STATEMENT OF
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SECURITY AND WATER QUALITY

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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to provide the views of the U.S. Geological Survey, Department of the Interior, on pharmaceuticals in the environment. The observed presence of pharmaceuticals in the environment has prompted public interest regarding potential adverse ecological effects and potential contamination of drinking water. The interest has already increased public awareness of the ways we handle and dispose of our medications and has resulted in interest by industries in waste treatment technologies and best management practices that are most effective at removing pharmaceuticals and other trace organic chemicals from surface and ground waters and solid and liquid wastes.

The USGS studies a wide range of chemicals of emerging environmental concern. Human and veterinary pharmaceuticals are only one class of chemicals in a new group of contaminants that enter the environment via human and animal wastes. These contaminants include many chemicals used in our homes, businesses, and industries, including detergents, fragrances, fire retardants, disinfectants, plastics, and insect repellants.

Many of these chemicals are a new focus for environmental research, because they are used in relatively small quantities, and therefore, were not expected to be of significant environmental concern. In recent years, they have been detected increasingly in the environment at very low levels (less than one part per billion). Despite these extremely low levels, investigation is warranted to determine if there are any potential adverse

environmental and human health effects. Research and monitoring by the USGS and others have demonstrated that
(1) the manner in which we handle and dispose of our wastes can concentrate these chemicals in some environmental settings to levels that may be an ecological health concern, and
(2) pharmaceuticals have been entering the environment for as long as we have used them.

In 1998, the USGS broadened its water-quality science programs by initiating research on pharmaceuticals and other human- and animal-waste related chemicals. We were spurred by the findings of European colleagues, who, looking for a pesticide, detected a heart medication in the North Sea (Buser et al., 1998). The realization that chemical-use and waste-handling practices had resulted in detectable concentrations of a drug in such a large water body suggested the need for further research. By 2002, a USGS study (Kolpin et al., 2002; Barnes et al., 2002; and Buxton and Kolpin, 2002) had documented the presence of pharmaceuticals and other waste-associated chemicals in the Nation's streams, and largely defined this issue in the United States.

Since 2002, the USGS has published more than 160 reports that:

- Document the occurrence, concentration, and mixtures of these chemicals in various environmental compartments, including stream water, well water, stream sediment, and soil amended with manure and biosolids (the solid byproduct of wastewater treatment plants);
- Demonstrate the comparative contributions from various sources, including wastewater treatment plants, livestock production and animal feedlot wastes, aquaculture, onsite septic systems, combined sewer overflows, and other industrial discharges; and
- Demonstrate that some of these chemicals are assimilated by organisms (Kinney et al., 2008) or cause adverse ecological health effects (Vajda et al., 2008).

The bibliography of USGS reports that support these findings on pharmaceuticals and other emerging contaminants in the environment is available on the Internet at: *http://toxics.usgs.gov/bib/bib-Emerging.html*.

A recent example of USGS research is described in a series of reports on the levels and mixtures of human- and animal-waste related chemicals that are found in wastewaters, biosolids, and manures, and the soils to which they are applied for fertilization, as well as the earthworms found in those soils (Kinney et al., 2006a, 2006b, and 2008).

USGS investigations at a conventional drinking water treatment facility in New Jersey described the changes in pharmaceutical concentrations from the source water through multiple stages of the treatment process (Stackelberg et al., 2004, 2007). Additional investigations like this one will inform decisions on improving existing and developing new treatment works that are more efficient at removing these compounds from source waters (the sources of drinking water).

Two USGS papers, anticipated to be published in the coming weeks in the peer-reviewed journal *Science of the Total Environment*, summarize the occurrence of these chemicals in ground water (Barnes et al., in press) and in raw (untreated) sources (streams and wells) of drinking water (Focazio et al., in press). The paper surveying source waters includes results from 74 sites near drinking water intakes in 25 states and Puerto Rico. All data from these reports will be made available to the public in accompanying data reports available on the USGS web site.

The ecological effects of some pharmaceuticals found in the environment have been documented in scientific literature For example, it was not a surprise when antibiotics, which are designed to act as antibacterials, were found to have adverse effects on soil microorganisms at environmentally relevant concentrations (Thiele-Bruhn and Beck, 2005). Testing also has found that some pharmaceuticals do not cause adverse effects on some organisms tested. In one study, three freshwater invertebrates were exposed to an anticonvulsant drug commonly found in the environment. Only one of the 3 species

demonstrated an adverse effect (Oetken et al., 2005). Furthermore, evidence suggests that chemical mixtures can act collectively to cause adverse effects, even when each component is below its individual effect level (Brian et al., 2007). These are examples of an increasing body of scientific knowledge on potential adverse health effects. Significant uncertainty remains regarding the effects of long-term exposure to levels found in environmental settings.

