The Kanawha River of West Virginia

An Ecosystem-Based Approach to Watershed Management

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Table of Contents

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I. Introduction

On January 9, 2014, 100,000 gallons of a mixture of Crude MCHM and Stripped PPH contaminated the Elk River in West Virginia as a result of a leak in a chemical storage tank owned by Freedom Industries, Inc. This leak then transported downriver into the West Virginia American Water treatment plant intake on the Kanawha River, and from here was pumped into the water distribution plant that serves 300,000 people living in nine surrounding counties. The mixture, Freedom Industries reported, contained 88.5% Crude MCHM, 7.3% PPH and 4.2% water, and later reports stated that a third mixture, DiPPH, was released as well.[1] The Centers for Disease Control and Prevention released a summary of the dangers of MCHM and PPH/DiPPH shortly after the spill, based on information gathered from various laboratory tests. The CDC concluded that the toxicity of the PPH was low due to the small amounts of PPH known to have been in the tank, however pregnant women were advised against drinking the contaminated water.[2]

Furthermore, the CDC reported that there was not enough calculated levels of MCHM for the water to be considered toxic, however citizens were advised caution when drinking water because not enough information exists on the long-term human and ecological health effects of the chemical.[3] Little is known about the effects of MCHM because it was grandfathered into the existing toxics law, the Toxic Substances Control Act (TSCA) in 1976, with almost no toxicity data required. The law also grandfathered around 62,000 other chemicals and did not require the EPA to test them for safety. Because of this, little is known on these chemicals today.[4]

Ultimately, the Freedom Industries disaster is merely one incident in a long line of coal and chemical-related accidents that have afflicted the Kanawha River Valley over the past

century. It is also the region's third major accident in the past five years. Home to one of the highest concentrations of chemical plants and coal mines in the United States, future disasters like the Freedom Industries spill are imminent unless West Virginia changes resource management and policy enforcement.

The deteriorating quality of one of West Virginia's most important natural resources due to the failure of proper management and enforcement strategies is an infringement of human rights and a violation of environmental justice. This problem should be acted upon with urgency because the people of the Kanawha Valley have the right to clean drinking water, as well as the right to safe use of their public natural resources. In order to improve water quality, the State of West Virginia must assert its regulatory power to fund, implement, and enforce stronger management policies.

The following sections of this paper explore the history and importance of the Kanawha River, review the failures of past and current watershed management policies, as well as provide recommendations for future policies that we believe will be essential for (a) facilitating a more effective cleanup of the current situation, (b) preventing future accidents and point-source pollution from occurring, and (c) preventing nonpoint source pollution from entering the streams and rivers of the Kanawha River Watersheds.

II. A History of the Kanawha River and its Surrounding Area

The region surrounding the Kanawha River is unique in its geography, history, and ecology. The main sources of pollution, regulatory agencies, and a brief environmental history of the area is described in further detail below.

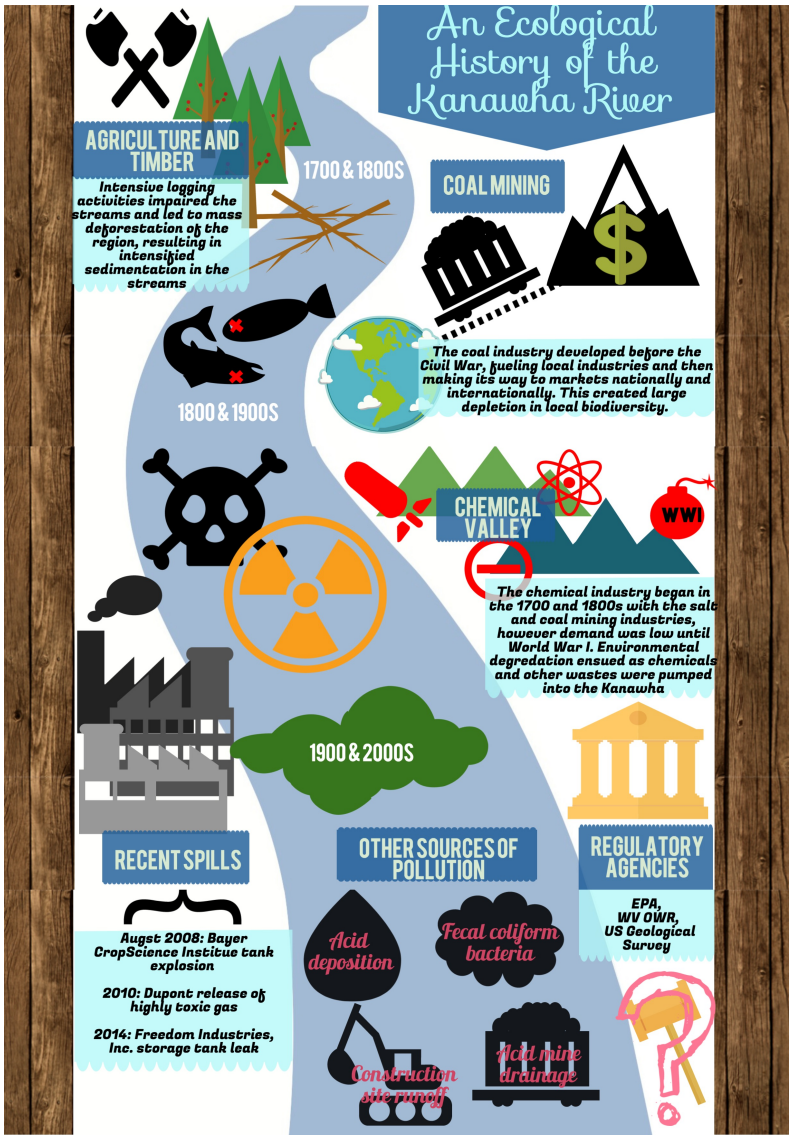

Figure 1. An Ecological History of the Kanawha River

Why the Kanawha Needs Protection

In order to comprehend the importance of protecting the Kanawha River, it is vital to understand the history of the resource and its surrounding area. This section examines the relevant stakeholders and the role they play in water use, resource protection, and policymaking. It also provides a brief overview of the economic and ecological histories of the Kanawha River

Valley, as well as an overview of different sources of pollution that threaten the health of the surrounding ecosystems.

