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Protection of Private Groundwater Drinking Supplies

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PROTECTION OF PRIVATE GROUNDWATER DRINKING SUPPLIES

by

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1. **TITLE SLIDE**

There are three general objectives that this slide presentation concentrates on; First of all, we want to acquaint you with the hydrologic cycle. If one understands this cycle; then, an appreciation for what activities might contaminate our water supplies can be obtained. Secondly, we want to review some of the land use practices that may result in water resource contamination. Thirdly, we want to review well construction and maintenance practices that may result in contamination of an individuals source of drinking water. That brings us to the major goal of this entire program. This major goal is to get each person to think about protecting his source of groundwater supply from contamination, whether that source be a well or a spring. If each person protects his own groundwater supply, then the regional groundwater supply will be protected and available for future use.

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2. HYDROLOGIC CYCLE

The hydrologic cycle can begin with a precipitation event as seen in the right hand portion of this diagram. A major portion of this precipitation becomes run-off. After it hits the ground, as the water travels over the ground, it erodes soils and rock, picking up sediment and dissolving chemicals. The second major portion of the water hitting the earth infiltrates to the subsurface. This becomes our groundwater supply. Of the total amount of water that hits the earth's surface as precipitation, 70% of this water is evaporated either off a standing water body, such as lakes and ponds, or transpired from plants that used the water in their growing processes. Twenty-nine percent of the water is run-off that eventually makes its way to our large bodies of water, in particular, the ocean. That leaves only 1% of the water to infiltrate into the ground to become part of our groundwater supply. Typically our groundwater resource can be divided as shown in this diagram, into shallow resources, that is the water table water and deeper groundwater that are available in the rock units underlying the land surface. Because the recharge to the groundwater system represent only 1% of the total rainfall in one year time, is the extremely important that we protect and care for this resource.

3. GROUNDWATER--out of sight...

In many cases, people say that groundwater is out of sight and therefore, out of mind. Although it is out of sight the need for protection and the use of groundwater, particularly in our rural communities and in the countryside, can not be out of mind.

4. FEDERAL LEGISLATION ON GROUNDWATER

Major environmental legislation addresses groundwater pollution. This is a listing of most of these laws.

5. AQUIFER

In order to talk about groundwater, we have to define a few terms. The first term that is often heard is the aquifer. The aquifer is the geological unit that can transmit water in sufficient quantity for a given demand.

6. AQUITARD

The second term is the aquitard. It is a unit that can not transmit sufficient water for a given demand. Such rocks as shale and siltstones in Kentucky are major aquitards or units that prevent water from readily flowing though them. These rock units are not available for sources of adequate groundwater supplies.

7. AQUIFER PROPERTIES

What distinguishes an aquifer from an aquitard? Basically, it is two parameters, porosity and permeability of the rock. Porosity is the ability of the rock to store water; that is, the void space in between the rock particles that are available for water accumulation. Permeability is the measurement of the alinement of these pores. For a rock to have good permeability, the pore space is well alined and the water is free to flow through the rock material. If the rock has good permeability we term it an aquifer, if the rock has poor permeability we term it an aquitard.

8. **POROSITY TYPES**

There are several types of porosity and permeability that can exit in our groundwater sources. We can have the interparticle porosity, as seen in the upper left hand portion of this slide; that is, the space in which water can resided between the individual grains that exists in a sandstone. In limestone terrains where we have sinkholes forming, we have solution porosity or permeability; that is, rock material is dissolved by the water allowing the opening of void spaces for water to reside in and move through. Third in the lower half of this slide we see fracture porosity; that is, forces within the earth's crust tend to fracture the rock, breaking it apart and providing void space for water.

9. **PRECIPITATION SURFACE RUNOFF...**

This slide is a simple schematic showing the relationship between precipitation, surface run-off and groundwater recharge. It is important to know that only 1% of the precipitated water is available for groundwater recharge to o5r aquifer systems.

10. **GROUNDWATER TRAVEL TIMES**

This slide gives you idea of the travel times for groundwater moving through aquifers. In the shallow aquifers, water that is being recharged at the ground surface may take only a few days to reach discharge points along major streams. In deeper aquifers it may take several decades and even centuries for that water to move through the aquifer systems and be discharged into the surface water.

11. **PHYSIOGRAPHIC REGIONS OF KENTUCKY**

There are five principal physiographic regions in Kentucky which are defined by the underlining geology which dictates the type of aquifer systems that we have. These regions are..

1) The Mississippian Embayment or the Jackson Purchase area in which the principal aquifers are sand and gravel deposits.

2) The Mississippian Plateau area, shown in blue, in which the water primarily flows through solution conduits in the limestones. These are the areas where we have sinkhole terrains.

3) The Western Kentucky coal field shown in orange and

4) the Eastern Kentucky coal field shown in green on the right hand side of the diagram in which groundwater flows primarily through sandstone aquifers and coal units.

