water quality

All wastes and wastewaters must be handled properly to protect the environment and public health. Runoff from feedlots and confined animal operations has the potential to harm both groundwater, which includes your drinking water and that of your neighbors, and surface water which many urban Iowans depend on for drinking water, and the plant and animal life that depends on it.

WATER QUALITY CONCEPTS

In order to understand water quality you must know that all water falling as rain or snow evaporates, soaks into the soil, or runs off the land. Water that does not evaporate either moves as surface runoff into streams, rivers, and lakes or percolates through the soil. Water on the land in streams and lakes is called surface water, while water under the surface is called groundwater. The movement of water on the land, in the ground, and through the air is termed the hydrologic cycle *(see Figure 1, water quality page 5)*.

Manure application acts much the same way as natural rainfall. Runoff from a manure application site is not acceptable. Therefore, the operator must match his or her manure application rate to

- The nutrient needs of the crop and
- The rate at which the soil will accept and hold the manure.

Point source pollution is a single identifiable source of pollution, such as a pipe through which factories or treatment plants discharge treated wastewater into a surface water. Open feedlots and confinement feeding operations are considered point sources. A permit is required for any point source discharge of pollutants into surface waters. However, Iowa law requires confinement feeding operations to retain all manure between periods of land application. **Nonpoint source pollution (NPS)** is more difficult to trace to its point of origin because it takes place over a broad area and results in the release of pollutants from many different locations. Runoff from agriculture, crop and pasture land, forestry, highways, and residential and urban development are examples of nonpoint source pollutants *(see Figure 2, water quality page 5)*.

CONDITIONS WHICH IMPACT WATER QUALITY

Immediate effects

The effects of manure spills on surface water quality can be immediate. Excessive levels of ammonia and/or biological oxygen demand (BOD) can quickly kill aquatic life. As a result, fish kills are common when manure discharges occur. Fish and other organisms are very sensitive to ammonia which is present in manure in high concentrations. High BODs quickly use up the oxygen in the water and simply cause the fish to suffocate. The ability of water to hold oxygen decreases as the water temperature increases. When water levels are low and temperatures are high, such as in the late summer, streams and lakes are especially sensitive to pollutants.

Natural sinkholes and agricultural drainage wells allow aquifers to be affected immediately by uncontrolled releases or mismanaged manure. They provide direct connections between the soil surface and adjacent aquifers. Extra care is necessary to protect them.

Manure nutrients

Eutrophication is the slow, natural nutrient enrichment of streams and lakes that is responsible for the “aging” of ponds, lakes, and reservoirs. Excessive amounts of nutrients from point and nonpoint source pollution, especially nitrogen and phosphorus, speed up the eutrophication

process. Rapid eutrophication usually is associated with increased algal growth. As more and more algae grow and then decompose, they deplete the dissolved oxygen in slow-moving water. This condition may result in fish kills, offensive odors, and reduced attractiveness of the water for recreation and other public uses. However, this condition occurs only when *excessive* nutrients are present. A certain amount of nitrogen and phosphorus is essential for any life to exist in water.

Other manure components

Other manure components also may affect water quality. Animal manure contains bacteria, viruses, ammonia, organics, and a variety of other chemicals which may impact plant and animal life in the water. Additionally, the bacteria and viruses have the potential to infect humans who use the water for fishing, recreation, or drinking water.

Soil characteristics

Excessive manure applications have the potential to harm groundwater as well. The soil is a very effective manure treatment system if wastes are applied at proper rates, preventing the soil from being overloaded. Groundwater contamination occurs when the soil has been overloaded or when measures have not been taken to adequately prevent manure from entering wells, sinkholes, or other conduits leading directly to ground water. The soil is a controlling factor in the groundwater recharge process because it may hold the water in soil pores, release it to plant roots or the atmosphere, or allow it to pass through to the lower
layers. While the soil can filter pollutants and prevent them from reaching groundwater, it varies tremendously in its adsorptive, or filtering, capacity. As a result, under some conditions, pollutants may take months or years to move from the land surface to the groundwater. In other cases they can flow almost directly into the groundwater. To determine the potential for groundwater
contamination in a given situation it is essential that you understand soil characteristics.

Depth to groundwater is important because it determines the volume of soil through which a pollutant must travel before reaching the groundwater. It also helps determine the amount of time that a pollutant is in contact with the soil. The processes of filtration, absorption and adsorption, biodegradation, and volatilization operate effectively where the soil is fairly deep. Conversely, shallow soils can adsorb only a limited amount of pollutants. The pollution potential increases where the soils are thin and the underlying bedrock is permeable, or where the water table is near the surface.

Soil texture is determined by the soil's relative proportion of sand, silt, and clay. Sandy soils allow water to drain rapidly; therefore, they do not retain the manure materials (nutrients) so they can be used by the crops. Soils with more clay, which are sticky when wet and hard and clumpy when dry, are better suited for holding the manure until the nutrients can be used by the crops. As a result, groundwater contamination is less likely in clay soils.

Organic matter has a very large adsorptive capacity for most pollutants. It usually is concentrated in the topsoil. Maintaining an active organic component in the topsoil through good soil and crop management enhances the soil's capacity to serve as a filter.

Runoff

Runoff from a site is determined by the slope of the land, the soil texture, and the thickness and type of cover crop. Soils heavy in clay have a much lower capacity to absorb water quickly than do sandy soils. Steeper slopes increase runoff. Using cover crops and the best management practices (BMPs) will enhance a site's ability to absorb water and reduce the possibility of runoff. While infiltration rate estimates are available, you must both tailor the manure application rate to your individual situation, based on your experience, and closely monitor the actual

application to ensure there is no runoff.

