LOWELL LOCK & DAM
WATER POWER PROJECT
FERC PROJECT NO. 13407

APPLICATION FOR AN ORIGINAL LICENSE
MAJOR WATERPOWER PROJECT
UNDER 5 MW – EXISTING DAM

VOLUME I OF IV

FREE FLOW POWER CORPORATION
CLEAN RIVER POWER MR-2, LLC

MAY 2012

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LOWELL LOCK & DAM WATER POWER PROJECT
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VOLUME CONTENT

Volume I: License Application
Initial Statement
Exhibit A – Project Description and Operation
Exhibit E – Environmental Report
Exhibit G – Project Maps

Volume II: Appendices
Appendix A – Consultation Documentation
Appendix B – Final Study Plans
Appendix C – Final Study Reports

Volume III: Critical Energy Infrastructure Information
(Per regulations filed separately with FERC and dam owner only.)
Exhibit F – Project Drawings and Supporting Design Report

Volume IV: Non-Public Information
(Per regulations filed separately with FERC, dam owners, and SHPO only.)
Cultural Resource Study Report

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VOLUME I OF IV

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LIST OF ACRONYMS AND ABBREVIATIONS

CEII	Critical Energy Infrastructure Information
°C	degrees Celsius
cfs	cubic feet per second
CWA	Clean Water Act
DLA	Draft License Application
DO	dissolved oxygen
°CF	degrees Fahrenheit
FERC	Federal Energy Regulatory Commission
FFP	Free Flow Power
FLA	Final License Application
FPA	Federal Power Act
JAM	Joint Agency Meeting
NOI	Notice of Intent
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OHPO	Ohio Historic Preservation Office
PSD	Planned Studies Document
PAD	Pre-Application Document
ROR	Run-of-River
SHPO	State Historic Preservation Officer
TLP	Traditional Licensing Process
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

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EXECUTIVE SUMMARY

Introduction

The Lowell Lock and Dam Project (Lowell Project) is a proposed major hydroelectric project under 5 MW to be owned and operated by Free Flow Power Corporation (FFP). The Project will be located on the Muskingum River (River Mile (RM) 14.2) in Washington County Ohio (Figure A-1). The dam is also referred to as the Muskingum River Lock and Dam No. 3. As also shown in Figure A-1, the Lowell Project is one of seven projects that FFP is proposing to develop on the Muskingum River at existing lock and dam structures owned by the state of Ohio. Separate license applications have been concurrently prepared for each of the seven Projects.

The Lowell Project facilities include:

- a 840-foot-long, 17.5-foot-high dam;
- a 80-foot-wide, 52-foot-high, 37-foot-long intake structure;
- a 160-foot-long, 75-foot-wide concrete powerhouse
- two 2.5 MW turbine generator units;
- a substation,
- a transmission line;
- and appurtenant facilities.
- The project will have an average annual generation of 30,996 MWh.

Consultation and Studies

FFP initiated Stakeholder consultation in advance of filing the Preliminary Permit Applications for the Muskingum River Projects in March, 2009, and continued early outreach during preparation of the Pre-Application Document (PAD). FFP also simultaneously filed its Notice of Intent (NOI) to file and original license application for the Project and a request for approval to use the TLP with FERC on November 30, 2010. FERC approved FFP's request to use the TLP on January 21, 2011.

FFP conducted Joint Agency Meetings (JAM) on March 8, 2011 in Zanesville, OH, March 9, 2011 in McConnelsville, OH, and March 10, 2011 in Beverly, OH. All comments received were addressed through studies and the analysis in this DLA. Copies of comments received are provided in Appendix B. Second Stage Licensing studies were scoped and conducted in consultation with the relevant resource agencies and other Stakeholders. FFP issued draft study plans on July 1, 2011 for agency review and comment. No comments were received on the study plans; however FFP did correspond with the ODNR on study methodology throughout their execution.

FFP Conducted the following studies in support of this licensing:

- Wetland Delineations Survey (Appendix C-1)
- Mussel Surveys and Impact Analysis (Appendix C-2)

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- Eastern Spadefoot Habitat Survey (Appendix C-3)
- Indiana Bat Habitat Survey (Appendix C-4)
- Desktop Fish Entrainment and Survival Study (Appendix C-5)
- Hydraulic Study (Appendix C-6)
- Dissolved Oxygen Study (Appendix C-7)
- Recreation Resources Management Plan (Appendix C-8)
- Cultural Resources Survey (Volume IV- Non Public Information)

Contents of the Application

This Application consists of the four Exhibits (A, E, F and G) prescribed by Regulation (18 CFR §4.61; applicable to Applications for Licenses for Minor Water Power Projects and Major Water Power Projects 5 Megawatts or Less), the record of the Applicant's consultation in the preparation of this application, and the study plans and reports. The major sections are specifically entitled:

Volume I: License Application
Initial Statement
Exhibit A – Project Description and Operation
Exhibit E – Environmental Report
Exhibit G – Project Maps

Volume II: Appendices
Appendix A – Consultation Documentation
Appendix B – Final Study Plans
Appendix C – Final Study Reports

Volume III: Critical Energy Infrastructure Information (Per regulations filed separately **with** FERC and dam owner only.)
Exhibit F – Project Drawings and Supporting Design Report

Volume IV: Non-Public Information (Per regulations filed separately with FERC, dam owner and SHPO only.)
Cultural Resource Study Report

Exhibit A describes the existing and proposed facilities, Project operations, and Project costs. Corresponding to Exhibit A, the Project works are shown in Exhibit F, Project Plans, and Exhibit G, Project Maps.

Exhibit E discusses the existing environmental resource baseline and studies conducted in support of the licensing, agency comments regarding Project impacts, and FFP's proposed protection, mitigation and enhancement measures. In addition to the Introduction, Exhibit E is comprised of five sections:

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E.1 Existing Environmental Resources
E.2 Project Impacts, Agency Recommendations, Studies Conducted and Measures Proposed by the Applicant
E.3 Agency Consultation
E.4 Comprehensive Plans
E.5 Literature Cited

Section E.1, "Existing Environmental Resources," presents a description of the existing resources in the Project area, incorporating results of pertinent studies. Even though this application is for a single Project, FERC is expected to prepare one multi-project environmental assessment for all of FFP's Muskingum River Projects. Therefore, section E.1 encompasses existing resources in all Project areas, and is identical in each application. Section E.2, "Project Impacts, Agency Recommendations, Studies Conducted and Measures Proposed by Applicant", presents a summary of all agency study requests, studies conducted in response to agency requests, resource impacts identified through the study process, and the Applicant's plans for mitigation, protection and enhancement. Sections E.3, "Agency Consultation" documents compliance with the agency consultation requirements of the FERC licensing process. Section E.4, "Comprehensive Plans" is a review of FERC-approved state and federal comprehensive plans, and describes how the Project complies with applicable plans. Section E.5, "Literature Cited," provides a listing of the literature cited throughout Exhibit E.

Appendix A is documentation of consultation with appropriate federal and state agencies concerning Project area resources in accordance with FERC Regulations. The Consultation Documentation appendix of this application provides a chronological list of consultation, as well as, copies of actual correspondence with resource agencies and non-governmental organizations.

Appendix B contains copies of final study plans for studies conducted as part of this licensing. Draft Study reports are provided in Appendix C.

Proposed Protection, Enhancement and Mitigation Measures

Proposed protection, mitigation and enhancement measures are listed in Table ES-1.

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Resource	Effect/ Issue	Proposed PM&E Measures	PROJECT						
			Zanesville	Philo	Rokeby	Malta	Beverly	Lowell	Devola
Botanical Resources	Effects on wetland species located in/adjacent to USCAE jurisdictional wetlands and waterways	Erosion and Sedimentation and Control Plan	X	X	X	X	X	X	X
	Effects on botanical communities located along new transmission corridors	Transmission Line Corridor Maintenance Plan	X	X	X	X	X	X	X
	Introduction or spread of invasive and noxious plant species	Invasive Species and Noxious Weed Control Plan	X	X	X	X	X	X	X
Wildlife Resources	Effects on Indiana bat nesting habitat during Project construction and future transmission line maintenance	Only remove trees in the construction area and along the transmission line corridor during (Oct 1-Mar 31) when Indiana bats are not roosting.	X	X	X	X	X	X	X
	Effects on the eastern spadefoot during Project construction	Presence/absence survey prior to construction			X				
		Limit heavy machinery traffic 8 pm to 6 am, for 2 days following major rain events between Mar 15 - Aug 31.	X	X	X	X	X	X	X
	Effects on mussels during Project construction and due to permanent changes in hydraulic conditions and changes in sediment transport and deposition	Erosion and Sedimentation and Control Plan	X	X	X	X	X	X	X
		FFP will consult further with the ODNR and USFWS regarding appropriate protection and/or mitigation measures for affected mussel communities.					X	X	X
	Effects on wildlife habitat located along any new transmission corridors	Transmission Line Corridor Maintenance Plan	X	X	X	X	X	X	X
	Transmission line effects on raptor/bird of prey species	Avian Protection Plan	X	X	X	X	X	X	X
	Introduction or spread of invasive species.	Invasive Species and Noxious Weed Control Plan	X	X	X	X	X	X	X
Fisheries Resources	Effects on near-shore fish habitat and water quality due to erosion and sedimentation during construction	Erosion and Sedimentation and Control Plan	X	X	X	X	X	X	X
	Turbine impingement and entrainment	2 inch trashracks and intake approach velocities < 2 fps	X	X	X	X	X	X	X
	Introduction or spread of invasive species.	Invasive Species and Noxious Weed Control Plan	X	X	X	X	X	X	X
Water Resources	Effects on water quality during construction	Erosion and Sedimentation and Control Plan	X	X	X	X	X	X	X
		DO and turbidity monitoring during construction downstream of tailrace cofferdam (anticipated to also be part of Erosion and Sedimentation and Control Plan)	X	X	X	X	X	X	X
	Construction Related hydraulic changes	The timing of hydraulic condition changes (disturbances in water levels and flows) will be factored into the construction schedule and sequencing in order to avoid hydraulic changes during the recreation season and any	X	X	X	X	X	X	X

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Resource	Effect/ Issue	Proposed PM&E Measures	PROJECT						
			Zanesville	Philo	Rokeby	Malta	Beverly	Lowell	Devola
		sensitive fish spawning periods indentified by Agencies.							
Land and Water Uses	Changes to existing recreational land uses	Recreation Resources Management Plan	X	X	X	X	X	X	X
	Conversion of land use for new transmission line corridor	Transmission Line Corridor Maintenance Plan	X	X	X	X	X	X	X
Recreational Resources	Construction related effects due to construction access needs and public safety concerns	Access for existing recreational facilities and uses will be maintained wherever feasible, but there will be some access restrictions at all sites. A public safety restriction area will be established for the project an d public signage will be maintained throughout construction	X	X	X	X	X	X	X
	Effects of canal intake flows on recreation boating through Zanesville canal and lock	Project will shutdown during lock operating hours in the summer, resulting in no effect.	X						
	Effects of canal intake flows on dock adjacent to the Zanesville Lock	Project will shutdown during lock operating hours in the summer, resulting in no effect.	X						
	Loss of shoreline fishing access to Zanesville canal at the project intake	FFP will consult with the ODNR to determine suitable mitigation for loss of shoreline fishing access in this area.	X						
	Loss of shoreline fishing access to the river at the Zanesville Powerhouse	FFP will consult with the ODNR to determine suitable mitigation for loss of shoreline fishing access in this area.	X						
	Restriction of public access for shoreline fishing at Philo intake and substation, to be located on parcel at County Highway 32 and Water Street	FFP will consult with the ODNR to determine suitable mitigation for loss of shoreline fishing access in this area.		X					
	Rokeby Lock restricted access at the substation	Project substation will be landscaped consistent with surrounding recreation lands			X				
	Restriction of shoreline fishing access along SR 669 where Rokeby intake, powerhouse, tailrace and shoreline protection measures will be located	FFP will consult with the ODNR to determine suitable mitigation for loss of shoreline fishing access in this area.			X				
	Restriction of shoreline fishing access on McConnels Island where substation will be located.	FFP will consult with the ODNR to determine suitable mitigation for loss of shoreline fishing access in this area.				X			
	Effects on boating due to Rokeby impoundment water surface elevation changes	FFP proposes to consult with ODNR, USFWS, and local stakeholders further regarding navigation issues in this pool and determine appropriate mitigation in consultations with these parties				X			
	Effect son boating due to Devola impoundment water surface elevation changes	FFP proposes to consult with ODNR, USFWS, and local stakeholders further regarding navigation issues in							X

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Resource	Effect/ Issue	Proposed PM&E Measures	PROJECT						
			Zanesville	Philo	Rokeby	Malta	Beverly	Lowell	Devola
		this pool and determine appropriate mitigation in consultations with these parties.							
Cultural Resources	Effects on Historic Properties and Prehistoric Site in the Project area during construction and in the future	Historic Properties Management Plan	X	X	X	X	X	X	X
Scenic and Aesthetic Resources	Effects on Instream Aesthetics	Aesthetic veiling flow during summer recreation season (May – October)	X	X	X	X	X	X	X
	Effects on Aesthetic Character of Existent Sites	Project powerhouse is designed to blend with existing dam and lock, and will be landscaped consistent with surrounding recreation lands	X	X	X	X	X	X	X
Geologic and Soil	Soils Erosion and Sedimentation During Construction	Erosion and Sedimentation and Control Plan	X	X	X	X	X	X	X
Socio-economic Resources	None	No mitigation requires but the Project will contribute to local economy through construction jobs, local sourcing for equipment and materials, and future tax payments.	X	X	X	X	X	X	X

Table ES-1. Proposed Protection, Mitigation and Enhancement Measures (Source: FFP)

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1.0. Project Description

1.1 Introduction

The Lowell Lock and Dam Project (Lowell Project) is a proposed major hydroelectric project under 5 MW to be owned and operated by Free Flow Power Corporation (FFP). The Project will be located on the Muskingum River (River Mile 13.6) in Washington County Ohio (Figure A-1). The Lowell Lock and Dam is also referred to as the Muskingum River Lock and Dam No. 3. As also shown in Figure A-1, the Lowell Project is one of seven projects that FFP is proposing to develop on the Muskingum River at existing lock and dam structures owned by the State of Ohio. Separate draft license applications have been concurrently prepared for each of the seven Projects.

The Lowell project is described throughout this Exhibit. Table A-1 provides a summary of important project parameters for the Lowell Project. Existing facilities at the Lowell Lock and Dam site that will be used for the hydro project include the dam which is 840 feet in length, has a structural height of 17.5 feet and a hydraulic height of 14.2 feet. The lock will not be part of the FERC licensed Project. The proposed hydroelectric project will include: the existing 840 foot long dam including new dam abutment; an intake structure; a 160 foot x 75 foot concrete powerhouse containing two 2.5 MW turbine generator units; a substation,; a transmission line; and appurtenant facilities. The project will have an average annual generation of 30,996 MWh.

The Project will be operated in a run-of-river (ROR) mode and the water surface elevation will be maintained at Normal Impoundment Elevation (crest of the dam spillway). The Lowell Project will divert those flows that are currently passed over the spillway (up to the maximum hydraulic capacity of the turbines), through the turbine for use in power generation. FFP is proposing to provide a veiling flow over the spillway to maintain aesthetics during the recreation season. This proposal is further discussed in Section 1.3.4 of this Exhibit.

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Figure A-1. Lowell Lock and Dam Project Location Map (Source: FFP)

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GENERAL		
Project Location:	Washington County Ohio	
Waterbodies:	Muskingum River, River Mile 13.6	
USGS Water Level Gage	None	
USGS Flow Gage:	03150000, Muskingum River at McConnelsville, OH	
Gage Drainage Area	7,422 square miles	
Period of Record	1921-2010	
Maximum Flow at USGS Gage	124,000 cubic feet per second (cfs)	
Minimum Flow at USGS Gage	325 cfs	
Mean Flow at USGS Gage	7,860 cfs	
Project Drainage Area:	7,990 square miles	
Average Gross Head at Power House:	12.32 feet	
Prorated Maximum Flow at Site:	133,573 cfs,	
Prorated Minimum Flow at Site:	350 cfs,	
Prorated Mean Flow at Site:	8,392 cfs,	
IMPOUNDMENT	**EXISTING**	**PROPOSED**
Normal Impoundment Elevation:	607.06 NAVD 88	No Change
Estimated Surface Area:	628 acres	No Change
Usable Storage Capacity:	Negligible	No Change
Gross Storage Capacity:	4,4492 acre-ft	No Change
DAM SPILLWAY	**EXISTING**	**PROPOSED**
Construction:	Timber crib with concrete	No Change
Length:	840 feet	No Change
Height:	17.5 feet	No Change
Crest Elevation:	607.06 NAVD 88	No Change
INTAKE STRUCTURE	**EXISTING**	**PROPOSED**
Length	Not Existing	37 feet
Height:	Not Existing	52 feet
Width:	Not Existing	80 feet
Number of Stoplog:	Not Existing	1
Stoplog Dimensions:	Not Existing	39 feet wide x 52 feet
Top of Stoplog:	Not Existing	616.5 NAVD 88
POWERHOUSE	**EXISTING**	**PROPOSED**
Construction:	Not Existing	Concrete
Length:	Not Existing	160 feet
Width:	Not Existing	75 feet
Minimum Tailwater Elevation:	Not Existing	593 NAVD 88
TURBINES	**EXISTING**	**PROPOSED**
Units 1-2, each:		
Manufacturer:	Not Existing	To Be Determined
Average Gross Head:	Not Existing	12.32 feet
Min. Hydraulic Capacity:	Not Existing	750 cfs each unit (Est.)
Max. Hydraulic Capacity:	Not Existing	2,750 cfs each unit (Est.)

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GENERATORS	EXISTING	PROPOSED
Units 1-2, each:		
Manufacturer:	Not Existing	To Be Determined
Phase:	Not Existing	3
Cycles:	Not Existing	60
MW:	Not Existing	2.5 MW each
Total Installed Capacity:	Not Existing	5.0 MW
Annual Average Generation:	Not Existing	30,996 MWh
Annual Plant Factor:	Not Existing	0.71
Power Factor:	Not Existing	0.90
SUBSTATION	Not Existing	40 ft x 40 ft
TRANSMISSION FACILITIES	Not Existing	1,200 feet, three-phase, 69kV

Table A-1. Summary of Important Project Parameters

(Source: FFP)

1.2 Generators (18 CFR §4.61(C)(1)(i))

Electricity will be generated by two identical 2.5 MW generators, which will have a combined nameplate capacity of 5.0 MW. Data for each unit is as follows:

Manufacturer: To Be Selected After Licensing
MW: 2.5
Phase: 3
Cycles:60

There are no provisions for future generators planned at this Project beyond those proposed herein.

1.3 Turbines (18 CFR §4.61(C)(1)(ii))

The Lowell Project will have two identical 2.5 MW Horizontal Pit Kaplan turbines. Nameplate data for each unit will be as follows:

Type: Horizontal Kaplan
Manufacturer: To Be Selected After Licensing
Average Gross Head: 12.32 feet
Min. Hydraulic Capacity (each): 750 cfs (Est.)
Max. Hydraulic Capacity (each): 2,750 cfs (Est.)

There are no provisions for future turbines planned at this Project beyond those proposed herein.

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1.4 Project Operations (18 CFR §4.61(C)(1)(iii))

1.4.1 Normal Operations

The Lowell Project will operate in a run-of-river (ROR) mode. Currently, flows are used seasonally for recreational lockage or passed over the spillway. The proposed operation plan takes seasonal recreational navigation, water quality, and aquatic ecosystem flow requirements into account.

The Lowell Project generates electricity by using the energy from water which under existing conditions flows uncontrolled over the dam. The amount of water diverted to the Project will range from approximately a minimum of 750 cfs to a maximum of 5,500 cfs. As one would expect, this change in future water flow management will result in a lower water surface elevation in the impoundment pool above each project for an increased percentage of time, but will not go below the dam spillway crest. As river discharge rises and falls throughout the year the Project impact on water surface elevation varies. Figure A-2 displays the water surface elevation changes at the dam throughout low flow, average flow, and high flow years under the existing conditions and with the proposed Project. The magnitude of the water surface elevation decrease will be proportional to the river flow, i.e. during low flow the Project will have a smaller effect on water surface elevations compared to higher flows. Further information on hydraulic modeling methodologies and results are found in Appendix C-H.

FFP will curtail operation of all turbines when river flow falls below 27% of the normal rated capacity of one turbine, which is approximately 750 cfs. During these low flow periods, the water will be passed over the existing dam. This is expected to occur approximately 8% to 10% of the time, typically during the summer months. It is expected that routine annual maintenance of the turbine generators and structures will take place at that time.

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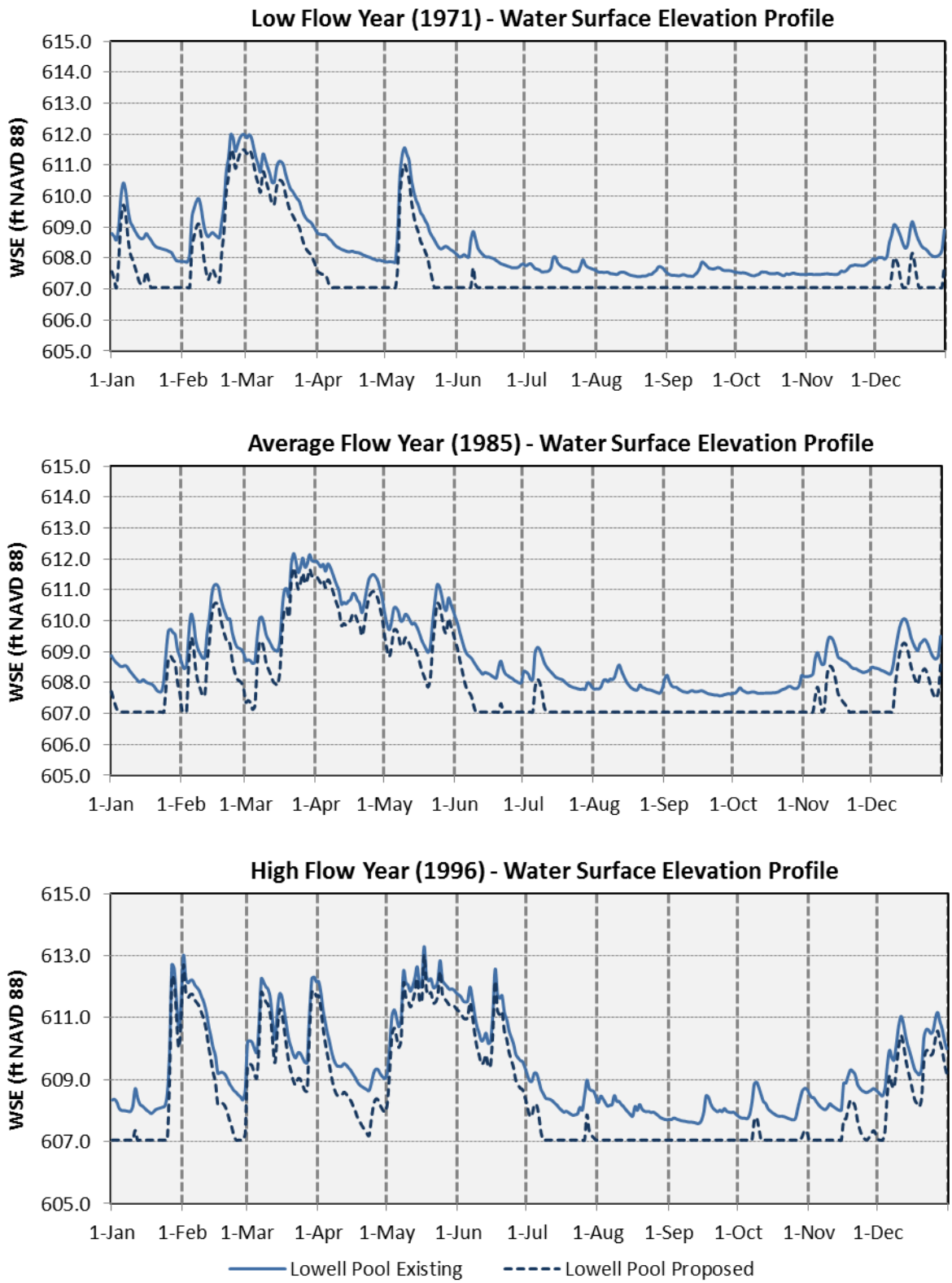

Figure A-2. Lowell Project Pool Water Surface Elevations in Low, Average, and High Years. (Source: FFP)

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1.4.2 High Flow Condition Operations

The addition of the turbine generators will not adversely impact the flood response currently provided by the Muskingum River Lock and Dam System.

FFP will suspend generation at the Lowell Project during flood flows when excessive debris conditions, or when tailwater levels rise to a point where not enough head exists for the turbines to operate efficiently. Normally, this is not expected to occur more than 10 days per year.

1.4.3 Maintenance Operations

FFP will have planned routine scheduled maintenance programs that will not involve draw-down of the impoundment. If the turbines require maintenance, stoplogs will be dropped into the intake structure slots and tailrace section slots to allow safe dewatering of the turbine.

1.4.4 Proposed Operational Provisions for Resource Protection

The Lowell Project will divert flows that are currently passed over the spillway for use in generation. However, total river flows will exceed turbine capacities approximately 50% of the year, primarily in the fall and spring. Thus, the spillway will continue to have flow passing over it approximately half the year. This will typically occur outside the summer recreation season, unless spillage is occurring due to river flows exceeding turbine capacities, or river flows being too low for unit operations.

Therefore, FFP is proposing to provide a veiling flow at the dam to maintain aesthetics during the recreation season. FFP will pass a flow equivalent to 1/2 inch of water (approximately 25.4 cfs) over the dam during the recreation season (May through October). This will enhance aesthetics for people recreating in the Project area. In addition, it may provide dissolved oxygen enhancement in the area downstream of the dam.

1.5 Average Annual Energy Production (18 CFR §4.61(C)(1)(iv))

Based on analysis of average daily flow characteristics for the period of record 1921 – 2010, the projected average annual generation for the Lowell Project is approximately 30,996 MWh.

1.6 Estimated Average Gross Head (18 CFR § 4.61(C)(1)(v))

The estimated average gross head at the Lowell Project will be 12.32 feet.

1.7 Impoundment (18 CFR §4.61(C)(1)(vi))

The Lowell Project reservoir has a surface area of approximately 628 acres at a normal pool elevation of 607.6 NAVD88. The reservoir has 4,492 acre-feet of gross storage capacity.

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However, the Project will be operated in a ROR mode, so that there will be no usable storage capacity.

1.8 Flow Data (18 CFR §4.61(C)(1)(vii))

1.8.1 Estimated Hydraulic Capacity

The Lowell Project will have an expected minimum and maximum hydraulic capacities of 750 cfs and 5,500 cfs, respectively. Each of the two turbines is expected to have a minimum hydraulic capacity of 750 cfs and maximum hydraulic capacity of 2,750 cfs.

