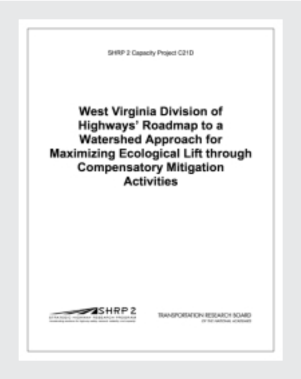

SHRP 2 Capacity Project C21D

West Virginia Division of Highways' Roadmap to a Watershed Approach for Maximizing Ecological Lift through Compensatory Mitigation Activities

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DETAILS

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SHRP 2
STRATEGIC HIGHWAY RESEARCH PROGRAM
Accelerating solutions for highway safety, renewal, reliability, and capacity

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

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Environmental Research Center
West Virginia University

TRANSPORTATION RESEARCH BOARD
Washington, D.C.
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Contents

Executive Summary

The West Virginia Division of Highways (WVDOH) impacts more waterways than any other public institution in the state of West Virginia. They have invested considerable resources into research and programs meant to limit their impacts and explore ways to improve mitigation opportunities, yet have no programmatic approach suitable to regulatory agencies that would help streamline their planning and permitting process. Furthermore, these same regulatory agencies have also invested in many disparate research programs meant to track and improve environmental forecasting and accountability.

The watershed approach to compensatory mitigation is the new mandate, approved and recognized by non-profit, research, federal, and state entities. It was established by federal agencies as part of the Final Mitigation Rule in 2008. It is intended to link compensatory mitigation projects to 'realized' ecological lift with regards to an overall landscape. This is analogous to improving a neighborhood by restoring dilapidated structures and brownfields, or repairing damaged infrastructure like bridges, wastewater, or water services in such a way that the entire community benefits.

The goal of the research effort led by West Virginia University (WVU) is to design a 'recipe' that will allow WVDOH to forecast ecological impacts, avoid and minimize the most sensitive environmental resources, and achieve meaningful ecological lift in their required compensatory mitigation activities. Despite recent advances in environmental impact analysis relying on geospatial technologies, a watershed-based approach to quantifying these impacts in an ecosystem service and function context is relatively new to West Virginia. In a state with over 6,000 bridges and rugged and complex terrain, a holistic approach to highway development is needed, as impacts are unavoidable, and the resulting compensatory mitigation can meet ecological goals while promoting the mission of the WVDOH.

The objective of this 14-month Strategic Highway Research Program 2 project was to evaluate current methodologies and develop new approaches as necessary. Study locations focused on the Coalfields Expressway and King Coal Highway, two highways currently planned and under construction in southern West Virginia. These highways, designed to promote economic development, decrease commuter time, and increase tourist opportunities, traverse a topographically challenging area dominated by steep slopes.

Several currently existing tools were evaluated for their efficacy within West Virginia. This study follows the guidelines developed by the Integrated Ecosystem Framework. While additional tools, such as the Watershed Resources Registry and NatureServe VISTA were evaluated, it became clear that a tool specific to West Virginia was necessary.

The WVU-led, multidisciplinary team of academic and private researchers shifted focus to draw upon regionally developed environmental accounting and forecasting tools already vetted or in the process of development. These tools came from the WVDOH and other state entities (West Virginia Division of Natural Resources and West Virginia Department of Environmental Protection), and federally-funded (U.S. Environmental Protection Agency, Natural Resources Conservation Service, U.S. Army Corps of Engineers, and U.S. Fish and

Wildlife Service) endeavors. Selected tools were then incorporated into a watershed approach to compensatory mitigation.

This process, by using tacitly-approved methodologies, is intended to promote reasonable 'buy-in' from regulatory agencies and in this way overcome the initial skepticism that often accompanies WVDOH environmental initiatives. Using the 1:24,000-scale segment-level watershed as the unit of resolution, and by summarizing to the commonly used 8-digit hydrological unit code (HUC), the research team developed a framework to evaluate highway impacts on streams, wetlands, and terrestrial landscape integrity.

"Landscape integrity" was a late-addition surrogate for the Endangered and Threatened Species Interagency Coordination Tool which was not yet ready for public release and evaluation during the course of this project. Landscape integrity was derived from a previously developed NatureServe index that incorporates a weighted distance to disturbance features methodology as a means to identify areas on the landscape most suitable to high biodiversity and ecological integrity.

Stream and flowing water impacts were calculated based on the West Virginia Stream Condition Index modeling tool which predicts changes in benthic macroinvertebrate communities in response to landscape changes. These communities are indicators of water quality and used as a means of determining the level of required compensatory mitigation associated with an activity. By estimating the decrease in these scores, the team was able to compare downstream water quality impacts at a watershed-level on a potential route-by-route basis.

Wetland impacts were determined using the soon-to-be-released, enhanced National Wetland Inventory (NWI) spatial data layer. These data are one component of an improved Wetland Monitoring and Tracking Plan for West Virginia, and feature relative levels of ecosystems services and functions (e.g., floodwater attenuation and nutrient processing) associated with wetlands on the landscape. Using this new layer, the team was able to compare highway impacts not only on a wetland acreage basis, but also on the function the wetland may be performing in each watershed.

This recipe, or framework that the team developed to quantify impacts, can also be used to identify ecological lift opportunities. In this way stream segments with poor water quality affecting downstream segments can be targeted for mitigation activity. Bottomlands can be screened for the likelihood of supporting mitigation activities to promote and maintain functioning wetlands. The research team used the derived landscape integrity units to ensure the mitigation occurs in regions within watersheds that are not already at risk of being ecologically compromised.

These analyses feature a traditional approach to mitigation activity while shifting the existing paradigm with consideration of an alternative approach to mitigation for roadway construction activities. Due to the cumulative magnitude of impacts, and considering the mandate of the WVDOH to serve the public as an ecological steward and facilitator of economic development (and provide safe transport), the team proposes allowing WVDOH to implement agency-approved and researched watershed-based plans for mitigation credit. These plans would list impairment sources and treatment options with anticipated costs and water quality improvements. To implement such a program, WVDOH will need a Memorandum of Understanding with agencies to create a "Highway Ecological Endowment Fund" that would ensure the operations and maintenance of these treatments *into perpetuity*, and in this way, satisfy mitigation requirements according to the credits determined by the West Virginia Stream and Wetland Valuation Metric. In doing so, it will demonstrate to the public the tangible benefits of compensatory mitigation that can extend beyond ecological lift and provide economic opportunity, improve public health, and make waterways accessible and as a result become a resource to the communities served by these highways once again.

This research effort has outlined steps and approaches to integrate this new comprehensive strategy into WVDOH mitigation activities. The following report outlines this approach in an easy to follow and understand recipe format that can be understood by both regulatory agencies and the WVDOH. It fulfills the mandate for a watershed approach to mitigation, and if implemented, will serve as a model for other states to adopt existing regional tools and incorporate them into a framework that streamlines the regulatory permitting and planning process, while remaining accountable to the ecosystem and the interests of the public at large.

CHAPTER 1
Background, Timeline of Mitigation Activities, and Stakeholders

Introduction

The Transportation Research Board (TRB) of the National Academies has a Memorandum of Understanding (MOU) with the Federal Highway Administration (FHWA) and the American Association of State Highway and Transport Officials (AASHTO) to administer the Strategic Highway Research Program (SHRP) 2. The purpose of this program is to research the most pressing needs of the Nation's highway system and develop proactive solutions to current or impending roadway challenges. There are four applied focus areas that are the target of SHRP 2; safety, renewal, reliability, and capacity.

SHRP 2 C21 projects are meant to focus on the capacity-building components of highway management, specifically in regards to valuing and ensuring ecological context without causing undue hardship or delays in the highway planning process. West Virginia was one of four recipients of this C21 funding meant to facilitate the integration of natural resource planning into the highway design and building process.

In West Virginia, this is an especially relevant topic, as the West Virginia Division of Highways (WVDOH) is responsible for the maintenance and construction of one of the largest road networks (36,000 miles) managed by one entity in the United States. This network also includes more than 6,000 bridges, and even more culverts. The water resources associated with those bridges are an important ecological resource functioning in a landscape context that needs to be considered prior to route selection. Doing so can enhance, restore, and preserve important public hydrologic and water quality functions through cost-effective mitigation.

The objective of this SHRP 2 research was to evaluate and, as necessary, customize previously designed pilot projects created to facilitate transportation planning and address environmental concerns in other states, for maximum effectiveness of their application within West Virginia. Working within the framework of current state and federal regulatory policy, and incorporating primary scientific literature, the research team attempted to streamline the planning process by integrating the planning steps into a comprehensive, applied 'recipe' book that could be used to improve methodologies to account for aquatic resources from a WVDOH policy-level perspective.

The funding mandate for this project required the evaluation of previously developed SHRP 2 research projects for adoption into West Virginia's planning policies. However, it quickly became apparent that these tools were not suited for West Virginia and that the team needed to adapt the scope of the project to fit the needs of the WVDOH and state and federal regulatory agencies. In response, the team overtly chose to apply regionally-specific tools using

a cumulative approach that promotes the mission of a watershed approach to mitigation.
The research teams' specific project objectives were to:

1. Assess the efficacy and cost effectiveness of these tools as feasible proactive mitigation, conservation, and planning steps;
2. Work with the mitigation Interagency Review Team (IRT) and partners to modify and adopt tools suited to conditions in West Virginia and then implement a plan designed to incorporate these tools into new, streamlined, regulatory guidance; and
3. Provide detailed guidance and review, so that other states can efficiently adopt appropriate SHRP 2 tools.

With cooperation and urging from the WVDOH, the research team chose to focus on two highways currently planned and under construction in six counties (Raleigh, Logan, Wyoming, Mingo, Mercer, and McDowell) within the southern portion of West Virginia. These highways, the Coalfields Expressway (CFX) and King Coal Highway (KCH), were originally part of the Appalachian Regional Commission's (ARC) 1960s development plans. These highways were planned to benefit people traveling within the study area and decrease commuting time for workers and health care emergency services; as well as facilitate commerce such as timber, coal, and other tourist travelers who are either passing through or are seeking recreational opportunities in the southern coal fields. Both highways traverse a topographically challenging area, and will replace state roads that are inhibited by steep grades, varying lane widths, areas of reduced speeds, and a high percentage of "No Passing Zones". The Environmental Impact Statements (EIS) were completed in late 1990s and early 2000s. Construction began in 2003 on the CFX and shortly thereafter on the KCH, and is currently under way on a segment-by-segment basis as funding allows (Figure 1.1).

Figure 1.1. Construction access to ongoing activities on the Coalfields Expressway.

Original EIS documentation indicated that 24 Build Alternatives (BA) were originally considered (12 within each route); however, many of the routes have overlapping sections. This approach allowed for a "compare and contrast" methodology for route selection. The intent of this research is to improve and standardize methodologies so that they can be used in future long-range and corridor planning, rather than having to re-visit analyses and decisions that have already been completed. Thus, because the preferred route is already planned, and rights-of-way have been purchased, the research team took care not to use this research project for route selection of the current projects. The team simply wanted to demonstrate that our methodology can facilitate overall adoption of these criteria during environmental review when the time and monetary savings are realized by stakeholder parties. To that end, the team focused the analyses on only three build alternatives of each route, to maintain objectivity in route selection and look at relative comparisons between these three different routes and not to create a 'least to greatest' ranking among all options (Figure 1.2).

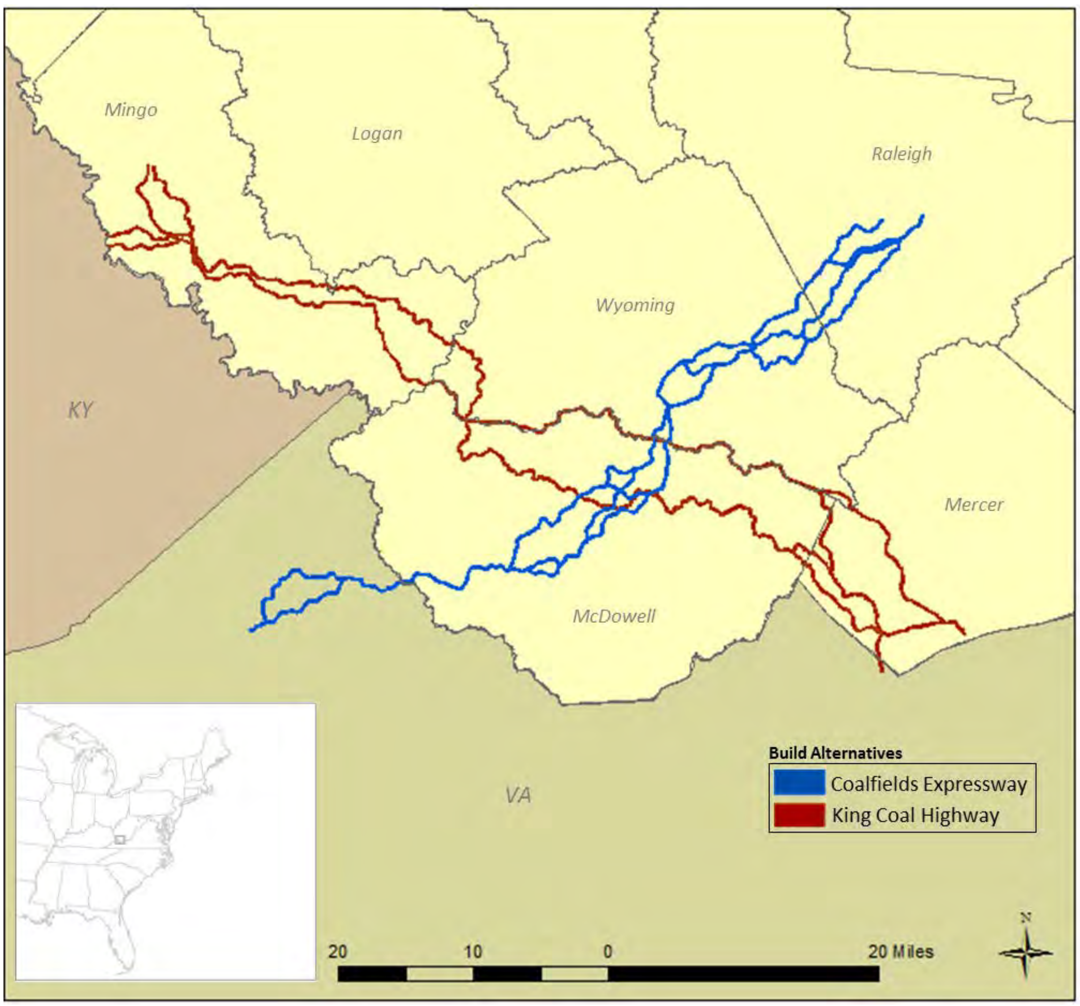

Figure 1.2. Coalfields Expressway and King Coal Highway route evaluations for C21D SHRP 2 pilot study in West Virginia.

Coalfields Expressway

The Coalfields Expressway (future U.S. Route 121) is a four-lane divided highway with partially controlled access that will run north-south approximately 62 miles from the vicinity of Slate, Virginia to the vicinity of Beckley, West Virginia. It intersects three West Virginia counties (McDowell, Raleigh, and Wyoming) and three 8-digit HUC (Hydrologic Unit Code) watersheds (Upper Guyandotte, Tug Fork, and Lower New River). It received $50 million from the Intermodal Surface Transportation Efficiency Act (ISTEA) and was designed as a "Congressional High-Priority Corridor" in 1995 as part of the National Highway System Designation Act (NHSDA). An in-depth analysis of project needs was performed and a summary of these results indicated safety, economic, and social demands among the top contributing factors (Table 1.1).

Table 1.1. Coalfields Expressway Purpose and Need Summary

Factor Contributing to Project Need	Coalfields Expressway Study Conclusions
Current and future capacities and level of service (LOS) of existing transportation network	Year 2013 projections reveal 72% of the study route will be operating at or below LOS 'D'. Coalfields Expressway will improve the LOS and decrease travel times in the study area.
Current and future transportation demands (regional and local)	Traffic demand exists to support a four-lane partially controlled-access highway through the study area.
Regional and local system linkage	There is a need to enhance both regional and local system linkage, as well as modal interrelationships in the region. The Coalfields Expressway will provide industries and the local populace with an efficient travel route and transportation system.
Safety and roadway deficiencies	The study route has higher than statewide (VA and WV) average accident rates. Roadway deficiencies such as substandard curves and steep grades were identified along over 50% of the study route. The Coalfields Expressway will decrease roadway deficiencies and therefore decrease accident rates.
Social demands	Coalfields Expressway will improve access for emergency services, as well as improve access to community services.
Economic demands	Coalfields Expressway will improve access to the study area and could enhance employment opportunities.
Legislation	The Coalfields Expressway has received continuous legislative support from the U.S. Congress as well as support from the West Virginia Legislature.

A broad range of alternatives were initially considered for the project including system-wide improvements, transit alternatives, and new highway or "build alternatives". Ultimately, only build alternatives were found to meet the project needs, and of the 12 alternatives considered, 8 were immediately eliminated and not included in the EIS due to environmental impacts. The remaining four alternatives resulted in unavoidable wetland and floodplain encroachments that would require compensatory mitigation.

King Coal Highway

The King Coal Highway (future I-73/74 corridor) is also a four-lane divided, limited-access highway that runs east-west approximately 95 miles from US-119 (Corridor G) near Williamson, West Virginia to Bluefield, West Virginia and intersects five West Virginia counties (Mingo, Logan, McDowell, Wyoming, and Mercer) and three 8-digit HUC watersheds (Upper Guyandotte, Tug Fork, and Middle New). As with the CFX, an in-depth analysis of project need was performed and a summary of these results indicated safety, economic, and social demands among the top contributing factors (Table 1.2) for the KCH.

Table 1.2. King Coal Highway Purpose and Need Summary

Factor Contributing to Project Need	King Coal Highway Study Conclusions
Current and future capacities LOS of existing transportation network	Year 2013 projections reveal 90% of the study route will be operating at or below LOS 'D'.
Current and future transportation demands (regional and local)	Traffic demand exists to support a four-lane partially controlled access highway through the study area.
Regional and local system linkage	King Coal Highway will enhance both regional and local system linkage, as well as modal interrelationships in the region.
Safety and roadway deficiencies	The study route has higher than the West Virginia statewide average accident rates. Roadway deficiencies such as substandard curves and steep grades were identified along most of the study route (US 52).
Social demands	King Coal Highway will improve access for emergency services, as well as improve access to community services.
Economic demands	King Coal Highway will improve access to the study area and could enhance employment opportunities.
Legislation	The U.S. Congress, through ISTEA, has designated the King Coal Highway as a high-priority segment of a high-priority corridor on the National Highway System.

Completion of this highway is expected to cut travel time in half over the existing state roads that connect the same area. It was designated as "a high-priority segment" of" a high-priority corridor" in the National Highway System.

Local Effect of Highway Building

The effect that these highways are anticipated to have on the local economies of the region have been long-awaited for by Economic Development Authorities (EDAs) in the southern counties. These highways will not be completed for at least an additional 20 years (Greg Akers, WVDOH environmental specialist, personal communication) which means construction jobs will be available. In addition, the highway construction process has included a number of development features that were integrated into the planning process. This includes the construction of a new consolidated school and stadium for southern counties (Figure 1.3), as well as industrial parks, residential sites, an 18-hole golf course in proximity to the Mingo County Airport, and even a federal prison built in the proximity of the KCH and CFX interchange.

Figure 1.3. This section of the King Coal highway, planned to incorporate the Mingo Central Comprehensive High School, was opened with the new school and ready for 2011-2012 year.

According to the EDAs, environmental concerns are secondary to economic development, indicating that the mitigation concept was not fully understood. This is an opportunity for the WVDOH to further complete their mission and serve the public's economic development interest by promoting mitigation activities that create economic opportunities as well as improve public health and the environment. Recreational activities, including tourism, can be improved through the improvement of water quality and access. The research team viewed this as an opportunity for compensatory mitigation to provide not only ecological lift in a watershed, but "economic lift" across a region.

Traditional WVDOH Approach to Compensatory Mitigation Activities

Historically, mitigation activities were not factored into the route selection. At the same time, the National Environmental Policy Act (NEPA), Clean Water Act (CWA), and other such regulations mandated consideration of protected resources such as waters of the United States, as well as threatened and endangered species habitat. These resources were quantified in an EIS. For aquatic resources, this EIS was expressed in number and size of stream crossings, wetland acreage, and National Wetland Inventory (NWI) classifications. These data were a result of previously-mapped data layers, not "on-the-ground" field visits.

