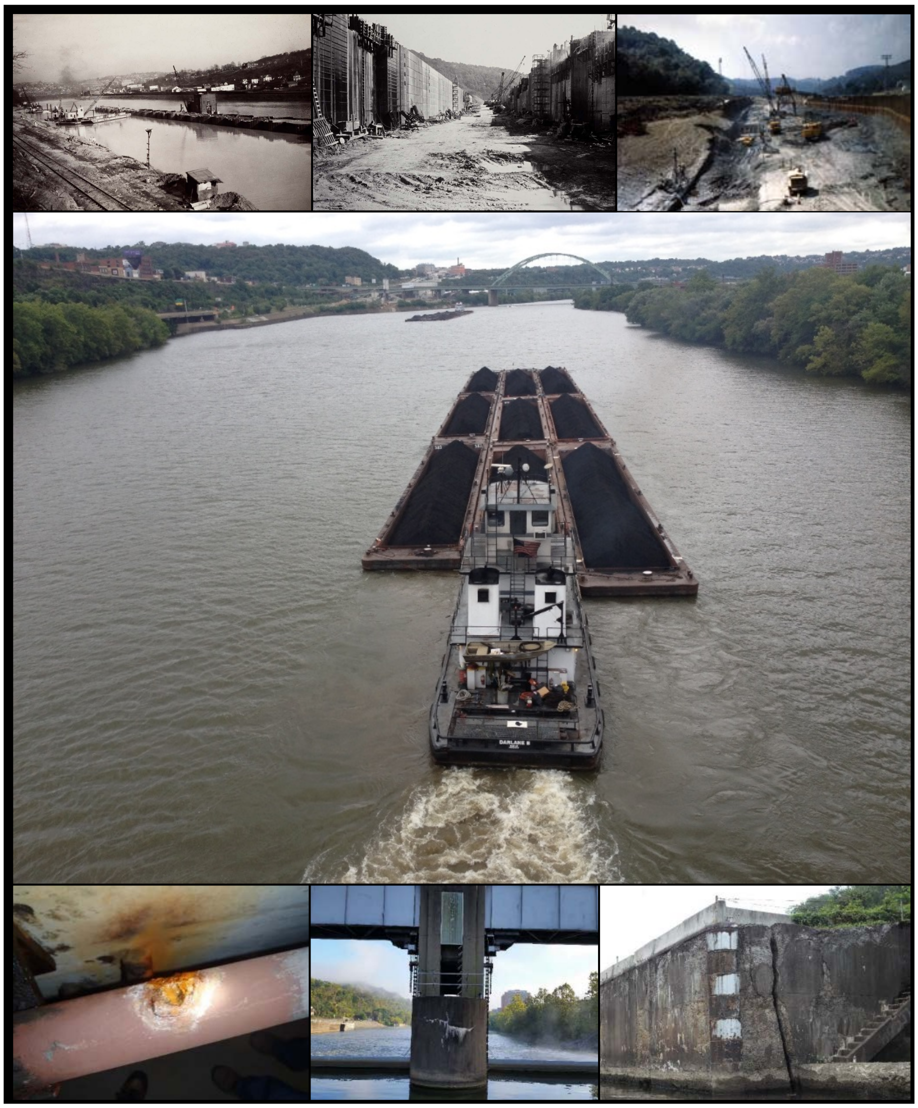
MAY 2018

UPPER MONONGAHELA RIVER STUDY
MORGANTOWN, HILDEBRAND, OPEKISKA LOCKS AND DAMS
MONONGAHELA RIVER, WEST VIRGINIA

Completed Under Section 216 of the River and Harbors Act of 1970 (Public Law 91-611)
Disposition of Completed Works



EXECUTIVE SUMMARY

The Upper Monongahela River Study analyzes potential actions available to the U.S. Army Corps of Engineers (Corps), regarding its ownership and management of the Monongahela River Morgantown, Hildebrand and Opekiska Locks and Dams in response to downward trends in commercial navigation at the projects over the last 20 years. This study considers whether sufficient federal interest exists to maintain these projects for their sole authorized purpose of commercial navigation, and to evaluate alternatives in response to changed conditions. Alternatives considered include multiple operations and maintenance funding levels, transfer, mothball, abandonment or removal of the projects. Study analysis is based on an evaluation and comparison of the benefits, costs, risks and impacts of continued operation, maintenance, repair, replacement, and rehabilitation.

The report developed is consistent with the Corps Planning Guidance Notebook and 2016 Disposition Study Implementation guidance, and provides findings, but it does not recommend any action. The vertical team, including the project delivery team, determined that the Study should be finalized as a "negative report." A negative report does not mean that the alternatives considered in this Study are not suitable for future implementation. The Study provides detailed, usable information that inventories current conditions, identifies potential alternatives, compares costs, and discusses potential environmental and socioeconomic impacts, commensurate with the Study's budget and scale. Its findings may be used as a basis for further consideration and refinement of alternatives under a full feasibility study, or other authority that can fully study impacts and identify appropriate mitigation in conjunction with a selected alternative/recommendation of federal action at any, or all of the projects.

Key findings in this study include:

- At current operations and maintenance funding levels none of the projects included in this study currently produce a net economic benefit.
- At current levels of commercial traffic, there is a Federal Interest to consider disposal alternatives.
- There are currently no suitable transfer partners for any of the projects.
- No Action or continued operations at any funding level considered in the study, without significant reinvestment, will most likely result in project failure prior to the end of the 50 year study period. Critical maintenance backlog is increasing at all projects and systems are rated as failed or failing for one or more component systems at each project.
- The maintenance backlog at each project is significant and increasing. Every project rated as failed or failing for one or more component systems.

- Alternatives that will significantly impact the ecosystem cannot be recommended at this time, under this authority. Future investigations into environmental impacts and mitigation strategies would be required.

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1 STUDY PURPOSE AND SCOPE

1.1 Scope

This Disposition Study analyzes potential changes to the Morgantown, Hildebrand and Opekiska Locks and Dams (L/Ds) on the upper Monongahela River managed by the US Army Corps of Engineers (Corps). This study was initiated in response to downward trends in commercial navigation at the included projects over the last 20 years. The purpose of this Study is to explore whether sufficient federal interest exists to retain these projects for their authorized purpose of commercial navigation, or whether a change to current levels of Operations and Maintenance (O&M) funding is appropriate. The study will also explore options including deauthorizing and disposing of real property and Government-owned improvements such as abandonment, transfer to a non-federal partner, or project removal. Study analysis is based on an evaluation and comparison of the benefits, costs, risks and impacts of continued operation, maintenance, repair, replacement, and rehabilitation.

1.2 Authority

Section 216 of the Flood Control Act of 1970 (Public Law 91-611) authorizes the Secretary of the Army to review operations of completed projects, when found advisable due to changed physical, economic, or environmental conditions.

> "The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to the significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

Disposition studies are a specific type of 216 study. These studies are conducted using only federal funds; there is no non-federal sponsor.

1.3 Study Area Defined

The study area includes the entire Monongahela River Navigation System, 130 miles of navigable channel from Fairmont, West Virginia, to Pittsburgh, Pennsylvania. The study area also includes the surrounding region impacted by river-dependent transportation, industry, and population centers that derive benefit from the Monongahela River (Figure 1). Within the context of the entire Monongahela River Navigation System, the planning study alternatives are limited to address Morgantown, Hildebrand, and Opekiska L/Ds, all situated in Monongalia

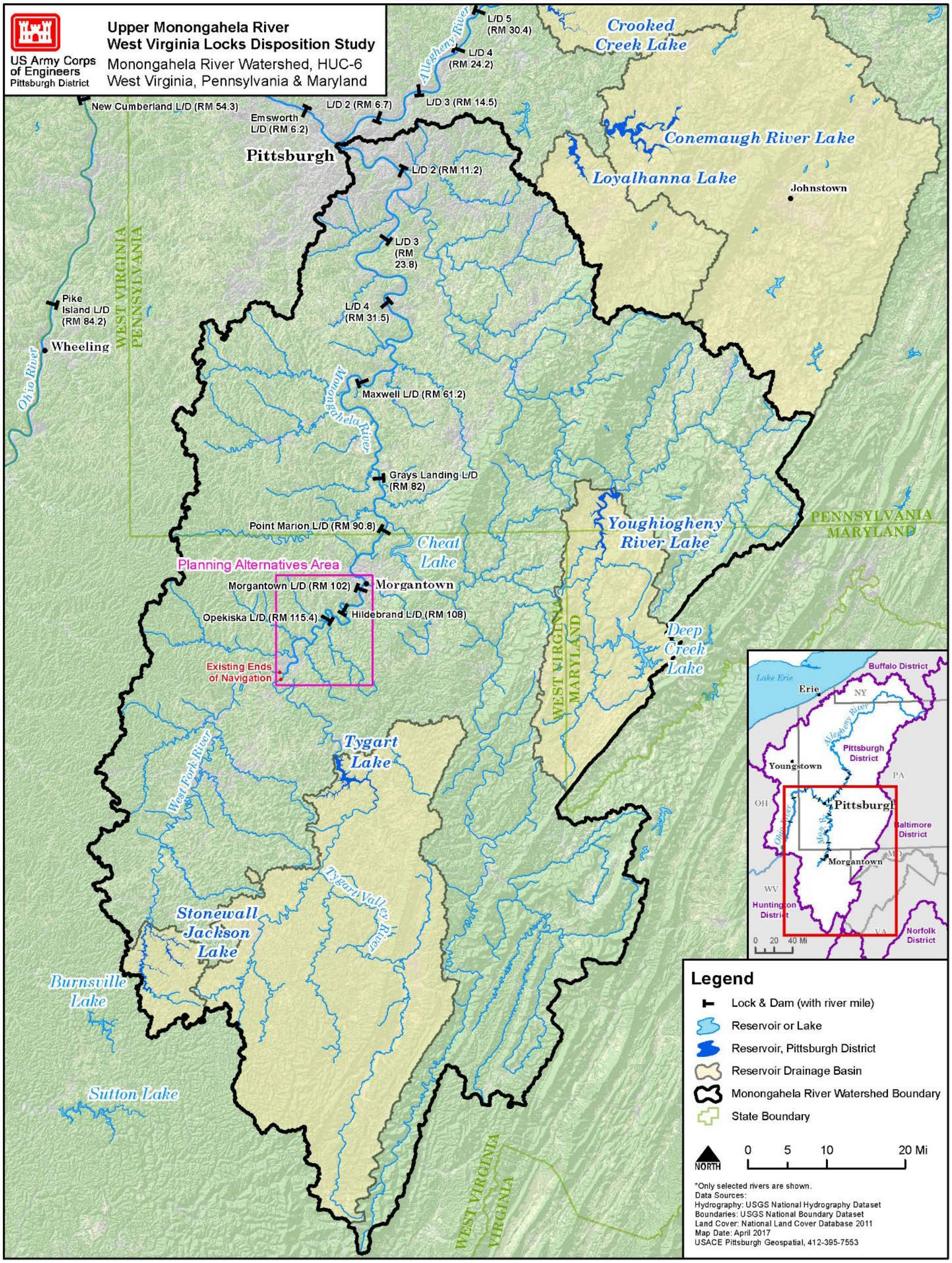


Figure 1. Monongahela River watershed map.

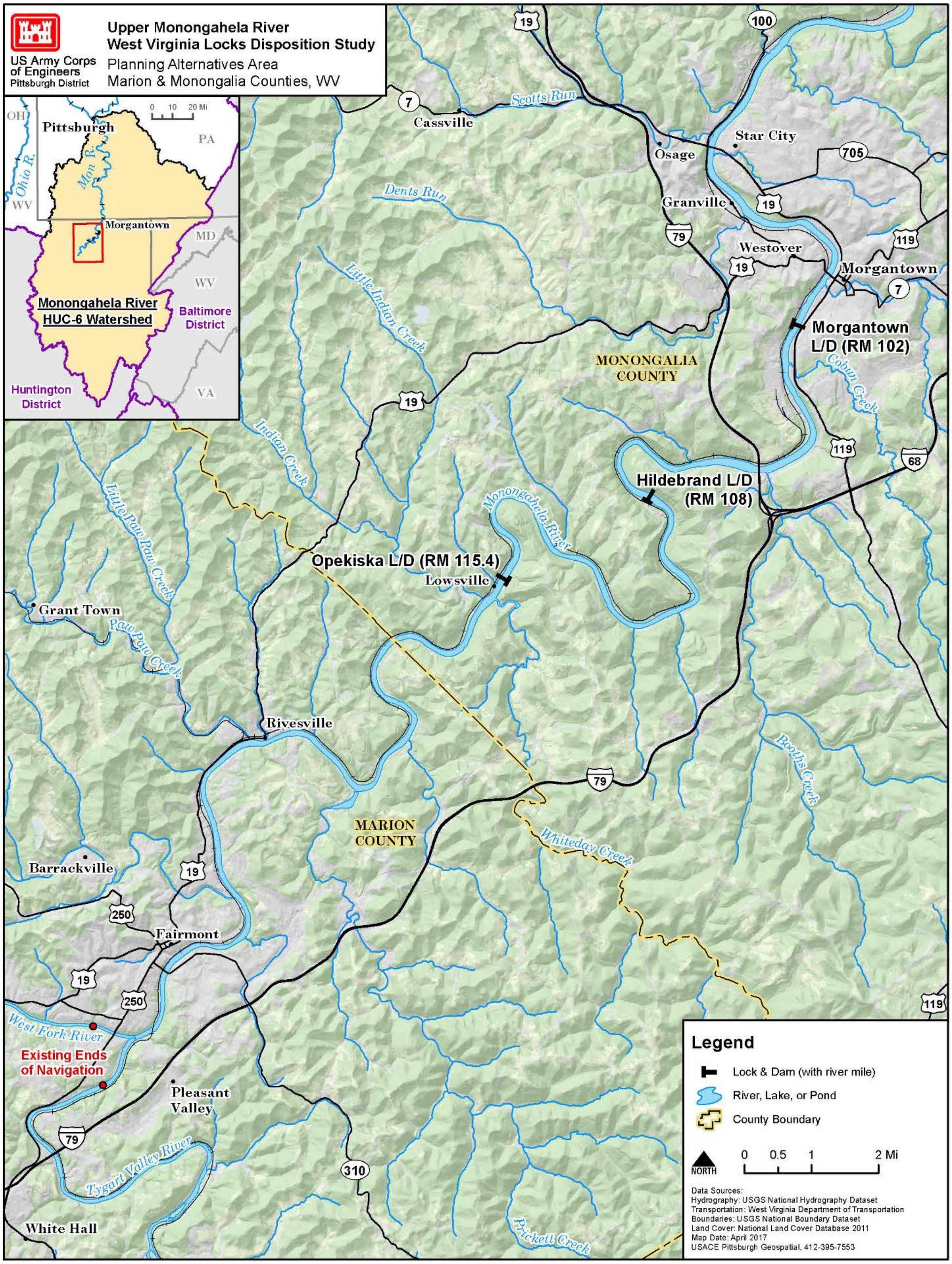


Figure 2. Planning alternative study area map.

County, West Virginia (Figure 2). The Opekiska Pool extends upriver into Marion County where the Tygart and West Fork rivers join at Fairmont to create the Monongahela River.

2 PROJECT AUTHORIZATION AND HISTORY

2.1 Authorization

In the late 1700's and early 1800's, the Monongahela River was navigable by steamboats only during high stages of the river and for a distance of about 56 miles upstream from Pittsburgh to Brownsville, Pennsylvania. In 1828, a survey of the River was made by an engineer employed by the Commonwealth of Pennsylvania that recommended a series of locks and dams be constructed on the Monongahela River, ranging in height from 7 to 12 feet. A second survey was authorized by Congress in 1832 with the goal to improve steamboat navigation on the Monongahela River from Pittsburgh to Brownsville, Pennsylvania. When no federal funding for improvements followed, the Commonwealth of Pennsylvania chartered a private corporation, the Monongahela Navigation Company, to construct a system of locks and dams from Pittsburgh to the West Virginia/Pennsylvania state line. They completed seven facilities from 1841 to 1883. The next federal activity did not occur until the funding of surveys of the West Virginia portion of the river in 1871 and 1875, and the authorization of L/Ds 8 and 9 in the Rivers and Harbors Act of 1872. Congress later directed the Corps to acquire the Monongahela Navigation Company system, which was realized in 1897, placing the entire system under Corps control.

Extension of navigation to the Monongahela headwaters at Fairmont, WV, was authorized in the Rivers and Harbors Acts of 1892, 1894, and 1896. L/Ds 10 – 15 were completed in 1903 from river mile (RM) 101.5 to 124.2. In 1948, citing the authority of the River and Harbor Act of 1909 (PL 60-317), the Secretary of the Army approved replacement of L/Ds 10 and 11. The River and Harbor Act of 1950 (PL 81-516), authorized the replacement of L/Ds 12 – 15, the modification of Dam 8 and increasing the navigation channel depth upstream of Dam 8 to nine feet.

Morgantown, Hildebrand, and Opekiska L/Ds, were completed from 1950 to 1964 and they replaced the six original L/Ds. 10 – 15. The construction of Morgantown L/D was authorized by the Secretary of the Army in 1948 under the 1909 Rivers and Harbors Act (PL 60-317). Hildebrand L/D and Opekiska L/D were both authorized by Congress in the River and Harbors Act of 1950 (PL 81-516). The sole authorized purpose of the navigation system was and remains commercial navigation.

The Corps' latest modernization project, the congressionally authorized (WRDA 1992) "Lower Mon Project," will modernize the Braddock and Charleroi facilities and remove L/D 3.

2.2 System Projects

Additional improvements on the middle Monongahela River resulted in the present Monongahela River Navigation System consisting of nine L/D facilities (Figure 3) that maintain a minimum 9-foot navigable depth the entire 130 miles of the river. Of the nine facilities on the Monongahela River, this Disposition study focuses on alternative development for the upper reaches of the river to include the Morgantown, Hildebrand, and Opekiska L/Ds.

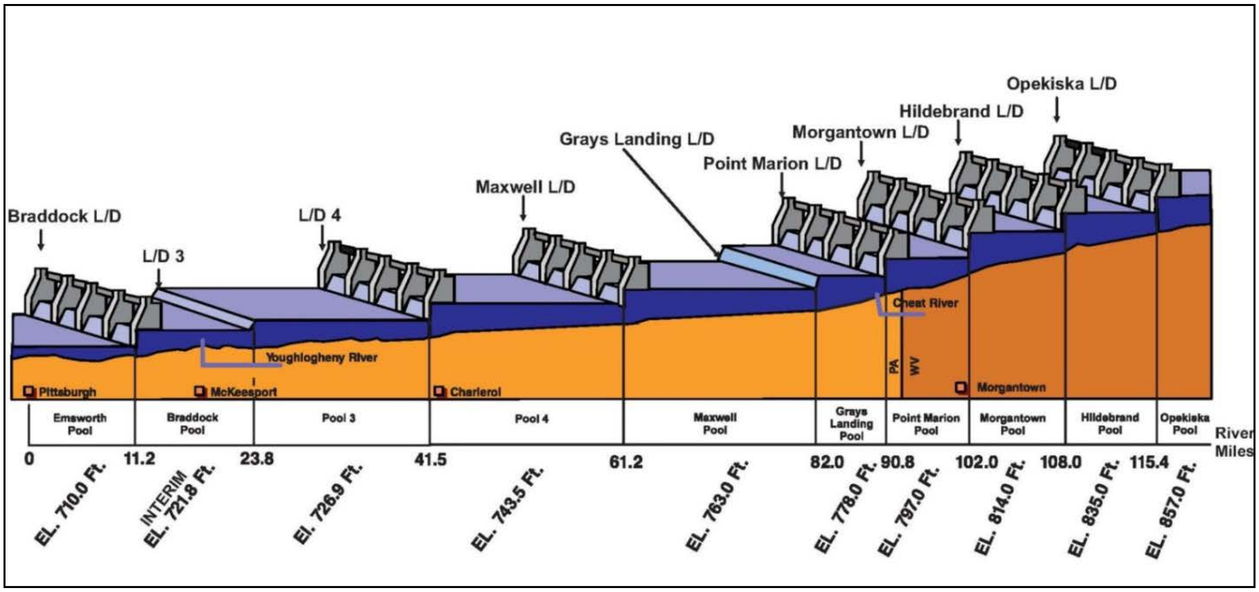


Figure 3. Monongahela River Navigation System Profile.

The Inland Marine Transportation System (IMTS) guidelines are used to determine the appropriate level of service (LoS) for the inland navigation system based on usage. This system ensures that the Corps evaluates fiscal responsibilities and provides opportunities to prioritize operational funding and resourcing from low usage locks to high usage locks where critical maintenance can be addressed and corrected to help maintain the facility and reduce lock outages. IMTS guidelines consist of six LoS based on the average amount of commercial and recreational lockages at each facility(Table 1).

Table 1. IMTS guidelines for LoS.

Level #	Title	Guideline for Range of Lock Operation Data
1	Full Service 24/7/365	More than 1,000 commercial lockages per year.
2	Reduced Service- Two Shifts Per Day	Between 500 to 1,000 commercial lockages per year.
3	Limited Service – Single Shift	Less than 500 commercial lockages per year or greater than 1,000 recreational lockages per year.
4	Scheduled Service – Set times per day	Limited commercial and/or substantial recreational traffic, more consistent daytime pattern of lockage.
5	Weekends & Holidays	Little to no commercial lockages with significant recreational lockages (500 or more per year).
6	Service by Appointment	Limited commercial traffic with no consistent pattern of lockage.

2.2.1 Morgantown Lock and Dam

Morgantown L/D is located in Monongalia County, WV, at RM 102.0 near the City of Morgantown and is operated with a LoS of 3. Construction was completed in 1950. Morgantown L/D has a single 84 foot by 600 foot lock chamber situated along the river's left descending bank. The 410-foot wide gated dam has a lift of 17 feet and forms a pool approximately six miles long with a surface area of 365 acres.

Figure 4. Morgantown Lock and Dam.

2.2.2 Hildebrand Lock and Dam

Hildebrand L/D is located at RM 108.0 about six miles upstream of the City of Morgantown in Monongalia County, WV and is operated with a LoS of 6. Hildebrand L/D was completed in 1959 and consists of a single 84 foot by 600 foot lock chamber on the left descending bank and a 530-foot long gated dam with a total lift of 21 feet. The pool created by Hildebrand L/D extends approximately seven miles with a surface area of 405 acres.

Figure 5. Hildebrand Lock and Dam.

2.2.3 Opekiska Lock and Dam

Opekiska L/D is located in Monongalia County at RM 115.4, about seven miles northeast of the city of Fairmont, West Virginia and is operated with a LoS of 3. Opekiska L/D consists of an 84 foot by 600 foot lock chamber and a 366 foot long gated dam with a lift of 22 feet. The facility forms an 800-acre pool approximately 13 miles to the head of the Monongahela River, extending about one mile upstream on the headwater tributaries, the Tygart and West Fork rivers.

Figure 6. Opekiska Lock and Dam.

3 FEDERAL INTEREST IN DISPOSITION

3.1 Eligibility for Disposition

The Monongahela River Navigation System was authorized solely for the purpose of commercial navigation. Due to the decline in usage of the Morgantown, Hildebrand, and Opekiska L/Ds by commercial navigation vessels, down to 175 vessels total amongst all three locks in 2015, there is federal interest to consider deauthorization and disposal of these facilities. Federal investments in O&M of these commercial navigation facilities has declined in recent years. The current level of annual funding for Morgantown, Hildebrand, and Opekiska L/Ds, approximately $2,253,485, does not address all necessary O&M activities to ensure their long-term safety and viability of the projects. These annual costs exceed the estimated $1,743,000 in commercial navigation benefits, which is also trending down and expected to further decline in the future.

3.2 History of Performance (as compared to authorized purpose)

Industrial output along the Monongahela River has continued to decline since the mid-20th century. Resource extraction operations including lumber, coal, and oil in the upper portions of the river have declined, or transportation of materials is taking place overland rather than down the river. This study only looks at traffic through navigation facilities from 1993 to 2015 due to the accessibility of detailed records. This 23 year record is considered a suitable time period to show long-term trends in river traffic.

Over this period, commercial navigation traffic on the upper three Monongahela River L/Ds peaked in 1993 with 1,628 vessels total. Since then, there has been a significant reduction in traffic across the system (Figure 7, Appendix B). Specifically, there has been an 89% reduction in commercial traffic from 1993-2015. Commercial traffic above Morgantown is almost non-existent, and traffic through Morgantown has dropped significantly since 1993.

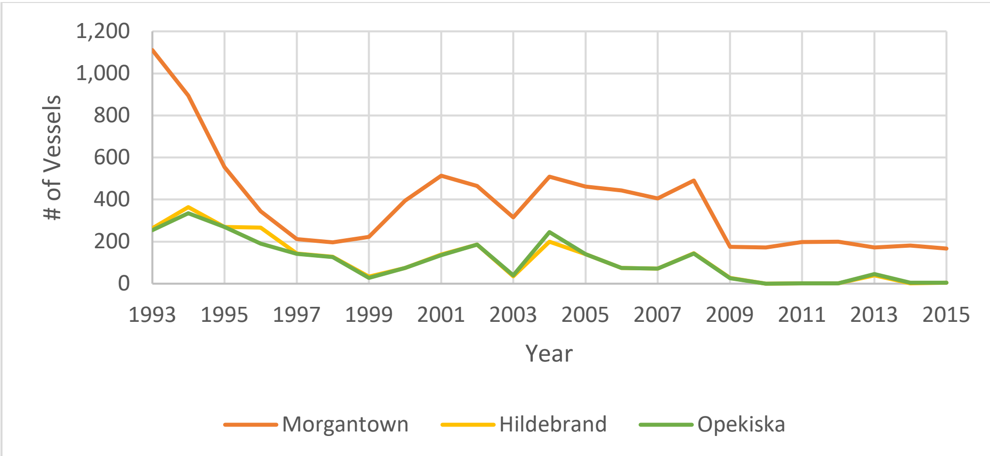


Figure 7. Upper Monongahela River Commercial Traffic 1993 – 2015.

Closure of coal mines in the upper reaches of the Monongahela River is primarily responsible for the steep reductions of commercial traffic at the Morgantown, Hildebrand, and Opekiska L/Ds in the late 1990's. Since 2009, the number of vessels locked has remained relatively static at all three projects, while tonnage continues to decline (Table 2).

Table 2. Tonnage of Commodities through Morgantown, Hildebrand, and Opekiska L/Ds.

Calendar Year	Morgantown	Hildebrand	Opekiska	
1993	1,589,000	494,000	487,000	
1994	1,264,000	571,000	548,000	
1995	630,000	357,000	370,000	
1996	362,000	312,000	259,000	
1997	292,000	256,000	242,000	
1998	247,000	177,000	179,000	
1999	384,000	27,000	28,000	
2000	601,500	72,100	66,400	
2001	830,400	292,700	289,700	
2002	923,600	442,000	441,800	
2003	491,000	47,000	57,000	
2004	1,011,000	408,000	446,000	
2005	884,700	282,400	286,000	
2006	881,000	241,000	241,000	

Calendar Year	Morgantown	Hildebrand	Opekiska	
2007	778,300	242,800	242,800	
2008	1,003,700	458,600	458,600	
2009	271,300	58,800	58,800	
2010	236,000	0	0	
2011	258,528	28	28	
2012	228,050	150	150	
2013	136,500	600	800	
2014	175,700	5,000	5,000	
2015	90,200	0	0	

The cost consequences to commercial navigation of complete project closure are shown in Table 3 and were estimated using data from 2011-2015. These are the additional costs to shippers for using alternative modes of transportation for cargo as calculated by the Shipper Carrier Cost (SCC) model, representing the economic value of commercial navigation benefits over this period of time.

Table 3. Estimated Average Annual Costs to Shipper with Loss of Commercial Navigation.

Facility	Economic Value
Morgantown	$1,541,000
Hildebrand	$10,000
Opekiska	$10,000

4 AFFECTED ENVIRONMENT

4.1 Socioeconomic Resources

4.1.1 Recreation

Water-based recreation activities on the Monongahela River include motorized and non-motorized pleasure-boating and fishing. In 2016, 1,077 recreational vessels utilized the upper three Monongahela River L/Ds. The amount of recreational traffic has fluctuated substantially from 1993 through 2015 (Figure 8, See Appendix B). From 2001 through 2004 there was steady decline; recreational traffic decreased by 63%. Then, from 2004 through 2010, recreational traffic increased by 231%. The lowest number of recreational users was in 2013. These low numbers correspond with the 2012 reduction in service levels to “Weekends and Holidays” for Morgantown and “By Appointment Only” for Hildebrand and Opekiska. In 2014, the Upper Monongahela River Association began voluntarily contributing funds to the Corps to ensure the locks were operated for recreational traffic on weekends, holidays, and other selected dates from April through October using authority from Section 1017 of the Water Resources Reform Development Act (WRRDA) of 2014. The approximate amount of funds contributed annually is

$40,000.   After the service level changes in 2012, traffic decresed by 62% at the three L/Ds. However, after the Upper Monongahela River Assocation volunteered funds in 2014, recreational traffic increased from 645 vessels (2014) to 1,258 vessels (2015).The current contributed funds agreement has been negotiated for a period of 5 years, though neither party has an obligation to maintain current levels of service or funding throughout the entire period.

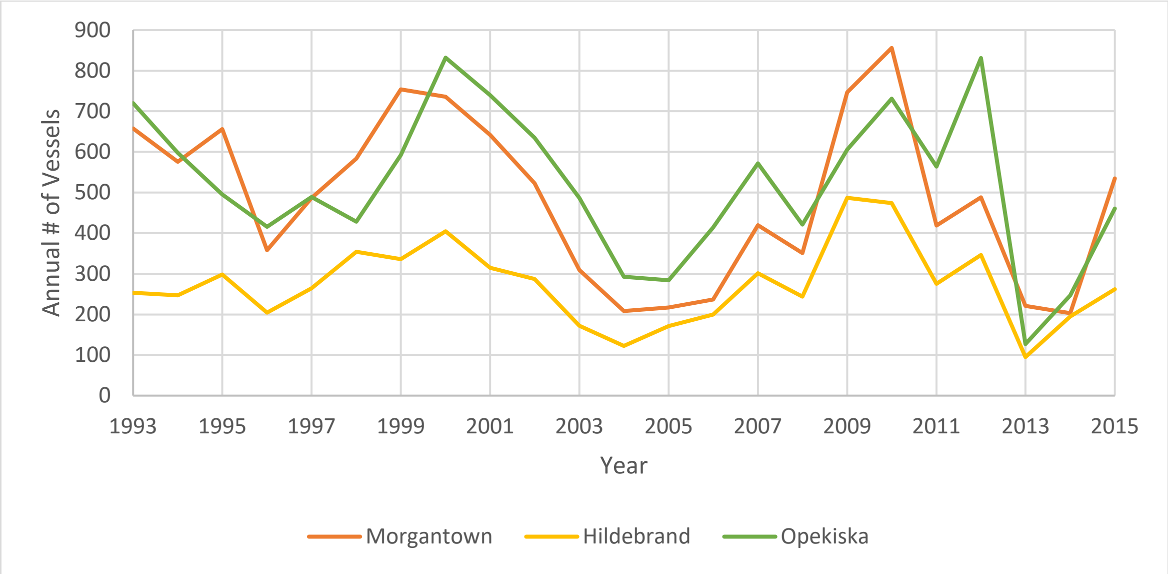


Figure 8. Upper Monongahela Recreational Traffic 1993 – 2015.

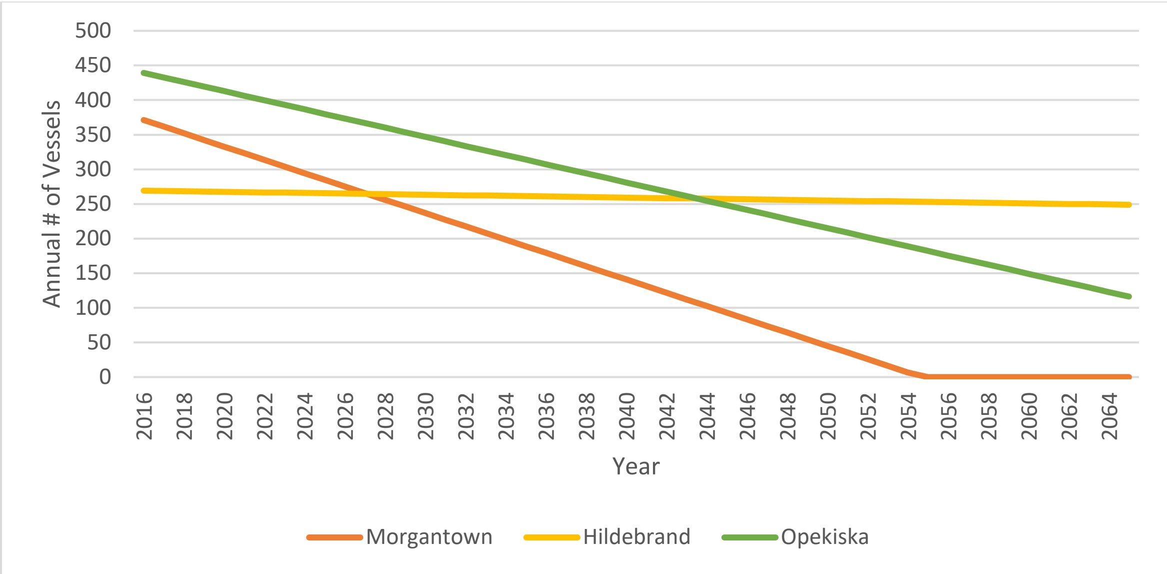


Figure 9. Upper Monongahela Forecasted Motorized Recreational Traffic 2016 – 2065.

Figure 9 is an approximated forecast of motorized recreation trends for the three L/Ds. The forecast is based on Lock Performance Monitoring System annual data from 1993 through 2015. The downward trend for each L/D is severe, but traffic will likely continue to decrease if the L/Ds are only open on holidays and weekends through a contributed funds agreement. The forecasts in Figure 9 show Morgantown reaching 0 annual vessels by 2054, Opekiska's recreational traffic continually decreasing through 2065, and Hildebrand's recreational traffic remaining fairly constant. Unlike the other two trend lines, Opekiska's trend line accurately represents the decrease in motorized recreational vehicles that would be expected. Morgantown L/D will likely have recreational traffic through the duration of the study period, which is not accurately represented in the forecasted trend; it is not expected that any of the three projects will reach 0 annual recreation vessels within the study period. Additionally, Hildebrand L/D is the least used of the three L/Ds, which indicates that its recreational traffic will likely decrease more rapidly than Opekiska and Morgantown. The trend lines presented above are based on the recreational data in Figure 8, which fluctuates significantly from 1993 through 2015. Hildebrand L/D has historically hovered around 250 annual vessels and that's represented through the trend line in Figure 9. These forecasts are based on the best available data, however, the trend lines do not perfectly represent expected future recreational usage of the L/Ds.

Boat registrations within the study area have been fairly stable with an overall positive trend over the last 14 years. Trends in boats registered with the West Virginia Department of Motor Vehicles from 2002-2015 show an overall increase in registrations of 21% over this period (see Appendix B).

4.1.2 Hydropower

There are no existing hydropower facilities on the Monongahela River navigation system. There are, however, applications with the Federal Energy Regulatory Commission (FERC) to develop hydropower at Morgantown and Opekiska L/Ds in West Virginia, and Point Marion, Grays Landing, Maxwell, Charleroi, and Braddock L/Ds in Pennsylvania.

4.1.3 Water Intakes

Although the L/Ds are authorized solely for commercial navigation, other benefits such as water supply, are provided to the public from the L/Ds.

Permits are issued for installation of water intakes within each pool. There are four water intakes within the pools of the upper three Monongahela L/Ds. Changes to the pool level would most likely impact placement of the existing water intakes, and could pose a threat to year round water supply. The value of water withdrawals are estimates based on Morgantown Utility Board (2017) residential rates for usage over 60,000 gallons per month. Water users are not charged for their usage. Table 4 below shows an approximate amount of water withdrawn and the value of said water based on 2015 data (newest currently available). Table 5 is an approximation of future forecasted withdrawals based on population trends for Monongalia County (based on 50 years of decennial census data) and the 2015 withdrawal data presented in Table 7. Commercial facilities are assumed to continue with the same level of withdrawals, as the only time this is likely to change is in the event of a closure, of which none are currently scheduled. The municipal withdrawals were increased to reflect the trend of increasing population within the county. Each year in ten-year increments reports an amount of water withdrawn for municipal intakes, a total amount of water withdrawn (municipal and commercial), and a total value for the water withdrawn based on the 2015 value of water.

Table 4. Value of Permitted Water Withdrawals

Pool	Facility	Facility Type	Total Water Withdrawal 2015 (gallons)	Value of Withdrawn Water ($3.69 per 1000 gallons)
Morgantown	Morgantown Utility Board	Public Water Supply	3,147,044,000	$11,612,592
Morgantown	OOG Facility	Oil and Gas	23,355,570	$86,182
Opekiska	Grant Town Power Plant	Thermoelectric (coal)	498,290,887	$1,838,693
Opekiska	Fibrek Recycling	Timber	1,119,609,505	$4,131,359
TOTAL			**4,788,299,962**	**$17,668,826**

Table 5. Future Forecasted Water Withdrawals

Year	Pop.	%±	Withdrawal (Municipal)	Withdrawal (Total)	Value
2020	97,026	0.9%	3,174,442,399	4,815,698,361	$17,769,927
2030	113,634	6.3%	3,101,701,418	4,742,957,380	$18,504,933
2040	120,355	5.9%	3,284,834,658	4,926,090,620	$19,239,940
2050	127,076	5.6%	3,467,967,898	5,109,223,860	$19,974,946
2060	133,797	5.3%	3,651,101,138	5,292,357,100	$20,709,953
2066	137,158	2.5%	3,742,667,758	5,383,923,720	$21,077,456
2070	140,518	5.0%	3,930,393,829	5,571,649,791	$21,830,896

4.1.4 Population Profile (Environmental Justice)

Executive Order 12898 instructs federal agencies to make achieving environmental justice part of their mission by identifying and addressing disproportionately high and adverse impacts to minority and low income populations. Low-income is defined as the number or percent of a census block group's population in households where the household income is less than or equal to twice the federal poverty level. Minority is defined as all but Non-Hispanic White Alone (EPA 2016b).