The Kanawha River was declared an American Heritage River in 1998, attesting to its importance as both a local and national icon. Because of its unique course and its existence prior to the formation of the Appalachian Mountains, the Kanawha River is regarded as the second oldest river in the world. The Kanawha River also serves as the primary source of water for southern West Virginia. Water contained in reservoirs is used mainly for domestic purposes, mining, industry, and power generation. Furthermore, water contained in aquifers is used outside of municipalities in well water. Therefore, relevant stakeholders include: the coal and chemical industries, government agencies, environmental groups, and local community members. As one might imagine, not all of these stakeholders can be satisfied sans conflict all the time, which makes management of this precious resource vital to the economic, social, cultural, and environmental health of the region.

In addition to being a source of drinking water, locals also use the Kanawha River for recreational purposes. Although this occurs most directly in the summer months, the region also draws tourists searching for fantastic views, which can be found in public access viewpoints scattered throughout the New River Gorge. On the water recreation usages include fishing, boating, water sports on lakes created by dams, swimming, and camping. Due to the highly varied uses of water from the Kanawha River, and the seasonal nature of certain recreations, individuals may belong to one or more stakeholder categories, creating complexity in the management profile of the region's water. An analysis of stakeholder involvement is below.

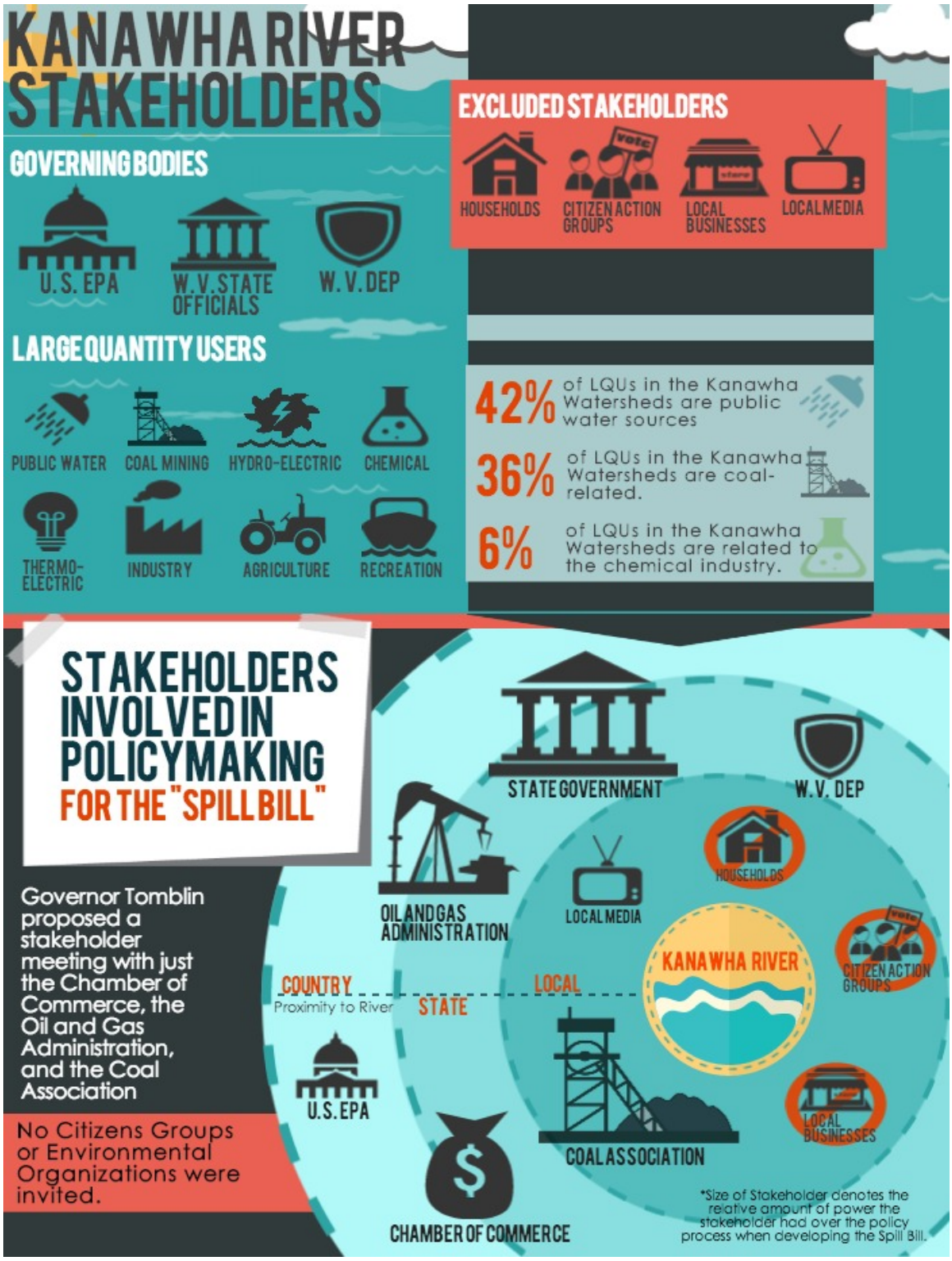

Figure 2. Stakeholders of the Kanawha River and Degrees of Involvement

An Ecological History of the Kanawha River Watersheds

The Kanawha River is divided up into an Upper and a Lower section. The lower includes the mainstream Kanawha River downstream from the Elk River, as well as all of the tributaries of the section. The Upper Kanawha River extends from the confluence of the Gauley River and the New River northwest to the confluence of the Upper Kanawha and the Elk Rivers. Unlike the Upper, the Lower Kanawha Valley never developed quite an intensive salt industry, and today there is still limited extraction of gas, oil and some coal. Before the twentieth century, the Lower Kanawha River was primarily a region for agriculture and timber. As of January 1998, at least 67 National Pollutant Discharge Elimination Systems (NPDES) were permitted within the watershed, 23 of which were sewage treatment plants and 44 were industrial discharges. After a 1998 ecological assessment of the watershed, West Virginia's Division of Environmental Protection suggested a series of recommendations to both restore highly degraded streams and preserve the high quality streams of the area. The study found stream bank degradation, increased erosion and sedimentation, as well as pollution from failing septic tanks and improper disposal of sewage or gray water.[5] However, due to the low chemical impacts of the surrounding watershed, the Lower Kanawha has had less overall degradation as compared to the Upper.