Wetland and stream impacts were detailed and recorded after route selection, after construction on an "*as-encountered*" basis. Mitigated wetlands were built to mimic the Cowardin et al. (1979) vegetation class of the type impacted, and multiplier ratios were applied to scrub-shrub and forested wetland to account for the later seral stage of the wetland vegetation on lands within or adjacent to the 8-digit HUC. Post-construction monitoring criteria was set for hydrologic indicators, wetland acreage, and vegetation success – including invasive species control – for a predetermined number of years, to satisfy permit conditions. Unfortunately, in the early years, there was less attention paid to the long-term stewardship of mitigation sites, resulting in projects under duress after the initial monitoring requirements had been satisfied (Norse Angus, WVDOH environmental specialist-retired, personal communication). However, WVDOH understands its stewardship responsibility and has demonstrated by their cooperation in this grant that they are looking for more responsible mitigation options that are in line with their overall public service mission.

With the urging of the FHWA, the drafting of *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (Brown 2006) initiated the movement for a coordinated watershed approach to mitigation with improved agency coordination. From this mandate came a number of tools developed through grant programs to demonstrate effective methodologies to promote this watershed ethos. The WVU-led team approach to SHRP 2 is to highlight those planning tools currently available and under development, and demonstrate their utility to state and federal agencies that oversee environmental review of roadways to improve the review and accountability process. In doing so, WVDOH will work within a framework developed with support and directives from the local agencies and be able to better communicate and justify the integration of ecological resources.

Section 404 of the Clean Water Act and related rules and regulations designate the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (ACOE) as the agencies responsible for reviewing permit applications to impact waters of the United States. Additionally, those agencies must achieve a goal of "no net loss" of water resources by guiding permittees to first avoid and minimize water impacts, and then oversee appropriate mitigation for any unavoidable impacts. The Final Mitigation Rule (issued in the *Federal Register* on April 10, 2008*)* called for the establishment of an IRT to guide compensatory mitigation activities in each state or region. The West Virginia IRT is comprised of members from the ACOE – Huntington and Pittsburgh districts, EPA, U.S. Fish and Wildlife Service (FWS), Natural Resources Conservation Service (NRCS), West Virginia Department of Environmental Protection (WVDEP), and West Virginia Division of Natural Resources (WVDNR).

The Final Mitigation Rule establishes performance standards and criteria for improvement of compensatory mitigation to be achieved through permittee-responsible mitigation, mitigation banks, and in-lieu fee programs. The rule establishes a goal of perpetual site protection for mitigation projects through conservation easements or other real estate instruments. It also requires that mitigation follow a watershed approach. Previously, some mitigation projects that were approved included the construction of boat launches and in some cases community recreational facilities, which did nothing to protect, preserve, or enhance aquatic resources. In part, the West Virginia Stream and Wetland Valuation Metric (WVSWVM) addresses the concerns for appropriate types of mitigation (West Virginia IRT 2011). According to the public notice issued by the ACOE, Huntington District on February 1, 2010, "the goal of a watershed approach is to maintain and improve the quality and quantity of aquatic resources in a watershed through strategic selection of mitigation sites". Mitigation project sponsors would be required to provide information, such as existing watershed plans or other relevant data, to demonstrate a watershed approach and use the WVSWVM to ensure appropriate replacement of aquatic resources impacted.

In response to the Final Rule, members of the IRT developed the WVSWVM to consistently correlate proposed impacts (debits) with compensatory mitigation activities (credits). The ACOE, Pittsburgh District has issued public notices for the WVSWVM (WV IRT 2/1/2010) and WVSWVM 2.0 (WV IRT 2/1/2011). The WVSWVM consists of a series of spreadsheets with formulae to capture stream: functions, conditions, and water quality indicators in order to generate index scores for both the impact and mitigation sites. Index scores are then multiplied by stream length to generate a unit score. The mitigation unit scores can then be compared to the impact unit scores to make sure that the goal of 'no net loss' has been achieved. Stream function, conditions, and water quality, are calculated using the EPA Rapid Bioassessment Protocol (Barbour et al. 1999), West Virginia Stream Condition Index (WVSCI) scores (Gerritsen et al. 2000), and if applicable, a hydrogeomorphic assessment designed for regional high-gradient streams (ACOE 2010), over the duration of the project. The WVSWVM also calculates incentives for mitigation site protection, different levels of restoration based on the extent of channel impairment and the extent of restoration necessary, riparian corridor planting and protection, temporal loss between impact and mitigation, and the time required for mitigation sites to reach maturity. This temporal loss factor serves as an incentive to use mitigation banks or the in-lieu programs prior to the creation of impacts and in this way favors permittee-responsible mitigation that completes projects as soon as possible after the permitted impacts.

> *The WVSWVM clarifies how compensatory mitigation credits and debits are calculated. By incorporating value based on water quality, stream functions and ecological conditions, impacted streams that are lower quality do not carry as much of a mitigation burden as higher-quality impacted streams.*

According to the Final Mitigation Rule, mitigation banks are to be the preferred alternative for mitigation, wherever possible. The IRT approves the service area requested by mitigation banks which is generally within and adjacent to the 8-digit HUC watershed containing the bank site. However, due to the lack of mitigation bank options, the service areas are typically larger than the 8-digit HUC, until the approval of more banks.

Developing wetland mitigation banks in West Virginia can be challenging. The lack of development activities in isolated portions of the state, exacerbated by the recent recession, has limited the demand for mitigation credits; as a result mitigation bankers are focusing their efforts on watersheds where there is a demand for credits. Moreover, perpetual site protection and establishing accountability for long-term stewardship past the monitoring time period is not in the financial interest of many mitigation bank developers. Therefore, sites must be selected with a caretaker in mind prior to bank development. Additionally, in West Virginia, there is a lack of flat land suitable for enhancing, restoring, or creating wetlands – especially in the southern portion of the state. Any flat land is typically a narrow floodplain used for residences or agriculture, thus creating a premium on suitable mitigation sites.

The second preferred option in the suite of mitigation alternatives established by the Final Rule is the In-Lieu Fee (ILF) program. The West Virginia ILF program was established through an agreement between the ACOE, Pittsburgh and Huntington Districts, and the WVDEP in 2006 which was designed to give individuals or businesses responsible for mitigation the option of paying into this fund rather than designing their own mitigation. The burden and liability of creating and maintaining appropriate mitigation is then transferred from the permittee to the WVDEP as the in-lieu fee program sponsor. In 2010, the WVDEP signed an MOU with The Nature Conservancy (TNC) and Canaan Valley Institute (CVI) to cooperate in managing the ILF program. When initially set up, permittees paying into the ILF program were usually charged $200 per linear feet of stream impacts and $30,000 per acre of wetland impact, with multiplier ratios based on vegetation class of the wetland. This model of pricing, however, did not reflect the true costs of mitigation in West Virginia. In 2010, the ACOE issued a public notice raising the fees to $400 per linear foot of stream impact and $60,000 per acre of wetland impact.

Currently, these fees are being shifted to unit credits for streams, calculated using the WVSWVM.

However, reconciling these debits with appropriate mitigation projects (credits) may be challenging. Many of the streams in West Virginia are susceptible to non-point and point source water quality impairment; meaning, despite improving physical stream structure and hydrology functions, the lack of biological and water quality response limits mitigation credit creation. Improving the sources of these water quality issues is not an appropriate form of compensatory mitigation in most cases.

The Final Mitigation Rule states that compensatory mitigation should replace the functions lost. Most impacts requiring mitigation are caused by the placement of fill. In addition, mitigation projects are meant to be “self-sustaining”, meaning that sponsors of projects that require active, long-term management must provide it, including mechanisms for long-term financing. Mitigation projects seek to replace and restore aquatic habitat, and ecological and hydrological functions impaired by the placement of fill. Fecal coliform and acid mine drainage impair water quality functions, and reducing these impairments would not necessarily replace the functions lost by the placement of fill material in aquatic systems. Secondly, the treatment options for impairment such as fecal coliform or acid mine drainage require infrastructure with operations and maintenance costs. In addition, it is a challenge to find suitable mitigation sites with landowners who agree to allow mitigation sites under conservation easement or other real estate instruments that provide for perpetual protection. Agriculture, timber, oil, gas, and mineral resources drive the state’s rural economy; as a result, landowners are often reluctant to lose access to a portion of their land if it means losing access to those valuable resources.

To generate mitigation credits, sites must be selected where the aquatic and riparian conditions are in poor enough condition to be able to provide quantifiable and sufficient “lift” in response to mitigation activities. However, generating the required level of credits has very real risks attached. The cost to build the mitigation associated with the projected lift requires high levels of restoration (e.g., restoring stream pattern by constructing new channel or excavating new floodplain). With these higher levels of restoration, however, comes increased risk of damages to more vulnerable, newly constructed landscapes from droughts and floods. Therefore, the conundrum from a mitigation standpoint is between achieving the desired number of unit credits though smaller, more intensive, higher-risk projects; or by means of projects involving lower-risk enhancement and riparian buffer activities spread over a larger area, which includes the added challenge of acquiring sufficient acreages of riparian buffers and larger conservation easements in order to protect into perpetuity.

The watershed approach taken by TNC and CVI in selecting in-lieu fee mitigation sites seeks to address the above challenges by first selecting subwatersheds within the service area where natural land cover and stream functions have been largely maintained, water quality impairments are minimal, and land use suggests some potential physical stream impairments. These organizations then attempt to find mitigation sites requiring some level of restoration but are associated with few if any upstream or adjacent activities that could threaten long-term site sustainability, and with landowners interested in perpetual site protection. In this report the approach to guiding mitigation opportunities is similar and attempts to identify poor water-quality reaches that indicate restoration needs nested within higher quality waters.

Current Roles, Motivations, and Concerns of Stakeholders

The ACOE is responsible for issuing nationwide permits (NWP) or individual permits under Section 404 of the CWA. These permits regulate the discharge or fill of material into a 'water of the United States.' Their role is to ensure that the integrity of stream and wetland resources are accounted for, maintained, and, if necessary, replaced through mitigation. The ACOE is represented on the IRT. They review mitigation activities to ensure compliance, and set permit conditions based on recommendations from WVDNR and WVDEP. Using the WVSWVM to quantify mitigation impacts and credits and incorporate landscape wetland functioning into the planning process will allow ACOE to set appropriate watershed-level mitigation requirements and gauge the effectiveness of the action.

The WVDEP is responsible for enforcement of the Section 401 water quality permits. The WVDNR provides technical input on 401permit requirements, recommendations, and monitoring and compliance of the permit conditions. Both agencies are represented on the IRT.

In addition to the efforts of the WVDEP, WVDNR, and ACOE in evaluating the impacts of aquatic resources in accordance with the Clean Water Act, projects are also reviewed by the FWS for potential impacts the threatened and endangered species. This process is mandated in Section 7 of the Endangered Species Act (ESA). The FWS ensures critical habitat and species impacts are minimized, and if necessary, issues incidental take permits and designates habitat mitigation requirements.

The West Virginia Department of Transportation's (WVDOT) mission statement is to "responsibly provide a safe, efficient, and reliable transportation system that supports economic opportunity and quality of life". The WVDOH is responsible for the facets of roadway infrastructure, including research and even roadside economic development. As stewards of highway rights-of-way (ROW), they have Environmental Coordinators (EC) in each of the ten planning districts that are accountable to the Engineering Division/Environmental Section at the headquarters in Charleston, West Virginia. Although WVDOH has a history of compliance with state and federal environmental regulations, mitigation projects and actual protection of these resources often fall short of the intention and plans for protection and enhancement of these resources. This is in part due to the difficulty in keeping up with changes in these environmental regulations. The WVDOH viewed this SHRP 2 grant as an opportunity to frame consistent resource reporting and accounting procedures, and ensure compliance to existing and future environmental challenges. They understand that ecological considerations need to be accounted for; however, ultimately their management priorities are: roadway safety, reliability, and the economic opportunities provided by transportation. They are not represented on IRT, and interact with the other agencies regularly as permittees as they are responsible for more impacts and needing to purchase more mitigation credits than any other public entity in the state. In working with the research team, the WVDOH has requested new tools for environmental planning that may help them meet agency demands in quantifying, comparing, avoiding, and minimizing impacts and costs of the highway impacts. If mitigation is necessary, as a publicly-funded state agency, the WVDOH would like SHRP 2 to help maximize the effect of their mitigation dollars in terms of watershed-level ecological lift.

Highway activities are subject to the same stringent environmental standards as other industries in the state; but due to the sheer number of employees and projects associated with the statewide footprint of WVDOH activity, it is difficult to accurately track permit compliance. Despite some progress and institutional changes to improve the management of permitting activities, culvert installation and design and its effect on stream passage is an example of the difficulties faced with reconciling environmental stewardship with everyday maintenance activities. The number of flowing waters interrupted by roadways is especially high in West Virginia – the 'Birthplace of Rivers.' Historically, stream crossings would not have triggered mitigation requirements. However, regulatory agencies are now considering mitigation requirements in some cases; as a result the WVDOH is struggling to address this policy change. This problem is confounded when mitigation policy, best management practices, and storm water recommendations are not reliably transferred to the working knowledge of the contractors the WVDOH hires or the WVDOH District employees charged with day-to-day roadway maintenance.

Research Team Approach

The WVU-led research team quantified and accounted for ecological impacts within existing agency parameters that will dovetail into future methodologies that account for mitigation impacts prior to construction. In Chapter 2 of this report, the research team reviews existing SHRP 2 tools, regionally developed ecological assessment tools, and forthcoming environmental resources, and considers their use and applicability if integrated into West Virginia's plan. In Chapter 3, the team demonstrates the use of the WVSWVM to quantify and compare the potential stream impacts of different possible highway corridors, as well as showcase the use of an enhanced wetland Geographic Information System (GIS) data layer indicative of wetland function to estimate and compare potential highway impacts to wetlands. Furthermore, the team introduces the forthcoming Interagency Coordination Tool (ICT), a web-based GIS tool currently in development in coordination with FWS and NRCS that can be adopted for highway planning purposes, although it was not ready in time to conduct any analyses for this report. The ICT will allow WVDOH planners to avoid sensitive habitat that will trigger a FWS consultation. Chapter 4 presents a case study of highway impacts and the resources needed, as determined by the WVSWVM, to mitigate for these impairments based on the existing regulatory framework. The team evaluates the criteria and suggests alternative mitigation activities that would still satisfy the watershed approach to mitigation. In the final chapter, Chapter 5, the team goes over lessons learned and outlines the measures and steps which may be used to streamline the permitting and environmental review process and allow resources to be tracked, while preserving and creating the potential to maximize ecological lift through compensatory mitigation activities.

CHAPTER 2
Applying Regionally Derived Tools for Route Selection

Tools Previously Developed by Transportation Research Board Pilots

The primary focus of this project was to complete the first five of nine steps in the Integrated Ecosystem Framework (IEF), which helps states' to shape and streamline a watershed approach to mitigation (Table 2.1). The research team found the steps to be very clearly laid out and defined. Subheadings within each step ensured critical inputs were not overlooked. However, it became almost immediately apparent that if one were to involve the local regulatory stakeholders, the process would best be served by incorporating the tools and terminology that stakeholders were already familiar with.

Table 2.1. The First Five Steps in the Integrated Ecosystem Framework

Integrated Ecosystem Framework steps
1. Build and strengthen collaborative partnerships vision.
2. Characterize resource status; integrate conservation, natural resource, watershed, and species recovery and state wildlife action plans.
3. Create a regional ecosystem framework.
4. Assess land use and transportation effects on resource conservation objectives identified in the regional ecosystem framework.
5. Establish and prioritize ecological actions.

As the team examined some of the other pilot test tools, they were found not to be applicable to the very geographically and culturally unique issues surrounding the KCH and CFX. For example, the team found that some tools, such as Nature Serve VISTA (2010) and the Watershed Resources Registry (WRR) (Spagnolo 2011) were not applicable for the situation, both in terms of format and context, respectively. The NatureServe VISTA program is based on having ArcMap 9.3®. This may seem trivial, but with the multiple software iterations sprinkled throughout the agencies, academia, and the private sector, relying on a tool dependent on a specific software version is unrealistic. In addition, sliding scales are problematic pertaining to permitting as each stakeholder, despite a difference in value of resources, ultimately must abide by the same regulatory statutes.

The team opted not to incorporate the WRR because it was determined that there were too many unknown variables for it to work properly in the West Virginia landscape. The WRR places an emphasis on forests to indicate water quality, but in this study region, a high percentage of forest cover is not indicative of high water quality due to the nature of the specific stressors (e.g., fecal coliform, sedimentation, mining-related impacts), all of which are not represented in the WRR tool input parameters. Moreover, many of the river systems in the Chesapeake Bay watershed are very different than the headwater systems encountered in West

Virginia. Emphasis on floodplain characteristics do not apply to many of these steep and often flashy systems.

Research Team Overview and Feedback Regarding TCAPP

The Transportation for Communities: Advancing Projects through Partnerships (TCAPP) website has been the focus of many webinars and conference calls (Appendix A). The research team attempted to incorporate certain components of it based primarily on fulfilling the Cumulative Effects Assessment and Alternatives (CEAA) and the report entitled 'Linking the IEF and the Transportation Decision Guide' (TCAPP 2011). However, as noted in many of the webinars and discussions, the TCAPP website is designed in a complex fashion and its interface is a challenge, according to a subset of WVDOH planners and some in the private sector (Amy S. Greene Environmental Consultants, Inc. (ASGECI), personal communication). For example, if a planner is using the Linking Report to compare TCAPP planning points with the IEF, it is simple enough to look at a step in the IEF, and then reference the TCAPP decision points at an individual step. However, when doing a comprehensive and cumulative project, and considering multiple IEF steps, it becomes challenging as the TCAPP decision points are repeated.

The WVU-lead research team pilot project (step 1 of the IEF) used a "back casting" approach to incorporate environmental planning into highway route selection based on new tools available through GIS technologies. The team's approach varied from the strict interpretation of the IEF because the decision for routing and highways construction had already been made and because of limitations associated with data-readiness. This approach allowed us to focus on agency needs and transform research into the applied methodology to tracking and quantifying water resource impacts presently existing in ACOE and other regulatory agency frameworks.

The IEF defines things in a comprehensive, logical, and stepwise fashion. However, based on this and previous experience, there can be a guide based solely on soliciting, incorporating, and maintaining feedback from stakeholders above and beyond the IEF. In some circumstances, the WVU-lead research team found the TCAPP reference to be non-intuitive and too complex to easily be integrated with the planning agenda. For this reason we suggest that the TCAPP would benefit by the addition of some sort of additional query capability allowing users to hide many of the upfront complexities while still enabling access to the information. The IEF can be improved by recognizing that many of the steps it calls for already exist under different premises. It is also important to alleviate data availability bottlenecks and ensure that everyone is using the same data in order to enhance consistency and efficiency.

The research team recommends improving the applicability and utility of TCAPP by altering the user interface in a way to make it more dynamic. For example, rather than acting as a repository for information (e.g., check back in the document library for updated information), there could be more of an interactive component with 'What's New' flash points.

In the course of the webinars the team recommended a 'query-like' interface where users could enter specific parameters about the project that would eliminate some of the non-applicable points. For example, is the project an urban retrofit setting where ESA and water quality issues are less likely to be of significance than a rural highway construction? Is one looking at two-lane or four-lane roads? This alone would help streamline and clean up the clutter of information that is presented and enable the user to drill down through the case studies until one is found that best matches the project being planned.

Furthermore, in the course of the webinar discussions, the team also proposed using the TCAPP as a repository for planning tools specific to each region. The research team believed that different agencies operating within each region in West Virginia have likely already developed many tools for a variety of purposes. For example, the NRCS is developing regional guidelines to evaluate the potential for Wetland Reserve Program (WRP), Environmental Quality Incentives Program (EQIP), and other cost-share programs. Moreover, the ACOE is developing hydrogeomorphic assessments for many aquatic systems throughout the United States. Numerous states already have extensive wetland monitoring programs (e.g., California, North Carolina, Delaware).

The YouTube tutorial video on understanding the role and utility of TCAPP was easy to follow and looked professional. The production quality and editing were good. The most helpful parts for learning to use the TCAPP's Decision Guide were the actual screenshots of the system. It would be helpful if more time were spent on each screenshot and more detail were provided regarding working through an actual example. There is a great deal of information on the website and clearly it cannot all be covered as part of the tutorial. However, working through one actual decision process in step-by-step detail would be useful.

The team proposes one of the best ways to maximize the IEF approach across the county is to use the TCAPP website, or one component of it, that will enable regulators from different agencies to see what other tools other regulatory agencies are already using and how they would promote a watershed approach to mitigation.

An interactive map could enable a user, by hovering over a state or region, to view a list of the assessment tools favored by the agencies required for different types of permitting along with a link to additional information. There can be a query to link to measures quantifying all characteristics of aquatic resources (e.g., GIS layer for wetland type and function, a streams water quality layer, rapid bioassessment procedures, and benthic macroinvertebrate sampling, which require on-the-ground fieldwork.), or just one type of assessment method (e.g., high-gradient stream hydrogeomorphic assessment). This would ensure people continually visit the site. Regulatory agencies could specify changes to policy and post checklists to ensure all materials are turned in for specific permits. It can even be applied to the planning of cultural resources, social values, or other stakeholder attributes recommended by the TCAPP website.