Populations protected by this order include minority populations, low-income populations, and indigenous peoples. The executive order also mentions "populations who principally rely on fish and/or wildlife for subsistence," a group that may overlap with other population groups of concern, but also has a unique exposure pathway (EPA 2016a). A 2008 fish consumption study (WVDEP 2008) in West Virginia showed that 43% of the population had eaten freshwater fish within the previous 12 months. The mean number of meals of freshwater fish eaten in the 30 days prior to the survey was 3.16 meals. Nearly half (46%) of the West Virginia residents who had eaten freshwater fish in the 12 months prior to the survey said they had also been freshwater fishing within the same time period.

Information on demographics was gathered through Environmental Protection Agency's (EPA's) EJSCREEN tool and through available census data (Table 6 and Figure 10). The minority population of Monongalia and Marion Counties is approximately 9 percent, which is high compared to the state population (73rd percentile) but is relatively low as compared to the EPA region and the country (32nd percentile and 22nd percentile, respectively). The low income population of the counties is 38 percent, which is about average in the state (45th percentile) but is high relative to the region and the country (70th percentile and 59th percentile, respectively). See Table 6 and Figure 10 for more information on population demographics.

Based on these demographic indicators, it appears that there is an elevated potential for protected populations to be disproportionately impacted by a loss of pool at these project.

Table 6. Demographic information for Monongalia and Marion Counties (EPA 2016b).

Demographic Indicators	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Demographic Index	24%	24%	58	30%	51	36%	39
Minority Population	9%	7%	73	31%	32	37%	22
Low Income Population	38%	40%	45	29%	70	35%	59
Linguistically Isolated Population	1%	0%	88	2%	57	5%	46
Population With Less Than High School Education	10%	16%	32	12%	52	14%	48
Population Under 5 years of age	5%	6%	49	6%	45	6%	41
Population over 64 years of age	13%	17%	29	15%	46	14%	53

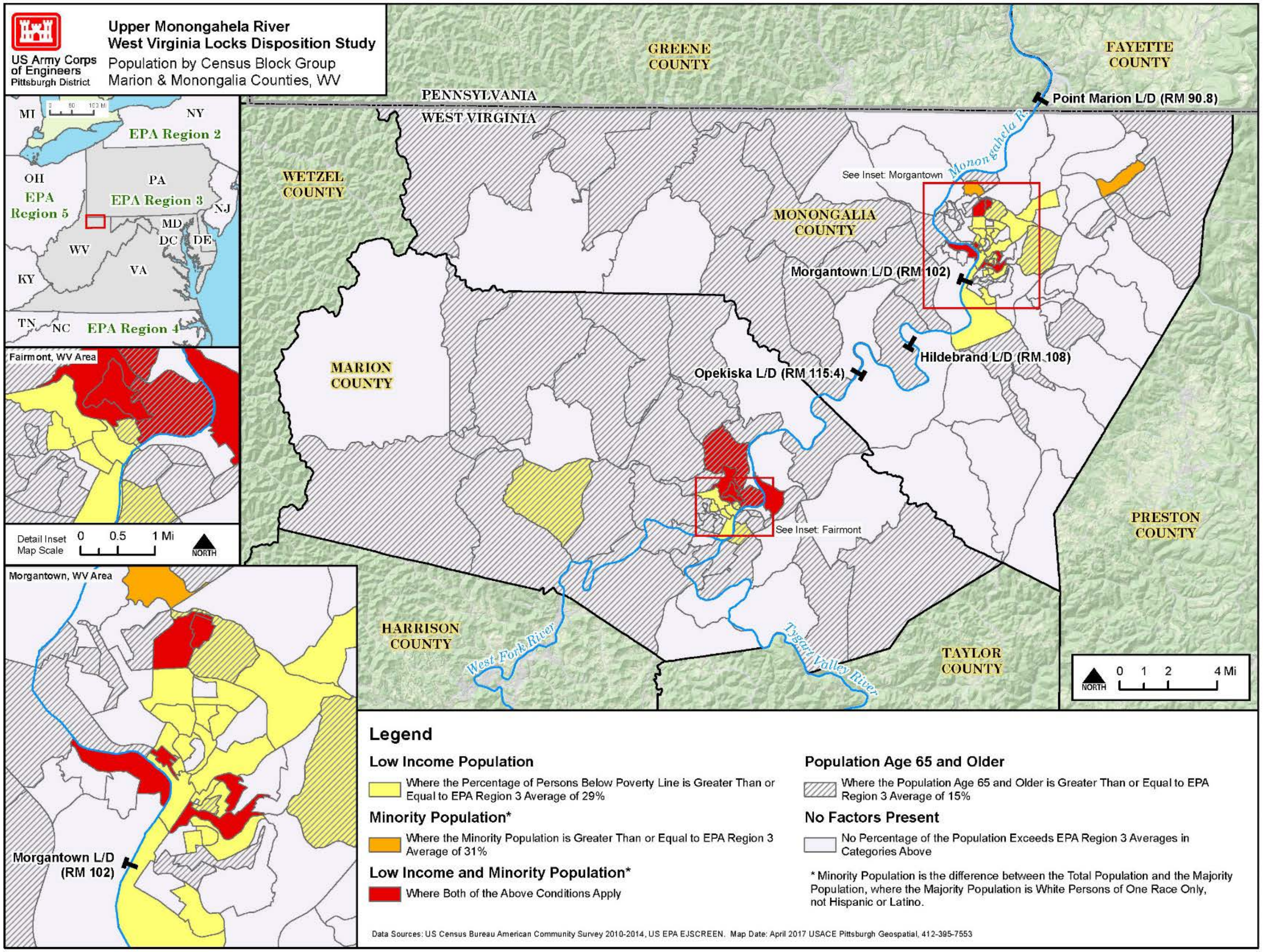


Figure 10. Population information for Monongalia and Marion Counties.

4.2 Environmental Resources

4.2.1 Geography

The Monongahela River forms at the junction of the Tygart Valley and West Fork rivers near Fairmont, West Virginia. The river then travels 130 miles north to its confluence with the Allegheny River in Pittsburgh, PA to form the Ohio River. The Monongahela River watershed has a total area of 7,386 square miles and lies mostly within the Appalachian Plateau physiographic province. The Monongahela River is part of a large riverine system that flows through a highly dissected plateau with deep eroded stream valleys. The land use is limited by rough terrain and nutrient-poor soil. Bituminous coal is mined extensively throughout the study area and as a result, acid mine drainage commonly affects streams throughout the watershed (USACE 2012).

The watershed exhibits a humid continental climate. The humid continental climate is marked by variable weather patterns and a large seasonal temperature variation. Precipitation is rather evenly distributed throughout the year, with an annual average of approximately 41 inches in the watershed (USACE 2012). February is typically the driest month with an average of about 2.6 inches in the basin. Highest monthly precipitations occur in July and August.

The nine L/D facilities along the river provide 9-foot navigable depth the entire 130 miles of the river. The navigation system converted the river from a free-flowing riverine environment to a stepped pool structure. Historically, the river displayed a pool and riffle morphology with a gentle meander pattern. At many locations the river was shallow enough to be waded at normal flows (USACE 2012). The current channel thalweg depths range anywhere from 15 feet immediately below the dams up to 35 feet immediately above the dams, but always maintain at least 9 feet for navigation purposes.

4.2.2 Vegetative Cover

4.2.2.1 *Forest Resources*

The Monongahela River lies in the Monongahela Transition Zone ecoregion. Historically, the vegetation surrounding the banks of the Monongahela River has been dominated by oak, beech, and hemlock forests. White oak-hickory is the typical upland forest in the region, while lowland forest communities include willow, beech, and maple (USACE 2012). Native vegetation is still predominant in areas of limited accessibility or rugged topographic relief that do not provide sites suitable for human development. Narrow bands of vegetation persist along the water's edge, even in the heavily developed industrial areas along the rivers.

The vegetation in the watershed has been affected by both industrialization and urbanization. Habitat fragmentation is a growing issue in the eastern U.S. due to the continued expansion of development. Fragmentation contributes to isolated populations of species and communities, and changes in habitat conditions. Some of the major contributors to this fragmentation are mining activities and the growing natural gas industry centered in the watershed. Within 0.5 miles of the river on both banks, the predominant landcover is forest (60%). About 5% of this one-mile corridor surrounding the river is crops or pasture lands and approximately 25% is developed (Figure 11).

4.2.2.2 *Wetland Communities*

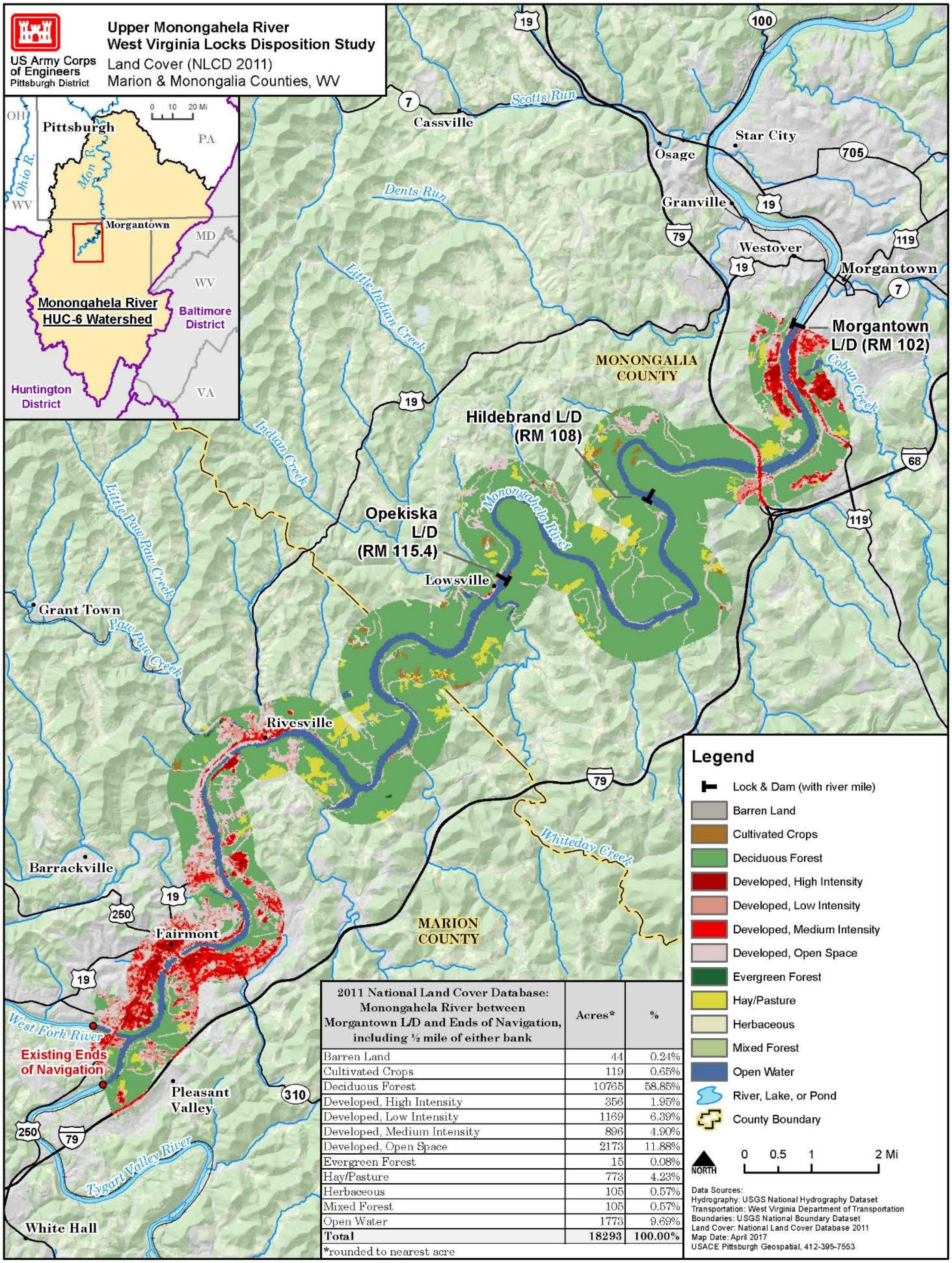
The steep topography and lack of glaciation has limited the formation of wetlands in West Virginia. Wetland communities occupy a small portion of the natural landscape of the state (less than 1%; USFWS 1996), but are of particular value because of the species they support and functions they perform. Wetlands provide valuable wildlife habitat, water quality improvement, flood damage reduction and erosion control functions. West Virginia's vegetated wetlands may be separated into three major types based on their dominant vegetation: (1) emergent wetlands characterized by grasses, sedges, and other nonwoody plants, (2) shrub wetlands dominated by low-to-medium height woody plants, and (3) forested wetlands which are dominated by taller trees (USFWS 1996). Monongalia County's wetlands are predominantly emergent wetlands (Tiner 1996). Approximately eight acres of wetland are directly associated with the Monongahela River within the project area (USFWS 2017a).

4.2.2.3 *Species of Special Concern*

Four plant species (shale barren rockcress [*Arabis serotine*], harperella [*Harperella nodosa*], northeastern bulrush [*Scirpus ancistrochaetus*], and Running Buffalo Clover [*Trifolium stoloniferum*]) found within West Virginia are federally-listed as endangered and two plants (small whorled pogonia [*Isotria medeoloides*] and Virginia spiraea [*Spiraea virginiana*]) are listed as threatened. Of these six species, none are known to occur in Monongalia or Marion Counties. In addition to the federal status, the West Virginia Natural Heritage Program (WVNHP) assigns state ranks to rare species. WVNHP has ranked 238 plant species in the state as critically imperiled and 146 species as imperiled (WVDNR 2017b, WVDNR 2017c).

4.2.2.4 *Invasive Species*

Invasive species are those that do not naturally occur in an area and are likely to cause harm to the environment. The number of non-native, invasive plant species in West Virginia is rising (WVDNR 2017a). Over 800 non-native plants can be found in the state, with 270 species considered invasive (WVDNR 2014). Several species have been identified by the state as being of greatest concern; these include kudzu, water shield, Crown vetch, Japanese knotweed, Japanese stiltgrass, and others (WVDNR 2017a).



2011 National Land Cover Database: Monongahela River between Morgantown L/D and Ends of Navigation, including ½ mile of either bank	Acres*	%
Barren Land	44	0.24%
Cultivated Crops	119	0.65%
Deciduous Forest	10765	58.85%
Developed, High Intensity	356	1.95%
Developed, Low Intensity	1169	6.39%
Developed, Medium Intensity	896	4.90%
Developed, Open Space	2173	11.88%
Evergreen Forest	15	0.08%
Hay/Pasture	773	4.23%
Herbaceous	105	0.57%
Mixed Forest	105	0.57%
Open Water	1773	9.69%
Total	**18293**	**100.00%**

*rounded to nearest acre

Figure 11. Landcover data for a one-mile corridor surrounding the river in the study area.

4.2.3 Fish and Wildlife

4.2.3.1 *Aquatic Species*

Historic mining operations and their negative effects on water quality have severely impacted the aquatic species on the Monongahela River. Portions of the river were largely devoid of fish as late as 1967. Conditions began to improve in the 1970's with the enactment of environmental laws and regulations. Gradual recovery of sport fisheries began with the improved water quality, followed by range expansion for native species as well. Lock chamber fish surveys have shown dramatic improvement. For example, at Maxwell L/D in East Millsboro, PA no fish were caught during the 1967 survey, and only a single bluegill was caught in 1968. In 2010, 26,690 individual fish were collected at Maxwell including 32 different species (Pennsylvania Fish and Boat Commission 2010). Fisheries on the river are still considered to be recovering as water quality continues to be degraded by coal mining and gas well development, as well as municipal (sewage and landfill operations) and non-point sources (agricultural, suburban, and urban run-off; Pennsylvania Fish and Boat Commission 2010).

Common fish species in the study area include sauger, walleye, smallmouth bass, bluegill, golden redhorse, silver redhorse, common carp, logperch, emerald shiner, gizzard shad, white bass, sand shiner, silver shiner, mimic shiner, and bluntnose minnow.

Although fish species began to reappear in the Monongahela River in the 1970's, mussel species have been slower to recover. Samples in 1971 found only 5 species of mussel, with 37 of the 45 sampling sites found to be devoid of mussels (Hart 2012). In 1982, surveys found 15 species in the headwaters (Hart 2012). Hart's 2008 surveys found seven species in the mainstem Monongahela River in Pennsylvania: pink heelsplitter, fat mucket, mapleleaf mussel, threeridge, giant floater, fragile papershell, and flutedshell. The macroinvertebrate community of the Monongahela River can be characterized as worm/midge/Asiatic clam dominated. Studies of the macroinvertebrate communities yield 139 taxa including hydra, roundworms, moss animals, flatworms, spiny-headed worms, leeches, aquatic worms, crustaceans, insects, snails, and clams.

A general fish consumption advisory exists for all waters in West Virginia for all fish except rainbow trout (WVDHHR 2017). The advisory recommends different rates of consumption for different fish, spanning one meal per week to one meal per month due to mercury and PCB contamination. There is no limit provided for rainbow trout. Fish consumption advisories also exist in Pennsylvania along the Monongahela River, from Point Marion L/D to the Ohio River (PFBC 2017). The advisory is specific to carp due to PCB contamination with a recommendation of no more than one meal per month.

4.2.3.2 *Terrestrial Species*

At least 250 species of birds, 47 species of mammals, and 51 species of amphibians and reptiles are present within the Monongahela River watershed (USACE 2012). The number of species and suitable habitats increases with distance from Pittsburgh.

4.2.3.3 *Species of Special Concern*

Seventeen Federally-listed animals occur in West Virginia. Of these, four species have ranges that are known to include Monongalia County. These include two mammals (the endangered

Indiana bat and the threatened Northern long-eared bat), one snail (the threatened flat-spired three-toothed snail), and one bird (the threatened red knot). No listed aquatic species occur in the project area. In addition to the federal status, the WVNHP assigns state ranks to rare species. WVNHP has ranked 425 species within the state as imperiled or critically imperiled, these include 13 amphibians, 33 birds, 53 fish, 18 mammals, 18 reptiles, 41 mussels, 53 snails, and 196 other invertebrates including crayfish, butterflies, millipedes, amphipods, spiders, etc. (WVDNR 2017b, WVDNR 2017c).

4.2.3.4 *Invasive Species*

Zebra mussels and rusty and virile crayfish have been documented in the Monongahela River (WVDNR 2014). Silver and bighead carp are not yet established in West Virginia and WVDNR is actively working to manage the spread of these species (WVDNR 2017b). Similarly, the snakehead fish is not known to be in West Virginia but their existence in nearby waterbodies is concerning (WVDNR 2014, WVDNR 2017c).

4.2.4 Water Quality

The Monongahela River has a watershed area of 7,386 square miles. The entire Monongahela River is navigable by barges, with depths maintained by nine navigation dams. The river is formed by the confluence of the West Fork and Tygart Valley Rivers (881 and 1,374 square mile watersheds, respectively). The major tributaries to the Monongahela River are the Youghiogheny River (1,764 square mile watershed) and the Cheat River (1,422 square miles), but these have no effect on the study area because their confluences are located below Morgantown L/D. The Monongahela River ends at its confluence with the Allegheny River in Pittsburgh, PA, where the two rivers merge to form the Ohio River.

Major influences on water quality within the Monongahela River Basin are:

1. Mineral extraction activities (oil and gas extraction and surface, underground, reclaimed, and abandoned coal mines),
2. Impoundments and maintenance of navigation channels,
3. Increased urban development, and
4. Reductions in industrial activity and coal production.

West Virginia has noted several water quality impairments in the study area, including iron, aluminum, manganese, metals, pH, metals, acidity, suspended solids, siltation, turbidity, nutrients, fecal coliform, pathogens, and PCBs and mercury (in fish tissue samples). Nutrient pollution from run-off and point sources, as well as shale gas impacts to water quality have increased within the Monongahela River Basin.

River flows within the study area are largely controlled by the operations of Tygart Lake, located on the Tygart Valley River, and Stonewall Jackson Lake, located on the West Fork River, upstream of the study area. Both reservoirs are authorized for flood control, water quality control, flow augmentation, fish and wildlife enhancement, and recreation. Stonewall Jackson Lake is also authorized for water supply storage. Currently the Corps contracts with the U.S. Geological Survey (USGS) to maintain real-time gaging stations measuring discharge and gage height. The following locations are monitored for discharge: Flaggy Meadows (03062235) between Opekiska and Hildebrand L/D, and Masontown (03072655) below Morgantown L/D. Annual median flows in the upper portion of the study area are approximately 2,100 cubic feet per second (cfs; based on a period of record of 3 years [10-01-2013 to 06-30-2017]) and 2,350 cfs (based on a period of record of 78 years [10-01-1938 to 06-30-2017]) in the lower portion of the study area (calculations based on a complete record of averaged daily discharge). Gage height is monitored above and below each of the L/Ds within the project site. The USGS location numbers are contained in Table 7.

The Corps monitors water quality conditions above and below each L/D within the study area (Table 7). These locations have been sampled annually since 1973 during the summer low-flow season. Monitoring includes whole water analysis for metals, nutrients, alkalinity, acidity, pH, salts, solids, hardness, color, turbidity, algae, chlorophyll, radioisotopes; occasional organic analyses; and field parameters such as: Secchi Disk depth, light transparency, water temperature, pH, dissolved oxygen, specific conductance, turbidity, chlorophyll, and blue-green algae.

Table 7. USGS station numbers for gage height measurements. Corps-LRP station numbers for water quality collection. Located above and below each lock in the study location.

	Upper Pool USGS Station ID	Upper Pool Corps Station ID	Lower Pool USGS Station ID	Lower Pool Coprs Station ID
Opekiska	03062224	OPW 1002	03062225	OPW 1201
Hildebrand	03062245	HDW 1002	03062250	HDW 1201
Morgantown	03062445	MGW 1002	03062450	MGW 1201

Some water quality parameters within the Monongahela River have improved during the past several decades. Corps data show a decreasing trend in acidity, sulfate, and metal concentrations from the period of 1973 to present. This decreasing trend is a result of reductions in acid mine drainage impacts which can be attributed to improved treatment of mining discharge, mitigation measures such as the release of dilution water from Corps reservoirs, improved mining techniques, and the demise of some of the large industries along the river. It is important to note that while there has been an overall reduction, the legacy of mining on the landscape from abandoned mines is still present. For example, within the Monongahela watershed, mined drainage basins have tripled the concentration of sulfate, manganese, and iron as compared to similarly situated unmined drainage basins.

In contrast, nutrient and thermal pollution within the Monongahela River have been increasing over the past several decades. Corps data show an increasing trend in nutrients (total nitrogen and total phosphorus) since 1973. Also, increases in water temperature above ambient conditions are prevalent and spatially distributed in areas throughout the entire river. The environmental demands of increasing urbanization through combined sewer overflows, municipal waste water effluent, industrial point source discharges, as well as non-point source run-off are driving these observed increasing nutrient trends. Water temperatures are elevated by wastewater, power plants, and other industrial discharges that discharge heated water directly into the river.

For the purposes of this study, we compared upper and lower pool water quality constituents to determine impacts caused by each individual L/D. Analytes were both averaged over the period of record and decadal scale. All metals and nutrients were log-transformed to improve normality and homoscedasticity. All other parameters were normally distributed and thus did not require transformation. ANOVA and Tukey-Kramer HSD statistical tests for all parameters were used to determine differences above and below each L/D.

Our analysis showed no statistically significant difference between upper and lower pools for any analyte with the exception of dissolved oxygen (DO) (mg/L) ($F_{5, 1001}=7.7034$, $P= <0.0001$), and pH (mV) ($F_{5, 923}=10.2379$, $P= <0.0001$). However, for pH the significant differences occurred between individual L/D rather than above and below a particular L/D. We attribute differences in pH to local tributary drainage influences and point source impacts, whose effects can be highly localized to an individual pool.

DO (mg/L) was higher below Hildebrand L/D, as compared to above the L/D. However, both the Opekiska and Morgantown L/D showed no significant difference in DO (Figure 12). In natural rivers, DO in the water comes from aeration at the water surface. This surface aeration is higher when turbulence is higher and depths are shallower. Within the study area turbulence has been decreased and depth increased by the navigation L/Ds. Due to this, the amount of surface aeration is low. As a result, the aeration of water as it spills over the dams is a critical source for DO replenishment within the Hildebrand L/D. In contrast, Opekiska and Morgantown L/D show no DO difference either above or below each L/D structure. The Opekiska Pool experiences severe DO deficits (Figure 13). This is due in part to thermal stratification, caused by colder water from the Tygart Valley River flowing under the warmer water of the West Fork River. The stratification is intensified by the thermal discharge from the Rivesville Power Plant, which discharges 6 miles upstream of the L/D. The gated Opekiska dam discharges from the lower, deoxygenated strata of Opekiska pool, without providing significant aeration below the L/D. This effect can be felt through the Hildebrand pool (Figure 13). The Morgantown L/D is located in the town of Morgantown, WV. Discharges from major point and nonpoint sources both above and below the L/D cause increased biochemical oxygen demand, organic and nitrogenous compounds that biodegrade rapidly, resulting in reduced DO concentrations on both sides of this L/D.

Figure 12. Dissolved Oxygen (mg/L) above and below Opekiska, Hildebrand and Morgantown L/D.

Letters above each boxplot are the results of ANOVA and Tukey-Kramer HSD analysis. Statistically significant difference is indicated by different letters. In turn the same letter indicates no difference with similar values.

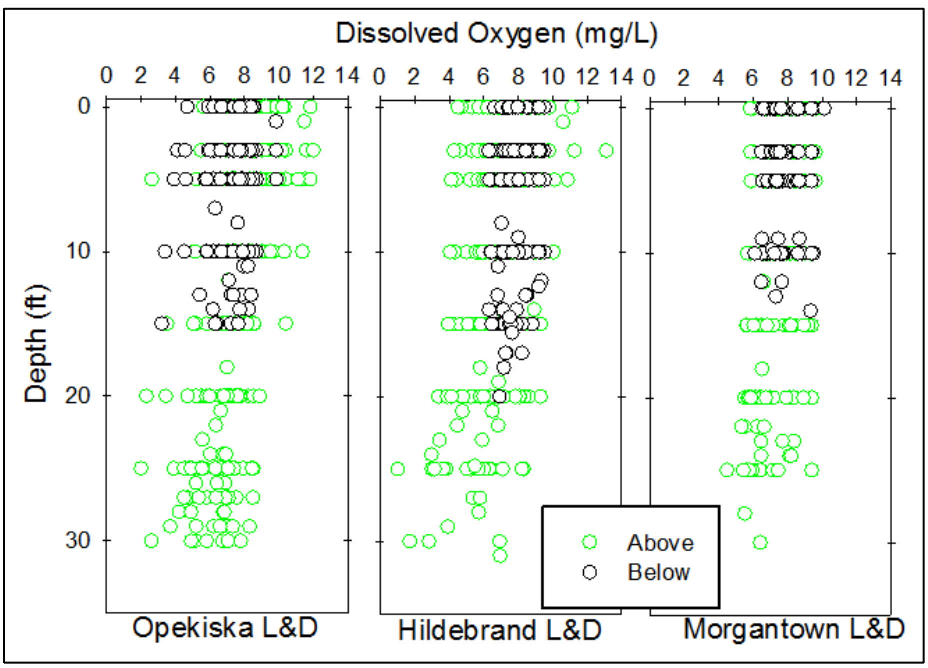


Figure 13. Dissolved Oxygen (mg/L) depth profiles above and below Opekiska, Hildebrand and Morgantown L/D. Opekiska and Hildebrand experience summer time low flow vertical stratification.

4.2.5 Air Quality/Greenhouse Gases/Climate Change

The Clean Air Act, as amended in 1990, requires the US Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. NAAQS have been set for six principal pollutants, known as criteria pollutants: nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone, lead, carbon monoxide (CO), particulate matter less than 2.5 microns in diameter (PM2.5), and particulate matter less than 10 microns in diameter (PM10).

The USEPA evaluates compliance with NAAQS. Attainment areas have concentrations of criteria pollutants below NAAQS, and non-attainment areas have concentrations above NAAQS. Maintenance areas are attainment areas that had a history of nonattainment but have since been reclassified as attainment. Both Monongalia and Marion counties are in attainment for all EPA regulated pollutants. The Air Quality Index for Monongalia County in 2016 (preliminary data; EPA 2017b) showed 21 days of moderate quality and 340 days as good quality.

Greenhouse gases (GHGs), as defined in Executive Order 13514 (Federal Leadership in Environmental, Energy, and Economic Performance), include carbon dioxide (CO2), methane, nitrous oxide (N2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. These gases trap heat in the lower atmosphere and are thought to contribute to global climate change. Each has a different global warming potential. To compare emissions, they are often converted to CO2-equivalents. For example, releasing 1 kg of methane is considered the equivalent of 25 kg of CO2, and 1 kg of nitrous oxide is equivalent to 298 kg of CO2 (Climate Change Connection 2017). In 2016, Council on Environmental Quality (CEQ) issued final guidance on inclusion of greenhouse gas emissions in NEPA documents, recommending that agencies quantify direct and indirect GHG emissions.

The Northeast has experienced a general temperature increase of almost 2°F and an increase of 5 inches of annual precipitation since 1895 (Melillo et al. 2014). With continued global emissions, projections show continued warming (3 to 10°F by the 2080s; Melillo et al. 2014). Precipitation changes are less certain, ranging from 5 to 20% increase in winter precipitation by the end of the century with only small summer and fall changes. Frequency of heavy downpours and the risk of seasonal drought are both also predicted to increase (Melillo et al. 2014).

4.2.6 Hazardous, Toxic, and Radioactive Waste Issues

Hazardous, Toxic and Radioactive Waste (HTRW) issues within the study area include the potential existence of contaminated sediment from historic hazardous material releases or spills and/or the potential introduction of existing hazardous materials that could impact sediment, soil, and air or water quality, if released.

In waterways with an industrial, agricultural or urban history, there is a potential for contaminants to be present in accumulated sediment (Bountry et al. 2009). The Monongahela River in West Virginia and Pennsylvania has historically included industries along its shoreline including mining and manufacturing facilities. Discharge or spill releases and runoff from these facilities may have potentially impacted sediment and water quality in the Monongahela River. In addition to industries along the waterfront, runoff from historical or current agricultural areas along the Monongahela River could also contribute to contamination of sediments, including introduction of pesticides (Evans, 2015).

With the enactment of several environmental regulations, conditions in the Monongahela River have steadily improved since the 1970s. However, many contaminants that may have been introduced decades ago can persist due to very slow or non-existent contaminant degradation in an aquatic environment (EPA 2005).

Previous sediment quality studies conducted within the study area indicate some potential level of contamination. Sediment samples collected in 2014 at Opekiska L/D indicate polycyclic aromatic hydrocarbons (PAH; specifically phenanthrene), iron, nickel and zinc were in exceedance of USEPA sediment screening criteria (CDM Smith, 2014). The material was classified as organic clay, sandy clay and silty clay. Similarly, samples obtained from Morgantown L/D indicate sediment contaminated with PAHs (acenaphthene, fluoranthene, phenanthrene), polychlorinated biphenyl (PCB), and manganese. The material was classified as sandy clay and gravel. Organic contaminants in sediment typically adsorb to fine sediment particles (clays and silts) and exist in pore water between sediment particles. Similarly, metals also adsorb to sediment (EPA 2005). Due to the fine grained nature of the sediment at these two L/D sites, absorption and concentration of these contaminants is likely. Recent data for Hildebrand L/D was not available. However, given its position between Opekiska and Morgantown, it is likely that Hildebrand contains sediment with similar properties and similar contaminants. Current fish consumption advisories exist for all waters in West Virginia as discussed in Section 4.2.3 and indicates some general level of PCB and mercury contamination.

Previous sediment quality sampling and studies conducted at downstream locations along the Monongahela River also indicate some potential level of contamination. Samples collected in 2013 from Grays Landing L/D (located 20 miles downstream from Morgantown L/D) indicate exceedances of PAH (phenanthrene), iron and zinc based on USEPA sediment screening criteria (CDM Smith, 2014). Sediment quality data near Maxwell L/D (located 40.8 miles downstream from Morgantown L/D) indicates the presence of PCBs and chlordane, possibly from contaminated sediment, PAH (phenanthrene), iron, manganese, nickel and zinc (CDM Smith 2014). Results of 2015 annual Corps maintenance dredging activities at both Grays Landing and Maxwell L/D indicate some sediment samples had elevated levels of arsenic, boron and cobalt and exceed Pennsylvania Department of Environmental Protection (PADEP) clean fill criteria. However, these levels are within the published acceptable range of naturally occurring metals and inorganics in southwestern Pennsylvania and were therefore considered “clean” and not in exceedance of PADEP clean fill standards. Due to the location downstream of the study area, results at Grays Landing and Maxwell L/Ds indicate general trends for the Monongahela River and the type of contaminants that may be present, but not necessarily representative of the study area.

Current operation of the L/D facilities at Morgantown, Hildebrand and Opekiska include storage and/or use of some hazardous materials and petroleum products. Minor amounts of chemical solvents and paint are stored at Morgantown, Opekiska and Hildebrand L/Ds. In addition, 55-gallon drums of hydraulic oil are stored at each of the three L/D properties and several above-ground storage tanks (ASTs) are located at each property. The ASTs store diesel, propane or gasoline (ranging from 250 to 1,000 gallons) and no known spills in the waterway have occurred.

All three locations also have onsite septic systems and herbicides are applied to the property once per year (Mohr 2017).

Morgantown, Hildebrand, and Opekiska L/D facilities were constructed in the 1950s and 1960s. As such, asbestos and creosote and/or lead (primarily in lead-based paint or pipes), might be in some of the buildings and/or infrastructure on the property.

4.3 Cultural Resources

Prehistoric occupation of the Ohio River Basin is generally divided into four temporal periods: (1) the Paleoindian period (prior to 8,000 B.C.); (2) the Archaic period (8,000-1,000 B.C.); (3) the Woodland period (1,000-1,600 A.D.); and (4) the Protohistoric period (1,600-contact).The Paleoindian period is characterized by highly mobile bands of hunter-gatherers traversing the landscape in search of food and high-quality stone tool material. Archaeological sites from this period are generally rare because of their age and ephemeral nature.

The Archaic and Woodland periods are characterized by a change in subsistence strategy as people began relying on smaller game and increased their reliance on plant materials. Although the Archaic period is not well understood in this region, archaeological sites dating to this period have been found in the Ohio River Basin. Woodland peoples used uplands and smaller streams more frequently than their Archaic ancestors, and their habitation sites, commonly located along floodplains, tended to be more permanent. By the end of the Woodland period, people were predominantly relying on agriculture supplemented by hunting and gathering. Changes in burial patterns, the construction of mounds, and material culture suggest changes in ceremonialism and social complexity during this period.

Little is known about the Protohistoric period in southwestern Pennsylvania. Archaeological evidence indicates that much of the area was abandoned during this time, and it appears that the indigenous peoples were displaced into the Ohio River Valley and adjacent Susquehanna and Allegheny River valleys.

The French and British began to settle along the rivers west of the Allegheny Mountains around 1730. This settlement led to increased tension among the British, French, and Native Americans as they sought control over land and economic opportunities. The tensions in the Ohio River area and northeastern North America in general led to the French and Indian War in the 1750s. The Ohio River and its tributaries were again a pivotal battle location during the Revolutionary War as the Americans held this position and used it to launch an offensive against the British and their Native American allies for control of the western extent of the Ohio River.

After the Revolutionary War, settlement increased in western Pennsylvania. The Allegheny, Ohio, and Monongahela Rivers were integral to transporting resources throughout the area. Although coal was the most common resource moved along the river, agricultural crops, livestock and other commercial products were also transported. Railroads were constructed along these rivers during the nineteenth century, but the river continued to be important for transporting commercial products.

Problems such as snags and sandbars created some difficulties in navigating the river, and, beginning in the nineteenth century, Congress appropriated funds to address safe navigation along the Allegheny, Ohio, and Monongahela Rivers. By the mid-nineteenth century, the Corps decided to construct a L/D on the Ohio River to aid navigation. By the beginning of the 20th century additional locks and dams were being constructed along the Allegheny, Ohio, and Monongahela Rivers.

Increased river traffic in the early twentieth century led the Corps to complete a series of improvements to the Monongahela River locks and dams. The recent reduction in coal production in the area has impacted the amount of traffic on the river.

The Monongahela River Navigation System is one the nation's earliest and historically most successful river navigation systems. The first private/state-chartered locks and dams, completed from 1840-1844, permitted reliable water transportation from the National Road at Brownsville to Pittsburgh and then westward along the Ohio River. Initially envisioned to transport western settlers, agricultural commodities, and locally manufactured goods downriver, the system's success was soon tied to transportation of coal mined along the length of the Monongahela. This coal was initially transported as far as New Orleans, but in the early 20th century mainly supplied Pennsylvania's important coke, iron, and steel manufacturing industries.

To recognize the contribution of the navigation system to regional and national history, and to comply with the requirements of Section 110, National Historic Preservation Act, the Corps prepared a National Park Service Multiple Property Documentation Form (MPDF) for the system, entitled, *"Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 – 1960."* Associated historic contexts are:

- Systematic Navigation Improvements to the Monongahela River, 1840 – 1960;
- Boat-Building Industry in the Monongahela River Valley, 1758 – 1960;
- Influence of the Monongahela River Navigation System on the Development of the Coal, Coke, Iron, and Steel Industries in the Monongahela River Valley, 1878 – 1960;
- Monongahela Riverside Community Development, 1878 – 1960.

The MPDF was endorsed by both the Pennsylvania and West Virginia State Historic Preservation Officers. Under the qualifying characteristics and criteria of the MPDF, it is anticipated that Morgantown, Hildebrand, and Opekiska L/D properties will be determined eligible for listing to the National Register of Historic Places for purposes of compliance with the National Historic Preservation Act, Section 106.

In addition to the historic navigation facilities, Prickett's Fort, situated entirely on Corps managed land acquired for recreation with Opekiska L/D, was listed on the National Register of Historic Places in 1974. The Corps managed property is outgranted by lease to the WV Division of Natural Resources, who manages it as Prickett's Fort State Park.