The Upper Kanawha River watershed is geologically characterized by cyclical sequences of sandstone, shale and coal. The topography is comprised of steep-sided hills carved out by narrow valleys. The Kanawha Valley is the exception. The Kanawha Valley is an alluvial valley - periods of glaciation created a huge reservoir, depositing alluvial material over thousands of years. The ice shelf eventually retreated, leaving the Kanawha River and its tributaries in the ancient alluvial lakebed. Salt was one of the main attractions to the Kanawha Valley when the

coal industry was just beginning. By the mid 1800s, much of the forests were cleared to meet the increasing charcoal demand used to fuel salt furnaces and for pasture to feed livestock. During this time of intensive agriculture and logging activities, sedimentation impaired the streams, though once the farms were abandoned the forests grew back and sedimentation decreased. Coal extraction from the Upper Kanawha streams began before the Civil War, initially used to replace the depleted forests as a fuel in the local salt industry. Later, the coal began fueling steam engines and making steel in industrial markets worldwide, largely thanks to the proximity of the Chesapeake and Ohio Railroad running parallel to the river. Before coal mining began, evidence suggests healthy levels of biodiversity in the Kanawha River and tributary streams. At one time, freshwater mussels and other fish scattered the rivers, supporting the local populations substantially. Today, however, the tributaries do not have any signs of mussels, and the recovering fisheries only shallowly mimic the thriving river that the Kanawha once was.[6]

The chemical history of the Kanawha Valley dates back to the early days of salt mining. What is now known as the "Chemical Valley" began at Gauley Bridge in central West Virginia, where the New River and the Gauley River flow into the Kanawha. While the chemical industry began in the late 1700s with the introduction of salt and coal miners, demand was relatively small until World War I, when demand for explosives and other chemical products skyrocketed, bringing business to the region.[7] Industrial development resulted in environmental degradation as large volumes of chemical wastes and other pollutants were discharged into the Kanawha River. Improvements to environmental quality began only around 1960 with the implementation of several federal regulations aimed at improving water quality. However, problems persisted despite progress. The National Enforcement Investigations Center (NEIC) conducted a study of the Kanawha Valley in 1983, which concluded many of the issues were not resolved.[8]

With the increase in chemical dependency on such volatile chemicals and the region's history of political corruption, chemical disasters were simply waiting to happen. In 1984, a chemical leak of methyl isocyanate (MIC) killed thousands of villagers in Bhopal, India. The only US plant known to manufacture MIC was located at the Union Carbide plant in West Virginia, although it was sold two years after the disaster. During the 1980s and 1990s, the same plant experiences a leak, an explosion, and a fire, resulting in many nonfatal injuries. Later, in 2008, after Bayer CropScience bought the plant, another explosion killed two workers and lead to federal attention after explosive projectiles nearly penetrated an aboveground MIC storage tank. Finally, in 2011, Bayer CropScience announced plans to dismantle the MIC production unit. While investigation ensued after the 2008 explosion, no action was taken by the state or federal government.[7] In 2010, another death occurred at a DuPont plant in Belle, West Virginia, resulting from the release of three chemicals.[9] These represent some of the more recent disasters of larger scale; however, many smaller ones have occurred over the history of the Valley and receive little to no media attention.

With around 200 chemical facilities and at least 50 hazardous waste sites in the Kanawha River Valley, disasters such as the Freedom Industries spill are imminent unless properly managed. Although improvements have been made since federal regulations have been put in place to regulate water and waste, toxic substances continue to be released into the river basin, ultimately contaminating the river and severely impacting the environmental health of the ecosystem.

A History of Pollution

Due to the nature of the resource extraction industry in southern West Virginia, the Kanawha River is no stranger to threats from pollution and the oft occurring resulting biological impairments for the species that rely on the water. Several agencies keep track of the aquatic health of the river, measuring changes in biotic and abiotic factors that affect organisms both in and out of the water. Some of the agencies that keep track of the aptly named Chemical Valley are the Environmental Protection Agency, the West Virginia Office of Water Resources (WV OWR), and the United States Geological Survey. Reports are divided into the Upper and Lower Kanawha River in order to best "address [the] challenges [of] enhancing and preserving the physical, chemical and biological integrity of surface and ground waters, considering nature and the health, safety, recreational and economic needs of humanity".[5]

In addition to toxic substances released from hazardous waste sites, the Kanawha River struggles with a multitude of other pollutants, which find their way into the water through various means, and which impair the health of the ecosystem in various ways. The WV OWR suggests that contaminants reach the river though a) seasonal fluctuations in the water cycle such as snow melt or flooding, b) sewage and waste contamination, c) animal waste pollution, d) and mine drainage; they propose contaminations are often a result of several of these factors compounding together.[6] Given all of the ways in which the river becomes polluted, it is no surprise that the list of contaminants in the river grows yearly. State and federal reports are concerned with a gamut of contaminants, from fecal coliform, inadequate disposal of sewage and greywater, runoff from construction sites, oil spills, acid mine drainage, acid deposition, siltation, and a variety of heavy metals, including aluminum, iron, and manganese.[5] The US EPA adds

dioxin, cyanide, lead, cadium, phenolics, carbon tetrachloride, chloroform, PCB, chlordane, and hazardous waste leachate to this list.[8, 10]

Pollutants from acid mine drainage pose the most significant threats to the Kanawha River. According to the EPA approved TMDL report overviews for the Upper (2005) and Lower (2012) Kanawha River Watersheds, 81% of Upper Kanawha Watershed and 55% of Lower Kanawha Watershed TMDL reports covered pollutants that stem from acid mine drainage. The WV OWR defines acid mine drainage as "acidic water discharged from an active or abandoned mine".[5] For a region that has heavily relied upon resource extraction generating a source of economic revenue, the plethora of both inactive and active mines threaten the safety of the water. Pollutants from acid mine drainage can cause increased acidity and heavy metal contamination, which are both major causes of toxicity in the water. When these metals interact with water, a precipitate is produced that can clog the gills of fish and macroinvertebrates, severely harming aquatic life. They can also infiltrate public drinking water, which can cause negative effects to human health.

Another source of heavy metal pollutants that negatively affects water quality in the Kanawha River is construction site runoff. Contaminants from construction site runoff also include debris that clogs waterways, which can harm aquatic ecosystems. These sites, along with general development, often are also responsible for localized petroleum product spills and runoff into the river from small leaks in vehicles and equipment. Larger oil spill accidents are also a concern for the region, and have had ill effects on the health of the ecosystem in the past. Erosion from urbanization also increases siltation, which occurs when silt clogs a waterway. Silt can be composed of soil or rock particles that range in size from a grain of sand to clay.[11] When siltation occurs, fine sediment loads smother the river bed, resulting in the inability of fish to spawn and

killing off other invertebrates. Silt also often carries other dangers, such as pesticides from agricultural runoff and phosphates.

