December 19, 2003
(For Board Meeting of January 8, 2004)

COMMITTEE ON RESEARCH AND DEVELOPMENT

Mr. John C. Farnan
General Superintendent
O F F I C E

AGENDA SUMMARY: Endocrine Disrupting Compounds, Antibiotics, and Other Pharmaceuticals in the Water Environment

Dear Sir:

The purpose of this letter is to provide you with an overview and update on the issue of endocrine disrupting compounds, antibiotics, and other pharmaceuticals in the water environment that are receiving increasing attention by the United States Environmental Protection Agency (USEPA), environmental groups, and the press. How these issues impact the Metropolitan Water Reclamation District of Greater Chicago (District), and what the District is doing about them, will also be discussed.

I. Endocrine Disrupting Compounds

A. Issue

The endocrine system consists of several glands in different areas of the animal and human body that produce hormones with various functions. These functions include growth, reproduction, metabolism, and others. The USEPA has defined an endocrine disrupting compound as “an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behavior.”

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Over 100 compounds are now considered to be endocrine disruptors. These can be divided into five categories.

- steroid compounds (estrogens)
- surfactants (nonylphenol and its ethoxylates)
- pesticides, herbicides, and fungicides (DDT, dieldrin, 2,4-D)
- polyaromatic compounds (PAHs, PCBs, brominated flame retardants)
- organic oxygen compounds (phthalates, dioxins, bisphenol A)

From the above groups, estrogen compounds and nonylphenol and its derivatives are getting the most research interest due to their potency. Brominated flame retardants, bisphenol A, PCBs, and dioxins are also being studied.

Although endocrine disrupting chemicals can have numerous effects on living organisms, the main areas of current concern are the following:

- So-called “feminization of river fish” which may affect fish population densities.
- Deformities in frogs.
- Earlier onset of puberty in humans, decreasing sperm counts in male humans, and subtle birth defects.

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The scientific community is currently divided on the magnitude and importance of the endocrine disruptor problem. In general, the feminization of fish seems to be the issue where there is more of a consensus of a problem. The other issues relative to endocrine disruptors are still being widely debated because of a lack of scientific research and studies. However, some research indicates that these types of endocrine disrupting compounds can have adverse effects, especially on aquatic organisms, even at extremely low concentrations.

B. Impact on the District

In the simplest terms, all five categories of endocrine disrupting compounds previously listed enter District water reclamation plants (WRPs) in the raw sewage. They originate from female urine, from household products, from industrial wastes, and from surface runoff after a rain event. In general, the predominant source of steroid compounds is female urine, the predominant source of surfactants is a combination of house hold waste and industrial waste, the predominant source of pesticides, herbicides, and fungicides, and the polyaromatic compounds is a combination of industrial waste and surface runoff, and the predominant source of organic oxygen compounds is industrial waste.

These compounds are present at extremely low concentrations that are often in the parts per billion range and at times even in the parts per trillion range. At these low levels, the District laboratories do not have the sophisticated instrumentation required to measure them. Thus, for a large number of these compounds, we do not know how much is entering our WRPs, how much is leaving our WRPs either in the effluent or the biosolids, and at what levels these compounds are occurring in our river systems. Research does indicate that some of these compounds are removed during the wastewater treatment process. However, many researchers, many environmental groups, and the USEPA are all

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pointing to wastewater treatment plants as one of the largest dischargers of endocrine disrupting compounds to the water environment. It is the amount of these compounds in a waterway that ultimately affects fish life, and indirectly affects humans because wastewater treatment plant effluent ultimately becomes the source of drinking water for the downstream user.

C. District Action

1. District staff is following the scientific literature on this issue. This is allowing us to learn more about the problem of endocrine disruptors in the water environment, about new analytical techniques for measuring endocrine disruptors, and about technologies for removing endocrine disruptors during the wastewater treatment process.

2. District laboratories are analyzing raw sewage, final effluent, sludge, biosolids, and waterway samples for the endocrine disrupting compounds that we can detect with our existing analytical equipment. These include some of the surfactants; some of the pesticides, herbicides, and fungicides; and some of the polyaromatic compounds. As mentioned previously, in most cases the concentrations are below District laboratory detection limits.

3. Where possible and cost effective, we are sending samples to university researchers and private laboratories for analysis of some endocrine disrupting compounds.

4. When possible through mutual interest, we are sending samples to the USEPA laboratories for analysis of some endocrine disrupting compounds. This is done at no cost to the District.

5. We are working with the USEPA, Region V, to learn more about potential sources of endocrine disrupting com-

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pounds in the District service area, and also to learn more about the effects that endocrine disrupting compounds are having on the District's waterways.

6. We are supporting Water Environment Research Foundation (WERF) projects on this subject through the payment of our annual membership dues.

To the best of our current knowledge, the only feasible method of reducing endocrine disruptor concentrations is through control of these compounds in the market place by limiting their manufacture or their use in commercial, industrial, and residential applications.

