Roanoke River PCB TMDL Success Story

Implementation of a Pollutant Budget Leads to Successful Reduction in PCBs

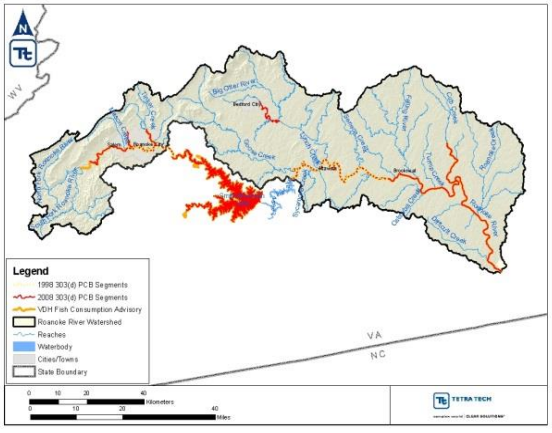
High PCB (polychlorinated biphenyl) loadings led to fish consumption advisories in the Roanoke River Watershed. As a result, the Virginia Department of Environmental Quality (DEQ) added three segments (about 170 river miles and 17,157 lake acres) of the Roanoke River Watershed to the 2008 Clean Water Act (CWA) section 303(d) list of impaired waters. A pollutant budget, or total maximum daily load (TMDL), documented sources and established load allocations and PCB reductions for all discharges to the river system. Sources were further isolated using a back-track process and via sample analysis using a method that can differentiate between the 209 types of PCB compounds (i.e., EPA's low-level PCB analytical method 1668). Staff from one source, ITG/Burlington Industries LLC, voluntarily decided to go above and beyond the minimum treatment required, in order to protect the Roanoke River and the environment as much as possible. Due to efforts addressing that one source that led to a significant reduction, roughly 10 percent of the PCBs that contributed to the annual baseline loading to the lower Roanoke River were eliminated. The reduction in measured fish tissue PCB concentrations should be expedited as a significant mass of PCBs was effectively kept out of the lower Roanoke River.

Polychlorinated Biphenyls (PCBs) have been demonstrated to cause a variety of adverse health effects. They have been shown to cause cancer in animals. (Source: Environmental Protection Agency).

PCBs were manufactured by Monsanto until the late 1970s. Varying mixtures of a possible 209 chemical compounds (i.e., congeners), which are identifiable based on chlorine placement and level of chlorination, were marketed by Monsanto as Aroclor®.

Study Area

Fish tissue monitoring by DEQ identified that the Roanoke River watershed is contaminated with PCBs. This led the Virginia Department of Health (VDH) to list fish consumption advisories for the affected river sections. The Roanoke River watershed includes a drainage area of approximately 3,343 square miles with a length of about 227 miles that flows in a southeasterly direction from the west. Impounded at two points within the study area, the river's channel passes through Smith Mountain Lake and the non-PCB contaminated Leesville Lake. Given the extent of



fish contamination data, the focus area of this PCB study included two river sections: the first, from the upper headwaters downstream to Niagra Dam (designated upper Roanoke; 29 miles) and second, from Leesville Dam downstream to its confluence with the Dan River (designated lower Roanoke; 96 miles). This lower section is locally known as the Staunton River.

Problem Background

Once released to the environment, PCBs persist for years while their fat-loving (lipophilic) property enables uptake or bioaccumulation within aquatic animals, including fish. PCBs were banned by the U. S. Environmental Protection Agency (EPA) because of their environmental persistence and their notoriety as probable carcinogens. The DEQ began collecting fish tissue from the Roanoke River watershed in 1993. The initial elevated fish tissue PCB levels resulted in the VDH issuing fish consumption advisories for both the upper and lower portions of the Roanoke River in 1998. The PCB advisories also led to these waterbodies being included within Virginia's 2008 CWA section 303(d) list as impaired for PCBs.

To address the PCB contaminated fish, a TMDL study was completed in December 2009 for the upper section and the more heavily contaminated lower section of the Roanoke River. Through the collection of river water and sediment samples with analysis using EPA's low-level PCB Method 1668, prospective PCB source areas were delineated. Based on the source investigation field study as well as the computer modeling effort, PCB sources were grouped into a number of categories including: point sources (Industrial, municipal, as well as municipal separate storm sewer system [MS4]), non-point source rural and urban background, known contaminated sites and atmospheric deposition. PCB loadings were calculated for each source category and allocated reductions were set in order to meet the TMDL PCB endpoint essential to restoring water quality. Since PCBs are diffuse and ubiquitous in the environment, rather than develop a traditional TMDL implementation plan designed to address non-point sources, in the case of PCBs the preferred approach is to tackle point source wastewater discharges that testing has identified as having exceeded their TMDL waste load allocations (WLA). Further implementation of other source categories such as known or newly discovered PCB contaminated sites may be addressed through DEQ's applicable Land Division programs as well as the VPDES program.

Waste Load Allocation is the assigned loading to a point source. The allocation is derived using the TMDL endpoint in order to be protective of the receiving stream.

ITG/Burlington Industries LLC Hurt Plant

Identified as one of several VPDES point source facilities within the TMDL watershed, the former ITG Burlington Industries Plant located in Hurt, VA, was permitted to discharge treated industrial wastewater to the lower Roanoke River. The facility, which has since been demolished, served as a textile dyeing and finishing plant

Baseline PCB Loading is the amount of PCBs released to the river prior to implementing reductions specified by the TMDL.

that operated from the late 1940s until it closed in June 2007. During the TMDL source investigation study, especially high concentrations of PCBs were detected in the industrial effluent. The baseline PCB loading calculated for this facility and included in the TMDL was 56,270.5 mg/yr or 9.4 percent of the PCB baseline load to the lower Roanoke River. The assigned PCB WLA necessary to protect water quality was calculated at 629.5 mg/yr, which is equivalent to a 98.9 percent reduction in effluent PCBs.