Another source of increased water acidity in the Kanawha River comes from acid deposition. Acid deposition is a result of acid rain, which often occurs in industrial areas that suffer from higher concentrations of air pollution. Acid rain alters the pH level of water; a low pH means the water is acidic, and a high pH means it is basic. Extremely basic or acidic conditions pose a threat to aquatic life, humans, plants, and other animals that rely on the water for sustenance.

Fecal coliform bacteria is another dangerous form of contamination that ranks the second highest on the pollutant concerns list, particularly in the Lower Kanawha watershed.[12] According to the EPA approved TMDL report overview for the Lower Kanawha River Watershed (2012), 42% of TMDL reports on streams in the Lower Kanawha Watershed have covered fecal coliform pollution. The WV OWR defines fecal coliform as "a group of single-celled organisms common in the alimentary tracts of some birds and all mammals, including man; indicates fecal pollution and the *potential* presence of human pathogens".[5] Fecal coliform bacteria can enter waterways through stormwater runoff as a result of combined sewage overflows (CSOs) and sanitary sewage overflows (SSOs). Fecal coliform pollution can also be the result of incorrect disposal of sewage and greywater. Gray water is the water that is leftover or produced from bathroom sinks, baths/showers, laundry, dishwashers, and kitchen sinks. Sewage carries the dangerous fecal coliform bacteria found in feces in large amounts, while greywater is relatively clean in comparison. Fecal coliform bacteria are extremely dangerous because they can contain disease-causing bacteria and viruses that pose severe threats to human health. Fecal coliform bacteria are also oxygen demanding pollutants that can lead to serious environmental consequences, such as

eutrophication, which can destroy aquatic ecosystems and devastate populations of fish and other aquatic organisms.

III. An Overview of Past and Current Management Policies

In order to most effectively recommend policy changes, consideration of the successes and failures of all past and current management strategies must take place. This section analyzes how existing legislation has been operationalized in West Virginia, specifically in the context of watershed management for the Upper and Lower Kanawha River Watersheds. Water and Waste management in Kanawha River Valley is regulated under various levels of policy, from Federal legislation to state and local legislation. The following sub-sections provide an overview of relevant Federal and State regulations, as well as an analysis missed opportunities that have resulted from failures in existing management strategies.

Federal Regulations that Govern State Management Policies

There are three main pieces of existing Federal legislation that are relevant to the management of the Kanawha River Valley. The Clean Water Act, the Surface Mining Control and Reclamation Act, and the Toxic Substance Control Act are all outlined in Figure 2, and described in further detail below.

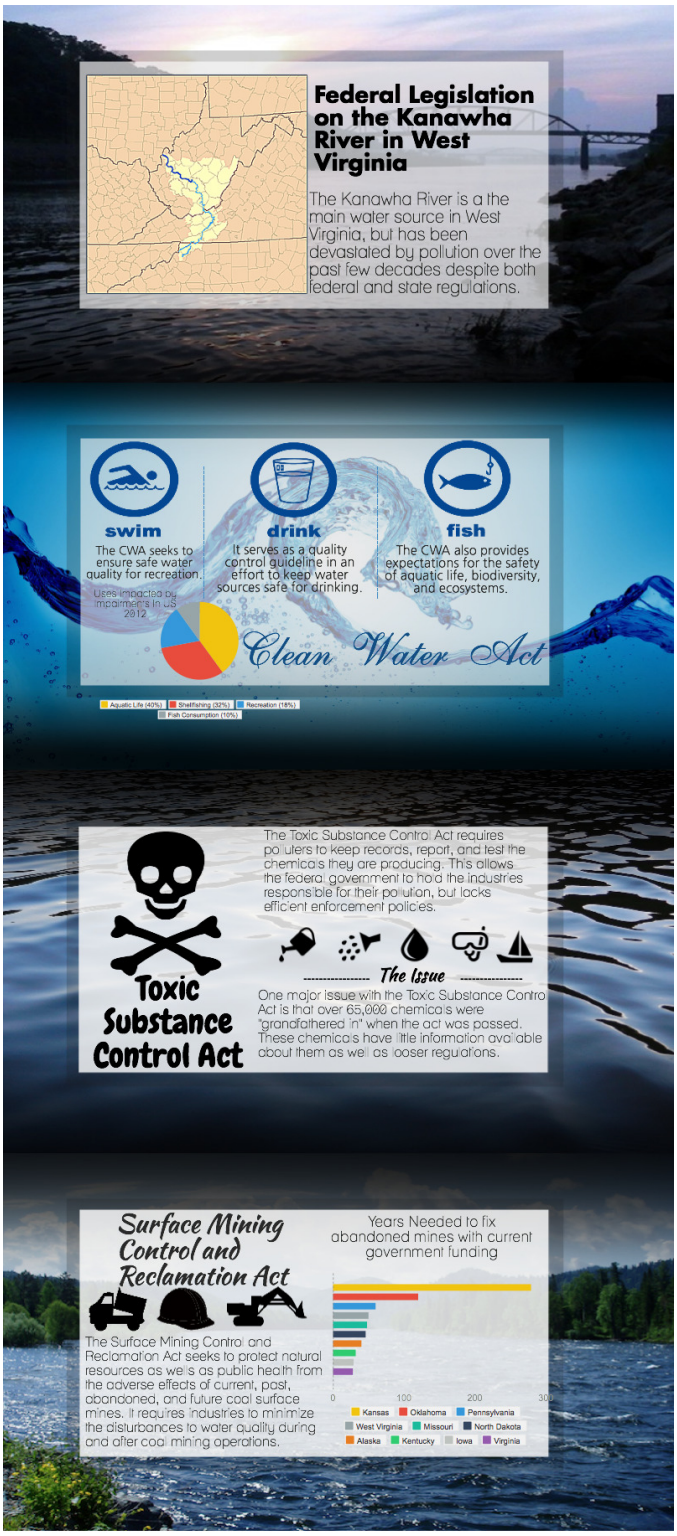

Figure 3. Federal Legislation Relevant to the Management of the Kanawha River

The Clean Water Act (CWA) of 1972 was enacted by the United States Federal government to establish a standard structure for regulating the discharge of pollutants into United States' waters, in order to maintain surface water quality standards. This act is responsible for the restrictions on what and how much of a substance can be put into a water source over a certain amount of time. It also calls for a mandatory permit to be held in order to discharge any pollutant into navigable waters from a point source. A point source includes any "discrete conveyances" such as pipes or man-made ditches.[13] This is especially relevant to the coal and other energy plants that are located along major bodies of water in the United States, like the Kanawha River. However, the CWA is merely an outline to water pollution control; it lacks enforcement potential and it gives the states control over policy. Individual state legislatures to determine which pollutants need to be regulated and to what extent.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) is another large piece of Federal legislation that has a strong influence over water and waste management policies in the Kanawha River Valley. The SMCRA "was enacted to establish a nationwide program to protect the beneficial uses of land or water resources, protect public health and safety from the adverse effects of current surface coal mining operations, and promote the reclamation of mined areas left without adequate reclamation".[12] It requires a permit for the development of any new, previously mined, or abandoned sites, which indicates that operators have promised to stick to certain performance standards. This includes, "minimizing disturbances to the hydrologic balance and to the quality and quantity of water in surface water and groundwater systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage".[12]