By upgrading TCAPP to the described experience, it would ease the burden of ensuring stakeholders are aware of the TCAPP website. The new design would draw consultants and planning agencies to the website in order to ensure they are complete in their planning process. Regulatory agencies would gain by having an additional forum by which they could direct certain steps of the planning and permitting processes by setting guidelines for applicants to follow.

With the ability to vary and query by project or region, it can even be used as a professional development tool for the curriculum from diverse collegiate programs such as Parks and Recreation, Environmental Protection, Business Management, and Public Administration. This "outside-the-box" and long-term, sustainable model would ensure that if students learn to use it in school, they would be more likely to adopt it in professional life. Although this is undoubtedly a different direction and component to TCAPP, with the number of applications incorporated into its database; a planning curriculum will help the exposure and long-term vitality of TCAPP.

Three items within TCAPP that were particularly useful are:

- Cross-referencing within the TCAPP, especially hyperlinks to more information, helps the user find those sections that are relevant to the specific issues.
- Topic headings for the Decision Guide all displayed on one topic page makes it easier to organize needs and goals.
- Flexibility to apply to a broad range of project types and contexts means the TCAPP is useful for many agencies and consultants.

Integrating Regional Tools into Highway Planning

The decision to apply many of these refined and enhanced regional tools developed specifically for West Virginia entities was, in part, driven by the initial evaluation of the case studies and other pilot projects. In reviewing these tools, the team understands that each environmental planning situation can be guided by the framework of TCAPP and the IEF. Ultimately however, the tools will need to be those best suited for meeting the management objective. If the goal is to have a watershed approach to avoiding and minimizing impacts and generating the maximum ecological lift, then practitioners will need to act as facilitators of information; bringing together disparate existing regulatory tools and their applied research utility.

The research team is composed of diverse investigators, many with research partnerships with the regulatory agencies that manage water resources. However, these partnerships have always been resource-specific. For example, Dr. Todd Petty and Dr. Mike Strager work with the EPA to model water quality parameters, Dr. Jim Anderson and Walt Kordek with the WVDNR are involved in the development of a statewide wetland plan under the EPA Wetland Development Grant Program series. Dr. Anderson is also working with FWS, NRCS, and WVDNR to screen potential projects for rare and endangered species impacts; as well as with Dr. Mike Strager on a mitigation site suitability contract with WVDOH. Dr. Lance Lin also has a significant role to play in the mitigation suitability project, by locating areas with chemical impairment to water quality which can then be treated. This TRB funding gave us an opportunity to weave these tools together into an applied product that will improve the way West Virginia's resources are tracked and protected, not only from a highway view, but from an overall planning perspective.

Flowing Water Resources

Prior to route selection, aquatic resources are defined based primarily on GIS layers, such as the National Hydrography Dataset (NHD) streams layer and the NWI wetland layer. Using these datasets, highway routes can be evaluated to give a relative estimate of the resources that would be impacted. However, site visits may still be necessary to confirm the existence of these resources and to understand their quality and function. Linear feet of impact by stream order (size) may aid in determining whether a bridge or a culvert is required; but the water quality condition in that stream is not typically known unless it is on the state’s 303(d) impaired water listing, which often does not indicate impairments within smaller waterways. Historically only linear feet of stream impacts were considered; however, with water quality now a significant component of compensatory mitigation credit determination due to the WVSWVM (West Virginia IRT 2011), more tools are needed to help better estimate impacts.

The WVU-led team approach incorporates cumulative downstream effects analysis into mitigation, which is in line with the advocated watershed approach. An advantage of this approach is that it is designed to work alongside the WVSWVM, which develops a credit value based on water quality, aquatic health, and hydrologic function. The research team based the methodology on an approach developed through an EPA-funded modeling tool which was designed to evaluate alternative landscape scenarios for the evaluation of permits. Downstream changes in water quality, beyond the reach of impact, are captured by incorporating cumulative analysis within a statistical modeling framework. The preliminary implementation of this tool has been in the southern coalfields of West Virginia which includes the area designated for the KCH and CFX. Upon completion, this tool will produce output predicting the influence of landscape changes on WVSCI and conductivity scores.

This approach can also be applied to the evaluation of potential mitigation activities. It allows planners to identify reaches currently experiencing conditions of such poor water quality that they are disproportionately affecting the quality of downstream reaches. These impaired reaches can then be targeted for mitigation options that will improve and maintain ecological lift beyond the immediate vicinity of the mitigation project footprint. Within each of the 8-digit HUCs, nested 12-digit HUCs (40,000 acres on average) can be evaluated and summarized to show how local impacts relate to more regional relationships. Therefore, the regional benefits may accrue with carefully planned strategic reclamation and restoration.

Currently this approach to predicting conductivity and WVSCI scores is limited to several 8-digit HUC watersheds in the southern portion of the state. However, due to the nature of the topography and land use patterns in this region, the application of this predictive tool to other watersheds in West Virginia is not recommended without further research in other ecoregions in the state in order to calibrate the relation between land use and water quality predictions. Creation of an interactive tool or dataset applicable to statewide waters would not only benefit WVDOH, but also other state and federal agencies (WVDNR, WVDEP, ACOE, EPA, NRCS) in predicting how management decisions would affect water quality.

Wetland Resources

Wetlands in the state are mapped digitally on the NWI, GIS layer. These data are mapped wetlands, categorized according to vegetation structure (Cowardin et al. 1979), as determined by aerial photography. The NWI is a FWS digital product providing identification and delineation of West Virginia wetland polygons. The product is dated (based on 1980-1986 color infrared imagery), only identifies wetlands larger than 1 to 3 acres and is not completely accurate relative to wetland polygon locations largely because of the scale of the base imagery (1:58,000). Despite these limitations, it remains the best statewide coverage of wetlands in the state. As such, it should be noted that the NWI consistently underestimates wetland occurrence in the mountainous regions of Appalachia (Anderson and Rentch 2007, Stolt and Baker 1995). In turn, this makes using GIS technologies for estimating wetland impacts somewhat limiting.

The estimation of wetland resources for consideration in the route evaluation procedure relied on an enhanced NWI layer that, at the time this was written, was set to be available October, 2012. This layer is a product of the West Virginia Wetland Program Plan (WVDEP and WVDNR 2011) that is being modeled after the Level 1-2-3 approach advocated by the EPA. The Level 1 assessment is GIS-dependent and was developed to provide broad condition and functional assessments using currently available geospatial data. Recognizing the current NWI inaccuracies, the state has undertaken a revision process that examines each NWI wetland polygon and registers it to its correct location and examines more current aerial photography and that adds maps that may have previously been missed. The research team has used this updated NWI layer, which includes information about the wetland's landscape position and function (Tiner 2003) as the new basis for comparing route impacts on wetland resources to one another. No new wetland polygons were catalogued in the study area during this process.

This landscape assessment model (Level 1) will incorporate landscape metrics to provide functional and wetland condition information. Although the analyses have not been completed for all counties or metrics and development is still under way, eventually it will utilize extant data or metrics to provide a landscape assessment of wetland ecological integrity and wetland provision of multiple functions: flood attenuation, groundwater recharge, water quality (nutrient processing, sediment trapping, pollution abatement), support of biodiversity (wildlife habitat, rare species and communities, pollinators), carbon sequestration, cultural values (historical, aesthetic, educational, and recreational), and provisioning.

This new and improved methodology will provide a tremendous improvement in the quality of information currently used to evaluate wetland resources remotely. A relative level of wetland function will be extremely useful in estimating the type and extent of wetland functions impacted and will assist in the estimation and sighting of mitigation opportunities. However, this GIS approach will not serve as a substitute for the on-the-ground surveys and wetland delineations required once a route is selected. Rather, the quality of the information will actually improve dramatically with site walk –as the Level 2 (rapid) wetland assessments known as the West Virginia Wetland Rapid Assessment Procedure (WVWRAP) will then be used to tally functional values based on a wetland delineation footprint.

Threatened, Endangered, and Candidate Species

Under the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA) permitting process, the WVDOH is responsible for avoiding and minimizing impacts to threatened, endangered, and Candidate (T&E) species. Historically, WVDOH used a GIS layer provided by FWS that identifies areas with endangered species present that should be avoided. This model worked, but as time passed its limitations became obvious and it was no longer the comprehensive approach that regulatory agencies were seeking. For example, the absence of an endangered species on the GIS layer would not always mean that the species was not present at a particular site (i.e., absence of evidence is not evidence of absence). Moreover, this was a static layer sent to the WVDOH planner's office. There was no directive of how to use this layer, nor was there consideration given to updating and maintaining the database of records indicative of a listed species occurrence. Therefore, despite the use of this layer brought to planning, the FWS still needed to intensively evaluate each potential route and conduct intensive surveys to rule out the presence of a species.

The initial plan was to incorporate the ICT currently being developed by FWS and NRCS and apply it to the route selection process. The concept of the ICT was born out of the need to streamline and simplify the compliance process for NRCS field offices. Compliance with the ESA was difficult for many of the same reasons as those facing WVDOH, including the lack of a clearly defined stepwise process, the lack of species information, knowledge of the habitat and life history, and reluctance by state and federal agencies to share location or other information concerning their status.

Programmatic agreements between the NRCS and the FWS throughout the country paved the way for development of expedited methods to allow field planners the ability to avoid conflicts with the ESA; thus aiding the recovery of species without having to consult with the FWS on each occurrence. Most of the programmatic agreements relied on the conservation planners having access to location information, population, and other data that was not readily maintained and available for public use in West Virginia. These data often included maps or GIS layers that required staff time and personnel to maintain, update, and manage.

The agencies in West Virginia responsible for safeguarding state natural heritage information were very concerned about dispensing locations of species of concern or otherwise listed species. There were concerns that the dispersal of this information could lead to people misusing the data thorough unauthorized specimen collection, development, or project obstruction, eradicating the species from private property and so forth.

In developing the ICT, the FWS, West Virginia Field Office, and the WVDNR partnered to develop a programmatic consultation for the federal-listed species that could be encountered during planning and other non-project activities. During this process, all NRCS conservation practices in West Virginia were reviewed for their likely potential effects on federally-listed T&E species. Determinations were made as to the type of effect (none, adverse, or beneficial) from a potential action, and in the cases of adverse effects, how those effects could be avoided. To fully solve the problem regarding the release of "sensitive" information by either agency, a "black box" method was agreed upon by FWS, NRCS, and WVDNR, in which only minimal information is offered in response to inquiries. This method allows only nominal, non-sensitive information within a predetermined area to be entered into a website. In return, the website would generate strategies to recover and minimize impacts to species or designated habitat without identifying the exact location or other sensitive information about the species. The resulting information would be based on the programmatic agreement, or based upon inductive species distribution models developed by the FWS. This method not only solved the privacy and sensitive species information issues, but also saved time and maintenance requirements by allowing one agency to maintain a single copy of geospatial maps and security needs in house. It avoided maintenance problems with maps and polygon layers and compatibility issues for computer software. In doing so, this method lends itself well to other applications including Cultural Resources, the CWA, and the NEPA permitting process – all of which are applicable to WVDOH planning and would represent significant savings to both WVDOH and regulatory agencies.

This tool is designed to provide automated reports based on a number of criteria. In a WVDOH context, the user would identify an area of interest and input the roadway practices (e.g., building, maintenance, or culvert replacement) and the spatial extents of those practices. The ICT then compares these data to other databases of information which include known or probabilistic locations of species, the potential impacts of practices, habitat suitability and agreed upon avoidance measures and requirements. The program then provides a printable report to the end user which outlines a conservation and avoidance strategy.

Interagency Coordination Tool Alternative

However, despite efforts, this tool was not readily available for adaptation into the context of the SHRP 2 project. Rather, the team chose to update and use a Landscape Integrity (LI) model developed by NatureServe (Tuffly and Comer 2005) and applied to West Virginia datasets. The first landscape integrity model developed for West Virginia was by the WVDNR as part of the Wildlife Resources Section (Byers and Dougherty 2008) based on the 2001 land use land cover classifications. Because this model was in use by the WVDNR, the team chose to update the data layer (2006 National Land Cover Data (NLCD) land use land cover) input parameters and use it as a surrogate until the ICT tool is available for WVDOH applied uses. In short, landscape integrity is calculated on a 30-meter grid spatial scale statewide based on weighted landscape disturbance features, including mining and other industries, residential and urban development, transportation corridors, and agriculture. The intention is to identify the distribution of high-integrity landscape, which an agency could then attempt to avoid and minimize, as well as estimate the changes in landscape integrity on a watershed scale (Faber-Langendoen et al. 2008), based on the each route in the evaluation process. For example, this methodology provides a standardized and non-arbitrary way to compare routing in terms of high-integrity landscapes by taking the average value of the LI grid by segment-level watershed (SLWs), and determining how these average values change in each scenario. One can then summarize this by HUC to look at the overall landscape integrity change in a watershed context.

Watershed Mitigation

Using the landscape data as an initial screening to determine potential impacts in terms of water quality and landscape integrity, one is able to find suitable mitigation areas that would provide ecological lift on the landscape level. For example, using the landscape integrity grid with the water quality WVSCI modeling, one can locate potential mitigation segment-level watersheds that do not have upstream disturbances. Knowing the upstream areas are of higher quality (both in terms of landscape integrity and water quality), one can then focus mitigation on segments from which the impairment enters the watershed. If one knows the upstream watersheds are not impairing water quality, and areas below a certain point are impaired by impacts that can be remedied through compensatory mitigation activities; the mitigation activity can be designed to produce a downstream effect that will provide ecological lift to the entire watershed. Once again, the research team must caution that finding suitable sites for mitigation ultimately depends on a willing landowner and finding a long-term steward to ensure the mitigation lasts 'in perpetuity.'

Summary of Tools

After reviewing a number of other tools and case studies, as well as speaking to regulatory stakeholders, the need to adopt and incorporate disparate regional tools into one planning 'recipe' over other tools was evident. Not only would there be built-in support by incorporating already familiar tools, but the GIS-based approach dovetails into existing planning steps without creating additional work beyond learning to locate new data sources and how to apply them, and educating the regulatory agencies on the utility of the new information when used to seek permits for impacts.

Furthermore, with the WVSCI modeling approach, one can truly get a sense of downstream impacts of highway construction and how they are reflected at the watershed scale. To the research team's knowledge, this is the only tool available that is able to look at the stream network and landscape attributes that quantifies the potential impacts beyond the SLW while incorporating the characteristic flows from other stream segments. This represents the cumulative effect approach that is advocated in Eco-Logical. By incorporating this downstream accountability, one is able to better estimate what the aquatic costs of highway construction are, and allows the estimated costs of compensatory mitigation to be based on more than just linear feet of direct impact.

CHAPTER 3
Methodology for Estimating Impacts and Prioritizing Mitigation Site Selection

Introduction

The research team designed a stepwise GIS-based watershed approach to quantifying proposed highway impacts and prioritizing mitigation opportunities. While this approach does not completely eliminate the need for site visits, field-scale analyses can be targeted in a more efficient and intelligent manner, ultimately saving time and reducing costs. The method focuses on three components of the natural environment: streams, wetlands, and ecological or LI. In addition to currently available statewide GIS layers such as elevation and land use category, several additional layers were developed for analyses based on published methods and concurrent research.

Consistent data sources that are actively updated and maintained are critical to route evaluation and impact avoidance and minimization. The team found that many of the stakeholders (WVDOH and regulatory agencies) were not aware that West Virginia maintains a GIS Technical Center/ Clearinghouse (http://wvgis.wvu.edu/) for all pertinent state data sources. Making all stakeholders aware of the data layers available at the GIS Technical Center, and ensuring each group is using the same data, quickly became one of the most applicable and useful objectives that should easily be incorporated into the route evaluation process.

The general approach to proposed highway impact assessment consisted of comparisons between current or baseline conditions and projected post-highway construction conditions for each proposed build alternative. The SLWs were the unit of measure for baseline and impact scores in each of the three categories (flowing water, wetland resources, and landscape integrity) of analysis. The individual SLW scores were then summed to the 8-digit HUC-scale, providing a more holistic watershed assessment.

Both CFX and KCH each considered 12 build alternatives; however, due to overlap as well as a means to simplify the “back casting” approach inherent in this highway impact analysis, three build alternatives were selected from each proposed highway system, resulting in a total of six routes considered overall.

The CFX build alternatives (Figure 3.1) lie in a northeast-southwest orientation, intersecting the Tug Fork, Upper Guyandotte, and Lower New (8-digit HUC) watersheds. The small section of the Coal River watershed intersected by the preferred alternative (PA; CFX-PA) was ignored, as were routes extending into Virginia.

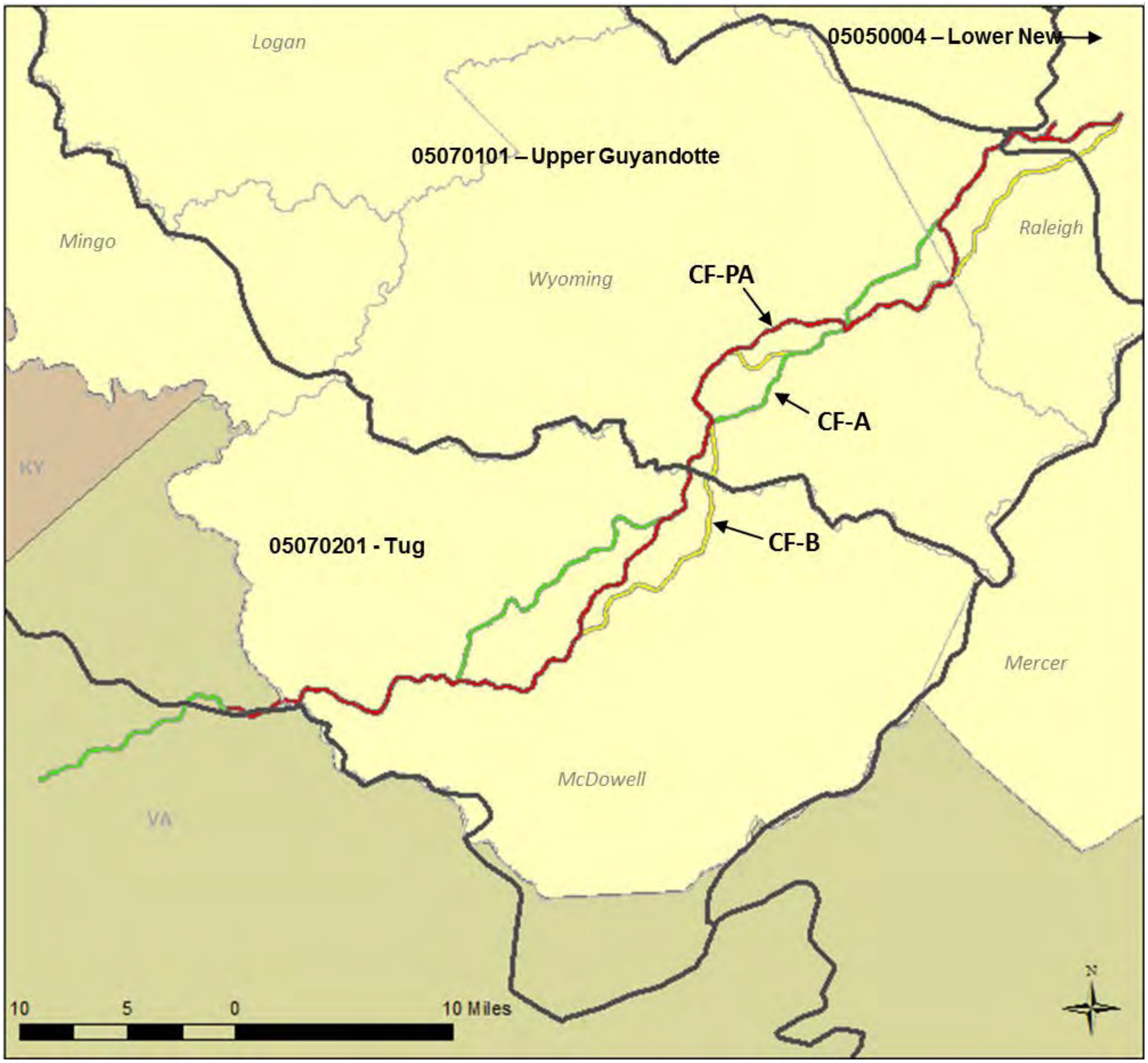

Figure 3.1. Coalfields Expressway selected build alternatives and intersecting 8-digit HUC watersheds.

The selected KCH build alternatives (Figure 3.2) are oriented from the northwest to southeast and intersect the Tug, Upper Guyandotte, and Middle New (8-digit HUC) watersheds. The preferred alternative (KCH-PA) is similar to KCH-2 except for the segment northeast of Bluefield and the western segment where KCH-2 extends only in the southernmost leg.