4.4 Future Without Project Condition

4.4.1 Commercial Navigation

Traffic through the Morgantown, Hildebrand and Opekiska Locks on the Upper Monongahela River has been declining in recent years. The decrease in overall traffic can be attributed to a combination of factors; coal mine and resource extraction operations, the primary drive of commercial navigation in the area, have closed, other industriessuch as cement production have closed or moved, and there has been a lack of new investment in river dependent industry over the last 30 years. There has been no indication that the lack of commercial investment will change in the near term. Future traffic demand, and potential traffic given no lock constraints, reflect this situation. In developing traffic forecasts for these projects the district economist reached out to the Planning Center of Expertise for Inland Navigation for guidance on the forecasting methodology. As a new methodology was still in development at the time, it was decided that the district would develop forecasts with PCXIN oversight. High, mid and low range estimates were developed for each facility. Where commercial traffic is already at or near zero all three forecast ranges assume no future commercial traffic.

4.4.1.1 *Mid-Range Forecast*

Morgantown: The mid-range forecast was calculated using a trending three year moving average of historical traffic from 2009-2015. The three year moving average showed a more gradual rate of decline than the individual annual tonnages. This forecast was held constant upon reaching half of the 2013-2015 average tonnage, estimated to occur in 2018. When the rate is not held constant, the trend would result in zero tons processed through Morgantown by 2020.

Hildebrand and Opekiska: The mid-range forecasts were calculated using the averages of the high and low forecasts, both of which were zero in the first year forecasted. With no known new commercial investment in the area, the forecast is held constant for the 50 year planning horizon.

4.4.1.2 *Low-Range Forecast*

The low-range forecasts were calculated using a linear trend of historical traffic from 2006 to 2015 for all three projects. Due to the consistent historical decline in tonnage through all three projects during that period these forecasts result in all projects reaching zero tons locked through by 2016.

4.4.1.3 *High-Range Forecast*

The high-range forecasts were calculated using an average of the previous three years' tonnage through all three projects, and held constant for the 50 year planning horizon. The three-year averages show a slight increase in traffic from 2015, which was the lowest year at all three projects from 2011-2015. These averages do not represent a large overall change in traffic, additionally they account for the possibility that the low traffic in 2015 was an outlier.

4.4.1.4 *Tables and Graphics*

In , historical traffic is shown in five-year increments from 1980 to 2010 to show that tonnage through the upper Monongahela locks has fluctuated between 230,000 and nearly two million tons.

Table 8. Monongahela River Historical Tonnage

Year	Morgantown	Hildebrand	Opekiska
1980	1,295,000	NA	NA
1981	974,000	NA	NA
1982	1,000,000	NA	NA
1983	700,000	NA	NA
1984	900,000	316,000	66,000
1985	1,400,000	781,000	211,000
1986	1,900,000	1,033,000	321,000
1987	2,900,000	1,734,000	730,000
1988	2,701,000	1,250,000	789,000
1989	2,644,000	1,117,000	723,000
1990	1,920,000	636,000	571,000
1991	1,766,000	656,000	565,000
1992	1,690,000	610,000	616,000
1993	1,589,000	494,000	487,000
1994	1,264,000	571,000	548,000
1995	630,000	357,000	370,000
1996	362,000	312,000	259,000
1997	292,000	256,000	242,000
1998	247,000	177,000	179,000
1999	384,000	27,000	28,000
2000	601,500	72,100	66,400
2001	830,400	292,700	289,700
2002	923,600	442,000	441,800
2003	491,000	47,000	57,000
2004	1,011,000	408,000	446,000
2005	884,700	282,400	286,000
2006	881,000	241,000	241,000
2007	778,300	242,800	242,800
2008	1,003,700	458,600	458,600
2009	271,300	58,800	58,800
2010	236,000	0	0
2011	258,528	28	28
2012	228,050	150	150
2013	136,500	800	800
2014	175,700	5,000	5,000
2015	90,200	0	0

Since 2010 (Hildebrand and Opekiska) and 2011 (Morgantown) traffic has gone down significantly with 2015 experiencing the lowest historical tonnages for all three projects. , , and below display the forecasts for each scenario (low, middle, high) from 2016 to 2020, the year in which all projects at all forecast levels have hit a constant expected tonnage, and then shows 10 year increments through 2065. , , and also show the value of the commodities that pass through each of the projects in the forecasted years. The initial values used were developed in

2010 and indexed up to October 2016 price level using the consumer price index. The 2010 values were calculated at the commodity level, so each forecasted year is assumed to use the same percentage of commodities that the 2015 total was comprised of. The individual commodity values were then summed to provide the total value of commodities processed through each lock in 2016 dollars.

Table 9. Monongahela River Low Forecasted Tonnage and Commodity Values

	Tonnage			Value of Commodities		
Year	Morgantown	Hildebrand	Opekiska	Morgantown	Hildebrand	Opekiska
2016	0	0	0	$0	$0	$0
2017	0	0	0	$0	$0	$0
2018	0	0	0	$0	$0	$0
2019	0	0	0	$0	$0	$0
2020	0	0	0	$0	$0	$0
2025	0	0	0	$0	$0	$0
2035	0	0	0	$0	$0	$0
2045	0	0	0	$0	$0	$0
2055	0	0	0	$0	$0	$0
2065	0	0	0	$0	$0	$0

Table 10. Monongahela River Middle Forecasted Tonnage and Commodity Values

	Tonnage			Value of Commodities		
Year	Morgantown	Hildebrand	Opekiska	Morgantown	Hildebrand	Opekiska
2016	113,000	1,000	1,000	$26,700,000	$215,000	$215,000
2017	82,000	1,000	1,000	$19,600,000	$215,000	$215,000
2018	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2019	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2020	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2025	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2035	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2045	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2055	67,000	1,000	1,000	$16,900,000	$215,000	$215,000
2065	67,000	1,000	1,000	$16,900,000	$215,000	$215,000

Table 11. Monongahela River High Forecasted Tonnage and Commodity Values

	Tonnage			Value of Commodities		
Year	Morgantown	Hildebrand	Opekiska	Morgantown	Hildebrand	Opekiska
2016	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2017	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2018	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2019	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2020	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2025	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2035	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2045	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2055	134,000	2,000	2,000	$31,800,000	$430,000	$430,000
2065	134,000	2,000	2,000	$31,800,000	$430,000	$430,000

The figures below show 9 years of historical traffic (2006 through 2015) and 50 years of forecasted traffic (2016 through 2065) at the high, middle, and low levels graphed together for Morgantown (), Hildebrand (), and Opekiska ().

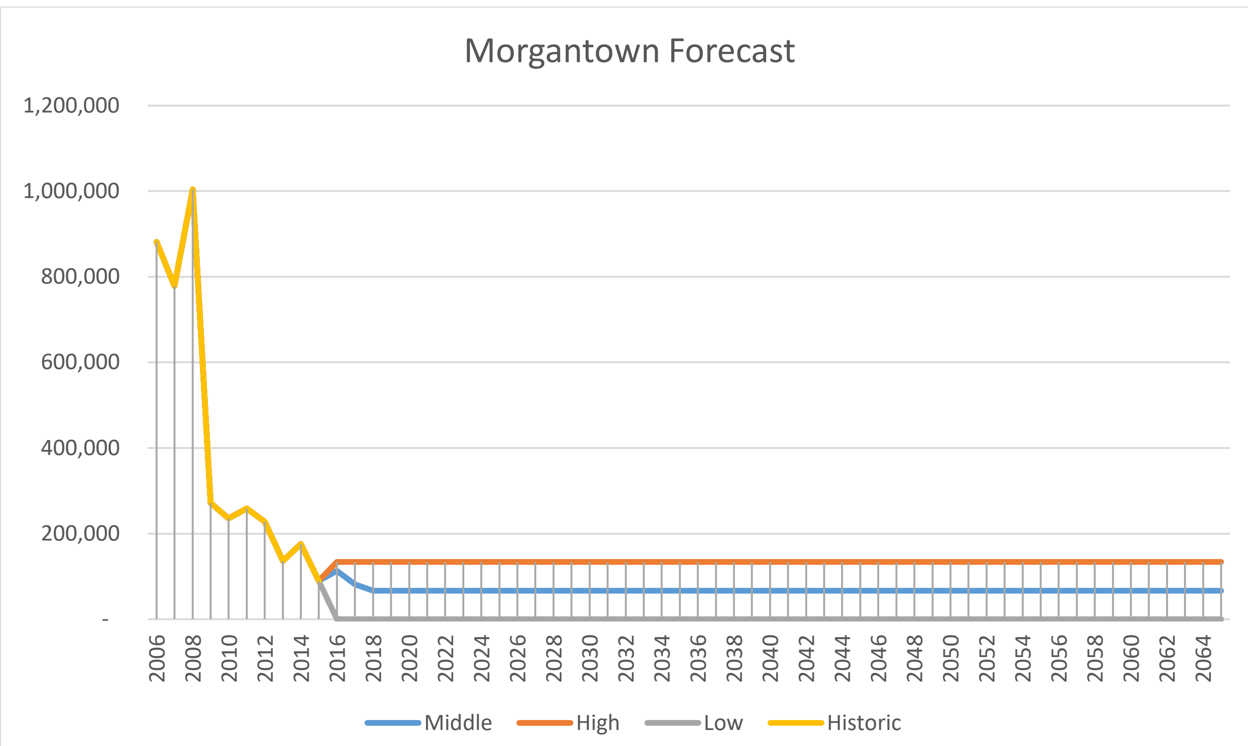


Figure 14. Morgantown L/D Forecasts

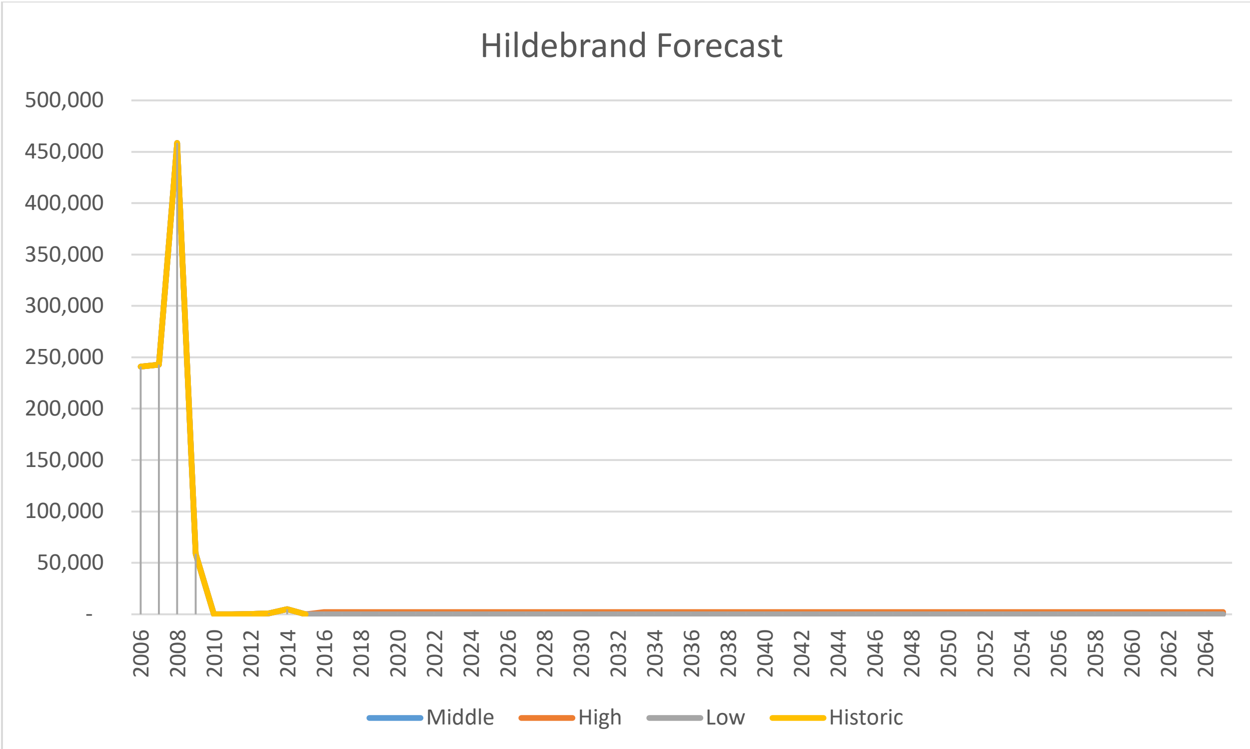


Figure 15. Hildebrand L/D Forecasts

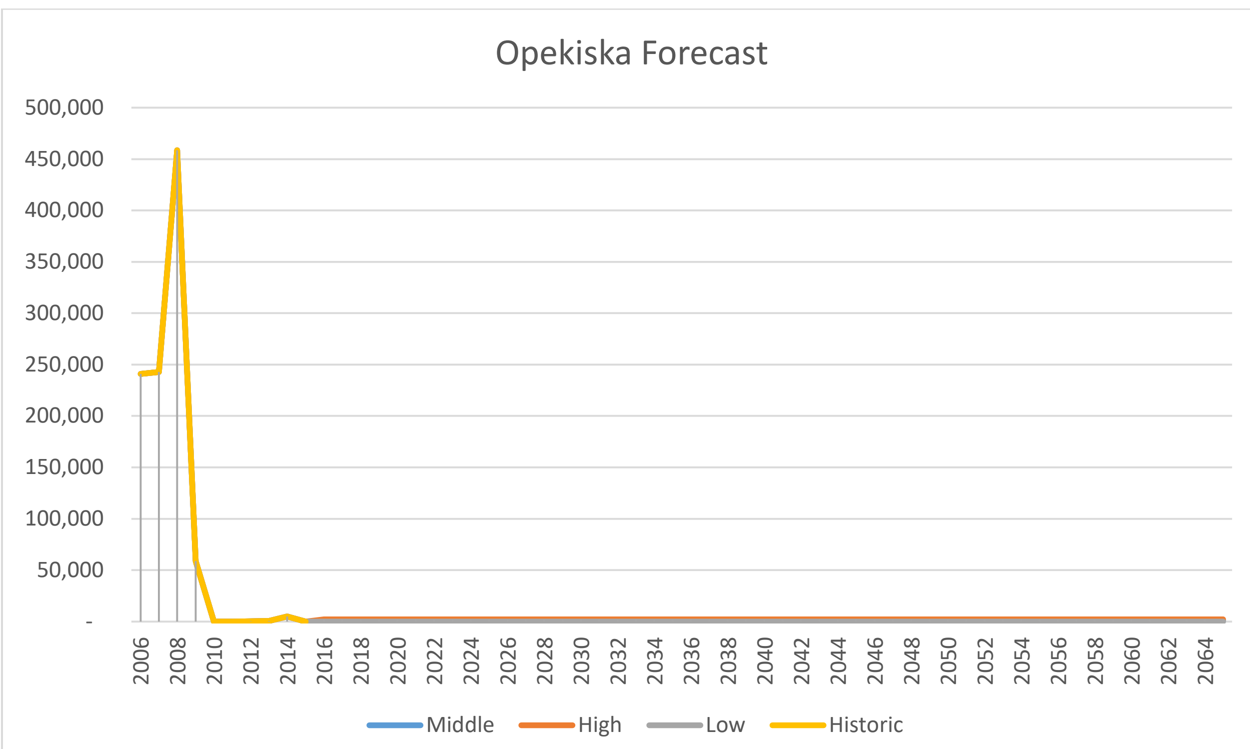


Figure 16. Opekiska L/D Forecasts

4.4.2 Hydropower

While there are currently no installed hydropower facilities on the Monongahela River L/Ds, there are proposals and license applications for facilities at all Monongahela River navigation facilities except for L/D 3 near Elizabeth, PA. The following table is a summary of the current proposals.

Table 12 Future Proposed Hydropower

Proposed Location	Applicant	Forecasted Annual Generation (MWh)	Planned Capacity (MW)
Morgantown	Rye Development	18,925	5
Hildebrand	Hydro Green Energy	87,660	20
Opekiska	Rye Development	25,291	6

The FERC issues 50 year licenses for installation and operation of hydropower at federal facilities. The licensee is charged a fee for usage of the property and provides free electricity for the operation of the facility. If installed, electricity produced at these facilities would be sold on the Mid-Atlantic power grid, which has a retail value of 12.3 cents per kWh (FEB 2016 pricing source: EIA). The average anticipated output would have an annual value of $16,221,000 based on 2016 pricing.

4.4.3 Socioeconomic Trends

Recreation data from the Lock Performance Monitoring System was available from 1993 to 2016. Throughout this time period, the average annual number of recreation vessels locking through the three L/Ds was 1,273. From 1993 to 2007, the annual number of recreation vessels locking through decreased by 34%. From 2007 to 2016, this number decreased by 17%. In 2016, the total number of recreational vessels locking through was 1,077. Recreation has decreased overall since 1993, however, it should be noted that in 2013, the LoS at Hildebrand L/D and Opekiska L/D were both downgraded to LoS 6, which is by appointment only. Recreation at these two L/Ds rely on contributed funds from user groups, which caused recreation demand at these facilities to decrease. An analysis of recreation benefits and consumer spending by recreation users can be found in Appendix B, Section 1 and they are also discussed inSection 7.4.

As discussed in Section 4.1.3, the L/D pools serve as a water supply to a portion of Monongalia County. It is estimated that the water supply from the L/Ds serves a total of 26,024 customers.

Since these L/Ds were placed in service, Monongalia and Marion counties have experienced an overall 21.5% increase in population (1950-2015). The current estimate of the population as of 2015 in the two counties is 163,176 which is a 5.1% increase from 2010. When forecasting the future population growth of this area, it is reasonable to assume the trends since 1980 are likely to continue. From 1980 – 2015, the population of the two counties increased from 142,793 to 163,176, which is an annual rate of population increase of 0.38%. If this trend continues, by 2065 the population of the two counties would increase to approximately 197,450.

4.4.4 Environmental Resources

Climate change is impacting urban and rural built and natural environments and will likely continue to do so throughout the project life. The anticipated longer growing seasons and warmer winters caused by climate change are expected to increase weed and pest pressure (Melillo et al. 2014) in the region. Earlier arrival and increased populations of some insect pests has already been seen. Also, the expected increase in atmospheric carbon dioxide favors aggressive weeds, such as kudzu, over crop species. Wildflowers and woody perennials are blooming earlier and migratory birds are arriving sooner (Melillo et al. 2014). Species distribution shifts, including bird and insect range expansion, have been ongoing and are expected to continue. The Hemlock woolly adelgid is one such species. Some northern hardwood trees may have increased productivity with the longer growing season, but summer droughts may offset this potential (Melillo et al. 2014).

In nearby Pennsylvania, amphibians and mussels were found to be the most vulnerable groups to expected climate change impacts (Furedi et al. 2011). Threatened and endangered mussels in the region have benefited from past water quality improvements. However, Ganser et al (2013) suggest that many freshwater mussels are currently living near their upper thermal limits and that future trends in warmer water could significantly impact native mussels.

Drum et al. (2017) note that the greatest changes expected for the Monongahela River basin include more water overall, larger spring flood events, and periodic droughts. Results of these changes include expected increases in scour, water level increases during sensitive mussel reproduction periods, and periodically lowered baseflow. The study offers adaptations that could be made to decrease impacts of climate change to the aquatic ecosystem, including reconnection of floodplains and wetland restoration efforts.

There have been substantial declines in the intensity of acid mine drainage pollution in the Monongahela River basin. This improvement in water quality has been shown to have significant impacts to fisheries. As noted previously, the fisheries in the river are still considered to be recovering and mussel communities have been slower to rebound. And although mining-related water quality degradation is decreasing, water quality impacts from urbanization are increasing. Nutrient and thermal pollution within the river has been increasing over the past several decades, likely due to increasing urbanization of the watershed. With the expected increases of air temperature due to climate change and the continued nutrient pollution, overall dissolved oxygen levels in the river are also likely to decrease (Melillo et al. 2014). Dissolved oxygen in streams is controlled by several factors, including water temperature, air temperature, hydraulic characteristics, photosynthetic activity, and the amount of organic matter in the water. As discussed in Section 4.2.4, dissolved oxygen varies within the pools both with depth and with distance from the dam. This stratification is likely to continue and intensify.

5 PROJECT DESCRIPTION –CURRENT CONDITIONS

5.1 Operation and Maintenance History

Available information on Operations and Maintenance (O&M) costs for the upper three L/Ds from 2011-2015 was used to calculate average annual O&M costs. These figures include a proportional amount of the Monongahela System O&M costs based on the percentage of total O&M costs that were attributable to each specific L/D. It should be noted that many of these L/Ds did not receive annual funding to conduct routine and preventative maintenance during this period so these figures may not represent the minimal funding amount required to maintain these facilities. Also, beginning in 2012, the LoS for Morgantown was reduced to “Weekends and Holidays” which only operates eight hours per day on weekends and federal holidays, while the level of service for Hildebrand and Opekiska was reduced to service by appointment only. Dredging is required to maintain the navigational channel and is conducted on an ad hoc basis primarily at the approaches of the lock chambers.

Table 13. Estimated Average Annual O&M costs for 2011-2015

	Maintenance	Operations	Total
Morgantown	$ 1,182,130	$ 546,390	$ 1,728,521
Hildebrand	$ 20,030	$ 290,785	$ 310,815
Opekiska	$ 85,008	$ 129,142	$ 214,149
Total	**$ 1,287,168**	**$ 966,317**	**$ 2,253,485**

5.2 Critical Maintenance

The Operational Condition Assessment or OCA program that was developed and used for asset management practices was utilized to capture the condition of critical components of the facilities. The failure of these components would directly affect mission, safety, security, and compliance with Corps standards. Condition ratings for navigation projects has been standardized (Table 14) and applied to the project facilities (Table 15).

Table 14. OCA ratings for Navigation Projects.

Rating		Definition
A	Excellent	1) Component is fully functional, 2) No documented critical design flaw in terms of structural/operational capacity or functionality, 3) No documented or observed deficiencies by definition, 5) No indication of wear.
B+ B B-	Good	1) Component is fully functional, 2) No documented critical design flaw in terms of structural/operational capacity or functionality, 3) Documentation, testimonies and/or observations concluded that a deficiency by definition exists, 4) A clear mode of failure cannot be confirmed, 5) The component's performance is not affected by the deficiency, 6) The feature mission requirements are not affected by the deficiency, 7) Normal operating procedures and routine maintenance requirements are not affected by the deficiency, 8) Safety of personnel and end users are not affected by the deficiency, 8) There are indications of normal wear as documented, reported or observed .
C+ C C-	Poor	1) Component is fully functional, 2) A critical design flaw potentially exist in terms of structural/operational capacity or functionality, but must be further substantiated by owning District, 3) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 4) Documentation, testimonies, and/or observation can confirm a progressing degradation of the component's condition, 5) A clear mode of failure cannot be confirmed, 6) The componen'ts performance is not presently affected by the deficiency, but is likely due to the substantiated progress in degradation, 7) The feature mission requirements are not presently affected by the deficiency, but likely due to the substantiated progress in degradation, 8) Normal operating procedures and routine maintenance requirements are not presently affected by the deficiency, but likely due to the substantiated progress in degradation, 9) Safety of personnel and end users are not presently affected by the deficiency.
D+ D D-	Inadequate	1) Component is functional, 2) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 3) Documentation, testimonies, and/or observation can confirm that the deficiency is significant by any of the following criteria: a. A clear mode of failure exists, b. The component's performance is presently affected, c. Feature mission requirements are presently affected, d. Normal operating procedures are presently affected, e. Routine maintenance requirements are presently affected, 4) A recent unsatisfactory performance or failure of service due to the deficiency cannot be confirmed by documentation or testimonies, 5) It is not likely that an imminent failure of the component will occur, 6) A critical life safety concern to personnel or end users does not exist.
F+ F F-	Failing	1) Component is functional, 2) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 3) Documentation, testimonies, and/or observation can confirm that the deficiency is significant by any of the following criteria: a. A clear mode of failure exists, b. The component's performance is presently affected, c. Feature mission requirements are presently affected, d. Normal operating procedures are presently affected, e. Routine maintenance requirements are presently affected, 4) In addition to the effect the deficiency has on performance and operation, a recent unsatisfactory performance or failure of service due to the deficiency can be confirmed by documentation or testimonies, 5) In addition to the effect the deficiency has on performance and operation, it is likely that an imminent failure of the component will occur, 6) In addition to the effect the deficiency has on performance and operation, a critical life safety concern to personnel or end users exists.
CF	Completely Failed	Component is presently out of service or not functional.

Table 15. OCA for Each L/D in the Study Per Asset Category.

[redacted]

5.2.1 Morgantown

[redacted]

5.2.1.1 *Lock Structure*

[redacted]

[redacted]

5.2.1.2 *Filling, Emptying Valves, and Operating Systems*

[redacted]

5.2.1.3 *Signage*

[redacted]

5.2.2 Hildebrand Lock and Dam

[redacted]

5.2.2.1 *Filling, Emptying Valves and Operating Systems*

[redacted]

5.2.2.2 *Signage*

[redacted]

5.2.3 Opekiska Lock and Dam

[redacted]

5.2.3.1 *Lock Gates and Operating Systems*

[redacted]

5.2.3.2 *Navigation Dam Structures*

[redacted]

5.2.3.3 *Signage*

[redacted]

5.3 Existing Safety Evaluation

The Corps dam safety program makes use of a risk classification system named the Dam Safety Action Classification (DSAC) to help guide key decisions within the program. This classification system portrays the need for urgency of action and the priority for responding to risk associated with Corps dams. Table 16 provides descriptions and definitions of the CorpsE DSAC Rating System. Table 17 contains the DSAC ratings obtained through the SPRA process for the upper three Monongahela River L/Ds.

Table 16 Dam Safety Action Classification System Ratings.

URGENCY OF ACTION (DSAC)	ACTIONS FOR DAMS IN THIS CLASS***	CHARACTERISTICS OF THIS CLASS
VERY HIGH (1)	Take immediate action to avoid failure. Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite investigations to support remediation using all resources and funding necessary. Initiate intensive management and situation reports.	CRITICALLY NEAR FAILURE: Progression toward failure is confirmed to be taking place under normal operations. Dam is almost certain to fail under normal operations to within a few years without intervention. OR EXTREMELY HIGH INCREMENTAL RISK**: Combination of life or economic consequences with likelihood of failure is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.
HIGH (2)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite confirmation of classification. Give very high priority for investigations to support the need for remediation.	FAILURE INITIATION FORESEEN: For confirmed and unconfirmed dam safety issues, failure could begin during normal operations or be initiated as the consequence of an event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public-safety. OR VERY HIGH INCREMENTAL RISK**: The combination of life or economic consequences with likelihood of failure is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.
MODERATE (3)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Prioritize investigations to support the need for remediation informed by consequences and other factors.	MODERATE TO HIGH INCREMENTAL RISK**: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with likelihood of failure is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances.
LOW (4)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Conduct elevated monitoring and evaluation. Give normal priority to investigations to validate classification, but do not plan for risk reduction measures at this time.	LOW INCREMENTAL RISK**: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with likelihood of failure is low to very low and the dam may not meet all essential USACE guidelines. USACE considers this level of life-risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines.
NORMAL (5)	Continue routine dam safety activities and normal operations, maintenance, monitoring, and evaluation.	VERY LOW INCREMENTAL RISK**: The combination of life, economic, or environmental consequences with likelihood of failure is low to very low and the dam meets all essential USACE guidelines. USACE considers this level of life-safety risk to be tolerable.

*At any time for specific events a dam, from any action class, can become an emergency requiring activation of the emergency plan.
** INCREMENTAL RISK is used to inform the decision on the DSAC assignment; NON-BREACH RISK is not reflected in this table.
***DSAC 1 and 2 dams with no life loss will be referred to the appropriate business line program and are given lower priority in the dam safety program.

Table 17. Current DSAC Ratings.

[redacted]

Periodic Inspections (PIs) are recurring engineering inspections conducted at dams and other civil works structures whose failure or partial failure could jeopardize the operational integrity of the project, endanger the lives and safety of the public or cause substantial property damage to their structural stability, safety, and operational adequacy. Periodic Inspections of the projects are scheduled to be conducted at five year intervals. Table 18 lists the dates of the most recent PIs along with some of the significant safety concerns that were noted.

Table 18. Safety Concerns at Locks and Dams.

Project	PI Date	Safety Concerns
Morgantown	2015	[redacted]
Hildebrand	2015	[redacted]
Opekiska	2016	[redacted]

The locks on the Upper Monongahela River are all operational at this time. This is due to the past maintenance and repair activities that have occurred throughout the years. However, the equipment and structural facilities are beyond their expected operating life and many of the facilities' redundancies have failed. Without redundant systems in place unanticipated failures of equipment could result in lock closures of project failures without warning.

Trespassing is an additional public safety concern at these facilities due to the fact that there is no full-time staff at the sites. Trespassers could injure themselves or be at risk of drowning, presenting a public safety hazard and a liability to the Corps.

5.4 Summary of Asset Holding

The Real Estate holdings at each facility include the lock, dam and any other associated building or major piece of machinery (e.g. generators). The current estimate of site betterments and property value are shown in the tables below.

Table 19. Real Estate Value of Facilities

	Lock	Dam	Other	Total
Morgantown	$ 4,409,256	$ 4,292,128	$ 30,500	$ 8,731,884
Hildebrand	$ 6,124,105	$ 6,082,603	$ 175,704	$ 12,382,412
Opekiska	$ 10,508,549	$ 9,309,905	$ 356,547	$ 20,175,001

Table 20 Number of Real Estate Tracts

	Fee tracts	Ease Tracts	Total tracts	Total Acres	Outgrants
Opekiska	34	279	313	389	8
Hildebrand	10	34	44	115	1
Morgantown	8	15	23	111	5
Total	**52**	**298**	**380**	**615**	**14**

6 DESCRIPTION OF INTERESTED PARTIES

6.1 Description of the Entity

Upper Monongahela River Association (UMRA): UMRA is a recreational and economic development association that supports continued operations of the projects under consideration. Since 2014, UMRA, through Monongalia County, has acted as a contributed funds partner to ensure the Locks remain open on weekends and holidays during the recreation season.

Rye Development: Rye holds permits for non-federal hydropower development at Morgantown and Opekiska L/Ds. They currently have no installed hydropower capacity on the Monongahela River system and do not currently hold licenses to proceed with development of hydropower at either of these facilities.

Morgantown Utility Board (MUB): MUB provides municipal water supplies for the City of Morgantown. They operate one intake in the study area servicing about 25,000 residents.

6.2 Capability of Entity to Assume Ownership

None of the identified entities were considered to be viable transfer partners. Non-federal hydropower interests, considered to be the most likely candidate for transfer, are not viable at this time due to the current stage of development on existing permits. Without installed hydropower or a late stage implementation plan it is unlikely that Rye Development or another entity could take on the financial responsibility of maintaining facilities throughout the FERC licensing process. In initial discussions with the hydropower developers they were unable to commit to taking ownership of properties without having completed the FERC licesnsing process. Rye development has historically prepared projects for implemenetation, which they then sell hydro operators making transfer of real property challenging. UMRA indicated that they are unable to take on the additional financial burden of operations and maintenance. They currently meet their contributed funds obligations through grants and fundraising, and do not have a steady source of funding that would make this a sustainable solution. The organization is also not currently set up in a manner that would allow it to hold property.

7 PLAN FORMULATION

7.1 Problems and Opportunities

7.1.1 Problems

- Commercial navigation on the three most upstream locks on the Monongahela River has declined by 90% since 1993. From 1993-1999 the projects lost 80% of their commercial traffic. 2000-2008 saw a partial recovery to, on average, 40% of traffic in 1993. In 2015 all three locks combined had only 175 vessels, the majority of which were at Morgantown. Hildebrand and Opekiska had only 4 commercial lockages each associated with one-time movement of construction equipment.
- Operating and maintaining the locks and dams on the Monongahela River is costly. Federal investments in O&M of these facilities has declined in recent years due to national pressures on O&M funding and due to a lower priority being placed on these facilities. The current level of funding, approximately $2,253,485 annually, does not address all necessary O&M activities to ensure long-term safety and viability of these facilities. As these facilities continue to age and maintenance continues to be underfunded, the risk of failure of one or more facilities increases.
- The Monongahela River has heavy recreational boater usage during the summer season. Reduction in services at navigation facilities has resulted in a significant decrease in the number of recreational lockages taking place, however, boaters still use the pools created by the dams for recreation without passing into other pools. The recreational boater community is active in promoting continued operation of the locks for recreational purposes. The Upper Monongahela River Association supplies contributed funds to Corps operations, allowing for recreational lockages during designated weekends.
- Navigation relies on the system of locks and dams acting together, such that any management decisions should consider the impact to the full system. For system level decision making, consideration of a measure that restricts navigation in some manner at one L/D, also would require de facto implementation of a similarly (or more) restrictive measure at all upstream L/Ds.

- The existing system of navigation dams segments the Monongahela River into a series of pools as opposed to a free-flowing river. This has altered natural riverine processes such as sediment transport, sand and gravel bar formation, and floodplain connectivity and dynamics, and has changed the riparian habitat. These facilities are barriers to the upstream movement of native fish and mussels from the Ohio River into upstream areas of the Monongahela River watershed.
- Alternately, the existing system of L/Ds presents a partial barrier for aquatic invasive species such as species of Asian carp. Removal of one or more of the L/Ds may require further consideration of how to limit the spread of invasive aquatic species in order to fully realize the benefits for native species .
- L/Ds on the Monongahela River are operated to compensate for the lack of naturally-generated dissolved oxygen that would occur in a free-flowing river which is an important component for biological productivity. The reduction in dissolved oxygen is due to the transformation from a riverine to a lacustrine environment. In the historic river, reaeration would have been generated by water flowing over rock-riffles and waterfalls. Today the loss of this process is compensated for by releasing water over the dam gates to supersaturate the upstream end of the next pool.
- Water quality in the Monongahela River is degraded due to abandoned mine drainage. This is believed to contribute to a lack of mussel species within the river. This may also contribute to HTRW concerns with suspended river sediments.
- Invasive plant species such as Japanese knotweed have infested many areas along the river and will likely continue to infest both disturbed and natural areas.

7.1.2 Opportunities

- Transfer of facility ownership would reduce the overall O&M burden on the federal government and, if properly maintained by the new owner, reduce potential for future failures or outages.
- Removal or breach of the dams would reduce the overall O&M burden on the federal government.
- Restoring run of river flows to one or more river segments could result in improved aquatic habitat, restoration of natural riverine process, improved water quality, increased riparian habitat, and restored habitat connectivity for species of concern and support the ecosystem restoration mission.
- There are currently proposals for private hydropower facilities at Morgantown, Opekiska, and Hildebrand, which would increase hydropower generation on the system by approximately 131,876 MWh annually.
- The opportunity exists to transfer the facilities to private hydropower interests who could then develop hydropower generation facilities and operate the L/Ds to maximize hydropower generation.
- The opportunity exists to enhance recreation in the project area by either ensuring an enhanced level of service at existing locks and dams or removing locks and dams to provide a larger stretch of river for unimpeded boating.

7.1.3 Study Objectives

The following planning objectives summarize the future conditions the alternatives for this study are seeking to consider based on the identified problems and opportunities.

- Identify potential transfer partners who current receive non-authorized, secondary benefits from the project and may have an interest in continuining lock operations or maintenance of the project pool idenpendently.
- Evaluate alternatives for the long term disposition of the projects, considering costs, stakeholder input, and socio-economic and environmental impacts.
- Assess the current contidtions of the projects to identify risks associated with structural and operational failure with continued operations of the project.

7.2 Alternatives Description

7.2.1 No Action – Flat Funding

The Flat Funding Alternative describes a continuation of the current levels of O&M funding provided on average over the last five years. Current funding provides for an Inland Marine Transportation System LoS 6 for Hildebrand and Opekiska and LoS 3 for Morgantown. Commercial vessels are able to lock through the system by appointment only. Seasonal hours for recreational boating are funded by contributed funds provided in partnership with user groups. Maintenance activities are minimal, recurring and preventative maintenance is not done. Deferred maintenance is documented but cannot be completed without supplemental funds. In the event of a system failure, the lock would become inoperable with a low likelihood of rehabilitation. This alternative is considered the most likely future without project condition, and is used as the baseline for the comparison of alternatives.

7.2.1.1 *Hydraulics and Hydrology*

Results of the No Action-Flat Funding scenario shows no change to the current river channel. The minimum 9-foot navigational channel depth is maintained through the study area from Morgantown at the downstream end and past Opekiska at the upstream extent. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV. The No Action scenario represents current conditions of the Monongahela River and the analysis results are used for comparison against the other scenarios analyzed.

7.2.1.2 *Discussion of Operational and Structural Risk*

Risk Level: Moderate to High, (risk is dependent on the amount of maintenance performed)

Risk Projection: Moderate and increasing level of operational and structural risk over time

The Flat Funding alternative is likely not sustainable over the 50 year study period. Operational failure is likely during that period though short-term environmental and socio-economic impacts would be neutral. Risk of operational and structural failure would increase over time as preventive and corrective maintenance efforts are significantly reduced and continually deferred.

7.2.2 No Action – Reduced Funding

The Reduced Funding Alternative would reduce the current level of O&M funding at all facilities. The current LoS 3 facility at Morgantown would be downgraded to LoS 6 'by appointment only' for commercial lockages. Contributed funds operations would be discontinued due to reduced staffing and maintenance requirements as outlined in the LoS 6 definition. Risk of operational or structural failure would increase over time as recurring, preventive, and corrective maintenance efforts are continually deferred.

7.2.2.1 *Hydraulics and Hydrology*

Results of the No Action-Reduced Funding scenario shows no change to the current river channel. The minimum 9-foot navigational channel depth is maintained through the study area from Morgantown at the downstream end and past Opekiska at the upstream extent. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV.

7.2.2.2 *Discussion of Operational and Structural Risk*

Risk Level: High, (minimal to no maintenance performed)

Risk Projection: Moderate with a rapidly increasing level of operational and structural risk over time

This scenario, like Flat Funding, is not considered sustainable over the 50 year study period. Risk of operational failure at the LoS 6 facilities would remain the same, while risk of failure for the LoS 3 facilities would increase from the flat funding scenario.

