University of Wisconsin-Extension

GEOLOGICAL AND NATURAL HISTORY SURVEY
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ROCK COUNTY SLIDE SET, WHAT YOU SHOULD KNOW ABOUT GROUND WATER AND ITS QUALITY:
Slide Set, 100 slides

by

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The enclosed slide set is intended to help you prepare a presentation on Wisconsin's ground water and its quality. It contains 100 slides grouped into four groups, which can be used individually or in groups. The accompanying brief narratives will help you better explain to your audience the use, occurrence, and movement, quality and pollution potential, and protection of Wisconsin's ground-water resources. For more information contact Alex Zaporozec.

WISCONSIN G&NHS

Slide No.		Narrative
1.	Opening frame	Ground water and its quality
2.	Faucet	Ground water is a valuable natural resource in Wisconsin that has to be protected for the benefit of the economy and general welfare of the state.
3.	GROUND-WATER USE	Its importance can be easily demonstrated by simple analysis of water-use data. About one half of all water used in the state comes from ground-water sources.
4.	Major categories of water uses	Traditionally, four major withdrawal uses of water are recognized in the United States: (1) public (for domestic, public, commercial, and industrial uses), (2) rural (for domestic and livestock uses), (3) irrigation, and (4) industrial. In addition, ground water can be used for recreation (swimming and fishing in abandoned gravel pits) and as a source of energy (ground-water heat pumps).
		Ground water is used in homes for:
5.	Kitchen tap	drinking and cooking,
6.	Dishwasher	washing dishes,
7.	Clothes washer	washing clothes,
8.	Bathroom sink	personal hygiene,
9.	Bathtub	bathing,
10.	Toilet	toilet flushing,
11.	Lawn sprinkler	lawn and garden watering, and
12.	Car wash	washing cars.
13.	Water tower (Orfordville)	However, residential and municipal use, although the largest of ground-water uses in the state, is not the only use.
		Ground water is also used for supplying
14.	Hand pump	parks and other recreational facilities,
15.	Drinking fountain (I 90, rest area 17)	transportation facilities, and

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16.	Industrial complex	industries and commercial establishments.
17.	Farm	In rural areas, in addition to domestic uses, ground water is used for:
18.	Watering trough	livestock watering, and
19.	Irrigation rig	irrigation.
		Ground water may also be used for beneficial uses other than water supply:
20.	Lions Park beach	for swimming in abandoned gravel pits, such as Lions Park in Janesville,
		and as a source of energy.
21.	Ground-water heat pump	Ground-water heat pumps are commercially proven, year-round air-conditioning systems used for residential and commercial heating and cooling.
22.	Ground-water heat pump arrangement	A water well provides the ground water necessary to operate the heat pump. The outgoing water may be discharged to a lake or stream or on the land surface. It is illegal in Wisconsin to inject the water back down a well.
23.	Ground-water flooding	However, ground water is not always of beneficial use and can be a nuisance by flooding underground excavations, basements, and septic tanks.
24.	GROUND-WATER MOVEMENT	Ground water is hidden beneath the land surface, and its behavior is considered by many mysterious or occult. Contrary to popular belief, ground water does not flow in huge underground rivers and lakes, and does not migrate thousands of miles through the earth.
25.	Rock openings	Ground water simply fills numerous, interconnected small openings: pores in sedimentary rocks (A-D), cracks caused by fracturing (F), or solution channels in carbonate rocks (E).
26.	Unconfined aquifer	Permeable rocks that have a sufficient number of interconnected openings for the water to pass through them in amounts adequate to supply wells, are called aquifers. In unconfined (water-table) aquifers, ground water only fills the openings below the water table. The water table is a free surface of a ground-water body, under pressure essentially equal to atmospheric pressure.

