Pharmaceutical and Personal Care Products (PPCPs) and Endocrine Disrupting Chemicals (EDCs)

Background. Regulatory agencies at all levels of government are realizing that pharmaceutical and personal care products (PPCPs) and endocrine disrupting chemicals (EDCs) in surface and drinking water are of concern. PPCPs and EDCs are being found in rivers, lakes, and groundwater, all which serve as sources of drinking water, and even in treated drinking water.

What are PPCPs and EDCs? PPCPs include over-the-counter (OTC) medications, prescription medications, dietary supplements, hormones, cleaning agents (especially antibacterial cleaners), and the inert ingredients that are associated with these products (which can be just as harmful, if not more so, than the active ingredients themselves). Many of the PPCPs are actually designed to impact the human hormone system. Some PPCPs are also Endocrine Disrupting Chemicals (EDCs). The endocrine system is a complex network of hormones and glands which release hormones into the body and regulate growth, development and maturation. Endocrine disruptors are synthetic chemicals which either block or mimic natural hormones, which in turn disrupt normal functioning of organs.

How do PPCPs get into our drinking water? Many of the components of OTC drugs, supplements, and prescription medications are not completely metabolized by the human body. Therefore, the unmetabolized portions of these compounds are excreted when people defecate or urinate. For example, when amoxicillin, a common antibiotic, is ingested, 60% of the drug comes out unchanged in the urine (See “Survey of the New York City Watershed for the Presence of Pharmaceuticals,” NYS Department of Health, Troy, NY and Wadsworth Center for Laboratories and Research, NYS Department of Health, Albany, NY; [http://www.neiwpcc.org/ppcpconference/ppcp-docs/Barbara%20Hartley%20Grimes/BarbaraHartleyGrimes.pdf]). Similarly, 40% to 50% of atenolol is excreted unchanged; and 90% of cephalexin (also known as the antibiotic Keflex).

Even if these compounds are then treated to the highest standards prescribed by state and federal law, the compounds make it into the waste stream and are discharged into the environment. Waste water treatment plants, such as the one proposed by Brickstone, are not designed or intended to remove these compounds from the waste stream.

What are the effects of PPCPs in our wastewater? From 1999 to 2002, the United States Geological Survey (USGS) studied surface and groundwater samples from around the country to determine whether PPCPs were present. They found at least one compound in 80% of streams and 93% of groundwater. The most commonly found compounds were: steroids, OTC medications (like ibuprofen), and insect repellants.

Different PPCPs have different toxilogical effects. For example:
The PPCPs triclosan and triclocarban\(^1\) have been found to disrupt development in frogs (Veldhoen, N. et al, Aquatic Toxicology 80, *The bactericidal agent triclosan modulates thyroid hormone-associated gene expression and disrupts postembryonic anuran development*, (2006) 217-227); causes endocrine disruption in mussels (Canesi, L. et al., *Effects of Triclosan on Mytilus galloprovincialis hemocyte function and digestive gland enzyme activities: Possible modes of action on non target organisms*, Comparative Biochemistry and Physiology Part C 145, (2007) 464- 472); disrupts thyroid hormones in rats after only short-term exposure (Crofton, et al., *Short term in Vivo exposure to the water contaminant triclosan: Evidence for disruption of thyroxine*, (2007), [www.ealing.gov.uk](http://www.ealing.gov.uk)). Triclosan and triclocarban are toxic to aquatic biota, bioaccumulate in algae and earthworms, are endocrine disruptors, can contain dioxin and other carcinogens, degrade to form other carcinogens, and are persistent in the environment ([http://www.neiwpcc.org/ppcpconference/ppcp-docs/RolfHalden.pdf](http://www.neiwpcc.org/ppcpconference/ppcp-docs/RolfHalden.pdf)).