1.8.2 Hydrology of the Muskingum River

The Muskingum River basin area has a drainage area of 8,051 square miles, making it the largest watershed in the state of Ohio. It drains portions of central, northeast, and southeast Ohio into the Ohio River. The northern border of the Muskingum River basin lies adjacent to the Great Lakes basin, representing the boundary between waters that drain towards the Gulf of Mexico via the Mississippi River and waters that drain towards the North Atlantic via the St. Lawrence River.

Flow data for the Lowell Project was developed using The US Geologic Service (USGS) gage 03150000, Muskingum River at McConnelsville, OH This gage has a period of record from 1921 to 2010, and lies roughly in the center of FFP's proposed Muskingum River Projects. Flow data for this gage was prorated for each site based upon drainage area.

The maximum, minimum and mean flows at USGS gage 03150000, Muskingum River at McConnelsville, OH for the period of record (1921 to 2010) were 124,000cfs, 325cfs and 7,860 cfs, respectively.

The prorated maximum, minimum, and mean, flows at the Lowell Project site are 133,573 cfs, 350 cfs, and 8,392 cfs, respectively. Monthly and annual flow duration curves for the Lowell Project are presented in Figures A-3 through A-15.

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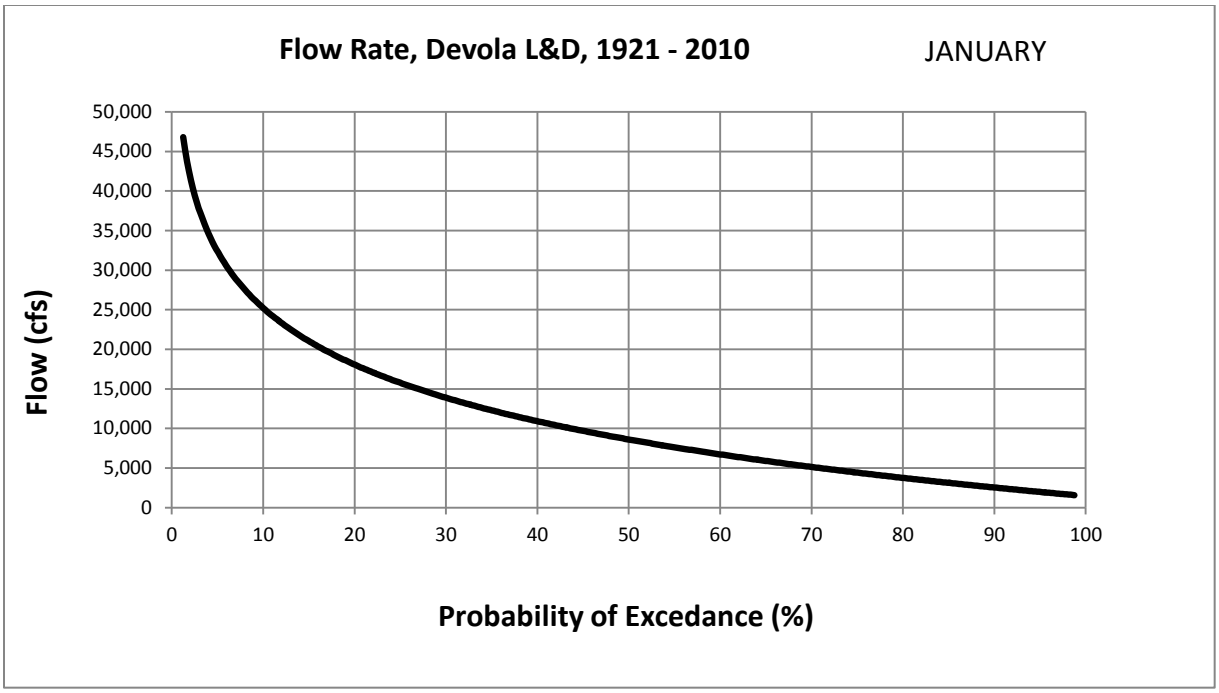

Figure A-3. Lowell Project January Flow Duration Curve (Source: FFP)

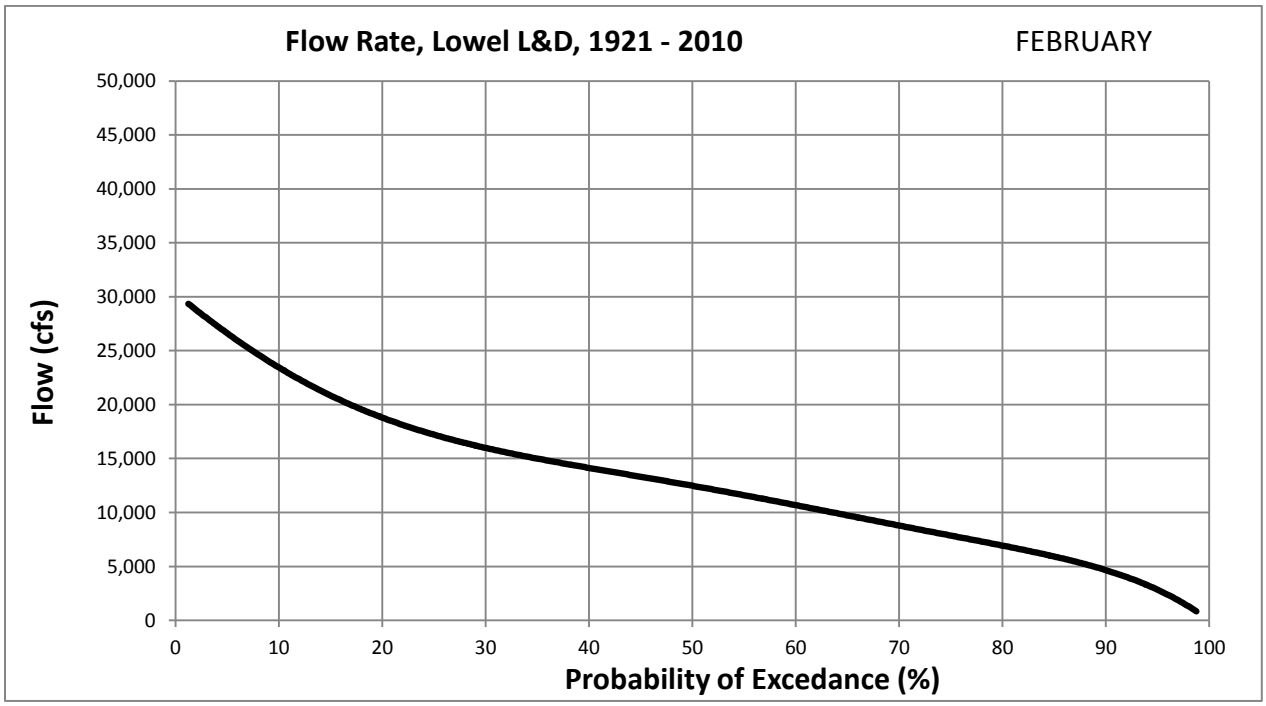

Figure A-4. Lowell Project February Flow Duration Curve (Source: FFP)

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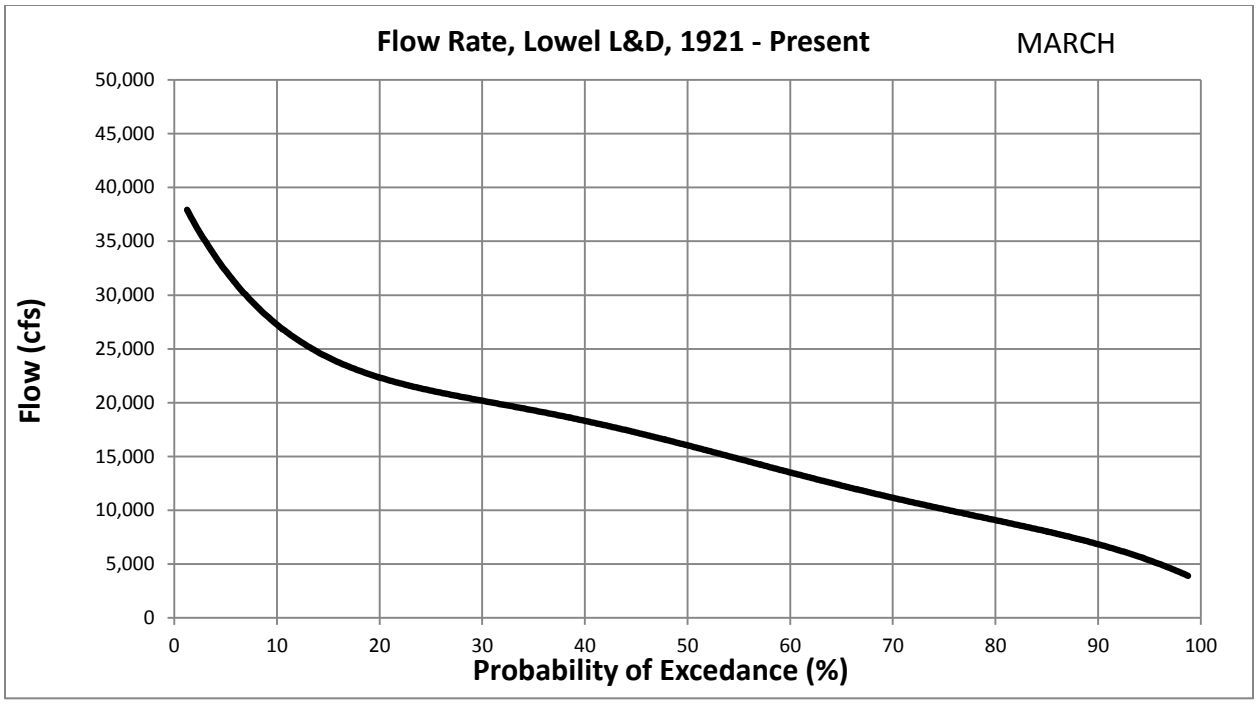

Figure A-5. Lowell Project March Flow Duration Curve (Source: FFP)

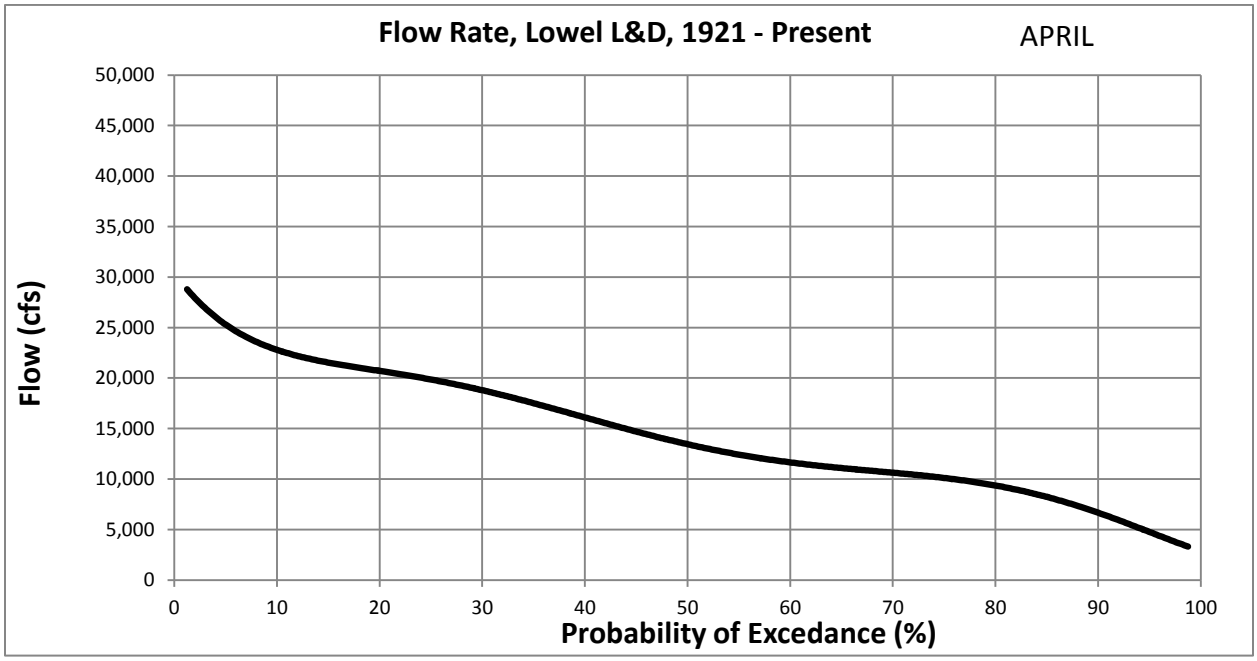

Figure A-6. Lowell Project April Flow Duration Curve (Source: FFP)

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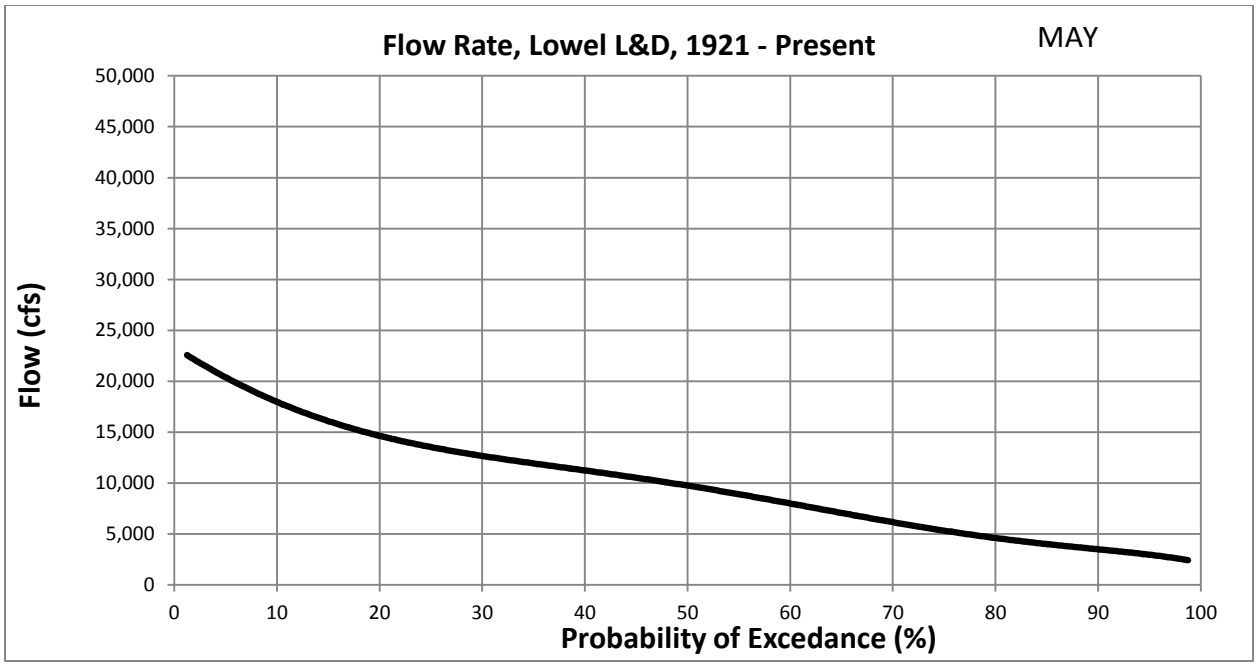

Figure A-7. Lowell Project May Flow Duration Curve (Source: FFP)

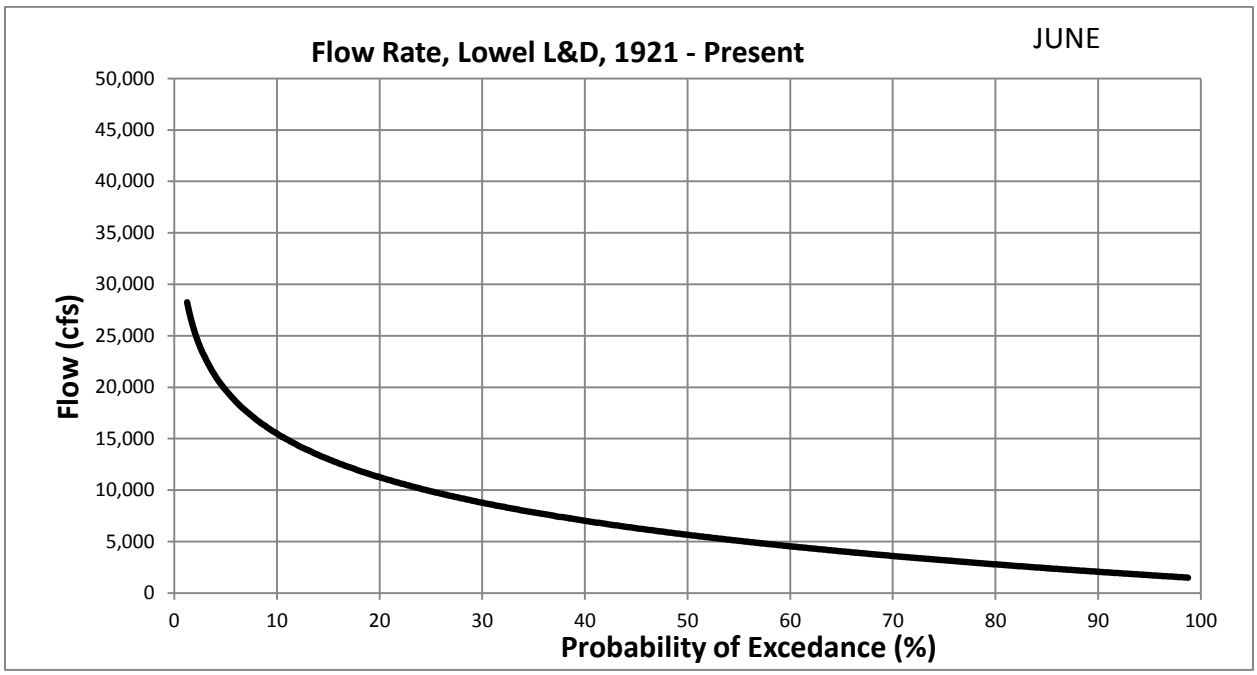

Figure A-8. Lowell Project June Flow Duration Curve (Source: FFP)

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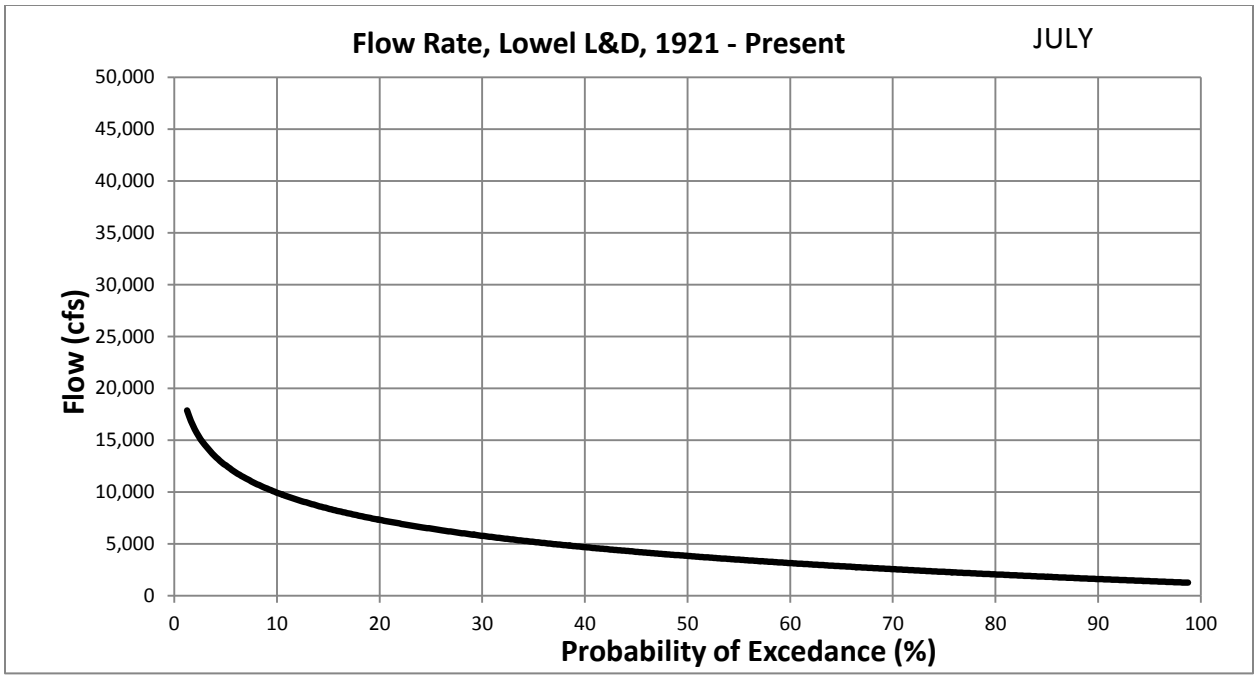

Figure A-9. Lowell Project July Flow Duration Curve (Source: FFP)

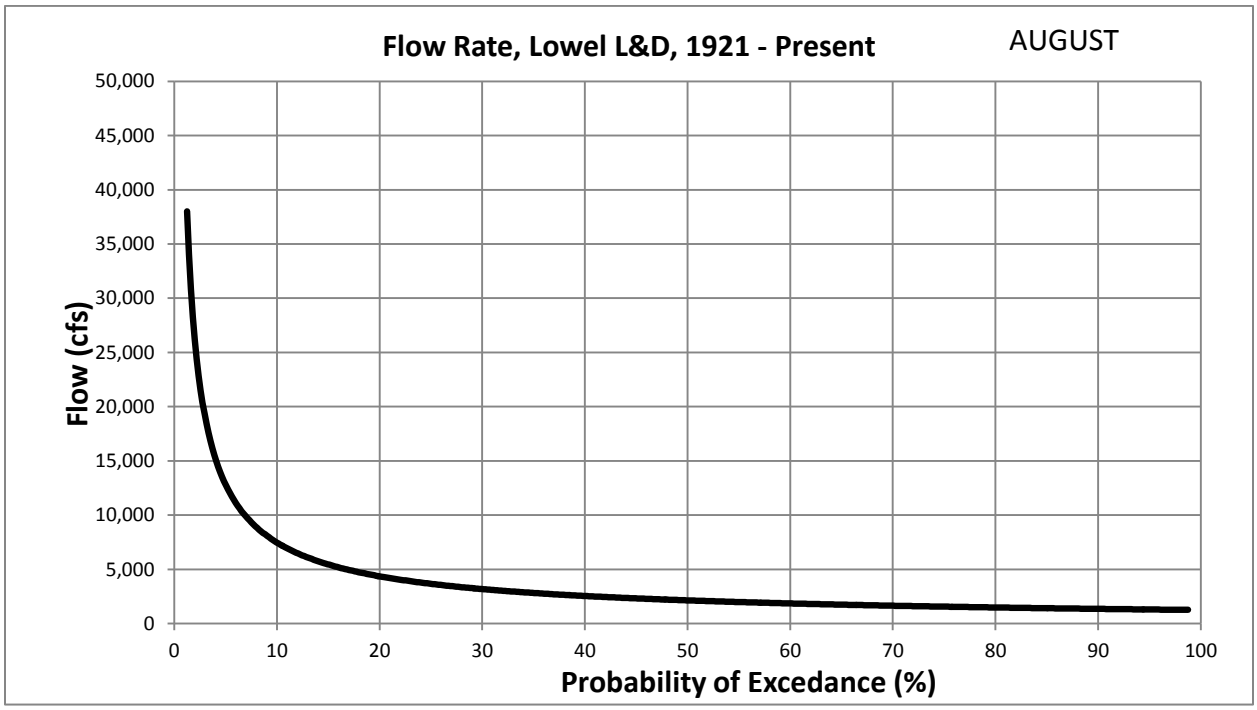

Figure A-10. Lowell Project August Flow Duration Curve (Source: FFP)

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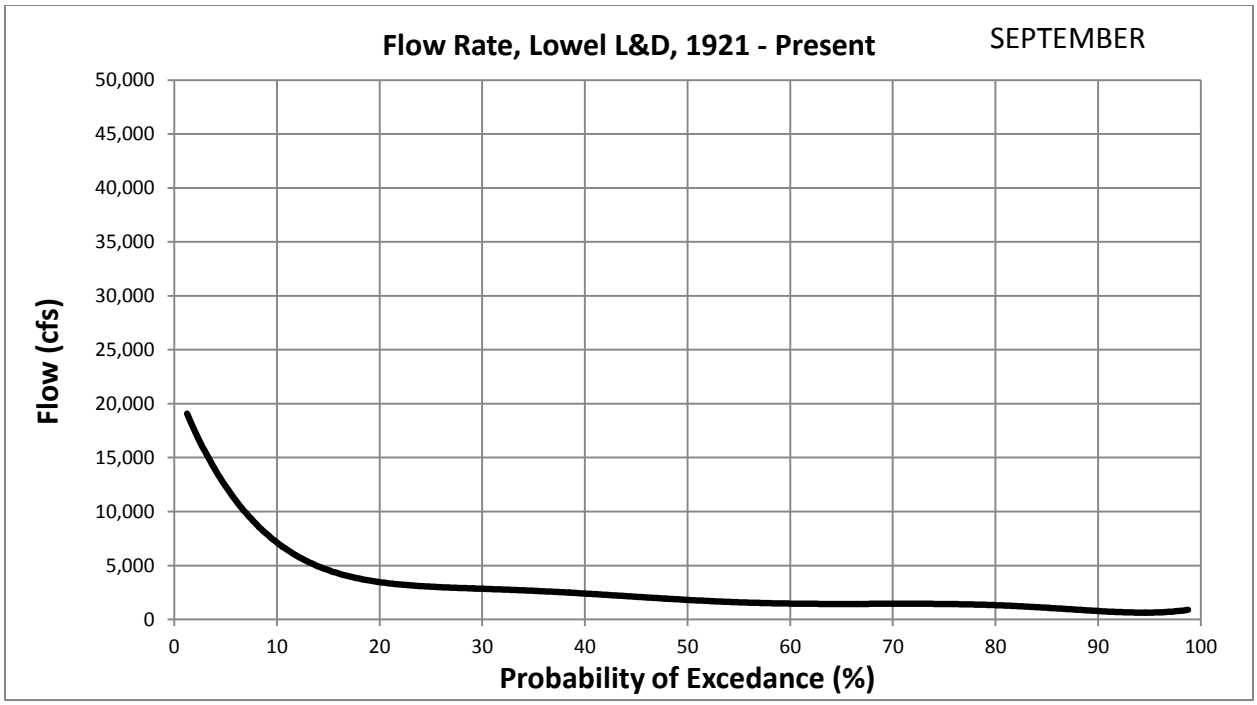

Figure A-11. Lowell Project September Flow Duration Curve (Source: FFP)