7.2.3 No Action - Sustainable Funding

The Sustainable Funding Alternative would increase the current level of O&M funding at all facilities and therefore increase current funding levels. Facilities would be operated at LoS 5 for current LoS 6 facilities (Hildebrand and Opekiska) or a continuation of LoS 3 (Morgantown). Upgrade to LoS 5 would no longer require contributed funds from user groups to operate facilities for recreation. Maintenance activities would be increased allowing for deferred maintenance to be rectified and would include recurring, corrective, and preventive maintenance at each facility. Corrective maintenance at the projects would be limited to those items that have the highest risk of operational failure. Risk of operational or structural failure would increase slowly over time.

7.2.3.1 *Hydraulics and Hydrology*

Results of the No Action-Sustainable Funding scenario shows no change to the current navigable river channel. The minimum 9-foot navigational channel depth is maintained through the study area from Morgantown at the downstream end up past Opekiska at the upstream extent. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV.

7.2.3.2 *Discussion of Operational and Structural Risk*

Risk Level: Moderate (dependent on the amount of deferred maintenance performed)

Risk Projection: Moderate with a slowly increasing level of operational and structural risk over time

This alternative would allow for a substantial reduction in current risk of operational or structural failure, especially at the facilities upgraded to LoS 5. Even at higher levels of annual spending this alternative would still likely result in an operational or structural failure over the 50 year period without significant reinvestment and replacement of component systems. Risk of operational or structural failure would be slightly lower than the Flat Funding and Reduced Funding alternatives.

7.2.4 Transfer

The Transfer Alternative will identify current users who receive a benefit from the facility that is not currently authorized by the facility. Potential transfer partners include hydropower, recreational users, water supply, or state interests. The transfer alternative will describe the costs and timeline associated with disposal of a project through the General Services Administration. The estimated cost includes only USACE actions to prepare legal descriptions, appraisals, disposal reports and NEPA review in preparation of transfer to GSA for disposal.

The transfer alternative is a form of decommissioning the facility by removing the project from Corps responsibility and control to mitigate long term operational and structural risk. This alternative does not include Corps dam safety requirements and there would be no operational or maintenance costs as the project would be maintained and under the control of the transfer partner.

7.2.4.1 *Hydraulics and Hydrology*

The Transfer Funding scenario would remove Corps from controlling upstream facilities along the Monongahela River system. The current navigable river channel would likely not be maintained by the transfer partner and may not meet current minimum 9-foot navigational channel depth as currently maintained through the study area from Morgantown at the downstream end up past Opekiska at the upstream extent. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV.

7.2.4.2 *Identification of transfer partner*

The district also reached out to entities including WVDOT, the Upper Monongahela River Association, the Morgantown Utility Board and Rye Development to discuss interest and ability in assuming the properties. Water supply, recreation, and state interests were unwilling to commit to a transfer agreement. One hydropower licensee holds the existing permits on Morgantown and Opekiska. The company has expressed interest in a potential transfer of facilities, however they were not able to commit to initiating the transfer process within the timeline of this study. There are concerns that increased maintenance costs from ownership of the dams may reduce or eliminate profitability at these sites making transfer unviable. The current lack of installed hydropower at the facilities reduces the likelihood of a successful long-term transfer.

7.2.4.3 *Discussion of Operational and Structural Risk*

Risk Level: Moderate to Low, (risk of the operational or structural integrity of the project is removed from Corps responsibility, however the transferred project would continue to require O&M and impact the river system)

Risk Projection: N/A

Risk of project failure under this alternative is low to Corps since they would not have ownership. A non-federal owner would have the responsibility to maintain the facility, and would most likely have financial incentives to ensure the long term viability of the structure. Without a specific transfer partner identified it is difficult to anticipate long term risk, however, a change in profitability, significant maintenance expenses, or a change in conditions could all affect a transfer partner's long term ability to operate or maintain the project. The largest source of short term uncertainty with this alternative is variability in operation by the transfer partner. Risk of operational or structural failure would not be applicable to Corps.

Concerns for long-term safety and liability with this alternative are related to the continued operation of downstream facilities still responsible for maintaining LoS 1 operations.

7.2.5 Mothball

The Mothball Alternative considers short-term sustainment of facilities with the option to re-open a facility should economic development trends indicate a return of river dependent industry. Mothballing will consider three costs; initial investment to prepare the facility for decommissioning for long term storage, annual costs to maintain and inspect the project, and costs associated with bringing a facility back online. Unlike the other alternatives considered, Mothballing is not considered for the full 50 year study period. This alternative will be evaluated for a 5 year and 10 year period. Beyond 10 years, this alternative would move to a state of de facto abandonment.

The mothball alternative is a form of decommissioning with recovery. It consists of securing or removing critical components out to the ten year milestone to mitigate operational and structural risk.

Operational maintenance of signage, buoys, and security would be maintained. Miter gates would be secured in miter position, dam gates would be secured in a raised position, filling and emptying valves would be closed. Mechanical systems would be coated with protective coatings, drained of fluids and prepared for long term storage and electrical systems would be disconnected to prevent accidental use of equipment. A new project pool would be maintained by the concrete dam sill at a revised and lowered pool elevation. After ten years this alternative would mirror the abandonment alternative requiring additional funding to prepare the facility for safe abandonment. This alternative would remove operational risk while in a mothball status but not structural risk of project failure. By not performing maintenance or critical repairs, the projects may experience adverse effects and increase the likelihood of operational or structural failure.

7.2.5.1 *Hydraulics and Hydrology*

The Mothball Funding scenario would lower the normal pool elevations changing the current navigable river channel. The minimum 9-foot navigational channel depth would not be maintained. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV.

7.2.5.2 *Discussion of Operational and Structural Risk*

Risk Level: Moderate

Risk Projection: Moderate, with increasing costs as well as increasing operational and structural risk over time

Risk of project failure during the mothball period is low. The largest source of uncertainty with this alternative is variability in cost to recover the project within the 10 year term. Recovery costs were estimated with an assumed rate of deterioration. Changed conditions or vandalism during the mothball period would significantly increase the costs associated with returning the facilities to an operational state. Similar to abandonment, the mothball alternative would cease operation of the dam gates reducing pool levels.

Concerns for long-term safety and liability with this alternative are related to the ongoing scour, and stability of monoliths during the mothball time period. These processes should be monitored and the data collected and analyzed on a periodic basis for potential impacts to any compromised foundation conditions.

7.2.6 Abandonment

The Abandonment Alternative consists of one time costs associated with ensuring structural stability and physical security at the project sites. Abandonment will define the least cost methods for site preparation that would limit long-term liability.   While abandonement is not an alternative that USACE would consider an acceptable end state, deauthorization of a project without a transfer partner or other disposal method would result in a de-facto abandonment of the project as additional federal funds could not be appropriate to modify or maintain the project at any level.

The abandonment alternative is a form of decommissioning the project and consists of securing or removing critical components to mitigate long term risk, responsibility and liability. Under this alternative, a determination was made to accept a higher level of risk, therefore no dam safety requirements would be captured in the cost. An estimate of these dam safety costs, including Periodic Inspections, Periodic Assessments, Scour and Deformation Surveys, is $47,000 per project annually. Operational maintenance of signage, buoys, and security would still be required. Miter gates, dam gates and filling and emptying valves would be removed along with all mechanical and electrical systems. Fuel and Hydraulic storage systems would be drained, lock appurtenant items and gantry cranes would be removed. All removed items would be evaluated for reuse at other similar projects. A lock closure structure would be installed to maintain a new project pool that would be now be controlled by the remaining concrete dam sill at a revised and lowered pool elevation. This alternative would remove operational risk but not structural risk of project failure. By not performing maintenance or critical repairs the projects may experience adverse effects and increase the likelihood of structural failure.

7.2.6.1 *Hydraulics and Hydrology*

The Abandonment Funding scenario would lower the normal pool elevations changing the current navigable river channel. The minimum 9-foot navigational channel depth would not be maintained. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV.

7.2.6.2 *Discussion of Operational and Structural Risk*

Risk Level: High (structural risk only)

Risk Projection: Moderate with a rapidly increasing level of structural risk over time

Abandonment of the facility would lead to a higher risk of unplanned loss of pool due to dam failure. While each facility has identified dam safety issues, none are currently considered critical. Continued degradation of the dam structures over time without any further investment would lead to failures at all facilities, likely within the 50 year study period.

7.2.7 Removal

The Removal Alternative will identify all project features to be removed and disposed of to mitigate long-term risk, responsibility and liability. Under this alternative the Corps would abandon its flowage easements and lands associated with the project not owned in fee. Any assets, such as land and equipment associated with the project would be disposed of.

The removal alternative is a form of decommissioning the project and consists of removing key project features to mitigate long term risk, responsibility, and liability. This alternative has no dam safety requirements and no operational or maintenance responsibilities as the project would be removed from the river system. Miter gates, bulkheads, filling and emptying valves and dam gates along with all mechanical and electrical systems would be removed. Additionally, dam fixed weirs, dam piers, lock walls (not including the land wall) and lock approach walls (land approach only if surrounded by water), buildings, mooring cells, bridges, fuel and hydraulic storage systems, lock appurtenant items, and gantry cranes would be removed. This alternative would remove all operational risks and significant if not all structural risk of project failure.

7.2.7.1 *Hydraulics and Hydrology*

The Remove Funding scenario would lower the normal pool elevations changing the current navigable river channel. The minimum 9-foot navigational channel depth would not be maintained. The maintained navigation channel extends upstream to RM 0.89 on the Tygart River, in Fairmont, WV.

7.2.7.2 *Discussion of Operational and Structural Risk*

Risk Level: Low

Risk Projection: N/A

This alternative removes future liability from the Corps and returns the study area to a free flowing river. There is a high potential for short-term negative socio-economic and environmental impacts. Long-term environmental impacts would generally be net positive. Mitigation for socio-economic impacts could also significantly reduce their severity over time.

7.3 Grouping of Alternatives at a System Level

The individual management measures are applied to each project to determine a final alternative grouping. The development of alternative packages allows for project specific decisions at each facility, while considering a system level approach to the final status of the river. Management measures include No Action, mothball, abandonment, and removal (listed from least to most restrictive future state for navigation). The selection of a management measure is made moving upstream with all measures considered at the first facility. Once a project has been downgraded to a more restrictive alternative only the current or more restrictive alternatives are considered at the next facility upstream (i.e. once abandonment is selected as the preferred measure for a facility all upstream projects would be limited to abandonment or removal). For purposes of system level decision making the transfer alternative would mirror the No Action (if continued operation of the lock is anticipated) or Abandonment (if the lock would no longer be in use). Should a transfer partner be found for a facility, their proposed usage would potentially dictate upstream decision making on projects not considered for transfer.

This constraint assumes that the final formation of the river system should not fragment navigability or pool levels though the study area. The river acts as a system and any benefits to a fragmented navigational pool with some projects opened and others closed would lead to diminished value due to its disconnectedness from downstream markets and constraints on future commercial investment in river dependent industry, at a greater cost over the study period. The range of alternatives presented are only those combinations of management measures considered implementable under this methodology.

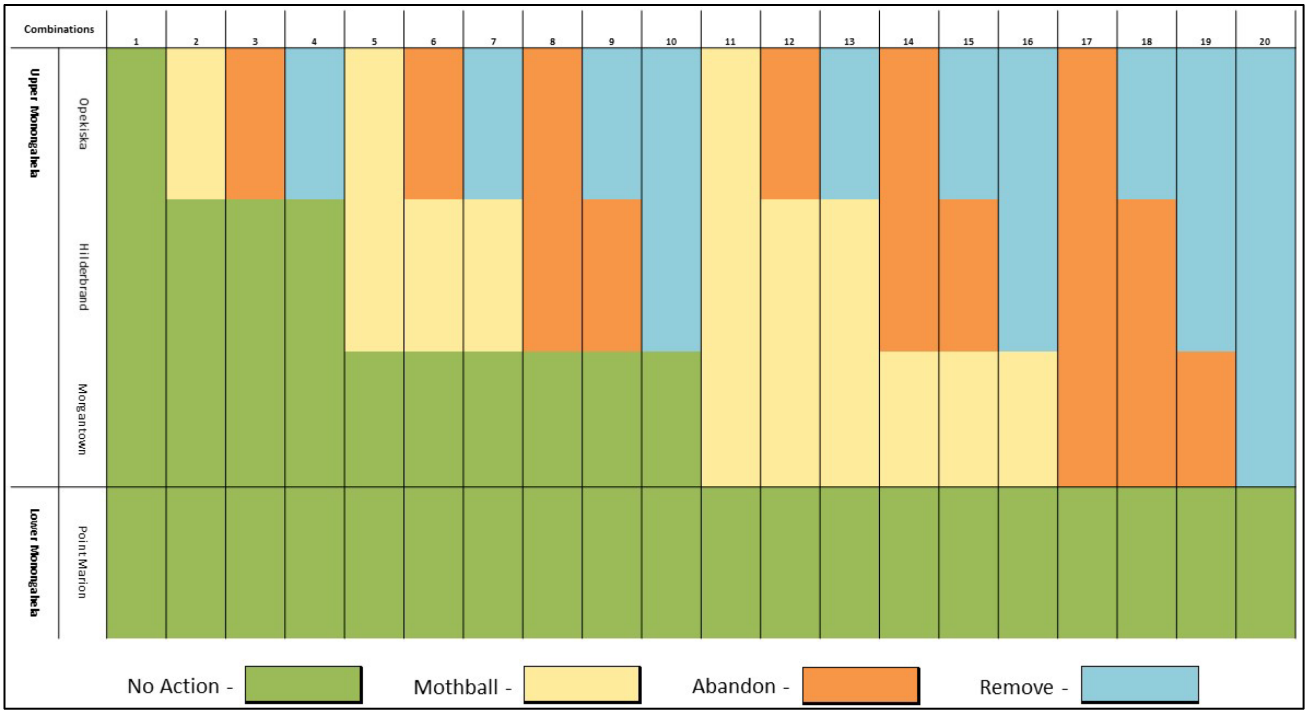


Figure 17. Graphical representation of the application of various measures at each L/Ds based on a system-level consideration of navigability.

7.4 Alternatives Considered but Eliminated

7.4.1 Major Rehabilitation

Major rehabilitation of the projects would entail significant reinvestment in the project to repair all deficiencies and replace all systems to return them to full operability. Major rehabilitation would also require ongoing O&M at a higher level than current O&M allocations.

This alternative was eliminated due to the high initial cost for limited economic benefit. Justification of a major rehabilitation would require a positive benefit to cost ratio, however with existing economic conditions this is unlikely. Current forecasts and existing benefits (even to include secondary benefits) would have to increase beyond the most optimistic expectations to make this alternative viable.

7.4.2 Reauthorization for a Purpose Other Than Commercial Navigation

Although commercial navigation at the L/Ds is minimal, other public services are provided by the facilities. Reauthorization for non-federal hydropower, water supply and/or recreation was considered, but not included in the final array of alternatives due to lack of current authority of the Corps to operate a project solely for those identified secondary purposes.

ER 1105-1-100 provides guidance on authorized purposes for Corps projects, and specifically addresses the secondary purposes listed above.

- Recreation: If there is no non-federal recreation sponsor, facilities or project modifications may not be recommended unless justified by other project purposes, in which case recreation benefits are considered incidental.

  Budget Policy generally precludes using Civil Works resources to implement recreation oriented projects in the Civil Works program. An exception is where a project is formulated for other primary purposes and average annual recreation benefits are less than 50 percent of the average annual benefits required for justification (i.e., the recreation benefits that are required for justification are less than an amount equal to 50 percent of project costs).

- Water Supply: National policy regarding water supply states that the primary responsibility for water supply rests with states and local entities. The Corps is authorized to provide storage in multipurpose reservoirs for municipal and industrial water supply and for agricultural irrigation.

- Hydropower: Corps development of single purpose hydropower is precluded. In addition, before hydropower can be included in a multiple purpose project, the project must be economically justified based on other outputs (e.g., flood damage reduction or navigation).

7.5 Socio-Economic Impacts

The Planning Center of Expertise for Inland Navigation (PCXIN) informed the Pittsburgh District that a quantitative analysis of business forecasts would not be possible due to time constraints and lack of data. If this document leads to a feasibility study, the PCXIN stated there are two alternatives for business forecasting: an economic model and formal surveying. From an economic model and/or surveys, revenue losses and unemployment could be estimated. However, for this document, the PCXIN stated that a qualitative analysis would adequately account for the socio-economic impacts.

The average annual recreation benefits for the Morgantown L/D, Opekiska L/D, and Hildebrand L/D can be found in Appendix B, Section 1. An analysis of property value impacts can be found in Appendix B, Section 2. A brief analysis of the relationship between Monongalia County and West Virginia University (WVU) can be found in Appendix B, Section 3. A brief analysis of the coal industry and Monongalia County can be found in Appendix B, Section 4.

7.5.1 *No Action - Flat Funding*

In the short-term, there would be no socioeconomic impacts for this alternative. However, in the long-term, operational failure of the L/Ds is likely, which would result in negative impacts. If a dam failure occurs, there would be a rapid loss of pool, which would result in a loss of water supply and potential life safety impacts. The Monongahela River is the source of water supply for 26,024 customers; if the dam fails, each customer would lose access to their water supply for an extended amount of time. Additionally, in the event of an unplanned loss of pool there is a high potential for riverbank erosion, which could result in damage to personal property, roads, and railroad tracks located along the river banks. Docks and boats along the river would likely be damaged or destroyed due to the rapid loss of pool. This would cause a short term loss of recreation benefits due to the rapid decrease in the number of available motorized vessels. The decrease in motorized vessels may result in marinas permanetely shutting down. If roads and railroad tracks are damaged, this may impact businesses who rely on truck and rail. Additionally, if the dam failure occurs while there are vehicles on are the roads/tracks, there could be potential life loss. The chances of life loss occurring during the dam failure are extremely low, but should be noted.

7.5.2 *No Action – Reduced Funding*

In the short-term, reduced funding would result in a decrease in recreation benefits. The Morgantown L/D would be downgraded to LoS 6, which is by appointment only for commercial lockages. Additionally, the contributed funds agreement in place with user groups would be discontinued due to reduced staffing and maintenance requirements at the L/Ds. The long-term impacts for this alternative are identical to those discussed above for the No Action – Flat Funding alternative.

7.5.3 *No Action –* Sustainable *Funding*

In the short-term, sustainable funding would likely cause recreation benefits to increase due to Opekiska L/D and Hildebrand L/D being upgraded to LoS 5 (lockages on weekends and holidays only); Morgantown L/D would remain at LoS 3. Contributed funds from user groups would no longer be required to operate facilities for recreation. The long-term impacts for this alternative are identical to those discussed above for the No Action – Flat Funding alternative because, as stated in section 7.2.3.2, the long-term risk of a structural or operational failure remains.

7.5.4 *Transfer*

If the L/Ds are transferred from Corps to another entity, this analysis assumes that the locks would no longer be operated, and therefore would become unavailable to recreation and commercial traffic. If the Opekiska, Morgantown, and Hildebrand L/Ds become unavailable for vessel traffic, Monongalia County would likely be negatively impacted. The community that would be most impacted is the City of Morgantown; it is within close proximity to the three L/Ds. However, the city of Morgantown and Monongalia County do not rely on river dependent industries for economic stability. Over the last several decades, employment has shifted from the coal industry towards the education sector. West Virginia University (WVU), WVU Hospitals, and Monongalia County Board of Education have consistently been among Monongalia County's top employers for the past decade (*Monongalia County Profile,* 2014). An analysis of Monongalia County and WVU can be found in Appendix B, Section 3; an analysis of Monongalia County and the coal industry can be found in Appendix B, Section 4. Although the county does not depend upon the L/Ds for economic stability, several riverfront businesses depend upon the L/Ds for financial stability. For example, Monongalia County is host to marinas, terminals, industrial parks, and river dependent ventures, which all have the potential to be negatively impacted if the locks become unavailable.

There are five marinas in Monongalia County; each are expected to be impacted if the locks become unavailable to recreational boaters. There are three marinas located on the Monongahela River: Morgantown Marina, Twin Spruce Marina, and Mark's Marine Repair. These are the marinas that would likely be negatively affected if the locks become unavailable. The owners of motorized boats would likely take their boats to a different marina that had either river access or lake access. Based on conversations with marina owners, the riverfront marinas would not survive without access to the L/Ds, which indicates that the marinas may permanently close or try to establish their business on the nearby Cheat Lake, which is approximately seven miles northeast of Morgantown. The other two marinas in the county, the Lakeside Marina LLC and Sunset Beach Marina, are located on Cheat Lake; these two businesses would likely see an increase in revenue if the locks become unavailable to recreational boaters. In addition to Cheat Lake, local boaters have two other nearby alternatives: Deep Creek Lake and Stonewall Jackson Lake. Riverfront marinas are likely to see a decline in revenue due to recreational boaters being unable to travel between L/Ds and due to the proximity of three nearby lakes

As illustrated in Appendix B, Section 1, the combined annual recreation benefits for the three L/Ds is approximately $124,000, on average. This number does not account for non-motorized vessels due to lack of data and was developed using Lock Performance Monitoring System data. If the L/Ds become unavailable, some, but not all, recreation benefits would likely be lost. Motorized vessels would be able to utilize the pools between L/Ds, but they would not be able to lock through. Pool levels would drop; at certain points due to decreased channel maintenance, leading to water depths under five feet. Motorized boats may not be able to travel at high speeds and some recreational activities such as jet skiing, tubing, wakeboarding, waterskiing, etc. would pose a threat to life safety. Due to limitations in motorized boating on the river, recreation would likely shift from motorized vessels to non-motorized vessels over time; kayaking, canoeing, and stand-up paddleboarding would likely not threaten life safety, and these activities may become more attractive if the river is more naturally flowing. Pathfinder is the largest independent outdoor retailer in West Virginia. They sell equipment for kayaking, canoeing, and stand-up paddleboarding. If the locks become unavailable, Pathfinder's kayak, canoe, and stand-up paddleboarding sales may increase, which would increase its revenue. If the locks become unavailable for recreation traffic, and motorized recreation decreases, Pathfinder's revenue will likely increase over time.

There would be no commercial navigation along the upper Monongahela River if the locks become unavailable, which negatively impacts terminals, warehouses, and industrial parks. The Vance River Terminal is located about two miles upstream of Morgantown L/D; it is the only riverfront terminal within the study area. Without the option to barge commodities, it is likely that this terminal would shut down. Terminals heavily rely on navigable waterways and barge traffic for consistent revenue. Companies ship commodities to the terminal via barge, the terminal then stores the commodities in a warehouse, and then ships the commodities out elsewhere via barge, truck, or rail. A terminal owner disclosed that 90% of all business transactions involve barge traffic. Without access to the L/Ds, many companies would be forced to ship their commodities via rail and truck. Due to the loss of competition in the shipping market, there may be an increased demand for trucking and rail companies, which would cause the companies to increase prices in the short-term. The increased prices paired with an increased demand will likely generate more revenue for the rail and truck companies, but would negatively impact businesses who utilize truck and rail. In the long-term, additional truck and rail companies would likely enter the county, which would cause shipping prices of rail and truck companies to slightly decrease. Additionally, without the navigable waterways, warehouses situated close to the river may become obsolete, but there would likely be an increased demand for inland warehouses situated near Interstate-79 and/or near the railroad.

The Morgantown Industrial Park is about half of a mile upstream of the Morgantown L/D. There are 16 current tenants (a tenant is an unaffiliated business that leases an industrial park site) and 12 open sites available for leasing. The industrial park is adjacent to the Monongahela River, Interstate-79, and the railroad owned by Norfolk Southern. The business is successful because it offers three modes of transportation to its tenants as opposed to other industrial parks that offer one or two modes of transportation. If the L/Ds become unavailable, the industrial park would lose part of their competitive advantage. Current tenants shipping commodities south may relocate upstream for river access; current tenants shipping commodities north may relocate to Pennsylvania or shut down their operations. Additionally, the industrial park may become less attractive to potential tenants. Without access to the L/Ds, the Morgantown Industrial Park's revenue would likely decrease and it may become more difficult to fill open sites.

The Wharf District is half of a mile upstream from Morgantown L/D. The Wharf District consists of various restaurants, local businesses, breweries, the WVU Convention Center, and the Waterfront Place Hotel. Additionally, within the Wharf District is a dock that could hold approximately 20 vessels and it's the location for the WVU rowing team's boathouse. The WVU Sports Net website states, "the Mon[ongahela] flows well below its banks and is largely sheltered from prevailing winds by the surrounding bluffs. As such, the WVU crew team is often fortunate to train on calm water with little current." The WVU rowing teams have trained at this location since 2007. In 2009, WVU hosted its first regatta on the Monongahela River; the teams raced from the Wharf District to Star City, WV. If the locks become unavailable, the WVU rowing team would be forced to relocate to calmer waters, especially if the water becomes more naturally flowing. The team may be able to relocate to Cheat Lake, but the lake may not be large enough to host regattas. Additionally, a new boat house and dock would need to be constructed at the lake. WVU has only hosted a few races or regattas over the past decade. Regattas and races bring more consumers into the economy and generate spending in Morgantown's economy. If the locks become unavailable, the county would lose an opportunity for economic development.

Access H_2O is a new river dependent business venture in Morgantown. Access H_2O is a passenger boat and outdoor recreational shuttle, which would offer dinner/dance cruises, private parties, educational outings, and sightseeing tours. The company would also eventually offer trips to Pittsburgh, PA. The vessel was purchased from the Gateway Clipper Fleet in Pittsburgh, PA. The boat is currently under repair, but will be ready to accommodate passengers by April 2018. Additionally, the owner informed Pittsburgh District that they would partner with local restaurants and businesses to aid economic development in Morgantown. This venture would potentially boost tourism spending and increase economic growth for the county. However, if the locks become unavailable, this company would relocate to a different area with navigable waterways, which would be a lost opportunity for economic development in the county.

7.5.5 *Mothball*

The impacts of this alternative are similar to those discussed above for the Transfer alternative, in that the loss of navigation would impact local businesses that are tied to river traffic. Additionally, the loss of pool for the mothballed period, would favor non-motorized recreation, such as kayaks, canoes, and stand-up paddleboarding. The lack of certainty for whether the L/Ds would be restored (restoring the navigable pools) or whether the river would remain largely free-flowing could stagnate the growth of recreational businesses in the area. However, if the mothballed L/Ds are restored, recreation and commercial navigation would be available again on the Upper Monongahela River. This indicates that over time, the recreation benefits would return to their annual average and commercial navigation benefits would return to this portion of the Monongahela River.

7.5.6 *Abandonment & Decommissioning*

Short-term impacts of this alternative would be identical to those impacts discussed above for the Transfer alternative, in that the loss of navigation would impact local businesses that are tied to river traffic. If the L/Ds are abandoned and decommissioned, there is a high chance that they may fail in the long-term. The long-term impacts for this alternative are similar to the long-term impacts discussed above in the No Action – Flat Funding alternative. The planned decommissioning, as opposed to a rapid loss of pool from a failure, would allow for mitigative actions to occur, such as protection of vulenerable slopes and removal of boats from the pool(s) prior to dewatering the pool.

7.5.7 *Removal*

Socioeconomic impacts of this alternative would be almost identical to impacts discussed above for the Transfer alternative. There are slight differences in recreation benefits when compared to the Transfer alternative. Much like the Transfer alternative, motorized vessels would still be able to use the river (in between L/Ds), but to an even lesser degree. If the L/Ds are removed, some areas of the river may be too shallow or too narrow for larger vessels. Additionally, the Removal alternative results in a more natural flowing river and a potential drop in pool levels. Non-motorized vessel users would likely view a natural flowing river as a positive impact. This may cause recreation to shift more rapidly towards non-motorized vessels, which could offset the majority of the lost benefits from motorized vessels. Additionally, this may cause an increase in revenue for Pathfinder; other companies (rafting, kayaking, etc.) may enter the market, which would result in positive economic growth for the county. The potential drop in pool levels may negatively impact property values; many residents along the river own motorized boats and have constructed boat docks. In the Removal alternative, motorized boats may not be usable on the river and personal docks could become obsolete. An analysis of property values in the county can be found in Appendix B, Section 2.

The removal alternative would create variability in water levels that would impact some or all of the commercial and industrial water intakes that are reliant on the stable water supply provided by the project pools. A detailed analysis has not been conducted, however, even occasional interruptions in water supply would result in either relocation of the water intake or the need to find a new, more consisten water source.

7.6 Environmental Impacts

7.6.1 Geography

7.6.1.1 *No Action - Flat Funding*

With the implementation of the Flat-Funding Alternative no impact to the geography of the Monongahela River would be expected. Operational failure of a facility (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. The river would maintain its existing stepped pool structure.

7.6.1.2 *No Action – Reduced Funding*

Impacts to geography from this alternative would be identical to those described for the Flat Funding Alternative.

7.6.1.3 *No Action - Sustainable Funding*

With the implementation of the Sustainable Funding Alternative, no impacts to the geography of the Monongahela River would be expected. The river would be maintained with its existing stepped pool structure. Sustainable funding would be expected to maintain the existing condition indefinitely.

7.6.1.4 *Transfer*

Under this alternative, no impact to geography is expected. It is anticipated that a transfer agency would maintain the dam indefinitely. The locks may not be maintained as usable facilities, but this would have no impact on the geography of the river or the surrounding lands.

7.6.1.5 *Mothball*

The Mothball Alternative is considered only in the short-term as the facility would either be reinvigorated in 5 to 10 years or, beyond 10 years, would move to a state of de facto abandonment. During the mothball period, a reduction of current pool levels would occur as the gated dam would be secured in a raised (open) position (Figure 18). The dam sill would then act as a fixed crest dam. The reduced water surface elevation would lead to a narrower river channel with faster water velocities. At Morgantown, upstream water elevations would be expected to drop approximately 15 ft from the current pool elevation. The sill would create only a relatively small drop (about 2 feet) in the water surface. At Hildebrand, the upstream water elevation would drop 19 feet. With the corresponding drop in the downstream Morgantown pool, water would fall approximately 10 ft at the Hildebrand sill to meet the downstream water surface. At Opekiska, the sill lies quite low and a high point in the natural ground elevation upstream of the dam largely dictates the water surface elevation. Therefore, at Opekiska, the opening of the gates largely resembles restoration of a free-flowing river (similar to the Removal Alternative). Closure of the gates to reopen the L/Ds after the mothball period would restore the current status quo.

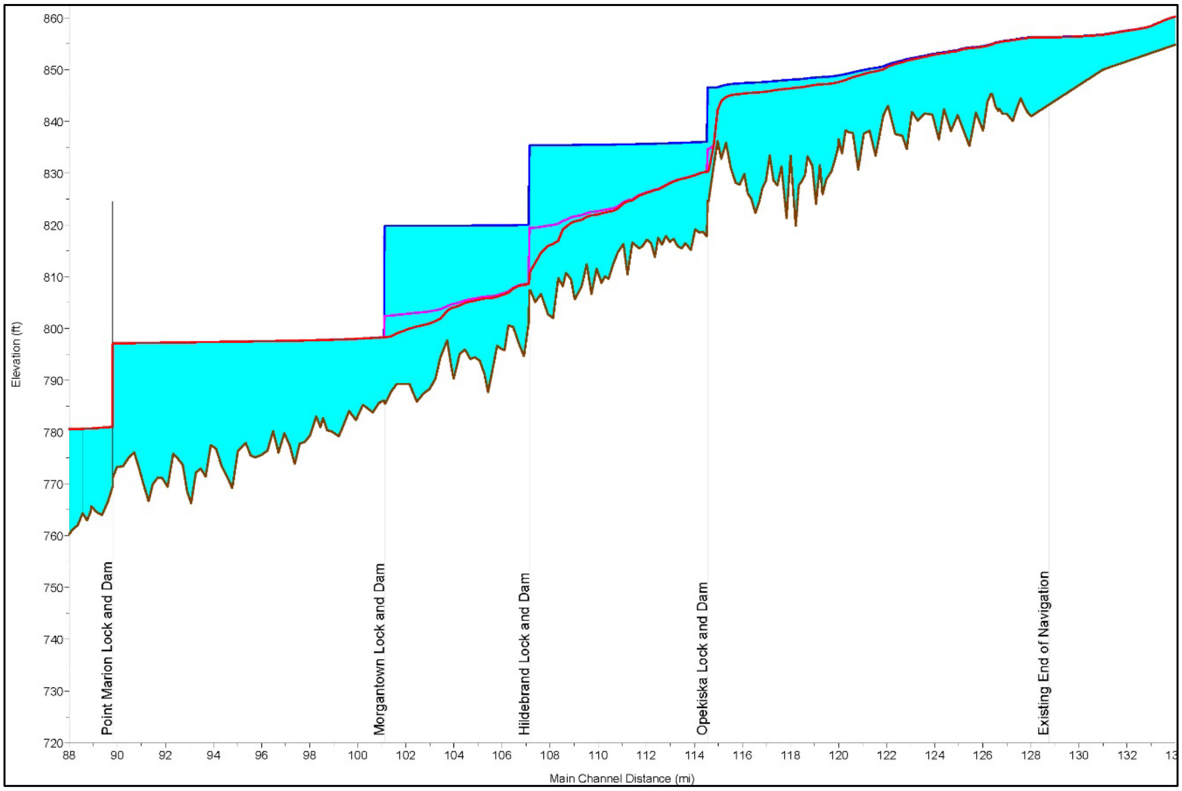


Figure 18. Mid channel profile depths at an average annual flow with various alternatives. Comparison of the No Action alternatives (blue) to the Mothball/Abandon alternatives (pink) and the removal alternative (red). The brown line represents the ground elevation.

Riverine morphology would be largely restored within much of the river. This would include an increase of water velocities and decrease of water depths throughout the affected area. Near Opekiska this could create riffles or rapids. Sediment in the channel could be mobilized downstream with the increased water velocities with the sill dams capturing some of the sediment mobilized between the dams.

The lowered water levels could expose large areas of unvegetated bank. Bank stabilization actions could begin before the pools are lowered to reduce the risk to infrastructure and allow for use of softer stabilization methods such as riparian plantings in some areas. Slow draw-down of the water levels could also reduce risk of bank failures. Likely impacts to geography would include: grain size increase in the channel bed with water velocity increases; restoration of riffle/run and pool/glide channel features; possible exposure, expansion or creation of mid-channel islands and gravel bars; and re-establishment of a more natural seasonal hydrograph throughout the impacted reach. Dams on the Tygart River and the West Fork River would continue to moderate flows, however inflow from unregulated tributaries would contribute to more variance in the flow regime in the mainstem.

At the end of the mothball period, restoration of the L/Ds would recreate the stepped pool architecture of the river. Any redistributed sediments would remain in their new locations, with surveys conducted to ensure that the navigable channel is fully restored.

7.6.1.6 *Abandonment & Decommissioning*

Initially, the impacts of the Abandonment Alternative would be similar to the Mothball Alternative. There would be lowered pools at each site as the dam gates would likely be removed. The Abandonment Alternative is considered unsustainable over the long-term. With this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the remaining pool(s).

Failure of a facility would result in further reduction of the upstream water elevation and the re-establishment of riverine morphology through the affected reach. Increased water velocities could mobilize river sediments. Rates of sediment erosion and downstream aggradation are dependent on the sediment characteristics (grain size, cohesion, and spatial variability) and dam removal method (Tullos et al. 2016, Doyle et al 2004). The river channel through the affected area may be unstable for a number of years following dam failure as sediments shift (Doyle et al 2004, Pizzuto 2002). Dam failure leading to scour of the sediments behind the Monongahela dams or movement of sediments currently trapped within dredge holes could mobilize unknown contaminants. See Section 7.5.6below for more information on contaminants.

As with the Mothball Alternative, lowered water levels would expose large areas of unvegetated bank. Unplanned loss of pool would expose more unvegetated banks in the vicinity of the dam. Emergency bank stabilization, likely with armoring, may be needed to protect existing infrastructure.

7.6.1.7 *Removal*

Removal of the Morgantown, Hildebrand, and Opekiska L/Ds would include changes to the river morphology throughout the project area, similar to the Mothball and Abandonment Alternatives. Removal of the sills would further reduce water levels near the dams. The Removal Alternative allows for planning and implementation of mitigation activities to reduce negative impacts on the ecosystem and surrounding communities. Pre-removal investigation could ensure that mobilization of the sediments behind the dams or trapped within dredge holes would not mobilize contaminants. Bank stabilization actions could begin before or during removal to reduce risk to infrastructure and allow for use of softer stabilization methods such as riparian plantings. Slow draw-down of the water levels could also reduce risk of bank failures.

7.6.2 Vegetative Cover

7.6.2.1 *No Action - Flat Funding*

With the implementation of the Flat Funding Alternative, no impact to the vegetation along or within the Monongahela River would be expected. Operational failure of a facility (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. The river would maintain its existing stepped pool structure.

7.6.2.2 *No Action - Decreased Funding*

Impacts to vegetation from this alternative would be identical to those described for the Flat Funding Alternative.

7.6.2.3 *No Action - Sustainable Funding*

With the implementation of the Sustainable Funding Alternative no impact to the vegetation along or within the Monongahela River would be expected. No change in the status quo that would lead to a change in vegetation is expected.

7.6.2.4 *Transfer*

With the implementation of the Transfer Alternative, no change in the status quo that would lead to a change in vegetation is expected.

7.6.2.5 *Mothball*

During the 5 to 10 year mothball period, a reduction of current pool levels would lead to a narrower river channel, and creation of additional dry land. The bare soils would be quickly colonized by weedy, pioneer species, some of which would be nonnative (Orr and Stanley 2006, Tullos et al. 2016; Shafroth 2002). A planting plan and weed control efforts could reduce colonization of these areas by a high percentage of non-native invasive species. Without intervention, establishment of monocultures of aggressive nonnative plants could impede the succession of some sites to diverse riparian habitats. With weed control, given the surrounding landcover being predominantly forested (Figure 11), seed sources for riparian recovery are readily available. Restoration of the L/Ds following the mothball period would cause the inundation and loss of any newly established vegetation.