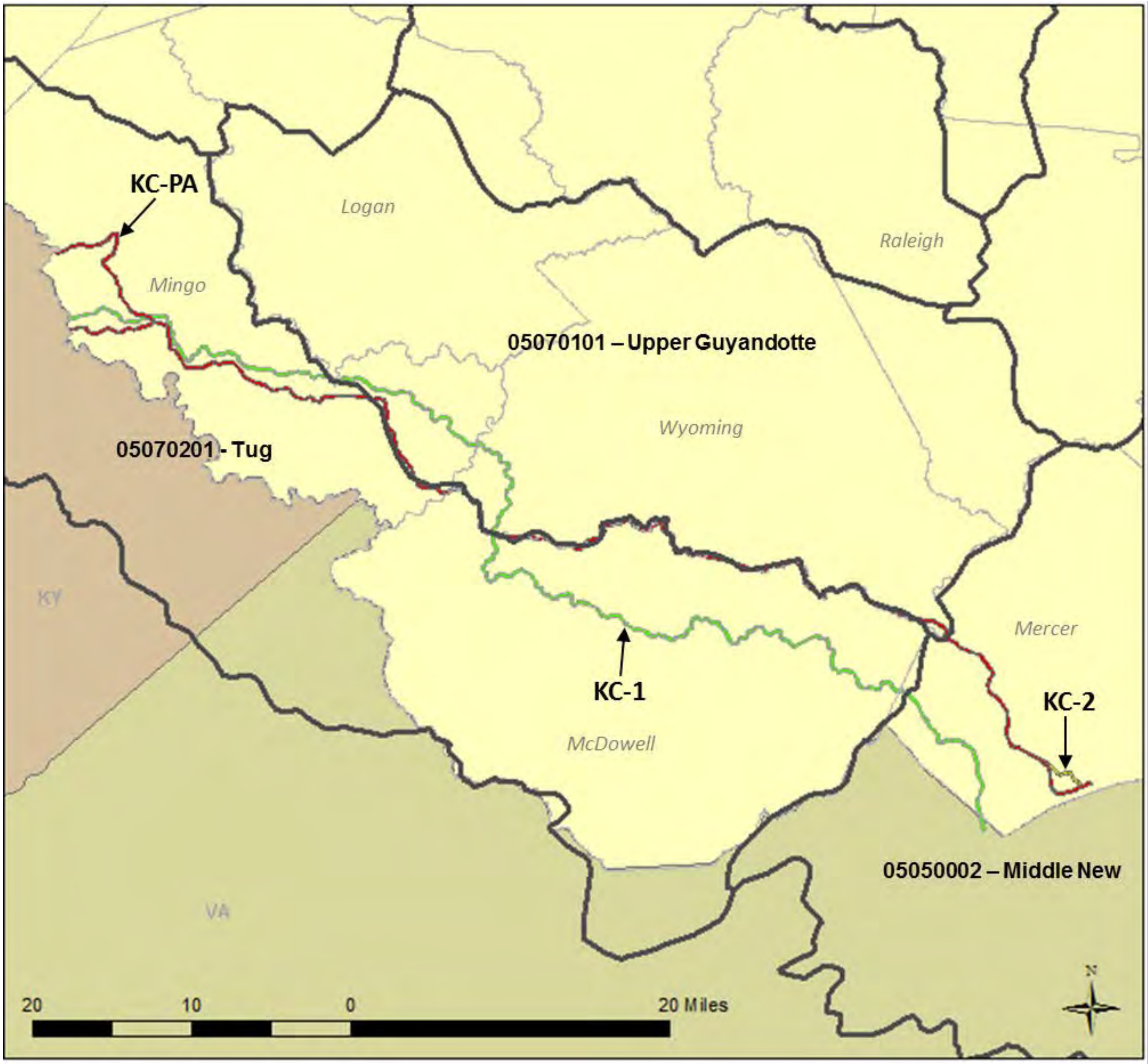

Figure 3.2. King Coal Highway selected build alternatives and intersecting 8-digit HUC watershed's GIS Layers.

GIS Layers

The base layers used for the analyses include the 1:24,000 NHD stream segments, the associated SLWs, the build alternatives for the KCH and CFX provided in the highway EIS, the 2006 National Land Use Land Cover (LULC) data, and elevation data from the 30 m National Elevation Dataset (NED), Digital Elevation Model (DEM) (Table 3.1).

The SLWs are defined as the area draining to each 1:24,000 stream segment and represent the primary unit of analysis for the approach. Measures of predicted impact and mitigation were summarized to each SLW. SLW totals were then summed for comparison at the 8-digit HUC watershed level; which is the unit of resolution used by the IRT to guide mitigation measures and actions. A key feature of the SLWs is their associated flow-path connectivity table, which allows for network-based analysis such as upstream, downstream, and cumulative impact assessments.

Table 3.1. Base Layers Providing the Foundation for GIS Analyses

Layer	Description	Source	Date
Elevation	30 m resolution DEM	NED	1982
Land Use	30 m resolution land use grid	NLCD	2006
Streams	1:24,000 scale stream lines	NHD	1982
SLW	1:24,000 scale subwatersheds	Natural Resource Analysis Center (NRAC)	2009
KCH Build Alternatives	1:24,000 scale proposed corridor from EIS	WVDOT	1999
CFX Build Alternatives	1:24,000 scale proposed corridor from EIS	WVDOT	2002

Flowing Water Resources

The research team determined baseline WVSCI scores for each SLW using a landscape-based model developed for the EPA. The WVSCI score is based on aquatic macroinvertebrate community sampling. The macroinvertebrates act as surrogates of water quality over the long-term and are not necessarily an indicator of current water quality conditions. The state regulatory agency (WVDEP) uses WVSCI scores as a component of the permitting process involved in the alteration or filling of any streams and rivers; the WVSCI score is then factored into any required compensatory mitigation.

The preliminary methodology for evaluation of proposed highway corridors relied on boosted regression trees (BRT) that use cumulative measures of percent surface mining and structure density as predictor variables to model expected WVSCI values. Using these variables, the team was able to account for over 57% of the variation in the expected WVSCI scores (Merriam et al., West Virginia University, preliminary results for dissertation). Ultimately, the team will use a more accurate BRT approach by including additional predictor variables as a means to determine the final landscape model for these receiving water quality relations. Preliminary landscape BRT models have accounted for approximately 75% of the WVSCI variation; however, these models have not been validated over the entire study area at this time.

What makes this statistical modeling unique is the incorporation of a spatially explicit watershed modeling framework that predicts conditions based on the SLW flow network. This method allows the capture of cumulative effects of all land use activities on downstream systems. The initial screening and use of variables are not necessarily synonymous with those represented in WVSWVM, but the final model does reflect many of the same riparian characteristics (e.g., cumulative upstream percent forested, cumulative upstream percent grass and pasture, cumulative roads upstream, the cumulative number of National Pollutant Discharge Elimination System (NPDES) permits upstream, and the local percent of barren and developed land).

Enhanced Wetlands Layer

The West Virginia Wetland Program Plan (WVDEP and WVDNR 2011) outlines the state's future strategy for wetland conservation, management, and regulation. An advanced version of the newly enhanced NWI layer is being developed by WVDEP and WVDNR. This layer includes a temporal and spatial update to the NWI geography and classification as well as the development of several wetland ecological conditions and functions by county. This product is the result of concurrent research for the WVDNR, and while it is not yet available statewide, the initial analyses of the six counties (Raleigh, Logan, Wyoming, Mingo, Mercer, and McDowell) involved in this study have been completed. Featured in this data layer are landscape variables or metrics that can be applied to wetlands. Moreover, these wetlands are identified by landscape position in addition to the vegetation class described by Cowardin et al. (1979). Although this plan is not yet available for public release, application of its core elements in a regulatory context demonstrates the utility of the enhanced dataset.

Landscape Integrity Grid

A landscape integrity grid was developed to represent the spatial distribution of areas likely to be representative of high ecological integrity. The resulting grid is a measure of distance to weighted disturbance features. This method follows an approach initially derived from Tuffly and Comer's (2005) NatureServe® integrity analyses. The research team recalculated a statewide grid for West Virginia with an updated data and weighting scheme based on methodology by Byers and Dougherty (2008). The resulting product represents deviations from the 'natural' state of the landscape and was used to quantify impacts of the proposed build alternatives. The layers and corresponding weights used for the updated landscape integrity grid are shown in Table 3.2.

Table 3.2. Landscape Characteristics and the Associated Disturbance Weighting, Adopted from Byers and Dougherty (2008)

Category	Description	Weight
Structures - Points	Buildings over a certain size	1
Structures - Polygons	Aerial survey of the state of West Virginia (1" = 2400')	1
Railroads	1:4,800 Rahall Transportation Institute (RTI)	4
Pasture/Hay	2006 NLCD Landuse	8
Dev. Med. Intensity	2006 NLCD Landuse	3
Dev. High Intensity	2006 NLCD Landuse	1

Dev. Low Intensity	2006 NLCD Landuse	4
Cultivated Crops	2006 NLCD Landuse	6
Barren	2006 NLCD Landuse	2
Abandoned Mine Lands	WVU, 1996	7
Roads	1:4,800, all roads, (2008 Census Tiger/Line)	2
Oil and Gas Wells	WVDEP Excel file w/lat-long	7
Underground mining limits	minli, WVDEP	10
Surface mining limits	perbnd, WVDEP	2
Valley Fills	Locations	2
Utility Power Line corridors	WVDNR, 2008	6
Divided highways	1:4,800, all roads, (2008 Census Tiger/Line)	1

The ESRI ® Spatial Analyst Path Distance tool was used with the 30 m DEM to calculate surface distance to each disturbance feature. Point, line, or polygon GIS layers of disturbance features were transformed to 30 m resolution grids. Each distance grid was then reclassified into 11 distance classes. A final landscape integrity grid was produced by multiplying each reclassified distance grid by its respective weight and summing those results together. In the end, product low numbers represent areas closer to disturbance features, while high numbers represent areas further away from disturbance features. Because the necessary data were gathered for WV only and not surrounding states, the resulting LI values at the state border are skewed.

Methodologies

Flowing Waters Approach

Baseline conditions of stream WVSCI scores were calculated and used for predicting impacts on stream condition. After determining the baseline WVSCI scores (Figure 3.3), the current landscape was updated to include the proposed highway build alternatives. Future highway construction was categorized as “surface mining” because of the similar scale and earth-moving associated with highway construction and preliminary model. By predicting quantitative changes in WVSCI scores in each SLW based on individual proposed highway build alternatives, the team compared impacts summarized by 8-digit HUC watersheds that incorporate downstream effects.

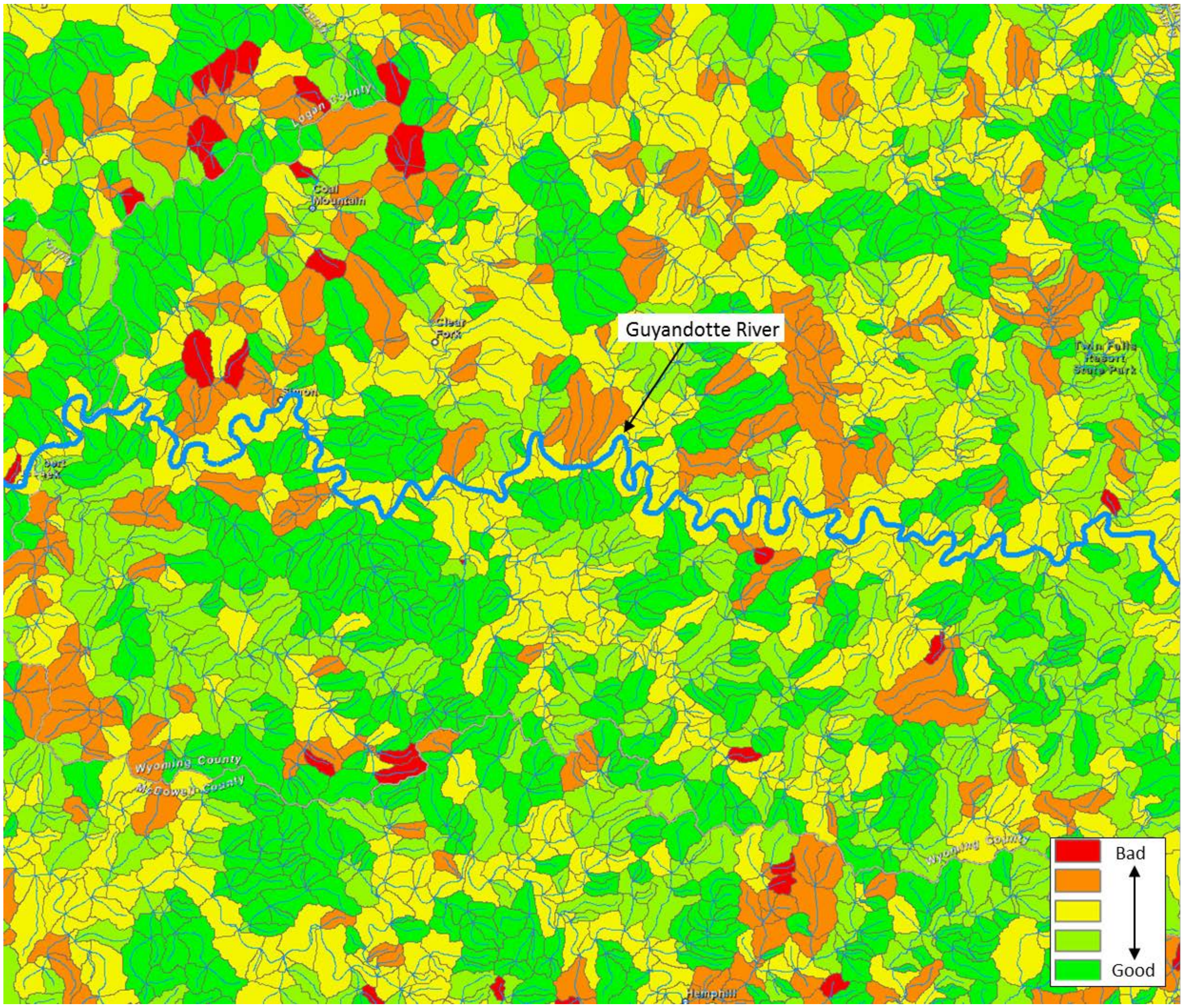

Figure 3.3. Baseline WVSCI scores summarized to SLW.

Wetlands

To determine which wetlands were likely impacted by the highway build alternatives, the team used the ‘intersect’ command in ArcToolBox and noted which wetlands were crossed by each build alternative. The attributes of these wetlands were then used to estimate a measure of net ecosystem functional impact by highway alternative.

To date, more than 50 potential landscape level assessment metrics have been calculated for each individual wetland. In terms of a regulatory context, it is most beneficial to understand the floodwater attenuation capacity, nutrient assimilation, sediment capture, and erosion abatement functions of wetlands (WVWRAP planning discussions with IRT, December 2011). Currently, the enhanced NWI data incorporates only a subset of the total number of landscape metrics required to determine these ecosystem functions (Table 3.3). The remaining landscape metrics are still in the project development phase.

Table 3.3. Landscape Metrics Presently Included in the NWI and Those in Development, Which will be Used to Determine an Estimate of Wetland Ecosystem and Landscape Function

	Ecosystem Function		
Landscape metric	Floodwater attenuation	Nutrient & sediment capture	Erosion abatement
Floodplain zone	x		
Percent impervious surface within 1/4 mile	x		
Landscape runoff curve	x		
Percent agriculture within 1/4 mile		x	
Percent development within 1/4 mile		x	
Percent open water in wetland			
Percent slope upstream			x
In development			
Number of downstream structures	x		
Location of wetland within watershed	x		
NPDES permits		x	
Water quality impairment upstream		x	
Sediment loading index score			

The approach used the raw values of a landscape metrics of interest which had been normalized and scaled from 0 to10 (Blocksom 2003). These metrics were then summed to determine a surrogate of the ecosystem functions provided by that wetland on the landscape. The final weighting of these metrics however, will be determined by a future, Analytical Hierarchal Process, which will be based on expert opinion.

Wetland impacts were compared based on wetland type relative level of the functions provided by that wetland within the landscape, for each 8-digit HUC watershed.

Landscape Integrity

The first step in the LI impact methodology was to calculate the baseline conditions for the study area following the methodology using the layers in Table 3.1. Baseline mean LI scores were assigned to each SLW using the “Zonal Stats” tool in Spatial Analyst. Figure 3.4 shows an example of this summarization along an approximately 25 mile stretch of the Guyandotte River. Areas in green reflect relatively high values of Landscape Integrity or areas having a greater distance to disturbance features such as structures, high-intensity development, and highways. While a thorough sensitivity analysis of possible biases and data errors has yet to be conducted, those areas having higher LI values generally characterize natural landscape conditions and have greater potential to support various wildlife habitats including T&E species.

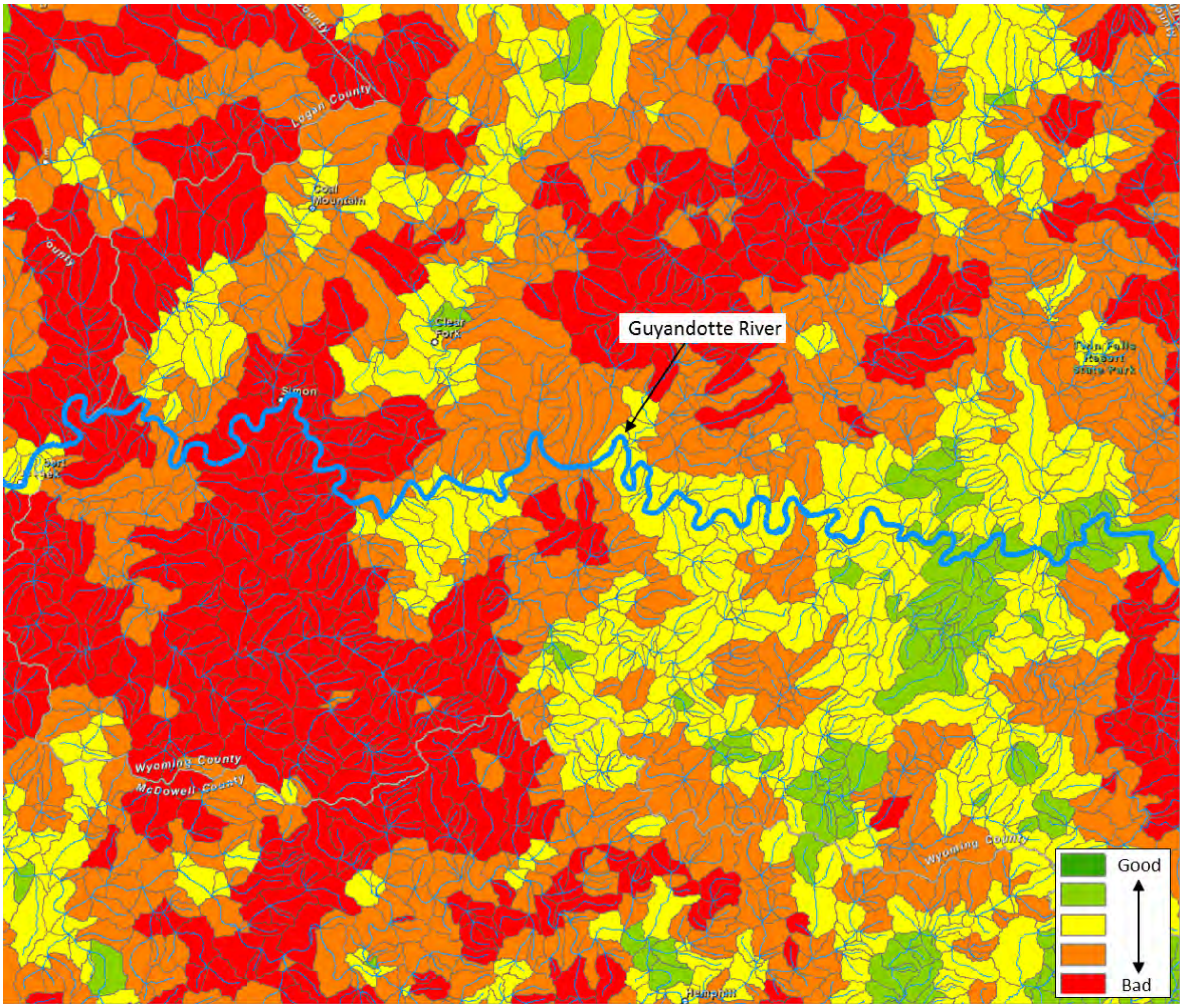

Figure 3.4. Baseline LI summarized to segment-level watersheds.
Areas in red indicate lower landscape integrity values (closer to disturbance features), while green areas indicate highest values.