II. Antibiotics

A. Issue

Antibiotics are chemical or biological compounds given to humans and animals to treat or prevent bacterial infections. In the United States, a doctor's prescription is needed to obtain these compounds, but they are sold over-the-counter in some countries. Examples of antibiotics are penicillin, amoxicillin, tetracycline, Cipro®, Biaxin®, etc.

Medical research has indicated that bacteria have the ability to gain resistance to certain antibiotics if they are misused or overused by people, and that this resistance is then passed along to succeeding generations of these same bacteria. This leads to the creation of so-called "antibiotic resistant strains" of bacteria, which are considered very dangerous as people infected with them do not respond to conventional medical treatment. At present, this can be a problem in a hospital setting, where documented cases of patient deaths have been reported from acquiring antibiotic resistant infections after sur-

gical procedures. The current solution to this problem is for pharmaceutical companies to continually develop new types of antibiotics. However, there is a limit as to how many antibiotics can be developed.

B. Impact on the District

1. Infected individuals who use antibiotics inappropriately can produce antibiotic resistant bacteria in their systems, and these can be discharged into the sewer systems in their saliva, feces, and urine. Also, healthy individuals exposed to antibiotic resistant bacteria can become infected, and likewise discharge their wastes into the sewer system.

2. Pharmaceutical industry wastewater containing antibiotics, unused antibiotics disposed of by individuals, and unmetabolized antibiotics which people excrete can all enter the sewer system in low concentrations. These low levels of antibiotics (usually in the parts per billion range) can exert a natural selection process at the wastewater treatment plant. This results in antibiotic resistant bacteria being propagated within the wastewater treatment plant or in rivers downstream of the wastewater treatment plant effluent discharge.

Limited research indicates that all types of bacteria entering a wastewater treatment plant are significantly reduced in number as they pass through the various treatment stages. However, some bacteria survive the treatment processes and are present in final effluent and biosolids. Limited research also indicates that the disposal of unused antibiotics and the discharge of unmetabolized antibiotics is occurring, but it is unclear as to the magnitude of the problem from an environmental standpoint. This is a relatively new area of research.

The District does not have the sophisticated analytical instruments needed to analyze for antibiotics in our wastewater. In addition, the District does not have the sophisticated microbio-

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logical facilities that are required to look for various antibiotic resistant bacteria. Therefore, at this time no research on this issue is being performed at the District.

C. District Action

1. District staff is following the scientific literature on this issue. This will allow us to understand the extent of the problem relative to the wastewater treatment industry.

2. We have recently entered into a cooperative agreement with researchers at Purdue University to analyze District biosolids for antibiotics, and also to track the fate of these antibiotics, if found, at land application sites receiving biosolids. Purdue University has obtained a research grant to do this work, and it is being done at no cost to the District.

3. The Engineering Department will be preparing plans to remodel a room at the Cecil Lue-Hing Research and Development Complex in 2004 for use as a molecular biology research laboratory. Although the study of antibiotic resistant bacteria is not our main interest for this new laboratory, this type of work could be performed if this issue becomes more important in the future.

To the best of our current knowledge, control of this problem resides with the health care profession and the pharmaceutical industry.

III. Other Pharmaceutical Products

A. Issue

Hundreds of medicines are produced and/or prescribed in the United States. When individuals consume these products, a portion of the dose may pass through the body unmetabolized and enter the sewer system. People also dispose of unused medicines

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by flushing them down the toilet. The pharmaceutical industry also discharges wastes containing various pharmaceutical products into the sewer system.

Thus low concentrations, often in the parts per billion range, of all types of pharmaceutical products can be entering District WRPs. The District does not possess the sophisticated analytical equipment needed to analyze these compounds, and we do not know to what extent these products pass through the wastewater treatment process unchanged, leaving the WRP in either effluent or biosolids.

Recent research has found trace amounts of various pharmaceutical products in many of the nation's rivers and streams. It is postulated that some of these could be effecting aquatic organisms. For example, a recent report stated that measurable levels of Prozac®, an antidepressant, had been found in fish tissue. It is speculated that this could effect the behavior of fish.

B. Impact on the District

All of these products usually end up in the sewer system and pass through the wastewater treatment process, ending up in either final effluent or biosolids. At this time, research work has not progressed to the point of truly knowing the significance of these discharges into the environment.

C. District Action

District staff is following the scientific literature on this issue. This will allow us to understand the extent of the problem relative to the wastewater treatment industry. This is a nationwide, societal problem, which the District currently does not have the resources to actively address.

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Like the problem with antibiotics, we believe that the control of disposal of unused medicines resides with the health care profession and the pharmaceutical industry. The control of the discharge of unmetabolized medicines will require extensive research by the USEPA to develop effective and affordable treatment technologies for the wastewater industry.

The discharge of endocrine disrupting compounds, antibiotics and other pharmaceutical products is a complex societal problem that does not lend itself to an easy solution. The discharge of these compounds and products to the water environment, especially in effluent dominated waters, may threaten fish and other aquatic organisms.

Respectfully submitted,

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