Reports Relating to Health Safety Issues of Recycled Water

A summary prepared by the Redwood City Public Works Services Department

City Council members and residents have asked for details on studies and reports relating to the health safety of using recycled water and agencies that regulate its use.

This report responds to these requests.

Updating EPA's Guidelines for Water Reuse: Study Addresses National Reclaimed Water Use Trends, E Disrupters, & More

Water reclamation and reuse rules and regulations are the responsibility of state agencies, and the guidelines are not intended to be regulatory standards. The revised guidelines will be available in 2003.

The U.S. Environmental Protection Agency (EPA) and the U. S. Agency for International Development (USAID) are revising portions of the 1992 EPA *Guidelines for Water Reuse* to reflect significant technical advancements and institutional developments since 1992. The guidelines will also address new areas, including national reclaimed water use trends, endocrine disrupters, and approaches to integrated water resources management.

Across the world, recycled water is becoming a critical water source, and reuse strategies are recognized in many U.S. states as an integral part of water resources management. The original guidelines, published in 1980, gave many state agencies direction in establishing reuse permits and helped to foster state water reuse regulations. The revised guidelines will include an updated inventory of state reuse regulations.

EPA Water Reuse Guidelines Major Revisions

Led by CDM, whose reuse experts prepared the 1980 guidelines and the 1992 update, the team of experts will examine several sections of the guidelines for major revisions, including:

Reuse and Water Conservation: How reuse could delay or eliminate the need for expansion of potable water supplies and treatment facilities and how to obtain credit for reuse conservation.

Pathogenic Microorganisms and Health Risk: Risk assessment and indicator organisms, and a report on recent research and development activities.

Treatment Requirements: Updated treatment requirements, including emphasis on disinfection processes and advanced wastewater treatment practices since 1992.

Quality Assurance in Monitoring: Reclaimed water quality monitoring methods for assuring suitability for intended use.
Groundwater Recharge: Expanded discussion on the fate of contaminants in recharges systems and health and regulatory considerations.
Augmentation of Potable Supplies: Discussion and examples of endocrine disrupters, reuse water quality objectives, and the EPA source water protection program.
Federal Legal Issues: Update of legal issues relating to EPA, U.S. Department of Defense, and U.S. Department of Administration.
Grant and State Revolving Fund Programs: Accessing grant funding.
Public Information Programs: Public participation in reuse planning and an overview of public perception.
Planning for Reclaimed Water Outside of the U.S.: Guidelines based on World Health Organization (WHO) water reuse regulations.
Potable Reuse Issues: Indirect potable reuse issues with an emphasis on recent studies and projects.

One of the most important topics to be addressed in the update is the coverage of indirect potable reuse. With populations growing and sources of available new raw water supplies diminishing, several authorities are taking necessary steps to address water supply issues. More emphasis will be placed on reuse as an alternative to expansion of potable water supplies and treatment facilities. One example is the movement to account for various reuse benefits as credit--including water conserved, fertilizer value, groundwater recharge, and energy savings.

Funding and Public Information

The evolution of beneficial reuse systems--where treated reclaimed water is used for non-potable purposes such as golf course irrigation and industrial manufacturing--required change in public perceptions, treatment technologies, and state regulations. Today, the public's acceptance of recycled water use is affected by the fate of various persistent organic compounds, pharmaceuticals, and personal care products in all water supplies. The revised guidelines will include an overview of public perceptions of water reuse and strategies for involving the public in reuse planning. The team of experts will also take a critical look at some of the proposed indirect potable reuse projects and the reasons why public objection prevented implementation.

Each successful reclaimed water system must also strike a balance between the cost of creating or expanding a beneficial reuse system, and the funds expended to ensure a permittable means of effluent disposal. Grant funding and state revolving funds are important in cases where high capital investment costs of initiating a water reuse program may preclude public support of such a program despite its numerous benefits.