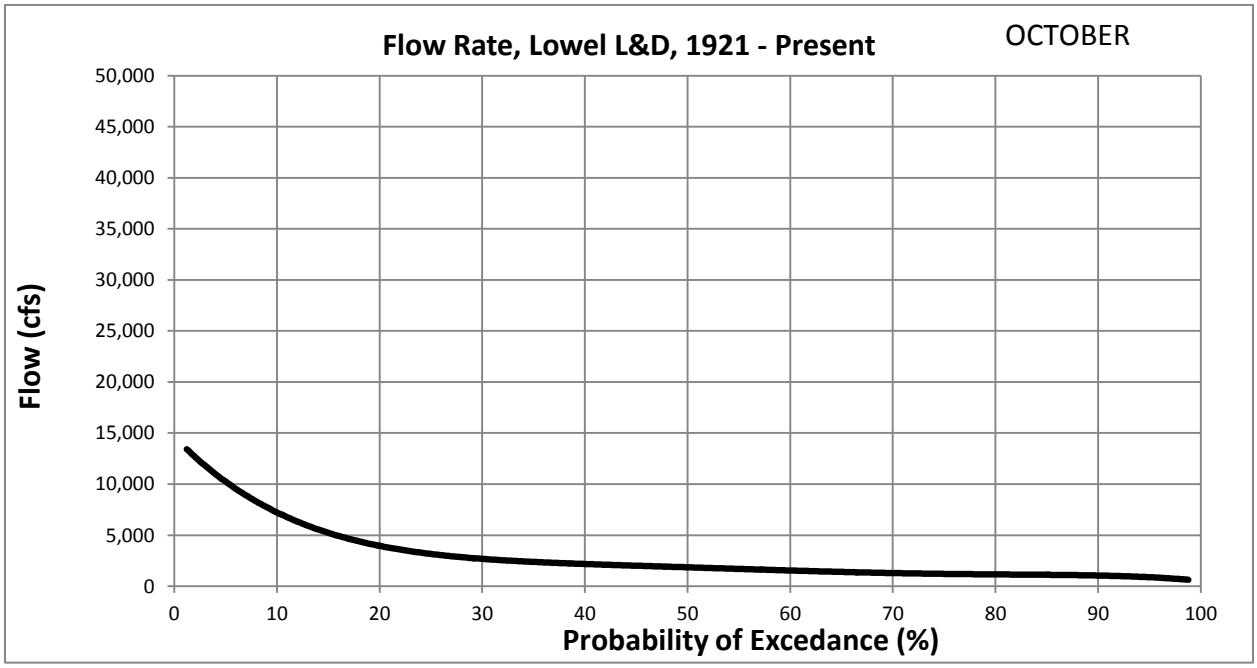

Figure A-12. Lowell Project October Flow Duration Curve (Source: FFP)

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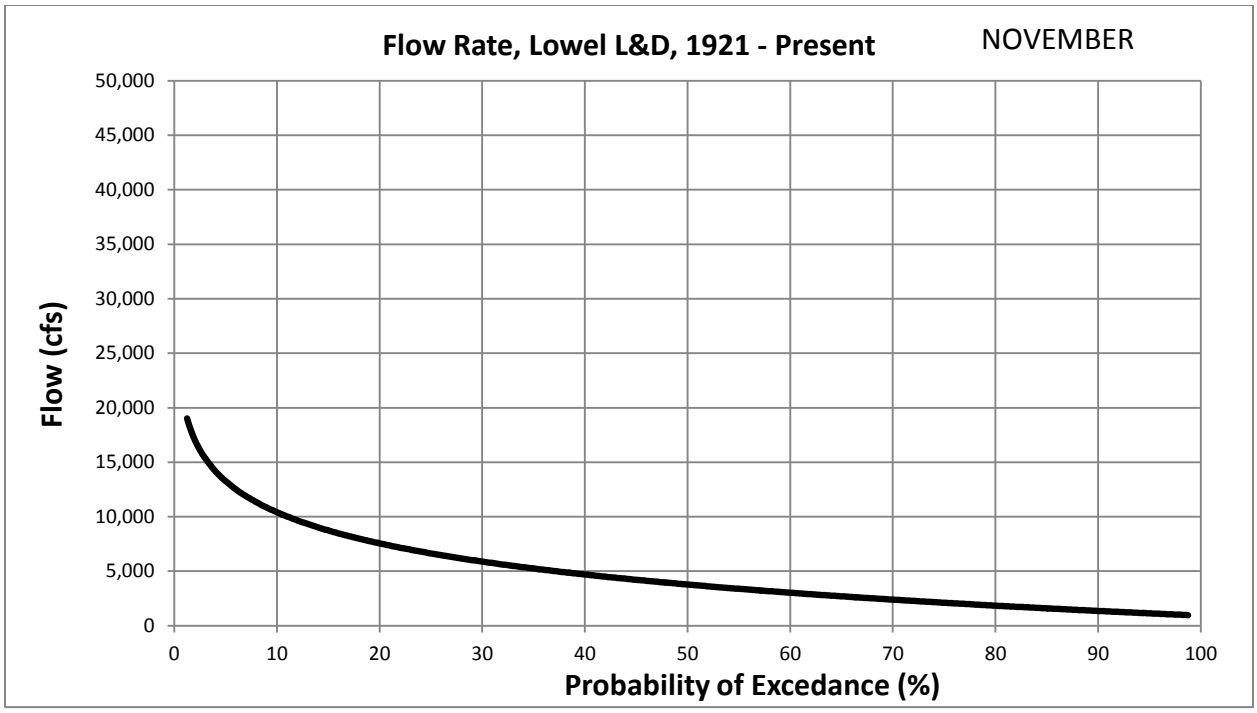

Figure A-13. Lowell Project November Flow Duration Curve (Source: FFP)

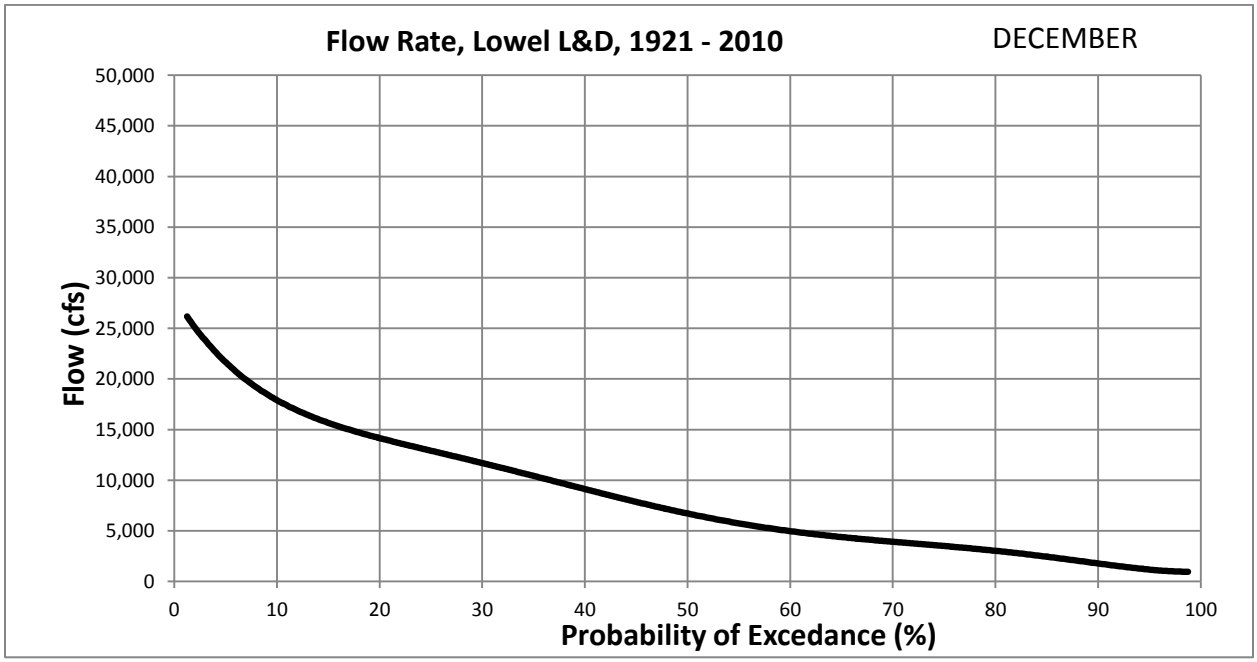

Figure A-14. Lowell Project December Flow Duration Curve (Source: FFP)

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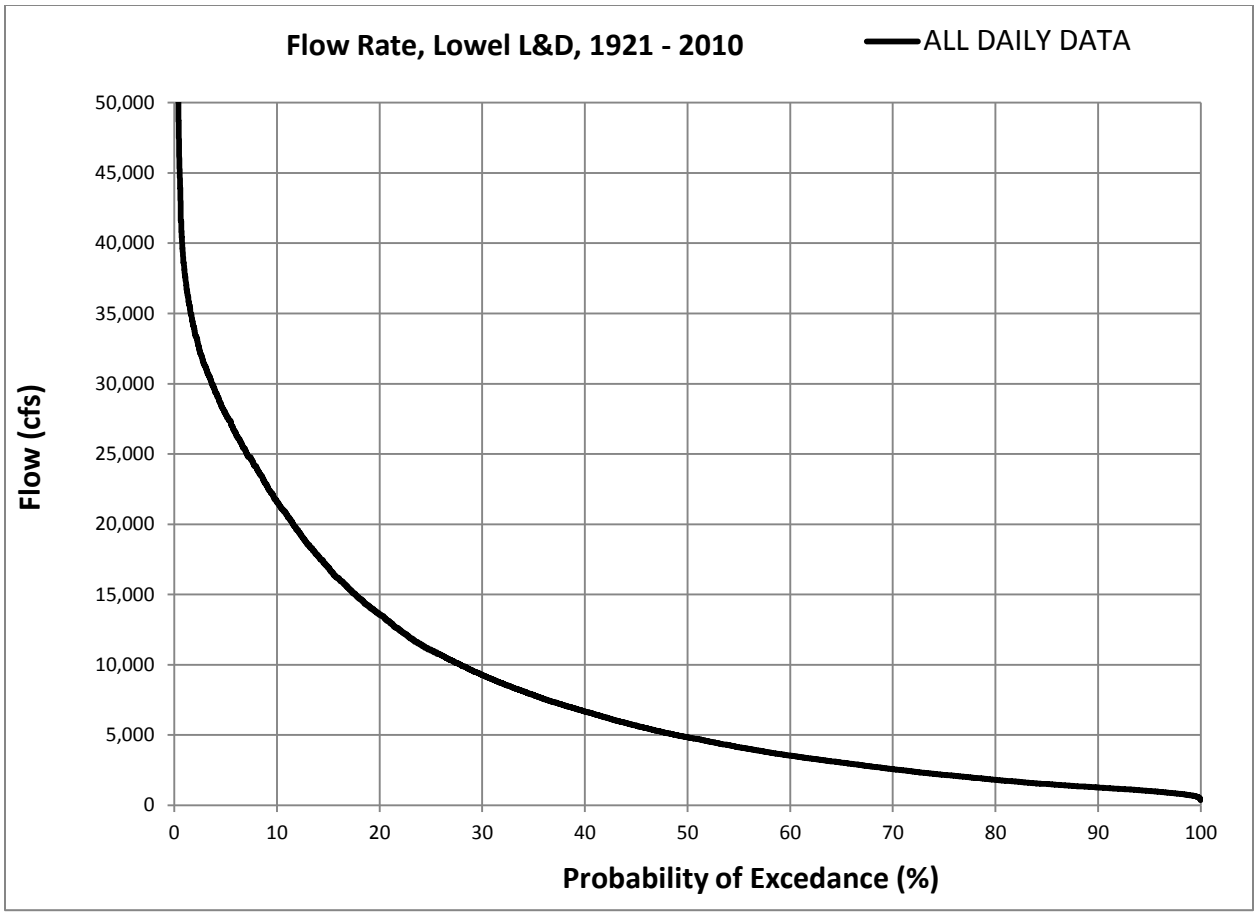

Figure A-15. Lowell Project Annual Flow Duration Curve (Source: FFP)

1.9 Project Structures (18 CFR §4.61(C)(1)(viii))

1.9.1 Existing Structures

The existing Lowell Lock and Dam is also referred to as the Muskingum River Lock and Dam No. 3. This existing dam is 840 feet in length, has a structural height of 17.5 feet and a hydraulic height of 14.2 feet. There is a one- mile-long by-pass canal located on the left bank of the river, allowing boat traffic to avoid the shallows below the dam. At the tail end of the by-pass canal is a single chamber lock, located 0.58 miles downstream from the dam.

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Photo A-1. Lowell Dam.
(Source: FFP)

1.9.2 Proposed Structures

FFP's proposed water power projects will be designed and constructed in a way that is historically and architecturally cohesive, using low-profile structures and aesthetics which seek to preserve the qualities of the site. Modern, high-efficiency generating equipment will be employed to maximize energy production and an operation plan will be developed that is integrated with the recreation, navigation, and public safety issues at the site. Plans for the proposed Project depicting all existing and proposed structures that will be part of the FERC Project are provided in Exhibit F.

1.9.2.1 Modified Dam

Since the powerhouse will be placed in the current spillway, the dam spillway length will be reduced to install a powerhouse of 180 ft by 75 ft. The powerhouse will be placed about 100 ft downstream of the dam axis. The reduced dam length will be replaced by a new dam abutment. The dam abutment will act as over flow weir. The length of dam abutment will be sufficient to match the length of displaced dam portion. Additionally this design will allow safe passage of ice and debris as required during normal project operation activities.

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1.9.2.2 Intake

The intake structures, comprised of poured reinforced concrete, will measure 80 feet in width and 37 feet in length and contain one bay per turbine unit with a dividing pier, to form two equally sized openings 39 feet in width and approximately 52 feet deep. These openings will have vertical slots at the entrance to accommodate stoplogs; allowing operators to dewater the powerhouse for inspection and maintenance.

Behind the stoplog slots, inclined trash racks will span the entire width of the intake structure to trap debris and protect the turbines.

There will be an operator's deck above trash racks to allow safe access for maintenance and cleaning of debris. The river channel immediately upstream of the intake will be excavated and contoured to transition smoothly to the new structure. Rip rap and large stone will be placed upstream of the intake structures and in areas of high velocity in the river channel to prevent potential scouring.

1.9.2.3 Powerhouse

The Lowell Lock Project powerhouse will be located adjacent to the left bank of the dam. The overall footprint of the powerhouse structure will be approximately 160 feet by 75 feet and it will be constructed of reinforced concrete.

Due to the low-profile design, about 90% of the structure will be below the water's surface. The highest point on the structure will be the intake section headwall, which will be about 6 feet above the pool level. The majority of the intake section will be 3 feet above pool level, and the majority of the draft tube section will be submerged.

1.9.2.4 Draft Tube

The draft tube section is a transitional box section structure at the downstream end of the powerhouse. The upstream end of each draft tube will be formed with a steel liner and the lower velocity downstream ends will be unlined concrete. The overall footprint of the draft tube section will be 65 feet in length and 75 feet in width. Each draft tube exit discharge opening will be approximately 31feet in width and 22 feet in height. The entire draft tube section will be below normal tailwater level and will not be visible except during the lowest flow periods of the year. Each draft tube structure will have stoplogs at the exit to allow unit dewatering for inspection and maintenance purposes. Downstream of the draft tube section, the river channel will be excavated to transition the new structure to the natural riverbed contours and direct flows back into the river channel. The tailrace area will be armored with stone rip rap as needed to prevent potential scouring.

1.9.2.6 Substation

The Project will have a new substation located adjacent to the proposed powerhouse. The substation will be compact in layout, with a footprint of less than 1,600 square feet. A single pad-

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mounted three-phase step-up transformer with a rating of 5 MVA will be used. The substation will also contain low-side disconnects, high-side fusing, and other protective equipment as dictated by the interconnecting utility. The substation will be surrounded by a containment dike and a security fence. The rim of the containment dike will be above the 100-year flood flow elevation.

1.9.2.7 Transmission Lines

A 1,200 foot long, three-phase, overhead 69kV transmission lines will be constructed from the project substation to the local utility distribution lines. The suitability of the chosen interconnection point and any necessary upgrades to the utility lines are yet to be determined and will be addressed through an interconnection study prepared by the serving utility.

1.9.2.8 Appurtenant Facilities

Appurtenant equipment at the Project will include, but not limited to:

Hydraulic power units, lube oil cooling system, batteries, control room with switch gear and controls for the power plant and HVAC equipment, fire protection systems, SCADA wireless controls, parking lots and security fencing.

1.10 Estimated Project Cost (18 CFR §4.61(C)(1)(ix))

The estimated Project cost in 2015 dollars is $20,416,000.

1.11 Estimated Project Operations and Maintenance Costs (18 CFR §4.61(C)(1)(x))

The estimated costs of environmental measures at the Lowell Project will be determined prior to filing of the FLA with FERC.

2.0 Project Purpose (18 CFR § 4.61(C)(2))

Power from the Lowell Project is sold to the power grid for local distribution. The Lowell Project will provide valuable socioeconomic benefits for the region. Project construction will bring investment and construction jobs to the region. As discussed further in Exhibit E.2, recreational opportunities at the Project will be enhanced.

The 30,966 MWh of annual renewable power generation from the Lowell Project will offset reliance on non-renewable fossil fuel sources. As shown in Table A-2, the annual generation from the Lowell Project is equivalent to approximately 26,000 tons of coal, 53,000 barrels of oil or 320 million cubic feet of gas. Table A-2 also shows the tons of air pollutants that would result if non-renewable fossil fuels were used to replace this annual generation.

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Project:	Lowell					
Project Annual Generation:		30,966	MWh	30.966	GWh	
				2	% Sulfur Content of Coal	
Equivalent Fossil Fuel Generation					Fuel to Achieve Proj. Generation	
	Coal Fired Steam:	1GWh =	419.65	tons coal	26,014.94	tons coal
	Oil Fired Steam:	1GWh =	1695.4	barrels oil	52,550.62	barrels oil
	Gas Fired Steam:	1GWh =	10.320	mill. cu. ft. gas	319.88	mill. cu. ft. gas
	Pollutants				Tons of Pollutants Produced	
	1GWh from coal (No pollution control) produces:					
		SO*x* -	6.5	tons 2 % Sulfur	402.948	tons
		NO*x* -	3.0	tons	92.988	tons
		CO -	0.193	tons	5.982	tons
		CO_2 -	1124.5	tons	34,855.002	tons
	1GWh from oil (No pollution control) produces:					
		SO*x* -	6.0	tons	185.976	tons
		NO*x* -	2.0	tons	61.992	tons
		CO -	0.178	tons	5.517	tons
		CO_2 -	836	tons	25,912.656	tons
	1GWh from gas (No pollution control) produces:					
		SO*x* -	0.05	tons	1.550	tons
		NO*x* -	0.85	tons	26.347	tons
		CO -	0.2064	tons	6.398	tons
		CO_2 -	567.5	tons	17,590.230	tons

Note: Based on standard fossil fuel calculations developed by
Dr. C. Frank Miller, Federal Energy Regulatory Commission, 1992
www.epa-gov/cleanenergy/energy-and-you/affect air- emission.html

Table A-2. Alternative Energy Source Calculations
(Source: FFP, based upon Miller, 1992)

3.0 Project Licensing Costs (18 CFR §4.61(C)(3))

The estimated cost to develop the license application was $474,000 in 2015 dollars.

4.0 Peak and Off Peak Power Values (18 CFR §4.61(C)(4))

Based on an analysis performed by London Economics International, LLC for FFP, in the PJM Regional Transmission Organization the estimated on-peak power value in 2015 will be $67.20/MWh and the estimated off-peak power value is $51.20/MWh.

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5.0 Change in Project Generation (18 CFR §4.61(C)(5))

The Project is an unconstructed project. Therefore there will be no increase or decrease in generation due to a change in current project operations.

Resource protection measures that will reduce future project generation include an aesthetic veiling flow to be provided during the recreation season. This flow will reduce total Project generation by 74 MWh/year.

6.0 Project Value (18 CFR §4.61(C)(6))

The Project net present value is estimated to be $8,522,000 in 2015 dollars.

7.0 Annual Operations and Maintenance Costs (18 CFR §4.61(C)(7))

The following cost estimates are in 2015 dollars. Annual operations and maintenance cost, including labor is estimated to be $134,000. Annual major maintenance including capital expenses is estimated to be $89,000. Other expenses including insurance, taxes, and administrative costs are estimated to be $263,000.

8.0 Single-Line Electrical Diagram (18 CFR §4.61(C)(8))

A detailed single-line electrical diagram is provided as Figure A-16.

9.0 Safe Management, Operation, and Maintenance of the Project (18 CFR §4.61(C)(9))

The project will operate automatically. The powerhouse will ordinarily be unmanned, except for daily periods of maintenance, inspection and cleaning performed by one primary operator plus additional part-time operators as necessary. Operations will be monitored remotely by means of a SCADA system and emergency personnel dispatched from a central maintenance facility serving all the Muskingum projects in the event of an emergency.

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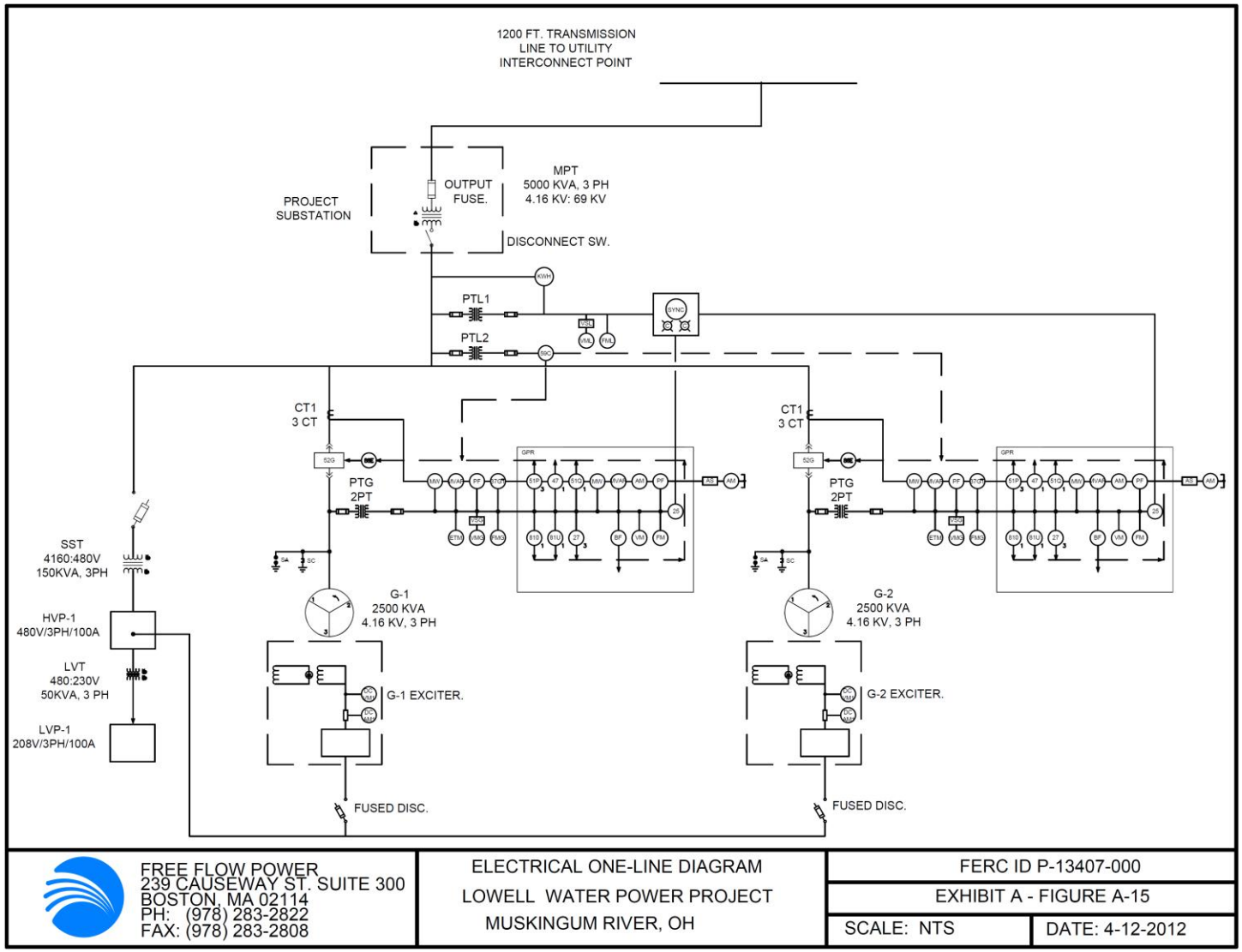

Figure A-16. Single Line Electrical Diagram (Source: FFP)

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Introduction

This Exhibit E discusses the existing environmental resource baseline and studies conducted in support of the licensing, agency and interested parties' comments regarding Project impacts, and FFP's proposed protection, mitigation and enhancement measures. In addition to this Introduction, Exhibit E is comprised of five sections:

- E.1 Existing Environmental Resources
- E.2 Project Impacts, Agency Recommendations, Studies Conducted and Measures Proposed by the Applicant
- E.3 Agency Consultation
- E.4 Comprehensive Plans
- E.5 Literature Cited

Section E.1, "Existing Resources", presents a description of the existing resources at the Project area, incorporating results of pertinent baseline information studies conducted by the Applicant. Even though this application is for a single Project, FERC is expected to prepare one multi-project environmental assessment for all of FFP's Muskingum River Projects. Therefore, section E.1 encompasses existing resources in all Project areas, and is identical in each application. Section E.2, "Project Impacts, Agency Recommendations, Studies Conducted and Measures Proposed by the Applicant," presents a summary of studies requested by agencies and interested parties, studies conducted in response to these requests, resource impacts identified through the study process, and the Applicant's plans for mitigation, protection and enhancements. Section E.3, "Agency Consultation", documents compliance with the agency consultation requirements of the FERC licensing process. Section E.4, "Comprehensive Plans", is a review of the FERC-approved state and federal comprehensive plans, and describes how the Project is in compliance with applicable plans. Section E.5, "Literature Cited", provides a listing of the literature cited used throughout Exhibit E.

Included as Appendix A is documentation of consultation with appropriate federal and state agencies concerning these resources according to the FERC regulations. The Consultation Documentation Appendix of this application provides a chronological list of consultation, as well as, copies of actual correspondence with resource agencies and non-governmental organizations.

Appendix B contains copies of final study plans for studies conducted as part of this licensing.

Draft study reports are provided in Appendix C.

Throughout Exhibit E there are several different geographic area references used.

"**Project Boundary"** is used to refer to only those lands within the proposed FERC Project boundary. The Project boundary must include all Project features and lands necessary to operate the Project.

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"Area of Potential Effect" (APE) includes an aquatic component and a terrestrial component. The aquatic APE is the river area upstream and downstream of the existing dam that the new hydropower projects will potentially effect. The aquatic APE was formally defined using two dimensional modeling. The terrestrial APE includes lands that will be affected by project construction, including transmission line corridors.

"**Project Area**" is a very general reference to the land and waters in the immediate vicinity of the proposed Projects. It is not equivalent to the Project Boundary or APE and can vary with usage.

"Project Region" is used to encompass a larger geographic area such as the state of Ohio, or the Muskingum River Basin. Its geographic scope varies according to subject matter and source document usage.