5) The fifth region, the Blue Grass area in the North Central portion of Kentucky which, like the Mississippi Plateau, is characterize by sinkhole terrains and water movement thought solution conduits.

12. **AQUIFER SYSTEMS**

This slide shows the three principal types of aquifer systems that exits within these physiographic provinces. The top diagram is an aquifer situated in sand and gravel along rivers. This is typical of river bottom lands. It is also typical of the Mississippian Embayment or Jackson Purchase area of Western Kentucky. Here the good groundwater supplies are found in the sand and gravel aquifers of those regions. The middle diagram is a aquifer system set up in the coal fields, where the sandstone and the coal beds act as aquifer units. The shale bed acts as an aquitard, preventing the movement of water and perhaps subsequent contaminates through the unit. The lower diagram is one typical of the limestone terrains, commonly called karst terrains due the number of sinkholes that are formed by dissolving the rock. These terrains are found in the Mississippi Plateau area, that is the limestone area surrounding the Western Kentucky coal field and in the Blue Grass physiographic province in North Central Kentucky. Typically, groundwater flows though solutions calvities, which sometimes are microscopic and sometimes large such as Mammoth Cave. In addition, springs are very common in this type of karst terrain and are commonly used for water supplies in rural areas and by municipalities.

13. **FAULT ZONES**

In some instances, across all three types of aquifers, as shown in the previous slides, we find fractures or faults. In some areas of the state, large fault systems are know to exist. The grey area in this slide is a fault zone in Union County.

14. **LIMESTONE CREVICE**

These faults and crevices, such as this one, are very good pathways for groundwater movement. Where these fractures are interconnected, groundwater supplies can be obtained. However, these fractures also are very good conduits that allow contaminates to get into our groundwater system.

15. **REFERENCE MATERIALS**

Geologic and hydrologic information is available through the Kentucky Geological survey. This slide lists some of these materials.

16. **CONTAMINATION**

The next portion of these slides will illustrate the different contamination pathways of our groundwater systems. These are a few of the major pathways.

17. **STREAM CONTAMINATING GROUNDWATER**

Contaminated surface water can pollute groundwater. Here is a diagram of surface water that moves into the groundwater. This occurs when the local groundwater level is below the surface of the water in the stream. This can also occur when high volumes of water are pumped from the aquifer by wells or by deep mining operations and their dewatering activity.

18. **SEWER LINE BREAKAGE**

In urban areas, sewer lines may be leaking due to breakages or fractures. A well constructed near a sewage line can be contaminated by this wastewater.

19. **TANK STORAGE**

Above or below ground storage tanks for fuels or chemicals can also leak. Tank failure due to corrosion or ruptures can release contaminates to the groundwater. Release of contaminants from buried tanks are hard to detect unless monitoring wells are in place.

20. **BRINE PITS**

This is a picture of a brine pit in the oil and gas regions which is used during drilling activities or hydrocarbon recovery. We may find that high concentration brine waters can infiltrate into the groundwater due to these activities.

21. **ANIMAL PRODUCTION**

Concentrated animal production sites are a potential source of groundwater pollution. Improper animal manure storage and disposal can lead to water contamination with fecal bacteria and nitrogen as nitrate or ammonia.

22. **SOLID WASTE DISPOSAL**

In many cases, improper handling of our solid waste, by dumping it into sink-holes or disposal sites not constructed to contain leachate, may contaminate our groundwater supplies. Many farms have there own farm dumps which may be contaminating their own water supplies.

23. **TRASH IN SINK HOLE**

This method of disposing of our trash in the limestone and karst regions occurs all too frequently. Decomposing organic matters and unused chemicals in the trash will be leached and carried to groundwater supplies though the sinkholes.

24. **AGRICULTURAL CHEMICAL MIXING**

This slide illustrates the situation of mixing an agricultural chemical with water from your well. Groundwater contamination can occur when there is backflow from the tank to the well during the mixing operation of an agricultural chemical with water. We need to add a backflow prevention device or separate the filling hose from surface of the water in the mixing tank so that accidental of back flow will not happen.

25. **SPRAYING CHEMICALS NEAR A WELL**

Spraying an agricultural chemical close to your well can also contaminate the water supplies. With improper well construction or wells that are less than 50 feet deep, there is a high probability that these chemicals can move into your water supplies. Disposal of pesticide tank rinseates near a well is also another source of potential contamination of the water from that well.

26. **LOCATION OF A WATER WELL**

Another source of well contamination is septic tanks leach fields particularly if the septic tanks are upflow or upstream relative to groundwater movement from our water well.

27. **DYE TRACING**

One of the ways in which we can determine whether or not water from a septic tank leach field enters our water supply is using a dye. By adding the coloring agent to our toilet bowl and flushing it, we can see if that dye appears in water supply. This would be an indication of a pathway existing and that a well is not properly sited or constructed.