Endocrine disruption is one adverse health effect of concern because it may occur as a result of exposure to very low levels of hormonally active chemicals. One form of endocrine disruption observed in environmental settings affects fish reproductive systems, where fish have been found to be “feminized” by exposure to a range of chemicals that act similar to the natural hormone estrogen. Some ways in which feminization is observed in fish include: (1) elevation in the percent of fish populations that are female, (2) changes in behavioral characteristics, such as nesting behavior, or (3) the presence of male fish with female characteristics, such as the presence of female egg cells in testes or of a female egg protein in their blood. A recent study (Kidd et al., 2007) demonstrated that the addition of ethinylestradiol (one of the active ingredients in birth control pills) at observed environmental concentrations to an experimental lake in Canada caused feminization and near extinction of fathead minnows in the lake.

A wide range of hormonally active chemicals can contribute to endocrine disruption, including actual biogenic hormones, synthetic hormones (pharmaceuticals, such as ethinylestradiol), and other chemicals that mimic or block hormone function (including certain pesticides, detergents, metals, and other industrial chemicals). These chemicals have been found together in waters affected by human and animal wastes and can occur together in various environmental settings. This reinforces why these chemicals must be studied together and not as separate classes of contaminants.

The effects of long-term exposure to the low levels of pharmaceuticals found in the environment on human health are not understood and warrant continued study. The USGS has collected information on the occurrence, concentrations, and mixtures of

pharmaceuticals and other waste-related chemicals in source waters used for drinking water and, to a much more limited extent, in finished (treated) drinking water. Information provided to the Food and Drug Administration (FDA) as part of the drug approval process can be useful in identifying more potent pharmaceuticals as the target of future research on possible effects of pharmaceuticals in the environment. However, whether or not there are adverse human health effects from cumulative lifetime exposures to the low concentrations and complex mixtures of pharmaceuticals found in the environment remains a research priority, particularly the effects on sensitive subpopulations such as children, women of child-bearing years, the elderly, and people with suppressed immune systems.

The USGS has developed the capability to analyze for approximately 70 pharmaceuticals in environmental samples. We have collected and analyzed samples from approximately 1,500 sites across the Nation. About a quarter of these sites were sampled in nationally-designed targeted surveys implemented by the USGS to assess the occurrence of pharmaceuticals across a wide range of environmental settings. The majority of the 1,500 sites were sampled as parts of studies conducted by the USGS in cooperation with State and local governments. These cooperative studies were designed to provide information for local resource managers on conditions in their area, and the findings are available to the public.

California provides an example of an extensive State program. The USGS California Water Science Center, in collaboration with the California Water Boards, has designed and implemented the Groundwater Ambient Monitoring and Assessment (GAMA) Project to assess the quality of California's ground water. The Priority Basin Program, a part of GAMA, will sample approximately 2,500 wells in about 120 ground-water basins in California over an 8-year period (2004-2012). From May 2004 through December 2007, we have sampled about 1,400 wells for a very large suite of constituents, both natural and human-generated, including pharmaceuticals. About 1,000 wells are being evaluated for the presence of pharmaceuticals.

The USGS is continuing to conduct research on pharmaceuticals in the environment. Our research priorities will continue to include assessing:

- Chemical loads of various sources including wastewater treatment plants, Animal Feeding Operations, landfills, and other industrial facilities,
- Ecological effects, including fish endocrine disruption in streams enriched with wastewaters and antimicrobial resistance in settings where antibiotics are released to the environment,
- The occurrence of pharmaceuticals in waters that are the source of drinking water and, to a limited degree, in treated drinking water, and
- The comparative performance of varying water and waste treatment processes to remove pharmaceuticals and other chemicals,

The USGS conducts research on pharmaceuticals in the environment with a number of partner Federal agencies, including the U.S. Environmental Protection Agency (USEPA), Centers for Disease Control and Prevention, Fish and Wildlife Service, and National Oceanic and Atmospheric Administration. The USGS, USEPA, and FDA co-chair the Federal Interagency Work Group on Pharmaceuticals in the Environment, under the auspices of the Committee on Environment and Natural Resources of the National Science and Technology Council. The Work Group has further increased coordination of Federal research. The USGS is working with our partner Federal agencies, including the FDA, to prioritize pharmaceuticals for environmental study.

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Thousands of pharmaceuticals are used for human therapies and veterinary purposes. The USGS is focusing environmental research on chemicals that are more likely to be of environmental concern, to increase the efficiency of research within the existing limited resources available. Similarly, investigations of adverse health effects must consider the actual levels and mixtures of chemicals that organisms are exposed to in the environment. Results of USGS studies of environmental occurrence are used by many scientists to guide both human and ecological health-effects studies to assure that actual environmental conditions are being tested.

We welcome the opportunity to provide any further information or assistance to the Subcommittee. Thank you, Mr. Chairman, for the opportunity to present this testimony, and I will be pleased to answer questions you and other Members might have.

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