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E.1 Existing Environmental Resources (18 CFR§ 4.61(d) (2) (i))

E.1.1 Botanical Resources

E.1.1.1 Vegetative Cover Types

The Muskingum River, formed by the confluence of the Walhonding and Tuscarawas Rivers in Coshocton, Ohio, traverses hilly countryside and is frequently bounded by rich floodplains featuring agricultural fields and forest, and low density residential, commercial, and industrial development. The overall topography of the Muskingum River watershed consists of steep hillsides, narrow ridge tops, and multiple small stream valleys. Most ridge tops have elevations from 800 to 1,000 feet. Valleys are typically 0.5 to 1.5 miles wide with broad areas of undulating or rolling slopes. Tributaries tend to be narrow and are separated by steep side slopes and fairly broad ridge tops (USDA et al. 1990). The Muskingum River is located in the Western Allegheny Plateau (WAP) ecoregion.

E.1.1.1.1 Upland Habitat

Forestland comprises 30 percent of the total land area of Ohio, and approximately two thirds of Ohio's forestland is located in the southeast region of the state. The amount of forested area in Ohio has increased since 1940, primarily due to conversion of abandoned farmland and reclamation and reforestation of strip mine areas. Ohio's forestland is 93 percent privately owned. Ohio's forest landscapes are diverse composed largely of beech and oak-maple forests in the North and Western portions of the state, mixed-oaks in the South and East, mixed mesophytic forests on protected slopes, bottomland hardwoods along the major streams and rivers, and elm-ash swamp forests and oak savannas on the eastern margin of the tall grass prairie in the northwest.

Today, Ohio's forests are 97% deciduous (hardwood) and 3% evergreen (softwood conifers). Ohio's forests are comprised of over 100 different species of hardwood trees, 25 different softwood tree species and 43 different forest types (including oak-hickory, beech-maple, oak-gum). Additionally, Ohio's forests are home to over 300 types of woody plant species (USFS, 2006). Oaks (*Quercus sp.*) have been a dominant component of eastern forests, including the forests of southeastern Ohio, for more than 5,000 years. Today, oaks continue to dominate the overstory layer, but shade-tolerant species such as red maple (*Acer rubrum*), sugar maple (*A. saccharum*), blackgum (*Nyssa sylvatica*), and beech (*Fagus grandifolia*) now dominate the midstory and understory layers. The herbaceous layer is often the very diverse and includes many different species of forbs and grasses.

Approximately 62% of the Lower Muskingum watershed is categorized as deciduous, evergreen and mixed forests. All but five percent of the forest is deciduous. Agriculture makes up approximately 34% of the land use in the watershed, with the majority of this land being used to grow pasture hay. Only a small amount of this agricultural land is used for row crops. The remaining 4% of the area is open water or developed lands.

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The Muskingum River Projects are primarily located in low density residential or rural areas, with the exception of the Zanesville Project and the Malta Project, which are adjacent to medium density urban development. Upland natural habitats in the immediate vicinity of the Muskingum River Projects includes deciduous forests, evergreen forests, mixed forests and agricultural (croplands/pasture) lands, as described below for each Project.

Zanesville: The land east and west of the river near the Zanesville Project is primarily developed for residential and commercial uses. While some isolated patches of natural habitats may occur in the residential areas, the area is predominately an urban landscape.

Philo: Adjacent to the Philo Project the land to the southwest is primarily deciduous forest habitat. Some developed land (industrial residential and commercial uses) occurs upstream and downstream of the Project site on this shore. The northeast shore lands are a mix of industrial residential and commercial developments, bordered by agricultural croplands and pasturelands further inland.

Rokeby: Deciduous forest habitat dominates on the southeast shore of the Rokeby Project, with smaller amounts of agricultural lands. On the northeast shore the habitat is agricultural lands, bounded inland by deciduous forests. Some light residential development also occurs on the northeast shore immediately downstream of the Project.

Malta/McConnelsville: Mixed forestland habitat occurs along the immediate southwest shoreline of the Malta/McConnelsville Project. Some agricultural habitat and residential development occurs upstream and downstream, and further inland, on this shore. On the northeast shore, residential development occurs immediately adjacent to the Project area, with deciduous and mixed forest habitats further inland.

Beverly: The land on the west shoreline of the Beverly Project is primarily cropland and pastureland habitat, with deciduous forest habitat occurring further inland. The east shoreline is predominantly deciduous forest habitat, with agricultural habitat upstream and further inland downstream. Residential development also occurs downstream of the Project area on the east shore.

Lowell: Cropland and pastureland habitat is dominant on the shout west shoreline of the Devola Project area, which transitions to deciduous forest habitat further inland. Similarly the northeast shore is primarily cropland and pastureland, with some residential development immediately upstream of the Project area.

Devola: The southwest shore of the Devola Project is evergreen and deciduous forest land habitats. The northeast shore is cropland and pastureland habitat, bordered inland by a residential area.

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E.1.1.1.2 Wetland Habitat

Wetlands make up a very small percentage of the Lower Muskingum watershed. Woody wetlands compose 0.03% of the land use cover while emergent herbaceous wetlands make up 0.13% (LMRWMP 2005).

A field reconnaissance survey was conducted in 2011 to map jurisdictional wetlands in the Project areas, in order to assess potential Project effects on this habitat. This survey identified no jurisdictional wetlands in the Project areas other than the open water of the river, canals and locks. Additional discussion of this survey is presented in Section E.2.1, and the survey report (EMH&T, 2012) is provided in Appendix C-1.

E.1.1.2 Rare, Threatened and Endangered Botanical Species and Critical Habitats

There are no federally listed threatened or endangered plant species in the Muskingum River area. There are also no Federal wilderness areas, wildlife refuges, or designated Critical Habitat within the vicinity of the proposed Projects (USFWS, 2010a).

The Ohio Division of Natural Areas and Preserves maintains a list of rare native Ohio plants and animal species, as well as critical habitats. This list includes plants and lichens, mosses, ferns, grass, trees, and wildflowers. According to the list 254 plants are endangered and 162 are considered threatened statewide. An additional 112 are considered potentially threatened. Only two state-listed threatened upland plant species occur within the Muskingum River watershed: the downy white beard tongue (*Penstemon pallidus*) and golden-knees (*Chrysogonum virginianum*).

Golden-knees *(Chysogonum virginianum):* Historical records document the presence of golden-knees (*Chrysogonum virginianum*), a state-listed threatened plant species within the Muskingum River watershed. The Golden-knees' common name includes green and gold. It is a semi-evergreen and herbaceous perennial that grows between five and nine inches tall in rich woods and around shaded rocks. This species has been state listed because its natural populations in Ohio have been found to be limited in abundance and its distribution has been found to be limited in geography (ODNR, 2010a).

Downy White Beard Tongue *(Penstemon pallidus):* The downy white beard tongue is currently state-listed as a threatened plant species. Its common name includes pale beard tongue. It is a perennial found in dry, often calcareous prairies, as well as hillside oak or jack pine woodlands, and is naturalized on roadsides and in pine plantations. It blooms in late May through late June with fruits occurring late July through late August. This species has been state listed because its natural populations in Ohio have been found to be limited in abundance and its distribution has been found to be limited in geography (ODNR, 2010b).

E.1.1.3 Invasive Botanical Species

Invasive plant species threaten the native plants within the watershed. Approximately 60 species of invasive plants have been identified in Ohio (ODNR, 2010c). Included on the list of non-

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native invasive species found within the Muskingum River watershed are the multiflora rose, purple loosestrife, Eurasian water milfoil, and several species of honeysuckle. Other invasive species include the tree of heaven and autumn olive. Species like the Eurasian water milfoil can proliferate in high densities in waterways and cause serious impairments to water recreation such as boating, fishing and swimming.

E.1.2 Wildlife Resources

E.1.2.1 Resident Species

E.1.2.1.1 Mammals

Native Ohio wildlife include many species of mammals, including beaver, black bear, bobcat, deer mouse, eastern chipmunk, eastern cottontail rabbit, flying squirrel, fox squirrel, groundhog, Indiana bat, little brown bat, long-tailed weasel, meadow vole, muskrat, opossum, raccoon, red fox, red squirrel, river otter, snowshoe hare, squirrel, star-nosed mole, striped skunk and white-tailed deer. In the Muskingum River watershed, common mammal sightings include muskrat, white-tailed deer, raccoons and squirrels.

E.1.2.1.2 Birds

Native Ohio wildlife include many species of birds, including American crow, American goldfinch, American kestrel, American robin, bald eagle, barred owl, black-capped chickadee, Baltimore oriole, belted kingfisher, Carolina wren, Canada goose, cedar waxwing, Cooper's hawk, downy woodpecker, eastern bluebird, eastern screech owl, eastern swallowtail, gray catbird, great blue heron, great horned owl, herring gull, killdeer, mallard duck, mourning dove, northern bobwhite, northern cardinal, osprey, pileated woodpecker, red-bellied woodpecker, red-winged blackbird, red-tailed hawk, ruby-throated hummingbird, scarlet tanager, spotted sandpiper, throated hummingbird, turkey vulture, trumpeter swan, white-breasted nuthatch, wild turkey, woodcock, wood duck, and yellow-bellied sapsucker. The Muskingum River watershed hosts many of these resident and migrant bird species.

E.1.2.1.3 Reptiles and Amphibians

Native Ohio wildlife includes many species of reptiles and amphibians. Species include American toad, black rat snake, bullfrog, copperhead, eastern box turtle, eastern box turtle, eastern garter snake, eastern hellbender, eastern hognose snake, eastern massasauga, five-lined stink, green frog, gray tree frog, leopard frog, mudpuppy, northern black racer, northern water snake, painted turtle, snapping turtle, spotted salamander, red-backed salamander, slimy salamander, soft-shelled turtle and spring peeper.

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E.1.2.1.4 Freshwater Mussels

The lower Muskingum River (Zanesville to the Ohio River) has historically supported a species rich unionid mussel fauna. Several comprehensive mussel surveys have been conducted in the Muskingum River in the past 50 years that have documented the mussel community.

- Bates surveyed from river from 1967 to 1970 (Bates, 1970) and documented 25 extant species. Bates concluded that the Muskingum River probably supported some of the best commercial shell stocks in the world (Stansbery and King, 1983).

- Stansbery and King (1983) repeated the survey between 1979 and 1981, and found 37 species (six only as weathered shells).

- Watters and Dunn (1993-1994) surveyed from Luke Chutes Dam to the Ohio River in 1992 and reported 40 species (seven only as weathered shells).

- ESI (1996) surveyed from Zanesville to Luke Chute Lock and Dam in 1995 and reported 19 live species.

A total of, 63 taxa (61 species, one subspecies, and one form) have been reported from the mainstem of the Muskingum River since the early 1800's (Table E.1.2-1). Eleven of the 63 are now either extinct, and eight are on the federal list of endangered species (*Plethobasus cyphyus*, *Pleurobema clava*, *Cyprogenia stegaria*, *Epioblasma o. obliquata*, *Epioblasma t. rangiana*, *Epioblasma triquetra*, *Lampsilis abrupta*, and *Villosa fabalis*), 11 are listed as endangered in Ohio (OE: *Elliptio crassidens*, *Fusconaia ebenus*, *Fusconaia s. subrotunda*, *Megalonaias nervosa*, *Pleurobema cordatum*, *Pleurobema rubrum*, *Quadrula c. cylindrica*, *Quadrula metanevra*, *Ellipsaria lineolata*, *Lampsilis ovata*, and *Lampsilis teres*), three are listed as threatened species in Ohio (OT: *Ligumia recta*, *Obliquaria reflexa*, *Truncilla donaciformis*), and six are listed as Special Concern species in Ohio (OSC: *Cyclonaias tuberculata*, *Pleurobema sintoxia*, *Lasmigona compressa*, *Simpsonaias ambigua*, *Ptychobranchus fasciolaris*, and *Truncilla truncata*).

The most recent comprehensive surveys (ESI, 1993 and 1996) suggest that species richness has declined throughout the river, and the abundance of unionid mollusks has declined in the middle river (Zanesville to Luke Chute) since the 1970s. Only 33 of the 63 reported taxa have been collected in the lower Muskingum River since 1990. No unionid mussel beds were identified from Zanesville to Luke Chute dam by either Stansbery and King (1983) or ESI (1996), rather a few unionid mussels were found scattered throughout the reach. The lower river, however, from Luke Chute to the Ohio River still harbors dense species rich unionid beds. Between 23 and 32 species have been found in these pools since 1980. Six beds were found in 1992 that have existed since at least 1970 (Bates, 1970). Lower density beds have also been found in Beverly Pool upstream of Beverly Lock and Dam. Federally endangered species that may still be extant in the lower pools include *P. cyphyus*, and *C. stegaria*. Seven to 12 Ohio T&E species have been collected in each pool since 1980 and most of these species could still occur in the river.

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Species[1]	Status[2]	Species[1]	Status[2]
Cumberlandia monodonta[4]	FE, OEXT	*Utterbackia imbecillis*	-
Amblema p. plicata	-	*Actinonaias l. carinata*	-
Cyclonaias tuberculata	OSC	*Actinonaias l. ligamentina*	OEXT
Elliptio crassidens	OE	*Cyprogenia stegaria*	FE, OE
Elliptio dilatata	-	*Ellipsaria lineolata*	OE
Fusconaia ebenus	OE	*Epioblasma flexosa*	EX
Fusconaia flava	-	*Epioblasma o. obliquata*	FE, OE
Fusconaia s. subrotunda	OE	*Epioblasma t. rangiana*	FE, OE
Hemistena lata	FE, OEXT	*Epioblasma t. torulosa*	FE, OEXT
Megalonaias nervosa	OE	*Epioblasma triquetra*	FE, OE
Plethobasus cicatricosus	FE, OEXT	*Lampsilis abrupta*	FE, OE
Plethobasus cyphyus	FE, OE	*Lampsilis cardium*	-
Plethobasus striatus	FE, OEXT	*Lampsilis fasciola*	OSC
Pleurobema clava	FE, OE	*Lampsilis ovata*	OE
Pleurobema cordatum	OE	*Lampsilis radiata luteola*	-
Pleurobema plenum	FE, OEXT	*Lampsilis teres*	OE
Pleurobema rubrum	OE	*Leptodea fragilis*	-
Pleurobema sintoxia	OSC	*Leptodea leptodon*	FE, OEXT
Quadurla c. cylindrica	OE	*Ligumia recta*	OT
Quadrula metanevra	OE	*Obliquaria reflexa*	OT
Quadrula p. pustulosa	-	*Obovaria olivaria*	OEXT
Quadrula quadrula	-	*Obovaria retusa*	FE, OEXT
Tritogonia verrucosa	-	*Obovaria subrotunda*	-
Alasmidonta marginata	OSC	*Potamilus alatus*	-
Anodontoides ferussacianus	-	*Potamilus ohiensis*	-
Lasmigona complanata	-	*Ptychobranchus fasciolaris*	OSC
Lasmigona compressa	OSC	*Toxolasma parvum*	-
Lasmigona costata	-	*Truncilla donaciformis*	OT
Pyganodon g. f. corpulenta	-	*Truncilla truncata*	OSC
Pyganodon g. grandis	-	*Villosa fabalis*	FE, OE
Simpsonaias ambigua	OSC	*Villosa iris*[4]	-
Strophitus undulatus	-		

Status Codes: FE=federally endangered (USFWS, 2012); EX=extinct, OEXT=extirpated from Ohio, OE=Ohio endangered species, OT=Ohio threatened species, OSC=Ohio Special Concern Species

Table E.1.2-1. Species reported from Muskingum River Pools, Zanesville to the Ohio River (Source: ESI, 2012)

A Mussel Survey was conducted in 2011 to determine whether mussels are present in the Project areas, in order to assess potential Project effects on these species. Additional discussion of this survey is presented in Section E.2.2, and the survey report (ESI, 2012) is provided in Appendix C-2.

E.1.2.1.5 Invertebrates

Native Ohio wildlife include many species of invertebrates, including cecropia moth, centipede, cicada, crayfish, daddy longlegs, damselfly, dragonfly, eastern tiger swallowtail, firefly, garden spider, giant water bug, green stink bug, grasshopper, Kamer blue butterfly, katydid, ladybird beetle, lightning bug, luna moth, millipede, mosquito, monarch butterfly, northern bumble bee,

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northern walking stick, Ohio cave beetle, polyphemus moth, praying mantis, paper wasp, pond snail, slug, water boatman, water strider, wolf spider, and wooly bear caterpillar.

E.1.2.1.6 Aquatic Macroinvertebrates

The Ohio Environmental Protection Agency (OEPA) conducted sampling of macroinvertebrate communities at 28 locations on the Muskingum River as part of the *2006 Biological and Water Quality Study of the Muskingum River* (OEPA, 2007). This study sampled macroinvertebrates communities in order to provide an integrated view of ecosystem health. The study found that all sites in the Muskingum River displayed exceptional aquatic macroinvertebrate assemblages.

E.1.2.1.7 Commercially, Recreationally or Culturally Important Species

Ohio offers many great hunting and trapping opportunities. These include dove hunting in early September, waterfowl hunting throughout the fall, a high quality white-tailed deer herd, late-season hunting opportunities for grouse and rabbits, and statewide spring turkey hunting. Many of these hunting and trapping opportunities occur on private lands. Public land areas throughout Ohio, including wildlife areas managed by ODNR, are also open for hunting. Based on surveys conducted between 2007-2008, popular hunting or trapping species in the Project areas include Canada geese, cottontail rabbits, gray & fox squirrels, mallard & other ducks, mourning doves, ring-necked pheasants, ruffed grouse, white-tailed deer and wild turkey (ODNR, 2010d)

Bird-watching is also a popular recreation activity in the Project areas. Local Audubon members recognize the Devola Dam as a prime site for observing flocks of ducks and geese, and for occasional bald eagle sightings. During the fall, the dam hosts migrants of many bird species. The confluence of the Muskingum and Ohio Rivers provides rich avian habitat that has hosted as many as 1,000 ringbilled gulls during the winter (ILGARD, 2005).

E.1.2.2 Rare, Threatened or Endangered Terrestrial Wildlife Species

The Muskingum River basin provides potential habitat for 25 species of rare, threatened, and endangered wildlife species (RTE) that could occur in the Project areas. These include 18 freshwater mussel species (four federally listed and 18 state listed species), 1 amphibian species (state listed), 1 reptile species (state listed), 3 mammal species (one federally listed and 3 state listed species), and 1 bird species (federally delisted but still state listed). Table E.1.2-2 presents the list of terrestrial RTE species that could potentially occur in the vanity of the Muskingum River Projects. Mussel species were listed previously in Table E.1.2-1 Each of these species is discussed below.

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Common Name	Scientific Name	Devola Lock & Dam	Lowell Lock & Dam	Beverly Lock & Dam	Malta Lock & Dam	Rokeby Lock & Dam	Philo Lock & Dam	Zanesville Lock & Dam	Status
Amphibian									
Eastern Hellbender	*Cryptobranchus alleganiensis*	x	x						E
Reptile									
Eastern Spadefoot	*Scaphiopus holbrooki*	x	x	x					E
Mammal									
Indiana bat	*Myotis sodalist*	x	x	x	x	x	x	x	FE, E
Black Bear	*Ursus americanus*	x	x	x	x	x	x	x	E
Bobcat	*Lynx rufus*	x	x	x	x	x	x	x	E
Bird									
Bald Eagle	*Haliaeetus leucocephalus*				x	x	x	x	T

Status Key: FE – Federally Endangered, E – State Endangered, T – State Threatened

Table E.1.2-2. RTE species documented to occur in the vicinity of the Muskingum River Projects (Source: FFP, data from ODNR letter dated 1/3/2011 and USFWS letter dated 12/16/2010)

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E.1.2.2.1 Mussel Species

Rare, threatened, and endangered mussel species found in the Muskingum River near the proposed Projects are listed in Table E.1.2-1, and discussed below.

Purple Wartyback *(Cyclonaias tuberculata):* The purple wartyback is currently state-listed as a species of concern. Its key characteristics include a rounded shell with a fairly prominent wing, beak covered with fine wavy sculpturing, no green stripe on the umbo and purple nacre. Similar mussels include the orange-foot pimpleback, pimpleback, mapleleaf, and wartyback species. Its length usually reaches up to 5 inches. Its fish hosts include the yellow bullhead and channel catfish (Watters 1995). Its habitat includes medium to large rivers in gravel or mixed sand and gravel (Cummings and Mayer 1992).

Eastern Fanshell *(Cyprogenia stegaria)*: The eastern fanshell is currently federally and state-listed as an endangered species. Its key characteristics include a rounded shape, numerous pustules, elevated growth lines and broken green rays. Similar species include the pimpleback and purple pimpleback mussels. Its length usually reaches up to 3 inches. Its fish hosts are presently unknown (Watters 1995). Its habitat includes medium to large rivers in gravel riffles (Cummings and Mayer 1992).

The eastern fanshell mussel has had a federal recovery plan in place since 1991 with five-year review last published in 2008. No federally listed critical habitat rules have been published for this species to date.

Butterfly *(Ellipsaria lineolata)*: The butterfly mussel is currently a state-listed endangered species. Its key characteristics include a triangular flattened shell with sharply angled posterior ridge, yellowish brown in color, and with broken brown rays. Similar mussels include the deertoe species. Its fish hosts include the freshwater drum, green sunfish, and sauger (Watters 1995). Its length may reach up to 4 inches. Its habitat includes large rivers in sand or gravel (Cummings and Mayer 1992).

Elephant Ear *(Elliptio crassidens):* The elephant ear mussel is currently a state-listed endangered species. Its key characteristics include a heavy, solid, and triangular shell with dark brown to black periostracum and light purple nacre. Similar mussels include the spike and mucket species. Its fish hosts include the skipjack herring (Watters 1995). Its length may reach up to 6 inches. Its habitat includes large rivers in mud, sand, or fine gravel (Cummings and Mayer 1992).

Snuffbox *(Epioblasma triquetra)*: The snuffbox mussel is currently a state-listed endangered and recently has been proposed as a federally listed endangered species. Its key characteristics include a thick triangular shell with yellow or yellowish-green color with green rays, blotches or chevron markings. There are no known similar species. Its fish host includes the logperch and breeding occurs from May through July (Watters 1995). Its length may reach up to 2.5 inches. Its habitat includes medium to large, clear rivers in gravel riffles (Cummings and Mayer 1992).

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USFWS has proposed to list the snuffbox (*Epioblasma triquetra*) as endangered in 2010, but at the present time is remains a federal candidate species. Since the snuffbox mussel is currently proposed for federal listing as an endangered species, no critical habitat or conservation plans have yet been created for this species to date. USFWS has determined that designating critical habitat for these species is prudent, but not determinable at this time (USFWS, 2010b).

Long-Solid *(Fusconaia maculate or subrotunda):* The long-solid mussel is currently state-listed as an endangered species. Its key characteristics include a smooth, elongate, and solid shell with a deep beak cavity and green rays on the umbo. Similar mussels include the ebonyshell and pigtoe species. Its fish hosts are unknown (Watters 1995). Its length may reach up to 5 inches. Its habitat includes large rivers in gravel (Cummings and Mayer 1992).

Pink Mucket *(Lampsilis abrupta)*: The pink mucket mussel is currently federally and state-listed as an endangered species. Its key characteristics include a rounded to slightly elongate shell, thick, inflated, smooth, and yellowish brown in color. Similar mussels include the Higgins eye, mucket, fatmucket, plain pocketbook, hickorynut species. Its fish hosts are unknown (Watters 1995). Its length may reach up to 4 inches. Its habitat includes the lower Mississippi and Ohio rivers and their larger tributaries in gravel or sand (Cummings and Mayer 1992).

A federal recovery plan has been in place for this species since 1985, with a five-year status review last published in 2008. No federally listed critical habitat rules have been published for this species to date. New populations of this mussel have been discovered in the Ohio River after an absence of 75 years, indicating that water quality in this region has improved in recent years (USFWS, 2010c).

Black Sandshell *(Ligumia recta)*: The black sandshell mussel is currently state-listed as a threatened species. Its key characteristics include an elongate shell, pointed on the posterior end, smooth surface, usually dark brown to black, with a pinkish or purple nacre. Similar mussels include the spike, spectaclecase, and yellow sandshell species. Its fish hosts include the black and largemouth bass, bluegill, sauger, walleye, and white crappie (Watters 1995). Its length may reach up to 8 inches. Its habitat includes medium to large rivers in riffles or raceways in gravel or firm sand (Cummings and Mayer 1992).

Washboard *(Megalonaias nervosa)*: The washboard mussel is currently state-listed as an endangered species. Its key characteristics include a large, black shell, heavily sculptured shell with V-shaped ridges in the front and large folds on the sides and back, particularly in smaller shells. Similar mussels include the threeridge and rock-pocketbook species. Its length may reach up to 11 inches. Its fish hosts include the American eel, black and brown bullhead, channel and flathead catfish, tadpole madtom, black and white crappie, bowfin, bluegill, green sunfish, white bass, freshwater drum, and gizzard shad (Watters 1995). Its habitat includes primarily large rivers with a good current and occasional medium-sized streams in mud, sand, or gravel (Cummings and Mayer 1992).

Threehorn Wartyback *(Obliquaria reflexa)*: The threehorn wartyback mussel is currently state-listed as a threatened species. Its key characteristics include large knobs on the shell that alternate from side to side will distinguish this mussel from all other species. Similar mussels

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include the pimpleback, sheepnose, and tubercled blossom species. Its length may reach up to 3 inches. Its fish hosts are unknown (Watters 1995). Its habitat includes large rivers in sand or gravel and may be locally abundant in impoundments (Cummings and Mayer 1992).

Sheepnose *(Plethobasus cyphyus)*: The sheepnose mussel is currently federally listed as a threatened and state-listed as an endangered species. Its key characteristics include an oblong shell with a smooth surface except for a single row of bumps or knobs running from the umbo to the ventral margin. Similar mussels include the white wartyback, threehorn wartyback, round pigtoe, wabash pigtoe and hickorynut species. Its length may reach up to 5 inches. It fish host includes the sauger (Watters 1995). Its habitat includes medium to large rivers in gravel or mixed sand and gravel (Cummings and Mayer 1992).

Ohio Pigtoe *(Pleurobema cordatum*): The Ohio pigtoe mussel is currently state-listed as an endangered species. It key characteristics include a triangular shell, umbos projecting forward, sulcus present, and deep beak cavity. Similar mussels include all the other pigtoe species. Its length may reach up to 4 inches. It fish host includes the rosefin shiner (Watters 1995). Its habitat includes medium to large rivers in sand or gravel in areas with moderate flow (Cummings and Mayer 1992).

A federal recovery plan has been in place for this species since 1984, with five-year review last published in 2007. No federally listed critical habitat rules have been published for this species to date. Reasons for this mussel's decline are not fully known, but throughout all the drainages from which it is now absent, habitat has been severely altered or destroyed (USFWS, 2010d).

Pyramid Pigtoe *(Pleurobema rubrum):* The pyramid pigtoe mussel is currently state-listed as an endangered species. Its key characteristics include a triangular shell, umbos projecting forward, sulcus present, and deep beak cavity. Similar mussels include all the other pigtoe species. Its length may reach up to 4 inches. Its fish host includes the rosefin shiner (Watters 1995). Its habitat includes medium to large rivers in sand or gravel in areas with moderate flow (Cummings and Mayer 1992).