A trackdown or "back-track" study is a step-wise approach used to identify sources of PCB contamination by moving upgradient within a wastewater collection system.

Once identified as a significant source, further investigation of the wastewater led to a discovery of a unique PCB signature. The distinct fingerprint included two PCB compounds (PCB 155 and PCB 184) that are not known to be included within traditional Aroclor mixtures. In fact, these unique compounds comprised approximately 75 percent of the PCB mass in the effluent. These same two compounds were readily traced in the river sediments many miles downstream. Even with the manufacturing plant no longer in operation, the on-site wastewater treatment plant continued to treat and release effluent to the river albeit at a reduced rate. Of note, between 10 million and 11 million gallons of residual PCB-contaminated wastewater remained within the treatment system along with contaminated sludge. To identify the source of PCBs that originated from the manufacturing site, a trackdown or "back-track" study was performed within the plant by sampling available sediment found in the wastewater collection piping. The signature PCBs were identified at some locations in various plant wastewater drains using EPA's low-level PCB analytical method 1668. The most probable source was eventually identified as the "fabric roll type continuous press machines," as these machines were relocated during plant expansion and PCB marker evidence was found at the previous and current locations. The machines were a "dry" operation where a hot roll was heated using oil heated by an electric heating unit. The hot oil served as a heat transfer fluid and was an Exon/Mobil product branded as MobilTherm ™ 603. As most of the equipment and products were removed from the facility after closure, one partial container of this same heat transfer oil was discovered that was used in a newer machine (laminator). With great difficulty to avoid contamination of the highly sensitive analytical equipment used to perform method 1668, the marker PCBs were confirmed within the MobilTherm ™ 603 product and are assumed to be an artifact of the manufacturing process caused by inadvertent PCB production. Even though these were closed systems, it was established that the press machines had a small leak that allowed the MobilTherm fluid to be released into the facility wastewater collection system. The "back-track" identification process proved critical in isolating source areas especially, since PCBs were not known to be used in the manufacturing process.

Following discussions between DEQ and Burlington personnel about exploring various options to address the PCB contamination, the company agreed to treat the wastewater to the maximum extent practical prior to releasing the effluent to the river. It was agreed by both parties that the best solution was to remove as much of the PCBs as possible from the wastewater in order to avoid or minimize releases to the lower Roanoke River. This was significant, as the effluent could have been

legally released under the auspices of the daily TMDL component at a rate of 1.72 mg/day. Essentially, this would have led to the release of almost 0.5 pounds of PCBs, or approximately seven times the amount of PCBs allowed annually by the TMDL for the lower Roanoke River watershed. In this case, the company voluntarily decided to go beyond the minimum treatment required, in order to be as protective of the Roanoke River and the environment as possible.

Treatment and PCB Removal

Burlington personnel took full advantage of the existing on-site wastewater treatment system infrastructure combined with the newest "off-the-shelf" technology, in order to treat the PCB contaminated wastewater. Operation of the new treatment train technology was initiated during fall 2012. The treatment train first included unit processes of chemically enhanced coagulation and settling using the plants' two existing clarifiers. The decanted effluent then was pumped through new "off-the-shelf" pre-filtration (using a 10-to-50 micron filtration bag), granular activated carbon (GAC), and post filtration (using a 0.5-to-1 micron filtration bag) prior to discharge to the Roanoke River. The effluent was treated in this way from November 2012 through May 2013, and resulted in a PCB release of about 24 mg to the Roanoke River. This represents more than a 99 percent reduction in PCBs between the untreated and post-treated effluent. Had the wastewater not been treated as described, an estimated load that could have been released to the river equals 185,200 mg (Source: Dunklee & Dunham 2/2/2012 report). Stated another way, roughly 10 percent of the PCBs that contributed to the annual baseline loading to the lower Roanoke River has been eliminated. With regulatory oversight, the remaining contaminated sludge was stabilized in the former wastewater treatment plant polishing pond and covered with a clay cap for encapsulation, safely away from the river.

Figure 2. Pre-Post Filtration and GAC Units.

Figure 3. Former Polishing Pond with Encapsulated Sludge.

TMDL Implementation that Led to Successful Reduction in PCBs

By successfully identifying and addressing the PCB-contaminated effluent from the Burlington Hurt Plant, implementation of the TMDL has led to a significant reduction of PCBs in the lower Roanoke River. First, the ability to detect low-level PCB concentrations using EPA's Method 1668 (which includes a full analysis of 209 PCB compounds, i.e., congeners) led to the initial discovery of PCBs from this discharge. Second, the implementation of the PCB TMDL led to collaborative reduction efforts by ITG Burlington and DEQ staff, resulting in the successful elimination of an estimated 185,000 mg of PCBs to this waterbody. Lastly, it is safe to conclude the identification and removal of the PCBs would not have occurred without the TMDL study. As such, this effort is considered a significant success. Given the persistent nature of PCBs, it may be years before a response is observed within fish. However, the reduction in measured fish tissue PCB concentrations should be expedited as a significant mass of PCBs was effectively kept out of the lower Roanoke River.