In order to use this measure of landscape disturbance in comparing the proposed alternatives, each BA was treated as an additional divided highway and separate LI grids were calculated for each BA. The net impact of each BA on landscape integrity at the 8-digit HUC watershed level was calculated by subtracting the LI values of each proposed alternative from the baseline, or current highway condition LI values.

Mitigation

The research team derived a system to identify and prioritize potential focus areas to offset impacts through compensatory mitigation based on methods similar to those used to estimate water quality and landscape integrity impacts. The screening processes focused on stream and wetland areas and included analyses of total upstream landscape integrity values by SLW, topography, soil types, man-made structures, and land use.

The research team recognizes that a GIS-based approach to identifying stream segments that are optimal for mitigation represents a first-pass approach and that, ultimately, field-level verification is required. Nonetheless, a broad-scoped method can help direct field-level analyses more efficiently and effectively. The WVSCI scores for each SLW provided an optimal starting point for such an analysis. The team selected SLWs with corresponding WVSCI scores between the 25th and 75th percentile. These mid-level scores identify areas that can potentially be improved with mitigation activity. Additionally, it is important to focus mitigation on areas with limited upstream impairment, ensuring the mitigation activity will be situated in an area with less chance of it being negated by current upstream disturbances. For this reason, stream segments with cumulative landscape integrity scores (average of all upstream scores) in the top 20% were used as the selection criteria. Segments that were listed on the 303(d) lists with an impairment requiring a chemical treatment with required maintenance (e.g., fecal coliform or selenium) were eliminated as mitigation options, as well as SLW with structures located within a 150-foot buffer zone from the waterways. These criteria were intended to facilitate locating stream and wetland mitigation sites where the presence of houses and related infrastructure would not complicate property acquisition and restoration activities.

Identifying potential areas for compensatory wetland mitigation was based on a modified approach from Strager et al. (2011) and Maxwell et al. (2012). Potential wetland areas were identified based on a series of raster analyses and scaled from 0 to 6. Areas with grid cells ranked from 3 to 6 were used to delineate potential areas for watershed-level restoration. However, caution is warranted with this GIS screening approach, and site visits are necessary to confirm the wetland mitigation potential. Ecological Land Units (ELU) were created and reclassified, as well as hydric soils identified by Soil Survey Geographic Database (SSURGO) data (Table 3.4). The 9 m DEM data for the region, resampled from 3 m, was used to classify the terrain into the following ELUs: cliff, steep slope, slope crest, upper slope, flat summit, side-slope, cove, dry-flat, moist-flat, wet-flat, and slope-bottom, based on Maxwell et al. (2012). These raster values in the study areas were then summed. If these areas were within an existing NWI boundary, their values defaulted to 0 as the team was attempting to identify areas that may be able to be converted into wetlands for mitigation, not those that were already defined as “wetland”.

Table 3.4. Values Used to Calculate Potential Areas for Wetland Mitigation Based on Modified Strager et al. (2011) Approach

Data layers	Raster value
Ecological Land Unit	
Dry flat	1
Moist flat	2
Wet flat	3
SSURGO soils	
Hydric soils	3
Partially hydric soils	2

The team further conducted a size screening to identify SLWs with the potential to create wetland areas in excess of 10 acres. Creating wetlands, and finding long-term stewards, is expensive and time consuming. Based on WVDNR recommendations, all wetland mitigation areas are to be at least 10 acres or more in size in order to maximize their watershed effect and help ease monitoring requirements (fewer, bigger sites versus numerous, smaller sites). Additionally, the team looked at the number of structures within each SLW in order to further screen potential mitigation areas, as lands without existing structures are more likely to be available for acquisition as part of a compensatory mitigation strategy.

As with stream determination, potential compensatory wetland mitigation areas were subject to an upstream SLW landscape integrity value screening. Only SLW that had wetland potential sites and upstream SLWs with landscape integrity values in the top 20% were included as potential wetland mitigation areas to minimize the likelihood of impairment from upstream sources.

The team considered additional screenings for both the identification of wetland as well as stream mitigation potential, but found that they were of limited utility. Among these were evaluating potential segments adjacent to and within existing protected state lands, as well as areas considered important in terms of biological integrity and lands that were within TNC conservation priorities.

Results

Flowing Water Resources

Baseline and impact WVSCI scores were calculated for each of the six build alternatives. Because of the upstream measurements that contribute to the WVSCI statistical model (i.e., total number of structures upstream of current location), highway impacts are visible beyond the immediate intersecting SLWs.

WVSCI scores summarized to SLWs for current conditions along a stretch of proposed Coalfields Expressway build alternative A (Figure 3.5). Notice the condition of the stream segments labeled “Fair” and “Good”, reflecting relatively high WVSCI scores.

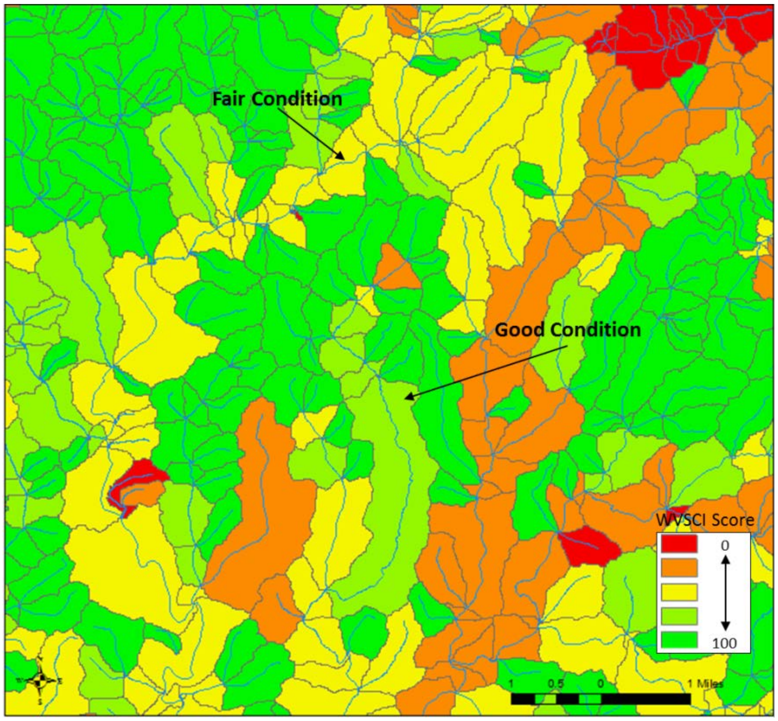

Figure 3.5. Baseline WVSCI scores summarized to SLW.

Post-build WVSCI scores were then calculated for each alternative and these scores are shown for the identical stretch along CFX-A (Figure 3.6). Notice that not only have the scores for intersecting SLWs decreased, those scores for SLWs downstream of the highway build alternative have also decreased. The severity of this impact (Figure 3.7) can also be visualized by subtracting the values in Figure 3.5 from Figure 3.6.

The net impact of the build alternatives on WVSCI scores is summarized in Table 3.5. The total number of substantially impacted segment-level watersheds (where change in WVSCI > 1 unit) was summed for each build alternative. This number includes both intersecting and downstream SLWs. The mean change in WVSCI score ("Mean Decrease") was then calculated for all impacted SLWs and totaled for each build alternative by 8-digit HUC watershed.

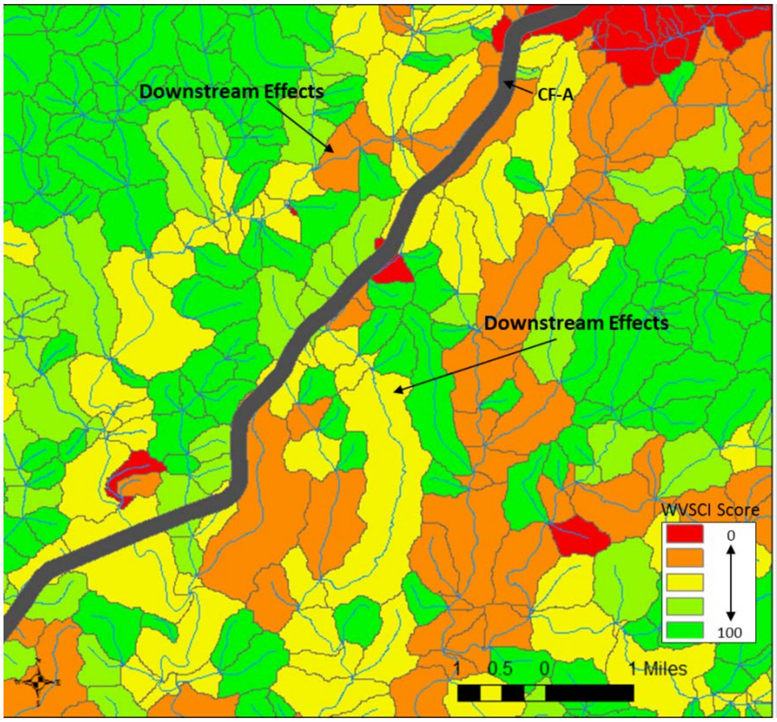

Figure 3.6. Post-build WVSCI scores summarized to SLW along Coalfields Expressway build alternative A.

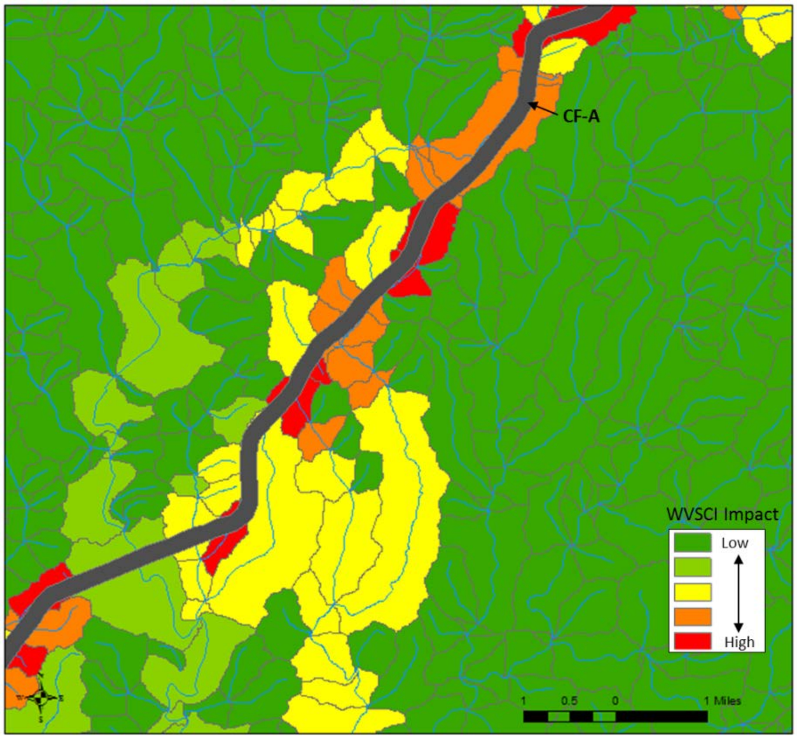

Figure 3.7. Relative impact of Coalfields Expressway build alternative A on WVSCI. SLWs colored red experience the greatest impact on stream condition, whereas those in green experience the least impact.

Table 3.5. Net WVSCI Impacts for Selected Build Alternatives by 8-digit HUC Watersheds

units = WVSCI scores (unitless)									
	KCH-1			**KCH-2**			**KCH-PA**		
King Coal	# SLWs	Mean Decrease	Net Impact	# SLWs	Mean Decrease	Net Impact	# SLWs	Mean Decrease	Net Impact
Upper Guyandotte	47	6.3	296	263	4.7	1,236	263	4.7	1,236
Tug Fork	91	5.3	482	292	4.1	1,197	296	4.1	1,214
Middle New	80	3.6	288	128	4.4	563	144	4.1	590
Total:	218	5.1	1,105	683	4.4	3,005	703	4.3	3,023
	CFX-A			**CFX-B**			**CFX-PA**		
Coal Fields	# SLWs	Mean Decrease	Net Impact	# SLWs	Mean Decrease	Net Impact	# SLWs	Mean Decrease	Net Impact
Upper Guyandotte	112	5.2	582	128	3.6	461	110	5.3	583
Tug Fork	177	4.9	867	174	4.6	800	190	4.8	912
Lower New	20	4.2	84	24	2.8	67	65	3.6	234
Total:	309	4.8	1,473	326	3.7	1,195	365	4.6	1,667

By examining the net impacts for each build alternative, it is evident that the preferred alternatives for both KCH and CFX have the greatest overall impact on in-stream conditions at 3,023 and 1,667 net WVSCI units, respectively. However, the greatest impact per SLW is given by KCH-1 and CFX-A with mean decreases in WVSCI units at 5.1 and 4.8, respectively. This methodology provides not only the ability to quantify total stream impacts, but also the relative magnitude of impacts at each segment-level watershed, resulting in a comprehensive, watershed-based analysis of proposed, build alternative stream impacts.

Wetlands

The research team identified the number, type, and approximate size of wetlands potentially impacted by the various route options (Table 3.6). Moreover, the team was able to determine a relative level of function likely associated with each wetland setting (Tables 3.7 and 3.8).

The methods used in this study have demonstrated that one is able to look at relative wetland impacts prior to doing on-the-ground detailed surveys with regards to acreage impacts, as well as watershed functional impacts. For both the CFX and KCH, relative acreage impacts are correlated with functional impacts. This is intuitive as acreage was the weighting multiplier for each index value. However, the number of individual wetlands encountered is not indicative of the true estimate of construction impact.

The utility of portioning out the functional values is indicated by comparing the impact of an individual forested/ shrub wetland (3.61 acres) on KCH alternative 1 with a smaller, emergent wetland (3.51 acres) in the path of the preferred alternative. Despite the larger size of alternative 1, the ecological and erosion index values are greater in the smaller wetland, while functional values for floodwater and nutrient/ sediment abatement are higher in the larger wetland.

Knowing these relative values allows regulatory agencies to look at a comprehensive watershed-level functional value, which is better suited to ecological decision making than considering wetland acreage alone.

Table 3.6. Number, Type, and Size of Wetlands by Route, with Anticipated Impacts Based on Enhanced NWI Layer

Wetland Type / Route	Landscape	Landform	Water Flow Path	Waterbody	Acres
Coalfields Expressway - alternative A					
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.458
Coalfields Expressway - alternative B					
Forested/Shrub Wetland		Fringe			3.359
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.228
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	3.321
Emergent Wetland	Terrene	Fringe	Isolated	Artificial pond	0.654
Forested/Shrub Wetland	Terrene	Floodplain	Isolated	Artificial pond	0.553
Forested/Shrub Wetland	Terrene	Floodplain	Isolated	Artificial pond	0.258
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.378
Coalfields Expressway - preferred alternative					
Forested/Shrub Wetland		Fringe			3.359
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.228
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	3.321
Emergent Wetland	Terrene	Fringe	Isolated	Artificial pond	0.654
Emergent Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.705
King Coal Highway - alternative 1					
Emergent Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.705
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	0.724
Emergent Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	1.149
Forested/Shrub Wetland	Terrene	Slope	Isolated	Palustrine	1.107
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream- low gradient	2.172
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream - dammed	3.609
Forested/Shrub Wetland	Lotic stream	Fringe	Throughflow- intermittent	Stream- intermittent	0.213
King Coal Highway - alternative 2					
Emergent Wetland	Lotic stream	Fringe	Throughflow	Stream- low gradient	3.511
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream - dammed	0.615
Lake	Lotic stream	Fringe/ Floodplain	Throughflow	Stream - dammed	60.987

King Coal Highway - preferred alternative					
Emergent Wetland	Lotic stream	Fringe	Throughflow	Stream- low gradient	3.511
Forested/Shrub Wetland	Lotic stream	Fringe/ Floodplain	Throughflow	Stream - dammed	0.615

Table 3.7. Functional Impact of Potential Highway Impacts, by Route, Weighted by Wetland Acreage Estimates on Coalfields Expressway

		Raw Index Values				Weighted by Acreage			
Wetland Type/ Route	**Acres**	**Ecological Value**	**Floodwater Value**	**Nutrient and sediment value**	**Erosion value**	**Ecological Index**	**Floodwater Index**	**Nutrient and sediment index**	**Erosion Index**
Coalfields Expressway - alternative A									
Forested/Shrub Wetland	0.46	2.65	0.87	0.16	0.96	1.21	0.40	0.07	0.44
Totals	0.46					1.21	0.40	0.07	0.44
Coalfields Expressway - alternative B									
Forested/Shrub Wetland	3.36		0.46	0.15	0.74	0.00	1.53	0.49	2.49
Forested/Shrub Wetland	0.23	2.87	2.00	0.08	0.74	0.65	0.46	0.02	0.17
Forested/Shrub Wetland	3.32	2.91	2.00	0.12	0.72	9.66	6.64	0.40	2.38
Emergent Wetland	0.65	2.66	0.43	0.14	0.82	1.74	0.28	0.09	0.54
Forested/Shrub Wetland	0.55	2.65	1.00	0.22	0.74	1.47	0.55	0.12	0.41
Forested/Shrub Wetland	0.26	2.66	1.00	0.22	0.68	0.69	0.26	0.06	0.18
Forested/Shrub Wetland	0.38	2.64	2.00	0.23	0.65	1.00	0.76	0.09	0.24
Totals	8.75					15.20	10.47	1.27	6.41
Coalfields Expressway - preferred alternative									
Forested/Shrub Wetland	3.36		0.46	0.15	0.74	0.00	1.53	0.49	2.49
Forested/Shrub Wetland	0.23	2.87	2.00	0.08	0.74	0.65	0.46	0.02	0.17
Forested/Shrub Wetland	3.32	2.91	2.00	0.12	0.72	9.66	6.64	0.40	2.38
Emergent Wetland	0.65	2.66	0.43	0.14	0.82	1.74	0.28	0.09	0.54
Emergent Wetland	0.70	2.99	2.00	0.01	0.67	2.11	1.41	0.01	0.47
Totals	8.27					14.16	10.32	1.01	6.05

Table 3.8. Functional Impact of Potential Highway Impacts, by Route, Weighted by Wetland Acreage Estimates on King Coal Highway

		Raw Index Values				Weighted by Acreage			
Wetland Type/ Route	**Acres**	**Ecological Value**	**Floodwater Value**	**Nutrient and sediment value**	**Erosion value**	**Ecological Index**	**Floodwater Index**	**Nutrient and sediment index**	**Erosion Index**
King Coal Highway - alternative 1									
Emergent Wetland	0.70	2.99	2.00	0.01	0.67	2.11	1.41	0.01	0.47
Forested/Shrub Wetland	0.72	2.37	1.39	0.32	0.82	1.71	1.00	0.23	0.60
Emergent Wetland	1.15	2.53	1.59	0.23	0.59	2.91	1.82	0.26	0.68
Forested/Shrub Wetland	1.11	1.19	0.42	0.73	0.41	1.32	0.47	0.81	0.46
Forested/Shrub Wetland	2.17	1.60	1.57	0.59	0.40	3.47	3.41	1.28	0.87
Forested/Shrub Wetland	3.61	1.82	1.57	0.54	0.40	6.55	5.66	1.94	1.43
Forested/Shrub Wetland	0.21	1.93	0.40	0.54	0.47	0.41	0.09	0.12	0.10
Totals	9.68					18.48	13.86	4.64	4.60
King Coal Highway - alternative 2									
Emergent Wetland	3.51	2.39	0.43	0.49	0.47	8.38	1.50	1.72	1.65
Forested/Shrub Wetland	0.62	2.48	1.58	0.24	0.55	1.52	0.97	0.15	0.34
Totals	4.13					9.90	2.47	1.87	1.99
King Coal Highway - preferred alternative									
Emergent Wetland	3.51	2.39	0.43	0.49	0.47	8.38	1.50	1.72	1.65
Forested/Shrub Wetland	0.62	2.48	1.58	0.24	0.55	1.52	0.97	0.15	0.34
Totals	4.13					9.90	2.47	1.87	1.99

Landscape Integrity

The net LI impact scores were calculated for each selected build alternative by subtracting the post-build scores from the pre-build scores or current conditions (Table 3.9). A greater deviation from the current conditions is analogous to a larger impact. By examining Table 3.6, it is evident that for the KCH-2 results in the least impact and KCH-1 results in the greatest impact, while the CFX-PA has the least impact and CFX-A the greatest for the CFX.

Table 3.9. Net LI Impact Scores by 8-digit HUC Watershed

units = weighted LI scores	*Impact Scores*		
King Coal	***KCH-1***	***KCH-2***	***KCH-PA***
Upper Guyandotte	660	691	699
Tug Fork	1,906	1,104	1,141
Middle New	299	471	441
Total Impact:	2,865	2,266	2,281
Coalfields	***CFX-A***	***CFX-B***	***CFX-PA***
Upper Guyandotte	920	995	897
Tug Fork	1,275	1,183	1,150
Lower New	101	79	200
Total Impact:	2,296	2,257	2,247

The LI impact scores were also summarized by the segment-level watersheds intersecting each build alternative. The baseline LI scores for each SLW intersecting CFX build alternative B are shown in Figure 3.8.