Round Pigtoe *(Pleurobema sintoxia or coccineum):* The round pigtoe mussel is currently state-listed as a species of concern. Its key characteristics include a highly variable shell that is relatively large, rounded or elongate, chestnut or brown, with a shallow beak cavity. Similar mussels include all the other pigtoes, hickorynut and round hickorynut species. Its length may reach up to 4 inches. Its fish host includes the bluegill (Watters 1995). Its habitat includes medium to large rivers in mud, sand, or gravel (Cummings and Mayer 1992).

Monkeyface *(Quadrula metanevra):* The monkeyface mussel is currently state-listed as an endangered species. Its key characteristics include a fairly thick shell with well-developed teeth, squared in outline, lateral surface with two rows of pustules separated by a sulcus. Similar mussels include the winged mapleleaf, pimpleback, purple pimpleback, monkeyface, and wartyback species. Its length may reach up to 4 inches. Its fish hosts include the bluegill, green sunfish and sauger (Watters 1995). Its habitat includes medium to large rivers and reservoirs with a mud, sand, or gravel bottom (Cummings and Mayer 1992).

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Fawnsfoot *(Truncilla donaciformis):* The fawnsfoot mussel is currently state-listed as a threatened species. Its key characteristics include a small, elongate shell, greenish yellow in color with zigzag markings. Similar mussels include the deertoe and rayed bean species. Its length may reach up to 2 inches. Its fish hosts include freshwater drum and sauger (Watters 1995). Its habitat includes large rivers or the lower reaches of medium-sized streams in sand or gravel (Cummings and Mayer 1992).

Deertoe *(Truncilla truncate):* The deertoe mussel is currently state-listed as a species of concern. Its key characteristics include a triangular shell, sharply angled posterior ridge, inflated, yellow, green, or brown, usually with numerous green rays. Similar mussels include the fawnsfoot, butterfly, Wabash pigtoe, and elktoe species. Its length may reach up to 2 inches. Its fish hosts include the freshwater drum and sauger (Watters 1995). Its habitat includes medium to large rivers in mud, sand, or gravel (Cummings and Mayer 1992).

Clubshell (*Pleurobema clava*): The clubshell mussel is currently listed as a federal and state endangered speciesin Ohio. Key characteristics include a triangular shell with an elongated posterior end and green rays on umbo. Similar species include the pyramid, pigtoe, ellipse species. Its length usually reaches up to 3.0 inches. Its habitat includes clean, loose sand and gravel in medium to small rivers and streams. This species will bury itself in the bottom substrate to depths of up to four inches (USFWS, 2012). Fish host species include central stoneroller, shiners, logperch and blackside darter (Theiling et al., 2000 and OSU, 2011).

Northern Riffleshell (*Epioblasma torulosa rangiana*): The northern riffleshell mussel is currently listed as a federal and state endangered species in Ohio. Key characteristics include yellowish brown or green color, and for males oblong with a sulcus running along the posterior ridge from the umbo to the ventral margin, and for females a large expanded posterior end. Similar species include the tubercled blossom species. Its length reaches up to 2 inches. The northern riffleshell and habitat is found in a wide variety of streams from large to small, and it buries itself in bottoms of firmly packed sand or gravel with its feeding siphons exposed (USFWS, 2012). Fish host species includes darters, mottled sculpin and brown trout (Theiling et al., 2000 and OSU, 2011).

Purple Cat's Paw (*Epioblasma obliquata obliquata*): The purple cat’s paw is currently listed as a federal and state endangered species in Ohio. Key characteristics include a yellowish brown or brown color, with males oblong and solid with a shallow sulcus along the posterior ridge from the umbo to the ventral margin, and females more rectangular with truncated and inflated posterior with a finely grooved surface and serrated growth lines. Similar species include the northern riffleshell species. Its length reaches up to 2 inches with males much larger than females. It habitat includes mostly large rivers of the Ohio River basin. It prefers shallow water and requires a swift current to avoid being buried in silt, and is found on bottom substrates ranging from sand to boulders (USFWS, 2012). Fish host species includes darters, rock bass, mottled sculpin, stonecat and logperch (Theiling et al., 2000 and OSU, 2011).

Rayed Bean (*Villosa fabalis*): The rayed bean mussel is currently listed as a federal and state endangered species in Ohio. Key characteristics include a very small size and solid shell with numerous wavy green lines on the outer surface and teeth that are unusually heavy and thick for

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their size. Similar species include the ellipse and rainbow species. Its length is usually less than 1.5 inches long. The rayed bean generally lives in smaller, headwater creeks, but it is sometimes found in large rivers and wave-washed areas of glacial lakes. It prefers gravel or sand substrates, and is often found in and around roots of aquatic vegetation (USFWS, 2012). Fish host species include spotted and Tippecanoe darters (Theiling et al., 2000 and OSU, 2011).

Ebonyshell (*Fusconaia ebena*): The ebonyshell is currently listed as a state endangered species in Ohio. Key characteristics include a round, heavy, thick, brown or black shell without rays or pustules. Similar species include the long-solid, hickorynut, round hickorynut, ring pink and pigtoe. Its length reaches up to 4 inches. It habitat includes large rivers in sand and gravel (USFWS, 2012). Fish host species include crappies and largemouth bass (Theiling et al., 2000 and OSU, 2011).

Rabbitfoot (*Quadrula cylindrical*): The rabbitsfoot is currently listed as a state endangered species in Ohio. Key characteristics include an elongate, rectangular shell with pustules and V-shaped markings. Similar species include the monkeyface and pistolgrip. Its length reaches up to 5 inches. Its habitat includes medium to large rivers in mixed sand and gravel (USFWS, 2012). No known fish host species have been identified (Theiling et al., 2000 and OSU, 2011).

Pocketbook (*Lampsilis ovate*): The pocketbook is currently state listed as endangered in Ohio. Key characteristics include a round or oblong shell, inflated, posterior end bluntly pointed in males and truncated in females. Similar species include the plain pocketbook, mucket, fat pocketbook and pink mucket species. It length reaches up to 6 inches. Its habitat includes large rivers in coarse sand or gravel (USFWS, 2012). No known fish host species have been identified (Theiling et al., 2000 and OSU, 2011).

Yellow Sandshell (*Lampsilis teres*): The yellow sandshell is currently listed as a state endangered species in Ohio. Key characteristics include an elongate and relatively thick glossy shell. Adults are usually solid yellow, juveniles yellowish green with fine green rays. Similar species include the fat mucket, black sandshell, pondhorn and scaleshell. Its length reaches up to 6 inches. Its habitat includes medium to large rivers in sand or fine gravel (USFWS, 2012). Fish host species include crappies, sunfishes, bluegill, largemouth bass and yellow perch (Theiling et al., 2000 and OSU, 2011).

Creek Heelsplitter (*Lasmigona compressa*): The creek heelsplitter is currently listed as a state species of concern in Ohio. Key characteristics include a relatively thin and elongate shell with well-developed lateral teeth and prominent flattened posterior ridge. Similar species include the fluted-shell and white heelsplitter. Its length reaches up to 4 inches. Its habitat includes creeks and the headwaters of small to medium rivers in fine gravel or sand (USFWS, 2012). Fish host species include crappies, sunfishes, bullheads, shiners, bluegill, smallmouth bass and gizzard shad (Theiling et al., 2000 and OSU, 2011).

Salamander (*Simpsonaias ambigua*): The salamander mussel is currently listed as a federal candidate and state listed species of special concern in Ohio. Key characteristics include a small, thin, elliptical shell with poorly developed teeth and double-looped beak sculpture. Similar species include the cylindrical papershell, spectaclecase and pondhorn species. Its length reaches

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up to 2 inches. Its habitat includes medium to large rivers on mud or gravel bars and under flat slabs or stones (USFWS, 2012). Fish host species includes the mudpuppy (Theiling et al., 2000 and OSU, 2011).

Kidneyshell (*Ptychobranchus fasciolaris*): The kidneyshell is currently listed as a state species of concern in Ohio. Key characteristics include a thick, kidney-shaped shell with heavy teeth and yellowish brown color with broken green rays. Similar species include the spike, mucket, ellipse and rainbow. Its length reaches up to 6 inches. Its habitat includes medium to large rivers in gravel (USFWS, 2012). Fish host species include rainbow and fantail darters (Theiling et al., 2000 and OSU, 2011).

E.1.2.2.2 Amphibian Species

Eastern Spadefoot *(Scaphiopus holbrookii*): The eastern spadefoot is currently state-listed as an endangered species. It is considered exceptionally rare but known to occur in Athens, Coshocton, Lawrence, Morgan, and Washington counties. It typically eats flies, spiders, caterpillars, earthworms, snails, moths, and crickets. Its length may reach between 1¾-2¼ inches. Its habit includes areas of sandy soils that are associated with river valleys in southeastern Ohio. Breeding habitats are located within these areas and may include flooded agricultural fields or other water-holding depressions. Eastern spadefoot spend most of their life hidden underground in burrows of their own making. Strong storms with heavy precipitation are needed to induce breeding usually between March and September. The tadpoles hatch in several days, and if the water-filled pool begins to dry, can complete transition to adulthood in only a couple of weeks. Breeding can occur several times a year, or not at all, depending on the weather. A statewide survey has not been completed for this species but its known range may be found within vicinity of the proposed Project areas (ODNR pers. Comm.).

The eastern spadefoot is Ohio's only endangered frog. The eastern spadefoot was only recorded breeding at 2 locations during the 1990s. Since 2000, breeding sites have been documented in 15 townships representing 5 distinct populations of eastern spadefoots. These populations are located in Morgan-Washington, Lawrence, Coshocton-Tuscarawas, Meigs and Athens counties. No additional breeding sites were verified during 2007 (ODNR, 2010e).

A field reconnaissance survey was conducted in 2011 to determine whether the eastern spadefoot or its habitat occur in the Project areas, in order to assess potential Project effects. Additional discussion of this survey is presented in Section E.2.2, and the survey report (Davis, 2012) is provided in Appendix C-3.

E.1.2.2.3 Reptile Species

Eastern Hellbender (Cryptobranchus alleganiensis): The eastern hellbender is currently state-listed as an endangered amphibian. Its length may reach between 11.½-20 inches. It typically eats crayfish, snails, minnows, insects, and worms. Its habitat includes unglaciated regions as found in southern and eastern Ohio, and prefers large, swift flowing streams where they hide during the day under large rocks. Hellbenders breed in late August or September. The female lays up to 500 eggs in a nest the male excavates under a large flat rock. Sometimes several

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females use the same nest. Hellbenders differ from other salamanders in that the male does not fertilize the eggs until after they have been laid. Young hellbenders hatch in two to three months and retain their gills until they are about 1½ years old. A statewide survey has not been completed for this species but its known range may be found within vicinity of the proposed Project areas (ODNR pers. Comm.).

E.1.2.2.4 Mammal Species

Indiana Bat *(Motes sodalist)*: The Indiana bat is currently federally and state-listed as an endangered species. It was first listed in 1967 primarily due to episodes of large numbers of Indiana bat deaths caused by human disturbance during hibernation. Indiana bats are extremely vulnerable to disturbance because they hibernate in large numbers in only a few caves (the largest hibernation caves support from 20,000 to 50,000 bats). Other threats that have contributed to the species decline include commercialization of caves, loss of summer habitat, pesticides and other contaminants, and most recently, the disease white nose syndrome. Indiana bats are found over most of the eastern half of the United States. Almost half of all Indiana bats hibernate in caves in southern Indiana. Other states within the current range of the Indiana bat include Alabama, Arkansas, Connecticut, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia, West Virginia. The 2009 population estimate is about 387,000 Indiana bats, less than half as many as when the species was listed as endangered in 1967 (USFWS, 2010e).

Indiana bats are small, weighing only one-quarter of an ounce, but they have an in-flight wingspan of 9-11 inches. Their fur is dark-brown to black. They hibernate during winter in caves or, occasionally, in abandoned mines. During summer they roost under the peeling bark of dead and dying trees. Indiana bats eat a variety of flying insects found along rivers or lakes and in uplands. In spring, reproductive females migrate and form maternity colonies where they bear and raise their young in wooded areas. Males and non-reproductive females typically do not roost in colonies and may stay close to their winter hibernation sites or migrate to their summer habitats. Summer roosts are typically behind exfoliating bark of large, often dead, trees. Both males and females return to their winter hibernate locations in late summer or early fall to mate and enter the hibernation process.

Indiana bat habitat consists of suitable trees that include dead and dying trees with exfoliating bark, crevices, or cavities in upland areas or riparian corridors and living trees of the species with exfoliating bark, cavities, or hollow areas formed from broken branches or tops. ODNR has identified the following species of trees within the proposed Projects areas that have relatively high value as potential Indiana bat roost sites:

- Shagbark hickory (*Caria ovate*)
- Shellbark hickory (*Caria lacunose*)
- Bitternut hickory (*Caria cordiformis*)
- Black ash (*Fraxinus nigra*)
- Green ash (*Fraxinus pennsylvanica*)
- White ash (*Fraxinus americana*)
- Shingle oak (*Quercus imbricaria*)

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- Northern red oak (*Quercus rubra*)
- Slippery elm (*Ulmus rubra*)
- American elm (*Ulmus americana*)
- Eastern cottonwood (*Populus deltoides*)
- Silver maple (*Acer saccharinum*)
- Sassafras (*Sassafras albidum*)
- Post oak (*Quercus stellata*)
- White oak (*Quercus alba*)

The Indiana bat is a federally listed endangered species and has had a federal recovery plan since 1983. The last review for the Indiana bat was published in 2009 (USFWS, 2010e). According to the USFWS Recovery Plan, "the Service had records of extant winter populations at approximately 281 hibernacula in 19 states and 269 maternity colonies in 16 states." This recovery plan, like its predecessor, focuses on the protection of hibernacula and summer habitat in four recovery units: Ozark-Central, Midwest, Appalachian Mountains, and Northeast. The Blackball Mine in LaSalle County, Illinois is listed as critical habitat for this species.

A field reconnaissance survey was conducted in 2011 to determine whether the Indiana bat or its habitat occur in the Project areas, in order to assess potential project effects. Additional discussion of this survey is presented in Section E.2.2, and the survey report (EHM&T, 2012) is provided in Appendix C-4.

Black Bear *(Ursus americanus)*: The black bear is currently state-listed as an endangered species. The black bear occurs in forested habitats throughout the eastern half of Ohio. During 2006, 113 sightings of black bears, representing an estimated 67 individuals, were reported to ODNR. The number of sightings was up from 105 received during 2005. Because of the large amount of unoccupied, suitable forest habitat available in eastern Ohio, the state's black bear population is expected to continue to increase in abundance and distribution in future years (ODNR, 2010f).

Bobcat *(Lynx rufus)*: The bobcat are currently state-listed as an endangered species. The bobcat also occurs in the forests of eastern Ohio. ODNR-DOW received reports of 134 unverified bobcat sightings in 2006 compared to 65 in 2005. In 2006, 37 reports were verified (i.e., road-killed, incidentally trapped, photographed, etc.), an increase from the 20 verified reports of 2005. Because of the large amount of unoccupied, suitable forested habitat available in eastern Ohio, bobcat sightings are also expected to continue to increase in future years as the population increases in abundance and distribution (ODNR, 2010g.

E.1.2.2.5 Bird Species

Bald Eagle (Haliaeetus leucocephalus): The bald eagle is currently state-listed as a threatened species. On August 9, 2007, the bald eagle was removed from the federal list of threatened and endangered species, as bald eagle populations are now flourishing across the nation. It feeds anytime during daylight hours. Its typical foods include mostly fish but will also feed upon waterfowl, small mammals, and carrion as well. It reproduces by pair bonding activity for both new and established pairs, which usually begins in the fall. Courtship behavior and nest building

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can occur anytime between October and early December. The female lays one to three eggs in mid-February to late March. Both the female and her mate spend time on the nest incubating and share the feeding responsibilities. Mating habits are monogamous and pairs for life. The incubation period of its eggs is normally 35 days on average between February through April. Its clutch size is usually 2 eggs. The young remain dependent on the parents until they leave the nest after 10-13 weeks. Bald eagles have continued to recover from a low of 4 breeding pairs in 1979. The number of breeding pairs increased from 150 in 2006 to 164 in 2007, and eagle production continued at a growth pace with 194 young (USFWS, 2010f).

Bald eagle adults are generally year-round residents while immature birds sometimes migrate during spring and fall. Its distribution is mostly found in small concentrations throughout the U.S. Its habitat is primarily found near sizeable bodies of water, natural and man-made. In Ohio, the bald eagle's stronghold is the marsh region of western Lake Erie. For the bald eagle, the ideal site is where water with ample food (fish) is located within two miles of the nest. The eagle shows a preference for a somewhat secluded home site. This is particularly critical when the nest is being established and young rose to sufficient size. Eagles are highly territorial and too much interference from other eagles can result in problems at the nest site. A statewide survey has not been completed for this species but its known range may be found within vicinity of the proposed project areas (ODNR pers. Comm.)

E.1.2.3 Natural Areas and Critical Habitat

There are no Federal wilderness areas, wildlife refuges, or designated Critical Habitat within the vicinity of the proposed sites (USFWS, 2010a). The Muskingum River watershed has several protected lands for wildlife conservation and public access.

E.1.2.4 Invasive and Exotic Species

Invasive and exotic wildlife species are considered to be one of the major threats to the integrity of native ecosystems. Invasive and exotic wildlife species found in Ohio include house sparrow, European starling, gypsy moth, Asian long-horned beetle, multi-colored Asian lady beetle, feral swine, Asian, clam, Chinese mysterysnail, freshwater jellyfish and zebra mussel (ODNR, 2012 and USGS, 2012). No documentation of these species specifically occurring in each of the Project Areas has been identified.

E.1.3 Fisheries Resources

E.1.3.1 Aquatic Habitat

The Muskingum River is located in the Western Allegheny Plateau (WAP) ecoregion and is currently assigned the Warmwater Habitat (WWH) aquatic life use designation in the Ohio Water Quality Standards (WQS) (OEPA 2006). The WWH designation defines the typical warmwater assemblage of aquatic organisms in Ohio's rivers and streams. Waters designated as WWH are capable of maintaining a balanced, integrated, and adaptive community of warmwater aquatic organisms.

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The Muskingum River is predominated by substrates of gravel, cobble, and sand, with lesser amounts of boulders. These conditions were found to be consistent across both free-flowing and impounded sections of river. But the impounded sections contained moderate embeddedness, in which cobble, gravel and boulder substrates are surrounded or covered by fine materials (i.e., siltation). Instream cover at most locations was considered moderate, reflective of adequate levels for supporting warmwater fish communities. Most free flowing sections of river were represented by well developed pool, run, and riffle areas. Impounded sections of river lacked riffle and run habitat.

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the OEPA for streams and rivers in Ohio (Rankin 1989, 1995). The QHEI is a measure of the ability of the physical habitat to support a biological community. Various attributes of the available habitat were evaluated based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient were among the metrics used to evaluate the characteristics of a river segment. As a unit of measure, QHEI scores obtained from hundreds of areas around the state indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

QHEI scores for free-flowing sites of the Muskingum River ranged from 71.0 to 86.0, with a mean value of 82.3. These scores are indicative of excellent river habitat, and are adequate for supporting warmwater and exceptional warmwater habitat biological communities. QHEI scores from impounded Muskingum River sites ranged between 54.0 and 64.5, with a mean value of 60.9. Impounded QHEI scores are marginally adequate for supporting warmwater fish communities, particularly in light of the lack of riffle and run habitats. Average QHEI scores for free-flowing sites were 21 points higher than impounded locations.

In general, OEPA (2006) found that entire length of river is fully attaining a high level of biological integrity, and meets the biological goals of the Clean Water Act. The surveys reveal in their opinion that the Muskingum River provides high-quality river habitat to support healthy populations of fish, communities along with localized populations of rare, threatened, and endangered species. Since their last major biological studies in 1988 and 1994, OEPA has found that that substantial improvement in biological conditions has occurred over the last 20 years.

E.1.3.2 Fish Community

The Muskingum River supports an excellent fishery, including high quantities of forage (minnow-type fish) and certain species of sport fish. A 1988 ODNR angler survey recorded high quantities of catfish, bullheads, carp, suckers, bass, white bass (*Morone chrysops*), and hybrids (Isbell 1988). The prevalence of sport fishing continues to increase on the Lower Muskingum River. Today the most popular fish among sport fisherman include: bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), spotted bass (*Micropterus punctulatus*), crappie (*Pomixis* spp.), channel (*Ictalurus punctatus*) and flathead catfish (*Pylodictis olivaris*),

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sauger (*Sander canadense*), walleye (*Sander vitreus*), and saugeye (*Sander vitreus* x *Sander canadense*).

OEPA has been conducting fish species surveys since 1986, which have documented 71 species of fish within the Muskingum River (OEPA 2006). In 2006, OEPA conducted the latest known water resource assessment of the entire 112 miles of the Muskingum River. The fish community was sampled with boat electrofishing at a total of 28 sites from river mile (RM) 5.6 to RM 110.7. Table E.1.3-1 Lists the sites sampled during the 2006 OEPA survey that represent the fishery within the FFP areas. Sites within each pool typically consisted of one or two sample locations within the impounded section and one sample location in the tailrace of the next upstream dam.

Project Pool	RM	Description
Zanesville	84.6	Ellis Dam Tailwaters/Zanesville Dam Pool
	80.2	Zanesville Dam Pool
	77.6	Zanesville Dam Pool
Philo	75.8	Zanesville Dam Tailwaters/Philo Dam Pool
	72.4	Philo Dam Pool
Rokeby	67.3	Philo Dam Tailwaters/Rokeby Dam Pool
	63.7	Rokeby Dam Pool
Malta	56.4	Rokeby Dam Tailwaters/Malta Dam Pool
	52.1	Malta Dam Pool
Beverly	33.5	Luke Chute Dam Tailwaters/Beverly Dam Pool
	29.2	Beverly Dam Pool
	26.2	Beverly Dam Pool
Lowell	24.7	Beverly Dam Tailwaters/Lowell Dam Pool
	20.9	Lowell Dam Pool
Devola	13.9	Lowell Dam Tailwaters/Devola Dam Pool
	9.4	Devola Dam Pool

Table E.1.3-1. 2006 OEPA Survey Sampling Sites within the FFP Project Areas (Source: OEPA 2006)

The Muskingum River contains a diverse and abundant warm and cool water fishery. Table E.1.3-2. Lists fish species collected during OPEA 2006 Biological and Water Quality Study. (OEPA, 2007).

Two studies were conducted in association with the licensing of the Muskingum River Projects to assess potential Project effects on the fishery and fish habitats. A desktop entrainment study was conducted to assess impingement, entrainment and turbine survival of resident fish species. In addition a hydraulic modeling was undertaken to aid in the assessment of how fisheries habitat may be affected due to changes in hydraulic conditions in the Project areas. Additional discussion of these assessments is presented in Section E.2.3, and the reports (HDR, 2012; FFP 2012a)) are provided in Appendices C-5 and C-6.