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27. Confined aquifer	In confined aquifers, ground water does not have free surface, it completely fills all openings, and is confined under pressure greater than atmospheric.
28. Artesian well	If the pressure in a confined aquifer is great enough to cause the water to rise in a well above the land surface, a flowing artesian well results.
29. Hydrologic cycle	The large amount of water stored underground is an important part of the hydrologic cycle--constant movement of water above, on, and below the earth's surface, having neither a beginning nor an end. Ground water is directly related to the other two basic components of the hydrologic cycle, atmospheric water and surface water.
30. Base flow (gaining stream)	Drainage from the ground-water body contributes substantially to streamflow (nearly two thirds of the streamflow is normally contributed by ground water) and maintains it entirely during dry periods.
31. Losing stream	During periods of heavy rainfall or snowmelt, stream stages rise, and the water from streams recharges the shallow ground-water reservoirs.
32. Relation to precipitation	Ground water is almost entirely dependent upon the supply of atmospheric water in the form of precipitation. Its level responds directly to changes in precipitation, even though after a certain period of time, ranging from hours in shallow wells near river channels to months or years in deep wells.
33. Effect on wells	Extended periods of low precipitation considerably deplete ground-water storage and may result in drying-up of shallow wells.
34. Effect on basements	High ground-water levels may cause flooding of basements in the lower-lying areas.
35. Ground-water flow system	Water from precipitation enters the ground-water system in recharge areas (usually in topographic high areas or uplands), moves through the system along precisely predetermined flow paths, and leaves it in discharge areas (usually located in lowlands).

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36. Movement of ground water	Movement of ground water in the subsurface is very slow, from a few tenths of a foot per year to several feet per day. The time required for ground water to move from recharge areas can range from days to hundreds of years.
37. Hydrologic budget	Wisconsin has plentiful supplies of ground water for years to come. For example, in Rock County only 18 percent of the total amount of water that infiltrates to the ground water is presently being withdrawn.
38. Aquifer map	There are three principal water-bearing units (aquifers) in Wisconsin: sand and gravel aquifer, Silurian dolomite aquifer, and sandstone aquifer. Locally, Precambrian rocks are used as a source of water supplies when other aquifers are absent.
39. Sand and gravel pit	Deposits of Quaternary age, consisting of unconsolidated glacial deposits and stream deposits, overlie bedrock throughout the state, except in the southwest, so-called driftless area.
40. Sand and gravel	The most productive sources of water are the outwash and alluvium deposits in stream valleys and in buried bedrock valleys, consisting of sorted and stratified medium to very coarse sand and gravel.
41. Movement through sand and gravel	The deposits of sand and gravel can transmit large amounts of water because of the large and numerous openings between the grains.
	Bedrock aquifers consist of sandstones and dolomites.
42. Dolomite	Dolomites form an important aquifer in eastern Wisconsin (Silurian dolomite) and are part of the sandstone aquifer.
43. Cracks in dolomite	Even though dolomite appears to be dense and massive rock, it contains many fractures and cracks.
44. Movement through cracks	Open rock fractures and solution channels provide paths for ground-water movement in dolomite.
45. Fracture spring	The occurrence of openings in dolomite is very irregular, and consequently, the ground-water flow is irregular also.

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46. Dolomite and sandstone	The dolomite is more resistant to weathering and erosion than is the sandstone. For this reason, many hills, especially in southwestern Wisconsin are capped by dolomite. However, these caps are usually dry, and sandstone is the principal source of water supplies.
47. Movement through sandstone	In the sandstone, ground water moves through the openings between the grains as well as along fractures and joints.
48. Uplands (recharge areas)	Generally, recharge to ground water may occur everywhere throughout the entire state, particularly in gently rolling, forested hills or upland fields and pastures. Much of the ground water originates and infiltrates the ground within a radius of a few miles from where it is found.
49. Wetland	Ground water is discharged artificially by wells and drainage ditches, and naturally by wetlands
50. Spring	and springs.
51. Common spring types: depression (top) and contact (bottom);	Most of the springs in Wisconsin can be classified as depression springs (where low spots intersect the water table) and contact springs (where water accumulates at the top of the underlying impermeable layer); and
52. barrier (top) and artesian (bottom)	barrier springs, where the ground water is forced to discharge because of the changes in permeability, and artesian springs, where the ground water is brought to the surface through pressure along a fault (fracture). Eventually, all ground water, including that discharged through wells and springs and that flowing invisibly under the ground, will end up into
53. Gibbs Lake (Rock County)	lakes,
54. Allen Creek (at U.S.H. 14)	streams,
55. Rock River (at Newville)	and ultimately, into major rivers, the valleys of which are the major ground-water discharge areas.