GROUNDWATER CONSIDERATIONS

Groundwater is an essential natural resource. Ninety percent of rural residents and 50 percent of the total U.S. population depend on groundwater for their drinking water. Eighty percent of Iowans rely on groundwater for their needs. Concern about its quality and potential contamination has made groundwater protection a national issue.

Dependence on groundwater

There are several reasons for the widespread dependence on groundwater. In its natural state, groundwater usually is excellent in quality and can be used without costly treatment or purification. It can be inexpensively tapped next to the point of use, thereby saving the cost of transporting water over long distances. For rural residents relying on individual wells and for public water supplies in some communities, groundwater often is the only available water supply.

The aquifer

Groundwater does not consist of large underground lakes or streams, but instead is the water in spaces within rock fractures or between particles of sand, gravel, silt, or clay. The underground formation through which groundwater moves is called an aquifer *(see Figure 2, water quality page 5)*. Furthermore, groundwater does not move rapidly in the aquifer. It may move only a few feet per month or even per year, whereas surface streams flow several feet per second.

Nitrate in drinking water

Excessive nitrate (NO_3) in drinking water can cause human and animal health problems, particularly for small babies. Over applying nitrogen fertilizers or manure on the soil is one source of excess nitrate in groundwater. Research clearly shows that properly manured soils have low nitrate in the shallow groundwater. If excess N is applied as either manure or commercial N, nitrate will likely increase in groundwater. The United States Public Health Service has established a specific standard of 10 milligrams of nitrate nitrogen per liter (10 ppm NO_3-N) as the maximum concentration that is safe for humans to drink.

SUMMARY OF KEY POINTS

- All manure and wastewater must be handled properly to protect the environment.
- Point source pollution is pollution from a single identifiable source.
- Nonpoint source pollution takes place over a broad area.
- Ammonia and BOD from manure spills can cause immediate water quality problems resulting in fish kills and the loss of other aquatic life.
- Sinkholes and ag drainage wells are especially sensitive to manure spills or mismanagement.
- Nutrients in manure, especially phosphorus and nitrogen, can move into surface water and cause eutrophication. This can result in a low oxygen content in the water which

can cause fish kills, offensive odors, and unsightliness.

- Manure contains bacteria, viruses, ammonia, organics, and a variety of other chemicals which may immediately impact plant and animal life in surface waters.

- The nitrogen in manure can be converted into nitrate in soils. Nitrate can leach into groundwater, creating a health hazard for humans and livestock.

- Groundwater is an essential natural resource. Eighty percent or more of Iowa's population, and fifty percent of the U.S. population rely on groundwater for their drinking water.

- Mismanagement of animal manure increases the potential for environmental contamination.

FIGURE 1

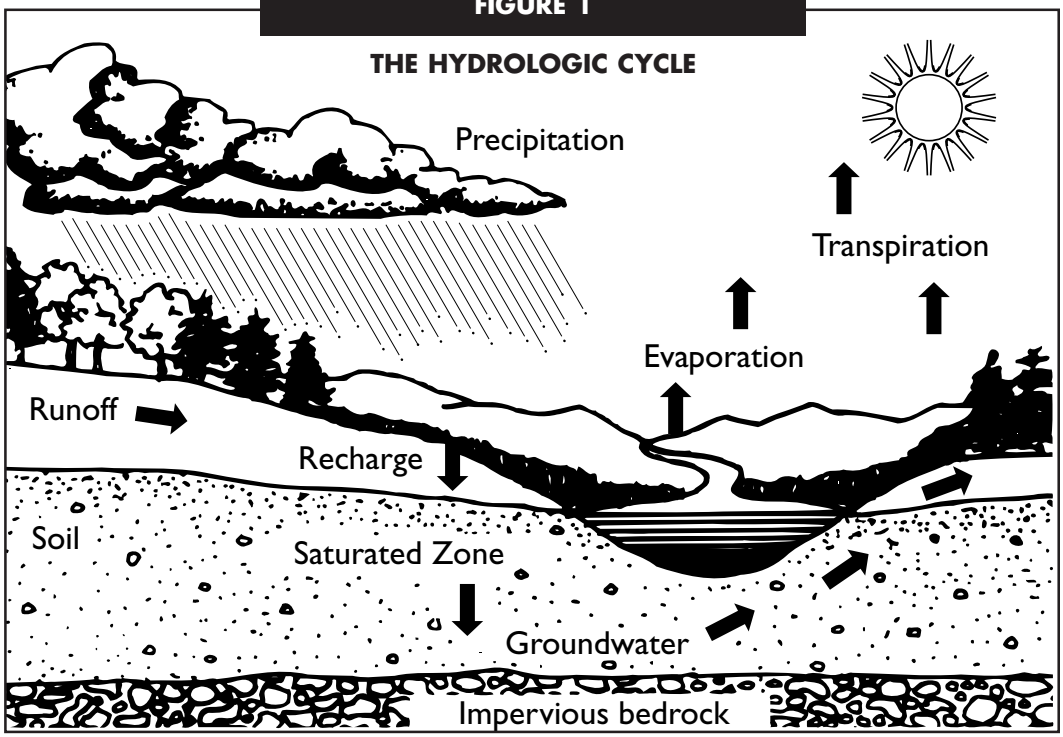

FIGURE 2