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Scientific Name	Common Name	Muskingum River (All 28 Sites)		Zanesville Pool (3 Sites)		Philo Pool (2 Sites)		Rokeby Pool (2 Sites)		Malta Pool (2 Sites)		Beverly Pool (3 Sites)		Lowell Pool (2 Sites)		Devola Pool (2 Sites)	
		N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%
Amiidae (Bowfins)																	
Amia Calva	Bowfin	2	0.01	2	0.11	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Atherinidae (Silversides)																	
Labidesthes sicculus	Brook Silverside	15	0.09	1	0.05	0	0.00	0	0.00	0	0.00	1	0.07	7	0.92	0	0.00
Catostomidae (Suckers)																	
Carpiodes carpio	River Carpsucker	11	0.07	0	0.00	0	0.00	0	0.00	0	0.00	1	0.07	0	0.00	10	1.46
Carpiodes cyprinus	Quillback	164	1.02	20	1.06	13	1.06	10	0.45	8	0.51	16	1.05	4	0.53	14	2.04
Carpiodes velifer	Highfin Carpsucker	45	0.28	1	0.05	0	0.00	0	0.00	0	0.00	10	0.66	6	0.79	10	1.46
Cycleptus elongatus	Blue Sucker	4	0.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.58
Hypentelium nigricans	Northern Hog Sucker	140	0.87	12	0.64	2	0.16	6	0.27	2	0.13	7	0.46	4	0.53	2	0.29
Ictiobus bubalus	Smallmouth Buffalo	459	2.85	0	0.00	15	1.22	18	0.80	49	3.15	81	5.33	70	9.22	55	8.03
Moxostoma erythrurum	Golden Redhorse	279	1.73	36	1.92	13	1.06	13	0.58	8	0.51	70	4.61	6	0.79	4	0.58
Moxostoma anisurum	Silver Redhorse	150	0.93	13	0.69	24	1.96	3	0.13	3	0.19	19	1.25	3	0.40	2	0.29
Moxostoma carinatum	River Redhorse	112	0.70	15	0.80	23	1.88	19	0.85	7	0.45	9	0.59	2	0.26	2	0.29
Moxostoma breviceps	Smallmouth Redhorse	339	2.10	29	1.54	27	2.20	35	1.56	17	1.09	26	1.71	7	0.92	13	1.90
Centrarchidae (Sunfish)																	
Ambloplites rupestris	Rock Bass	22	0.14	7	0.37	4	0.33	0	0.00	1	0.06	0	0.00	1	0.13	0	0.00
Lepomis cyanellus	Green Sunfish	45	0.28	1	0.05	3	0.24	0	0.00	5	0.32	8	0.53	0	0.00	6	0.88
Lepomis gulosus	Warmouth	2	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Lepomis humilis	Orangespotted Sunfish	314	1.95	5	0.27	15	1.22	1	0.04	56	3.60	141	9.28	8	1.05	22	3.21
Lepomis hybrid	Hybrid Sunfish	5	0.03	0	0.00	0	0.00	0	0.00	3	0.19	0	0.00	1	0.13	0	0.00
Lepomis macrochirus	Bluegill	480	2.98	38	2.02	43	3.51	7	0.31	79	5.07	84	5.53	48	6.32	115	16.79
Lepomis microlophus	Redear Sunfish	6	0.04	0	0.00	2	0.16	1	0.04	1	0.06	0	0.00	0	0.00	1	0.15
Micropterus dolomieu	Smallmouth Bass	179	1.11	26	1.38	21	1.71	16	0.71	20	1.28	2	0.13	1	0.13	2	0.29
Micropterus punctulatus	Spotted Bass	334	2.07	22	1.17	76	6.20	10	0.45	40	2.57	74	4.87	23	3.03	23	3.36
Micropterus salmoides	Largemouth Bass	50	0.31	9	0.48	0	0.00	0	0.00	13	0.83	5	0.33	4	0.53	4	0.58
Pomoxis annularis	White Crappie	20	0.12	1	0.05	2	0.16	1	0.04	0	0.00	2	0.13	1	0.13	4	0.58
Pomoxis nigromaculatus	Black Crappie	15	0.09	0	0.00	2	0.16	1	0.04	1	0.06	1	0.07	1	0.13	1	0.15
Clupeidae (Herrings)																	
Alosa chrysochloris	Skipjack Herring	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.15
Dorosoma cepedianum	Gizzard Shad	1,619	10.05	50	2.66	76	6.20	137	6.10	392	25.18	243	15.99	128	16.86	86	12.55
Cyprinidae (Carps and Minnows)																	
Campostoma anomalum	Central Stoneroller	17	0.11	4	0.21	1	0.08	0	0.00	0	0.00	1	0.07	0	0.00	0	0.00
Ctenopharyngodon idella	Grass Carp	4	0.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Cyprinella spiloptera	Spotfin Shiner	1,931	11.98	107	5.69	18	1.47	53	2.36	69	4.43	174	11.45	38	5.01	31	4.53
Cyprinus carpio	Common Carp	285	1.77	29	1.54	40	3.27	15	0.67	19	1.22	10	0.66	19	2.50	9	1.31
Erimystax dissimilis	Streamline Chub	4	0.02	0	0.00	0	0.00	1	0.04	0	0.00	0	0.00	0	0.00	0	0.00
Erimystax x-punctatus	Gravel Chub	74	0.46	7	0.37	1	0.08	4	0.18	0	0.00	0	0.00	1	0.13	1	0.15

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Scientific Name	Common Name	Muskingum River (All 28 Sites)		Zanesville Pool (3 Sites)		Philo Pool (2 Sites)		Rokeby Pool (2 Sites)		Malta Pool (2 Sites)		Beverly Pool (3 Sites)		Lowell Pool (2 Sites)		Devola Pool (2 Sites)	
		N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%
Hybopsis amblops	Bigeye Chub	18	0.11	2	0.11	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Luxilus chrysocephalus	Striped Shiner	4	0.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Notropis atherinoides	Emerald Shiner	5,238	32.51	1,078	57.37	693	56.57	1,602	71.33	641	41.17	266	17.50	180	23.72	34	4.96
Notropis buchanani	Ghost Shiner	75	0.47	7	0.37	10	0.82	44	1.96	4	0.26	3	0.20	1	0.13	0	0.00
Notropis photogenis	Silver Shiner	14	0.09	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Notropis rubellus	Rosyface Shiner	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Notropis stramineus	Sand Shiner	805	5.00	63	3.35	5	0.41	17	0.76	3	0.19	17	1.12	4	0.53	2	0.29
Notropis volucellus	Mimic Shiner	445	2.76	28	1.49	28	2.29	73	3.25	7	0.45	13	0.86	2	0.26	0	0.00
Phenacobius mirabilis	Suckermouth minnow	10	0.06	1	0.05	0	0.00	0	0.00	0	0.00	1	0.07	3	0.40	4	0.58
Pimephales notatus	Bluntnose Minnow	391	2.43	42	2.24	6	0.49	18	0.80	35	2.25	36	2.37	4	0.53	1	0.15
Pimephales vigilax	Bullhead Minnow	132	0.82	50	2.66	8	0.65	3	0.13	0	0.00	43	2.83	7	0.92	8	1.17
Rhinichthys obtusus	Western Blacknose Dace	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Esocidae (Pikes)																	
Esox lucius	Northern Pike	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Hiodontidae (Mooneyes)																	
Hiodon tergisus	Mooneye	9	0.06	0	0.00	0	0.00	0	0.00	0	0.00	3	0.20	3	0.40	2	0.29
Ictaluridae (North American Catfishes)																	
Icatlurus puntatus	Channel Catfish	495	3.07	74	3.94	13	1.06	33	1.47	13	0.83	53	3.49	25	3.29	34	4.96
Pylodictis olivaris	Flathead Catfish	137	0.85	4	0.21	4	0.33	9	0.40	13	0.83	22	1.45	19	2.50	29	4.23
Noturus eleutherus	Mountain Madtom	3	0.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Noturus flavus	Stonecat Madtom	2	0.01	0	0.00	1	0.08	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Lepisosteidae (Gars)																	
Lepisosteus osseus	Longnose Gar	137	0.85	4	0.21	3	0.24	26	1.16	9	0.58	8	0.53	26	3.43	18	2.63
Moronidae (Temperate Bass)																	
Morone chrysops	White Bass	163	1.01	1	0.05	1	0.08	1	0.04	3	0.19	4	0.26	62	8.17	46	6.72
Morone chrysops × M. saxatilis	Hybrid Striped Bass	8	0.05	1	0.05	0	0.00	0	0.00	0	0.00	0	0.00	2	0.26	1	0.15
Percidae (Perch)																	
Ammocrypta pellucida	Eastern Sand Darter	2	0.01	2	0.11	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Etheostoma blenniodes	Greenside Darter	40	0.25	0	0.00	0	0.00	0	0.00	1	0.06	0	0.00	0	0.00	0	0.00
Etheostoma camurum	Bluebreast Darter	14	0.09	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Etheostoma flabellare	Fantail Darter	2	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Etheostoma nigrum	Johnny Darter	9	0.06	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Etheostoma variatum	Variegate Darter	23	0.14	0	0.00	2	0.16	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Etheostoma zonale	Banded Darter	96	0.60	0	0.00	4	0.33	1	0.04	2	0.13	4	0.26	0	0.00	1	0.15
Perca flavascens	Yellow Perch	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Percina caprodes	Logperch	115	0.71	30	1.60	3	0.24	8	0.36	1	0.06	6	0.39	2	0.26	4	0.58
Percina maculata	Blackside Darter	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

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Scientific Name	Common Name	Muskingum River (All 28 Sites)		Zanesville Pool (3 Sites)		Philo Pool (2 Sites)		Rokeby Pool (2 Sites)		Malta Pool (2 Sites)		Beverly Pool (3 Sites)		Lowell Pool (2 Sites)		Devola Pool (2 Sites)	
		N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%	N	RC%
Percina phoxocephala	Slenderhead Darter	104	0.65	0	0.00	0	0.00	20	0.89	8	0.51	14	0.92	3	0.40	0	0.00
Sander canadense	Sauger	13	0.08	0	0.00	0	0.00	1	0.04	0	0.00	1	0.07	1	0.13	2	0.29
Sander vitreus x Sander canadense	Saugeye	82	0.51	0	0.00	0	0.00	18	0.80	2	0.13	12	0.79	4	0.53	14	2.04
Petromyzontidae (Lampreys)																	
Ichthyomyzon unicuspis	Silver Lamprey	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Sciaenidae (Drums)																	
Aplodinotus grunniens	Freshwater Drum	394	2.45	57	3.03	23	1.88	21	0.93	22	1.41	29	1.91	28	3.69	63	9.20
	Total	**16,113**	**100**	**1,879**	**100**	**1,225**	**100**	**2,246**	**100**	**1,557**	**100**	**1,520**	**100**	**759**	**100**	**685**	**100**

Table E.1.3-2. Fish species collected during OPEA 2006 Biological and Water Quality Study (Source: OEPA, 2007)

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E.1.3.3 Recreational Fishery

The Muskingum River supports an excellent recreational fishery, including high quantities of bait- and minnow-type fish and certain species of sport fish. A 1988 ODNR angler survey recorded high quantities of catfish, bullheads, carp, suckers, bass, white bass, and hybrids (Isbell 1988). The prevalence of sport fishing continues to increase on the Lower Muskingum River. Today the most popular fish among sport fisherman include: bluegill, largemouth bass, spotted bass, crappie, channel and flathead catfish, sauger, walleye, and saugeye.

E.1.3.4 Migratory Species

There are no anadromous or diadromous migratory species in the Muskingum River. However, one lampray was found during the 2006 OEPA survey.

E.1.3.5 Rare, Threatened and Endangered Species

The Muskingum River basin provides potential habitat for three state-listed endangered fish species, four threatened fish species, and two fish species of concern that could occur in the Project areas. Table E.1.3-3 presents the list of RTE species that could potentially occur in the vanity of the Muskingum River Projects. Each of these species is discussed below.

Common Name	Scientific Name	Devola Lock & Dam	Lowell Lock & Dam	Beverly Lock & Dam	Malta Lock & Dam	Rokeby Lock & Dam	Philo Lock & Dam	Zanesville Lock & Dam	Status
Sand Darter	*Ammorcypta*	x		x	x	x	x	x	FCE, SC
Bluebreast Darter	*Etheostoma camurum*	x							T
Tippwecanoe Darter	*Etheostoma tippercanoe*		x						T
River Redhorse	*Moxostoma carinatum*	x	x	x		x			SC
Mountain Madtom	*Noturus eleutherus*		x	x			x	x	E
Northern Madtom	*Noturus stigmosus*			x			x	x	E
Channel Darter	*Percina copelandi*	x							T
River Darter	*Percina shumardi*		x						T
Ohio Lamprey	*Ichthyomyzon bdellium*	x	x	x					E

Status Key: FE – Federally Endangered, FT – Federal Threatened, FCE – Federal Candidate Evaluation, F – State Endangered, T – State Threatened, SC – State Species of Concern, X – State Extinct

Table E.1.3-3. RTE species documented to occur in the vicinity of the Muskingum River Projects (Source: FFP, data from ODNR letter dated 1/3/2011 and USFWS letter dated 12/16/2010)

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Eastern Sand Darter (Ammocrypta pellucida): The eastern sand darter is currently state-listed as a species of concern and is being considered as a candidate for federally listed species of concern. It belongs to the family of Percidae (perches and darters). It is not known by any other names. Adult sizes typically reach 2-3 inches long with a maximum of 3.5 inches. It typically eats midge fly larvae and other aquatic invertebrates. The eastern sand darters spawn later in the year than many other darter species. Females full of eggs can sometime be found as late in the year as August. They more typically spawn in June or early July burying their eggs in sand. No further parental care is given.

Eastern sand darters are found in slow moving portions of streams and rivers where the bottom is composed of clean sand. They are very intolerant of silt or mud covering up the clean sand and often disappear from an area or entire stream if this happens. They spend much of their time buried in the sand with only the tip of their snout and eyes exposed. From their hiding place they watch for passing food items and quickly dart out, grab the food, and then quickly burrow back into the sand. The eastern sand darter is primarily found in Ohio in both Lake Erie and the Ohio River drainage. They are most abundant in medium to large size streams that stay relatively clear and have an abundance of clean silt free sand (ODNR, 2010h).

Bluebreast Darter (Etheostoma camurum): The bluebreast darter is currently state-listed as a threatened species. It also belongs to the family Percidae (perches and darters). It is not known by any other names. Adult sizes typically reach 2-3 inches long with a maximum of 3.5 inches. It typically eats insect larvae, crustaceans, and other aquatic invertebrates. Bluebreast darters spawn in June and July. They bury their eggs in gravel in fast flowing riffles. Males guard a small territory around the spawning site until the eggs hatch. After the eggs hatch no further parental care is given.

Bluebreast darters are found in Ohio in medium to large streams and rivers primarily in the Ohio River drainage. At one time they had become quite rare in the state and were only found in limited portions of the Muskingum and Scioto River drainages. Fortunately, as a result of improved water quality, the bluebreast darter has made an impressive recovery in Ohio. They can now be found in every major tributary to the Scioto River from Columbus to the Ohio River. They have also made a similar expansion in the Muskingum River drainage (ODNR, 2010i).

Tippecanoe Darter (Etheostoma tippecanoe): The tippecanoe darter is currently state-listed as a threatened species. It also belongs to the family Percidae (perches and darters). It is not known by any other names. Adult sizes typically reach 1-1.5 inches long with a maximum of 2 inches. It typically eats insect larvae, crustaceans, and other aquatic invertebrates. Tippecanoe darters spawn later in the summer than most species of darters. It is not uncommon to find females still full of eggs well into August. Most spawning probably occurs from late June through early August. Males guard small territories usually in 6-12 inches of water often near the top or bottom end of riffles. Eggs are guarded by the male until they hatch. No further parental care is given after the eggs hatch.

Tippecanoe darters are found in Ohio in medium to large streams and rivers primarily in the Ohio River drainage. They are found in riffles of moderate current with a substrate of gravel and small cobble sized rocks. They spend most of their time in crevices between these rocks, and

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because of their small size they are often difficult to find. Historically the tippecanoe darter was found in the Walhonding River and the lower Muskingum River of the Muskingum drainage and in the Olentangy River, Big Walnut Creek, Big Darby Creek, and Deer Creek of the Scioto River drainage. Since the early 1980's they have made an impressive expansion of their distribution in the Scioto River drainage where they can now be found in nearly every major tributary to the Scioto River and the main-stem of the Scioto River from Columbus downstream to the Ohio River. Unfortunately they appear to have been extirpated from the Muskingum River drainage with the exception of a small population in the lower end of the Muskingum River (ODNR, 2010j).

River Redhorse *(Moxostoma carinatum):* The river redhorse is currently state-listed as a species of concern. It belongs to the family Catostomidae (suckers). It is also known by other names as the redhorse and sucker. Adult sizes typically reach 18-26 inches with a maximum of 32 inches. It usually weighs 3-7 pounds but can reach 12 pounds. It typically eats larval insects, snails, small mollusks and other aquatic invertebrates. The river redhorse spawns in April and May. They migrate into smaller streams and spawn at night at the top and bottom ends of shallow riffles. They burry their eggs in fine gravel with their tails. No further parental care is given.

River redhorses are normally found in the largest rivers of the Ohio and Lake Erie drainage systems. They are typically found in deep pools with moderate current over bedrock or gravel substrate. River redhorse are intolerant of pollution and turbid water which makes their presence an indicator of good water quality (ODNR, 2010k).

Mountain Madtom (Noturus eleutherus): The mountain madtom is currently state-listed as an endangered species. It belongs to the family Ictaluridae (North American catfishes). It is not known by other names. Adult size typically reaches 2-3 inches with a maximum of 5 inches. It typically eats various aquatic invertebrates. The mountain madtom spawns in early summer under large rocks in the riffles where they live. The male guards the eggs until they hatch.

Mountain madtoms are found in deep swift riffles of large rivers. They usually are found in and around cobbles and boulders. In Ohio this species had been reduced to a few remnant populations but because of improvements in water quality they appear to be making a comeback. Relatively large populations now occur in parts of the Little Miami, Muskingum, Walhonding, and Tuscarawas Rivers (ODNR, 2010l).

Northern Madtom (Noturus stigmosus): The northern madtom is currently state-listed as an endangered species. It belongs to the family Ictaluridae (North American catfishes). It is not known by other names. Adult sizes typically reach 2-4 inches with a maximum of 5 inches. It typically eats various aquatic invertebrates. The northern madtom spawns in early summer under large rocks in the riffles where they live. The male guards the eggs until they hatch.

Northern madtoms are found in deep swift riffles of large rivers. They usually are found in and around cobbles and boulders. In Ohio this species has a limited range and is only found in a few locations in the Muskingum, Scioto, and Little Miami River drainages (ODNR, 2010m).

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Channel Darter *(Percina copelandi):* The channel darter is currently state-listed as a threatened species. It belongs to the family Percidae (perches and darters). It is not known by any other name. Adult sizes typically reach 1-2 inches with a maximum of 2.5 inches. It typically eats May fly larvae, midge larvae, and other aquatic invertebrates. Channel darters spawn during the spring and summer. Males defend territories centered around at least one rock. The females deposit their eggs in the gravel on the downstream side of rocks. This species remains in water that is deeper than three feet during the day and migrates into shallow water at night.

Channel darters are found largely in course sand or fine gravel bars and primarily in large rivers or along the shore of Lake Erie. Up until the invasion of the round goby, large schools of channel darters could be observed on the bars around the Lake Erie islands. It is likely the Lake Erie population no longer exists. They are still found in the Ohio River and the lower portion of the Scioto, Muskingum and Hocking Rivers. There may also be a small remnant population in the lower Maumee and Sandusky Rivers in the Lake Erie drainage (ODNR, 2010n).

River Darter *(Percina shumardi):* The river darter is currently state-listed as a threatened species. It belongs to the family Percidae (perches and darters). It is not known by other names. Adult sizes typically reach 2-3 inches with a maximum of 4 inches. It typically eats snails, crustaceans, and other aquatic invertebrates. River darters spawn in April or May in Ohio. They lay their eggs in areas of swift current at a depth of 1-3 feet burying them in gravel. They provide no further parental care for the eggs or young.

River darters are found in very large rivers typically in areas of swift current. They are found over a gravel or rocky bottom in depths of 3 feet or more. In Ohio this species has historically been found in some of the larger western Lake Erie tributaries. They have also been found in the Ohio River and the lower portion of larger tributaries such as the Scioto, Hocking, and Muskingum Rivers. There are no recent reports of them from the Lake Erie drainage but there are recent records for the Ohio River, possibly even some expansion of their range in that drainage (ODNR, 2010o).

Ohio Lamprey *(Ichthyomyzon bdellium):* The Ohio lamprey is currently state-listed as an endangered species. It belongs to the family Petromyzontidae (northern lampreys). It is also known by other name as lamprey. Adult sizes typically reach 10-14 inches with a maximum of 15 inches. It typically eats by filter feeding algae, plankton, and other organic matter. The adults are known to be parasitic on larger fish species. Ohio lampreys spawn in late May or early June in shallow pits that are excavated near the upper ends of gravel riffles. Females then deposit many eggs in these pits. After hatching, the larval stage drifts downstream to larger slower moving streams and burrow into the sediment. During this phase, they eat organic particles strained from bottom sediments and the water, as well as microscopic organisms. After several years, the juveniles transform into a parasitic adult in spring.

These parasitic lamprey species require three distinctly different habitats for its life cycle. Spawning adults are found in clear brooks with fast flowing water and either sand or gravel bottoms. Juveniles are found in slow moving water buried in soft substrate of medium to large streams. Non-spawning parasitic adults are found in large bodies of water with populations of large fish. Ohio lampreys are usually found only in the Ohio River and the lower portion of its

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tributary streams, but some have been observed in the Muskingum River system (ODNR, 2010p).

E.1.3.6 Identification of Essential Fish Habitats

The 1996 amendments to the Magnuson-Stevens Act authorized the National Marine Fisheries Service, in coordination with regional fisheries management councils, to delineate Essential Fish habitat (EFH) for the protection of habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. EFH include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Muskingum River Basin is not located within designated EFH for any species.

E.1.3.7 Invasive and Exotic Species

Invasive and exotic fish species are considered to be one of the major threats to the integrity of native aquatic ecosystems. Invasive and exotic fish species found within Washington, Morgan and Muskingum Counties that contain the Project Sites on the Muskingum River in Ohio include the grass carp (USGS, 2012). No documentation of this species specifically occurring in each of the Project Areas has been identified.

E.1.4 Water Quantity and Quality

E.1.4.1 Water Quantity

The Muskingum River basin has a drainage area of 8,051 square miles, making it the largest watershed in the state of Ohio. It drains portions of central, northeast, and southeast Ohio into the Ohio River. The northern border of the Muskingum River basin lies adjacent to the Great Lakes basin, representing the boundary between waters that drain to the Gulf of Mexico via the Mississippi River and waters that drain to the North Atlantic via the St. Lawrence River.

Flow data for each Project was developed using USGS gage 03150000, Muskingum River at McConnelsville, which has a daily discharge record from 1921 to present. In addition to having the longest continuous discharge record of the available gages, it lies roughly in the center of the proposed Projects. The discharge record at the McConnelsville gage was prorated based on the ratio of the basin area at the gage to the basin area at the dam in order to estimate the flows at each dam. The adjusted minimum, mean, and maximum recorded stream flows at each Project dam are presented in Table E.1.4-1. Monthly flow duration curves were developed using the same method described above are available in Exhibit A.

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Development Name	River Mile	Adjusted Minimum (cfs)	Adjusted Mean (cfs)	Adjusted Maximum (cfs)
Zanesville L&D	77.4	271	6,508	103,584
Philo L&D	68.6	315	7,554	120,224
Rokeby L&D	57.4	323	7,753	123,399
Malta L&D	49.4	325	7,791	124,000
Beverly L&D	24.6	348	8,341	132,771
Lowell L&D	13.6	350	8392	133,573
Devola L&D	5.8	351	8,428	134,141

Table E.1.4-1. Adjusted Minimum, Mean, and Maximum Flow at Muskingum River Projects (Source: USGS, 2010)

The Muskingum River flow regime is regulated by 14 reservoirs in the Upper Muskingum River basin. The Muskingum Watershed Conservancy District (MWCD) is responsible for the maintenance and operation of this system. This MWCD coordinates the operation of storage reservoirs to limit flow into the Muskingum River by impounding water for later release. Each of the Muskingum River locks and dams utilized by the proposed Projects are fixed crest dams with no active storage capacity.

E.1.4.2 Water Quality Standards

Under the Federal Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of “swimmable” and “fishable” waters. The State of Ohio Environmental Protection Agency (OEPA), Division of Surface Water, is responsible for setting and enforcing water quality standards in the State of Ohio. In addition to the OEPA, the Ohio Department of Natural Resources (ODNR), Division of Water and Soils, manages two Continuously Monitoring Water Quality wells in the Lower Muskingum Watershed as a part of the State of Ohio Water Inventory Program. ODNR owns and operates each of the nine locks and dams on the Muskingum River where FFP’s proposed are proposed, as a part of the larger Muskingum River State Park system.

Stakeholder outreach identified the primary water quality concerns related to the proposed hydroelectric Projects are dissolved oxygen (DO), temperature, and mobilization of potentially contaminated sediment. Therefore, the water quality standards presented in this section focus on these parameters.

E.1.4.2.1 Ohio’s Water Quality Standards

Ohio’s water quality standards are set forth in Chapter 3745-1 of the Ohio Administrative Code (OAC). Primary components include:

- Beneficial Use Designations definitions, paragraph (B) of rule 3745-1-07 of OAC
- Beneficial Use Designations assigned, rules 3745-1-08 to 3745-1-32 of OAC
- Narrative “free forms”, rule 3745-1-04 of OAC
- Biological Criteria, rule 3745-1-07 of OAC

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- Chemical Criteria, rule 3745-1 of OAC
- Antidegradation Provisions, rule 3745-1-05 and rule 3745-1-54 of OAC

There are three major categories of water quality standards relevant to hydroelectric project licensing in the State of Ohio: (1) use designations, (2) applicable water quality criteria, and (3) anti-degradation category.

State water quality standards consist of waterbody-specific evaluations of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Therefore, numeric water quality criteria (i.e., maximum or minimum chemical concentrations) are applicable depending on the use designation assigned to a water body.
In addition to numerical criteria, water quality standards include narrative criteria which state generalized goals for surface water conditions. These narrative criteria, reflected in Table E1.4-2 below, are applicable to all state surface waters.

The antidegradation category for a waterbody determines what impacts to water quality are allowable and what justification, planning, and mitigation efforts are required. Water quality degradation is more stringently restricted in high quality waterbodies.

Parameter	Criteria[1]
Suspended solids and floating debris	Free from suspended solids, floating debris, oil, scum, or other substances that will settle to form putrescent or objectionable deposits or adversely affect aquatic life.
Color and odor	Free from material which produces color, odor, or other conditions which create a nuisance.
Toxicity	Free from substances in concentrations that are toxic or harmful to human, animal, or aquatic life and/or are rapidly lethal in the mixing zone.
Nutrients	Free from nutrients in concentrations that create nuisance growths of aquatic weeds and algae.
Public health nuisances	Free from public health nuisances associated with raw or poorly treated sewage.

[1]Criteria apply to surface water conditions that are the result of human activity, not natural occurrences.

Table E.1.4-2. Ohio Surface Water Criteria

(Source: State of Ohio Water Quality Standards, Chapter 3745-1-4 of the Administrative Code)

Each waterbody in the state is assigned one or more use designations. There are three types of use designations in the State of Ohio water quality standards: (1) aquatic, (2) water supply, and (3) recreation.

Aquatic use designations aim to protect the assemblage of aquatic organism which a waterbody supports or could support. The use designation is established by comparing a baseline assemblage for the water body's ecoregion to the conditions in the waterbody. The Muskingum River's aquatic use designation is Warm Water Habitat (WWH), which defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams. These are waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified reference sites. This use represents the principal restoration target for the majority of water resource management efforts in Ohio and is the baseline regulatory requirement in line with the Clean Water Act's "fishable goal" expectations.

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Water supply use designations aim to protect municipal, agricultural, and industrial water uses. The Muskingum River's water supply use designations are Agricultural Water Supply (AWS) and Industrial Water Supply (IWS). AWS and IWS use designations apply to all state waterbodies unless it can be shown that they are not applicable.

Recreational water use designations aim to protect the public while utilizing waterbodies for recreational purposes. Recreational uses are evaluated based on bacteria levels. The Muskingum River's recreational use designation is Primary Contact Recreation (PCR). PCR waters are waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving.

E.1.4.2.2 Muskingum River Water Quality Standards Use Designations

The following standards are applicable to the Muskingum River based on its use designations: WWH, AWS, IWS, and PCR. When a water body meets the biological standards and numeric criteria associated with its use designation, that water body is in "attainment," a water body failing to meet criteria associated with its use designation is in "nonattainment." "Partial attainment" may be reached by fulfilling certain aspects of the criteria but not all.

Many water quality parameters have separate "outside mixing zone" and "inside mixing zone" criteria. Outside mixing zone criteria are applicable where any wastewater effluent is reasonably well mixed with receiving waters, inside mixing zone criteria are applicable to end-of-pipe wastewater effluents. All criteria presented here are for the outside mixing zone standard.

Biological Criteria

Biological criteria are based on aquatic community characteristics that are measured both structurally and functionally. These criteria are used to evaluate the attainment of aquatic life uses. The data collected in these assessments are used to characterize aquatic life impairment and to help diagnose the cause of this impairment.

The principal biological evaluation tools used by OEPA, reflected in Table E.1.4.-3 below, are the Index of Biotic integrity (IBI), the Modified Index of Well-Being (MIWB) and the Invertebrate Community Index (ICI). These three indices are based on species richness, trophic composition, diversity, presence of pollution-tolerant individuals or species, abundance of biomass, and the presence of diseased or abnormal organisms. The IBI and the MIWB apply to fish; the ICI applies to macroinvertebrates. OEPA uses the results of sampling reference sites to set minimum criteria index scores for use designations in water quality standards. The Muskingum River sites are compared to WWH biocriteria for the Western Allegheny Plateau ecoregion.

Biological criteria for warmwater, exceptional warmwater and modified warmwater habitats description and derivation of indices and ecoregions are contained in "Biological Criteria for the Protection of Aquatic Life: Volume II, Users Manual for Biological Field Assessment of Ohio Surface Waters."

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Index	Description	Index Range	WWH Criteria
Index of Biotic Integrity (IBI)	Reflects total native species composition, indicator species composition, species pollution tolerance, and fish condition.	0-60	40[1]
Modified Index of Well-Being (MIWB)	Reflects fish population mass and density, is corrected for pollution intolerant species.	N/A	8.6[1]
Invertebrate Community Index (ICI)	Reflects aquatic invertebrate species composition and pollution tolerance.	0-60	36

[1]Stated criteria is for sites sampled by boat.