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56. GROUND-WATER QUALITY	The natural quality of ground water depends upon its environment, movement and source. In Wisconsin, the chemistry of ground water is a result of its movement through and the interaction with glacial deposits and sedimentary rocks that contain large amounts of calcium-magnesium carbonate.
57. Major constituents of ground water	Mineral compounds dissolve when they come into contact with the passing water, and their components dissociate into electrically charged particles called ions. The major ions which comprise more than 95 percent of all mineral constituents dissolved in ground water are: calcium, magnesium, sodium, iron and manganese (positively charged particles called cations), and bicarbonate, sulfate, chloride and nitrate (negatively charged particles called anions).
58. Common ground-water quality problems	The overall quality of ground water is good and it is suitable for most uses. Hardness, iron, manganese, and nitrate are the four constituents of ground water that commonly exceed recommended or mandatory drinking water standards. Because the principal constituents of ground water are calcium, magnesium and bicarbonate, all ground water in Wisconsin is very hard, and softening is required for most purposes. Practically all water supplies in the state contain some iron or manganese. Concentrations causing problems for domestic and some industrial uses can be found locally almost anywhere in the state. Their occurrence is determined by natural factors and cannot be controlled.
59. The nitrogen cycle	Nitrate is the most common identifiable pollutant. It is the result of nitrogen fixation by bacteria. Nitrogen is the major nutrient for vegetation, and the element essential to all life. Nitrogen gas makes up about 78 percent of the atmosphere. The part of nitrate, which is not consumed by plants or converted to gas by bacteria remains in the soil, and can be leached below the root zone if water percolates through the soil.

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60. Sources of nitrate	The sources of nitrate are natural and man-made. Most nitrate in ground water comes from organic sources (decaying vegetation, decomposition of organic matter, animal wastes), discharge of sewage wastes, industrial chemicals, and nitrogen-based fertilizers. Lesser amounts are derived from precipitation and solution of rocks. Higher concentrations of nitrate occur more frequently in rural areas where the potential for their introduction to ground water is greater because of:
61. Barnyard	barnyard and exercise-yard drainage,
62. Manure spreading	spreading of manure on fields,
63. Fertilizing	use of fertilizers and pesticides,
64. Manure pit	poorly located and constructed manure-storage pits and poorly constructed and maintained shallow wells.
65. GROUND-WATER POLLUTION	Ground water becomes polluted when undesirable substances are added to water by natural or man-made processes, which may inhibit the use of ground water.
66. Pollution entries	Shallow aquifers are the most susceptible to pollution. The entry of pollutants to shallow aquifers occurs most often by downward percolation from the sources above or below the land surface through the zone of aeration, or directly through improperly constructed or abandoned wells.
67. Potential sources of pollution	The sources of ground-water pollution are many and varied because in addition to natural processes practically every man's activity may eventually contribute to ground-water quality problems. The greatest potential hazard to ground water in the state may come from waste-disposal practices, agricultural activities, storage of chemicals on the ground, spills and leaks of toxic liquids, and improperly constructed or abandoned wells.
68. Waste-disposal practices	Inadequately designed, constructed, and maintained waste-disposal facilities, such as dumps, landfills, surface impoundments of wastewater, and septic tanks, may all contribute to ground-water pollution by allowing the leaching of pollutants into ground water.

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69. Dump	In open dumps, refuse is directly exposed to rainwater or surface runoff. As rainwater infiltrates through trash and garbage, it accumulates a variety of chemical and biological substances and carries them into the ground water.
70. Sanitary landfill	Sanitary landfills are constructed by placing refuse in excavations and covering the deposited material with the soil daily. Rainwater and surface runoff are diverted from the fill area to minimize the contact of refuse with water and the subsequent production of leachate.
71. Pollution from landfill	Water accumulates in most landfills because the fill is more permeable than the surrounding material, which raises the water table to form a mound under the landfill site. Under these conditions, only infiltrating water can move to its immediate vicinity and the extent of pollution is limited.
72. Sewage ponds	Similar mechanism of pollution is involved in the seepage of wastewater from sewage ponds.
73. Septic tank installation	In unsewered areas of the state, the disposal of domestic wastewater is accomplished through the use of septic tanks and soil-absorption fields.
74. Soil absorption of septic tank effluent	If the system is properly installed in suitable soil and located a sufficient distance from a water-supply source, the pollutants are removed or degraded during percolation through the zone of aeration before they can reach the water supply.
75. Mound system	In areas where soils have severe limitations for septic tanks, seepage bed is built inside a mound of sandy soil fill material on top of the original soil surface.
76. Agricultural activities	Agriculture may introduce pollutants to the ground water by disposal or storage of animal wastes and agricultural products, by irrigation, and by the application of fertilizers and pesticides. Potential problems that may result from storage of animal waste can be eliminated by improving manure handling and storage methods. Manure storage pits are becoming an increasingly common type of animal-waste handling facility.