The third piece of Federal legislation relevant to water and waste management in the Kanawha River Valley is the Toxic Substance Control Act (TSCA) of 1976. The TSCA provides the EPA with the authority to require reporting, record-keeping and testing requirements, as well as the power to impose restrictions relating to chemical substances. The TSCA specifically addresses the production, importation, use, and disposal of polychlorinated biphenyls (PCBs), asbestos, radon, and lead based paint. This, like the CWA, requires premanufacture reports as well as regular testing of chemical concentrations. The TSCA has established an inventory of chemicals that are required to be monitored; however, if there is a chemical that fails to appear on the list, it has been excluded and does not require any reports to be submitted under this act. With the implementation of the TSCA, there were over 65,000 chemicals grandfathered in with little known information about their potential hazards to the environment or human health, such as those spilled into the Elk and Kanawha Rivers by Freedom Industries. This causes serious issues because these chemicals are being produced and disposed of in the West Virginia water system, including the Kanawha, and may be devastating the water quality for both aquatic ecosystems and human consumption.

West Virginia's Current Water Resource Management Policies

While Federal legislation provides a standard structure for regulation, the state of West Virginia ultimately has the authority over the management of water resources and pollution prevention. The West Virginia Department of Environmental Protection (WVDEP) is the official body responsible for implementing and enforcing these regulations. As the WVDEP works to

regulate the waters of West Virginia, they have to consider not only the environmental impacts and health concerns of their policies, but feasibility as well.

In addition to the Clean Water Act, the West Virginia Legislature has enacted various policies concerning the use and management of its water resources. West Virginia's Water Resources Protection and Management Act (WRPMA), which was enacted in 2004 but recently amended in 2008, claimed West Virginia's surface and groundwater resources to be owned, controlled, and protected by the state's Department of Environmental Protection (WVDEP). The WRPMA required the WVDEP both to continue collecting annual water use surveys, as well as to produce a State Water Resources Management Plan by November, 2013. The purpose of the Plan is "to protect and define the state's valuable water resources while promoting its availability for the public, tourism, and industry".[15] The Plan addresses and identifies the state's valuable surface and groundwater water resources and details its current demands for water use by stakeholder. Using data provided by the water use survey, the plan provides a protocol for developing water budgets that account for future consumptive demands for water, as well as for conditions affecting current and future water availability. Finally, the Plan develops a process for determining critical planning areas within the state of West Virginia, and provides recommendations for future water use.

As far as West Virginia's watershed management is concerned, the state has as a number of policies and protocols aimed to reduce pollutant emissions that contaminate surface and groundwater resources in order to maintain strict water quality standards set by the Clean Water Act. For best water management practices, the WVDEP has divided the state of West Virginia into 32 major watersheds, two of which belong to the Kanawha River (Upper and Lower). As a product of Clean Water Act regulations, the WVDEP's Division of Water and Waste

Management has adopted the CWA's five-part watershed management program, which is outlined in Figure 4 and explained in further detail below.

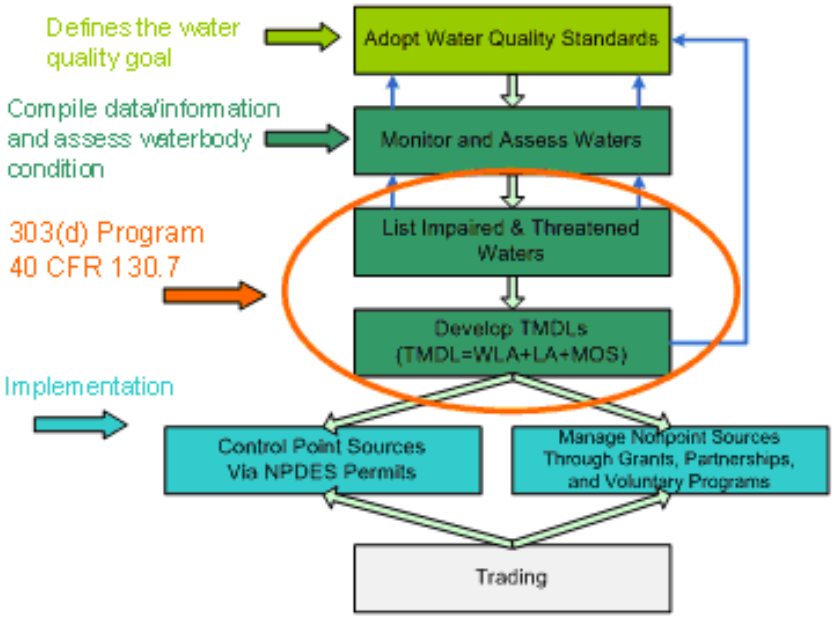

Figure 4. Five Part Water Management Program

(Courtesy of the United States Environmental Protection Agency)[13]

The first step of the program is the assessment and reporting of the state's stream water quality. Water quality monitoring is performed by the Watershed Assessment Branch of the DEP. Large rivers, such as the Kanawha River, are monitored using bi-monthly Ambient Water Quality (AWQ) Monitoring. The WVDEP has nine AWQ sites along the Kanawha/New River. Most of these sites are located at the mouths of confluences with other large rivers, but some exist downstream of Chemical Valley in order to detect and potentially isolate sources of pollution.

The WVDEP is also required by the CWA to establish water quality standards for each body of water, which are meant to "help protect and maintain water quality necessary to meet

and maintain designated or assigned uses, such as swimming, recreation, public water supply, and/or aquatic life".[15] According to the WVDEP's webpage on Water Quality Standards, the standards consist of four basic elements: "designated uses of the water body, water quality criteria to protect designated uses by limiting chemical constituents that may be present in the water body, an antidegradation policy to maintain and protect existing issues and high quality waters, and general policies addressing implementation issues".[15] West Virginia's Water Quality Standards are reviewed every three years by the WVDEP and all other stakeholders.