Table E.1.4-3. Biological Criteria Applicable to the Muskingum River.
(Source: OEPA (1987a and 1989b)

Dissolved Oxygen Standard

For the Muskingum River mainstem the State of Ohio has established an instantaneous minimum Dissolved Oxygen (DO) criteria of 4.0 milligrams per liter (mg/L) and a 24-hour average minimum DO of 5.0 mg/L.

Water Temperature Standards

The criteria for water temperature vary depending on the time of year. The monthly water temperature criteria for the protection of aquatic life on the Muskingum River are presented in Table E.1.4-4.

Date	Maximum Average Temperature (°F)	Daily Maximum Temperature (°F)
January 1-31	45	50
February 1-29	45	50
March 1-31	53	58
April 1-15	58	63
April 16-30	65	70
May 1-15	68	74
May 16-31	72	77
June 1-15	76	84
June 16-30	85	89
July 1-31	85	89
August 1-31	85	89
September 1-15	85	89
September 16-30	80	85
October 1-15	73	77
October 16-30	67	72
November 1-30	62	67
December 1-31	47	52

Table E.1.4-4. Temperature criteria for the Muskingum River
(Source: OAC 3745-1-07, Table 7-14 (E)

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Antidegradation Classification

The Muskingum River is classified by OEPA as a superior high quality water throughout the mainstem (OEPA, 2008). This classification signifies that the river supports diverse aquatic life and endangered or threatened species. Practical impacts of the superior high quality water designation include a 35% set aside in pollutant loading in order to preserve water quality above minimum standards required for beneficial use, more stringent pollution controls for new sources, and a social/economic justification is needed to undertake any actions which will lower water quality.

E.1.4.3 Existing Water Quality

The Ohio Environmental Protection Agency (OEPA) is the primary source for water quality information on the Muskingum River. Central to statewide monitoring efforts are biosurveys, a combination biological and water quality monitoring study that determine the overall health of a waterbody. The most extensive study of existing water quality relevant to the proposed Projects to date is the *2006 Biological and Water Quality Study of the Muskingum River* (OEPA 2007). This biosurvey covered the entire 112-mile length of the Muskingum River and assessed the biological, surface water, sediment, and recreational (bacterial) status. A total of 28 biological, 15 water chemistry, 15 bacterial, 12 sediment, and 17 fish tissue stations were sampled during 2006. The primary goals of this report were to assess the aquatic, water supply, and recreational use attainment status throughout the river, assess environmental and biological conditions that pertain to river health, and evaluate the cause of any impairments.

From 1982 to 1992 the OEPA performed a sediment and surface water study on the Muskingum River. This report aimed to determine any potential for the river to contribute contaminants to the McConnelsvillle well field, assess fish bioaccumulation, and monitor accumulation of specific metals and solvents.

Monitoring shows that water quality in the Muskingum River has improved over the past 20 years and is in very good condition. According to the 2006 Biological and Water Quality Study, the Muskingum River is fully attaining the Warmwater Habitat aquatic life use designation and several sections of the river obtain Exceptional Warmwater Habitat (EWH) status due to the presence of threatened or endangered species and a high level of biological integrity. Several sites failed to meet temperature and chemical water quality criteria owing to industrial discharges.

The *2010 Integrated Report* (OEPA 2010) provided updated use attainment status for the Muskingum River. This report states that the entire Muskingum River achieved full attainment of water use standards. The sites failing to meet use attainment status in the 2006 report saw improvements that lead to being in attainment.

Biological Water Quality Criteria

The *2006 Biological and Water Quality Study* demonstrated that the entire Muskingum River is fully attaining its WWH aquatic life use designation. Aquatic life use indicators such as the IBI,

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MIwb, and ICI reflect the cumulative impact of water quality by monitoring the health and diversity of fish and aquatic invertebrate species. Higher IBI and ICI scores are obtained by an increased number of "pollution intolerant species." Because these species do not tend to inhabit polluted water, their presence indicates good water quality. Since aquatic life criteria is an aggregate indicator of water quality, the complete attainment of aquatic life use criteria indicates that the Muskingum River is attaining the goals of the Clean Water Act and has overall good water quality.

Dissolved Oxygen and Temperature

The *2006 Biological and Water Quality Study* monitored hourly DO concentrations and temperature at four locations from August 29, 2006 to August 31, 2006. Data from stations in the vicinity of proposed Projects (19.5 miles upstream of Zanesville Lock and Dam, Beverly Lock and Dam pool upstream of Muskingum EGS outfall, and downstream of Beverly Lock and Dam) are presented in Figure E.1.4-1. This monitoring showed DO levels meeting water quality standards. Continuous monitoring showed little diurnal change in DO concentration. The water temperature downstream of the Muskingum Electrical Generating Station, which represents a thermal load on the river, exceeded both the average maximum temperature criteria and the daily maximum criteria.

Dedicated temperature monitoring occurred at half-hour intervals from August to mid-September at five locations. The location at RM 26.2 exceeded average temperature criterion during August. Several days exceeded the maximum temperature criterion. RM 26.2 was located approximately two miles downstream from the thermal discharge at the AEP Muskingum River Electrical Generating Station. The upstream temperature results at RM 29.2 were all below the Ohio criteria for average and maximum temperature. Despite not meeting temperature criteria, these sampling sites were in attainment of aquatic life use criteria.

A DO and temperature study was conducted in 2011 in order to assess potential Project effects. Additional discussion of this survey is presented in Section E.2.4, and the survey report (FFP, 2012b) is provided in Appendix C-7.

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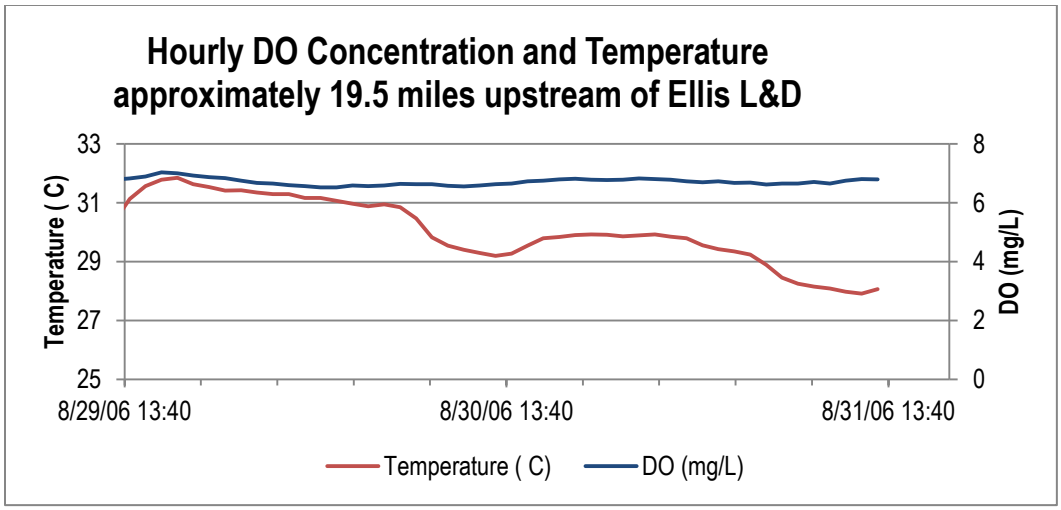

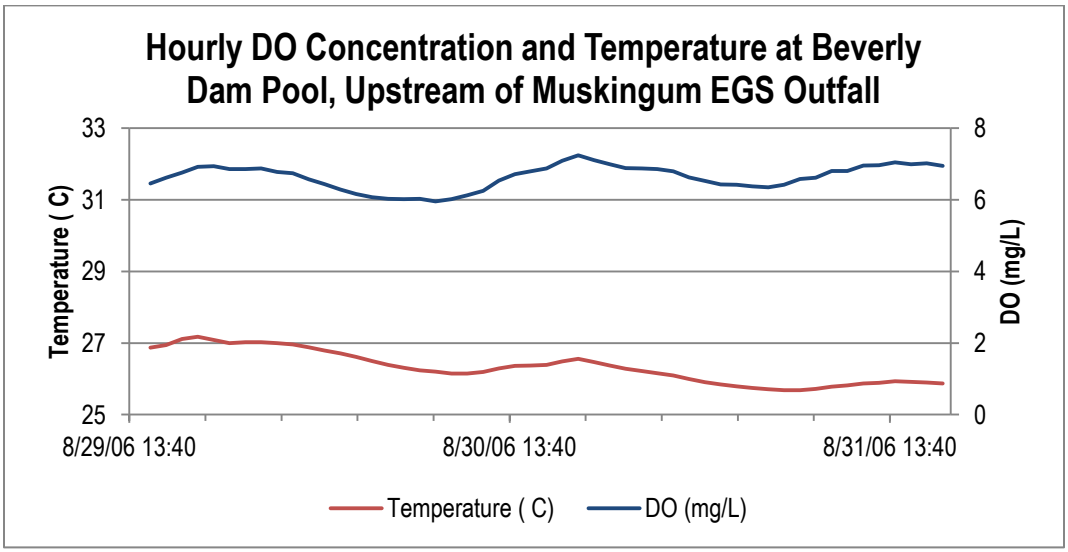

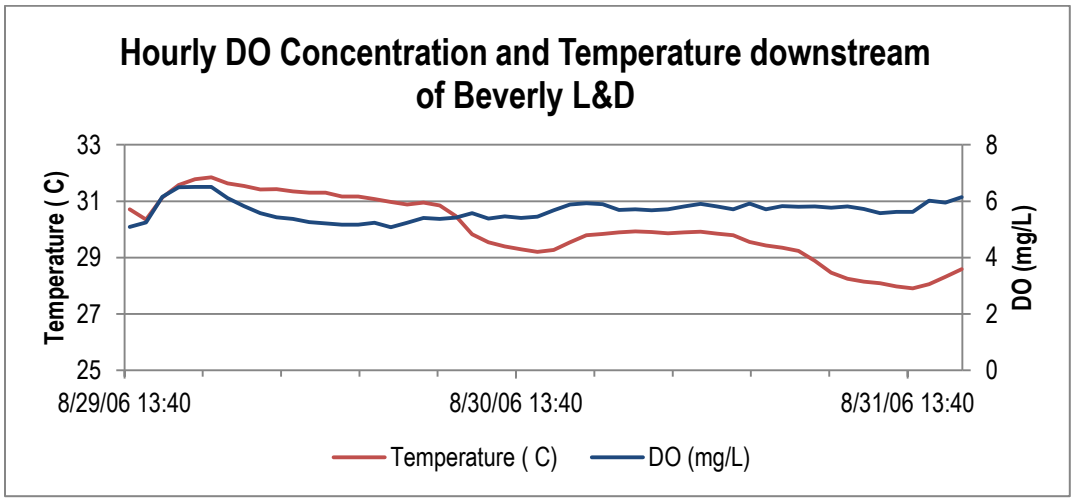

Figure E.1.4-1. Hourly DO concentrations and temperatures from the 2006 (Source: Ohio EPA 2007)

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Sediment Quality and Loading

During the 2006 Biological and Water Quality study fine grain sediment samples were collected at 12 locations on the Muskingum River. Nine of these sites were located in dam impoundments. The four categories of parameters were analyzed; semi-volatile compounds and PCBs (at four sites), total analyte list inorganics, and nutrients.

Three concentration levels are highlighted in Table E.1.4-5: (1) the Threshold Effect Concentration (TEC), the level of sediment chemical concentration below which harmful effects are unlikely to be observed; (2) the Probable Effect Concentration (PEC), the level of sediment chemical concentration above which harmful effects are likely to be observed; and (3) Ohio Specific Sediment Reference Values (SRVs) for metals, which are standards established by OEPA representing maximum criteria targets for sediments.

Sampling sites near two proposed project impoundments, the Zanesville Lock and Dam (RM 77.6) and Rokeby Lock and Dam (RM 62.7), had nickel concentrations exceeding the PEC. However, only one of these sites, Zanesville Lock and Dam, had a nickel concentration exceeding the Ohio SRV of 61 mg/kg. Two sites had metal concentrations exceeding Ohio SRVs, Zanesville Lock and Dam (RM 77.6) exceeded cadmium standard and the site at RM 42.2 exceeded the manganese standard. These results indicate that fine grain sediment in the Muskingum River contains some notable contaminants but is rarely above the standards set in the Ohio SRVs.

The 1982 to 1992 OEPA study of sediment and surface waters in the area of McConnelsville well field found elevated and/or unsafe levels of metals and organic compounds, including lead, copper, tetrachloroethene, trichloroethene, and dichloroethene (OEPA 1993).

Other Parameters

Recreational use attainment was revisited in 2007 and is reported in the Final 2010 Integrated Water Quality Monitoring and Assessment Report. It was found that bacterial conditions did improve at all sites visited. However, the Muskingum River is still listed as not attaining recreational use E. coli criteria.

The 2006 Biological and Water Quality Assessment found pH and conductivity to be within acceptable levels and generally uniform throughout the river. All flowing water grab samples reported non-detect levels of PCBs and pesticides. One organic chemical, hexachlorobenzene, was above detected, however it was below Ohio water quality standard criteria.

Metal concentrations were tested in grab samples at 15 locations. In general, Mercury represents a commonly exceeded pollutant criterion on the Muskingum River, with samples exceeding human health drinking and non-drink criteria at RM 108.1, RM 67.3, RM 49.8, RM 39.7, and RM 0.9. Lead was found to exceed outside-mixing zone average criterion at River Mile 75.8 and was strongly correlated with Total Suspended Solids and increased river flow.

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		RM 97.4	RM 86.0	RM 77.6	RM 72.0	RM 62.7	RM 42.2	RM 26.2	RM 19.0	RM 8.1	RM 0.9
Near Proposed Project Impoundment:			Ellis L&D	Zanes-ville L&D	Philo L&D	Rokeby L&D		Beverly L&D	Lowell L&D	Devola L&D	
Arsenic	(mg/kg)	9.31	13.4	14.2	13.6	13.4	12.3	9.42	7.98	10.5	8.69
Cadmium	(mg/kg)	0.475	0.674	0.907	0.624	0.688	0.709	0.469	0.398	0.51	0.456
Chromium	(mg/kg)	21	39	69	32	45	30	24	19	26	23
Lead	(mg/kg)	<23	30	48	39	47	<34	<31	24	37	26
Nickel	(mg/kg)	30	50	64	41	52	47	40	32	40	34
Zinc	(mg/kg)	116	172	202	163	176	183	133	108	138	120
Manganese	(mg/kg)	1640	2080	2340	2020	1830	3030	2200	1250	2210	1730
Fluoranthene	(ug/kg)	NA	NA	NA	<780	NA	NA	<790	NA	NA	<750
Phenanthrene	(ug/kg)	NA	NA	NA	<780	NA	NA	<790	NA	NA	<750
Pyrene	(ug/kg)	NA	NA	NA	<780	NA	NA	<790	NA	NA	<750
Hexachlorobenzene	(ug/kg)	NA	NA	NA	67.7	NA	NA	45.3	NA	NA	74.2
PCB-1254	(ug/kg)	NA	NA	NA	47.2	NA	NA	<39.2	NA	NA	<37.2

	Threshold Effect Concentration (TEC)
	Probably Effect Concentration (PEC)
	Ohio Sediment Reference Values for Metals

Table E.1.4-5. Pertinent and Detectable Parameters Detected in Muskingum River Sediments (Source: Ohio EPA (2007)

E.1.5 Land and Water Uses

E.1.5.1 Land Uses

The Lower Muskingum River watershed within FFP's proposed Project Areas includes the three counties of Muskingum, Morgan, and Washington. The majority of the watershed is rural but contains many small villages and towns. The largest communities in the area include Marietta, located in Washington County, and McConnelsville, located in Morgan County. The Muskingum River watershed in the area of FFP's proposed Projects tends to be undeveloped (Figure E.1.5-1).

The Muskingum River watershed is dominated by deciduous, evergreen and mixed forests. All but five percent of the forest is deciduous, with trees such as oaks and hickories on the hillsides, and walnut, elm, cottonwood, and sycamore in the floodplain valleys. Agriculture represents approximately 34% of the land use, with approximately 28% of the land being used to grow pasture hay and 6% row crops .The prevalence of pasture hay cultivation results from the suitability of reclaimed surface mining site for growing hay. The Muskingum River Valley is notable for its fertile soils and vegetable cultivation, and a significant amount of land adjacent to the river is used for agriculture. Low-intensity residential use represents 1% of land cover.

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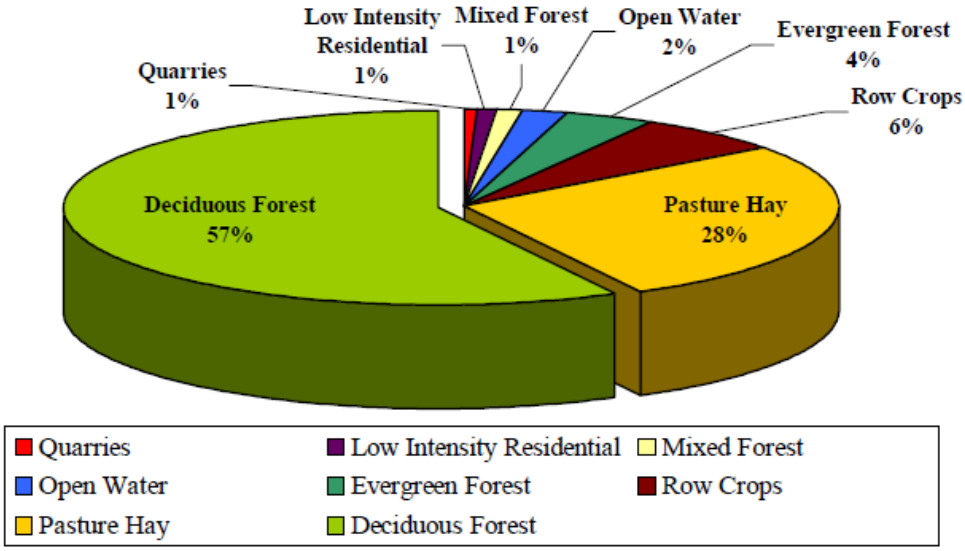

Source: LANDSAT Satellite Data 1994

Figure E.1.5-1. Land Use in the Lower Muskingum Watershed (Source: ILGARD, 2005)

Wetlands make up a very small percentage of the Lower Muskingum watershed, due to the high relief and prevalence of agriculture in riparian zones. Urban areas account for approximately 1% of the total land use in the watershed. The largest urban areas are found in the southern reaches of the watershed in Marietta and Devola. Zanesville and McConnelsville also represent relatively populous areas in the Project Area. Commercial/industrial/transportation land use areas, which account for only 0.26% of the watershed, tend to be concentrated in these urban areas.

Maps displaying land use classification in the area of each of FFP's proposed Projects are provided in the following Figures E.1.5-2 through E.1.5-8.

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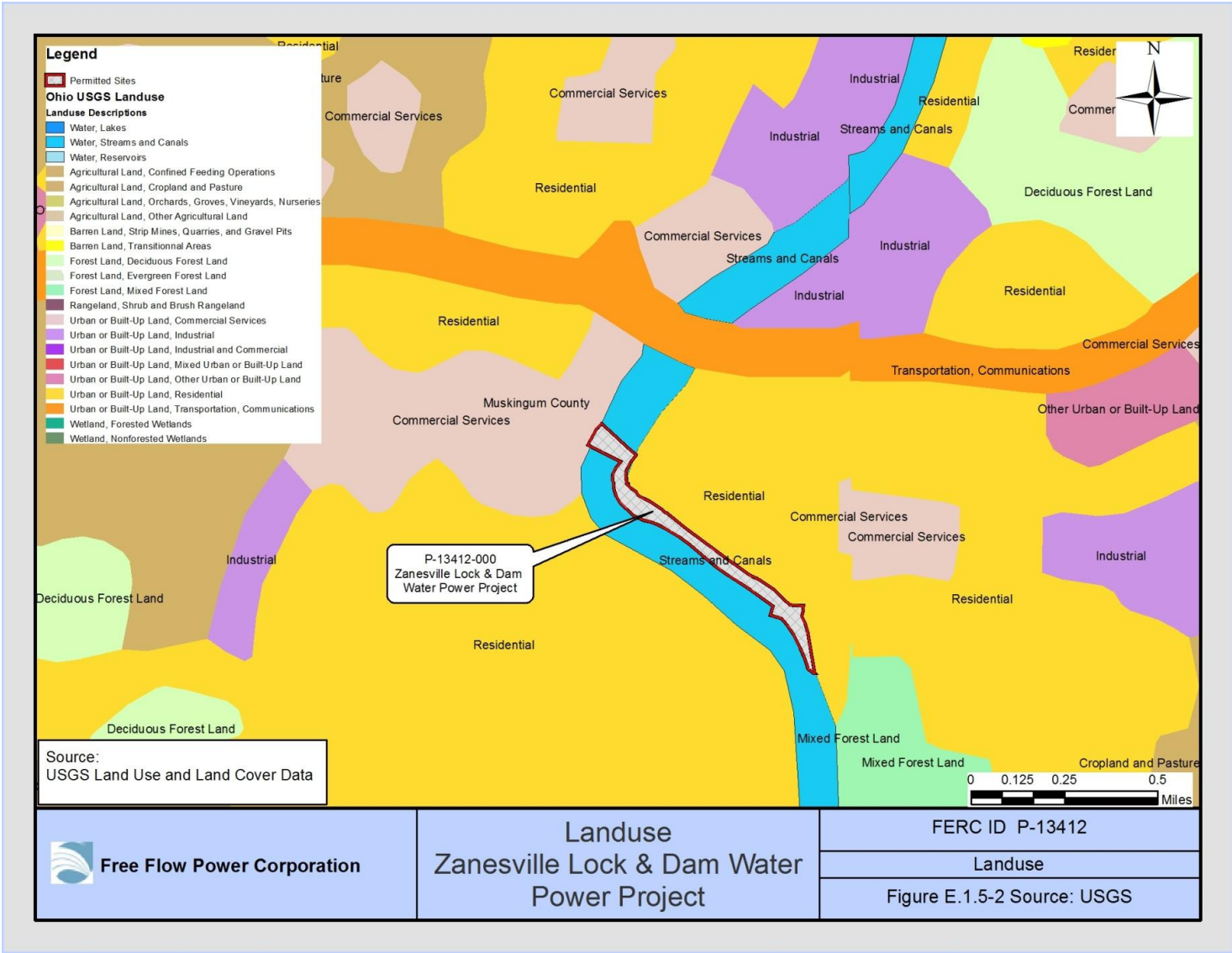

Figure E.1.5-2. Zanesville Land Use (Source: FFP)

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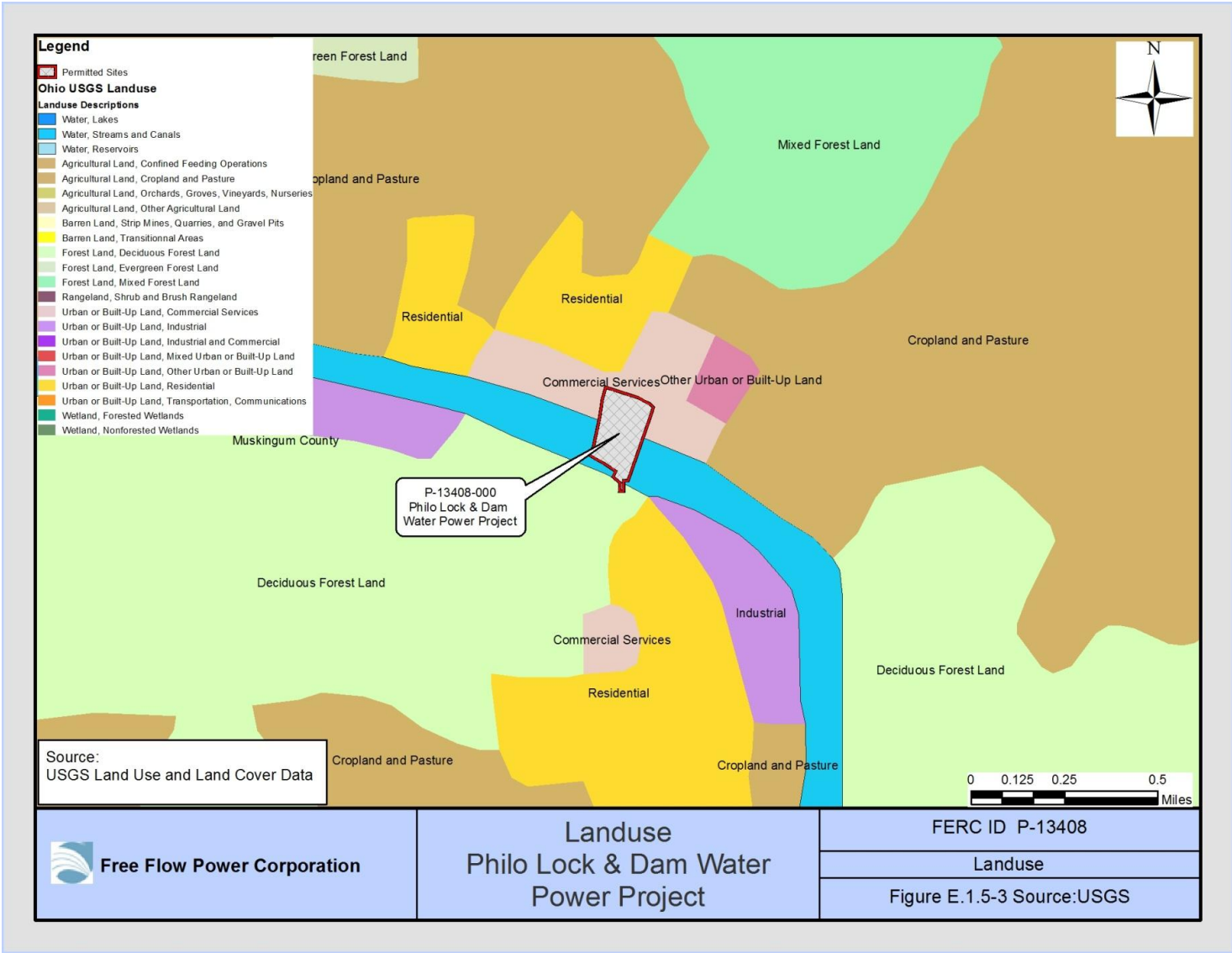

Figure E.1.5-3. Philo Land Use (Source: FFP)

