research may address advanced water treatment op-portunities. Nevertheless, the high cost to implement cooling causes this environmental enhancement project to be cost prohibitive at the present time.

4 Fate and Transport in Cooling Towers

During cooling tower operations, water is released to the atmosphere. Most of this water exits as pure water in the form of vapor, while a small percentage leaves in droplets, referred to as drift. It has been suggested that if cooling water drift contained EDCs and if the drift landed on streams or percolation ponds, those contaminants could reach surface waters and groundwater. This potential EDC pathway is largely mitigated by cooling tower regulations that require minimizing drift to less than 0.005 percent of the total amount of water released, and the use of the latest drift eliminators that further reduce drift volume. Potential areas of future study include investigating volatile compounds in cooling towers and the likely concentration of EDCs remaining in drift.

Future Challenges

The EDC issue is complicated since it involves thousands of individual chemicals and little environmental impact data. Scientific research for the effects of EDCs on humans and wildlife is in its infancy with respect to individual compounds, their effects on primary and secondary sexual characteristics, and potential multi-generational effects. The amount of incomplete information continues to grow, given the number of compounds to consider, the inherent difficulty in obtaining definitive cause-and-effect relationships, and the understanding that future medical and scientific advances will continue to create additional compounds for evaluation. No simple and inexpensive water treatment technology presently exists that will remove these compounds.

To help reduce these scientific and technical uncertainties, researchers throughout the world are assessing EDCs and their potential impact. The City of San Jose, and other water utilities nationwide, are sponsoring scientific research to assess:

1. EDC removal from water treatment systems,
2. The occurrence and ecological significance of EDCs in watersheds,
3. Estrogenic activity of source and drinking waters, and
4. Research needs for pharmaceutically active compounds.

The WMI's EDC Workgroup will continue to track and actively support these scientific research endeavors.

The potential environmental consequences of EDCs challenge government and the private sector to determine how to evaluate the benefits and risks of using products containing EDCs. On the one hand, an approach based on the "weight of scientific evidence" would suggest patience in eliminating products until more information is available. On the other hand, the "precautionary principle" recommends avoiding those practices which have a reasonable potential to cause damage even when all the facts are not known. Since the potential risk of continuing to release EDCs into the environment is too great for our community to delay action until the scientific and technical issues are completely resolved, the EDC workgroup seeks to balance these directions by focusing the community's attention on opportunities to prevent pollution and reduce release of EDCs into the environment.

EDC Workgroup challenges for the future will include:

- Developing decision-making criteria that reduce the potential for unintended harm in the absence of complete scientific analysis (precautionary principle)[5]
- Exploring innovative wastewater treatment processes for specific target compounds and/or intended water uses
- Communicating feasible and effective pollution prevention strategies for known and suspected EDCs
- Educating community leaders and the public on the emerging EDC issues.

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3 www.epa.gov/opptintr/chemrtk/volchall.htm

4 Huang, C.H., Cwiertney, D. and Sedlak, D.L. 1999. Estrogenic hormones in effluents from conventional and advanced wastewater treatment plants. *Environ. Toxicol. Chem.* 2001, 20, 133-139.

5 "An Example of the Precautionary Principle at Work: Endocrine Disruption" at www.gdrc.org/u-gov/precaution-2.html

The EDC Workgroup of the WMI discusses EDCs and emerging contaminants. Interested parties welcome.

Santa Clara Basin Watershed Management Initiative (WMI)
MISSION: To protect & enhance the watershed, creating a sustainable future for the community and the environment.
For more information about the WMI, contact Alice Ringer at (650) 494-3819 or email at Alice.Ringer@CityofPaloAlto.org. To download WMI publications, go to www.scbwmi.org.

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SANTA CLARA BASIN

WMI

WATERSHED MANAGEMENT INITIATIVE

Information Sheet

February 2003

WMI SIGNATORIES

Public Agencies
CA Department of Fish & Game
City of Cupertino
City of Palo Alto
City of San Jose
City of Santa Clara
City of Sunnyvale
Guadalupe-Coyote Resource Conservation District
San Francisco Bay Regional Water Quality Control Board
San Francisquito Creek Joint Powers Authority
Santa Clara County
Santa Clara County Open Space Authority
Santa Clara Valley Transportation Authority
Santa Clara Valley Urban Runoff Pollution Prevention Program
Santa Clara Valley Water District
US Army Corps of Engineers
US Environmental Protection Agency
USDA Natural Resource Conservation Service

Business/Trade Associations
California Restaurant Association/Dairy Belle Freeze
Home Builders Association of Northern California
San Jose Silicon Valley Chamber of Commerce
Santa Clara Cattlemen's Association
Santa Clara County Farm Bureau
Silicon Valley Manufacturing Group

Environmental and Civic Groups
CLEAN South Bay
League of Women Voters
Salmon and Steelhead Restoration Group
San Francisco Bay Bird Observatory
San Francisquito Watershed Council
Santa Clara Valley Audubon Society
Silicon Valley Pollution Prevention Center
Silicon Valley Toxics Coalition
Western Waters Canoe Club