DHS' Drinking Water Action Level for NDMA

There have been some public inquiries into N-nitrosodimethylamine (NDMA) and its potential impact with recycled water. As noted above, the EPA is initiating a new inquiry into this and other health safety factors, but historically, NDMA has not been regarded as a common drinking water contaminant, and it is not regarded as an issue with recycled water. Nonetheless, this is the California Department of Health's comment on the subject as it relates to drinking water.

http://www.dhs.ca.gov/ps/ddwem/chemicals/AL/actionlevels.htm

Last Update: December 6, 2001

Basis for the NDMA Action Level
Actions To Be Taken if Action Level is Exceeded
N-nitrosodimethylamine (NDMA) historically has not been considered a common drinking water contaminant, and it has no state or federal drinking water standards (maximum contaminant levels, MCLs). In the absence of an MCL, DHS uses a drinking water "action level" for the protection of public health.
If the NDMA action level is exceeded, the following apply:

REQUIREMENT
Requirement for Local Governing Body Notification: If NDMA in a drinking water well exceeds the action level, notification of local governing bodies is required. Section 116455 of the California Health and Safety Code requires a public water system, whenever a well that is used as a drinking water source for a public water system is discovered to contain—or is closed because it contains—a contaminant in excess of a MCL or an action level, to notify the governing body of the local agency in which users of the drinking water reside (e.g., the city council or county board of supervisors) within 30 days of the discovery or closure.
RECOMMENDATIONS
Recommendation for Source Removal
If NDMA in a drinking water source exceeds 0.2 µg/L, DHS recommends that the source be removed from service. This concentration corresponds to a 10^{-4} cancer risk, the upper bound of the risk range considered "acceptable" by regulatory agencies.
Recommendation for Consumer Notice
DHS recommends that the utility inform its customers and consumers as soon as is feasible about NDMA's presence and its potential for adverse health effects. DHS recommends that whenever such a public "right-to-know" notice occurs as a result of exceeding a drinking water action level, it should be provided to customers and to the water-consuming population in the affected area that would not directly receive such information, including renters, workers and students.
As with other consumer notification, drinking water systems should work with the local district office of the DHS Drinking Water Program in the developing any proposed notice for NDMA contamination.
FOR NDMA PRODUCTION IN DRINKING WATER TREATMENT: If NDMA is present in drinking water as a product of disinfection/treatment water, DHS recommends consumer notification if the NDMA concentration exceeds 0.02 µg/L. This level is also applicable to recycled water that is associated with an indirect potable reuse project. The notification may include information about NDMA's presence as a potential disinfection or treatment byproduct. DHS recommends that systems produced NDMA in their water treatment reduce

the production of NDMA to levels as low as feasible.

NDMA OF OTHER ORIGIN: For NDMA that is not the result of drinking water disinfection/treatment or recycled water for indirect potable reuse, or of unknown origin, DHS recommends consumer notification if NDMA present in water is served to the public in excess of 0.002 µg/L.

Basis for the NDMA Action Level

NDMA causes cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals that cause cancer in laboratory animals also may increase the risk of cancer in people who are exposed over long periods of time. The National Toxicology Program lists NDMA as "reasonably anticipated to be a human carcinogen" (NTP, 2000)

NDMA is listed as a chemical known to the state to cause cancer [Title 22, California Code of Regulations (22 CCR), Section 12000], pursuant to the Safe Drinking Water and Toxic Enforcement Act of 1986 ("Proposition 65"), Health and Safety Code Section 25249.5, *et seq*.

The US EPA also evaluated the health effects of NDMA, and classifies it as a probable human carcinogen, based on the induction of tumors at multiple sites in laboratory animals exposed by various routes. NDMA produces liver tumors after oral administration in rats, and tumors in lung, liver and kidney in rats and mice after inhalation exposures. NDMA also acts as a transplacental carcinogen when administered by various routes to pregnant rats, mice and hamsters. NDMA is also mutagenic, and is structurally related to known carcinogens.

Following the initial northern California findings in February 1998, DHS informed affected drinking water utilities that the Office of Environmental Health Hazard Assessment (OEHHA) evaluated NDMA's cancer risk. OEHHA established in 22 CCR §12705(b)(1) a 0.04-µg per day exposure level for NDMA for "no significant risk" (10^{-5}), for purposes of Proposition 65's warning requirements and discharge prohibition. This equates to 0.02 µg/L in drinking water, using a 2-liter daily consumption for 70 years.