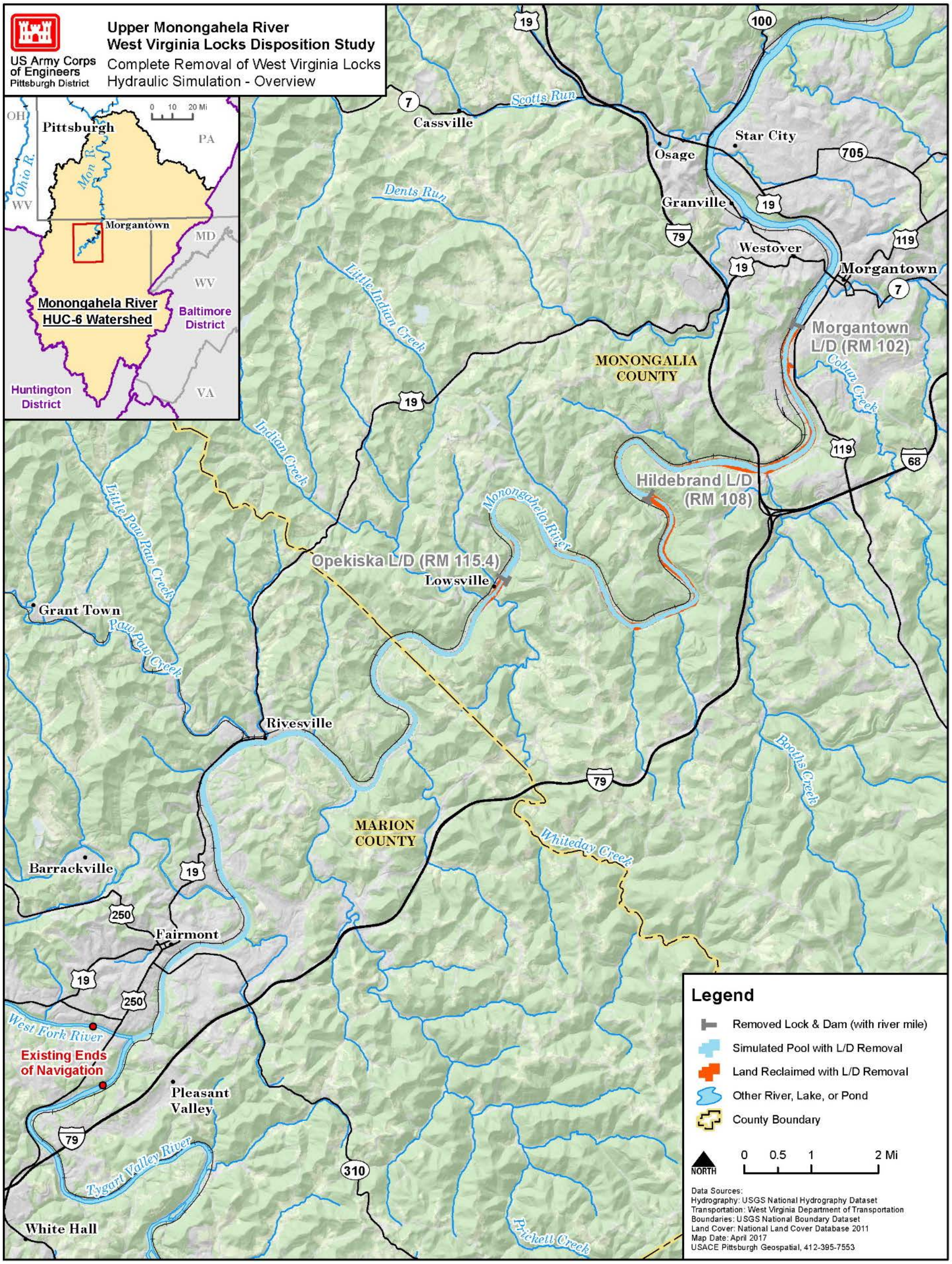


Figure 19. Map of reclaimed lands within the project areas with removal of all 3 L/Ds.

Lowered water levels during the mothball period could dewater the existing wetlands within the project area. Additionally, lowered water levels can cause mortality to riparian vegetation along the former pool margin for species that are sensitive to the water table (Shafroth et. al 2002). The USFWS National Wetlands Inventory shows approximately 8 acres of wetlands, about 0.3 acres per mile, associated with the mainstem Monongahela River in the project area (USFWS 2017a). For comparison, the Tygart River (above the Opekiska pool to the Tygart Dam) averages 0.6 acres of wetland per mile, the West Fork River (upstream of the Opekiska pool to Stonewall Jackson Lake) averages 0.13 acres per mile, and the Cheat River (in the 50 miles of river above Cheat Lake) shows approximately 1.6 acres of wetland per mile. Although existing wetlands may be dewatered, new wetlands may form along the new river margins. Mid-channel islands and shallow edge habitat could emerge. Restoration of key physical processes such as natural flow variability and seasonal flooding may allow for establishment of more fringe wetlands than exists currently. With plant management to reduce expansion of invasive nonnatives, the expansion of wetlands could benefit several plants that are state species of concern which are associated with wetland habitats.

7.6.2.6 *Abandonment & Decommissioning*

Initially, impacts to vegetation of the Abandonment Alternative would be similar to the Mothball Alternative. However, the Abandonment Alternative is considered unsustainable over the long-term. With this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the remaining pool(s). Failure of a facility would include changes to the river both upstream and downstream of the facility with further exposure of new dry land.

7.6.2.7 *Removal*

The removal alternative would result in the dewatering of approximately 220 acres of land. Initially, this would be unvegetated. As noted above, these bare soils would be quickly colonized by weedy, pioneer species, some of which would be nonnative (Orr and Stanley 2006, Tullos et al. 2016; Shafroth 2002). In a review of data from 25 dam removals around the world, Tullos et al. (2016) found that the proportion of nonnative to native plants on former reservoir sites was similar to many riparian floras around the world, though the range was quite varied. Orr and Stanley (2006) found that in Wisconsin, introduced species were a regular and abundant component of plant communities on former reservoir sites. Planned drawdown of the pools would allow for mitigative efforts such as establishment of a planting plan and weed control efforts to reduce colonization by aggressive nonnative plants. With weed control, given the surrounding landcover being predominantly forested (Figure 11), seed sources for riparian recovery are readily available.

As noted for the Mothball Alternative, lowered water levels could dewater the existing wetlands within the project area. New wetlands would be expected to form along the naturalized river. Mid-channel islands and shallow edge habitat could emerge. Restoration of key physical processes such as natural flow variability and seasonal flooding may allow for establishment of more fringe wetlands than is seen currently. With plant management to reduce expansion of invasive nonnatives, the expansion of wetlands could benefit several state species of concern that are associated with wetland habitats.

7.6.3 Fish and Wildlife

7.6.3.1 *No Action - Flat Funding*

With the implementation of the Flat-Funding Alternative no impact to wildlife in the project area would be expected as the status quo would be largely maintained. Operational failure of a facility (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. The complete loss of the operability of the locks would further reduce the movement of fish within the project area. This impact would need to be further explored in order to determine significance, based on a better understanding of how fish are currently able to use the locks, particularly during important migratory seasons. Similarly, use of the locks by species of fish specifically used as hosts for mussel larvae would need to be further studied. Current use of the locks for upstream passage is likely limited due to the lack of attractant flows within the locks and presence of competing attractant flows over the dams. The river would maintain its existing stepped pool structure and overall habitat impacts would be negligible.

7.6.3.2 *No Action - Reduced Funding*

The impacts of this alternative on fish and wildlife would be similar to those described for the Flat Funding Alternative. The loss of recreational lockages further reduces the passage opportunity for fisheries. The reduced maintenance would likely lead more quickly to operational failure, and the complete loss of passage. As described above, the significance of this would need to be further studied to understand how this would impact fish and mussel populations.

7.6.3.3 *No Action - Sustainable Funding*

With the implementation of the Increased O&M Funding Alternative no new impact to the fish and wildlife in the project area would be expected. No change in the status quo is expected. With the continued decrease in commercial lockages anticipated over the 50 year project life, some decrease in fish passage would be anticipated. Lockages for recreation would be expected to continue to provide some continuity and passage opportunity for fisheries.

7.6.3.4 *Transfer*

The Transfer Alternative would not be expected to directly impact wildlife in the project area. The existing pools and terrestrial habitat would be maintained. Impacts to fisheries, discussed below, could impact prey base for some wildlife and birds.

Currently there are no hydropower facilities in the project area, however this alternative assumes that the most likely transfer partner would be hydropower operators. There are applications with FERC to develop hydropower at all three L/Ds.

For aquatic resources, the transfer alternative may have significant negative impacts. Fish injury and mortality from hydropower facilities is possible, though use of low-impact turbines and improved operations can reduce this impact (Čada 2001). Ongoing negotiations for future hydropower on the Corps facilities include requirements for high standards for downstream water quality. The facilities, as run by the Corps, would maintain a non-degradation standard for water quality. The locks and their pools reduce dissolved oxygen in the river due to the transformation from a riverine to a more lacustrine environment. In a free-flowing river, aeration is generated by water flowing over rock-riffles and waterfalls. The Corps operates the locks on nearby rivers to compensate for the lack of naturally generated dissolved oxygen by releasing water over the dam to supersaturate the upstream end of the next pool. With the Transfer Alternative, FERC licenses may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines (and decrease that released through the dam) to increase the power generation of the facilities. During re-licensing, the required water quality standards for the facilities could be reduced to the state minimum. This is likely to result in reduced dissolved oxygen levels downstream of the dams, particularly during periods of low flow.

The continued operation of the locks under this alternative is uncertain. As noted above, the loss of the operability of the locks would further restrict the movement of fish within the project area. This impact to fish and mussels would need to be further explored in order to determine significance of this impact. The river would maintain its existing stepped pool structure and overall habitat impacts would be negligible.

7.6.3.5 *Mothball*

Lowering of the pools would create newly available terrestrial habitat. Impacts to most terrestrial species would be negligible, given the availability of surrounding habitats of similar quality. Species that favor pool habitats, such as waterfowl, would lose habitat in the project area. Species, such as amphibians, that benefit from floodplain habitats and wetlands may gain habitat over time. The rarity of these habitat types in the project area (USFWS 1996) could lead to long-term benefits to amphibian populations in the project area. Additional floodplain forest habitat could also increase habitat available to special status species in the region, such as the Federally-listed Indiana bat.

Impacts of the Mothball Alternative on fisheries would be significant. As noted above, during the mothball period, a reduction of current pool levels would occur as the gated dam would be secured in a raised (open) position (Figure 18) and increased river velocities would likely mobilize sediments. Short-term negative impacts to aquatic species would be expected with the implementation of this alternative. Impacts could include the initial degradation of water quality (increased turbidity from the initial mobilization of fines), sedimentation/burial of spawning habitats, damage/burial of plants and benthic macroinvertebrates, and stranding of fish and dewatering of mussel beds. Increased sediment movement through the reach can occur for several years, as discussed above (Section 3.3.1; Tullos et al. 2016, Doyle et al 2004).

Initial adverse impacts to mussels due to the loss of pool could be significant. Desiccation and stranding of muscles with a loss of pool can cause significant population loss (Nedeau 2006, Sethi et al. 2004). Adverse short-term impacts of the reduced pool level on mussel assemblages and fisheries can be minimized with appropriate planning and timing (Nedeau 2006, Heise et al. 2013). Mussel relocation efforts, particularly for areas known to harbor any species of special concern, could reduce impacts of the action (Nedeau 2006).

Significant long-term benefits to aquatic species could be expected. Riverine morphology would be largely restored within much of the river. This would include an increase of water velocities and decrease of water depths throughout the affected area. Near Opekiska this could create riffles or rapids that would improve aeration and dissolved oxygen levels. Flows would continue to be moderated by upstream dams, but re-establishment of a more natural seasonal hydrograph and restoration of riffle/run and pool/glide channel features would be expected to result in the increase of habitat available to species of concern.

Freshwater mussels are one of the most imperiled groups of organisms on earth (Freshwater Mollusk Conservation Society 2017, Smith and Meyer 2010). Of the 300 species of freshwater mussels once in North America, 38 are presumed to be extinct and an additional 77 are considered critically impaired (Freshwater Mollusk Conservation Society 2017). Impoundments are one of the biggest concerns for river mussels (Brown and Banks 2001) as they disrupt natural flow patterns, change water temperatures and water quality, and block host fish passage (USFWS 2016c, NRCS and USFWS 2010). Re-establishment of connectivity between tributaries, restoration of riverine morphology, decreased water depths, and improvements to water quality within the mainstem could increase muscle populations within the watershed.

Fish can use locks for upstream and downstream migration and population connectivity. However, due to the low number of lockages occurring, particularly during important migration periods, overall fish passage within the project area would be improved with the Mothball Alternative. The dam sills at each facility would continue to act as a fixed crest dam under this alternative. However at Morgantown and Opekiska, the remaining sill would create only a relatively small drop (about 2 feet) in the water surface. This would likely be passable by many fish species during much of the year. Hildebrand would continue to act as a fish passage block, particularly with the loss of lockages.

Aquatic species assemblages within the project area may shift, with a reduction of species that favor warmer lentic habitats and an increase of those favoring cooler lotic environments. Fish assemblage changes have been seen quickly after dam removal in some systems, while others have developed over several years (Gardner et al. 2013, Dorobek et al. 2015). The level of change in muscle and fish populations expected within the 5 to 10 year mothball period is unknown, however restoration of the locks at the end of the mothball period would cause a second shift in population characteristics. The restoration of the slower, deeper habitats of the pools would again favor lentic fisheries and reduce habitat function in the mainstem for native muscles.

The impact of the mothball alternative on invasive species distribution and abundance in the river is uncertain. Because of the limited connectivity, the existing system of L/Ds presents a partial barrier for aquatic invasive species such as species of Asian carp. As of 2011, Pennsylvania Fish and Boat Commission stated that there were no known occurrences of invasive Asian carp in Pennsylvania, though they were in the Ohio River. Asian carp could be within the Monongahela River within 10 years (Thomas 2016). Removal of the fish passage barriers at two of the three dams could ease the spread of invasive aquatic species throughout the project area. Conversely, zebra mussels, colonization of which is a threat to native freshwater mussels, are sensitive to turbulent forces (Horvath and Crane 2010, Smith and Meyer 2010, Rehmann et al. 2003). These mussels thrive in pooled waters and the restoration of free-flowing conditions could decrease the threat of further colonization within the project area. Freshwater jellyfish, which are native to China but have been found in the Monongahela River pools, (USGS 2017) do not persist in flowing waters and their populations would also be expected to diminish (NRCS and USFWS 2010).

7.6.3.6 *Abandonment & Decommissioning*

Initial impacts to fish and wildlife from the Abandonment Alternative would be the same as those discussed above for the Mothball Alternative. With this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the remaining pool(s). The loss of the pool behind the failed facility would result in the re-establishment of riverine morphology throughout the affected reach. Without control of the methodology and timing of a loss of pool, the immediate impacts to species could be significant. Fish passage with this type of dam failure are uncertain, as the method of failure and the resulting condition of the facility and the river in this reach is unknown. As noted above, under the mothball alternative, fish passage at Morgantown and Opekiska would be restored initially with the lowered pool, though a dam failure could inhibit passage.

7.6.3.7 *Removal*

Removal of the L/Ds would create approximately 220 acres of newly available terrestrial habitat. As with the Mothball Alternative, impacts to most terrestrial species would be negligible, given the availability of surrounding habitats of similar quality. Species that favor pool habitats, such as waterfowl, would lose habitat in the project area. Species such as amphibians, that benefit from floodplain habitats and wetlands may gain habitat over time. The rarity of these habitat types in the project area (USFWS 1996) could lead to long-term benefits to amphibian populations in the project area. Additional floodplain forest habitat could also increase habitat available to special status species in the region, such as the Federally-listed Indiana bat.

Short-term negative impacts to aquatic species would be expected with the implementation of this alternative. Impacts would include the degradation of water quality (increased turbidity), sedimentation/burial of spawning habitats, damage/burial of plants and benthic macroinvertebrates, and stranding of fish and dewatering of mussel beds. Increased sediment movement through the reach can occur for several years(Tullos et al. 2016, Doyle et al 2004).

With the implementation of the Removal Alternative, initial adverse impacts to mussels due to the loss of pool would likely be significant. A study in Wisconsin found that a small dam removal caused the loss of 95% of the mussel population in the former impoundment due to desiccation and stranding (Nedeau 2006, Sethi et al. 2004). Adverse short-term impacts of dam removal on mussel assemblages and fisheries can be minimized with appropriate planning, timing, and removal techniques (Nedeau 2006, Heise et al. 2013). Mussel relocation efforts, particularly for areas known to harbor any species of special concern, could reduce impacts of the action (Nedeau 2006).

Significant long-term benefits to aquatic species would be expected. Removal of the Morgantown, Hildebrand, and Opekiska L/Ds would restore free-flowing conditions to approximately 26 miles of river and improve connectivity to many miles of adjoining tributaries. Flows would continue to be moderated by upstream dams, but re-establishment of a more natural seasonal hydrograph and restoration of riffle/run and pool/glide channel features would be expected to result in the long-term increase of habitat available to species of concern.

removal of dams can have a very positive and significant impact on the future restoration of imperiled populations of mussels (NRCS 2007, Sherman and Doyle 2013, Sethi et al. 2004). In 2016, the USFWS led the removal of three dams along the West Fork River in Harrison County. The main goal of the project was to restore free-flowing conditions to approximately 40 miles of river to restore habitat and improve connectivity for aquatic species, including the Federally-endangered clubshell, rayed bean, and snuffbox mussels (Payne 2016, USFWS 2016a, NRCS and USFWS 2010). Particularly, the project increased connectivity for fish host species between known populations of listed-mussels in small tributaries and other nearby suitable, but unoccupied streams. Although no Federally-listed mussels are known to use the mainstem river in the project area, the removal alternative could create suitable habitat within the reach and could improve connectivity between tributaries.

Aquatic species assemblages within the project area may shift, with a reduction of species that favor warmer lentic habitats and an increase of those favoring cooler lotic environments. Assemblages of mussels and fish within impounded environments have shown in-pool variation, with the faster waters and higher dissolved oxygen levels at the upstream end of each pool supporting riverine species that are limited at the downstream end of the pool (Smith and Meyer 2010, Gardner et al. 2013). Fish assemblage changes have been seen quickly after dam removal in some systems, while others have developed over several years (Gardner et al. 2013, Dorobek et al. 2015).

Fish can use locks for upstream and downstream migration and population connectivity. However, due to the low number of lockages occurring, particularly during important migration periods, overall fish passage within the project area would be significantly improved with the Removal Alternative. The addition of 26 miles of riffle/run and pool/glide habitat and the reconnection of populations would significantly benefit fish and mussel populations.

As with the Mothball Alternative, the impact of dam removal on invasive species distribution and abundance in the river is uncertain. Because of the limited connectivity, the existing system of L/Ds presents a partial barrier for aquatic invasive species such as species of Asian carp. As of 2011, Pennsylvania Fish and Boat Commission stated that there were no known occurrences of invasive Asian carp in Pennsylvania, though they were in the Ohio River. Asian carp could be within the Monongahela River within 10 years (Thomas 2016). Removal of the L/Ds could ease the spread of invasive aquatic species throughout the project area. Conversely, zebra mussels, colonization of which is a threat to native freshwater mussels, are sensitive to turbulent forces (Horvath and Crane 2010, Smith and Meyer 2010, Rehmann et al. 2003). These mussels thrive in pooled waters and the restoration of free-flowing conditions could decrease the threat of further colonization within the project area. Freshwater jellyfish, which are native to China but have been found in the Monongahela River pools, (USGS 2017) do not persist in flowing waters and their populations would be expected to diminish (NRCS and USFWS 2010).

7.6.4 Water Quality

7.6.4.1 *No Action - Flat Funding and No Action – Sustainable Funding*

These alternatives would avoid both adverse and beneficial impacts to water quality. These alternatives would have negligible impact on current water quality conditions within the study area. The existing impoundments impact water quality through chemical and physical stratification (metals, conductivity, water temp, dissolved oxygen, etc.) and these alternatives maintain the status quo. Water aeration to increase DO in the navigation channel would continue to occur during spillage through each of the L/Ds. Regional effects of climate and localized effects from point sources and non-point sources would continue to influence water quality as discussed above. From the trends seen in the data we would expect pool DO vertical stratification to continue, as well as decreasing trends in acid mine pollution and increasing trends in nutrients and thermal pollution.

7.6.4.2 *No Action - Decreased Funding*

This alternative would have a negative impact on water quality. Without lockages, there would be an increase in retention times for water in the pools. Coupled with increasing nutrient, sediment, and thermal pollution loads over time, stratification would become more severe and water quality would degrade.

7.6.4.3 *Transfer*

Water quality is a concern in new hydroelectric development at navigation dams because of the reduced mixing of air and water aeration of discharges, increased stratification in downstream pools, increased fish entrainment and mortality, and impediment to both upstream and downstream fish passage during hydropower operation and the re-suspension of contaminated sediments that may occur during construction of the proposed facilities. Hydropower licenses are currently under review by the FERC at Opekiska (FERC No. P-13753), Morgantown (FERC No. P-13762). No hydropower development is currently proposed at the Hildebrand L/D due to second successive preliminary permittee denial by FERC (FERC No. P-13734). Currently no construction has been undertaken. Conditions of the license would require the licensee to conduct studies to determine the spill flow needed to protect DO concentrations and fishery resources. All transfer partners would be governed by the conditions set forth in the FERC license. However, without the Corps as the facility owner, FERC licenses may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines (and decrease that released over the dam) to increase the power generation of the facilities. During re-licensing, the required water quality standards for the facilities could be reduced to the state minimum. This is likely to result in reduced dissolved oxygen levels downstream of the dams, particularly during periods of low flow.

7.6.4.4 *Mothball Alternative*

The reestablishment of a natural flow regime, temperature regime, oxygen levels and sediment transport in portions of the Monongahela River would have significant ecological benefits. Following drawdown, increased water flow in the former pool area would likely re-suspend sediment for some period of time, which would result in increased turbidity and total suspended solids downstream. Over time, this process would result in redistributing the sediment. The remaining dam sills will continue to trap sediment and modify the movement of sediment through the system. Increased water velocity in portions of the former pool area would also likely result in increased aeration, higher dissolved oxygen levels, and reduced stratification. With the restoration of the L/Ds following the mothball period, the inundation of the pools would reinstate the stratification and return the system to its current stepped pool architecture. The inundation of any shoreline vegetation that established during the mothball period could increase the rate of decomposition within the river, leading to depleted oxygen levels and increased stratification as compared to the current condition.

7.6.4.5 *Abandonment Alternative*

The lowering of the pools with this alternative would have impacts similar to the Mothball Alternative. However, the Abandonment Alternative could also produce negative impacts to water quality through contamination due to the increased risk of structural failure and unplanned loss of the remaining pool. During failure there would be a high potential for the resuspension of contaminated sediments which are currently in place behind each L/D structure. Suspension of sediments into the water column can result in the sediments being re-deposited in undesirable locations and in overall short-term water quality degradation.

7.6.4.6 *Removal Alternatives*

Removal of the L/D structures from the Monongahela River would have significant ecological benefits, including the reestablishment of a natural flow regime, temperature regime, oxygen levels, and sediment transport. During the L/D removal, temporary increases in turbidity would likely create short-term degradation of water quality downstream from any work sites. Following dam removal, increased water flow in the former pool area would likely re-suspend sediment from that area for some period of time, which would result in increased turbidity and total suspended solids downstream. Over time, this process would result in redistributing the sediment. Eventually, all sediment available for mobilization would be picked up from the former pool area above the dam and redistributed downstream, creating a more natural bed elevation throughout the channel. Increased water velocity in the former pool area would also likely result in increased aeration and higher dissolved oxygen levels as well as reduced stratification. A long-term net benefit to water quality would be expected.

7.6.5 Air Quality/Greenhouse Gases/Climate Change

7.6.5.1 *No Action - Flat Funding*

Continuation of the current levels of O&M within the project area is not expected to significantly impact air quality, greenhouse gases, or climate change. Although operation of the locks may be compromised over the project life, the pool is expected to be maintained. Incorporation of hydropower facilities into the dams within the project life would minimally increase the level of emissions at the sites, though would have a beneficial impact on emissions within the region. In West Virginia, the vast majority of the net electricity generation is coal-fired (94.2%; USEIA 2016). Hydropower currently generates 2.5% of West Virginia's electricity (USEIA 2016). Electricity generation by hydropower produces much less emissions than coal-fired power plants, with lifecycle CO_2-equivalent emission per kWh being 34 times greater for coal (Schlömer et al. 2014). Increasing the availability of hydropower for the region would decrease dependence on coal-fired plants and improve air quality.

Expected impacts of climate change on this alternative are minimal. Periodic droughts and severe spring flood events may reduce the ability to navigate the river at times. Impacts to the L/Ds from the low or high flow periods or to the increase in water temperatures is expected to be minimal.

7.6.5.2 *No Action - Decreased Funding*

Under this alternative, the continued degradation of the L/D facilities may deter investment by hydropower operators. Therefore the potential benefit to air quality from hydropower may not be actualized and the status quo would be maintained.

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.3 *No Action – Sustainable Funding*

Increased levels of O&M funding is not expected to significantly impact air quality, greenhouse gases, or climate change. As noted above, incorporation of hydropower facilities into the dams within the project life would minimally increase the level of emissions at the sites, though would have a beneficial impact on emissions within the region by decreasing dependence on coal-fired plants.

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.4 *Transfer*

With implementation of the Transfer Alternative, the facilities would likely be transferred to hydropower operators. As hydropower generation emits extremely low amounts of pollutants, this alternative could result in improved air quality and reduced greenhouse gas emissions within the state.

Impacts of climate change on the Transfer Alternative could include an increased risk for potential transfer partners. During periods of drought, the hydropower facilities would generate a reduced amount of electricity or potentially would be unable to generate power at all.

7.6.5.5 *Mothball*

Implementation of the Mothball Alternative would impede hydropower development throughout the mothball period. There are no hydropower facilities that would be impacted by this alternative, however there are applications with FERC to develop hydropower at all three L/Ds in the study area. The lost opportunity for hydropower at the Monongahela L/Ds would maintain the status quo for emissions in the state. The restoration of the L/Ds following the mothball period may restore the potential for hydropower development.

The lowering of the pool for this alternative would create new dry land for plant growth. As plants grow, they sequester carbon from the air through photosynthesis. Sequestration rates of vegetation vary greatly according to the age, composition, location, and the type of soil (Tufts University 2017). Initial vegetation growth would be expected to sequester larger amounts of carbon, with the amount decreasing over time as root structures and above ground biomass stabilize (EPA 2017d, Anwar 2001). The restoration of the L/Ds and their associated pools at the end of the mothball period would cause the inundation and loss of these plants. The rapid decomposition of this vegetation could produce large amounts of greenhouse gases (Graham-Rowe 2005, Sorensen 2016, Deemer et al. 2016).

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.6 *Abandonment & Decommissioning*

The loss of the pool coupled with the high risk of failure of the facility would preclude hydropower investment at the L/Ds. Therefore the potential benefit to air quality from hydropower may not be actualized and the status quo would be maintained

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.7 *Removal*

Temporary impacts to air quality from the removal project would include the emissions created by the use of heavy equipment to conduct the onsite (demolition and site restoration) work and from trucks used to transport debris or other materials and personnel during construction. This short-term impact would not be significant.

As noted above, there are no hydropower facilities currently at these sites, however there are applications with FERC to develop hydropower at all three L/Ds in the study area. The lost opportunity for hydropower at the Monongahela L/Ds would maintain the status quo for emissions in the state.

EPA (2009) published a rule that established mandatory reporting for sources that emit over 25,000 metric tons of CO_2-equivalent. In 2015, eight facilities in Monongalia County reported 10,756,243 metric tons of CO_2-equivalent, with 91% of these emissions from 3 power plants (EPA 2016c). The forecasted amount of electricity generated through the proposed hydropower facilities in the study areas could potentially reduce power plant emissions by 100,000 metric tons CO_2-equivalent annually by moving from coal to hydropower (Schlömer et al. 2014). In 2015, over 8000 facilities nationwide reported direct emissions of a total of 3.05 billion metric tons of CO_2-equivalent, which is about half of the nation’s total GHG emissions (EPA 2017c).

As plants grow, they sequester carbon from the air through photosynthesis. Sequestration rates of vegetation vary greatly according to the age, composition, location, and the type of soil (Tufts University 2017). Initial vegetation growth would be expected to sequester larger amounts, with the amount decreasing over time as root structures and above ground biomass stabilized (EPA 2017d, Anwar 2001). Although the actual amounts of carbon that would be sequestered are difficult to assess, rough estimates can provide perspective. Using cropland biomass numbers to roughly estimate the annual carbon sequestration for the initial years, 220 acres of new vegetation would sequester approximately 444 metric tons of carbon (2.02 tons of carbon sequestered per acre, EPA 2017e). By year 50, assuming all land were to become forested, approximately 233 metric tons would be sequestered annually (1.06 tons of carbon sequestered per acre, EPA 2017e). Although these sequestration numbers are rough guidelines, they show that the newly vegetated land would provide minimal assistance in offsetting emissions in the county.

Impacts of climate change on the Removal Alternative may include the moderation of the potential benefits for sensitive species. Warming trends and increased frequencies of droughts and heavy downpours may stress the aquatic environments, such that the long-term benefits of restoring a riverine system are reduced.

7.6.6 Hazardous, Toxic, and Radioactive Waste

7.6.6.1 *No Action - Flat Funding*

With implementation of the No Action – Flat Funding Alternative, no impact resulting from HTRW in the project area would be expected as the status quo would be largely maintained. Operational failure of a facility (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. Assuming that hazardous and petroleum products would be removed from the facilities once they are no longer operable, operational failure may have some minor benefit in that occasional minor accidental spills of hazardous materials and petroleum products used for operation of the facility would be largely eliminated.

7.6.6.2 *No Action – Reduced Funding*

With implementation of the No Action – Reduced Funding Alternative, impacts resulting from HTRW would be similar to the No Action – Flat Funding Alternative. Decreased funding could lead to operational failure earlier as compared to the No Action – Flat Funding Alternative. Assuming that hazardous and petroleum products would be removed from the inoperable facilities, minor benefits may result in that occasional minor accidental spills of hazardous materials used for operation of the facility would be largely eliminated.

7.6.6.3 *No Action – Sustainable Funding*

With implementation of the No Action – Sustainable Funding Alternative (increased O&M), impacts resulting from HTRW would be largely similar to the No Action – Flat Funding Alternative. Some minor benefits may result with sustainable funding in that potential upgrades to the L/D facilities may result in fewer hazardous material spill incidences.

Increased O&M funding may also provide more opportunities for maintenance dredging of the L/D areas. While some short-term impacts may be expected from disturbance of contaminated sediment during dredging, some long-term benefits may result from the permanent removal of potentially contaminated sediment from the waterway.

7.6.6.4 *Transfer*

The Transfer Alternative may result in HTRW-related impacts. The assumption with the Transfer Alternative is that the L/D facilities would be transferred to hydropower operators. Assuming that some construction of the hydropower facilities would occur in-water, HTRW-related short-term impact may result from disturbance and downstream migration of potentially contaminated sediment during construction. In addition, flow patterns during operation of the hydropower facility may result in some turbidity/disturbance of contaminated sediments within the study area. This could result in resuspension and transport of contaminated sediment downstream and/or release of dissolved contaminants into the water column.

Further studies and implementation of a sampling and testing program would likely be required to identify and quantify contaminants and characterize the geotechnical and hydraulic properties prior to construction. If contaminants are present above USEPA sediment screening criteria, a mitigation plan would likely be required to reduce potential migration of these contaminated materials downstream during construction activities and/or operation of the hydropower facilities. These plans could include potential stabilization of the contaminated sediment (i.e. in-situ treatment, capping or placement of geotextiles) and/or dredging or excavation of contaminated sediments in a controlled manner prior to construction of the hydropower facility. Any contaminated sediment removed from the site would likely involve treatment of the sediment and water and/or transport to a disposal facility (EPA 2005). Short-term impacts to the aquatic resources may still occur from some sediment disturbance associated with mitigation of contaminated sediment prior to implementation of hydropower facilities. However, long-term benefits would also be expected due to permanent removal and/or stabilization of contaminants that would otherwise potentially continue to impact the waterway.

FERC licenses for hydropower facilities may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines (and decrease that released over the dam) to increase the power generation of the facilities. Changes in flow could increase resuspension of contaminated sediments resulting in short-term and long-term impacts downstream.

Other HTRW-related risks and concerns associated with the Transfer Alternative include the introduction of additional hazardous materials and petroleum products to be used for operation of the hydropower facility.

7.6.6.5 *Mothball*

The mothball alternative considers short-term sustainment of facilities with the option to reopen a facility. This would require materials and fuels necessary for operation of the facility to remain onsite during the period of time that the facility is effectively out of commission.

Because the facilities are maintained in a state where they could be restarted, some fluids and potentially hazardous materials will remain. Therefore, the Mothball Alternative has the risk of spills and/or leaks of potentially hazardous materials and petroleum products into the river. These spills or leaks could occur from a catastrophic failure or from slow degradation of the facility. Without routine inspections and staff on site, unknown/unreported leaks may occur that could result in widespread downstream impacts to sediment quality, water quality, and aquatic resources.

Increased flows due to the lowered pool could cause the resuspension of contaminated sediments within the river. As with the Transfer Alternative, a sampling and testing program would likely be required to identify and quantify contaminants and characterize the geotechnical and hydraulic properties prior to implementation. If contaminants are present above USEPA sediment screening criteria, a mitigation plan would likely be required to reduce potential migration of these contaminated materials downstream. These plans could include potential stabilization of the contaminated sediment (i.e. in-situ treatment, capping or placement of geotextiles) and/or dredging or excavation of contaminated sediments in a controlled manner prior to lowering the pool. Any contaminated sediment removed from the site would be treated and/or transported to a disposal facility (EPA 2005). Short-term impacts to the aquatic resources may still occur from some sediment disturbance associated with mitigation of contaminated sediment. However, long-term benefits would also be expected due to permanent removal and/or stabilization of contaminants.

7.6.6.6 *Abandonment & Decommissioning*

Impacts of this alternative are similar to the Mothball Alternative in that mitigation action would be required prior to the pool lowering so that increased flows would not cause movement or resuspension of contaminants. Additionally, under the Abandonment and Decommissioning Alternative, there is high risk of structural failure of one or more of the L/D facilities to occur at some point within the 50-year project period.

With any catastrophic failure, HTRW-related risk from migration of any potentially contaminated sediment accumulated behind the L/D structures downstream is significant. In addition, the breach of any structure could lead to an uncontrolled loss of pool behind the failed facility and therefore could result in significant turbidity and scouring of sediment near or downstream of the facility. The result could be a substantial migration of resuspended contaminated sediment and dissolved contaminants downstream; short-term and long-term impacts to aquatic and terrestrial species would be expected to be significant.

Unlike the Mothball Alternative, it would be expected that prior to abandonment the facilities would be abated of any potential PCBs, lead, asbestos or creosote in building materials or equipment and that potential hazardous materials or petroleum products would be removed from the site. As a result, catastrophic or gradual failure of the structures would not be likely to result in inadvertent spills or introduction of hazardous materials into the waterway.

7.6.6.7 *Removal*

As a result of the historic industrial and agricultural nature of the Monongahela riverbank, there is a potential for contaminants to be present in accumulated sediment and materials behind or near L/D structures. Implementation of the Removal Alternative could result in significant disturbance and potential migration of contaminated sediments and materials to downstream locations.

Short-term impacts from the release of accumulated sediment behind L/D structures during removal activities would be expected, including potential resuspension and downstream transport and deposition of contaminated sediment. During resuspension, the release of dissolved contaminants from sediment into the water column may occur resulting in impaired water quality and easier transport of contaminants to destinations even further downstream (EPA, 2005).

Depending upon the extent and type of sediment contamination, long-term impacts could also potentially be expected from the downstream release of resuspended sediment and dissolved contaminants. Negative impacts from the disturbance and release of contaminants can affect drinking water quality, aquatic species and potentially terrestrial species in downstream reaches (Bountry et al. 2009). Case studies of previous dam removals/failures have indicated contaminated sediment release can result in serious environmental impacts downstream (Evans, 2015 and Hart et al. 2002).

Implementation of the Removal Alternative would likely involve mitigation of HTRW prior to removal of the L/D structures. HTRW-related risk during removal activities could be minimized by identifying the type and extent of contamination. Prior to removal activities, further studies and implementation of a sampling and testing program would likely be required to identify and quantify contaminants and characterize the geotechnical and hydraulic properties at each L/D facility. The scope of sampling for contaminants would be similar to a Phase II Environmental Site Assessment (ESA) and would include input and criteria as identified by EPA and applicable state regulatory agencies.

If contaminants are present above EPA sediment screening criteria, a mitigation plan would likely be required to reduce potential migration of these contaminated materials downstream during removal activities. These plans could include potential stabilization of the contaminated sediment (i.e. in-situ treatment, capping or placement of geotextiles) and/or dredging or excavation of contaminated sediments in a controlled manner prior to removal of structures. Any contaminated sediment removed from the site would likely involve treatment of the sediment and water and/or transport to a disposal facility (EPA 2005). Short-term impacts to the aquatic resources may still occur from some sediment disturbance associated with mitigation of contaminated sediment prior to removal of the structures. However, long-term benefits would also be expected due to permanent removal and/or stabilization of contaminants that would otherwise potentially continue to impact the waterway.

Other HTRW-related risks and concerns associated with the Removal Alternative include the removal and/or abatement of existing hazardous or contaminated material from the L/D facilities. Current operation of the L/D facilities includes storage and/or use of hazardous materials and petroleum products, some of which could potentially impact the environment if a spill or release were to occur. Existing above-ground storage tanks (ASTs) which store petroleum products would need to be drained and removed. Prior to demolition, building materials and equipment at the facility which could contain PCBs, lead, asbestos, or creosote would need to be tested and/or identified and would likely be required to be removed and disposed of at a properly permitted facility.

7.7 Cultural Resources and Historic Properties

7.7.1.1 *No Action - Flat Funding*

Under the flat funding scenario, continued deterioration of the facility would be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Lacking adequate funding to maintain the facility or comply with Section 106 would place the Corps out of compliance.