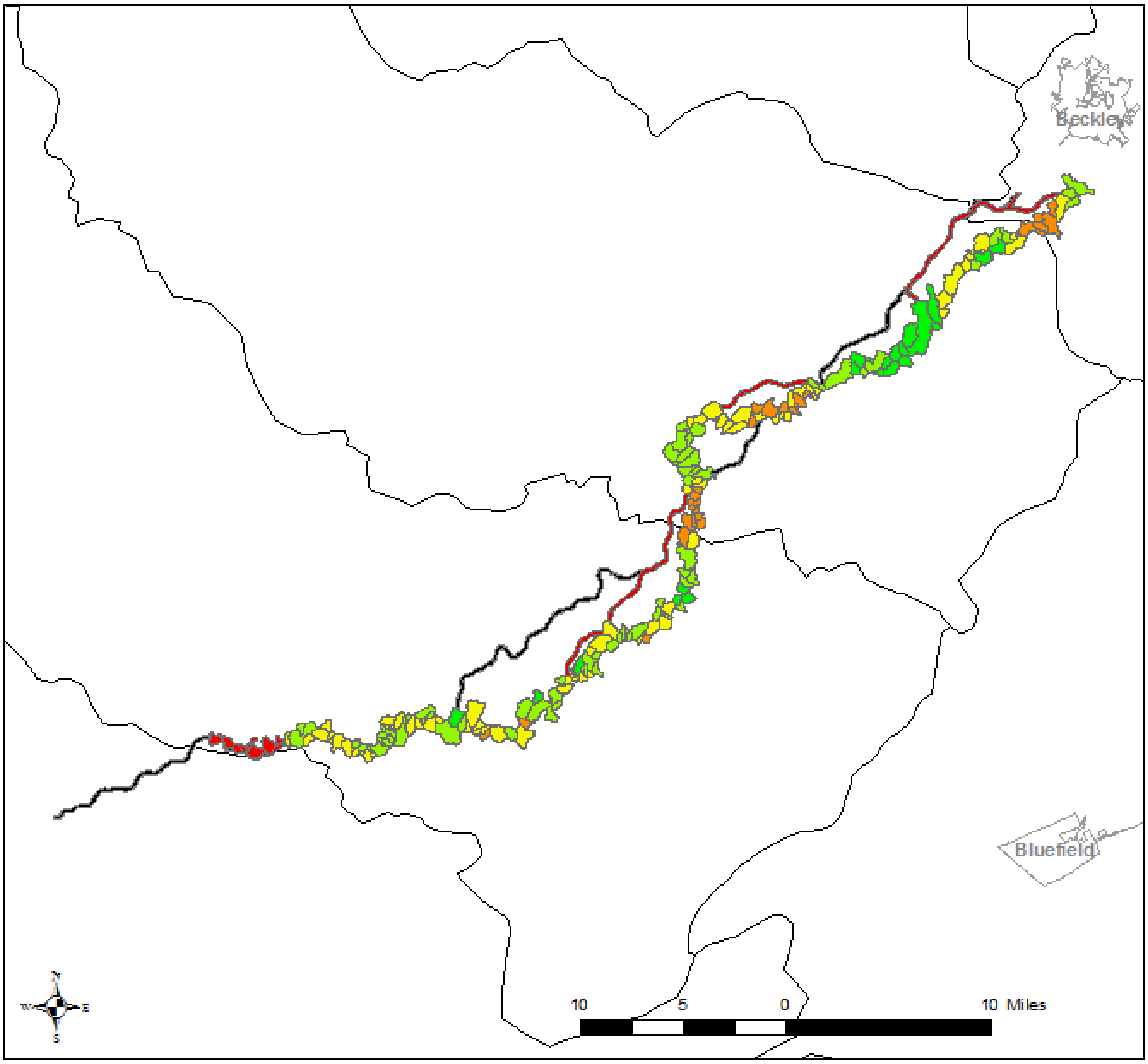

Figure 3.8. Segment-Level Watersheds Intersecting Coalfields Expressway, Build Alternative B.

The net LI impact was calculated over intersecting SLWs by subtracting the total post-build score from the total pre-build score for each build alternative. By dividing the net impact scores by the respective number of SLWs a measure of average impact per SLW for each build alternative was calculated (Table 3.10).

Table 3.10. Net LI Integrity Impact Scores by Build Alternative

units = weighted LI scores (m)			
King Coal Highway	***KCH-1***	***KCH-2***	***KCH-PA***
Impact LI	2377	1701	1718
# SLWs	347	255	265
Impact per SLW	6.9	6.7	6.5
Coalfields Expressway	***CFX-A***	***CFX-B***	***CFX-PA***
Impact LI	1693	917	1530
# SLWs	222	209	221
Impact per SLW	7.6	4.4	6.9

Prioritizing Areas for Potential Wetland Mitigation

A GIS-based method of prioritizing and identifying areas most suitable for wetland mitigation was developed based on a modified approach from Strager et al. (2011). This method considers a suite of stream and landscape attributes, including: topography, soil types, upstream, WVSCI scores, to identify areas that would potentially support and sustain wetland development in the long-term. The resulting segment-level watersheds are shown in Figure 3.9.

A total of 159 SLWs were selected based on the criteria described above (Methodology - *Mitigation* section), with the majority existing in the eastern portion of the Middle New, 8-digit HUC watershed where slopes are gentler due to the ridge and valley landforms.

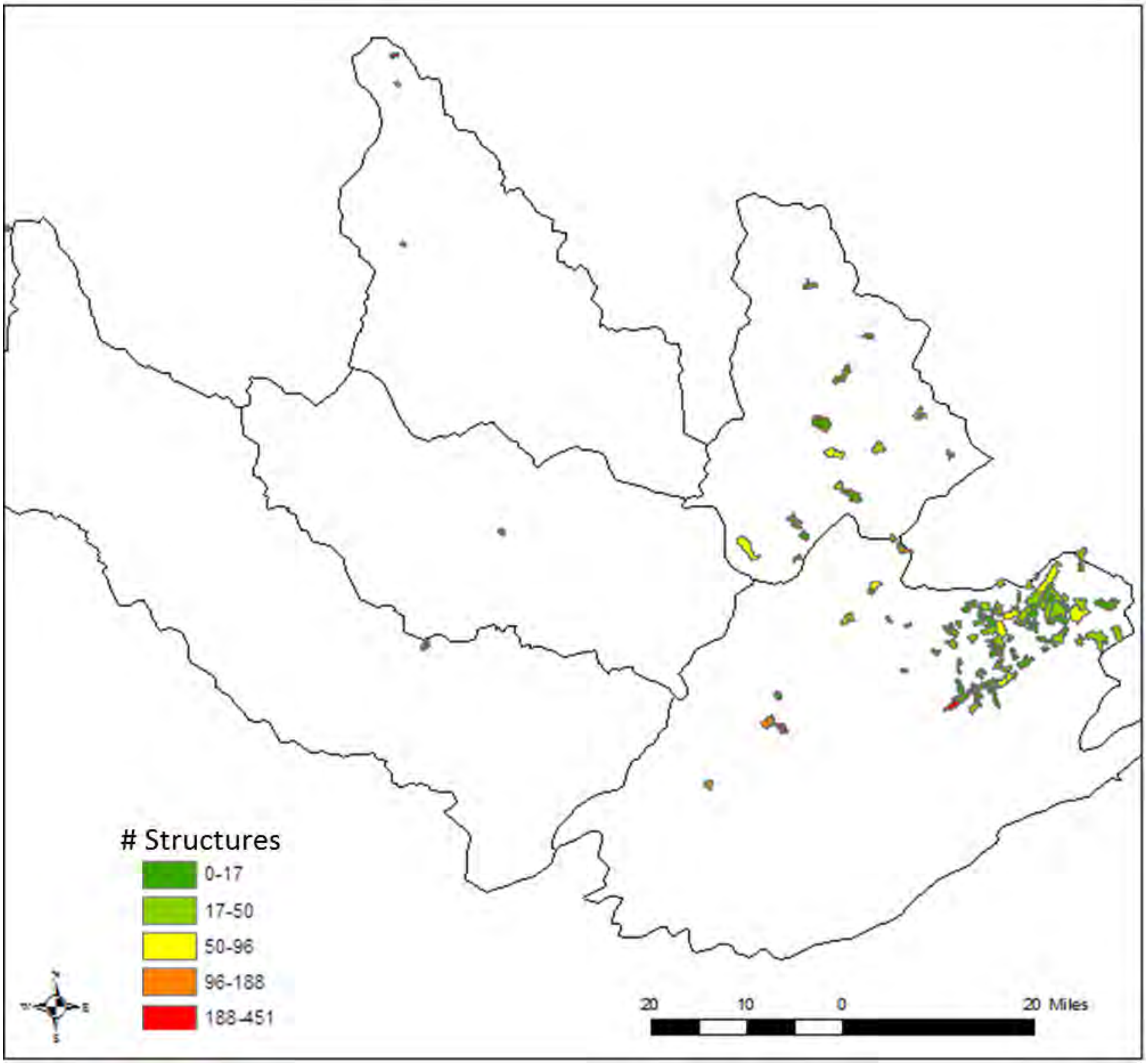

Figure 3.9. Segment-level watersheds identified as most suitable for wetland construction and sustainability.

By zooming in to several of these SLWs (Figure 3.10) it is evident that the criteria is optimized on flat land (fields) with few structures, which is more likely to support and sustain wetland development.

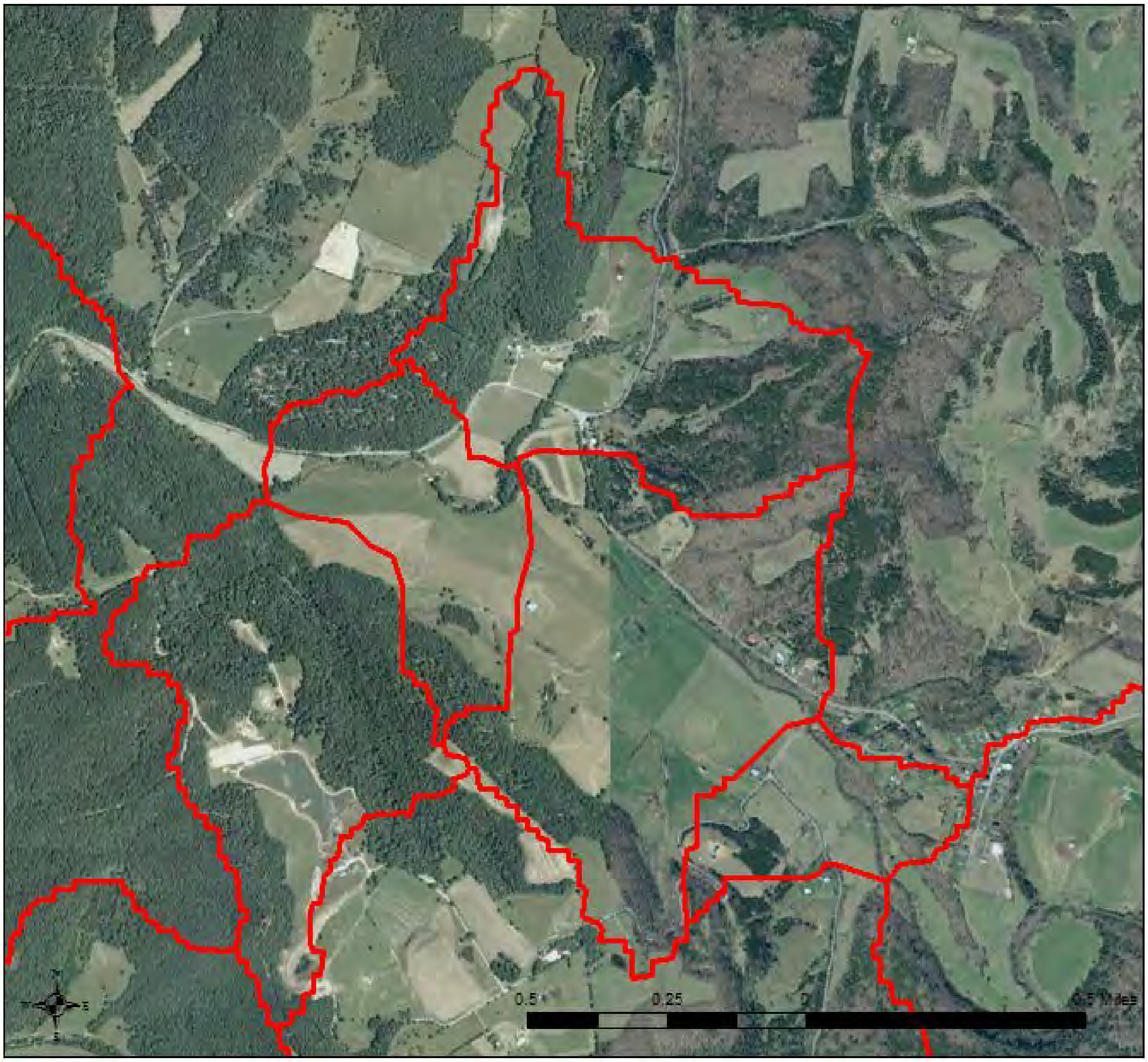

Figure 3.10. Close-up view of SLWs selected as most suitable for wetland mitigation.

It is recognized that this method is an initial screening process and cannot replace site visits. However, by spatially prioritizing potential wetland mitigation areas, the number of site visits can be reduced while the overall effectiveness and efficiency of necessary field time can be improved.

Prioritizing Areas for Potential Stream Mitigation

Following the methodology described for wetlands, and including a provision that limits the appropriate SLW to those not having any structures within 150 feet of the water resource, the team selected a total of 1,772 SLWs as potential sites suitable for stream-based mitigation (Figure 3.11). A summary of stream length and WVSCI score by 8-digit HUC is shown in Table 3.11.

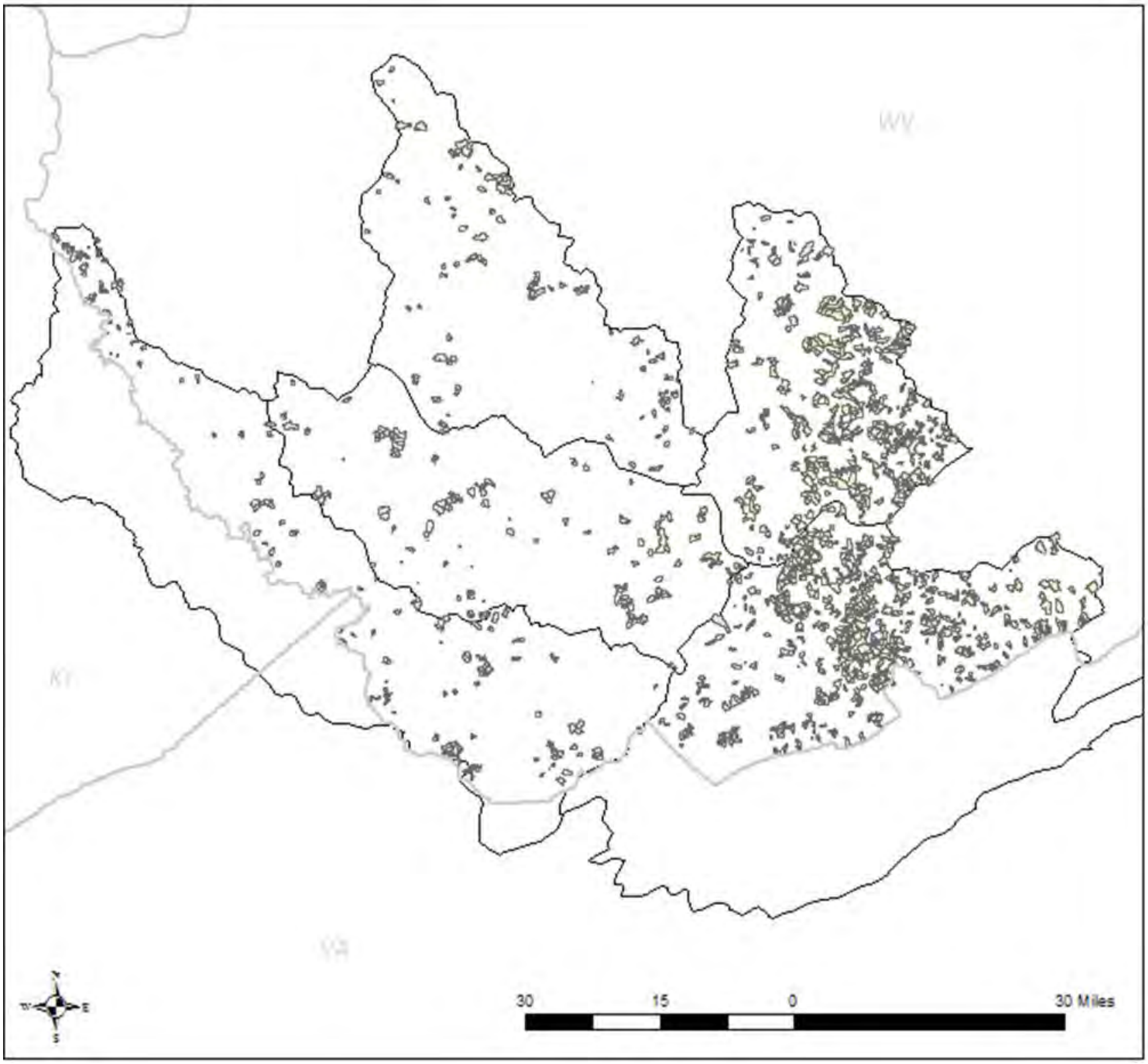

Figure 3.11. Segment-level watersheds identified as most suitable for stream mitigation.

Table 3.11. Summary of Stream Segments Suitable for Mitigation by 8-digit HUC

8-digit HUC	*# SLWs*	*Mean WVSCI*	*Total Length (mi)*	*Mean Length (mi)*
Upper Guyandotte	152	63	89	0.59
Tug Fork	214	65	90	0.42
Middle New	754	62	399	0.56
Lower New	524	63	293	0.56
Coal	128	65	67	0.53

Knowing the spatial location of the 1,772 possible SLWs appropriate for structural and riparian mitigation is of limited use, because determining possible mitigation sites still will ultimately depend on the landowner. It is important to note that there are truly limited opportunities, in terms of mileage, to do physical enhancement for compensatory mitigation. In the following chapter, the team demonstrates the limitations posed by the WVSWVM physical habitat restoration crediting. For example, if 12 miles of enhancement is needed, and each segment-level watershed is approximately ½ mile, it will be all but impossible to get a grouping of 24 interconnected SLWs that can be enhanced to provide a measure of ecological lift that fits the context of a watershed-based approach to mitigation. It will be even more difficult to find a long reach of interconnected SLWs in which all landowners are willing to provide a conservation easement.

Applied Objectives and Purpose of Methodology

The methodology proposed by the research team is meant to complement, not replace, the majority of the information needed to make route determinations and consider aquatic resources. The research team understands that ultimately costs and other cultural factors may play a larger role in the route selection process, but the methodology helped describe the ecosystem service and watershed functions that may be lost in the construction process. Cultural and historical considerations were not part of the evaluation process, but should be considered and potentially incorporated into planning, similar to the ICT tool that screens for any potential of T&E Species occurrences.

CHAPTER 4
An Alternative Approach to Watershed-Based Mitigation in West Virginia

Rationale

Physical restoration and enhancement of stream and wetland habitats through compensatory mitigation activities is one way to create and enhance a number of ecosystem services and functions. The research team has demonstrated, through this research methodology, that this technique provides a better estimate of detailing the cumulative and functional losses associated with stream and wetland potentially impacted by highways, and that these losses can be quantified and predicted by watershed. However, identifying mitigation opportunities with these tools is limited in terms of flowing waters (rivers and streams – perennial, intermittent, and ephemeral). As noted, finding areas suitable for aquatic mitigation are largely dependent on intensive on-the-ground reconnaissance, and interactions with multiple landowners is often necessary before securing the rights to be able to provide compensatory mitigation. In the case of highway impacts, the encasing of streams in culverts is a necessary component of highway construction. One may be able to minimize these impacts with best management practices (BMPs) and techniques (e.g., natural bottom substrate or diversion structures); but the end result is still ultimately a 300- to 800–foot-long or more tunnel (Figure 4.1). In this chapter, the team demonstrates the use of the WVSWVM (West Virginia IRT 2011) in approximating theoretical impacts and calculating credits produced though available mitigation options.