Antibiotics such as *sulfamethoxazole*, trimethoprim, *erythromycin*, and Keflex can get into the water and create antibiotic resistance. Antibiotics are turning up in surface and ground waters, and are of concern due to the fact that antibiotics in the environment selects for drug-resistant strains of bacteria. When bacteria are exposed to low doses of antibiotics, they develop a tolerance for those same drugs. When humans are subsequently infected with these drug-resistant bacteria, certain antibiotics are ineffective at treatment (see, e.g., [http://www.ijc.org/rel/pdf/09_Pharma-fall2002.pdf](http://www.ijc.org/rel/pdf/09_Pharma-fall2002.pdf)). According to information released by the CDC in the fall of 2007, approximately 90,000 people die annually from antibiotic resistant infections. ([http://www.fda.gov/FDAC/features/2002/402_bugs.html](http://www.fda.gov/FDAC/features/2002/402_bugs.html)).

In 2006, the USGS found intersex fish in the Potomac River that were likely created by EDCs. EDCs are also responsible for other abnormal sexual function in non-human animals, such as decreased fertility. During a March, 2007 congressional briefing on compounds of emerging concern, Dana Kolpin, Chief of the U.S. Geological Survey's toxic substances hydrology program, stated that the USGS has "definitive" evidence from laboratory experiments that chemical compounds found in household detergents, drugs, and other compounds that pass through wastewater treatment plants are responsible for "feminizing" male fish downstream of such plants ([http://www.mgsglaw.com/ehsarchive.html](http://www.mgsglaw.com/ehsarchive.html)). Potential human health impacts include: cancer, Type II diabetes, behavioral changes such as increased aggressiveness and decreased attention span, compromised immunity, and neurological effects (Spano, T., “Contaminants of Emerging Concern: Endocrine Disruptors,” Presentation to COG Chief Administrative Officers Committee, August 1, 2007). It has also been suggested that EDCs may cause lowered sperm counts in humans, and abnormalities in male sex organs.

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\(^1\) Triclosan and triclocarban are antibacterial agents found in some toothpaste, mouthwash, cleaning products, soaps and cleaners. It is also prescribed for patients with resistant *staph* infections as a shower gel.
There is clear evidence that exposure to EDCs result in adverse health impacts on non-humans and many scientists therefore caution that we must invoke the precautionary principal when considering the potential impacts on humans. In fact, the World health Organization states:

“The biological plausibility of possible damage to human reproduction from exposure to EDCs seems strong when viewed against 1) the background of known influences of endogenous and exogenous hormones on many of the processes involved, and 2) the evidence of adverse reproductive outcomes in from wildlife and laboratory animals exposed to EDCs. The biological plausibility and the striking changes in human reproductive health trends in some areas, for some outcomes, are sufficient to warrant concern and make this area a research priority….there is biological plausibility and some experimental evidence that EDCs may contribute to hormonally influenced human cancer…” (Damstra, T., Barlow, S., Bergman, A., Kavlock, R., and Van der Kraak, G. (2002). “Global Assessment of the State-of-the-Science of Endocrine Disruptors,” WHO publication No. WHO/PCS/EDC/02.2, pages 69 and 86).

Other PPCPs found in water include:

- Sulfamethoxazole – antibiotic
- Codeine – painkiller
- Cotinine – metabolite of nicotine
- Trimethoprim – antibiotic
- Dehydronifedipine – metabolite of hypertension and angina med
- Diltiazem – high blood pressure and angina
- Acetaminophen – OTC pain killer
- Ranitidine – peptic ulcer and reflux
- Caffeine – found in some painkillers
- Diphenhydramine – benadryl – antihistamine
- Carbamazepine - anticonvulsant and mood stabilizing drug, used primarily in the treatment of epilepsy and bipolar disorder
- Cimetidine – ulcer medication
- Metformin – anti-diabetic drug
- Erythromycin – antibiotic
- Thiabendazole – fungicide and parasiticide (used primarily for roundworm treatment)
- Atenolol – a beta-blocker used to treat cardiovascular disease