7.7.1.2 *No Action - Decreased Funding*

Impacts of this alternative on cultural resources would be identical to those impacts discussed above for the Flat Funding Alternative.

7.7.1.3 *No Action - Sustainable Funding*

Under the increased O&M funding scenario, major maintenance work would be subject to Section 106 consultation, and any adverse effects taken into account as part of the work (36 CFR 800.5(a)(2)(ii)). Should a major rehabilitation study be pursued, it would be more likely that Section 106 compliance may lead to a mitigation requirement stipulated in a Section 106 Memorandum of Agreement. Typically these mitigation requirements involve documentation of the original design and historic interpretive products for public distribution. Neither of these would affect the engineering requirements or construction schedule if appropriately pursued with adequate lead time.

7.7.1.4 *Transfer*

Transfer of a federal property out of federal ownership, if that property is eligible for listing to the National Register of Historic Places, is an adverse effect under Section 106 criteria (36 CFR 800.5(a)(2)(vii)). Attaching permanent historic preservation covenants to the deeds is often adequate for Section 106 compliance. If the transfer recipient is unwilling to accept these covenants, some form of mitigation would be necessary.

7.7.1.5 *Mothball*

While remaining in federal ownership, facility deterioration, due to lack of maintenance funding, could be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Section 106 compliance prior to mothballing the facility may lead to a mitigation requirement stipulated in a Memorandum of Agreement. Typically these mitigation requirements involve documentation of the original design and historic interpretive products for public distribution.

Under this alternative, the effects of pool lowerings would also need to be considered through studies to identify and evaluate properties along the affected riverbanks, and determine effect of pool lowering.

7.7.1.6 *Abandonment & Decommissioning*

While remaining in federal ownership, facility deterioration, due to lack of maintenance funding, would be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Section 106 compliance prior to abandonment may lead to a mitigation requirement stipulated in a Memorandum of Agreement.

Typically these mitigation requirements involve documentation of the original design and historic interpretive products for public distribution. Marketing for adaptive reuse is a typical requirement with disposal proposals, but if the disposition study found that there is no willing transfer partner, marketing would not likely be required.

Under this alternative, the effects of pool lowerings would also need to be considered through studies to identify and evaluate properties along the affected riverbanks, and determine effect of pool lowering.

7.7.1.7 *Removal*

The partial or total removal (deconstruction) of an historic L/D property would be an adverse effect under Section 106 criteria (36 CFR 800.5(a)(2)(i)). Under this alternative, the effects of pool lowerings would also need to be considered through studies to identify and evaluate properties along the affected riverbanks, and determine effect of pool lowering.

7.8 Comparison of Alternatives

7.8.1 Cost Comparison

Table 21. O&M Scenario Costs (April 2017 Dollars)

Alternative	Costs	
No Action - Flat Funding	Annual	50 Year
Morgantown	938,872	46,943,600
Hildebrand/Opekispa (per project)	169,006	8,450,300
Total No Action - Flat Funding	**1,276,884**	**63,844,200**
No Action - Sustainable Funding	Annual	50 Year
Morgantown	938,872	46,943,600
Hildebrand/Opekispa (per project)	333,230	16,661,500
Total No Action - Sustainable Funding	**1,605,332**	**80,266,600**
No Action - Reduced Funding	Annual	50 Year
Morgantown/Hildebrand/Opekiska (per project)	169,006	8,450,300
Total No Action - Reduced Funding	**507,018**	**25,350,900**

Table 22. Constructed Alternative Costs (April 2017 Dollars)

Alternative	Costs			
	Lump Sum	Annual	Recovery	Total – 5/10 year
Mothball - 5 Year Recovery	148,100	100,895	2,077,000	2,729,576
Mothball - 10 Year Recovery	148,100	120,895	2,384,000	3,741,052
	Lump Sum	**Annual**	**Recovery**	**Total – 50 year**
Mothball - 10 Year Abandon	148,100	100,895	2,550,395	3,647,447

			(Prep for Abandonment)	
Abandon	2,789,651	0	N/A	2,789,651
Remove	20,159,963	0	N/A	20,159,963
Transfer	233,000	0	N/A	233,000

7.8.2 Screening and Selection Criteria

In order to screen alternatives and present findings, a set of criteria was developed by the PDT. In addition to the four criteria required by the Principles and Guidelines of completeness, effectiveness, efficiency and acceptability, the team also choose environmental impacts, socioeconomic impacts, budgetability, cost, safety, and risk. Following is a description of each of the criteria and how each criteria is rated for comparison. The full rating of alternatives is located in Section 7.7.

Completeness: The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.
Red – High probability planned effects will not be met without significantly higher costs
Amber – Moderate probability planned effect will not be met without higher costs
Green – Low probability that planned effect will not be met without higher costs

Effectiveness: The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. The performance against the planning objectives was used to assess effectiveness of alternatives for this study.
Red – Does not resolve the majority of defined problems or does not achieve opportunities
Amber – Resolves some defined problems and/or achieves some opportunities
Green – Resolves or mitigates for all defined problems and achieves some opportunities

Efficiency: The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and achieving the opportunities. A relative comparison of cost effectiveness was conducted based on assumptions and existing information.
Red – Does not achieve majority of identified opportunities or alleviate problems in a cost effective manner
Amber – Achieves some identified opportunities and/or alleviates some problems in a cost effective manner
Green – Meets all or most identified opportunities and alleviates most problems in a cost effective manner

Acceptability: The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations and public policies. The extent to which alternatives avoided planning constraints was used to assess acceptability for this study.

Red – Not acceptable to most stakeholders or not compatible with existing law
Amber – Not acceptable to one or more major stakeholders
Green – Acceptable to all major stakeholders and compatible with existing law

Environmental Impacts: A relative assessment of the potential for environmental impacts and environmental benefits was assessed to include affects to federally listed species and water quality.

Red – Increased environmental degradation within the study area
Amber – Limited or no change to the affected environment
Green – Overall environmental improvement within the study area

Socioeconomic Impacts: This criteria includes assessments of the potential to impact recreation, water supply, hydropower, and other socioeconomic factors.

Red – Socio-economic outlook within the study area is negatively impacted
Amber – Limited or no socio-economic impact
Green – Socio-economic outlook within the study area is improved

Cost: This is a measure of the overall cost to the federal government to implement the alternative over the 50 year period of analysis.

Red – High initial or 50 year costs compared to No Action
Amber – Similar initial and 50 year costs to the No Action
Green – Lower initial and 50 year costs compared to No Action

Budgetability: This is a measure of the likelihood that the Corps will be able to secure the necessary funding in a timely manner needed to efficiently implement the alternative.

Red – Alternative cannot be budgeted for without changes to the process or law
Amber – Budgeting mechanisms exist but the alternative does not compete favorably
Green – Budgeting mechanism exist and could receive the identified level of funding

Safety: Although improvement to safety is also identified as a study objective, it was included as an evaluation criteria because the potential impacts to public safety as a result of a federal action is an important consideration as to whether or not an alternative is viable.

Red – Increased safety risk compared to current conditions
Amber – Similar safety risk to current conditions
Green – Safety risk decreased or eliminated

Risk: The extent to which an alternative mitigates for, or maintains a maximum threshold of acceptable risk to the agency over time. This criteria is primarily concerned with operational or structural failure at a project site.

Red – Risk is increased or higher than current conditions
Amber – Moderate risk, comparable to current conditions
Green – Long-term risk is low or eliminated

7.8.3 Evaluation

The table below shows a comparison between alternatives based on 10 evaluation criteria. None of the alternatives investigated met/remained neutral (amber) or improved/exceeded (green) in all of the criteria. Four criteria in particular did not meet or degraded current conditions for three or more alternatives: completeness, acceptability, socioeconomic impacts, and risk. These criteria, discussed below, are the greatest concern for successful implementation of the alternatives considered. Further evaluation of alternatives would require development of mitigation measures or key concerns that would need to be resolved in coordination with the affected stakeholders prior to a recommendation being made.

Table 23. Evaluation Criteria per Alternative.

Criteria	NA-Flat	NA-LoS 6	NA-Sust	Transfer	Mothball	Abandon	Remove
Completeness	Red	Red	Amber	Green	Red	Amber	Green
Effectiveness	Red	Red	Green	Green	Amber	Amber	Amber
Efficiency	Amber	Amber	Red	Green	Red	Green	Green
Acceptability	Amber	Amber	Amber	Red	Red	Red	Amber
Environmental Impacts	Amber	Amber	Amber	Amber	Amber	Amber	Green
Socioeconomic Impacts	Amber	Amber	Green	Red	Red	Red	Red
Cost	Green	Green	Red	Green	Amber	Green	Red
Budgetability	Green	Green	Amber	Green	Amber	Green	Amber
Safety	Amber	Amber	Green	Amber	Amber	Red	Green
Risk	Red	Red	Amber	Amber	Amber	Red	Green

Completeness: With the exception of removal and transfer, none of the alternatives are considered a complete solution to the project status over the 50 year study period. The projects under consideration range from 60-70 years old. Without significant reinvestment it is unlikely that the locks would remain functional until 2067. Operational failure is likely even under a sustainable funding scenario. Continued operations under reduced or static funding would likely lead to an operational or structural failure within the next 10 years. See the alternative descriptions for more discussion on operational and structural failures and critical maintenance for suspect failures.

Acceptability: There are competing interests on the Monongahela River with different preferred outcomes. Environmental advocacy groups, such as American Rivers, prefer removal and return to a free flowing river. Economic development and recreation groups oppose any alternative that would limit or eliminate the flow of traffic affecting future development of river dependent industry. Finally, hydropower permit holders need the dams to be maintained for future development. Competing stakeholder interests make it impossible to find an alternative that would meet the needs of all interested parties.

Socioeconomic Impacts: Closure and removal of facilities would reduce recreational opportunities, and eliminate remaining commercial traffic through the locks. There is also potential to discourage future investment in the region should lock closure negatively impact transportation costs.

Risk: Continued operations of the projects at static or reduced funds creates a high risk of operational failure during the study period. Abandonment would increase the risk of an unplanned loss of pool during the study period as facilities degrade and inspections are reduced. Figure 19 shows a conceptual comparison of risk between alternatives. Without disposal of the projects risk will continue to grow at varying rates as the facilities age until there is a failure or major reinvestment in the facility.

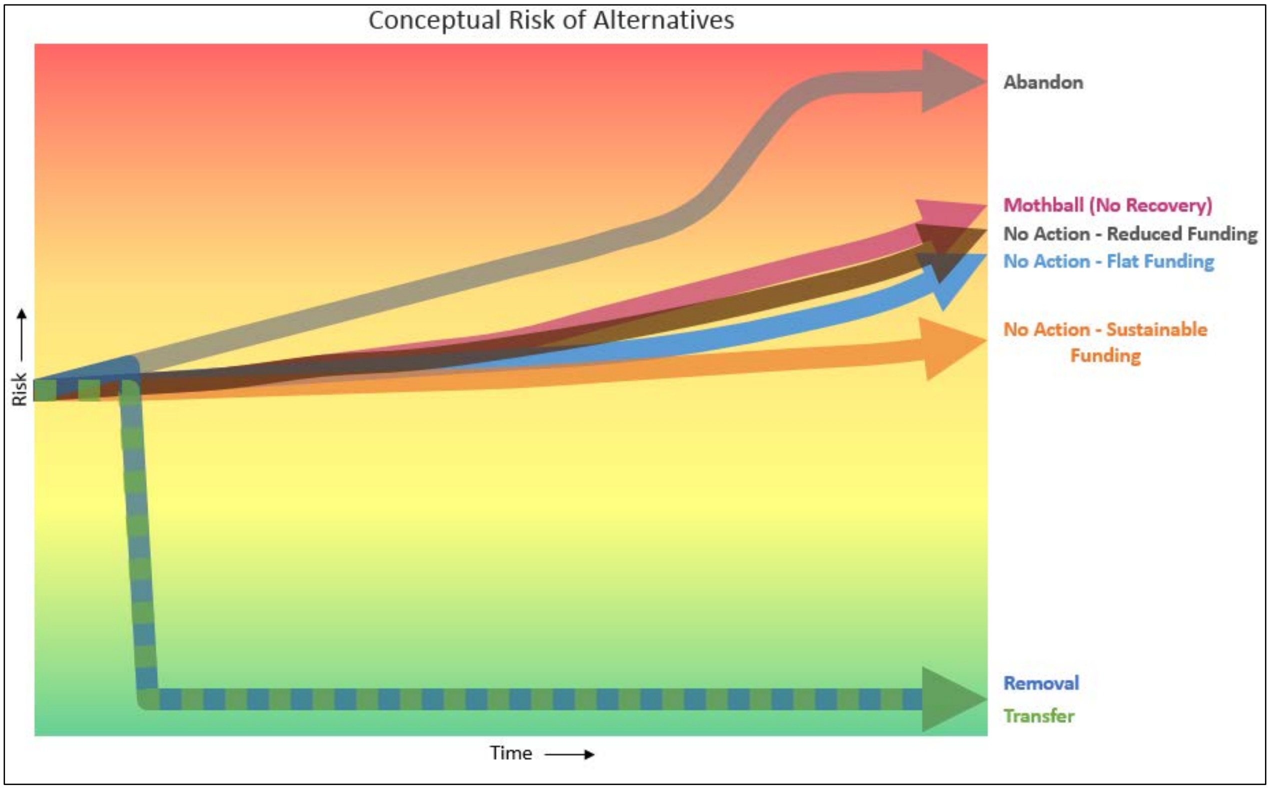


Figure 20. Conceptual Risk of Alternatives

A comparison of alternatives show that none meet all the evaluation criteria used for assessment. Each alternative fails under two or more criteria meaning that further investigation would be needed to develop a mitigation strategy and fully understand the impacts of implementation of any of these alternatives.

8 ENVIRONMENTAL COMPLIANCE CONSIDERATIONS

Federal Laws and Executive Orders	Compliance Considerations
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq	It is anticipated that Morgantown, Hildebrand, and Opekiska L/Ds will be determined eligible for listing to the National Register of Historic Places. Any actions that would have an adverse effect on these facilities, or remove them from federal ownership, will require further effort to ensure compliance with these laws. Implementation of any alternative that could cause the lowering or loss of the pool would require further analysis to identify and evaluate areas vulnerable to increased erosion along the affected riverbanks and possible impacts to protected resources.
Archaeological Resources Protection Act, 16 U.S.C. 470aa-11, et seq	
Historic Sites Act, 16 U.S.C. 461-467, et seq.	
National Historic Preservation Act, 16 U.S.C. § 470 et seq.	
Native American Graves Protection and Repatriation Act of 1990, as amended, 25 USC 3001-3013	
Bald and Golden Eagle Protection Act, 16 U.S.C. 668, et seq	Bald eagles are seen periodically near the L/Ds though nest locations are unknown. Prior to any construction action associated with a proposed alternative, surveys would be needed to ensure compliance. No impacts to eagles would be expected from implementation of any of the proposed alternatives.
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Emissions from construction activities associated with various alternative (maintenance activities or demolition) would be de minimis. The forecasted amount of electricity generated through the proposed hydropower facilities could potentially reduce power plant emissions by 100,000 metric tons CO_2-equivalent annually by moving from coal to hydropower (Schlömer et al. 2014). Several of the alternatives would likely result in the lost opportunity for hydropower at the Monongahela L/Ds, thereby maintaining the status quo for emissions in the state.
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C	The potential exists for contaminated sediment to be located in the study area. Further studies and/or implementation of a sampling program to identify extent of any contaminants would likely be required prior to implementation of any alternative that would disturb sediment in the study area.

Clean Water Act, as Amended, 33 U.S.C. §1251 et seq.	The Action Alternatives would require further analysis for compliance with Sections 404 and 401 as in-water work could include discharge of temporary or permanent fill material into waters of the U.S. and the lowering of the pools could cause the dewatering of existing wetlands. Any construction sites which disturb over one acre of ground must control stormwater runoff and receive authorization through a permit for compliance with Section 402. A Stormwater Pollution Protection Plan would be needed and a Construction General Permit obtained from the WVDEP prior to construction.
Endangered Species Act of 1973, as amended, 16 U.S.C. §§ 1531-1544	As no Federally-listed aquatic species are found in the project area, impacts to species protected under the ESA are unlikely. Long-term benefits to listed species could occur. Although no Federally-listed mussels are known to use the mainstem river in the project area, the removal alternative could create suitable habitat within the reach and could improve connectivity between tributaries for future population expansion.
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Initial scoping letters were sent to the USFWS on 3 Feb 2017. On 7 Mar 2017, the USFWS responded that they were interested in the study and would like to remain involved in the project. Their initial response stated "Although the Monongahela River currently does not provide habitat for any federally listed freshwater mussels species, the alternative proposing the removal of the locks and dams would convert the river to free-flowing conditions and could create suitable habitat for freshwater aquatic species, which would be beneficial to the recovery of listed freshwater mussels. Other alternatives may provide opportunities to enhance fish and wildlife resources within the Monongahela River or adjacent terrestrial and riparian areas." Implementation of any of the action alternatives would require further consultation with the USFWS to ensure compliance with the FWCA.
Migratory Bird Treaty Act, 16 U.S.C. 703, et seq.	Construction activities (maintenance/repairs or demolition) would seek to avoid nesting periods for any tree removal activities and a survey for nesting

	activities would be conducted prior to clearing and grubbing to ensure compliance with this act. No significant negative impact to migratory birds is anticipated with any of the alternatives.
National Environmental Policy Act, 42 U.S.C §4321 et seq.	This analysis has determined that effects to the human environment as a result of various alternatives could be significant for socioeconomics, recreation, navigation, cultural resources, water quality, greenhouse gas emissions, fisheries, and/or species of special concern. Pursuit or further development of any of the action alternatives would require development of an environmental impact statement. Public participation would also be needed for NEPA compliance.
Rivers and Harbors Act, 33 U.S.C. 401 et seq.	All of the alternatives except the Sustainable Funding Alternative would adversely impact navigation by either removal, lock closing, or probable operational failure. Each of the alternatives is being reviewed for its potential impacts to navigability and other resources. This information is being presented to Corp's decision-makers for their consideration. The final disposition of these facilities would be recommended by the Chief of Engineers and authorized by the Secretary of Army, as required by this Act.
Executive Order 12898, Environmental Justice	Based on the demographic indicators, there is a moderate potential for protected populations to be disproportionately impacted by this project. The most likely stressor that could occur is increased exposure to contaminants within the sediments behind the dams. This impact could occur due to an unexpected structural failure, the risk of which is elevated with several of the alternatives. Additionally, the increased risk of spills or leaks due to insufficient maintenance, as associated with several of the alternatives, could negatively impact water quality and fish and wildlife populations downstream. Given the existing consumption advisories coupled with the high percentile of low-income people, implementation of any of the study alternatives would require further analysis for the impacts on environmental justice. Additionally, implementation

	of any of the alternatives would require further public participation, as required by EO 12898.
Executive Order 11988, Floodplain Management	No impact on floodplain development would occur with this project. Under some alternatives river levels would drop. With this, new lands would be created which could provide additional flood storage capacity in the area.
Executive Order 13112, Invasive Species	The impact of pool lowering and dam removal on invasive animals is uncertain as increased mobility within the river could allow for the spread of some species, while the restoration of natural flow characteristics could decrease other populations. New lands created with some of the alternatives could be colonized by invasive plant species. An adaptive management plan would need to be created if these alternatives were pursued.
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	None of the alternatives would disproportionately affect children or increase health or safety risks for children.
Executive Order 11990, Protection of Wetlands	Any alternatives that cause or potentially allow the loss of pool has the potential to dewater existing wetlands. The Corps will coordinate with its regulatory section to ensure compliance with this executive order if any of these alternatives is to be pursued.

9 FINDINGS

This study examined the federal interest in retaining these projects for their authorized commercial navigation purposes, as well as alternatives such as changing the level of project O&M funding, project removal, project transfer to a third-party, or abandonment in-place. Because agency disposition study guidance primarily addresses application of Section 216 requirements to authorize project disposition via a transfer alternative, this report is considered informational in nature only. The report identified alternatives warranting additional consideration in future studies, but no recommendations were made.

Further evaluation of the alternatives identified in this document could occur under a disposition study or a feasibility study, in which each alternative's potential impacts would be subject to National Environmental Policy Act review at a level commensurate with the scope of study's proposed impacts and/or preferred alternative.

Finding 1. Under the current authroitized purpose of commercial navigation the projects produce a negative net economic benefit, a Federal Interest exists to pursue disposal opportunities.

Finding 2. The study has identified public and private agencies and organizations that have an interest in maintaining some or all of the project infrastructure. At the time of this report, none of these potential transferees were interested in negotiating a transfer.

Finding 3. This level of study is limited in scope by design. So, it is not appropriate to recommend a specific alternative at one or more project without substantial public involvement, additional analysis (environmental, economic, etc), and further modelling to quantify impacts and develop mitigation strategies.

Finding 4. Comparison of these alternatives against the evaluation criteria show that no alternative meets all criteria. At least one of the proposed alternatives (removal) would require preparation of an environmental impact statement.

Finding 5. The L/Ds have outlived their design life and are in need of significant investment to maintain utility and safety over the next 50 years. And though the need driving the purpose for which the facilities were initially authorized has diminished, the communities surrounding the facilities have developed cultural and economic ties to them.

Finding 6. This study showed that the current commercial use of the facilities and the annual expenditure for maintaining the structures will not produce overall net positive national economic development benefits based of commercial navigation alone. Federal stewardship of these facilities for commercial navigation alone over the next 50 years does not appear to be feasible. However, a comparison between monetary efficiencies and non-monetary benefits (such as cultural desires or environmental lift), is appropriate, but not easily quantified.

Finding 7. Future study is warranted. Any such study should include community outreach, an assessment of transfer partner viability (either to maintain the status quo or to diversify project use), and consideration of returning to a free-flowing river.

10 RECCOMENDATION

This study has included an examination of all potential and practicable alternatives to analyze potential changes to the Morgantown, Hildebrand, and Opekiska L/Ds on the upper Monongahela River managed by the Corps.

Under the disposition study guidance no federal action could be recommended. A negative report under the disposition study implementation guidance does not mean that the alternatives considered in this study would not be suitable for implementation. The study found viable alternatives, however they would need further investigation and potentially an environmental impact statement to address mitigation for environmental and socio-economic concerns or benefits.

The disposition study was not considered the appropriate method for determining the acceptability of alternatives outside of transfer or disposal. The findings of this report may be used as a basis for further consideration and refinement of these alternatives under a full feasibility study or other authority that can fully study impacts and recommend mitigation in conjunction with a selected alternative. As conditions change at the facilities, including potential project failure or emergence of viable transfer partners, this negative report could be used to further develop a report recommending federal action at one or more of the projects.

The recommendations contained in this report reflect information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor they perspective of higher levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for implementation.

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APPENDIX A. ADDITIONAL MAPS AND FIGURES

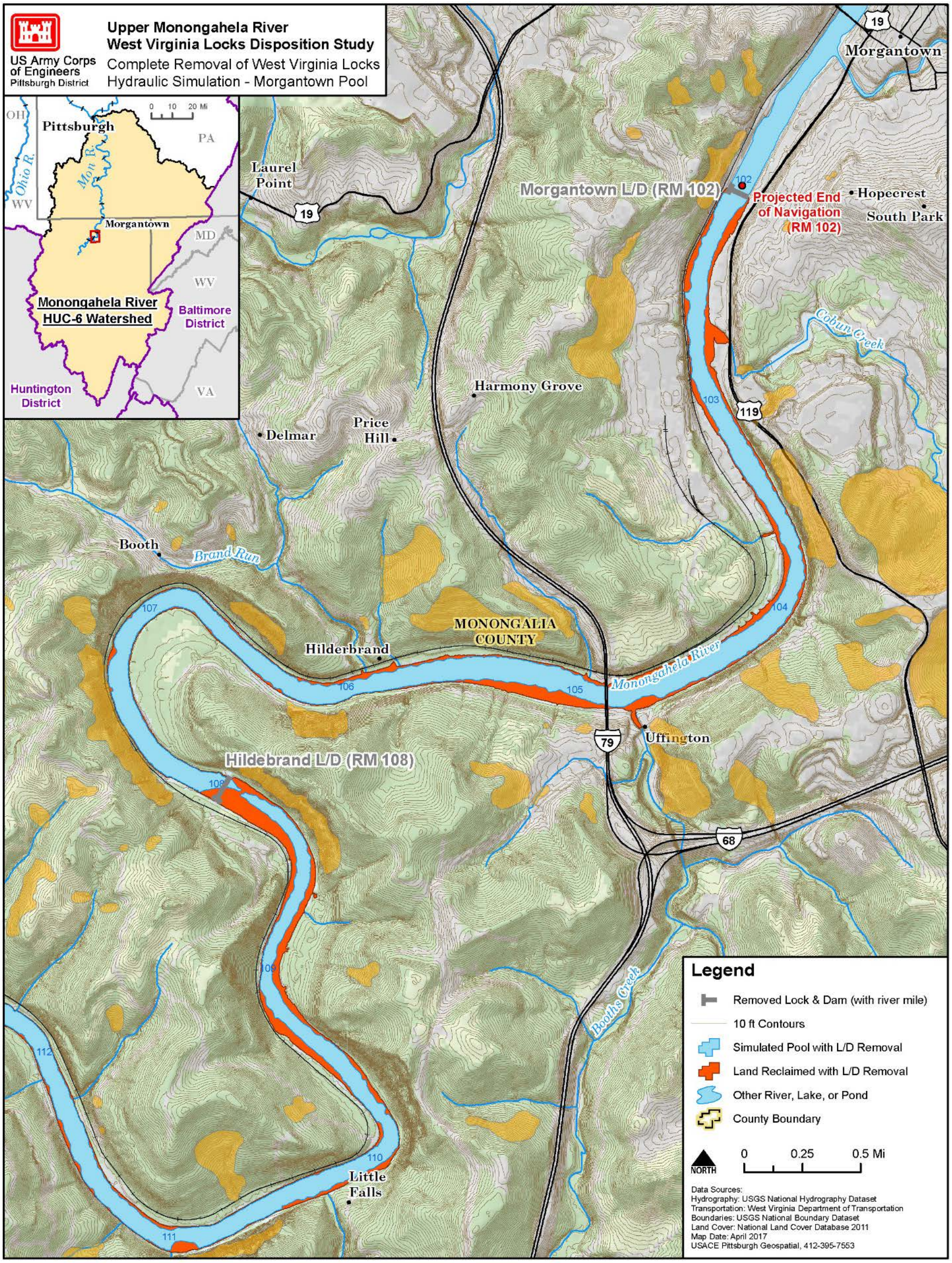

Figure A-1. Reclaimed land expected with removal of Morgantown L/D.

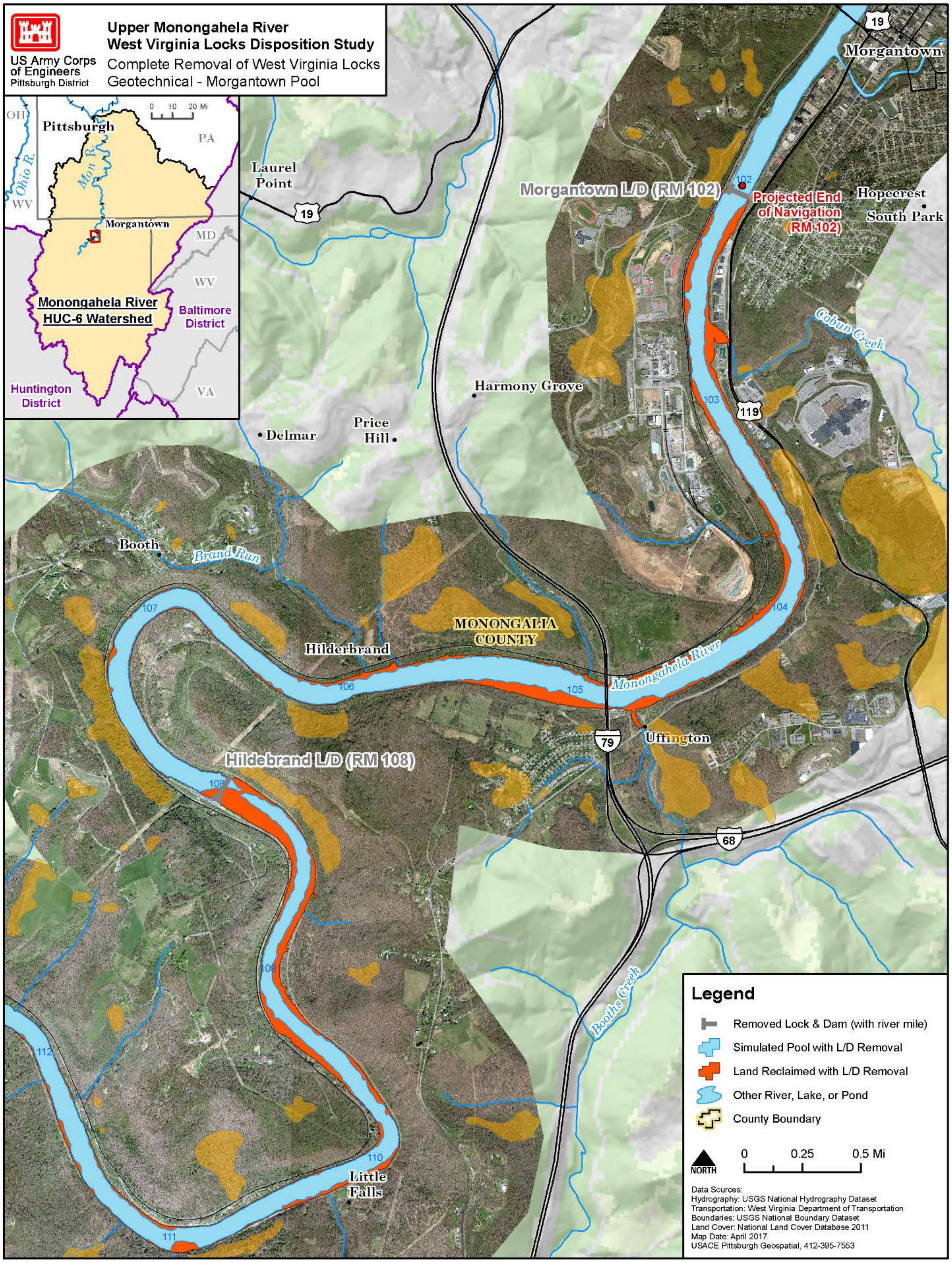

Figure A-2. Reclaimed land expected with removal of Morgantown L/D shown on aerial imagery.

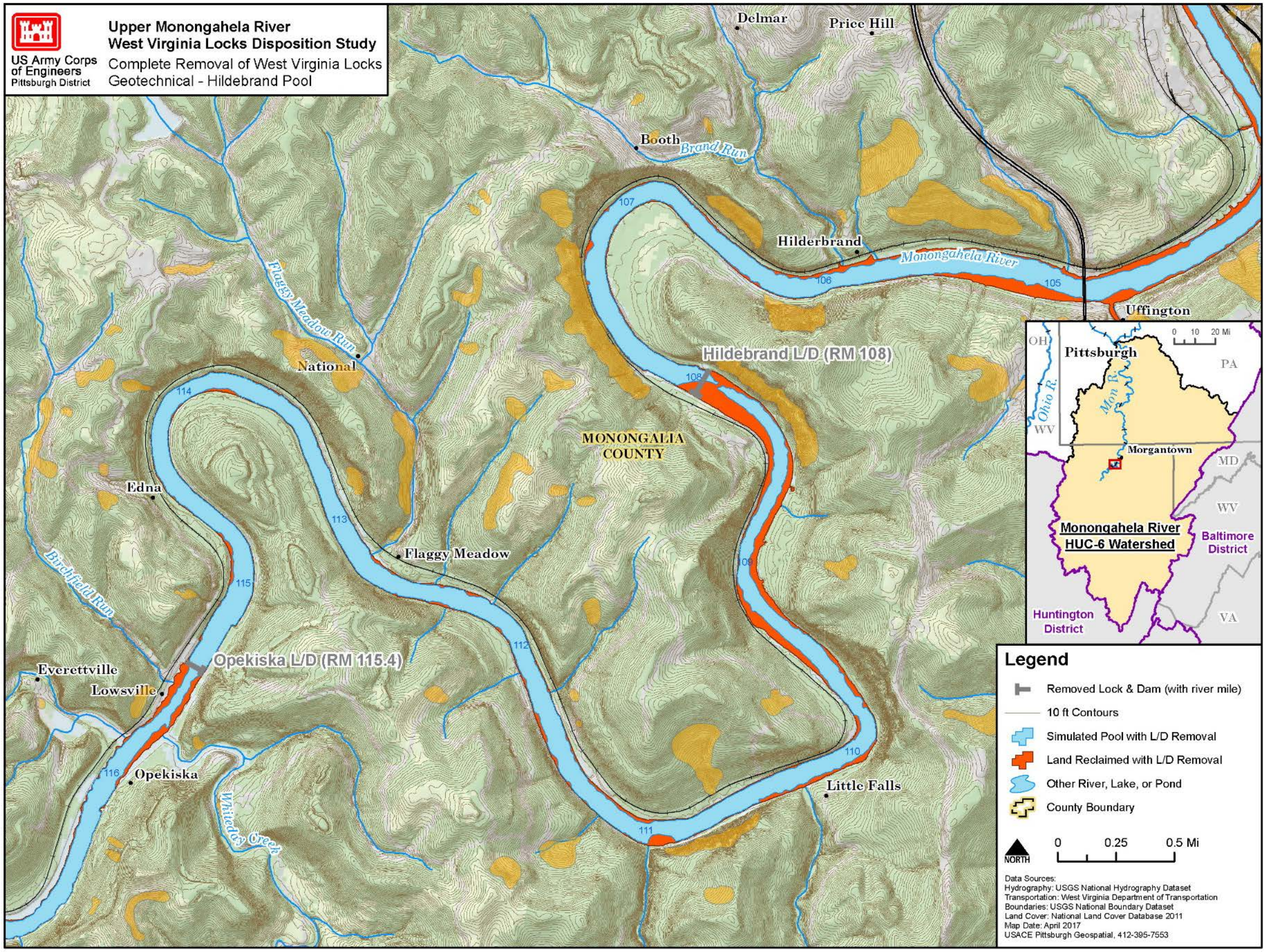

Figure A-3. Reclaimed land expected with removal of Hildebrand L/D.

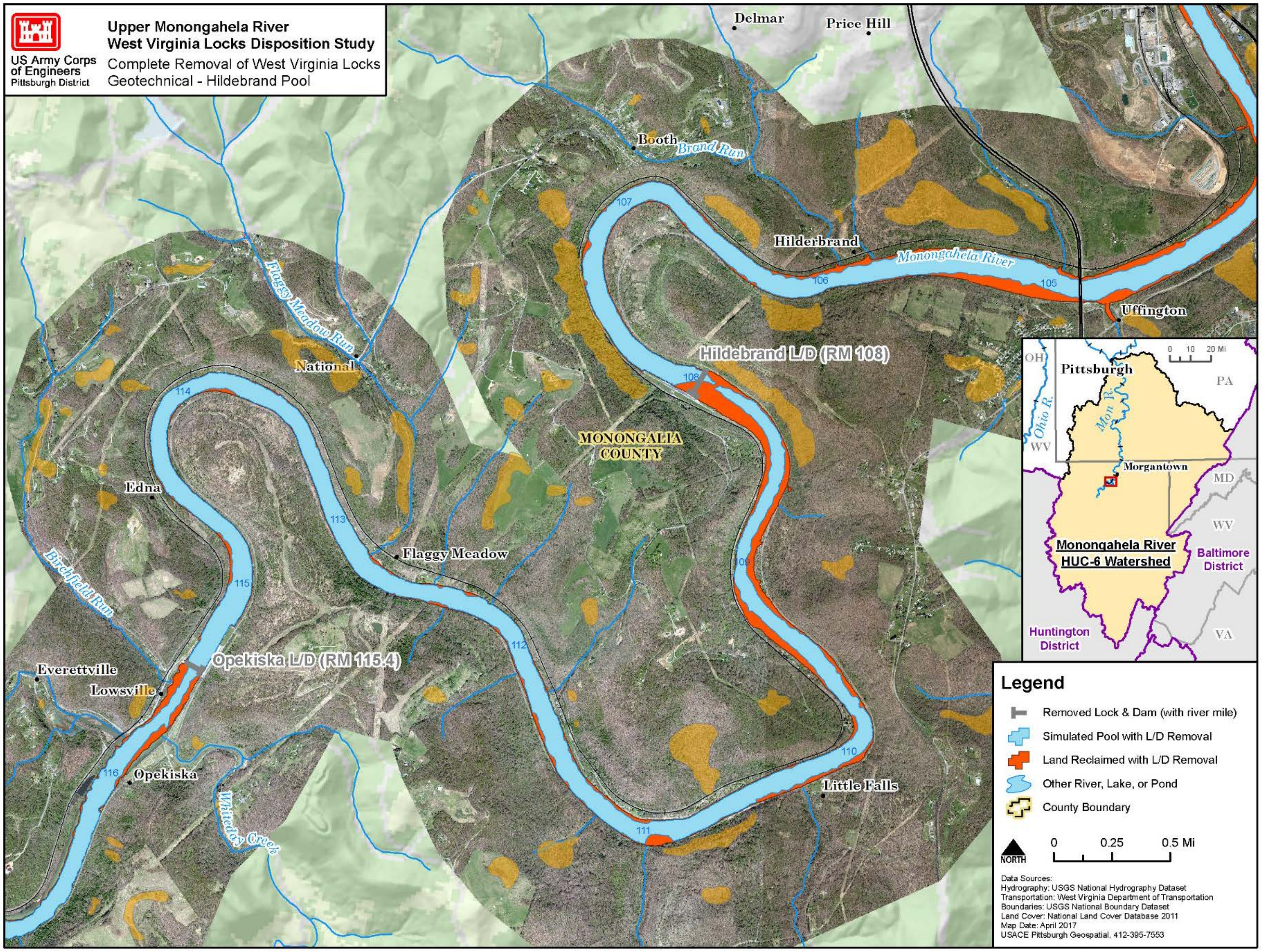

Figure A-4. Reclaimed land expected with removal of Hildebrand L/D shown on aerial imagery.