Comparing water quality data collected by the Watershed Assessment Branch to the water quality standards for each body of water, the WVDEP's Division of Water and Waste Management is required by the EPA to produce an Integrated Water Quality Monitoring and Assessment Report, which provides an overall assessment of West Virginia's waters, along with a list of impaired streams to be subject for TMDL reports. To qualify as an 'impaired stream,' the body of water must not meet water quality standards set by the WVDEP. The Clean Water Act requires the WVDEP to produce Total Maximum Daily Load (TMDL) reports for all streams on the impaired stream list. TMDL reports develop a plan of action to clean up impaired streams and set up new management strategies in order to help streams meet water quality standards.

Finally, West Virginia is also required by the CWA to have a Nonpoint Source Program, which coordinates multiple agencies and non-governmental organizations to address nonpoint source pollution. This program has established a fund to assist in the development of projects that target nonpoint source solutions. This program is relatively unadvertised to the public, and very few nonpoint source projects have actually been implemented in West Virginia.

Failures of Current Inspection and Enforcement Protocols

Within the DEP, the Environmental Enforcement (EE) staff are responsible for the inspection and enforcement of activities monitored by the DEP's Division of Water and Waste Management. According to its website, the EE "promotes compliance with the Solid Waste Management Act, Water Pollution Control Act, Groundwater Protection Act, Hazardous Waste Management Act, Underground Storage Tank Act, and Dam Safety Act by providing assistance, inspecting regulated sites, and enforcing conditions required by these acts".[16] EE has inspection and enforcement protocols for dam safety, hazardous waste, underground storage tanks, and water and waste. Each of these protocols addresses inspection, enforcement, citizens' complaints, and spills/emergency responses. However, while the majority of contamination problems in the Upper and Lower Kanawha Watersheds are a result of coal-related practices, both the dam safety and water and waste protocols intentionally exclude coal-related issues from their inspection and enforcement criteria.

Coal-related issues are regulated by the WVDEP's Division of Mining and Reclamation, as well as by the Office of Abandoned Mine Lands and Reclamation. In 2010, the WVDEP released the *Permitting Guidance for Surface Coal Mining Operations to Protect West Virginia's Narrative Water Quality Standards*, which is an attempt to assist permit writers in "developing site-specific NPDES permit conditions for surface coal mining operations using a holistic watershed monitoring approach through the use of biological and chemical monitoring, whole effluent toxicity testing, and the development of Aquatic Ecosystem Protection Plans".[17] This document utilizes adaptive management techniques to protect water quality standards, emphasizing the assessment and re-assessment of permit plans to see what strategies are the most effective. While this adaptive, place-based management strategy seems effective in theory, it has

clearly not been as successful in practice. Despite having regulations put in place to prevent point- and nonpoint sources of acid mine drainage for decades, the Kanawha watersheds still face high levels of pollutants from active and abandoned mines. It seems as if the failures in management policy and pollution prevention are more a result of enforcement failures than policy failures. Enforcement failures may be, in part, the result of a lack of communication between the two WVDEP divisions that are responsible for managing water quality.

In addition to failures in the enforcement of mining policies, the WVDEP's protocol for underground storage tanks claims to require compliance inspections on all active storage underground storage facilities. It is important to note that this protocol fails to mention inspections for aboveground storage tanks, such as the one used by Freedom Industries. Additionally, as evidenced by the case of the Freedom Industries spill, it is evident that storage tanks are rarely, if ever, actually inspected after they are initially installed, regardless of enforcement protocols. According to a recently retired senior WVDEP official, Pam Nixon, the WVDEP is constantly being pressured by local government officials and large corporate interests to scale back its enforcement of Clean Water Act Policies.[19] She argued that local officials continue to emphasize "compliance assistance" over heavy-handed enforcement. Compliance assistance, according to Nixon, means that the DEP's top priority in the face of a problem will always be to keep the company in operation.[19] This unofficial policy becomes apparent in the WVDEP Clean Water Act enforcement statistics reported by the Charleston *Gazette* in 2008. According to Osnos, "the Charleston *Gazette* discovered that in a nearly five-year period coal companies had self-reported around twenty-five thousand violations of the Clean Water Act, but he DEP had not reviewed the reports or issued a fine".[19] In response to this statistic, DEP

inspectors argued that the process of issuing an evaluation is very time consuming, and there is simply just not enough time for them to enforce every violation.

Missed Opportunities in Pollution Control Policy

Throughout the past few decades of frequent coal and chemical-related disasters, numerous policy recommendations have been proposed to prevent spills in Chemical Valley. Both after the 2008 explosion at the Bayer CropScience chemical plant and again after the 2010 accidents at DuPont chemical plant, the U.S. Chemical Safety Board strongly recommended that the Kanawha-Charleston Health Department create a chemical accident prevention program. This program recommendation suggested that, in addition to inspections by the WVDEP, the Health Department send government inspectors to check on these chemical plants as well.[20] While Kanawha County officials have reached out to the state to help them implement the Chemical Safety Board's recommendation, the state government has continuously ignored their requests.

Similarly, a 1984 report by the EPA's National Enforcement Investigations Center highlighted that West Virginia's attempts at managing toxic air and water pollution were not adequately protecting environmental and public health in the area, which it argued was mainly due to a lack of information about the potential effects of toxic substances present in the valley. Officials at the EPA recommended that the WVDEP deal with environmental pollution using a more integrated program that would consider all types of pollution simultaneously.[21] The state of WV ignored this suggestion.

After the spill by Freedom Industries earlier in 2014 that put over 300,000 West Virginians out of water, the state has proposed new legislation to address the underlying issues of

this problem. The proposed bill, the Chemical Safety and Drinking Water Protection Act of 2014 (commonly known as the Spill Bill), is meant to protect surface water from contamination by chemical storage facilities by amending the Safe Drinking Water Act.[22] This amendment would create new safety standards for aboveground storage tanks and would provide for oversight and inspection of covered chemical storage facilities to prevent the release of chemicals into the water supply in watersheds with public water systems that rely on surface water. The original plan required inspections of the covered chemical storage facilities to occur no more than 5 years apart, and 3 years for specified facilities. Financially, the operator would be liable for all costs of any response action taken by the state due to the release of any chemical that does not follow all state and federal regulations. In addition, there must be a system in place to share all of the information above with several different agencies on both the state and federal level, including both government and private agencies.

This original proposal addressed much of the problem with the current management practices and policy in the state. However, much of this policy proposal was debated and altered behind closed doors. Meetings that were referred to by the Governor as "stakeholder meetings" only included lawyers and lobbyists connected to the coal and chemical industries. The resulting policy proposal "defines what chemicals would be included leaving the potential for a subset of chemicals to be exempt from the bill's requirements. The new proposal also allows for certain types of storage tanks to be exempt from inspections, which leaves room for future accidents to occur.