To generate these credits, in terms of functional replacement, the sponsor of a compensatory mitigation project typically would restore steams and enhance riparian areas to varying degrees. This method is preferred because it typically does not require future operating costs beyond monitoring and treating for invasive species. The sponsor has short-term liability for ensuring that the mitigation project functions as designed and remains structurally intact. Long-term liability for the site rests with the steward of the property, who must ensure the mitigation bank boundaries and easements are upheld

In the best cases, the mitigation site is incorporated into lands currently being managed by the state (i.e., state parks, Wildlife Management Areas) or another land stewardship entity (i.e., TNC). This represents the best opportunity to truly maintain and preserve the mitigation in perpetuity. On the other end of the mitigation landscape, there are projects that function like postage stamps spread out, and not connected to meaningful habitat, neglected after the initial monitoring. Projects such as these provide questionable ecological or functional lift on a watershed level. However, even in the best case, flooding and disasters that cause mitigation structure failure may happen over the long-term, and funding the necessary repairs can be challenging.

Figure 4.1. The outlet of a culvert crossing beneath a section of the Coalfields Expressway.

Here lies the problem with regards to mitigation for the WVDOH. They are the biggest single entity in the state requiring mitigation. However, enhancing and restoring streams at the level required to cover their mitigation liability poses significant challenges. The research team proposes alternatives that would allow WVDOH both to satisfy their mitigation liability based on the WVSWVM formulae, as well as arguably providing a better measure of comprehensive ecological lift to the watershed with value-added economic benefits.

The WVDOH Incentive and Argument for Special Case Scenario

The WVDOH and other state agencies have spent significant amounts of research funds examining mitigation options. They include methods for initially prioritizing mitigation sites (Strager et al. 2011), examining the functional replacement value of the mitigation projects which have previously been built (Balcombe et al. 2005 a, b, c), and more recently, looking at cost options for chemical treatment of a variety of water contaminants.

Despite these efforts there has been no comprehensive agreement reached between WVDOH and the regulatory agencies. The challenge lies in the fact that WVDOH has a mission and capacity to build highway infrastructure, but not to restore, enhance, and maintain stream corridors. WVDOH understands compensatory mitigation is necessary, but would prefer suitable alternatives that provide public water quality benefit and ecological lift, without having to maintain and manage extensive land holdings. The team hopes this case study demonstrates the difficult position of the WVDOH and can lead to new agreements addressing the mitigation requirements of regulatory agencies.

The WVSWVM provides the credit framework upon which mitigation is based. These credits are generated through improvements in water quality, habitat, and function of a waterway. As noted, creating, restoring, and enhancing habitat to generate sufficient mitigation credits is not feasible at the scale of highway impacts generated by the WVDOH. Improving water quality is what mitigation is meant to achieve. The mechanism behind these improvements is of less importance to the people of West Virginia than achieving a good end result. The value of this type of improvement is especially evident on the Cranberry and Blackwater Rivers, which support some of the state's premier trout fisheries largely because of a limestone 'doser' that neutralizes the acidity of the waters (Figure 4.2). Although these dosers are not part of any compensatory mitigation, they are funded by perpetual monies generated from interest on bonds held by the State of West Virginia.

Waterways in the southern portion of the state are plagued with the remnants of a bygone era, such as untreated sewer discharge and a mining legacy resulting in heavy metal contamination. To truly maximize mitigation dollars, the WVDOH should be allowed to create an equivalent Highway Ecological Endowment Fund (HEEF) with which to finance operations and maintenance costs of chemical treatment options in order to improve overall water quality. The tangential effects of cleaner aquatic resources would leverage these compensatory mitigation activities in ways which would improve the regional quality of life and water-based economic opportunities. The issue of perpetuity is resolved because WVDOH is a public institution that is forever linked to the welfare of West Virginia. This model of a perpetual funding endowment is drawn from a similar plan that funds and pays for Abandoned Mined Land (AML) remediation. This approach only applies to WVDOH as a public entity and should not be considered an option for private companies that cannot ensure treatment options lasting into perpetuity.

Figure 4.2. Limestone doser on the Blackwater River in Tucker County, West Virginia. Note the small impact area, and treatment resulting in some of the most well-known catch-and-release trout fishing opportunities in the state.

Means of Generating Mitigation Credit

The implementation of the WVSWVM is a quantifiable approach to calculating mitigation credits and debits. The metric is used to account for temporal loss and biological, physical, and chemical impacts, and is meant to ensure the true costs of both impact and restoration activities are quantified consistently. However, under these consistent rules, alternatives are proposed to riparian and stream channel restoration as a way to generate mitigation credit.

Aquatic Connectivity Re-establishment

Under NWP 27, it could be possible to generate mitigation credit by replacing hanging culverts that acted as an impediment to fish passage structures that facilitate passage. This has been a focus of past WVU-led research conducted in cooperation with the WVDOH (Poplar-Jeffers et al. 2009, Ward et al. 2008). The WVDOH is well suited to handle this kind of work, and doing so would generate credit that would offset highway mitigation liabilities elsewhere.

Generically speaking, the replacement of the culvert could potentially generate one-third the credits possible for the upstream reach by restoring the biological connectivity. Unfortunately, until the WVDOH and the IRT adopt guidelines that specify how culvert replacement for credit can be tracked and quantified using the WVSWVM and under NWP 27, this will not be a plausible option.

Chemical Treatment Options

The treatment of the chemical stressors that degrade water quality is another way to potentially generate mitigation credit. Improving the chemical integrity of a waterway provides ecological lift in addition to improving macroinvertebrate and fish communities. Additional benefits of chemical treatments include not requiring extensive land holdings in order to treat long reaches of streams, the inherent, beneficial downstream effect of the improved water quality, and the potential for public recreation in the waterways, often the officially designated use.

However, just as it is not in the WVDOH interest to maintain land holdings for mitigation, they are not in the position to decide the location and type of chemical treatment options that can be used to generate credits. In keeping with the spirit of Eco-Logical (Brown 2006), calling for cooperation between agencies, the team recommends mitigation activities be steered by WVDEP-approved Watershed-Based Plans (WBPs). These WBPs represent the most comprehensive studies providing treatment options with the highest likelihood of successful water quality remediation. In a WBP, input is received from stakeholders, benefactors, and stewards before any funding can be allocated. Additionally, these plans already have cost estimates associated with each treatment option and water quality monitoring strategies in place to ensure ecological lift is occurring, and can predict reasonably well the downstream water quality effect. Moreover, the issue of temporal loss is resolved because the remediation action of water quality improvement is almost instantaneous if such systems are operational.

Leveraging Flood Risk Mitigation Activities through Physical Floodplain and Channel Restoration

The NRCS and ACOE have floodwater mitigation strategies that include home buyouts for areas under repetitive flooding stress (Joseph Trimboli, ACOE; Pam Yost, NRCS, personal communication). Under these buyout programs, private property is purchased along frequently flooding streams and rivers. In some instances, houses are lifted up and moved from the floodplain to higher ground, or occupants are relocated to homes outside of the floodplain. The resulting property may require physical habitat restoration activities, which, if funded by the WVDOH and done under NWP 27, could provide another source of mitigation credit without requiring the acquisition and long-term stewardship of conservation easements.

Summarizing On-Site Treatment Options

WBPs propose tangible water quality improvements that can improve quality of life for citizens within the impacted watersheds. Physical restoration of small channels and riparian conservation easements within private property does provide ecological lift, but not to the extent and magnitude provided by the chemical mitigation options that may exist in a watershed. The watershed approach to mitigation, in the spirit of agency cooperation and leveraging limited government resources, should provide benefit to both aquatic resources and people; and WBPs are one of the best ways to implement meaningful water quality improvements with mitigation dollars. Remediation methods for water quality impairments identified in the studied watersheds are constructed wetlands (CW), riparian zones, bioretention ponds, and residential septic systems. Wetland systems have proven to be a viable option for removing fecal bacteria (Steer et al. 2005, Perkins and Hunter 2000, Axler et al. 2001, de Ceballos et al. 2001).

In terms of technologies, there are a number of available treatment options for specific impairments that may be identified on 303(d) or other impaired waters lists. In addition to options presented in WBPs, low-impact best management practices also exist that will address some water quality issues. These BMPs can address three main factors: flow control, pollutant removal and pollutant source reductions. Two common chronic impairments for the streams in this study area are fecal coliform and sediment. These impairments may be in the form of point-, or non-point source, or a combination of both source types. If these impacts are greater when associated with rain events, recent innovations in storm water management can help to mitigate them. These innovations include: bioretention or rain gardens, gravel or constructed wetlands, green roofs, porous pavement, rain cisterns, retention or detention ponds, swale retrofits, and tree filters or stream buffer zones. The research team has summarized effective treatment options for a range of pollutants. These treatment options may be implemented as part of a comprehensive mitigation plan to address water quality (Table 4.1). These pollutants are commonly identified as sources of impairment in many of West Virginia's waters and, if treated, would provide numerous opportunities for public use and enjoyment, as well as help spur and sustain new channels of economic development.

Table 4.1. Summary of BMPs That Can Be Used as Part of a Watershed-Based Approach to Mitigation to Improve Water Quality Characteristics

Mitigation BMP options	Reference	Source	Pollutant	Removal Efficiency
Vegetation buffer	Sullivan et al. (2007)	Agriculture	Fecal Coliform	99%
Wetland	Brown and Bay (2005)	Urban	Dissolved Organic Carbon	0%-6.7%
			Ammonia	17%-88%
			Total Suspended Solids	31%-90%
			Cd	97%-99%
			Cr	4%-25%
			Cu	20%-29%
			Ni	75%-84%
			Se	10%-18%

			Zn	64%-91%
	Zhang et al. (2009)	Agriculture	TSS	70%-90%
			BOD_5	20%-50%
			TP and NH_3-N	30%-70%
Detention Pond	Lin et al. (2006)	Mining Facility	TSS	83%
	Hunt et al. (2008)	Urban	TN	32%
			TKN	44%
			BOD_5	73%
			Fecal Coliform	69%
			Escherichia coli	71%
			TSS	60%
			Cu	54%
			Zn	77%
			Pb	31%
	Li and Davis (2009)	Urban	TSS	88%
			Escherichia coli	57%
			Zn	78%
	Hossain et al. (2005)	Highway Storm water	TSS	68.1%-99.4%
	Hossain et al. (2005)	Highway Storm water	TSS Metal	68.1%-99.4% 54.7%-64.6%
			Orthphosphate	77%
			Nitrate	63%
			NO_3-N	11%
			Total Coliform	74%
			Escherichia coli	75%
			Metal	37%-72%
			Petroleum Hydrocarbons	43%-99%

West Virginia Numerical Case Study

For this case study, the team is evaluating how to address the compensatory mitigation for reaches impacted by highway construction. To demonstrate the mitigation liability associated with highway building, the team used a total of 50 culverts being built that are an average of 400 feet, for a total linear impact of 20,000 feet. The team will use the WVSWVM to determine the debits and credits generated by impacts as well as sources of mitigation. Assuming these are not high-gradient streams, the WVSWVM will not be scored based on hydrogeomorphic characteristics, but will use water quality parameters common for that region in the state.

In terms of mitigation impacts for placing culverts over these streams, the WVWSVM generated 14,000 debits based on a 0.7 cumulative index score for the 20,000 feet (Appendix B, Table B.1). Generating the required number of credits for these debits could come through riparian restoration, conservation easements on 150-foot buffers, and bank stabilization, and would require a total of 65,000 feet (12.35 miles) of restoration and protections. This number would be nearly impossible to meet. In addition, this approach assumes that riparian activities will be mature in 10 years; however, this outcome cannot be assured. The alternative to such mitigation would be to place $11.2M into the state's in-lieu fee fund (Appendix B, Table B.2).

If water quality is improved through chemical treatment options, lowering conductivity and increasing the corresponding WVSCI scores, 14,666 credits can be generated based on 80,000 linear feet of water quality improvement (Appendix B, Tables B.3 and B.4). Although this distance is considerable (80,000 feet = 15.2 miles), existing WBPs have outlined treatment options to improve stretches of water like this at prices significantly lower than the alternative in-lieu fee fund costs of $11.2M. For example, the Martin Creek WBP (2008) would improve over 1.3 miles of stream before entering the Smith Creek Watershed (in the Coal River 8-digit HUC) and may even have a greater quantified effect for an estimated cost of $472,000. This pales in comparison to the Upper Pigeon Creek Watershed Restoration Plan (West Virginia Water Research Institute and Canaan Valley Institute 2008) that has the potential to improve over ***32 miles*** of steam for an estimated $10M in the Tug Fork watershed.

Each of these WBPs was developed in conjunction with the WVDEP and had both federal and state agency support in their scope and anticipated benefit. In addition, they occur within and adjacent to watersheds that will be impacted by highway construction. If an MOU is developed, for the creation and management of the afore-mentioned HEEF by the IRT and the WVDOH, it will create truly meaningful mitigation options that would benefit these southern communities in tangible ways.

CHAPTER 5
Lessons Learned to Promote Future Watershed-Based Mitigation

Background

The legacy of West Virginia waters is two-fold; one as the birthplace of rivers, and the other showing just how destructive human impacts can be to aquatic habitats. These impacts are both historical as well as contemporary. How to handle water quality degradation is relevant to both aquatic and human health (Hitt and Hendryx 2010). In addition to the energy extraction industries, highway and road construction and maintenance present the potential for significant alterations in water quality. Avoidance, minimization, and then compensatory mitigation are the regulatory standard designed to protect aquatic resources.

The team's methodology captures the preferred sequence of events: avoid, minimize, and mitigate accordingly. Using GIS-derived variables, one is able to screen the potential impacts for each route, with estimates of the quality and function of the water body encountered. The WVSWVM formula incorporates water quality and function to raise and lower mitigation credits needed. This tool will allow planners to understand mitigation liabilities associated with each build alternative before a final route is selected.

Moreover, when selecting locations and projects for compensatory mitigation one can maximize the ecological lift associated with the mitigation on a watershed-level. Using the same GIS tools to gauge impacts, the ecological lift potential can be estimated by screening the upstream landscape integrity, water quality, and, in some instances, the downstream cumulative effect from the mitigation.

Herein lays the challenge with generating credits with which to offset debits calculated in the WVSWVM. The opportunities for channel and riparian mitigation projects are limited by landowner and long-term stewardship options. Water treatment mitigation options exist, but to incorporate these changes will require following through on the HEEF using the IEF framework as well as establishing programmatic agreements between WVDOH and regulatory agencies on the IRT.

Future Scenario Actions

The WVDOH will need to be proactive and realize that facilitating chemical mitigation options is in their best interest financially, ecologically, and as a public relation opportunity. Cleaning up waterways that have been unusable for generations in the southern counties is a tremendous statement to the citizens of West Virginia. The newly built highways, and chemically restored waterways would enhance quality of life and provide vitality to an entire region. Moreover, the alternative, using tax dollars for the physical restoration of first- or second-order stream habitat which is often not readily accessible is not acceptable to the public. If tax dollars are being spent on mitigation, projects should maximize both the environment and human utility values. This will require a sustained effort and resources allocated by WVDOH. However, if successful, compensatory mitigation projects can change the frame of reference for the local EDA by helping them to understand that they have a vested interest in working to facilitate this arrangement and can work with local lawmakers to push for compensatory mitigation required by public projects to benefit the public's use of the water resources.

One of the many hurdles will be in the manner in which the IRT sets up criteria to prioritize and authorize water quality treatment as a mitigation option. The existing, in-lieu fee program managed by TNC and CVI may provide guidance to leverage these water quality treatment options within the existing context. Moreover, WVDEP-approved WBPs provide costs and water quality improvement estimates that can be incorporated into the WVSWVM in order to estimate credit generation.

The WVDOH will need to establish the HEEF that can be modeled after AML funds. There is outside-the-box potential to piggyback these existing funds to leverage capital and provide an immediate operating and maintenance capacity. However, there remain a number of tangential steps that WVDOH can make that will further help define their role as proactive and responsible stakeholders that take water quality impacts and improvements very seriously.

Additionally, the WVDOH will need to work with FWS and the NRCS to integrate and upgrade the applicability of the ICT for T&E species distribution maps and apply it to a WVDOH linear project context.

> *In the interest of true cooperation, cost-sharing this with WVDEP and the Public Service Commission (PSC) could help with linear transmission or natural gas pipeline permitting.*

This will require a funding expenditure, but will save countless hours on the coordination end in the long run. The following are other examples of expenditures that will help streamline and make the environmental stewardship efforts by WVDOH more quantifiable and will ease some of the regulatory challenges.

Consistent Data Sourcing

Identifying and quantifying water quality impacts can be done with GIS-derived data layers if the layers used to do this are consistent. The WVDOH and the regulatory agencies need to define a list of data layers that are acceptable for use in submitting proposed impact statements or other planning documents. These data layers can then be housed at the West Virginia GIS Technical Center website, the official state clearinghouse for GIS data and information. This eliminates the question of metadata or data source, and will allow planners to access the LI grid, the enhanced NWI layer, and other ecological resources that are considered in route planning.

Consistent Best Management Practices

The replacement of culverts as part of operation and maintenance can be an additional source of mitigation credits. Although not all culverts will meet the criteria, re-establishing downstream-to-upstream aquatic connectivity can be a source of mitigation credit if quantified with a NWP 27. The top-down action required for each district to accomplish this starts with the WVDOH EC understanding the potential financial value and ecological benefits of these retrofits. Teaching heavy equipment operators and road maintenance foremen the techniques of counter-sinking culverts and maintaining natural flow conditions and substrate will demonstrate an investment by district personnel and a commitment to watershed water quality improvements.

Consistent Environmental Training for Contractors and Employees

Many water quality impairments can be prevented by simple action. The first of these actions is how to teach personnel to recognize opportunities for best management practices (BMPs) and make this recognition part of a bi-annual training given by district ECs. However, this training should extend beyond WVDOH employees. It should also be part of the criteria required for private contractors to conduct work for the WVDOH. The WVDOH is ultimately responsible for the actions of the contractors they use, for this reason the same consistent BMP and awareness training should be required for contracting personnel. This gives assurances to members of the IRT, who can ultimately approve the curriculum for such a program, that programmatic safeguards are part of the plan to protect watershed health and quality.

Conclusions

The research team has demonstrated improvements in methodology for tracking and forecasting highway impacts with which to facilitate highway route evaluation and permitting. These methods are a combination of improving the applicability of existing tools and showcasing tools in development and applying them to a highway context. Our methodology continues to rely on GIS data layers, but the quality and utility of the associated data is improved with the analyses. Furthermore, these methods are a cost-effective option because the associated data can be dynamic and housed in the GIS clearinghouse accessible to all stakeholders. In this way data and tools can be standardized across all users.

By defining a consistent methodology and the data layers and type that best evaluates how to minimize and avoid sensitive environmental resources, one can apply this to a number of linear infrastructure projects commonly occurring in West Virginia, including but not limited to transmission line sighting and natural gas pipeline routing. By having both the quality and function of the resources quantified, agency personnel will better understand the downstream effect and how activities may affect overall watershed health. Concurrently, these same tools allow us to better locate compensatory mitigation activities, enabling overall ecological lift in the watershed and providing the best chance of sustaining improved water quality along with all the associated economic and societal benefits that are possible with it. This concept is transferrable and easy to support both by the general public and the regulatory agencies, while still remaining close to the core mission and in the interest of the WVDOH.

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APPENDIX A
Responses from WVU-Led Research Team to Email Questions Prior to Conference Calls Regarding the Use and Applicability of the Transportation for Communities Website

January 13th Conference Call

1. What have you been you have been doing with your pilot and how have you been using the IEF over the last year?

The WVU-lead research team pilot project (steps 1-5) uses a back casting approach to incorporating environmental planning into highway route selection based on new tools available through GIS technologies. These tools were developed by previously funded research, but if integrated together they can be used to minimized proposed impacts and maximize the ecological lift provided by any necessary mitigation dollar. The IEF has served as a 'guide' to facilitating relationships among agencies and personal, that will increase the likelihood of successful implementation of these environmental planning tools.

2. How have you diverged or supplemented the IEF in your pilot?

The approach varied from strict interpretation of the IEF because the decision for routing and highways construction had already been made; and also because of limitations associated with data-readiness not anticipated. This allowed us to focus on agency needs and transforming research to an applied methodology to tracking and quantifying water resource impacts within the existing Army Corps of Engineers and regulatory agency framework. A setback was encountered with data associated with T&E species. The team had anticipated adapting newly developed NRCS tool that indicated potential for T&E species in a defined project area. This project is currently in its final stages of beta-testing for applying to NRCS-type limited area-based projects. As such, the research team has not had the opportunity to apply it to a highway, linear-based context. In its place, the team has substituted a combined WVDNR and NatureServe product, the LI index as a surrogate to the 'pristineness' of the area impacted.

3. What is working well with using the IEF?

The IEF defines things in a very logical and stepwise fashion. It is comprehensive, although based on this and previous experience, there can be a guide based solely on soliciting, incorporating, and maintaining feedback from stakeholders above and beyond the IEF.

