Domestic Waste Water Discharge Scenario

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Municipal Waste Water treatment plants (WWTP) are known to be a source of various types of chemicals including pharmaceuticals, personal care products, household pesticides, naturally occurring hormones and steroids, metals, salts, and others. The particular chemical mixture present in a given WWTP discharge probably depends on several factors such as the type of wastewater treatment and its operation efficiency, population size and associated wastewater flow, and perhaps the geographic region and/or climatic regime. Municipal WWTP discharges are often subject to wide variations in chemical composition because of changing inputs to the plant. The hydraulic retention time of the WWTP, as well as any other process that tend to equalize the water being treated, may provide some consistency in effluent composition over time and therefore some predictability regarding mixture composition. The output of this workgroup will be important information for the Urban workgroup, along with the agricultural output.

Like the urban exposure scenario, it is not uncommon for WWTP discharges to be sited on waterbodies that have a human-modified environment and accompanying habitat modifications. In addition, some WWTPs discharge to estuarine marine or great river systems, which are also challenging in terms of appropriate reference conditions. Also, depending on the WWTP discharge flow, the geometry of the discharge relative to the receiving waterbody, and the size of the receiving waterbody, there may be geomorphological modifications of the waterbody directly downstream of the discharge resulting in at least near field habitat effects, which need to be separated from chemical mixture effects on biota.

Given the continued focus on improved WWTP efficiency and more stringent effluent limits for metals, many pesticides, solvents, and other priority pollutant chemicals over the past 30-40 years, the number of potentially toxic chemicals present in advanced WWTP effluent (at least secondary treatment) may be relatively few, and perhaps mostly unregulated chemicals that are unlikely to cause acute or even chronic toxicity effects. One of the challenges with this scenario is relating these types of chemical mixtures and biological community condition in the waterbody. Given the large number of unregulated chemicals that could potentially occur in some WWTP discharges, prioritizing the most critical ones in terms of risk potential, and/or identifying more easily measured chemicals that are often associated with high risk unregulated chemicals, may be a useful approach for prospectively identifying WWTP discharges for which mixture effects may be an important consideration.

Potential WWTP Scenarios for Discusssion

The simplest scenario is a set of municipal WWTP discharges to small or mid-size streams in which upstream has reference-quality biological condition and the habitat quality downstream of each discharge is unimpaired. The WWTP discharge is the only real input to the stream in this scenario. If the different WWTPs have different treatment efficiency (with respect to nutrient removal, etc.) but all of them treat almost entirely domestic waste, it may be feasible to evaluate mixture effects, if any, on biota downstream. This workgroup will evaluate the questions below (and possibly other questions) based on this simple scenario and, if there is interest, other more complicated scenarios (e.g., large receiving waterbody with no appropriate reference condition available; multiple co-located municipal WWTP discharges; other stressors). We will discuss up front the type(s) of WWTP scenarios that the group is concerned about and wants to focus on.

- Prospective
    - What is the proportion of wastewater served by domestic vs. industrial sources?
    - Dilution factors – instantaneous as well as upstream contributions?
    - Is the population age structure a useful indicator in terms of drugs that could be in the effluent?
    - Can we relate the level or type of wastewater treatment to probability of chemicals of concern in the effluent? How precisely and for what types of chemical mixtures?
    - Other site factors that could affect biotic exposure to WWTP chemicals in the waterbody that can/should be used prospectively (e.g., dams)?
    - Chemistry
) Measured contaminants
            - Is the WWTP working in proper order (i.e., meeting DO, BOD, NH_3)?
            - Contaminants measured (metals, pharmaceuticals, consumer products chemicals, hormones, etc.)
            - Assuming concentration addition and response addition principles, would ecological impacts be expected (e.g., multi-substance potentially affected fraction of species >> 5%)?
                - If so, is there particular contaminant(s) that appear to be driving the mixtures assessment?

        a) Modeled contaminants
            - Based on knowledge of per capita use of various down the drain chemicals, estimate municipal effluent and receiving water concentrations
            - Certain contaminants likely given the types and proportion of wastewater inputs [domestic, industrial, etc]?
            - Can we characterize the probability (at least qualitatively) of a WWTP effluent causing biological impacts due to certain chemicals?
            - What type of biological expectations are generally associated with different levels (types) of wastewater treatment?
            - Can we identify certain effluent “marker” chemicals that often indicate the presence of other, higher risk chemicals and mixtures?
    - Do measured and modeled contaminants lead to the identification of potential risks associated with mixtures? If so, is it due to the cumulative of all contaminants, or the dominance of just few chemicals?

- Retrospective
    - What is the relationship of prospectively identified risks with measured biological data per site?

) Can we identify certain effluent “marker” chemicals that often indicate the presence of other, higher risk chemicals and mixtures?

a) Can we distinguish instream biological effects of poor effluent quality as opposed to other stressors (e.g., agricultural effects)?

b) Can we distinguish chemical effects of WWTPs in the absence of reference conditions or in species-poor areas?

c) Habitat

- Is there an adequate understanding of the relationship of in-stream habitat that can potentially support aquatic communities that are classified with good ecological status?
    - The goal here is to avoid conducting site-based monitoring at sites where habitat quality is limiting.

d) Are their known aquatic impairments, such as degraded fish and benthic macroinvertebrate communities? If yes, what are the indicators of impairment and are they indicative of certain types of chemicals (e.g, nutrients, PAHs, endocrine disruption)?

- There are biological indicators with specific sensitivity towards different types of stress factors and chemicals: e.g. BMWP-score (BOD loading), SPEAR-index (pesticide loading), Nutrient loading (forgot the name), etc.