Although we do not yet know all of the effects of PPCPs and EDCs on humans, we do know that chronic exposure (low levels of compounds over a long period of time) is of great concern. This is particularly true for children in utero, young children, elderly, and people with compromised immune systems.
How far will the contaminants travel? It is impossible to predict how far the PPCPs and EDCs discharged from the proposed Brickstone facility will travel. However, a study in Massachusetts found that acetaminophen, carbamazepine, and sulfamethoxazole detected in a wastewater plume one mile away from the source (see Zimmerman, M.J., 2005, Occurrence of Organic Wastewater Contaminants, Pharmaceuticals, and Personal Care Products in Selected Water Supplies, Cape Cod, Massachusetts, June 2004, U.S. Geological Survey Open-File Report 2005-1206, [http://pubs.usgs.gov/of/2005/1206](http://pubs.usgs.gov/of/2005/1206)). The geology of Rattlesnake Hill will likely contribute to the distance the contaminants travel as well. There is a lot of ledge in the area, and wastewater and contaminants can travel long distances fairly quickly through this type of substrate.

Why is the proposed Brickstone development of more concern than other developments around town? Brickstone’s proposed development is very near private water drinking wells some of which are as shallow as 40 feet. Furthermore, the 100,000+ gallons of water daily which will leave the Neponset River watershed and enter the Taunton River watershed will be doing so near private drinking water supplies in the neighboring towns of Stoughton and Easton. This development will contain 1,404 bedrooms for seniors, average age of 75 (according to Brickstone officials), and a 150-bed nursing home. According to the National Institute on Aging, people ages 65 and older consume more prescription and OTC medicines than any other age group. Moreover, seniors tend to have more long-term, chronic illnesses that require pharmaceuticals, including arthritis, diabetes, high blood pressure and heart disease than younger people. In fact, people over age 65 buy 30% of all prescription drugs and 40% of all OTC drugs ([http://www.fda.gov/fdac/features/1997/697_old.html](http://www.fda.gov/fdac/features/1997/697_old.html)). Specifically:

**Bacterial infections:** The elderly have increased susceptibility to bacterial infections, and therefore are on antibiotics more often than younger counterparts ([http://www.biochemsoctrans.org/bst/031/0449/0310449.pdf](http://www.biochemsoctrans.org/bst/031/0449/0310449.pdf)).

**Heart disease:** Several of the PPCPs commonly found in water are used to treat heart disease, such as dehydronifedipine, diltiazem, and atenolol. Heart disease is a leading cause of death in the United States, and 84% of persons 65 years or older succumb to heart disease. Prescription drugs are a standard method of treating heart disease in the elderly ([http://www.aafp.org/afp/20050615/2289.html](http://www.aafp.org/afp/20050615/2289.html)). To complicate matters further, the elderly often have multiple cardiovascular risk factors (e.g., high blood pressure, diabetes, and/or abnormal cholesterol), and therefore need multiple drugs to treat them.

**Pain medications:** Pain is also far more common among the elderly than among younger people. Scientists found that pain prevalence in the elderly ranged from 36% to 88%, with pain more prevalent among nursing home residents. In the US, about 1/5 of elderly people take analgesics at least several times per week, and 2/3 of these people take prescription analgesics for longer than 6 months ([http://www.merck.com/mkgr/mmg/sec6/ch43/ch43a.jsp](http://www.merck.com/mkgr/mmg/sec6/ch43/ch43a.jsp)).
**EDCs:** Hormones are frequently given to the elderly to treat and prevent various diseases. Osteoporosis, an age-related disorder, is treated in postmenopausal women by estrogen replacement (Am J Obstet Gynecol. 1987 Jun;156(6):1516-23). Oral estrogen is given to elderly men to improve serum lipids, homocysteine and fibrinolysis (Atherosclerosis. 1998 Apr;137(2):359-66). Hormone replacement therapy (HRT) is used in women over than 60 to prevent coronary artery disease (J R Soc Med. 1998 September; 91(9): 475–478).