DHS generally uses a *de minimis* (*i.e.*, 10^{-6}) risk as the basis for an action level for contaminants considered to pose a cancer risk. A *de minimis* risk is considered to be below regulatory concern, and is the risk level DHS uses for action levels for carcinogens such as NDMA. This corresponds a theoretical risk of to up to one excess case of cancer per million people drinking 2 liters of water per day for a 70-year lifetime. In April 1998, DHS established an action level for NDMA of 0.002 µg/L in drinking water, the 10^{-6} level, derived from OEHHA's regulatory level mentioned above. For purposes of comparison, US EPA's 10^{-6} risk level in drinking water corresponds to a concentration of NDMA of 0.0007 µg/L (US EPA, 1997).

In 1998, analytical capabilities did not enable detection at levels as low as 0.002 µg/L, so DHS' approach was to consider any detectable quantity as exceeding NDMA's action level. Several laboratories are now able to detect NDMA at 0.002 µg/L. [See NDMA laboratory analyses]

References

National Toxicology Program (NTP), 2000, *"N-Nitrosodimethylamine CAS No. 62-75-9," Ninth Report on Carcinogens*, Public Health Service, US Department of Health and Human Services.

US Environmental Protection Agency (US EPA), 1997. N-nitrosodimethylamine; CASRN 62-75-9 (04/01/97), Integrated Risk Information Service (IRIS) Substance File, Internet download.

WateReuse Foundation Research Summary 2002

Summary

The WateReuse Foundation (WRF) is funding a number of projects in 2002, as described below, using a combination of Federal and state funding. The projects being funded consist of the highest priority projects identified by the membership and the Foundation's Research Committee. The Redwood City Public Works staff is monitoring these studies and will provide copies of results as they become available.

New Initiative in Salinity Management & Desalination Research

Two specific concerns have been voiced by members of the Tri-State Coalition (Nevada, Arizona, California) and the WateReuse Association: 1) the challenge posed by disposal of brine concentrate (i.e., reverse osmosis reject waters); and 2) the ever increasing levels of total dissolved solids (TDS) in both surface and groundwaters.

Descriptions of Currently Funded WRF Research Projects

Removal and/or Destruction of N-nitrosodimethylamine amine (NDMA) in Wastewater Treatment Processes

NDMA, a known human carcinogen, occurs or is used in the manufacture of rocket fuels, such as hydrazine. NDMA also forms in wastewater treatment, particularly as a result of chlorination of wastewater that contains dimethyl amine and nitrite. The objective of this project is the investigation and optimization of wastewater treatment processes for removal of NDMA precursors, minimization of NDMA formation, and removal/destruction of NDMA. The current methodology for measurement of NDMA is extremely costly, ranging from $500 to $1000 per sample. The project objective is to reduce the cost of accurate, repeatable analysis of NDMA in wastewater, surface water, and groundwater samples.

Characterizing Salinity Contributions in Sewer Collection and Reclaimed Water Distribution Systems

As utilities continue to develop sources to meet increased demand and as those sources become scarcer, an increasingly important source of water for agricultural and urban use is recycled water. One of the governing factors for the use of recycled water is the salinity level. This research will develop and test a protocol for characterizing commercial, industrial, and residential salinity contributions in sewer collection and reclaimed water distribution systems.

Characterizing Microbial Water Quality in Non-Potable Reclaimed Water Distribution Systems to Optimize End Uses

One of the most challenging issues facing current and future users of reclaimed water is the potential deterioration of distribution system water quality caused by regrowth of coliforms and other organisms in distribution systems and storage reservoirs. This research will characterize the

extent and nature of problems of water quality deterioration as it relates to microbial regrowth in recycled water distribution systems.

Impact of Using Recycled Water on Edible Crops

The objectives of this project are as follows: 1) to measure the public health and economic impact of long-term irrigation of edible food crops with recycled water; 2) to develop data to document differences in growth rates, plant appearance and yield, and plant physiology between a control water source and recycled water of various water qualities and irrigation delivery methods; and 3) to evaluate the potential of intrusion of microbial organisms of public health significance into the edible portions of the plants.