28. **GEOLOGY DICTATES GROUNDWATER MOVEMENT**

Even though this water well does not have a potential source of pollution that on the surface is uphill, the underlying geology indicates that the contamination source on the other side of the hill can influence the quality of water in a well.

29. **CERTIFIED DRILLER**

Since 1985, it has been unlawful any person to commercially construct, alter or repair a water well without first having to obtain a valid certificate. The Kentucky Division of Water maintains a directory of certified water well drillers. This directory, as well as a copy of the Kentucky Water Well Construction Practices and Standards which outlines the regulation governing water well construction, can be obtained from the Division of Water in Frankfort.

30. **WELL CONSTRUCTION STANDARDS**

In order for a well to be constructed according to regulation several requirements must be met:
1) First the well must be located away from source of possible contaminations, for example, 50 feet away for septic tank, 75 feet away pit privies and 150 feet away from cesspools.
2) Second, regulation requires a minimum of 20 feet of properly installed and sealed casing which helps protect the well from surface and near surface contamination.
3) Third this well casing and all other materials used in well construction must meet construction standards and be designed especially for use in water wells.
4) Fourth, the open well casing must be covered with a sanitary well seal or cap.

31. **WELL CONSTRUCTION STANDARDS CONT'D**

After construction, the well much be disinfected and sampled for bacterial. If the well is to be modified or abandoned, a certified driller much perform the work according to appropriate regulations. If a well can not be constructed strictly in accordance with the regulation, a variance may be granted on a case by case basis. Finally, the driller is required to submit a record to both the homeowner and the Division of Water for each well that he drills.

32. **WELL LOCATION**

Whenever possible, a well should be located up gradient from possible sources of contamination. Here the well is up gradient from possible fuel storage, septic tank and source of animal contamination.

33. **WELL CONSTRUCTION ILLUSTRATION**

This is a cross section of accepted well construction. The annulus or space between the well casing and the bore hole is sealed with grout. The top of the well casing is sealed with a well cap and the pitless adaptor has been used. The pitless adaptor provides a water tight subsurface connection for buried pump discharge lines and eliminates a need for completion in an unsanitary well pit. Well pits are not allowed by current regulations.

34. **PITLESS ADAPTER**

This slide shows a pitless adaptor connecting the wells discharge pipe to a pressure tank in the house.

35. **GROUTING WELL**

In order to seal the annulus, grout is pumped around the casing. This prevents a movement of surface water down the sides of the casing and possibly into the aquifer.

36. **WELL SCREEN**

Wells in unconsolidated formations, such as sand and gravel, are completed with slotted well screen in order to filter out unwanted sediment.

37. **WELLHEAD TERMINATION**

This is a picture of a properly terminated and sealed water well. The well is terminated above ground, as required by regulation, and a sanitary well cap is used to seal the top of the well casing.

38. **IMPROPER WELL HEAD CONSTRUCTION**

Wells with casing cut off below ground level are susceptible to contamination from many sources, such as septic systems and animal waste.

39. **WELL CASING REQUIREMENTS**

In some parts of the state, most notably in the east, naturally occurring contamination, typically iron or sulfur, makes some aquifers unusable. Such aquifers must be sealed off with casing and grout in order to prevent contamination of the underlining clean aquifers. This slide illustrates how a bad water zone can pollute a clean zone if grout is not used to seal the casing.

40. **IMPROPER WELL HEAD CONSTRUCTION**

The annulus seal around this well has collapsed and could allow surface water to enter the well. Standing water has percolated down the sides of the casing and has eaten away at the grout because the well was finished in a pit. This can potentially contaminate the water source even though this well has a sanitary seal on top of the casing

41. **IMPROPER WELL HEAD MAINTENANCE**

The well cap has been discarded from this well head. Note the generally unsanitary conditions. Wells that are left open like this can easily be contaminated.

42. **WELL HEAD CUT OFF BELOW SURFACE**

This well is finished in a small pit. It is open and is easily contaminated.

43. **WELL HEAD IN PIT**

This is yet another example of an improperly sealed well which is also finished in a pit.

44. **UNSEALED WELL HEAD**

Another unsealed well.

45. **ABANDONED HAND DUG WELL**

This is a hand dug well approximated 2 feet in diameter that has been left open. Such well are easily contaminated. If this is an abandoned well, the state requires that the well be filled and sealed to prevent groundwater contamination.

46. **WELL HEAD ENCLOSURE**

This slide shows a solid properly constructed well house. If conditions inside are also properly constructed and clean, this well could be a source of clean drinking water.

47. **WELL DISINFECTION**

Upon completion of a well or if a well is contaminated with bacteria, the well can be disinfected with chlorine bleach. Here a well is being disinfected in that manner. Recommendations for appropriate dosages of chlorine can be found in the Handbook for the Kentucky Water Well User. A copy of this handbook can be obtain from your locate Health Department or from the Division of Water in Frankfort.

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