Endocrine Disrupting Compounds and Potential Impact on Water Use in the Santa Clara Valley Watershed

Introduction

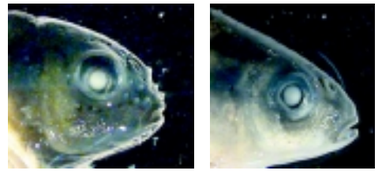
Endocrine disrupting compounds (EDCs) are defined as chemicals that interfere with the normal function of hormones that control growth and reproduction in animals and humans. Many pollutants that are considered potential EDCs are found in surface waters throughout the world. Studies are currently proposed to determine the impact of EDCs in the San Francisco Bay.

EDCs find their way into the environment from human use and production followed by disposal or release into soil, air, and water. Through atmospheric deposition, stormwater runoff, wastewater discharges, and application to food crops and animal feed, EDCs may find their way into garden soil, food products, groundwater basins, creeks, and rivers. A recent report from the U.S. Geological Survey concluded that many waterways throughout the United States contain detectable concentrations of hormones, pharmaceuticals, and personal care products (including EDCs) from domestic, industrial, and animal husbandry wastewaters.[1]

Pharmaceutically active compounds (PhAC) and other industrial and household chemicals are often included in discussions about endocrine disrupters. However, this report only considers those compounds that have the potential to disrupt the endocrine system.

There are several well-documented cases of endocrine disrupting effects on fish and wildlife. Scientific studies have demonstrated a relationship between exposure to EDCs and abnormal thyroid function, sex alteration, poor hatching success, decreased fertility and growth, and altered behavior. Aquatic organisms have been shown to be particularly sensitive to exposure to low levels of EDCs.

The science of EDCs and their impact is an emerging field. The U.S. Environmental Protection Agency (U.S. EPA) has been tasked with evaluating more than 87,000 compounds for potential endocrine effects. Based upon current scientific information, the US EPA considers endocrine disruption to be "a mode or mechanism of action that may lead to other outcomes or effects" rather than an adverse endpoint in and of itself.

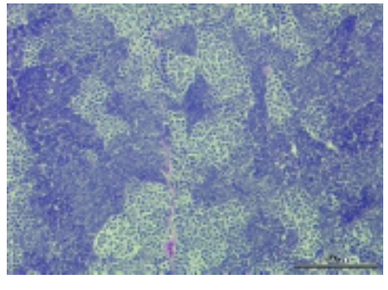


Secondary sex characteristics may also be affected by EDCs. Above left is a male fathead minnow. Above right is a female fathead minnow. At right is a female minnow that developed male nose markings following exposure to androgenic EDCs. (Provided by G. Ankley, U.S. EPA, Duluth, MN)

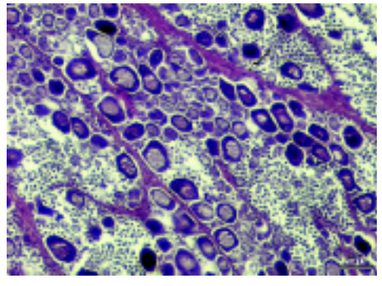
Categories of Known and Suspected EDCs and Primary Pathways to Waterways

Category	Examples	Primary Pathway to Waterways
Prescription and non-prescription drugs	Birth control pills, steroid-based medications, chemotherapy medications	• Drugs partially metabolized in the body. Remaining drug and metabolites excreted in urine and feces. Wastewater treatment facilities may partially remove or breakdown these chemicals. Remainder of drugs and metabolites discharged to surface water. • Improper disposal of leftover medication.
Household products	Detergents, surfactants, and their breakdown products	• Commonly rinsed down sinks and flushed down toilets. Wastewater treatment facilities may partially remove or breakdown these chemicals. Remainder of compounds and breakdown products discharged to surface water.
Industrial chemicals and metals	Polybrominated diphenyl ethers, bisphenol-A, PCBs, phthalates, styrenes, mercury, lead, dioxins and furans	• Discharged to the sewer from industrial and commercial facilities and from households. Wastewater treatment facilities may partially remove and/or breakdown these chemicals. Remainder of compounds and breakdown products discharged to surface water.
Fungicides	Hexachlorobenzene, maneb, tributyltin	• Outdoor uses lead to runoff into storm drains which drain directly to surface waters in subsequent rainstorms. • Indoor uses or the cleaning of contaminated equipment and clothing leads to discharge to the wastewater treatment plant where partial removal or breakdown may occur. Remainder discharged to surface water.
Herbicides	2,4-D, 2,4,5-T, atrazine	• Outdoor uses lead to runoff into storm drains which drain directly to surface waters in subsequent rainstorms. • Indoor cleaning of contaminated equipment and clothing leads to discharge to the wastewater treatment plant where partial removal or breakdown may occur.
Insecticides	Carbaryl, chlordane, dieldrin, lindane, parathion	• Outdoor uses lead to runoff into storm drains which drain directly to creeks and the Bay. • Indoor uses or the cleaning of contaminated equipment and clothing leads to discharge to the wastewater treatment plant where partial removal or breakdown may occur. Remainder discharged to surface water.
Animal husbandry products	Steroid-based supplements to increase milk, egg and meat production	• Drugs are partially metabolized in animal's body. Remaining drugs and metabolites are excreted in urine and feces where they run off to surface waters.