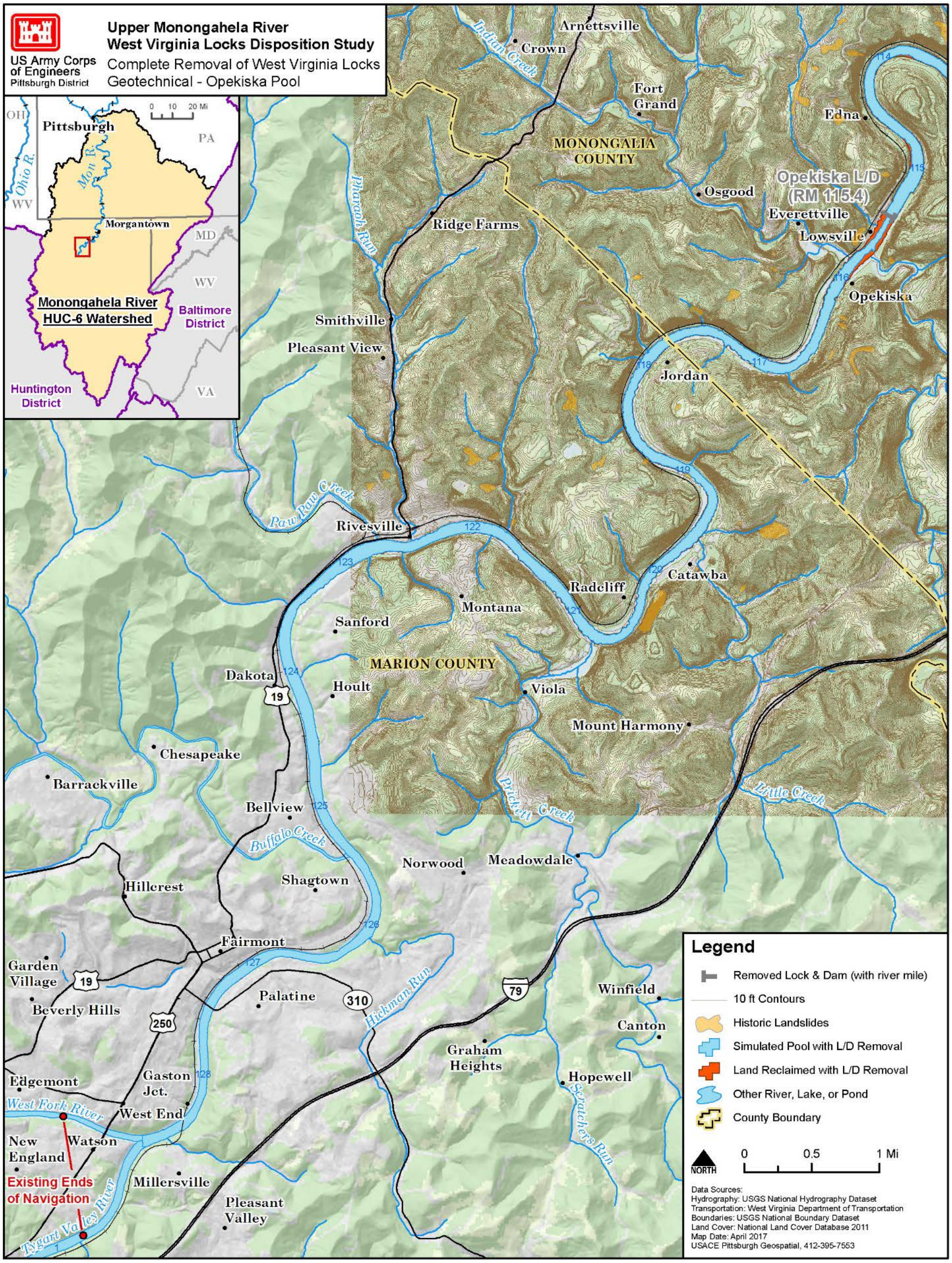

Figure A-5. Reclaimed land expected with removal of Opekiska L/D.

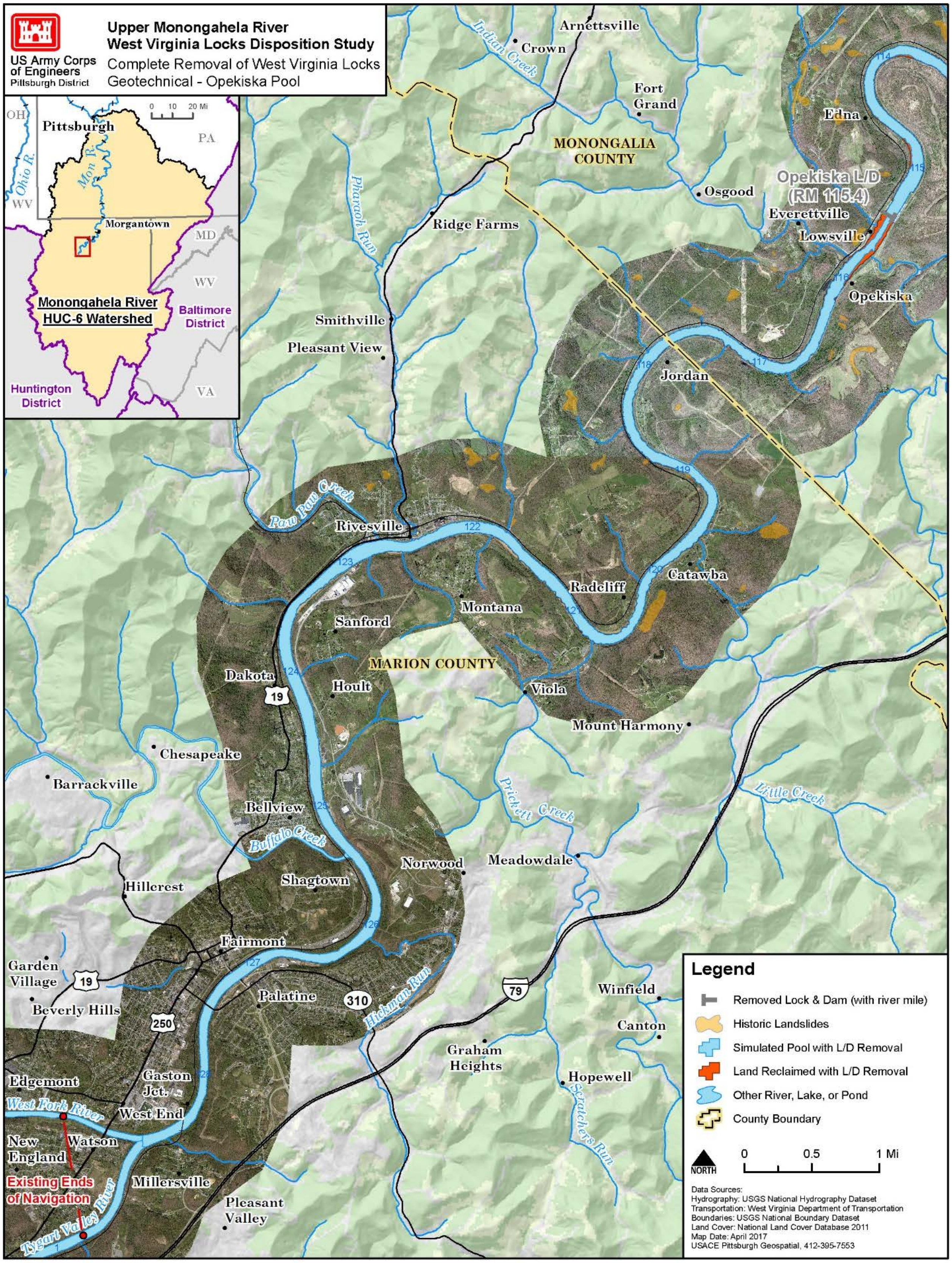

Figure A-6. Reclaimed land expected with removal of Opekiska L/D shown on aerial imagery

APPENDIX B. ECONOMICS APPENDIX

Section 1: Recreation Impacts

Table B-1. Recreation Benefits

L/Ds		High Estimate			Low Estimate		
	Average Annual Amount of Vessels	Number of Unique Vessels	Annual Number of People	Annual Recreation Benefits	Number of Unique Vessels	Annual Number of People	Annual Recreation Benefits
Morgantown	491	354	1,027	$47,860	264	765	$35,656
Hildebrand	272	196	569	$26,495	146	424	$19,739
Opekiska	510	368	1,068	$49,741	274	796	$37,057
Total:	**1,273**	**919**	**2,664**	**$124,096**	**684**	**1,985**	**$92,451**

Stakeholder input on usage and economic impacts was gathered with targeted meetings with local businesses and user groups. This information was incorporated into the economic analysis to better understand impacts to recreation, business and future development within the study area.

Recreation benefits represent the total value of each L/D to consumers. The lost recreation benefits for Monongalia County were based on the average amount of recreational vessels that lock through Morgantown L/D, Hildebrand L/D, and Opekiska L/D. Non-motorized vehicles (i.e. kayaks, canoes, etc.) were not considered in this analysis due to lack of data. The annual recreation data was gathered from the Corps' Lock Performance Monitoring System (LPMS) website. LPMS provides the annual number of recreational lockages and annual number of recreational vessels. The annual recreation benefits lost and annual economic loss for each L/D can be found above in Table B-1.

The first step in determining the annual recreational lost benefits was calculating an average annual amount of vessels. For each L/D, the average annual amount of vessels is an average from 1993 through 2016, excluding years that reported zero recreational vessels and lockages due to full year closure. The Pittsburgh District economists determined it would be best to use all available data for the average to capture all the potential future conditions.

The next step was to determine the number of consumers utilizing the L/Ds. In order to estimate this number, the number of *unique* vessels needed to be determined in order to not overestimate the number of consumers that use the L/D. This was accomplished by accounting for multiple lockages within theaverage annual amount of vessels needed to be discounted for multiple lockages. Multiple lockages is defined as a single vessel that locks through multiple L/Ds in a single day, which includes vessels that round trip through the same L/D in a single day. For example, a boat owner lives just south of Morgantown and wants to visit downtown Morgantown via motorized boat. In a single day, the boater would lock through the Morgantown L/D, visit downtown, then lock back through Morgantown L/D to return home. This vessel gets counted twice because it locks through two separate times; however, he counts as only one consumer. To account for multiple lockages in a single day, the average annual amount of vessels wasadjusted. There is no data for multiple lockages, but a Corps report, ***Allegheny River Recreation Benefits****, October 2000,* estimates that on average, a single vessel will lock through 1.86 locks per day. There is a level of uncertainty with this figure, which is why this analysis presents a high and a low estimate for recreation benefits loss and economic loss in Table B-1. The 1.86 estimate from the 2000 report assumes that a higher percentage of vessels lock through the L/Ds. However, in 2013, both the Opekiska L/D and Hildebrand L/D went from level of service 3 (open for at least 8 hours per day, 7 days a week, year round) to level of service 6 (by appointment only; no consistent lock pattern). Due to the limited time that the L/Ds are now open, it is less likely that a vessel will have multiple lockages in one day, which indicates that the 1.86 estimate is likely too high. The higher the average number of lockages per day per boat, the lower the annual number of unique vessels. The 1.86 locks per day per boat is used in the low estimate.

$$\frac{Average\ Annual\ Amount\ of\ Vessels}{1.86} = Low\ Estimate's\ Number\ of\ Unique\ Vessels$$

Since the levels of service changed in 2013, it is highly likely fewer boats lock through the L/Ds and they remain in-pool (between L/Ds), causing a decrease in thenumber of locks per day per boat. To account for this decrease, a new estimate to capture the current conditions was determined. This new estimate is found by calculating the average annual number of vessels from 2000 through 2012 for each L/D. The first year of this average is 2000 because the 1.86 locks per day per boat originated in the 2000 ***Allegheny River Recreation Benefits*** report. Then, the average annual numbers of vessels from 2013 through 2016 was calculated for each L/D. Determining the averages for 2000 to 2012 and 2013 to 2016 allows the analysis to determinehow the level of service change in 2013 impacted the annual amount of recreational vessels. The Morgantown L/D did not experience a change in its level of service, but was likely impacted by the level of service changes to the Opekiska L/D and the Hildebrand L/D. A ratio of the two averages was then calculated:

$$\frac{2013\ through\ 2016\ average}{2000\ through\ 2012\ average}$$

This ratio provides a percent change in the average annual number of vessels for each L/D following the change in the level service. Then, the average percent change inthe average annual number of vessels for each of the L/Ds being studied for possible removal along the Monongahela and the Allegheny was calculated. The Allegheny L/Ds were included to increase the sample size of the averages. These L/Ds include: Morgantown, Hildebrand, Opekiska, and Allegheny L/D 5 through 9. The average ratio for the listed L/Ds is 0.745, which represents a 74.5% decrease in the usage of the L/Ds. The average ratio (0.745) was multiplied by the original estimate of average lockages per day per boat (1.86), which results in an updated estimate of 1.39 lockages per day per boat, on average.The 1.39 average number of lockages per day per boat was used in the high estimate.

$$\frac{Average\ Annual\ Amount\ of\ Vessels}{1.39} = High\ Estimate's\ Number\ of\ Unique\ Vessels$$

The number of unique vessels does not fully account for the number of consumers using the L/Ds. The final step in finding the number of consumers who use the L/Ds is determining the number of people per vessel. The ***Allegheny River Recreation Benefits*** report states that an average of 2.9 people are on board each recreational vessel. This number is based on a Corps observation, and is assumed tostill accurately represent the number of people on a recreational vessel. The 2.9 people per vessel number was used for both estimates. To determine the lost recreation benefits, 2.9 was multiplied by the number of unique vessels in order to accurately represent the number of consumers using the L/Ds for motorized boating. Below is how the average annual number of consumers was calculated for Morgantown L/D's high estimate:

$$\frac{490.96}{1.39} = 354.3\ \times 2.9\ people =\ 1{,}027\ Average\ Annual\ Consumers$$

Below is how the average annual number of consumers was calculated for Morgantown L/D's low estimate:

$$\frac{490.96}{1.86} = 263.96 \times 2.9\ people = 765\ Average\ Annual\ Consumers$$

In order to calculate the recreation benefits, a dollar value was assigned to recreation. According to the ***Allegheny River Recreation Benefits*** report, the value of a single boater per day is $46.48 (updated from June 2000 dollars to May 2017 dollars using a Consumer Price Index of 1.42). This estimated value is based on formal surveys. Different boating activities were valued and then assigned a weight to create a single weighted value for recreation. This recreation value of $46.58 was used for this analysis because it assigns a different value to different boating activities, which can be seen in Table B-2. This value was used for both sets of estimates. Each L/D's lost recreation benefits estimate was found by multiplying the value of a single boater ($46.58) by the L/D's Annual Number of Consumers.

Table B-2 : Recreation Value from the Allegheny River Recreation Report

Boating Activity	Percent of Sample	Reported Value	Weighted Value in June 2000 Dollars	Weighted Value in May 2017 Dollars
Boat Fishing	9.5%	$8.02	$0.76	$1.08
Single Day Boating	7.1%	$14.85	$1.05	$1.49
Multi-Day Boating	38.6%	$37.17	$14.35	$20.39
Marina Boating	44.8%	$37.17	$16.65	$23.64
Totals	**100.0%**		**$32.82**	**$46.58**

In addition to the annual lost recreation benefits calculation, the annual economic loss for each L/D was also determined. The annual lost recreation benefits and annual economic loss are two separate calculations. This figure was found by multiplying the Annual Number of Consumers by

Table B-3. Lost Recreation Benefits and Economic Losses.

	High Estimate			Low Estimate		
L/Ds	Annual Lost Recreation Benefits	Annual Economic Loss	Total	Annual Lost Recreation Benefits	Annual Economic Loss	Total
Morgantown	$47,860	$37,082	$84,942	$35,656	$27,626	$63,282
Hildebrand	$26,495	$20,528	$47,023	$19,739	$15,294	$35,033
Opekiska	$49,741	$38,539	$88,280	$37,057	$28,711	$65,768
Total:	**$124,096**	**$96,149**	**$220,245**	**$92,452**	**$71,631**	**$164,083**

the amount of spending a recreational boater spends per day, on average. The ***Allegheny River Recreation Benefits*** report values this at $36.09 (updated from June 2000 dollars to May 2017 dollars using a Consumer Price Index of 1.42). The annual economic loss indicates how much consumer spending may decrease if the L/Ds become unavailable. The total monetary loss for each L/D can be found above in Table B-3. The high estimate provides an annual total loss of $220,245. The low estimate provides an annual total loss of $164,082. The two estimates represent losing all motorized boating benefits. However, non-motorized vessels could potentially offset some of these losses. If the lock is no longer operational, motorized boating can still occur within the pools due to a minimal change in pool levels. If there is a planned loss of pool (the lock is still not operational in this scenario), motorized boating can still occur, but to a lesser degree. The pool levels decrease significantly, which indicates that water skiing, tubing, wakeboarding, and similar activites would cease. This causes higher short-term loss of recreation benefits than just if the lock is no longer operational. However, non-motorized vessel usage would likely increase and could at least partially offset motorized boating losses in the long-term. Finally, if there is an unplanned loss of pool (the lock is still not operational in this scenario), boats docked in the river would likely get damaged due to the rapid loss of pool. This would cause an immediate loss of recreation benefits because less consumers are able to use the river for motorized boating. This is the scenario that results in the highest loss of recreation benefits in the short-term. However, like the planned loss of pool scenario, motorized boating can still occur, but to a lesser degree, and non-motorized vessel usage would likely increase, which would offset some of the lost recreation benefits in the long-term.

Section 2: Property Value Impacts

Table B-4. Monongalia County – Property Value Assessment.

Location of Parcel	Median Number of Acres	Median Assessment Value per Acre	Expected Parcel Value
Inland	2.01	$7,740	$15,557
Riverfront	2.48	$7,109	$17,630

Detailed data was extracted from the county parcel data using ArcMap 10.3.1. The Pittsburgh District's Real Estate office used a Monongahela River line shapefile and extended the shape's width (using the Buffer tool in ArcMap) by 1,000 feet. This buffer allowed the river line to touch both sides of the riverbanks and intersect the riverfront parcels. Monongalia County provided the Real Estate office with a shapefile that contained data from every parcel in the county. Real Estate then selected the parcels that touched the river shapefile (using "select by location" feature in ArcMap) and exported the selected data as a separate shapefile. This shapefile contained approximately 7,000 riverfront parcels, which covered the full extent of the county. This shapefile's attribute table was used in determining the parcel values of riverfront parcels.

To obtain a random sample of inland parcels, a polygon was drawn on the east side of the Monongahela River and a polygon was drawn on the west side of the Monongahela River. These polygons were drawn as to not include any riverfront parcels. Then, the parcels that touched the drawn polygons were selected (using "select by location" feature in ArcMap) and then exported as a separate shapefile. This shapefile contained approximately 7,000 randomly selected inland parcels. This shapefile's attribute table was used in determining parcel values for inland parcels. For both sets of parcel data (inland and riverfront) the median assessment value and median acreage was determined, which can be found above in Table B-4.

The average assessment value was first calculated, but there were a few high value parcels that significantly exaggerated the average. The median assessment value was used in order to eliminate outliers; the median value is also more representative of current housing market conditions. The median acreage was multiplied by the median assessment value to show the expected parcel value for both datasets. The expected parcel value allows the riverfront and inland parcels to be compared based on both value and size.

Section 3: Monongalia County and West Virginia University

Morgantown's main source of economic stability is West Virginia University (WVU), which is not river dependent. This university has continuously grown throughout the city since its establishment in 1867. Below in Figure B-1, you can see the undergraduate enrollment trends for WVU's main campus in Morgantown. From 2000 to 2008, undergraduate enrollment consistently increased year to year. Despite varying tuition raises, enrollment from 2009 to 2014, was fairly consistent.

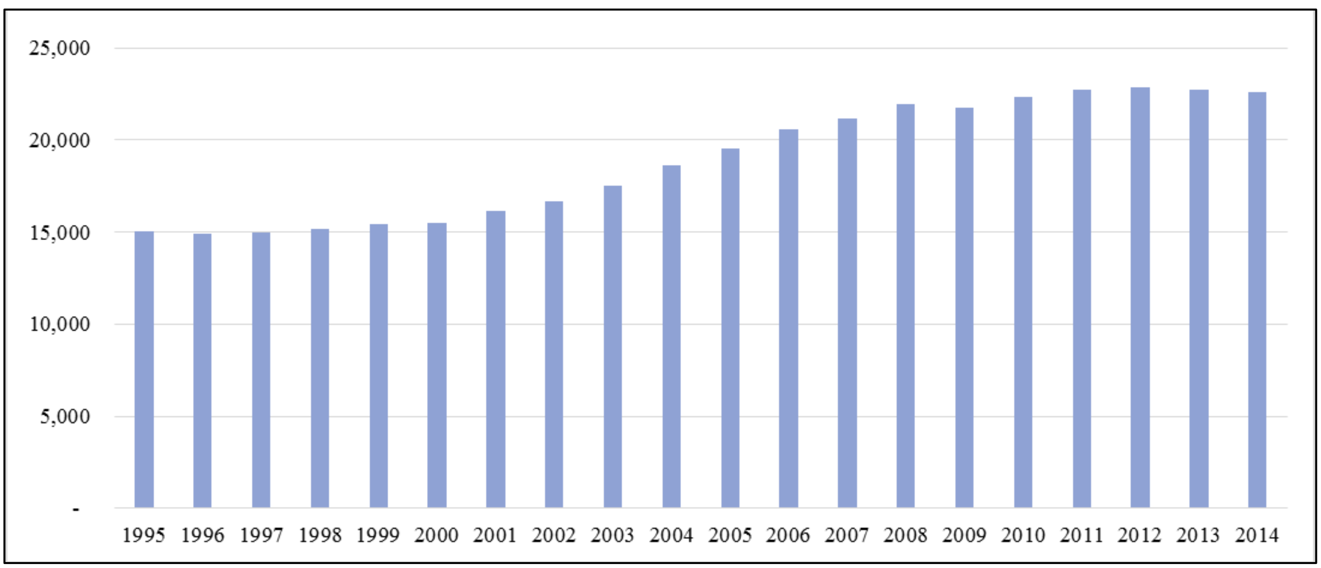

Figure B-1. West Virginia Undergraduate Enrollment, Fall 1995 to Fall 2014

In 2014, there were 44,406 paid employees in Monongalia County. As you can see in Table B-5, WVU Medicine, Mylan Pharmaceuticals, Monongalia General Hospital, and the Center for Disease Control were all among the county's largest employers in 2016. As you can see in Figure B-2, health care and social assistance is the largest employment sector in

Monongalia County; it accounted for about 33% of the county's workforce. WVU has consistently been the county's top employer over at least the past five years; in 2014, WVU and WVU Hospitals were the county's top employers. This demonstrates that the county is economically dependent upon the university.

Table B -5. Top 10 Employers in Monongalia County

1. West Virginia University
2. West Virginia University Hospitals
3. Mylan Pharmaceuticals, Inc.
4. Monongalia County Board of Education
5. Morgantown General Hospital
6. Wal-Mart Stores, Inc.
7. West Virginia University Medical Corporation (University Health Associates)
8. The Kroger Company
9. Teletech Customer Care Management (WV), Inc.
10. Gabriel Brothers, Inc.

Source: Work Force West Virginia – ***Monongalia County Profile***, *2014*

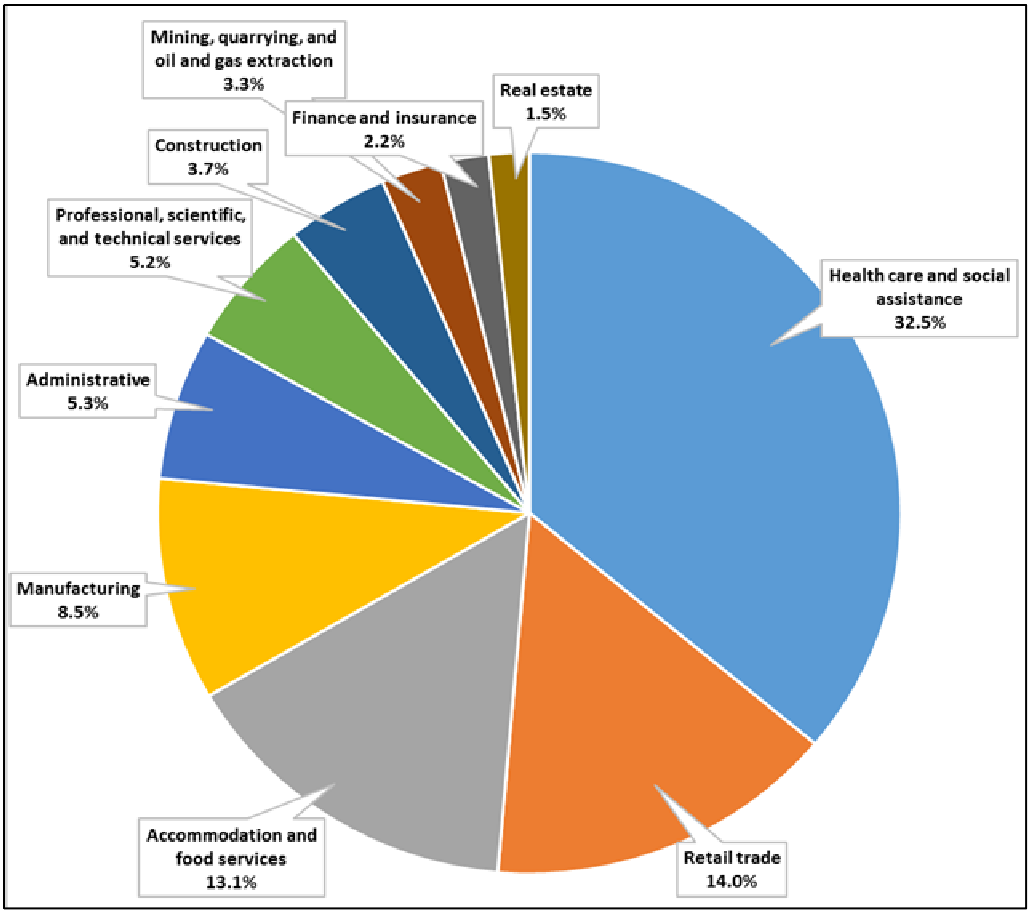

Figure B-2. Top 10 Employment Sectors for 2014. (Source: U.S. Census Bureau – County Business Patterns, 2014)

<u>Section 4: Monongalia County and the Coal Industry</u>:

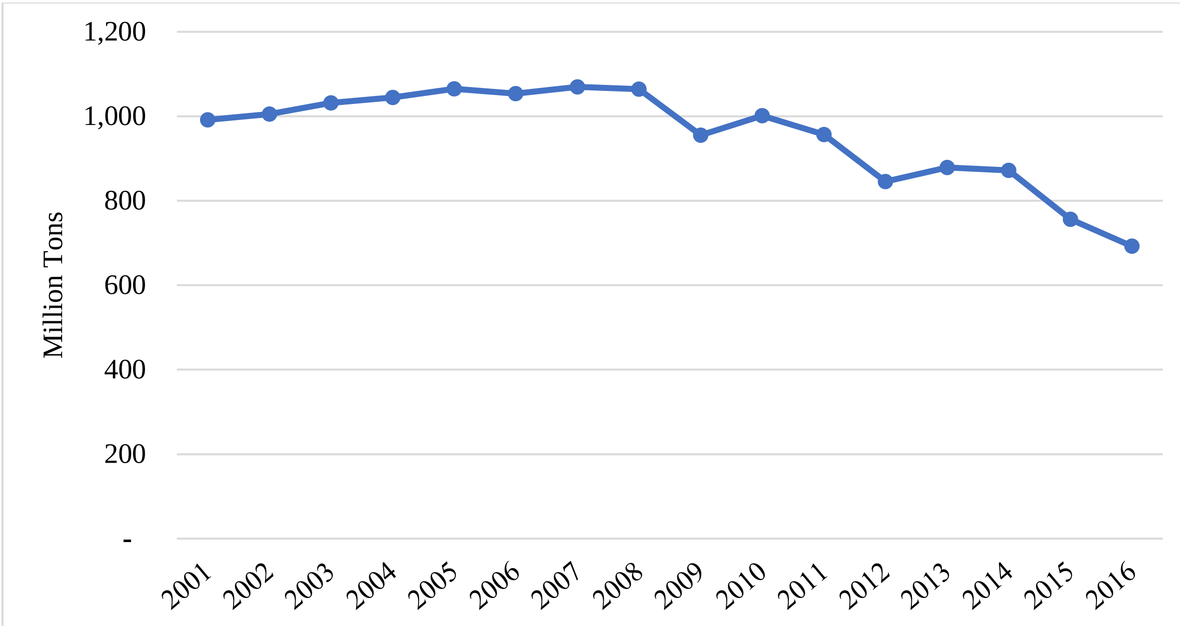

Figure B-3. U.S. Coal Consumption – All Sectors. (Source: U.S. Energy Information Administration).

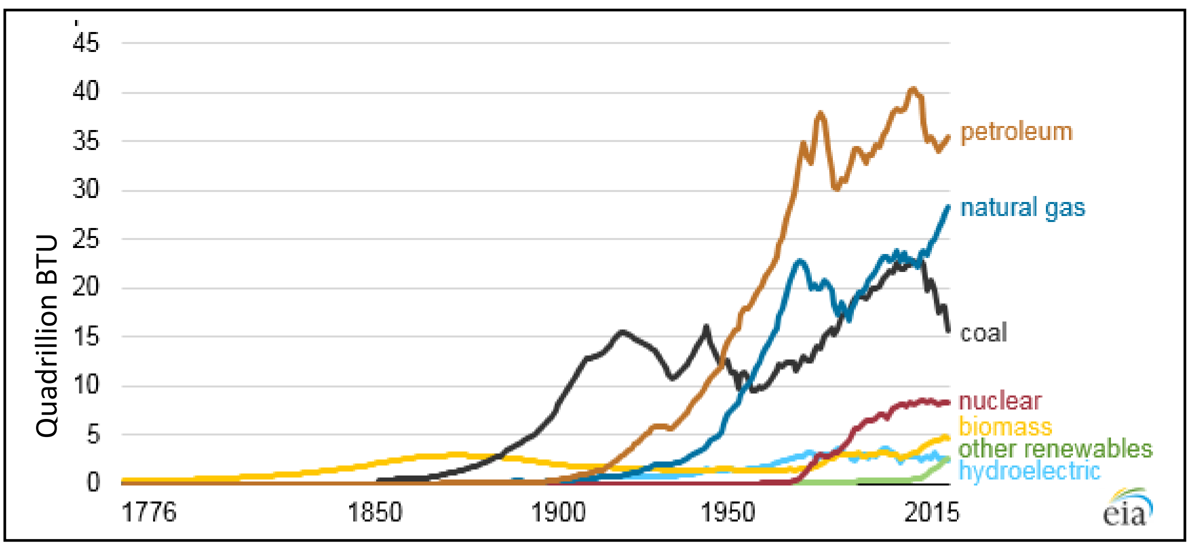

Figure B-4. Energy Consumption in the U.S. (1776-2015)

West Virginia (WV) has historically produced large volumes of coal to export domestically and internationally. Domestic coal would get transported via barge, truck, and rail. Coal was a source of economic stability for WV throughout the mid-1900s. However, national coal consumption has significantly decreased over the past decade, which can be seen in Figure B-3. The U.S. Energy Information Administration (EIA) states, "The most significant decline in recent years has been coal: U.S. coal consumption fell 13% in 2015, the highest annual percentage decrease of any fossil fuel in the past 50 years." U.S. consumption compared to consumption of other energy sources can be seen in Figure B-4.

Table B-6. Pounds of CO_2 Emitted per Million British Thermal Units

Energy Source	CO_2 Emitted (lbs)
Coal (anthracite)	228.6
Coal (bituminous)	205.7
Coal (lignite)	215.4
Coal (subbituiminous)	214.3
Diesel fuel and heating oil	214.3
Gasoline	157.2
Propane	139.0
Natual gas	117.0

Source: U.S. Energy Information Administration

Figure B-4, you can see that both petroleum and natural gas consumption have steadily increased since the 1970s. Coal has become relatively more expensive and emits more carbon dioxide (CO_2) when burned than other energy sources (Table B-6). Additionally, renewable energy consumption has increased over the past decade. The EIA states, "The greatest growth in renewables over the past decade has been in solar and wind electricity generation."

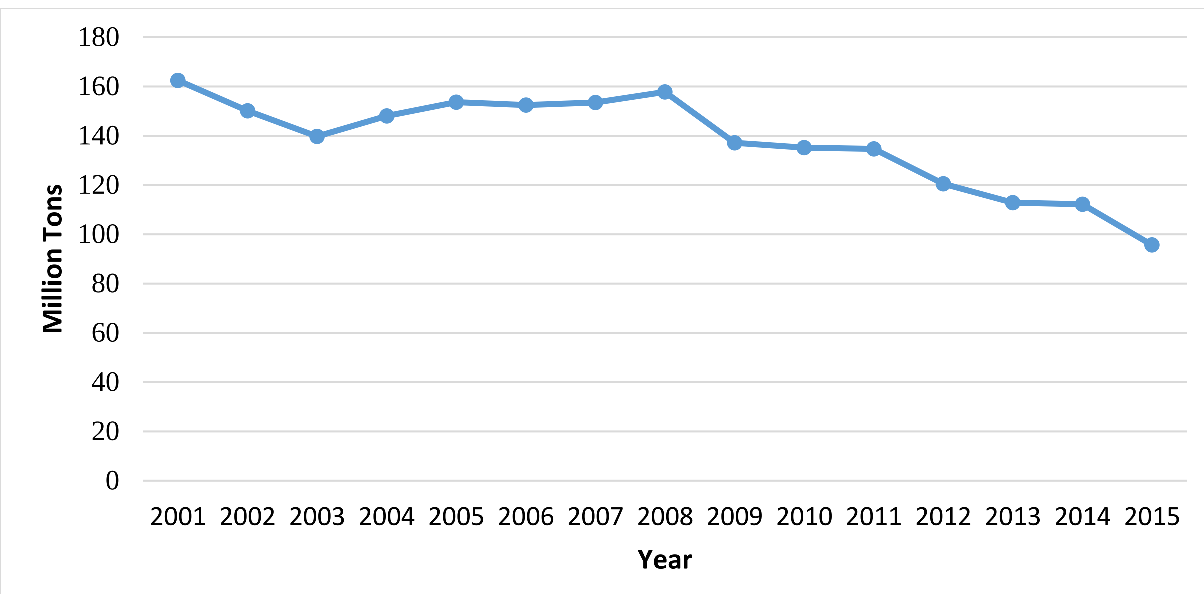

Figure B-5. West Virginia Coal Production. (Source: U.S. Energy Information Administration)

Utility companies have switched to using natural gas and renewable energy as opposed to coal (*U.S. Energy Information Administration*). This switch has directly and negatively impacted WV's economy. As you can see in Figure B-5, coal production in WV has steadily declined since 2007. Additionally, in Figure B-6, you can see that coal production is forecasted to consistently decline through 2040. The forecast in Figure B-6 is an average of four different coal forecasts from Marshall University Center for Business and Economic Research, West Virginia University Bureau for Business and Economic Research, Energy Ventures Analysis, and Energy Information Administration.

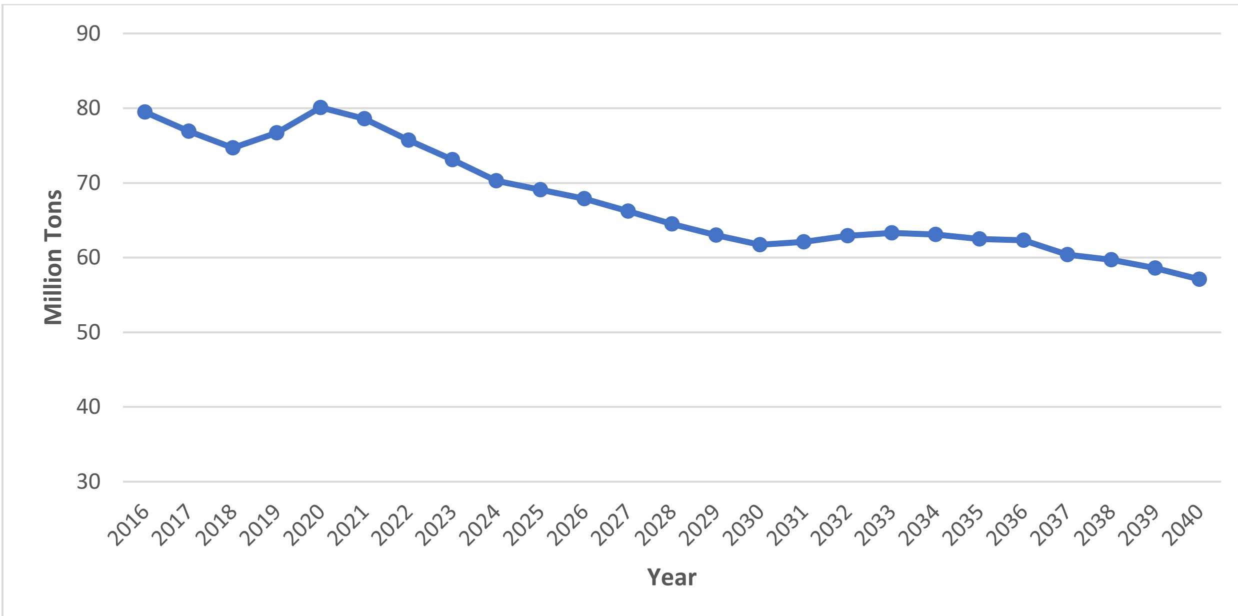

Figure B-6. West Virginia Coal Production Forecast: 2016 – 2040. (Source: Consensus Coal Production Forecast for West Virginia: 2016, September 2016)

West Virginia's economy has suffered from the continuous decline in production and consumption of coal. However, Monongalia County's economy experienced minimal negative impacts from the loss of mining jobs. Some counties in WV, like Monongalia County, diversified their economies into other sectors as soon as coal production started declining in the early 2000s. Looking back to Figure B-2, we see that mining jobs only made up 3% of Monongalia County's employment in 2014. Health care and social assistance and retail trade are the sectors that the county now relies on for economic stability. Monongalia County is consistently more resilient than WV and the United States. As you can see in Table B-7, Monongalia County consistently had lower unemployment rates than both WV and the United States. When coal mining jobs rapidly decreased, Monongalia County diversified its economy efficiently, which resulted in minimal negative impacts. If the L/Ds become unavailable, coal production in WV would likely decline more rapidly than if the L/Ds remain installed. However, the county no longer relies on coal for economic stability; it now relies on WVU. Even if coal production plummets in WV, Monongalia County's unemployment rate is expected to remain low due to WVU's continuous expansion throughout Morgantown.

