium*, Total Dissolved Solids (TDS), Sodium Absorption Ratio (SAR), Calcium, Magnesium
					***Others:** Filterable residue, total organic carbon, aluminum, barium, beryllium, boron, cadmium, chromium, molybdenum, nickel, silver, vanadium, zinc, antimony, arsenic, lead, selenium, thallium, uranium, mercury, cyanide
North Dakota Department of Health *Certified by EPA *www.ndhealth.gov/lab* **Call for current pricing**	(701) 328-6140	Chemistry Division 2635 Main Ave. E. P.O. Box 5520 Bismarck, ND 58506	Nitrate* only		**Partial Mineral Chemistry:** Bicarbonate, Calcium, Carbonate, Conductivity, Iron, Magnesium, Manganese, Percent Sodium, pH, Potassium, Sodium, Sodium Absorption Ratio (SAR)
					Complete Mineral Chemistry: Partial mineral chemistry plus Chloride, Fluoride, Sulfate
					Lead* and Copper*
					Fluoride
					***Others:** Chloroacetic acid, bromoacetic acid, dichloroacetic acid, dibromoacetic acid, trichloroacetic acid, chloroform, bromoform, dibromochloromethane, dichlorobromomethane, nitrite, nitrate + nitrite, cyanide, fluoride, uranium, antimony, arsenic, barium, beryllium, cadmium, chromium, mercury, selenium, thallium, 2,4,5-TP (silvex), 2,4-D, alachlor, atazine, carbonfuran, chlordane, dibromochloropropane, ethylene dibromide, heptachlor, heptachlor epoxide, lindane, nethoxychlor, pentachlorophenol, polychlorinated biphenyls, toxaphene, banzo(a)pyrene, dalapon, di(2-ethylhexyl)adipate, di(2-ethylyhexyl)phthalate, dinoseb, diquat, endothall, endrin, glyphosate, hexachlorobenzene, hexachlorocyclopentadiene, oxamyl, picloram, simazine, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-Dichloroethylene, 1,2,4-Trichlorobenzene, 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,4-Dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, cis-1,2-dichloroethylene, dichloromethane, ethylbenzene, styrene, tetrachloroethylene, toluene, trans-1,2-dichloroethylene, trichloroethylene, vinyl chloride, xylenes (total)
Southwest District Health Unit *www.swdhu.org*	(701) 483-0171	2869 3rd Ave. W. Dickinson, ND 58601		$12*	No chemistries at this location

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For more information on this and other topics, see: www.ag.ndsu.edu

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