An Example of EDCs Affecting the Primary Sexual Characteristics in Male Flounder



Scientists observe the effects of EDCs at the cellular level. The photo at left shows testicular tissue from a normal male flounder. Notice that at this magnification, the tissue appears undefined with very small cells. By contrast, the photo at right is testicular tissue from an intersex male flounder. The large, circular, well-defined cells are female cells amongst the male flounder's testicular tissue.[2]



Status of National Risk Assessment Evaluation

The 1996 Safe Drinking Water Act and the Food Quality Protection Act require the U.S. EPA to determine which of 87,000 chemicals currently in use—as well as new chemicals introduced each year—may have endocrine disrupting effects. After the chemicals are screened, they will be ranked based on a risk assessment paradigm from human health and ecological effects data.[3]

Concurrently, the U.S. EPA is developing longer-term tests, such as a multigenerational fish bioassay, to evaluate endocrine disrupting effects at the population and community levels of ecological organization.

Scientists at U.S. EPA and around the world are also conducting research regarding human health risks. However, this research is complicated by the fact that subtle neurological problems are difficult to detect, and other adverse effects may be delayed by decades. Another difficulty in linking aquatic EDCs to harmful health effects is the fact that humans are exposed at home and in the workplace to a wide variety of consumer products, pharmaceuticals, pesticides, and industrial chemicals that may contain EDCs.

Treatment Technologies for EDCs

Recent studies indicate that the removal of synthetic estrogens during wastewater treatment is likely correlated with the degree of sophistication of the treatment system. For example, simple activated sludge treatment removes fewer EDCs than filtration and microfiltration, while reverse osmosis yields even lower concentrations of these substances. [4]

One reason EDCs are hard to remove completely is that they are typically present in waters at concentrations of less than one part per billion (ppb), and are a minute fraction of all the organic material present. The ability to detect chemicals at lower levels has raised awareness about advanced treatment in drinking water and wastewater. The water research community has committed significant resources to investigate the efficiency of conventional and advanced treatment processes with regard to removing EDCs.

EDC removal efficiencies appear to be chemical-specific, especially since many synthetic compounds are designed to be resistant to biological degradation. There is no single treatment technology that will remove all of these compounds. The challenge for the future is how to maximize removal efficiency by modifying current treatment technologies while remaining cost-effective. Operating cost is particularly important because most advanced water treatment technologies (like reverse osmosis) are energy intensive and more expensive than conventional treatment.

Local Water Use Concerns

Participants in the Watershed Management Initiative (WMI) have recently begun looking into a number of possible sources of EDCs in Silicon Valley watersheds and have identified several areas for further study.

1 Fate and Transport of EDCs in Groundwater

Given that some of the thousands of EDCs potentially present in our water may persist in the environment, irrigation followed by evapo-transpiration could concentrate EDCs in subsurface water. Studies that assess the potential for degradation of certain EDCs in and below the root zone could help determine the extent to which these chemicals could enter local groundwater supplies. Because chemical degradation is site-specific, studies are planned to understand the fate of EDCs in the particular soils and groundwater of Santa Clara County.

2 Fate and Transport in San Francisco Bay

In 2001, the San Francisco Estuary Institute (SFEI) reviewed San Francisco Bay water and sediment data dating back to 1993 from the Regional Monitoring Program (RMP). They identified previously unknown contaminants that may exhibit endocrine disrupting effects, bioaccumulate in wildlife tissues, induce toxicity, or be persistent in the environment. As a result, SFEI expanded its 2002 RMP monitoring to include polybrominated diphenyl ethers, phthalates, nonylphenols, and nitro and aromatic musks in water, sediment and tissue samples. The results will be used to determine the value of annual monitoring and inclusion of these contaminants in the 2003 fish tissue sampling program.

3 Fate and Transport in Streams

In 2000, the City of San Jose and the Fish and Aquatic Habitat Collaborative Effort Program (FAHCE) each suggested that tertiary treated recycled water might be used to augment the flow in local streams and reduce wastewater flow to the South Bay. This environmentally beneficial project is currently on hold pending further study of any potential effects on groundwater and investigation into ways to reduce the high cost of cooling the water prior to release.The City of San Jose and the Santa Clara Valley Water District plan to research the fate of water (and its constituents) released into the stream, including flow to the river mouth and infiltration to groundwater. This research is intended to determine if large-scale (2-3 times baseflow) releases of highly treated recycled water can be adequately filtered by the streambed during natural percolation and whether releases may impact stream and/or groundwater quality. If water quality is impacted, additional