I. Endocrine disrupting compounds in water resources: New pollutants require new treatment methods.
Endocrine disrupting compounds (EDCs) and pharmaceuticals produce adverse effect on the reproductive, neurological and immune systems of human health and wildlife. The occurrence of trace amounts of pharmaceuticals and EDCs have been reported in surface water and even in drinking water for decades. It is only in recent years, those compounds are raising the public’s attention and becoming a major concern for water quality. Graphene is a two-dimensional material consisting of a single layer of pure carbon, which has extraordinary capacity to sorb complex organic compounds. In this study, three commercially available graphene particles, of varied particle size, specific surface area, and surface chemistries, were evaluated for their abilities to sorb EDCs and pharmaceuticals. Graphene may offer a greater specific surface area and a more favorable interaction with low molecular weight organic compounds compared to conventional carbon-based sorbents.

II. Selenium pollution in the Western U.S.: New characterization tools based on stable isotopic methods.
Selenium contamination of water resources occurs throughout the western United States within irrigation canals, lakes, and wastewaters due to weathering, mining, combustion, petroleum processing, and irrigation activities. The health risks to human and wildlife have garnered a pressing need to understand selenium speciation, transport, and bioaccumulation in the natural environment and how to minimize exposure to toxic amounts. We are exploring the use of stable oxygen isotope indicators of chemical and microbial reactions among different selenium redox species in hopes to create a diagnostic tool for observing selenium transformation in water resources. Selenate (SeO\(_4^{2-}\)), one of the more mobile and toxic Se species, can be readily removed from water and immobilized as elemental Se(0) through reactions with iron minerals or selenate-respiring bacteria. These reactions may leave tell-tale isotopic signatures useful in environmental pollution forensics.

III. Metallic quantum dots in water resources: How will they behave when released into the environment?
We are exploring explores the behavior of quantum dots—semiconducting nanocrystals with extraordinary electrical properties featured in the next generation of consumer electronics and solar cells—within the environment upon their accidental release from product disposal or industrial waste streams. With the projected market volume for nanomaterial-based products approaching trillions of dollars annually, handling of these products and their waste will inevitably pose challenges to environmental health, particularly for metallic nanomaterials that may be toxic to aquatic organisms. Laboratory experiments will address how quantum dots change physically and chemically within lakes, rivers, and groundwater. The results are expected to identify important chemical reaction processes and to improve analytical chemistry methods for detection and quantification of potentially toxic quantum dots in water.