**Depression:** Depression affects more than 6.5 million of the 35 million Americans 65 years or older. Depression in older persons is closely associated with dependency and disability, and is often treated with prescription drugs (http://www.nami.org/Template.cfm?Section=By_Illness&template=/ContentManagement/ContentDisplay.cfm&ContentID=7515).

It is clear, then, that the elderly tend to take more pharmaceuticals than their younger counterparts. Coupled with the sheer number of drugs that would be discharged from the proposed Brickstone facility is the fact that the proposed facility is incredibly dense. According to Silent Spring, a not-for-profit organization that looks at environmental contaminants, residential density is a factor in the number of PPCPs and EDCs, and the concentrations of those contaminants (“Contamination of Ponds on Cape Cod, MA by Steroidal Hormones and Pharmaceuticals from Septic-Contaminated Groundwater,” Standley, L. et al., (www.silentspring.org, 2007). Nursing homes and long-term care facilities are known to produce significant quantities of PPCPs (http://www.nesc.wvu.edu/nsfc/pdf/pipeline/PL_wi07.pdf).

Therefore, our concern regarding the proposed facility at this location stems from four factors: 1) elderly people ingest, and therefore excrete, more pharmaceuticals than younger people; 2) the density of elderly proposed at the Brickstone facility would greatly increase the risk of water contamination; 3) the geology of Rattlesnake Hill makes it more likely that contaminated water will travel offsite; and 4) hundreds of homes surrounding the proposed facility are on private drinking water wells.

Apparently, the Sharon ZBA shares our concern. When the ZBA issued its 2003 Comprehensive Permit on this very same property, it allowed only 67 single family dwellings (with a maximum of 4 bedrooms each) plus 53 townhouses (with a total maximum of 138 bedrooms). This is a total (maximum) of 406 bedrooms. The ZBA said the density of 406 bedrooms was the maximum the site could withstand. Specifically, the ZBA said:

The Board’s review of all of these matters has led the Board to find that the public health and safety of the residents of the Project can not be assured, and will be threatened, if the Project is allowed at a density greater than that approved below…. Given the site topography and geology, as presented at the Hearing, the Board finds that as extensive a development as the Applicant proposes may lead to a degradation of groundwater and abutting wells, due to limited available area for the relocation or expansion of a wastewater treatment facility serving a 250 unit development.
In contrast, note that Brickstone is proposing 1404 bedrooms – almost 1000 bedrooms more than the Comprehensive Permit allowed. Should the abutters’ wells become contaminated, evidence such as this ZBA permit could be used as evidence of the Town’s negligence in allowing such a dense use of such an inappropriate site.

**Additional complicating factors:** PPCPs and EDCs are often present as complex mixtures, which can lead to unknown synergistic effects ([http://www.neiwpcc.org/ppcpconference/ppcp-docs/EdwardFurlong.pdf](http://www.neiwpcc.org/ppcpconference/ppcp-docs/EdwardFurlong.pdf)). Moreover, some PPCPs can disrupt the processes in a septic system, posing a risk of groundwater contamination from PPCP compounds and fecal matter. Because no drinking water standard for PPCP compounds currently exists, coupled with the fact that drinking water treatment plants can’t and don’t treat for these compounds, the responsible course of action is to use the precautionary principle.

Finally, pesticides and fertilizers from the golf course and grounds of the Brickstone facility will enter the private wells of abutters without even passing through the wastewater treatment plant. Many pesticides are “probable” or even “known” carcinogens.

**Conclusion:** The water impacts associated with the proposed Brickstone project warrant close scrutiny. We firmly believe that the geology of the site, together with the fact that hundreds of homes in the area are on private drinking water wells, makes this a completely inappropriate place to build such a dense age-restricted housing development and associated nursing home. Although the science of PPCPs and EDCs is still in the early stages, there is enough evidence and concern among scientists to require the protection of our town’s citizens.