4. What is not working well with using the IEF?

The WVU-led research team has found the TCAPP reference to be non-intuitive and too complex to easily be integrated with the planning agenda. It is simply not possible to keep track of four distinct components (Long-Range Transportation Planning, Programming, Corridor Planning, and Environmental Review), with 9 to 13 steps each, each of which varies which number is applicable based on the IEF step. It also repeats itself as far as saying what steps are relevant to the IEF, without ever changing context.

5. What is needed to improve the use of the IEF by future users?

The IEF can be improved by recognizing that many of these steps it calls for already exist under different premises. Be sure agencies know they do not need to reinvent the wheel, but rather apply existing tools in a manner that is transparent and agreeable to stakeholders. A lot of money has already been invested in developing these regional tools, so using existing resources increases efficiencies without adding to significant costs to enable change. The team also emphasizes the impact that alleviating data availability bottlenecks and ensuring everyone is using the same data can have on consistency and efficiency.

Moreover, the format of TCAPP should be changed to simplify and minimize the data accessed at any given time. A query that differentiates project type would (e.g., rural vs. urban, two-lane vs. four-lane) would help streamline the data discovery process and facilitate use by stakeholders on a more permanent basis.

6. What do you anticipate that you will be doing with your pilot over the next six to eight months, and what technical assistance do you think you might need?

Over the next six to eight months, the research team will look for supplemental funding from within the West Virginia Division of Highways or other entities to complete the full nine steps of the IEF process. The team's intention is to set the standard in aquatic resource impact reporting and mitigation crediting based on a watershed directive, which the DOH and even private consulting firms will follow to streamline the agency review of proposed environmental impacts for linear infrastructure projects. The team then hopes to adapt this model for area-based footprint impacts, as well as incorporate the T&E species layers readily available for planning infrastructure projects.

7. As part of the C06 outreach, we are thinking about having case study presentations at conferences (you presenting the pilot and one of the C06 team members there as a co-presenter in terms of the IEF, etc.). What conferences do you think we should consider targeting?

National Council for Science and the Environment and Ecological Engineering Society Meeting.

2nd March Conference Call

1. TCAPP does not seem to provide the type of support/tools needed for IEF implementation – so what would we envision instead of TCAPP or as an add-on to TCAPP?

As stated previously, TCAPP would benefit if there was some sort of additional query capability that allows you to hide a lot of the upfront complexities and still be able to access the information. For example, being able to differentiate from approaches to environmental issues like new road route planning versus existing lane-widening expansion immediately facilitates headway. Within these categories there is even further differentiation: if you are simply repaving, then no action is required; if you are building a new base, expanding ROW, and are sticking in a new lane, then these rules come into play.

2. Getting the regulatory agencies to turn away from business-as-usual and looking landscape-scale is very challenging – is there a proof of concept needed or another approach or idea we should discuss to address this challenge?

Ultimately, this has to happen from within the regulatory agency; but this process can supply tools and information that will help them to promote better decision-making options. The watershed approach will catch on. However, one must approach it from a multiple angles, and understand that regulatory change has a lot of internal challenges and logistics that need to be coordinated before any full-scale effort can be met. For example, the ACOE personnel do not have access to Universal Serial Bus drives and ports, and must work through approved and protected internet protocols. This is challenging when it comes to GIS data layers from various sources, so the team is promoting the WV GIS Tech Center as a safe and secure clearinghouse resource.

Additionally, the team chose an approach that featured using the existing agency tools and reports to demonstrate a theoretical case study involving highway impacts and how to mitigate for them. This approach changed the mitigation paradigm by showing the difficulty in restoring physical stream and riparian function and habitat on an appropriate level (to generate the necessary mitigation credits) versus a chemical treatment of waterways historic legacy anthropogenic impairments that can be fixed and create sufficient water quality credits while also allowing the waterway to meet its intended designated use – which may include public recreation.

The take-home point is to use the existing tools or variations the agencies are comfortable with and make the case for a change in mitigation policy with regard to highway impacts. The change will benefit not only the aquatic resource, but also society's derived benefit from the resource – fitting within the WVDOH mission statement. The rationale is that chemical mitigation options can be protected into perpetuity if the WVDOH sets up an IRT-approved Endowment Fund (HEEF) to build and fund operations and maintenance of these facilities.

3. Getting local agencies educated about the IEF approach so that they understand it and see the potential benefits – how can we tackle this challenge?

The experience of the WVU-led research team is that the local agencies can immediately see the benefits that can potentially be derived from the watershed approach, but there is more that goes into incorporating such a program. There must be some incentive built in to initiate this change, and something to differentiate it from the other new 'policies' that are handed from the top-down. If state departments of environmental protection or natural resources can start to see how the mitigation can be used in their districts, and have a role in doing so, the buy-in will begin. For example, if WVDOH did restore 32 miles of impaired waterways (Upper Pigeon Creek Watershed Restoration Plan 2008) based on WVDEP watershed-based plan estimates while generating mitigation credit; there will suddenly be more interest for WVDEP and WVDNR to manage a better resource. This includes maintaining access, creel limits, and monitoring water quality, etc. It will also garner local buy-in by investing in the region's water and by default the local public.

4. How do we address the need for better data in a climate when the agencies seem unwilling to invest in data development?

In the team's opinion, state data development and storage should be handled and updated by impartial, third-party state resources (e.g., WV GIS Tech Center). This way all information is maintained, current, and available to all state agencies with metadata and consistent quality. Data are always being developed in academic institutions, so it was an easy choice to house such an office at WVU where they have sufficient IT resources to maintain such a system. Agencies do not necessarily have to 'invest' capital into data development, but they must buy into the clearinghouse approach.

5. What systems/tools do we think are rising to the 'top' in implementing an Eco-Logical approach?

The tools the WVU-led team brought into the Eco-Logical approach were regional adoptions and integration of existing and newly developed tools. The team used them in an Eco-Logical context, and attempted to frame the discussions and rationale for bringing these tools together under the auspices of Eco-Logical. Therefore, to the research team, Eco-Logical was important as a document giving mandate for all agencies to work together, and also the steps needed to calibrate and get everyone on the same page; but the tools will always need to be regionally-specific variations of general principles.

APPENDIX B
Mitigation Impacts

Table B.1. Debits Generated by 20,000 Feet of Stream Impacts Via Culverts from Highway Construction; Associated Credits Generated from 65,000 Feet of Physical Stream Bank Restoration Using the West Virginia Stream and Wetland Valuation Metric

USACE FILE NO./Project Name:	Reynolds Creek Development (SWVM V2.0 Example)			IMPACT COORDINATES: (in Decimal Degrees)	Lat.
STREAM CLASSIFICATION:	Intermittent		IMPACT STREAM/SITE ID AND SITE DESCRIPTION: (% stream slope, watershed size (acreage), unaltered or impairments)		
STREAM IMPACT LENGTH:	20000	FORM OF MITIGATION:	Permittee Responsible-Onsite	MIT COORDINATES: (in Decimal Degrees)	Lat.

Column No. 1- Impact Existing Condition (Debit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			750-999 - 30 points
750-999 - 30 points	0-90	0-1	800
pH			
6.0-8.0 = 80 points	0-80		7
DO			
<5.0 = 10 points	10-30		6
Sub-Total			0.7
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Good	0-100	0-1	70
Sub-Total			0.7

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.7	20000	14000

Column No. 2- Mitigation Existing Condition - Baseline (Credit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	10
2. Embeddedness	0-20		10
3. Velocity/ Depth Regime	0-20		10
4. Sediment Deposition	0-20		10
5. Channel Flow Status	0-20		10
6. Channel Alteration	0-20		10
7. Frequency of Riffles (or bends)	0-20		10
8. Bank Stability (LB & RB)	0-20		10
9. Vegetative Protection (LB & RB)	0-20		10
10. Riparian Vegetative Zone Width (LB & RB)	0-20		10
Total RBP Score	Marginal		100
Sub-Total			0.5
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
1000-1499 - 20 points	0-90	0-1	1200
pH			
6.0-8.0 = 80 points	5-90		7
DO			
<5.0 = 10 points	10-30		3
Sub-Total			0.55
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Fair	0-100	0-1	45
Sub-Total			0.35

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.466666667	65000	30333.333

Table B.1. Debits Generated by 20,000 Feet of Stream Impacts Via Culverts from Highway Construction; Associated Credits Generated from 65,000 Feet of Physical Stream Bank Restoration Using the West Virginia Stream and Wetland Valuation Metric (continued)

0	Lon.	0	WEATHER:		DATE:	February 7, 2012
Channel Slope 4%, 70 ac Watershed, Un-impaired Forestland			MITIGATION STREAM CLASS./SITE ID AND SITE DESCRIPTION: (% stream slope, watershed size (acreage), unaltered or impairments)		Watershed-based plan options	
	Lon.		PRECIPITATION PAST 48 HRS:		Mitigation Length:	65000

Column No. 3- Mitigation Projected at Five Years Post Completion (Credit)			
HGM Score (attach data forms):			Average
Hydrology			
Biogeochemical Cycling			0
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	12
2. Embeddedness	0-20		12
3. Velocity/ Depth Regime	0-20		12
4. Sediment Deposition	0-20		12
5. Channel Flow Status	0-20		12
6. Channel Alteration	0-20		12
7. Frequency of Riffles (or bends)	0-20		12
8. Bank Stability (LB & RB)	0-20		12
9. Vegetative Protection (LB & RB)	0-20		12
10. Riparian Vegetative Zone Width (LB & RB)	0-20		12
Total RBP Score	Suboptimal		120
Sub-Total			0.6
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
1000-1499 - 20 points	0-90	0-1	1200
pH			
6.0-8.0 = 80 points	5-90		7
DO			
<5.0 = 10 points	10-30		3
Sub-Total			0.55
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Fair	0-100	0-1	55
Sub-Total			0.45

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.533333333	65000	34666.667

Column No. 4- Mitigation Projected at Ten Years Post Completion (Credit)			
HGM Score (attach data forms):			Average
Hydrology			
Biogeochemical Cycling			0
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
1000-1499 - 20 points	0-90	0-1	1200
pH			
6.0-8.0 = 80 points	5-90		7
DO			
<5.0 = 10 points	10-30		3
Sub-Total			0.55
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Fair	0-100	0-1	55
Sub-Total			0.45

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.566666667	65000	36833.3333

Column No. 5- Mitigation Projected At Maturity (Credit)			
HGM Score (attach data forms):			Average
Hydrology			
Biogeochemical Cycling			0
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	16
2. Embeddedness	0-20		16
3. Velocity/ Depth Regime	0-20		16
4. Sediment Deposition	0-20		16
5. Channel Flow Status	0-20		16
6. Channel Alteration	0-20		16
7. Frequency of Riffles (or bends)	0-20		16
8. Bank Stability (LB & RB)	0-20		16
9. Vegetative Protection (LB & RB)	0-20		16
10. Riparian Vegetative Zone Width (LB & RB)	0-20		16
Total RBP Score	Suboptimal		160
Sub-Total			0.8
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
1000-1499 - 20 points	0-90	0-1	1200
pH			
6.0-8.0 = 80 points	5-90		7
DO			
<5.0 = 10 points	10-30		3
Sub-Total			0.55
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Fair	0-100	0-1	55
Sub-Total			0.45

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.6	65000	39000

Table B.2. Balance Sheet of Credits and Debits for 20,000 Feet of Stream Impact, 65,000 Feet of Physical Stream and Riparian Restoration, and the Alternative In-Lieu Fee Costs

PART III - Impact Factors
(See instruction page to insert default values for MITIGATION BANKING and ILF)

Temporal Loss-Construction

Note: Reflects duration of aquatic functional loss between the time of an impact (debit) and completion of compensatory mitigation (credit).

Years	0
Sub-Total	0

Temporal Loss-Maturity

Note: Period between completion of compensatory mitigation measures and the time required for maturity, as it relates to function (i.e. maturity of tree stratum to provide organic matter and detritus within riparian stream or wetland buffer corridor).

% Add. Mitigation	Temporal Loss-Maturity (Years)
10%	10
Sub-Total	0.07

Long-term Protection

% Add. Mitigation and Monitoring Period	Long-Term Protection (Years)
0 + 5/10 Year Monitoring	101
Sub-Total	0

PART IV - Index to Unit Score Conversion

Final Index Score (Debit)	Linear Feet	Unit Score (Debit)	ILF Costs (Offsetting Debit Units)
0.77	20000	15400	$12,320,000.00

PART V- Comparison of Unit Scores and Projected Balance

Final Unit Score (Debit) [No Net Loss Value]	15400	Mitigation Existing Condition - Baseline (Credit)	30333.33333	Mitigation Projected at Five Years Post Completion (Credit)	34666.66667	Mitigation Projected at Ten Years Post Completion (Credit)	36833.33333	Mitigation Projected At Maturity (Credit)	39000
FINAL PROJECTED NET BALANCE					4333.333333		6500		8666.666667

Part VI - Mitigation Considerations (Incentives)

Extent of Stream Restoration

*Note1: Reference the instructional handout to determine the correct Restoration Levels (below) for your project
*Note2: Place an "X" in the appropriate category (only select one).

Level I Restoration	
Level II Restoration	
Level III Restoration	x

Extended Upland Buffer Zone

*Note[1]: Reference instructional handout for the definitions of the Buffer Zone Mitigation Extents and Types (below)
*Note[2]: Enter the buffer width for each channel side (Left Bank and Right Bank)
*Note[3]: Select the appropriate mitigation type

Buffer Width	Left Bank	
	0-50	Preservation and Supplemental Planting
150	51-150	Preservation and Supplemental Planting
Buffer Width	**Right Bank**	
	0-50	Preservation and Supplemental Planting
150	51-150	Preservation and Supplemental Planting
Average Buffer Width/Side	150	

Site	Impact Unit Yield (Debit)	Mitigation Unit Yield (Credit)
Reynolds Crk Stream 1 - Segment A	15400	15600

Table B.3. Debits Generated by 20,000 Feet of Stream Impacts Via Culverts from Highway Construction; Associated Credits Generated from 80,000 Feet of Chemical Water Quality Restoration Using the West Virginia Stream and Wetland Valuation Metric

USACE FILE NO./Project Name:	Reynolds Creek Development (SWVM V2.0 Example)			IMPACT COORDINATES: (in Decimal Degrees)	Lat.
STREAM CLASSIFICATION:	Intermittent		IMPACT STREAM/SITE ID AND SITE DESCRIPTION: (% stream slope, watershed size (acreage), unaltered or impairments)		
STREAM IMPACT LENGTH:	20000	FORM OF MITIGATION:	Permittee Responsible-Onsite	MIT COORDINATES: (in Decimal Degrees)	Lat.

Column No. 1- Impact Existing Condition (Debit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity		0-1	750-999 - 30 points
750-999 - 30 points	0-90		800
pH			
6.0-8.0 = 80 points	0-80		7
DO			
<5.0 = 10 points	10-30		6
Sub-Total			0.7
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Good	0-100	0-1	70
Sub-Total			0.7

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.7	20000	14000

Column No. 2- Mitigation Existing Condition - Baseline (Credit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity		0-1	
1000-1499 - 20 points	0-90		1200
pH			
6.0-8.0 = 80 points	5-90		7
DO			
<5.0 = 10 points	10-30		3
Sub-Total			0.55
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Fair	0-100	0-1	45
Sub-Total			0.35

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.533333333	80000	42666.667

Table B.3. Debits Generated by 20,000 Feet of Stream Impacts Via Culverts from Highway Construction; Associated Credits Generated from 80,000 Feet of Chemical Water Quality Restoration Using the West Virginia Stream and Wetland Valuation Metric (continued)

0	Lon.	0	WEATHER:		DATE:	February 7, 2012
Channel Slope 4%, 70 ac Watershed, Un-impaired Forestland			MITIGATION STREAM CLASS./SITE ID AND SITE DESCRIPTION: (% stream slope, watershed size (acreage), unaltered or impairments)		Watershed-based plan options	
	Lon.		PRECIPITATION PAST 48 HRS:		Mitigation Length:	80000

Column No. 3- Mitigation Projected at Five Years Post Completion (Credit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
600-749 - 40 points	0-90	0-1	700
pH			
6.0-8.0 = 80 points	5-90		7
DO			
>5.0 = 30 points	10-30		6
Sub-Total			0.65
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Good	0-100	0-1	70
Sub-Total			0.7

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.683333333	80000	54666.667

Column No. 4- Mitigation Projected at Ten Years Post Completion (Credit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
600-749 - 40 points	0-90	0-1	700
pH			
6.0-8.0 = 80 points	5-90		7
DO			
>5.0 = 30 points	10-30		6
Sub-Total			0.75
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Good	0-100	0-1	70
Sub-Total			0.7

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.716666667	80000	57333.3333

Column No. 5- Mitigation Projected At Maturity (Credit)			
HGM Score (attach data forms):			Average
Hydrology			0
Biogeochemical Cycling			
Habitat			
PART I - Physical, Chemical and Biological Indicators			
	Points Scale	Range	Site Score
PHYSICAL INDICATOR (Applies to all streams classifications)			
USEPA RBP (High Gradient Data Sheet)			
1. Epifaunal Substrate/Available Cover	0-20	0-1	14
2. Embeddedness	0-20		14
3. Velocity/ Depth Regime	0-20		14
4. Sediment Deposition	0-20		14
5. Channel Flow Status	0-20		14
6. Channel Alteration	0-20		14
7. Frequency of Riffles (or bends)	0-20		14
8. Bank Stability (LB & RB)	0-20		14
9. Vegetative Protection (LB & RB)	0-20		14
10. Riparian Vegetative Zone Width (LB & RB)	0-20		14
Total RBP Score	Suboptimal		140
Sub-Total			0.7
CHEMICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WVDEP Water Quality Indicators (General)			
Specific Conductivity			
600-749 - 40 points	0-90	0-1	700
pH			
6.0-8.0 = 80 points	5-90		7
DO			
>5.0 = 30 points	10-30		6
Sub-Total			0.75
BIOLOGICAL INDICATOR (Applies to Intermittent and Perennial Streams)			
WV Stream Condition Index (WVSCI)			
Good	0-100	0-1	70
Sub-Total			0.7

PART II - Index and Unit Score		
Index	Linear Feet	Unit Score
0.716666667	80000	57333.333

Table B.4. Balance Sheet of Credits and Debits for 20,000 Feet of Stream Impact, 80,000 Feet of Water Quality Restoration, and the Alternative In-Lieu Fee Costs

PART III - Impact Factors
(See instruction page to insert default values for MITIGATION BANKING and ILF)

Temporal Loss-Construction	
*Note: Reflects duration of aquatic functional loss between the time of an impact (debit) and completion of compensatory mitigation (credit).	
Years	0
Sub-Total	0

Temporal Loss-Maturity	
*Note: Period between completion of compensatory mitigation measures and the time required for maturity, as it relates to function (i.e. maturity of tree stratum to provide organic matter and detritus within riparian stream or wetland buffer corridor).	
% Add. Mitigation	Temporal Loss-Maturity (Years)
0%	0
Sub-Total	0

Long-term Protection	
% Add. Mitigation and Monitoring Period	Long-Term Protection (Years)
0 + 5/10 Year Monitoring	101
Sub-Total	0

PART IV - Index to Unit Score Conversion

Final Index Score (Debit)	Linear Feet	Unit Score (Debit)	ILF Costs (Offsetting Debit Units)
0.7	20000	14000	$11,200,000.00

PART V- Comparison of Unit Scores and Projected Balance

Final Unit Score (Debit) [No Net Loss Value]	14000	Mitigation Existing Condition - Baseline (Credit)	42666.66667	Mitigation Projected at Five Years Post Completion (Credit)	54666.66667	Mitigation Projected at Ten Years Post Completion (Credit)	57333.33333	Mitigation Projected At Maturity (Credit)	57333.33333
FINAL PROJECTED NET BALANCE					12000		14666.66667		14666.66667

Part VI - Mitigation Considerations (Incentives)

Extent of Stream Restoration	
*Note1: Reference the instructional handout to determine the correct Restoration Levels (below) for your project *Note2: Place an "X" in the appropriate category (only select one).	
Level I Restoration	
Level II Restoration	
Level III Restoration	

Extended Upland Buffer Zone		
*Note[1]: Reference instructional handout for the definitions of the Buffer Zone Mitigation Extents and Types (below) *Note[2]: Enter the buffer width for each channel side (Left Bank and Right Bank) *Note[3]: Select the appropriate mitigation type		
Buffer Width	Left Bank	
0	0-50	Preservation and Supplemental Planting
	51-150	Preservation and Supplemental Planting
Buffer Width	Right Bank	
0	0-50	Preservation and Supplemental Planting
	51-150	Preservation and Supplemental Planting
Average Buffer Width/Side	0	

Site	Impact Unit Yield (Debit)	Mitigation Unit Yield (Credit)
Reynolds Crk Stream 1 - Segment A	14000	14666.66667