WPIC Panel Discussion 8/17/2007

Endocrine Disrupting Chemicals: What are they? Why we should be concerned?

Gary Icopini
Montana Bureau of Mines and Geology
1300 West Park Street
Butte, MT 59701
Phone: 406-496-4841
Email: gicopini@mtech.edu

1) **What are EDCs?**
   a) Endocrine disrupting chemicals interfere with the body's endocrine system
   b) Active at very low concentrations (µg/L to ng/L; parts per billion to parts per trillion)
      i) 1 ng/L is analogous to one drop of detergent in enough dishwater to fill a string of railroad tanker cars ten miles long
   c) There are hundreds of known or suspected EDCs
   d) Pharmaceutical chemicals are common EDCs
      i) Pharmaceuticals that pass through the body
      ii) Pharmaceuticals discarded through waste-water systems
   e) Industrial chemicals and by products are also common EDCs
      i) Examples include: bisphenol A, polychlorobiphenyls (PCBs), dioxins, furans, chloroform, pentachlorophenol, and many others
   f) Pesticides (herbicides and insecticides) are also common EDCs

2) **What is the Endocrine System?**
   a) The glands of the endocrine system and the hormones they release influence almost every cell, organ, and function of our bodies
   b) Instrumental in regulating mood, growth and development, tissue function, and metabolism, as well as sexual function and reproductive processes
   c) While the nervous system is in charge of processes that happen quickly, the endocrine system is in charge of body processes that happen slowly, such as cell growth
      i) Effects of endocrine disruption often become apparent long after exposure
      ii) Exposure can affect subsequent generations that were not exposed

3) **Human health reasons we should be concerned about EDCs**
   a) EDCs have been implicated in the following adverse human health effects
      i) Sperm maladies, altered sex ratios, early onset of puberty, increased cancer rates, hypospadia, endometriosis, and many others
      ii) These effects are primarily inferred from animal experiments or from general population studies

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4) **Ecosystem health reasons we should be concerned with EDCs**
   a) Birds - Diclofenac has caused the near extinction of several species of gyps vultures in Asia (Smithsonian Magazine 02/2007)
   b) Fish populations
      i) Potomac River, USA – 80% of male bass exhibited some degree of feminization (unpublished US Geological Survey data)
      ii) Boulder Creek, CO – 83% female white suckers downstream of the waste water treatment plant (WWTP) outfall for the city of Boulder, CO compared to 45% female white suckers upstream (Woodling et al., 2006)
         (1) Authors conducted a follow-up study using WWTP effluent and adult male fathead minnows
            (a) When exposed to 100% effluent the male fish were indistinguishable from female fish within 14 days
            (b) When exposed to 50% effluent the male fish were indistinguishable from female fish within 28 days
      iii) Canadian Lake Experiments – addition of 5-6 ng/L 17α-ethynylestradiol (EE2) caused the feminization of fathead minnows and led to population collapse after two years of EE2 addition to the lake (Kidd et al., 2007)
      iv) Implications for Montana – Montana trout streams rely on natural reproduction.

5) **Montana waters**
   a) Streams – Four streams sampled by the USGS all contained EDCs (Barnes et al., 2002)
   b) Ground water – 35 water-supply wells in the Helena Valley were sampled for 28 EDCs (Miller and Meek, 2006)
      i) The five most prevalent compounds were:
         (1) Sulfamethoxazole (antibiotic) present in 78% of wells
         (2) Atrazine (herbicide) present in 41% of wells
         (3) Carbamazepine (anticonvulsant) present in 31% of wells
         (4) Dilantin (anticonvulsant) present in 24% of wells
         (5) Diclofenac (anti-inflammatory) present in 18% of wells
      ii) There was no correlation with nitrate or microbial indicators

6) **Specific Questions (from Krista)**
   a) **What type of water analysis is usually conducted when surface water is discharged to an aquifer?**
      i) Currently there are no restrictions on the discharge of EDCs to the environment
      ii) Soils can remove significant amounts of EDCs, especially soils with high organic carbon concentrations or very active microbial populations
      iii) However, an artificial-recharge study examining surface infiltration of sewage effluent indicates that EDCs could enter the ground water (Cordy et al., 2004)

   b) **How expensive is water quality analysis, what elements are usually analyzed, what is the complexity?**
      i) Routine water analysis is not currently done for EDCs
      ii) Commercial analysis is expensive – $700 to $1000 per sample
      iii) Very few commercial labs do these type of analyses

iv) In this country most of these analyses are conducted by the US Geological Survey or at Universities
v) Currently there are no labs in Montana doing these analyses

c) Are there risks associated with introducing surface water to ground water? Are there benefits? What are they and why?
i) Using effluent from waste water treatment plants (WWTPs) will spread EDCs to the ground water
(1) The risk depends on the abundance and type of EDCs present
(2) The risk also depends on the distance from a discharge point

d) What kinds of requirements exist in other states?
i) There are no requirements dealing with release of EDCs to the environment

e) Is there a difference in the level of treatment between individual septic systems and other types of sewage or effluent disposal? Are there potentially different impacts to the ground-water resource as the result?
i) Yes. Different secondary treatment approaches remove variable amounts of EDCs.
ii) Initial studies indicate that WWTPs using activated sludge or membrane biological reactors remove 10 times more EDCs than do trickling filter plants
(1) Nebraska study saw no biological effect on fish downstream from plants employing activated sludge or biological secondary treatment, but did see an effect downstream of a trickling filter plant (Kolok, unpublished data)
iii) Individual septic systems are much less efficient in removing EDCs from the waste stream than are WWTPs (Godfrey and Woessner, 2004)
(1) 50% of subdivision requests with >100 parcels were for exempt wells
(2) 75% of all subdivisions requests were for exempt wells

f) What role does the soil profile play and how does this vary from site to site?
i) The soil can be very effective at removing EDCs.
ii) Typically the more natural organic carbon present the greater the removal of EDCs
iii) Sand and gravel aquifers in Montana often contain little organic carbon and are likely to be poor at removing persistent EDCs

g) What can treatment facilities reasonably be expected to remove from waste streams? What are the various options and associated costs?
i) WWTPs using activated sludge or membrane biological reactors can remove well over 90% of EDCs from the waste stream, but that still may leave a significant amount in the effluent

h) Pharmaceuticals -- federal standards on the horizon? Does the state need to take action?
i) Waste water discharges – probably
ii) Drinking water supplies – probably – some have been incorporated in the most recent list of unregulated chemicals the US EPA requires to be tested for in drinking water

i) **What level or type of treatment is required for public water systems?**

i) There are no treatments required to remove EDCs from drinking water

ii) Soil filtration, activated carbon adsorption, and reverse osmosis have been proposed as possible treatment options

j) **References and websites**

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Miller, K.J. and Meek, J., 2006, Helena Valley ground water: Pharmaceuticals, personal care products, endocrine disruptors (PPCPs), and microbial indicators of fecal contamination, Montana Bureau of Mines and Geology: Open File Report 532, 20 p.

Woodling, J.D., Lopez, E.M., Maldonado, T.A., Norris, D.O., and Vajda, A.M., 2006, Intersex and other reproductive disruption of fish in wastewater effluent dominated Colorado streams, Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology Vol. 144(1), p. 10-15

http://toxics.usgs.gov/regional/emc/index.html – USGS website they lead the nation in this area of research

http://www.epa.gov/ppcp/ – EPA website

http://www.endocrinedisruption.com/ – Scientific/activist webpage

http://www.ourstolenfuture.org/index.htm – Scientific/activist webpage