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77. Manure pit - concrete	Some have concrete floors and walls,
78. Manure pit - earthen	and some are just dug from the earth.
79. Spray irrigation	Irrigation may contribute to ground-water quality problems mainly by carrying chemicals that are applied at the land surface (fertilizers and pesticides) through the soil into the underlying ground water.
80. Fertilizer routes	The overapplication of fertilizers to agricultural lands usually results in a portion of nitrogen being leached into ground water.
81. Pesticide movement	The overapplication of pesticides may also result in ground-water pollution. The potential for pollution is greatest on irrigated sandy soils; their infiltration rates do not provide sufficient time for breakdown of pesticides.
82. Corn silage	Local problems can result from corn silage or agricultural wastes deposited on the ground.
83. Miscellaneous sources of pollution	Aside from the possibility of pollution from waste-disposal and agricultural practices, there are numerous other sources that can cause degradation of ground-water quality, such as stockpiles of soluble chemicals, leaking tanks and pipelines, spills of toxic or hazardous liquids, salt used for highway deicing, and poorly constructed and improperly abandoned wells that can introduce polluted water from the surface to ground water.
84. Chemical stockpile (Janesville)	Unprotected stockpiles of soluble materials can produce leachate when exposed to rain. An example of ground-water pollution caused by stockpiles is the salt used for highway ice control.
85. Pollution from salt pile	Rainfall or surface runoff can dissolve salt piled on the land surface, and polluted water then seeps into shallow aquifers.
86. Storage tanks (Janesville)	Leaky or ruptured storage tanks or pipes at industrial facilities, both above and below the ground, are potential pollution sources. These facilities are also quite often sites of accidental or deliberate spills.

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87. Gasoline station (Beloit, Milwaukee Rd. at I 90)	Leakage is particularly frequent from gasoline service station and home fuel-oil storage tanks.
88. Leaking sewer	Cracked or defective pipe sections or pipeline breakage or rupture can result into leakage of sanitary or storm sewers. Underground leaks may be very difficult to detect and locate, and they usually go unnoticed until the pollutants reveal themselves.
89. Accidental spill	Accidental spills are an unavoidable hazard inherest in storing and transportation of chemicals, gasoline, and toxic materials. Spills are most likely to occur along highways and railroads.
90. GROUND-WATER PROTECTION	Ground-water pollution by human activities cannot be completely eliminated and every effort should be made to effectively minimize it by controlling the pollution sources.
91. How the earth purifies water	Natural protection is provided by earth materials through which the polluted water passes. Pollutants in ground water tend to be removed or reduced in concentration with time and distance traveled. Purification occurs in filtering action of earth materials and in chemical and biological processes.
92. Protection alternatives	However, the cleansing ability of earth materials is not unlimited and has to be complemented by man's protective measures. Ground water can be protected either by the control of pollution sources or by the protection of a water-supply source--the water well. It is much easier to prevent pollution from occurring than to clean the polluted aquifer.
93. Well construction	The actual construction of a water well is extremely important to the maintenance of good ground-water quality. The sanitary protection of the well is provided by the casing surrounded by the grout seal.
94. Pollution through the well	If the space around the casing is not carefully sealed, polluted water from surface drainage can move downward along the exterior of the surface casing and pollute the well.

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95. Well drilling	The water well should be constructed by a registered well driller. Only those persons registered with the DNR and holding a valid permit may construct wells.
96. Well casing	Protective, water-tight steel casing is lowered in the well.
97. Pumping test	After the well is constructed, a pumping test is performed to determine the yield of the well.
98. Sampling	Samples are taken for the laboratory testing of bacterial quality of water.
99. Ground-water protection program	Adequate protection of ground water requires the development of a ground-water protection program. A wide variety of mechanisms for achieving the objectives of the program is available: educational campaign, economic incentives, best management and operation practices, inspection of facilities, eliminating pollution sources, laws and regulations (including land-use controls), and monitoring and remedial actions.
100. Closing frame	For more information contact the Wisconsin Geological and Natural History Survey in Madison.