IV. Policy Recommendations

Ecosystem-Based Management

The purpose of this policy memorandum is to develop a set of realistic, yet effective policy recommendations for the protection and management of the Kanawha River Watersheds. This policy memo focuses on finding strategies that will allow West Virginia's Department of Environmental Protection to develop, implement, and enforce management strategies that are consistent with the general practice of Ecosystem-based Management (EBM).

EBM is an environmental management approach that recognizes the full range of interactions that occur within an ecosystem, including humans; it considers everything, avoiding considering single issues, species, or ecosystem services as independent parts.[29] An ecosystem-based approach is especially important when a region has both terrestrial and aquatic parts to manage, like the Kanawha River does. The Clean Water Act already has some ecosystem-based qualities because it incorporates a variety of management policies into one in order to recognize every part of the ecosystem. By managing the Kanawha river as an ecosystem instead of just focusing on the eco-services it provides, allows for a more comprehensive management strategy as well as broader benefits. Although there is some ecosystem-based management in place, a stricter policy and better enforcement will help ensure that this management policy works properly so that all the benefits can be reaped. A closely followed ecosystem-based management policy accompanied with the Spill Bill will improve the Kanawha not only for human consumption, but for the environment and ecosystem as a whole.

As advocates of EBM, we have developed three policy recommendations that will a) facilitate a more effective cleanup of the current situation, (b) prevent future accidents and point-source pollution from occurring, and (c) prevent nonpoint source pollution from entering the

streams and rivers of the Kanawha River Watersheds using strategies that are consistent with EBM. A detailed description of the problems affecting the region and the proposed solutions is in Figure 5 below.

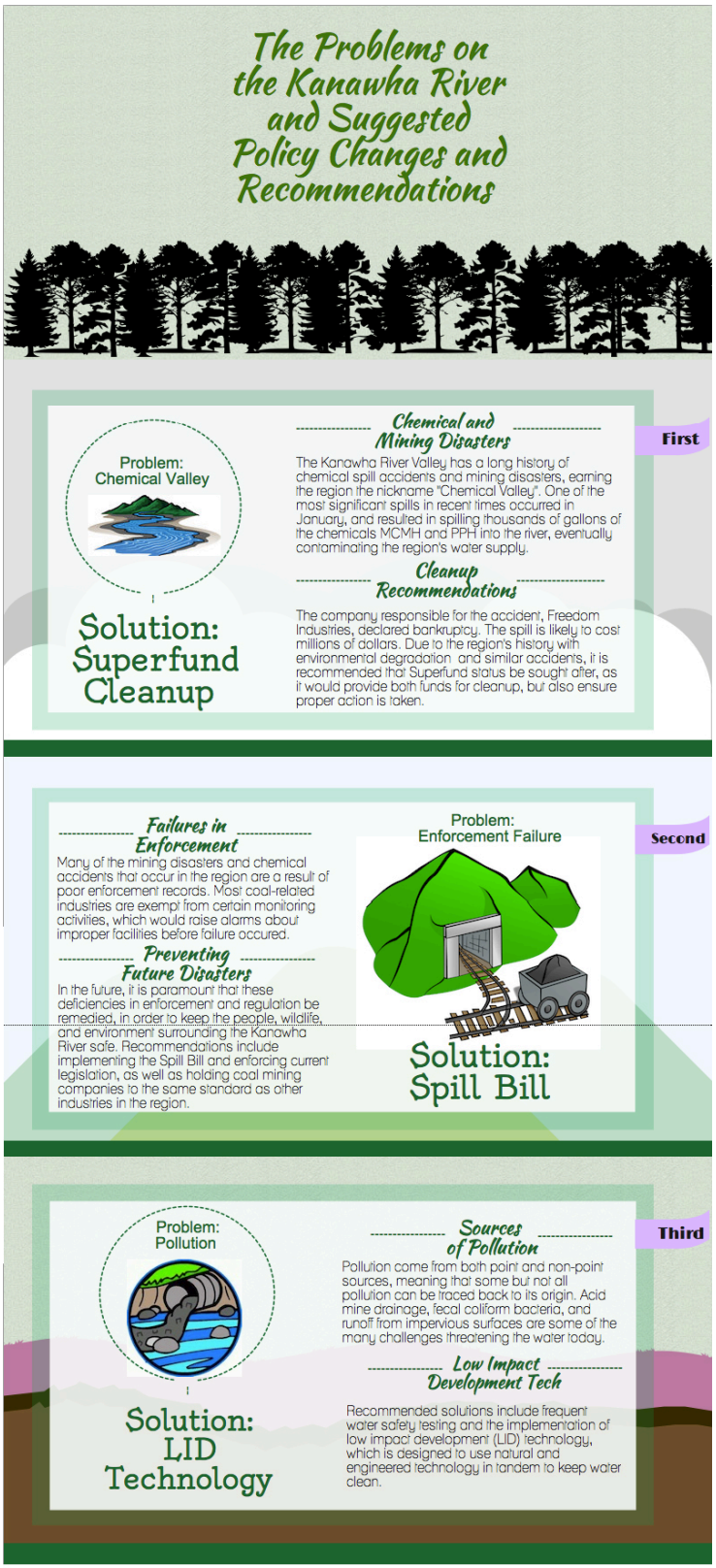

Figure 5. The Problems and Proposed Solutions for the Kanawha River

Cleaning up the Current Situation

In order to begin and expedite the cleanup progress, we propose an appeal to name Chemical Valley as a Superfund site. Superfunds were created by the federal government "to clean up the nation's uncontrolled hazardous waste sites," and are overseen by the EPA's Office of Solid Waste and Emergency Response.[23,24] Superfunds were established by the Comprehensive Environmental Response and the Compensation and Liability Act of 1980 in the wake of discovering severe environmental degradation as a result of toxic waste dumps such as Love Canal and Times Beach.[24] The steps to get a site classified as a superfund are arduous and complex, as it involves assessing the sites, placing them on the National Priorities List, and then both establishing and implementing appropriate cleanup plans. The Kanawha River falls into region 3 of the 10 regions designated to respond to hazardous substance releases.

Arguably, Chemical Valley has had numerous hazardous substance releases, drawing national attention for numerous accidents and not just the most recent fiasco with MCHM. Most assuredly, this region should be assessed for inclusion into the Superfund program, as it would provide funding for cleanup efforts and hold corporations accountable for their actions that led to the release of hazardous materials into the region's drinking water supply.