Table B-7. Unemployment Rates in the Project area.

Year	Monongalia County	West Virginia	United States
2006	3.5%	4.9%	4.6%
2007	3.1%	4.6%	4.6%
2008	2.8%	4.5%	5.8%
2009	4.4%	7.8%	9.3%
2010	5.6%	8.6%	9.6%
2011	5.6%	8.0%	8.9%
2012	5.2%	7.4%	8.1%
2013	4.5%	6.7%	7.4%
2014	4.4%	6.6%	6.2%
2015	4.7%	6.0%	5.3%

Source: St. Louis Federal Reserve Economic Data

Section 5: Economic Analysis of NED Benefits:

For the purposes of this study the NED benefits for Morgantown, Hildebrand, and Opekiska have been determined to be the navigation related benefits to shippers on the Monongahela River that lock through these projects. Based on the expected consistency of traffic on the waterway from the middle forecasts in section 4.4.1, the most recent calculated navigation benefits for each project have been used for the average annual benefits. These values do not perfectly reflect expected future traffic, but they are relatively close and should reflect similar values to what would be expected from additional model runs. The three "No Action" alternatives are assumed to have the same average annual benefits despite slight differences in the levels of service between alternatives. This is due to uncertainty related to the effects of these level of service changes on shipper responses, so further study would be required to better determine how those changes would alter these benefits. All six of the "Constructed" alternatives also include benefits from avoiding current levels of O&M funding that would continue to be expended in the three "No Action" alternatives. Additional adjustments were made for the "Mothball (5-Year Recovery)" and "Mothball (10-Year Recovery)" alternatives as they would not see full navigation or reduced O&M funding benefits across the 50-year study period. The values presented are likely still high due to the assumption that river traffic would return immediately following the recovery of the projects, but further study would be required to determine the actual benefits that would return in the years immediately following the recovery process. All benefits were annualized using the federal discount rate of 2.75% across a 50-year period of analysis. The average annual costs for the "No Action" alternatives were taken from table 21 in section 7.7.1. Average annual costs were calculated for the "Constructed" alternatives which did not have them presented in Table 22. Tables B-8, B-9, and B-10 below show the average annual benefits, costs, net benefits, and benefit cost ratios for each of the three projects under each alternative scenario.

Table B-8. Morgantown L/D Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$2,854,003	$2,854,003	$2,854,003	$1,738,834	$4,307,437	$4,022,036	$1,738,834	$1,738,834	$1,738,834
Costs	$938,872	$169,006	$938,872	$8,631	$101,106	$138,572	$135,105	$103,331	$746,744
Net Benefits	$1,915,131	$2,684,997	$1,915,131	$1,730,204	$4,206,331	$3,883,464	$1,603,729	$1,635,503	$992,091
BCR	3.04	16.89	3.04	201.47	42.60	29.02	12.87	16.83	2.33

Table B-9. Hildebrand L/D Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$18,520	$18,520	$18,520	$313,007	$329,675	$327,823	$313,007	$313,007	$313,007
Costs	$169,006	$169,006	$333,230	$8,631	$101,106	$138,572	$135,105	$103,331	$746,744
Net Benefits	($150,486)	($150,486)	($314,710)	$304,376	$228,569	$189,251	$177,902	$209,676	($433,737)
BCR	0.11	0.11	0.06	36.27	3.26	2.37	2.32	3.03	0.42

Table B-10. Opekiska L/D Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$18,520	$18,520	$18,520	$313,007	$329,675	$327,823	$313,007	$313,007	$313,007
Costs	$169,006	$169,006	$333,230	$8,631	$101,106	$138,572	$135,105	$103,331	$746,744
Net Benefits	($150,486)	($150,486)	($314,710)	$304,376	$228,569	$189,251	$177,902	$209,676	($433,737)
BCR	0.11	0.11	0.06	36.27	3.26	2.37	2.32	3.03	0.42

The lack of navigation benefits for all projects during the “Transfer,” “Mothball – Abandon,” “Abandonment,” and “Removal” alternatives are due to commercial navigation being unavailable under those four scenarios, leaving only O&M costs foregone as the benefits gained by these alternatives. All nine alternatives all yield positive net benefits for Morgantown L/D. The “Transfer,” “Mothball” (5-year recovery, 10-year recovery, and Abandon), and “Abandonment” alternatives yield positive net benefits for both Hidlebrand L/D and Opekiska L/D.

Section 5: System of Accounts Evaluation:

The 1983 Principles and Guidelines (P&G) established four accounts to facilitate evaluation of alternatives in Federal water resources planning: National Economic Development (NED), Environmental Quality (EQ); Regional Economic Development (RED); and Other Social Effects (OSE).

The NED account measures contributions to National Economic Development and are the increases in the net value of the national output of goods and services, expressed in monetary units. The net benefits of any plan are the amount that the benefits exceed its costs. Positive net benefits indicate the plan is economically feasible to implement; negative net benefits denote that it is not economically feasible.

The EQ account is a means of displaying and integrating into water resources planning that information on the effects of alternative plans on significant EQ resources and attributes of the NEPA human environment that is essential to a reasoned choice among alternative plans. Significant means likely to have a material bearing on the decision-making process. The purpose of evaluating EQ is to identify significant beneficial and adverse effects of alternative plans on significant EQ resources discussed in section 7.6.

The RED account registers changes in the distribution of Regional Economic Activity that result from each alternative plan. The primary measures used in this account for this study are recreation and recreation-related spending.

The OSE account is a means of displaying and integrating information on alternative plan effects from water resource planning perspectives that are not reflected in the other three accounts. Categories include: hydropower and water supply impacts; life, health, and safety factors; and property and infrastructure impacts.

These accounts are assessed for each of the final plans below.

No Action – Flat Funding

NED: This alternative yields positive net benefits for one of the three projects as mentioned in section 4 above.

EQ: In the short-term, very little environmental impact is expected. Operations of the projects will continue at the current levels and the surrounding environment will not likely incur major positive or negative effects. In the long-term, the possibility of structural or operational failure increases and this would result in many (mostly negative) environmental impacts. Potential impacts are further discussed in section 7.6.

RED: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of pool, leading to loss of recreation and loss of water supply) could be quite high. Potential impacts are further discussed in section 7.5.

OSE: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of water supply, damage to infrastructure, damage to property, safety risks, and loss of life) could be quite high. Potential impacts are further discussed in section 7.5.

No Action – Reduced Funding

NED: This alternative yields positive net benefits for one of the three projects as mentioned in section 4 above.

EQ: Similar to the flat funding alternative, in the short-term, very little environmental impact is expected. Operations of the projects will continue at slightly different levels of service and the surrounding environment will not likely incur major positive or negative effects. In the long-term, the possibility of structural or operational failure increases and this would result in many (mostly negative) environmental impacts. Other additional negative impacts could result from the reduction in levels of service, such as a reduction in fish passage and degradation of water quality. Potential impacts are further discussed in section 7.6.

RED: In the short-term, a small decrease in recreation benefits is expected due to the reduced levels of service. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of pool, leading to loss of recreation and loss of water supply) could be quite high. Potential impacts are further discussed in section 7.5.

OSE: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of water supply, damage to infrastructure, damage to property, safety risks, and loss of life) could be quite high. Potential impacts are further discussed in section 7.5.

No Action - Sustainable Funding

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.

EQ: Similar to the flat funding alternative, in the short-term, very little environmental impact is expected. Operations of the projects will continue at slightly different levels of service and the surrounding environment will not likely incur major positive or negative effects. In the long-term, the possibility of structural or operational failure increases and this would result in many (mostly negative) environmental impacts. Some positive impacts could result from the increase in levels of service, such as an increase in fish passage and improved water quality. Potential impacts are further discussed in section 7.6.

RED: In the short-term, a small increase in recreation benefits is expected due to the increased levels of service. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of pool, leading to loss of recreation and loss of water supply) could be quite high. Potential impacts are further discussed in section 7.5.

OSE: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of water supply, damage to infrastructure, damage to property, safety risks, and loss of life) could be quite high. Potential impacts are further discussed in section 7.5.

Transfer

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.

EQ: This alternative is likely to have minimal impacts to geography, vegetation, and wildlife with the potential to have positive impacts to air quality and negative impacts to fish and mussels as well as water quality and raising HTRW-related concerns. Potential impacts are further discussed in section 7.6.

RED: The most likely transfer partner would be one interested in hydropower produced by the projects and so this alternative has a high chance of permanently ceasing operation of the locks on these projects. The results would be substantial with negative impacts to recreation due to a loss of mobility between pools, although within pool recreation should remain close to the same or see slightly negative impacts. Furthermore, many businesses located along the river would likely see a decrease in revenue due to the decline of recreation boating. Potential impacts are further discussed in section 7.5.

OSE: Under this alternative, hydropower benefits could be seen at Morgantown and Opekiska if the transferee takes the projects with the intended purpose of hydropower generation. Risks to water supply, infrastructure, property, safety, and life loss are not expected to increase as the project will still be operated and maintained by the transferee. Potential impacts are further discussed in section 7.5.

Mothball

NED: This alternative yields positive net benefits for one of the three projects in both the “5-Year Recovery” and “10-Year Recovery” scenarios. It yields no positive net benefits at any of the projects for the “Abandon” scenario. Details can be found in section 4 above.

EQ: In the short-term, this alternative will have impacts similar to, but more negative than, the “No Action – Reduced Funding” alternative, due to the locks no longer being operated. In the long-term, this alternative expects the projects to be brought back online which could result in impacts similar to any of the three “No Action” alternatives (depending on level of funding), which includes the potential impacts of structural or operation failure. Potential impacts are further discussed in section 7.6.

RED: In the short-term, recreation benefits and other regional benefits derived from recreation (river-side businesses, recreation-related businesses, etc.) are expected to decline similar to the "Transfer" alternative. These benefits have the potential to return if the projects are brought back online and recreation returns, but businesses that close in that period of recreation decline may not return. Potential impacts are further discussed in section 7.5.

OSE: In the short-term, water supply benefits would be maintained with little to no impact and risks to infrastructure, property, safety, and life loss are not expected to increase. If the projects are not brought back online, then the expected impacts would be similar to those outlined in the "No Action – Flat Funding" alternative. Potential impacts are further discussed in section 7.5.

Abandonment

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.

EQ: This alternative is expected to have impacts similar to the "Mothball" alternative, except that a lack of funding across 50 years is not sustainable, so in the long-term structural or operational failure are much more likely. The failure of these projects would result in impacts similar to the long-term "No Action" alternatives. Potential impacts are further discussed in section 7.6.

RED: In the short-term, impacts of this alternative are identical to the impacts of the "Mothball" alternative. In the long-term, the possibility of structural or operational failure increases and the resulting impacts of this alternative are similar to those outlined in the "No Action – Flat Funding" alternative. Potential impacts are further discussed in section 7.5.

OSE: In the short-term, impacts of this alternative are identical to the impacts of the "Mothball" alternative. In the long-term, the possibility of structural or operational failure increases and the resulting impacts of this alternative are similar to those outlined in the "No Action – Flat Funding" alternative. Potential impacts are further discussed in section 7.5.

Removal

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.

EQ: This alternative would see both positive and negative impacts to the environment and it has greater potential to mitigate certain impacts due to the nature of removing portions of the project instead of allowing them to potentially fail. Potential impacts are further discussed in section 7.6.

RED: This alternative would see impacts to recreation similar to those outlined in the "Transfer" alternative. Motorized recreational boating would likely be more negatively impacted, but the non-motorized recreational boating could increase to the point of offsetting that loss. This alternative also presents other possible positive impacts to recreation-related businesses. Potential impacts are further discussed in section 7.5.

OSE: This alternative would result in at least partial loss of water supply benefits. Negative impacts to infrastructure, property, safety, and life loss would be reduced considerably due to the removal of components that would otherwise result in greater negative impacts in the event of a structural or operational failure. Potential impacts are further discussed in section 7.5.

APPENDIX C. REAL ESTATE APPENDIX

APPENDIX D. CLIMATE CHANGE ANALYSIS.

Monongahela River Disposition Study

Climate Change Impacts Qualitative Analysis

Phase I: Relevant Current Climate and Climate Change

a) Literature Review.
A May 2017 report conducted by the USACE Institute for Water Resources and the Ohio River Basin Alliance (ORB Pilot Study, Drum et al, 2017) summarizes the available literature for the Ohio River Basin (ORB), which includes the Monongahela River basin. The report presents a pilot study based on global circulation models (GCM) produced by the International Panel on Climate Change Fourth Assessment (2007) and Coupled Model Intercomparison Project-Phase 3 (CMIP3) climate and hydrology projections downscaled to the ORB. Three 30-year time periods from 2011-2099 were established for precipitation and temperature modeling. The NOAA Ohio River Forecast Center used the GCM modeling to simulate annual mean and seasonal flow discharges for 25 forecast points within the basin, as well as a range of temperature changes (annual mean, annual maximum, and annual minimum) for those same points.

For the ORB, modeling results indicate a gradual increase in annual mean temperatures between 2011 and 2040 amounting to one-half degree per decade, with greater increases between 2041 and 2099 of one full degree per decade. Hydrologic flow changes show substantial variability across the ORB through the three time periods, with Hydrologic Unit Code-4 (HUC4) sub-basins located northeast, east, and south of the Ohio River expected to experience greater precipitation and thus higher stream flows—up to 50% greater—during most of the three 30-year periods. Conversely, those HUC4s located north and west of the Ohio River are expected to experience ever-decreasing precipitation (especially during the autumn season) resulting in decreased in-stream flows—up to 50% less—during the same periods.

b) The USACE Climate Hydrology Assessment Tool.
Historic trends in instantaneous peak flows at Monongahela River gages were analyzed using the USACE Climate Hydrology Assessment Tool (CHAT) at two gages located downstream of the project area: Monongahela River near Masontown, PA (USGS 03072655) and Monongahela River at Elizabeth, PA (USGS 03075070). Results from the CHAT analysis of annual peak instantaneous streamflow are presented in the figures below. Note that both gages display **a negative trend** in the annual peak streamflow linear regression that is **not statistically significant** (i.e., p-value greater than 0.05). This

trend may be due in part to the construction of flood control reservoirs within the Monongahela River basin (1938-1988) and the lack of recent basin-wide floods of record.

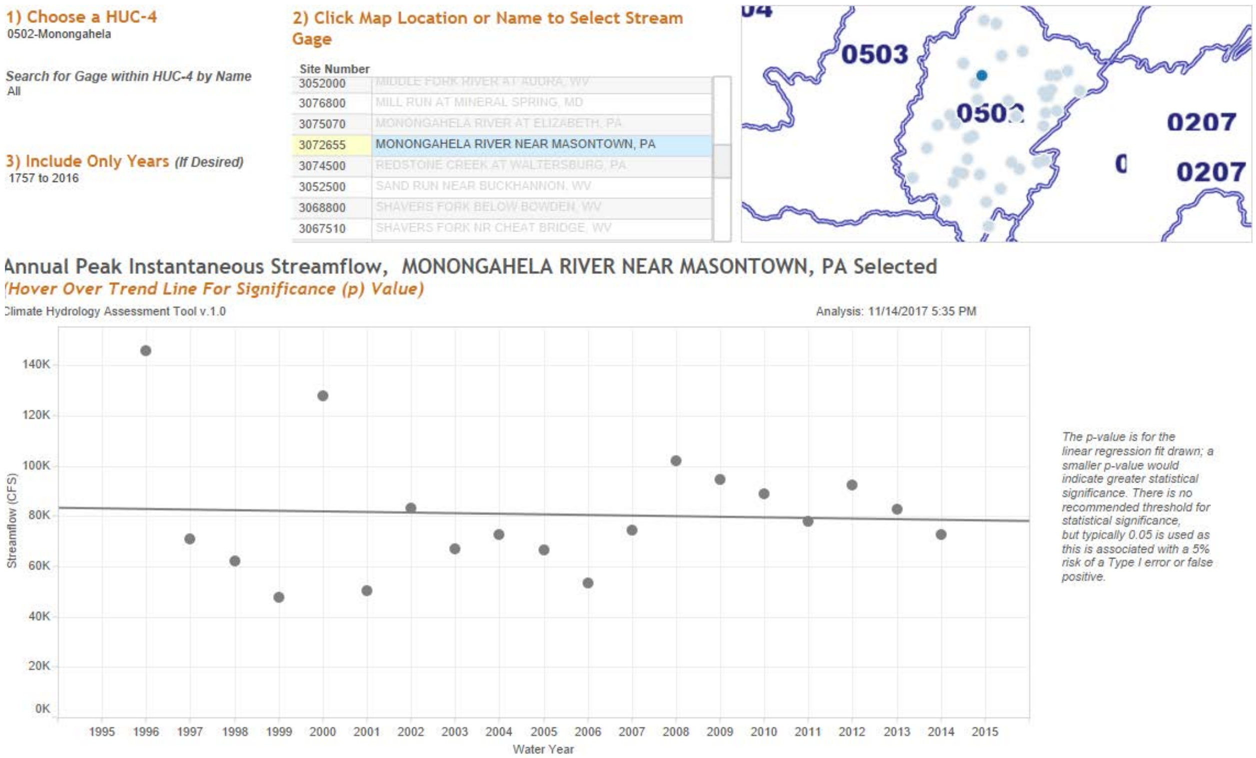

Figure D-1: Annual Peak Instantaneous Streamflow, Monongahela River near Masontown, PA

Linear Regression: Value = -239*Water Year + 559459, R-Squared: 0.003, P-value: 0.826

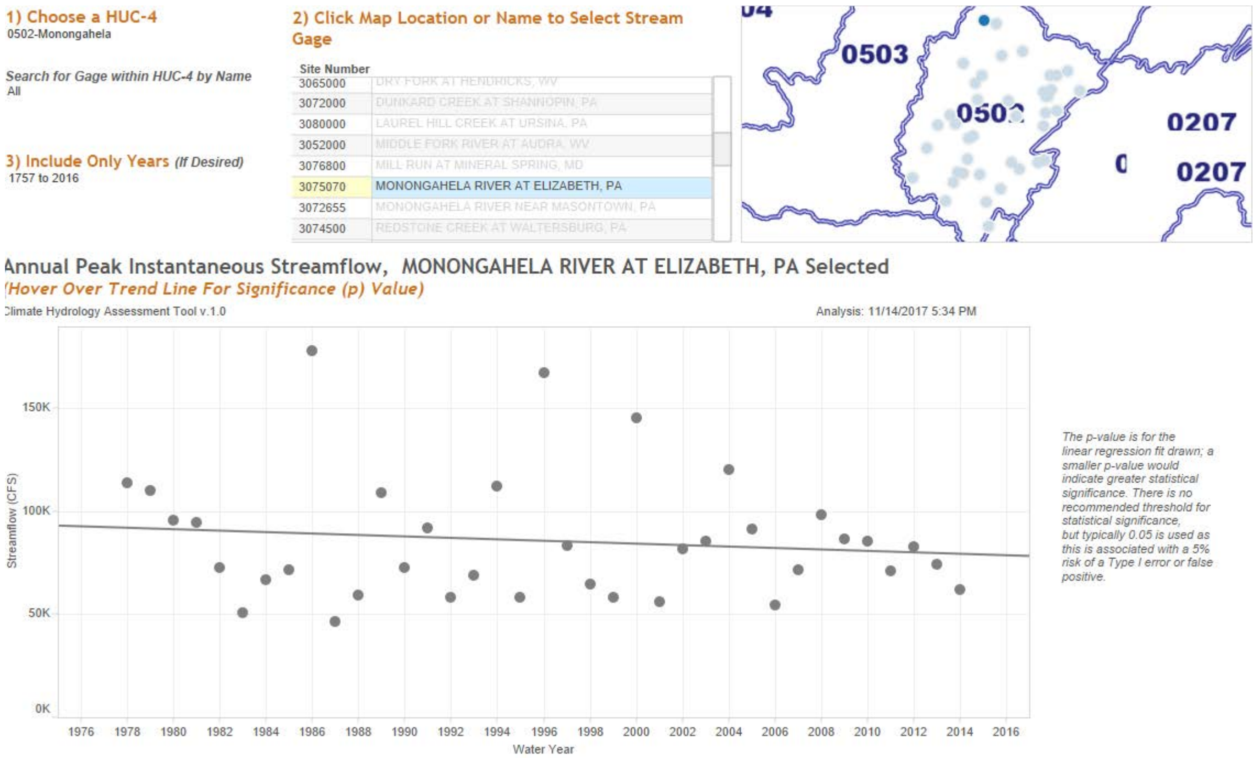

Figure D-2: Annual Peak Instantaneous Streamflow, Monongahela River at Elizabeth, PA
Linear Regression: Value = -350*Water Year + 785071, R-Squared: 0.0156, P-value: 0.461

c) The USACE Nonstationarity Detection Tool.
The Nonstationarity Tool did not detect a nonstationarity in the mean, standard deviation, or variance of the maximum annual flow for the Monongahela River at Elizabeth. The tool does not include the Monongahela River near Masontown gage. The available period of record for the Elizabeth gage is 1978-2014 (37 years). Statistically significant trends may not be visible due to the short period of record for this analysis. Results from the Nonstationarity Detection Tool are presented in the figures below. A trend analysis was also completed for the Elizabeth gage using this tool and no statistically significant trends were detected, which verifies the CHAT results.

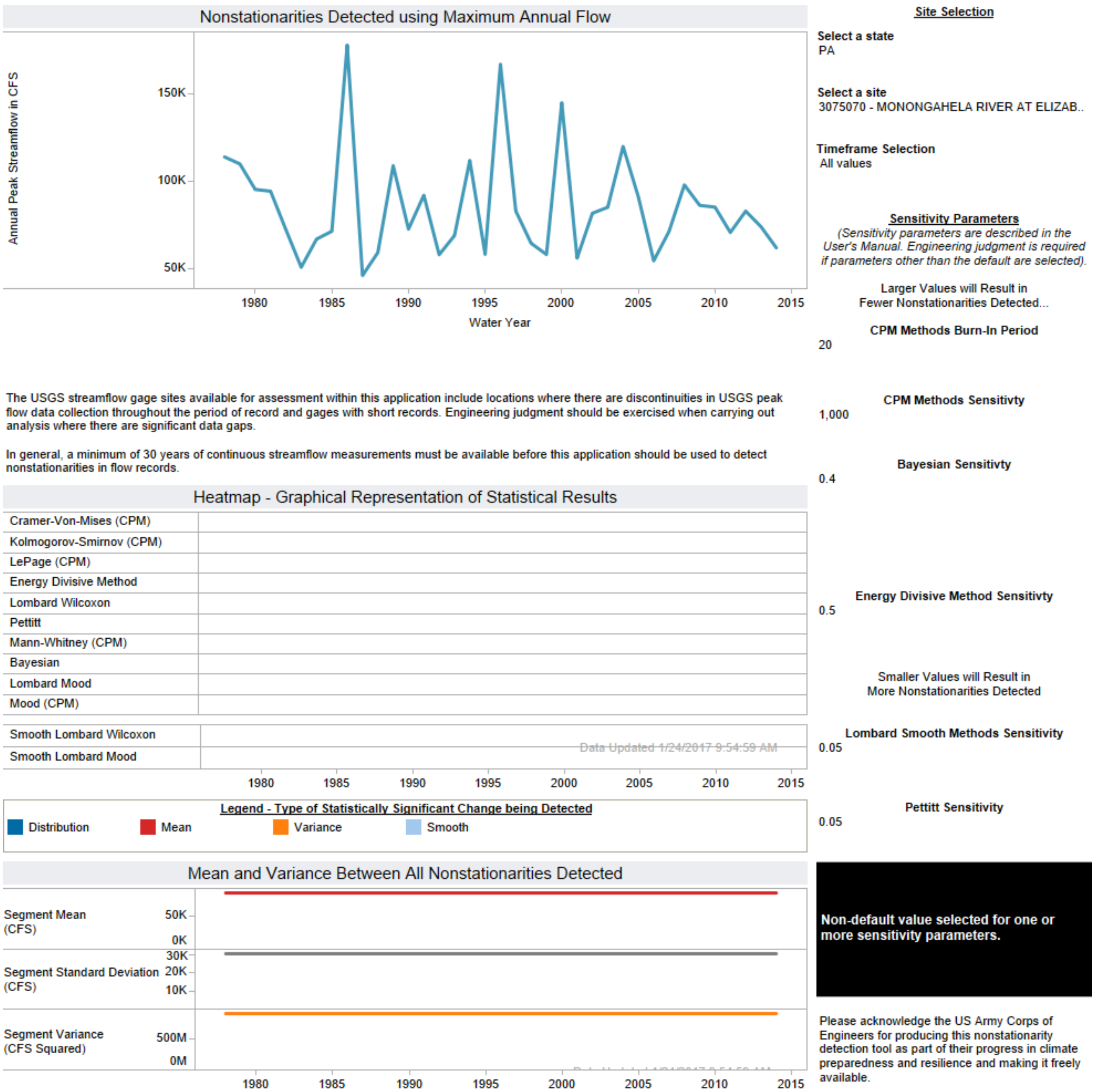

Figure D-3: Nonstationarity Analysis of Maximum Annual Flow, Monongahela River at Elizabeth, PA

Phase II: Projected Changes to Watershed Hydrology and Assessment of Vulnerability to Climate Change.

a) The USACE Climate Hydrology Assessment Tool.

The CHAT was used to identify projected changes in annual maximum monthly flows for the Monongahela River basin, HUC4 0502. Figure D-4 displays the range of the projected annual maximum monthly streamflows computed by 93 different combinations of GCM/RCP (Representative Concentration Pathways) model projections for a period of

1950 to 2099. Figure D-5 presents a trend analysis of mean projected annual maximum monthly streamflow with **a positive trend that is not statistically significant**.

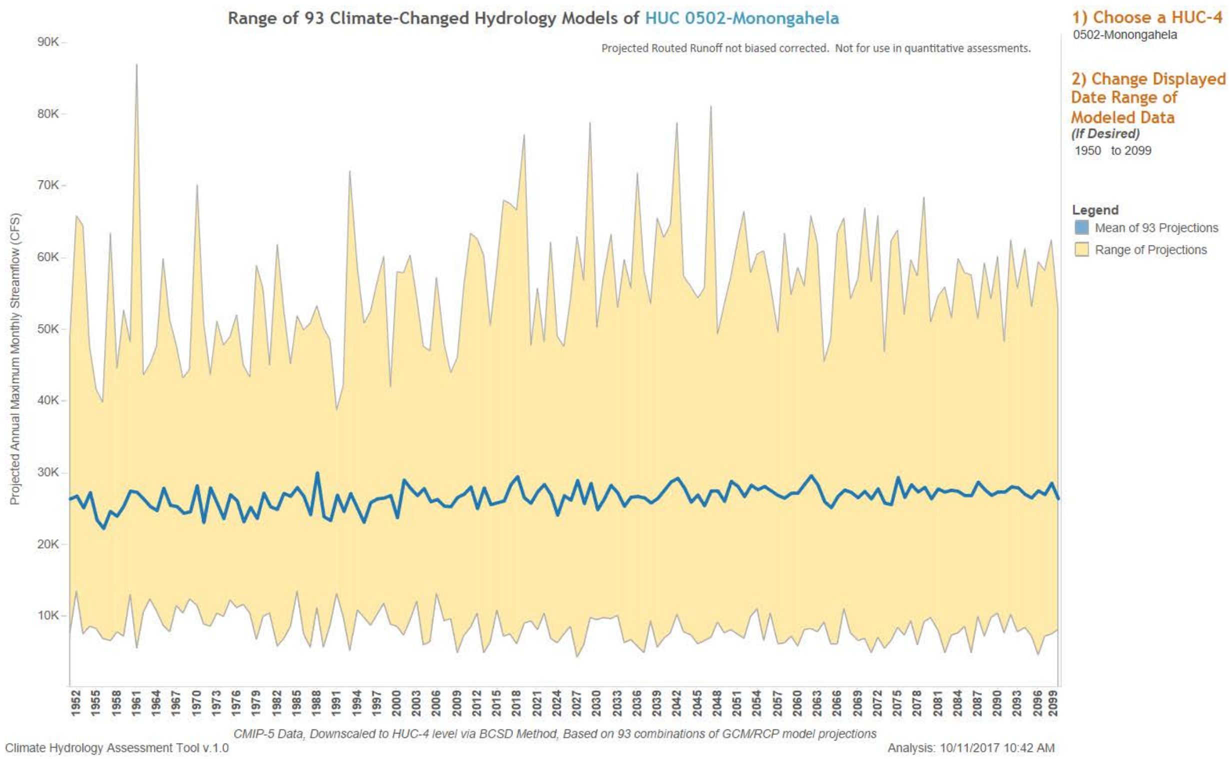

Figure D-4: Range of Projected Annual Maximum Monthly Streamflow using 93 Climate-Changed Hydrology Models, HUC 0502 Monongahela River, Pennsylvania

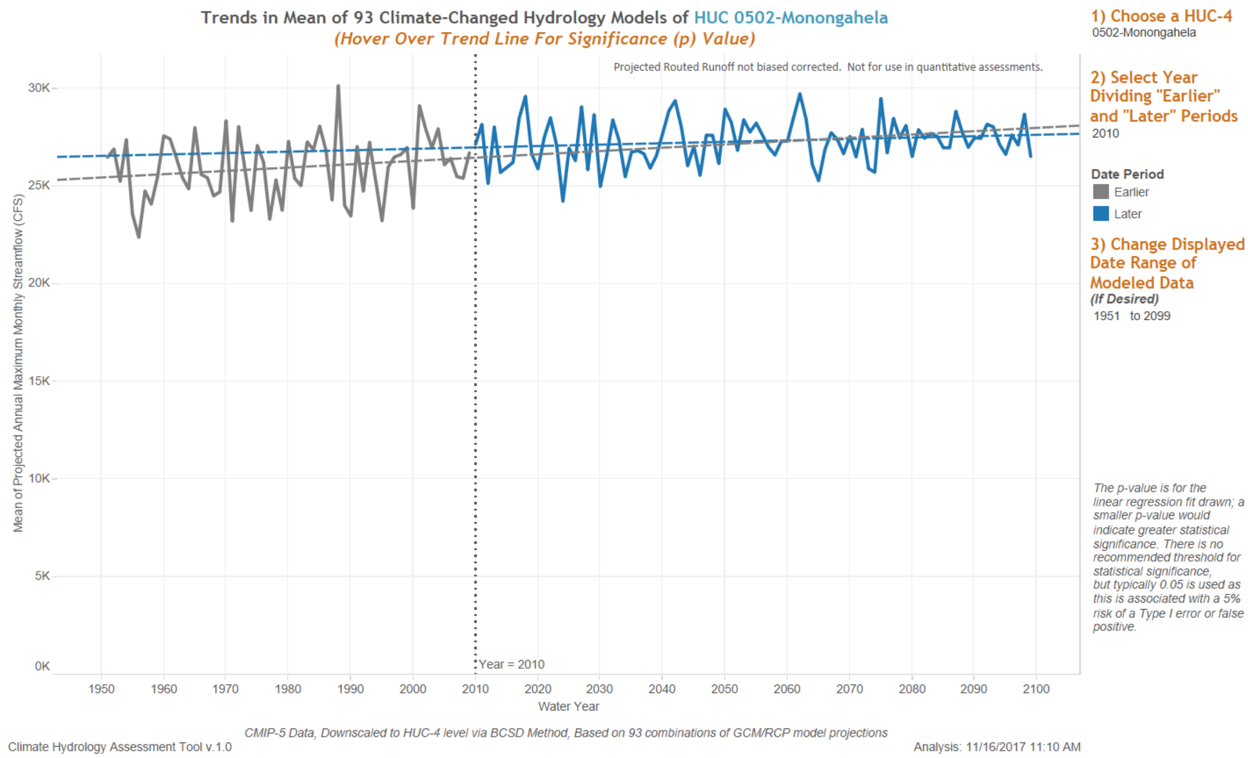

Figure D-5: Mean of Projected Annual Maximum Monthly Streamflow, HUC 0502 Monongahela River, Pennsylvania, Earlier period P-value: 0.11, Later period P-value: 0.18

b) The USACE Watershed Climate Vulnerability Assessment Tool.

The Watershed Climate Vulnerability Assessment (VA) Tool was used to provide information on the relative vulnerability of the Monongahela River basin to climate change using a wider variety of flow variables. The tool enables a VA assessment for each USACE business line within each HUC4 watershed across the United States and provides a Weighted Order Weighted Average (WOWA) score to evaluate composite indices of climate change indicators. This qualitative analysis focused on the Navigation and Recreation business lines for the Monongahela River basin. The primary indicators for the Navigation business line were 90% exceedance during the dry scenarios (29% of WOWA score) and flood magnification during the wet scenarios (30% of WOWA score). Overall, the Navigation business line does not appear to have high vulnerability in HUC 0502 when compared nationally or divisionally for either the Dry or Wet scenarios. In fact, Pittsburgh District watersheds (HUC4 0501, 0502, and 0503) are not identified as vulnerable for any USACE business lines. However, within the Pittsburgh District, HUC 0502 does have the highest WOWA score for the navigation business line across all scenarios and epochs.

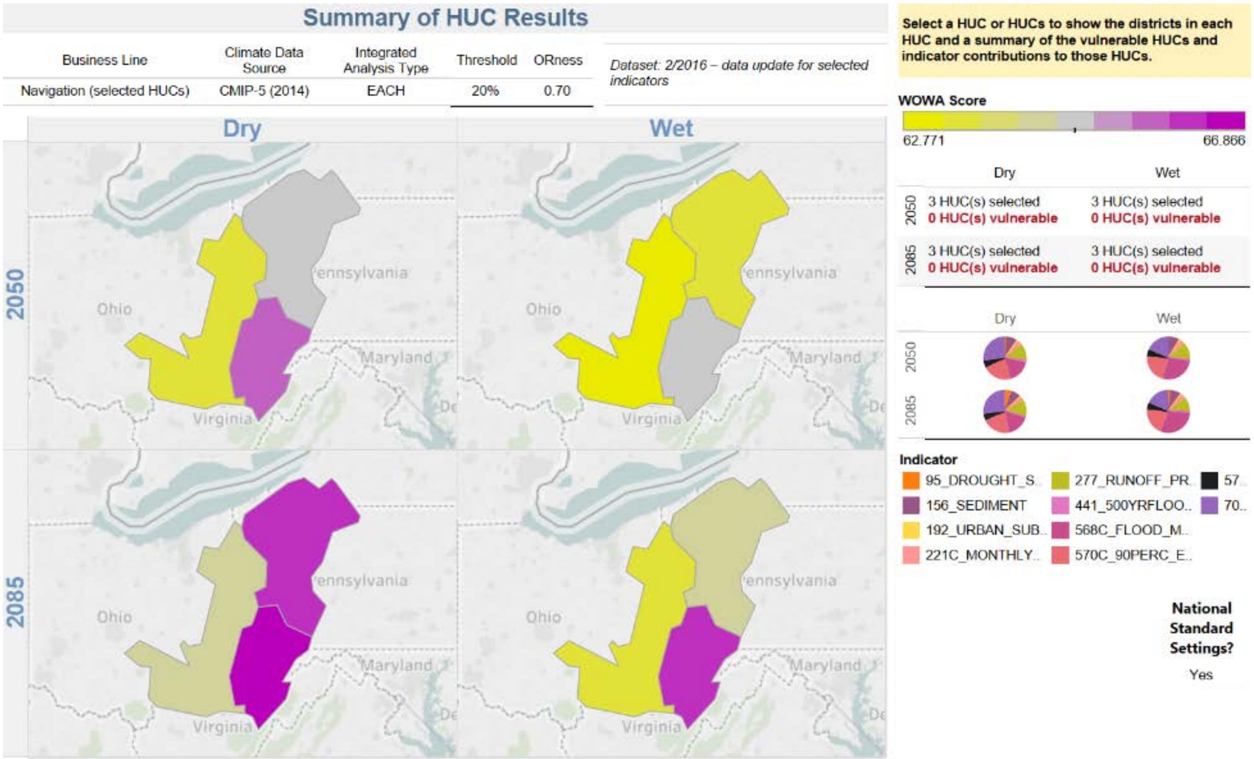

Figure D-6: USACE Watershed Climate Vulnerability Assessment for the Pittsburgh District, Navigation Business Line

Conclusions.

Overall, no strong signal exists within the Monongahela River basin qualitative analysis to indicate what definitive impacts climate change will hold for the river hydrology. While the ORB pilot study indicates that there will be increases in temperature, precipitation, and streamflow, the IWR qualitative tools using available USGS gage data do not display the same increases in streamflow. This may point to the importance of producing an unregulated streamflow record for analysis.

Recommendations.

Based on this assessment, which shows no significant signals, the recommendation is to treat the potential effects of climate change as occurring within the uncertainty range calculated for the current hydrologic analysis. There may be other indicators of climate change, such as changes in biotic communities, but this analysis is focused on changes in climate hydrology. Methods of translating climate change impact uncertainty for an engineering-based analysis do not currently exist. In this analysis, no compelling evidence exists to alter the execution of the project to incorporate climate change.

References.

Drum, R. G., J. Noel, J. Kovatch, L. Yeghiazarian, H. Stone, J. Stark, P. Kirshen, E. Best, E. Emery, J.

Trimboli, J. Arnold, and D. Raff (2017), Ohio River Basin–Formulating Climate Change Mitigation/Adaptation Strategies Through Regional Collaboration with the ORB Alliance, May 2017. Civil Works Technical Report, CWTS 2017-01, U.S. Army Corps of Engineers, Institute for Water Resources: Alexandria, VA