The Use of Bioassays and Chemical Measurements to Assess the Removal of Endocrine Disrupting Compounds in Water Reclamation Systems

The purpose of this project is to improve the current understanding of removal of endocrine disrupting chemicals during water reclamation processes. This project will employ bioassays as a component of studying removal and/or inactivation of endocrine disrupting compounds by unit operations

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Evaluation and Testing of Bioassays for Pharmaceutics in Reclaimed Water

Diverse classes of pharmaceutics and their metabolites have been identified in wastewaters and the aquatic environment and the risk to public/ecological health from exposure to these contaminants is unknown. This research will evaluate the use of DNA arrays to rapidly screen changes in gene expression in response to aquatic pharmaceutical exposure.

RECYCLED WATER SAVES CALIFORNIA FARMS

http://www.environmental-center.com/articles/article1000/article1000.htm#article1

After studies show no viable microorganisms in tertiary treated wastewater, growers in Salinas Valley now get two-thirds of their agricultural water needs from recycled sources.

Recycled water is saving the farm for approximately 75 growers in the Salinas Valley along California's Central Coast. Because their wells were becoming contaminated with seawater, these growers began irrigating their high-value food crops with recycled water from a nearby wastewater treatment plant. The Monterey (California) Regional Water Pollution Control Agency (MRWPCA) began exploring the feasibility of a recycled water project in the 1980s because of seawater intrusion into well water in the Salinas Valley.

The Salinas Valley is one of the nation's top producers of cold season vegetable crops, such as lettuce and broccoli. While state regulations allow for application of tertiary treated water on agricultural crops, it is usually used on crops for animal fodder or for food crops that will not be eaten raw. Because many of their crops are intended for raw consumption, local growers and health officials were concerned that recycled water might contaminate the produce with pathogens. Consequently, health officials directed the MRWPCA to conduct pathogen studies before they would authorize the project.

MRWPCA conducted an extensive study that would ultimately demonstrate that recycled water is as safe as well water when used to irrigate food crops. Released in 1987 (and updated in 1998), the $8 million dollar study showed no contamination from the pathogens tested, which included viruses and fecal coliform, when recycled water was used on a variety of food crops common to the region, including artichokes, lettuce, broccoli, and cauliflower. State and local regulators soon gave approval for use of MRWPCA's recycled water on food crops. The agency then had the green light to upgrade its plant from a secondary to a tertiary treatment system. While secondary treatment is a biological process resulting in biosolids and clear water, tertiary treatment involves further processing to remove microorganisms and disinfect the water.

CONCERNS OVER "EMERGING PATHOGENS

As the plant was nearing completion in 1997, farmers who were planning to use the recycled water became concerned that it might be contaminated with what they called "emerging pathogens". These pathogens, which were not included in the 1987 study, included the resistant E. coli 157:H7 strain, Crytosporidium, Giardia, and Salmonella. The growers' fears were fueled by increasing media coverage of food poisoning incidents related to pathogen contaminated produce, such as the 1996 Odwalla incident involving E. coli contaminated apple juice.
In response to these fears, MRWPCA conducted additional studies to test for the presence of the emerging pathogens. The tests found no evidence of viable microorganisms in the tertiary treated water. **These results were released in a report in 1998.** The MRWPCA also enhanced its treatment and pathogen-monitoring program to further assure the growers.

MISSION ACCOMPLISHED

In 1997, the MRWPCA completed the $78 million reclamation project in partnership with the Monterey County Water Resources Agency. Capable of producing 19,500 acre-feet of water per year, the plant now distributes water to 12,000 acres of coastal farmland.
Delivering the recycled water to coastal farms required construction of an extensive distribution system. The system consists of 45 miles of pipeline, 112 connection turnouts, and serves approximately 75 growers. Pumps connected to the pipeline are identified by bright purple paint and dot fields throughout the region. Growers connected to this system receive approximately two-thirds of their agricultural water needs from recycled water, while well water meets their remaining needs.

To date, the farmers using recycled water seem pleased with the quality of the water. The MRWPCA continues to work with the growers to ensure that the recycled water is suitable for agriculture. Because the recycled water contains salts, the MRWPCA periodically tests soil salinity at farms that are using its recycled water. Chlorine levels of 4-6 ppm have not presented a problem for the farmers.