With the implementation of the program, Chemical Valley will be properly assessed and cleaned accordingly. With the assessment, appropriate measures can be taken for cleanup. In some cases upon completion of site assessment, the agency determines potentially responsible parties (PRPs) as responsible for cleanup, assuming they are still present in the community and have the funds to clean up. This creates strong relationships with PRPs, allowing for an atmosphere of cooperation and mutual respect. Furthermore, this brings the PRPs to the table and encourages cleanup of sites not listed on the national priorities list. It also encourages those who

handle hazardous substances to be more careful as to avoid future liabilities.[25] This will allow for safe and effective cleanup of the Valley and would not impose heavy costs of cleanup on society.

Despite the benefits of the Superfund proposal, weaknesses and threats exist as well. Critics, for instance, argue that "the liability scheme is unfair, slows cleanup, and results in unnecessary transaction costs".[25] Just because cleanup may be instituted does not mean that the liable parties are doing it effectively or efficiently. Furthermore, applying for the superfund is an extensive process in itself, and could be very hard to appeal for all of Chemical Valley.

Preventing Future Mining and Chemical Disasters

While the WVDEP already has management policies in place that are consistent with ecosystem-based management (i.e. CWA watershed management policy and regulation of acid mine drainage and the storage of hazardous wastes), very few of the existing policies are being implemented or enforced effectively. While the Spill Bill would be an important step towards preventing future chemical disasters because of its regulation of aboveground storage tanks, it is important that the WVDEP and the WV State Government focus its efforts on the enforcement of current and future management practices in order to prevent the failures of past ones. One way that they can improve enforcement procedures is by making the process more transparent.
In order to improve transparency, we recommend that the Governor invite a more inclusive group of stakeholders to discuss the details of the new "Spill Bill." With the involvement of more stakeholders, more groups will feel directly responsible for making sure the bill is enforced. The citizens groups and environmental organizations that were originally excluded from the conversation might be more likely to monitor the WVDEP's adherence to the policies, and they might be better informed on how to enforce the regulations themselves using other

times of governance, such as information-based governance. Using the spread of information, public interest organizations can better inform public of West Virginia on the inconsistencies and biases of the state's regulatory agencies.

Mitigation and Prevention of Nonpoint Source Pollution in the Future

Outside of pollution from chemical disasters, the two most significant point-sources of pollution in the Kanawha River Watersheds are acid mine drainage and combined sewage overflows. While current federal legislation requires permits and best management practices for the development of all mining and sewage sites, pollution from those point sources is still clearly problematic for water quality in the Kanawha River watersheds. Additionally, non-point sources for pollution are becoming increasingly problematic as well, which makes the management of water and waste much more difficult for the WVDEP and other stakeholders. Various forms of land disturbances, such as logging, energy extraction, construction/urbanization, and agriculture, cause increased stormwater runoff and erosion that sends a variety of pollutants, including metals, chemicals, and dissolved solids into the waterways of the Kanawha River basins.

While there are many active management strategies that target specific sources and pollutants, these strategies are often highly invasive and expensive solutions that don't follow an ecosystem-based approach. Therefore, we propose that the WVDEP attack the pollution problem at its source by capitalizing on natural ecosystem services. There are several passive treatments for acid mine drainage, which capitalize on naturally occurring chemical and biological processes to restore polluted waters. Similarly, Low Impact Development (LID) retrofit strategies, facilitate the use of natural systems to control and filter stormwater runoff in order to prevent buildup that causes CSO.

We argue for the implementation of passive systems to treat acid mine drainage strategies in problem areas where TMDLs have been produced. Specifically, we argue for the implementation of anaerobic wetlands and successive open limestone channels (OLCs) because these two are designed to treat net acidic water. These passive treatment systems are much cheaper than active chemical treatment of acid mine drainage and do not require continuous chemical inputs. They utilize of naturally occurring chemical and biological processes to clean contaminated waters. In anaerobic wetlands, much of the water treatment occurs through water passage into organic rich substrates. Anaerobic wetlands both promote metal oxidation and hydrolysis and precipitate metals and neutralize acid through subsurface chemical and microbial reduction reactions. This can dramatically decrease acidic levels in water, leaving safe and healthy water for use. Similarly, with OLCs, acid water runs through open limestone channels and is then treated by limestone dissolution.[26]

We argue for the implementation of two LID methods that would be particularly effective for this case, bioretention areas and permeable pavements. Bioretention areas are designed to absorb excess storm water in order to filter out pollutants and recharge groundwater. They serve as soil- and plant-based filtration devices that use physical, biological, and chemical treatment processes to remove pollutants. By installing one of such areas into the Kanawha Valley, we can achieve mass removals of heavy metals. Studies have found that copper, zinc, and lead have had reductions of up to 90% with this technique, and in some cases as much as 98% and 99% removal resulted for lead and zinc. This will help us control water quality and runoff quantity, ensuring a safer water supply for the future[27]. One last passive measure we propose to implement is permeable pavements. Paved roads and parking lots play a central role in carrying stormwater and contaminated runoff into receiving waters. By installing pavements that can locally infiltrate

water, we can decrease downstream flooding, the frequency of combined sewer overflow events, and the thermal pollution of sensitive waters. There are many forms of permeable pavements, which include block or grid paving, pervious asphalt, and pervious concrete that increase surface area for water infiltration.[28] This too will be central in implementing strategies that naturally and efficiently cleanse contaminated waters.

V. Conclusion

The continued accidents and disasters occurring in the Chemical Valley pose an imminent threat to the health and safety of the entire ecosystem that relies on the Kanawha River. These violations infringe upon human environmental rights and the basic rights of humans and other organisms to access clean and healthy water for survival. The exclusion of all stakeholders in the decision making processes for water resource management results in a dearth of viewpoints and opinions, and allows for decisions to be concentrated in the hands of a few individuals. This allows corruption to enter into what should be unbiased resource management where all stakeholders have equal access to a resource vital for life. Failures in the past have proven that the state's current adaptation management strategy simply does not work, and enforcement leaves much to be desired. For the health of the ecosystem, we suggest that an ecosystem-based management approach be adopted and enforced in order to avoid future disasters and prevent both point and nonpoint pollution from entering the water. Lastly, we advocate for Superfund site status for the entirety of the Kanawha River Valley – anywhere that has earned the nickname Chemical Valley and experienced so many disasters could benefit from the cleanup efforts, enforcement policies, and future regulations that said status would grant.

VI. References

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