USE IN ORGANIC FARMING

Since distribution of treated water began in 1997, many growers throughout California, especially those who embrace sustainable and organic farming practices, have expressed an interest in using recycled water. Brian McElroy of California Certified Organic Farmers (CCOF), an independent certifying organization of organic farms, addressed the acceptability of recycled water for use on organic farms at the recent Ecological Farming Conference that is held annually near Monterey. Although CCOF has yet to take a formal stance on recycled water, McElroy stated, "The organic and sustainable farming community has an obligation to assess recycled water because organic is about sustainability."

While California has a long history of water supply problems, water recycling programs throughout the state are helping to create a solution. MRWPCA's General Manager, Keith Israel,

believes that water recycling will soon become mandated in the not-so-distant future in California. “Water is more scarce than landfill space, and there are laws for mandatory recycling to keep waste out of landfills. I predict there will be mandatory recycling of water in the future.”

Statement of Support for Water Recycling

The United States Environment Protection Agency (EPA), Region 9; the California Water Resources Control Board; the California Department of Water Resources; the California Department of Health Services; the California Conference of Directors of Environmental Health; the Unites States Bureau of Reclamation; and the WateReuse Association of California adopt the following joint statement of support for the water reclamation.

Whereas, water reclamation is defined as the beneficial use of treated wastewater for such planned uses as irrigation, industrial cooling, recreation, groundwater recharge, environmental enhancement, and other uses permitted under California law; and

Whereas, the Governor of California has made water reclamation an important element of California’s water supply policy; and

Whereas, the California State Legislature has adopted statewide goals for the water reclamation providing 700,000 acre-feet by the year 2000; 1,000,000 acre-feet by the year 2010 so as to help the state meet its future water needs; and

Whereas, the Department of Water Resources estimates that California will need to increase its water supply by 3,000,000 to 5,000,000 acre-feet by 2020, which includes an assumption that 1,300,000 acre-feet of conservation will be achieved by then; and

Whereas, the Bureau of Reclamation is currently engaged in several water conservation and reuse projects and plans to help promote water saving throughout California and the west.

Whereas, the amount of water reclaimed in California has increased from 165,00 acre-feet per year in 1977 to over 380,000 acre-feet in 1993; and

Whereas, the WateReuse Association of California’s 1993 survey reports that water reuse will continue to increase from 380,000 acre-feet per year in 1993 to a projected 1,000,000 acre-feet in 2000 and to a projected 1,300,000 acre-feet by 2010, and that the major constraints to achieving these levels of reuse appear to be funding, institutional and regulatory disincentives, the permitting process, and public acceptance; and

Whereas, California’s extensive experience with water reclamation

provides reasonable assurance that the potential public health risks associated with water reclamation in California are minimal, provided all regulations pertaining to water quality, monitoring, reporting, and reliability are adhered to; and

Whereas, California law and regulations are fully protective of human health and require a specific level of water quality and treatment corresponding to each beneficial use of reclaimed water; and

Whereas, this set of laws and regulations also provides general requirements and provisions which reclaimed water purveyors and users must comply, including monitoring and reliability requirements to further assure that the use of reclaimed water is safe; and
Whereas, Congress established pollution prevention as a "natural objective" in the Pollution Prevention Act of 1990 and EPA has adopted pollution prevention as the new environmental ethic, and EPA's definition of pollution prevention, pursuant to the Act, includes increased efficiency in the use of water.

Now, therefore, be it resolved, the undersigned agencies support the pursuit and development of federal, state, and local water reclamation policies and regulations that will reduce constraints and promote water reclamation. Specifically, the agencies will work to overcome and reduce institutional and regulatory disincentives and funding constraints, and to promote public acceptance of water reclamation.

The agencies will cooperate to develop specific policies and resource commitments that will enable the State of California to meet the Legislature's water reclamation goals and to help satisfy the State's overall water needs.

Signed:

- **The United States Environment Protection Agency (EPA), Region 9;**
- **The California Water Resources Control Board;**
- **The California Department of Water Resources;**
- **The California Department of Health Services; the California Conference of Directors of Environmental Health;**
- **The United States Bureau of Reclamation; and**
- **WateReuse Association of California**