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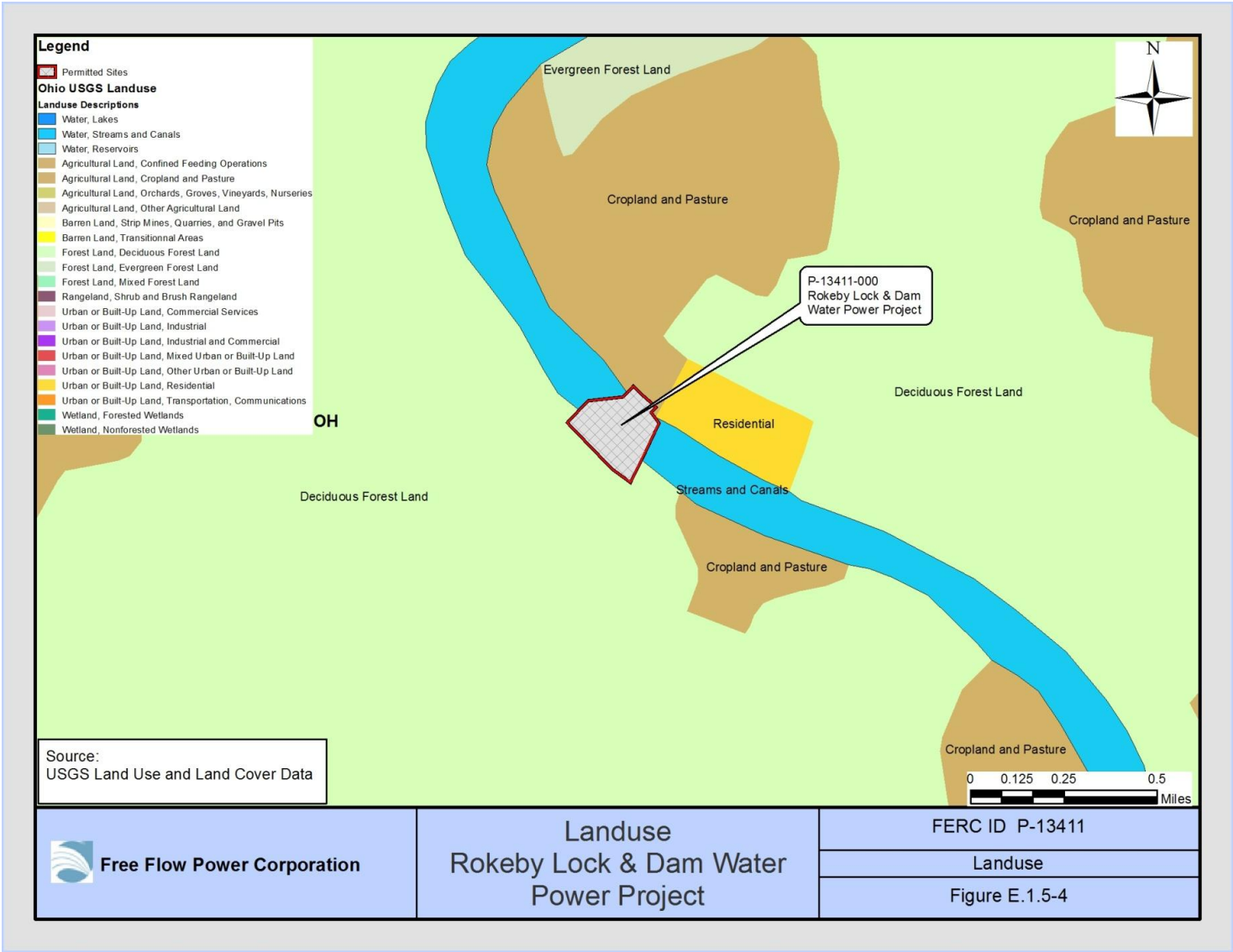

Figure E.1.5-4. Rokeby Land Use (Source: FFP)

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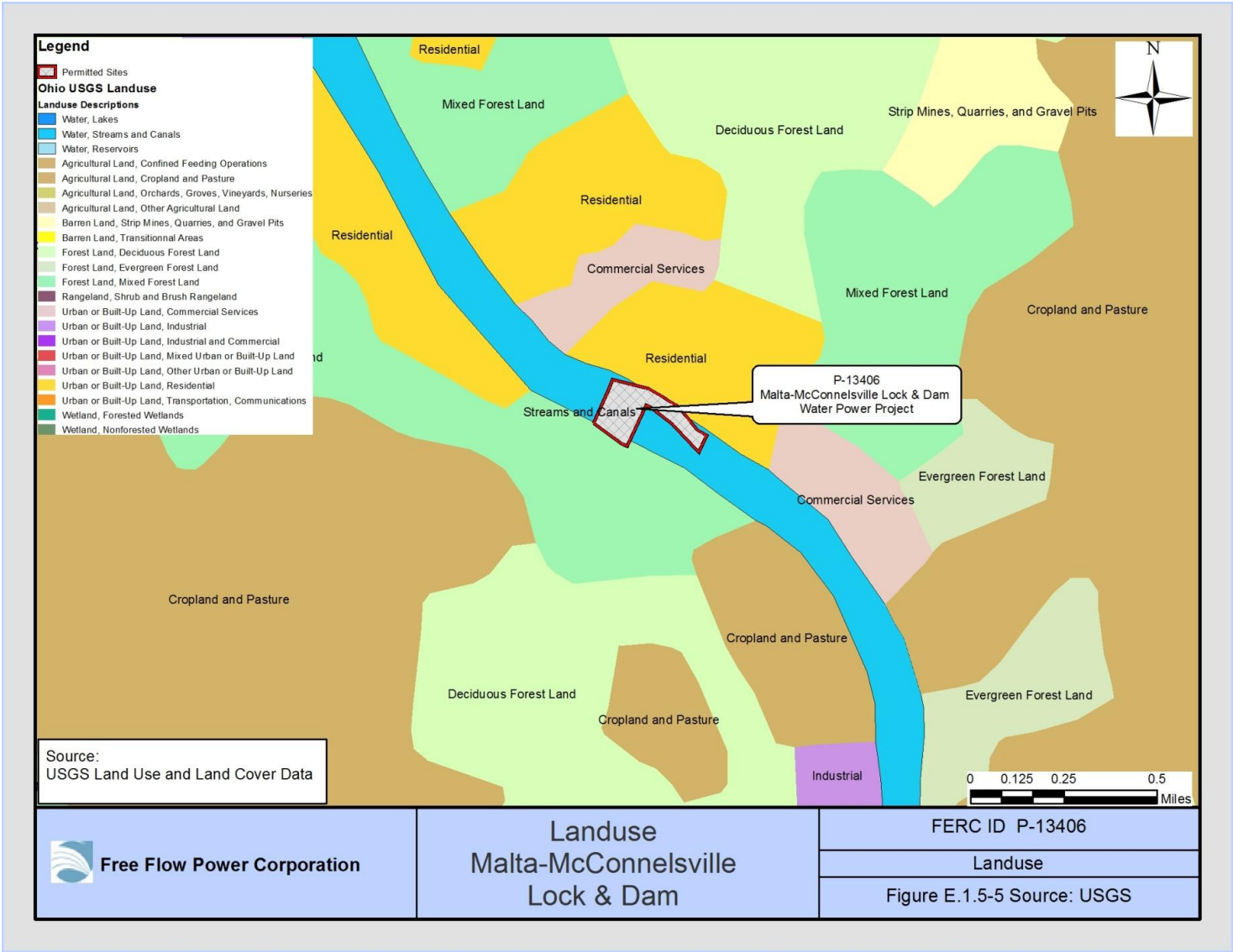

Figure E.1.5-5. Malta-McConnelsville Land Use (Source: FFP)

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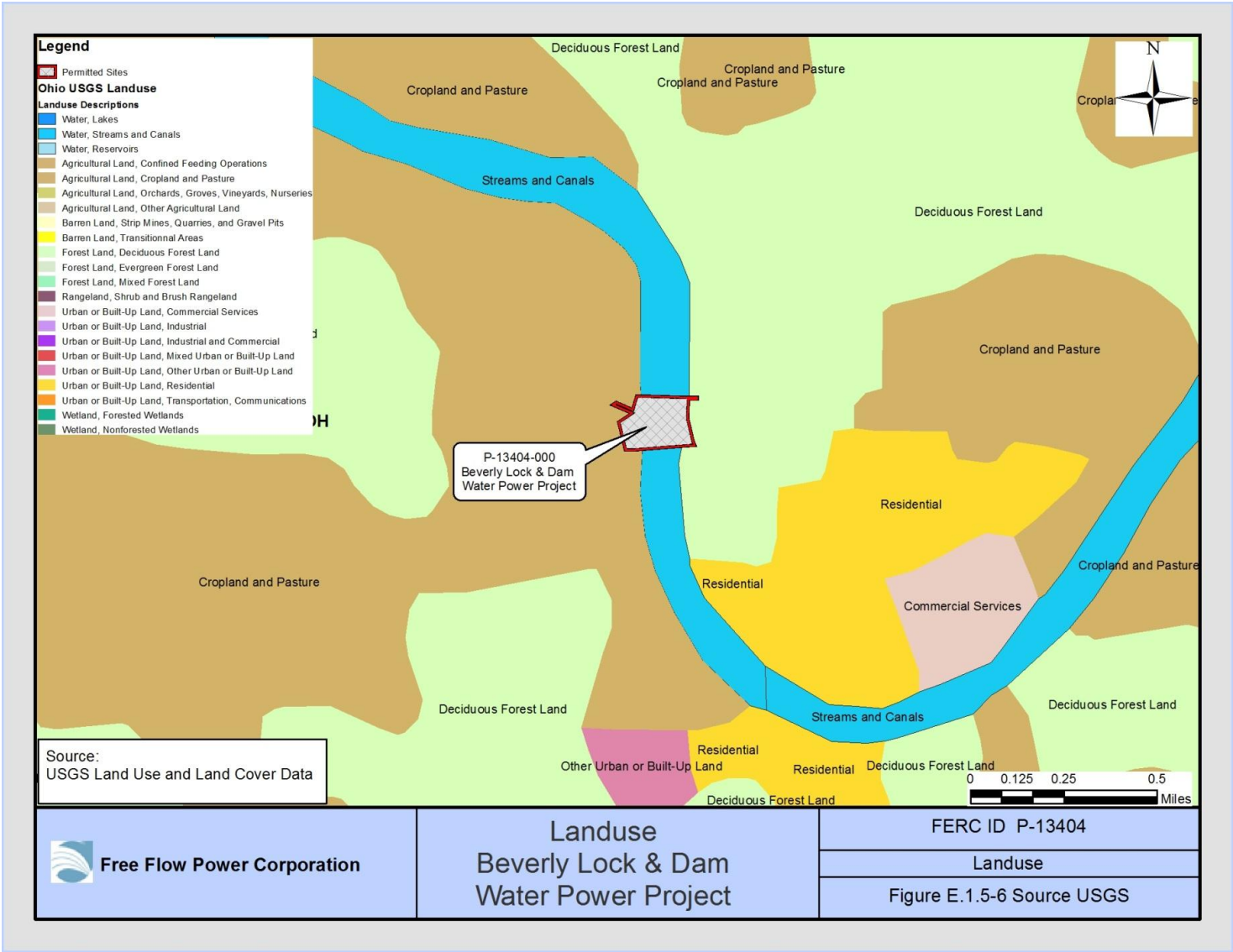

Figure E.1.5-6. Beverly Land Use (Source: FFP)

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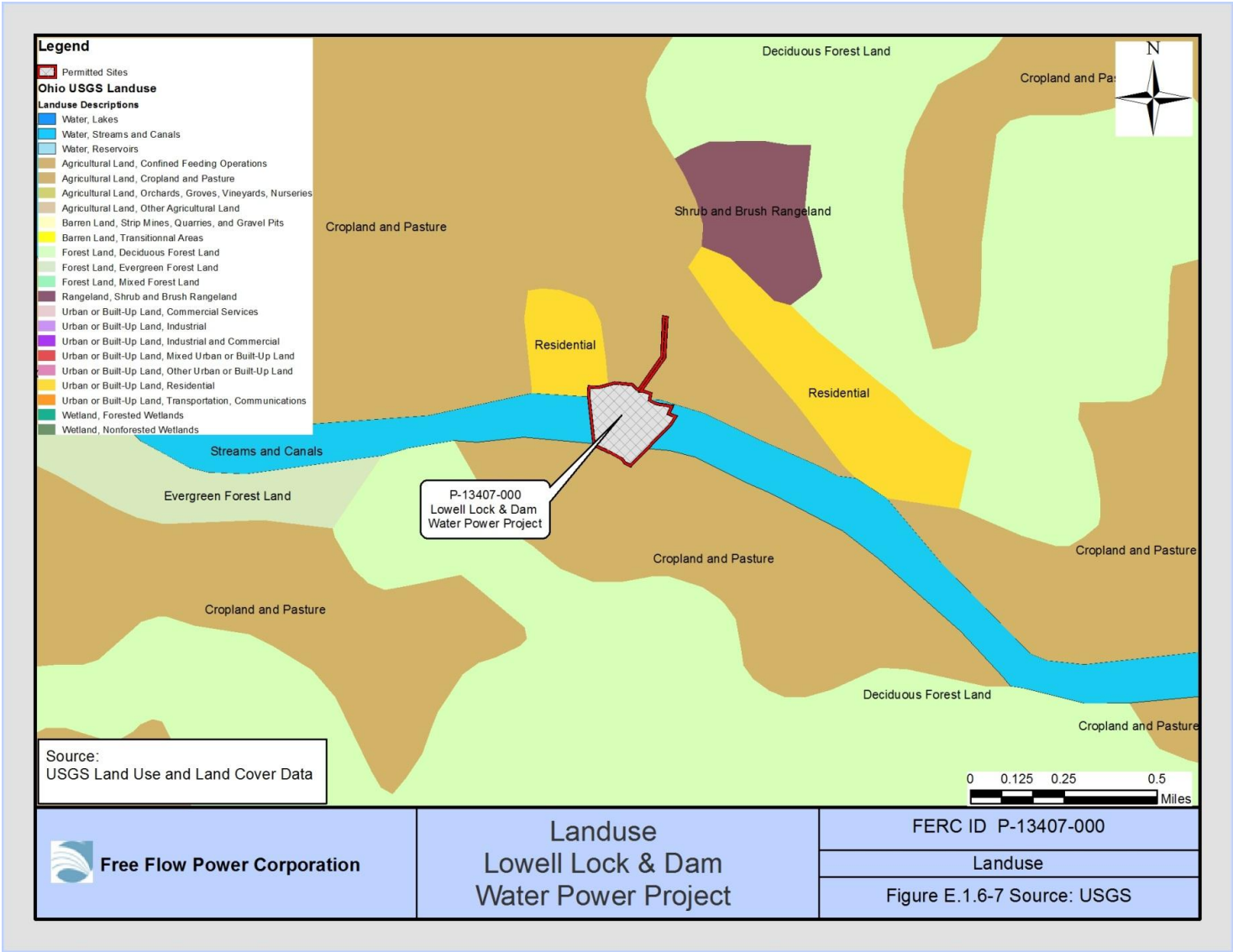

Figure E.1.5-7. Lowell Land Use (Source: FFP)

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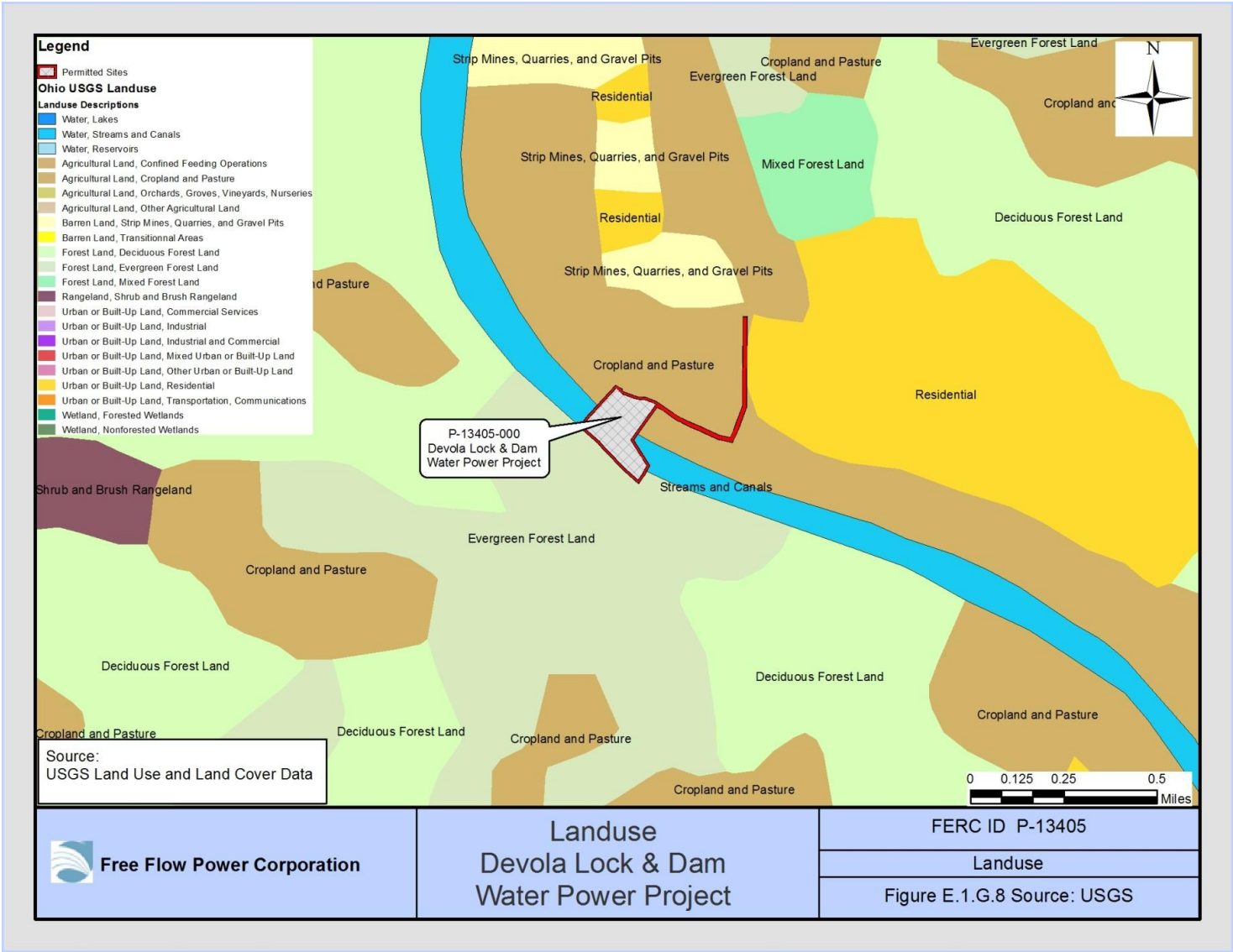

Figure E.1.5-8. Devola Land Use (Source: FFP)

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E.1.5.2 Water Uses

E.1.5.2.1 Locks, Dams and Navigation

The Muskingum River was formerly an important artery for the transport of goods in southeast Ohio following the construction of the lock and dam system in the mid 1800s. However, since the early 1900s, commercial navigation has declined and current navigation is restricted to motorized and non-motorized recreational boats.

Thirty-four regulated dams are located in the Lower Muskingum River watershed. Eight of these are the mainstem dams on the Muskingum River, seven of which are dams where FFP is proposing to develop hydroelectric projects. Paired with these dams are eight locks that allow recreational boat traffic on the Muskingum River from the mouth in Marietta to Philo at the very edge of the Lower Muskingum River watershed (ODNR 2004).

E.1.5.2.2 Recreation

The Muskingum River is a valuable outdoor recreational resource for southeastern Ohio. A variety of recreational activities take place in and around the river. Resources such as boating access, public fishing and hunting areas, campgrounds, state parks, and historic areas are found throughout the region.

E.1.5.2.3 Municipal and Industrial Wastewater Discharges

The Muskingum River is an important local receiving water for municipal and industrial waste water. It assimilates both chemical and thermally polluted effluent from a variety of sources. The U.S. EPA Facility Registry System returns a total of 103 National Pollution Discharge Elimination System (NPDES) individual permits in the Muskingum River HUC (05040004). The 2006 Biological and Water Quality Study on the Muskingum River recorded 29 National Pollution Discharge Elimination System NPDES permitted facilities discharge into the Muskingum River mainstem.

E.1.5.2.4 Water Rights

Water rights in Ohio are determined by the civil law doctrine of riparian rights. Rights to use water in a stream with a well-defined channel are assigned to adjacent landowners for reasonable use, including commercial purposes. FFP's proposed Projects would not initiate any consumptive use of water, nor would the Projects alter the water in a way that would inhibit usage rights of downstream landowners.

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E.1.6 Recreational Resources

E.1.6.1 Regional Resources

The Muskingum River represents an active and valuable outdoor recreational resource for southeastern Ohio. A variety of recreational activities take place in and around the river. As discussed in the following subsections, resources such as boating access, public fishing and hunting areas, campgrounds, state parks, and historic areas are found throughout the region.

The Ohio Department of Natural Resources (ODNR) manages recreational facilities at the seven Muskingum River Lock and Dams where hydroelectric developments are proposed. The Ohio State Parks system is the ODNR department that facilitates extensive recreational opportunities in the area, along with the Division of Forestry, the Division of Wildlife, and the Division of Watercraft. The Muskingum River State Park includes the reach of the proposed hydroelectric Projects and is managed by the ODNR (Figure E.1.6-1). The Muskingum River Water Trail was designated a state water trail in 2006 and includes the facilities within the Muskingum River State Park.

There are no river segment designated or under study for inclusion in the National Wild and Scenic River system. However, the National Historic Trails System, established by the National Trails System Act of 1968, commemorates historic routes and promotes their preservation, and development for public use. The North Country National Scenic Trail is approximately 4,600 miles long and runs from Crown Point, New York to Lake Sakakawea in North Dakota. The North Country National Scenic Trail follows the Buckeye Trail in the Muskingum River region, crossing the Muskingum River near Stockport. This trail is, however, not in proximity to any of FFP's proposed Projects.

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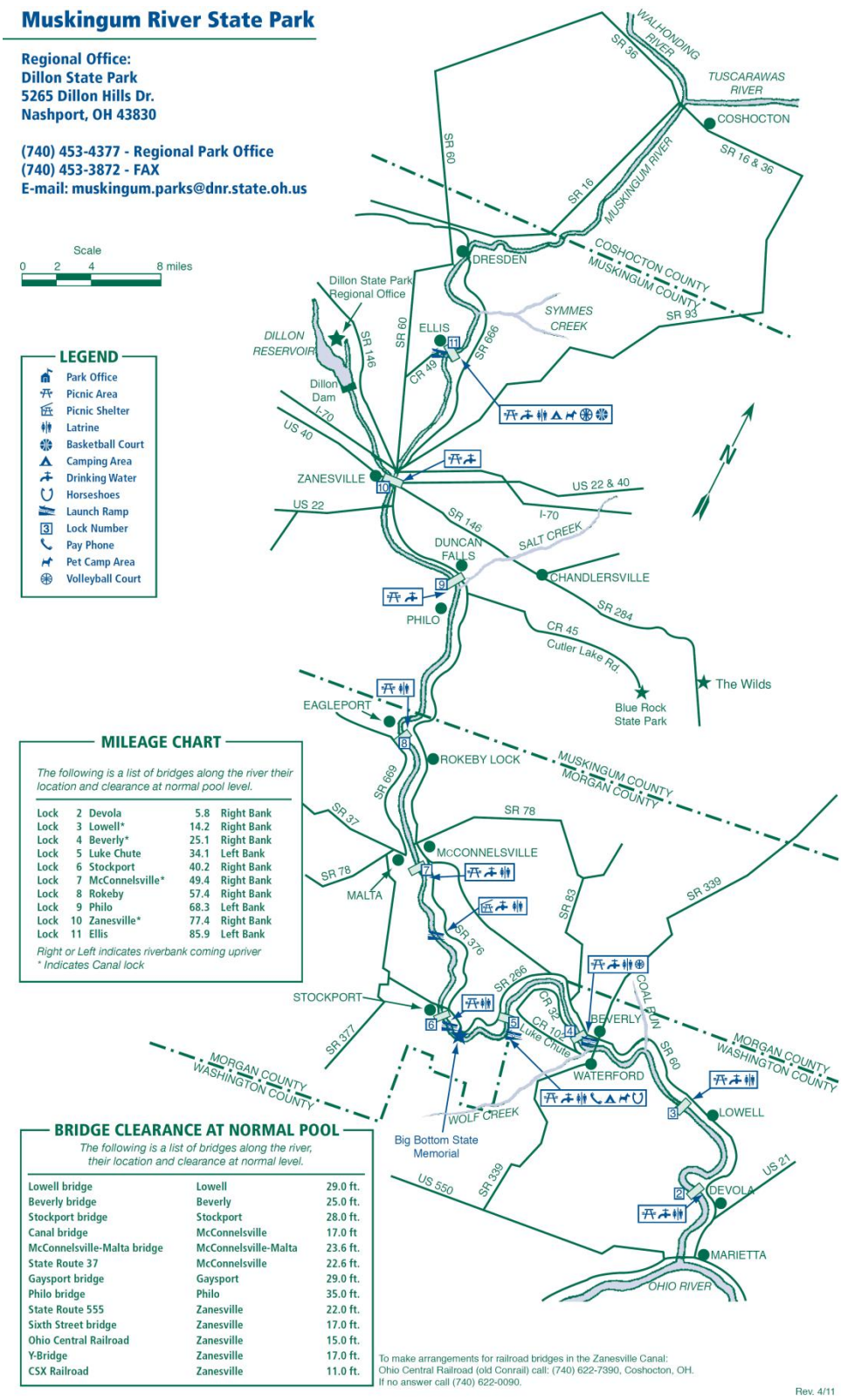

Figure E.1.6-1. Muskingum River State Park Map (Source: ODNR, 2011b)

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E.1.6.1.1 Recreational Boating and Paddling Opportunities

The Muskingum River is navigable from south of Dresden, OH to Marietta, OH. The collection of outdoor recreational resources available on and next to the river is called the Muskingum River Water Trail. Eight of the nine dams at which FFP's Projects are proposed are located adjacent to an operable lock, except for Ellis Lock and Dam, where the lock has been closed for several years due to disrepair. The passage through each dam is facilitated with hand-operated locks staffed by an ODNR lock technician. In addition to ODNR and municipal park facilities, there are four privately owned boat access points that provide a variety of amenities on the Muskingum River. There are 26 public boat access points that may be trailer ramp accessible and suitable for larger motorboats or carry-in only, which can also be used for canoes and kayaks. Recreational boating facilities exist at each of the proposed project dams. Restrooms, parking, docks, boat ramps, and carry-in accesses are found at several of the dams.

The hours of lock operation during the 2010 season were: May 28 to September 13 – 9:30 am to 2:00 pm, 2:30 pm to 6:00 pm Friday and Monday; 9:30 am to 2:00 pm, 2:30 pm to 8:00 pm Saturday and Sunday; and September 18 to October 10 – 9:30 am to 2:00 pm, 2:30 pm to 6:00 pm, Saturday and Sunday. Purchase of a lock pass is required to navigate through the locks. Weekend and seasonal passes are available; they range from $15 to $50. According to the monthly use data gathered at all ten Muskingum River lock and dams by the ODNR, most boats lock through during July, August and September (Figure E.1.6-2).

Facility use data was obtained from ODNR (cited as ODNR, 2011a) for the Muskingum River locks and dams where the proposed Projects are located. ODNR staff gathers facility use data on the Muskingum River during lock hours of operation. This is performed by the Lockmasters who are responsible for operating the locks for recreational navigation. For hours outside of lock operation, ODNR Staff estimates facility usage. Use data for each individual lock and dam site was only available from 2000 to 2003. Monthly use data was available from 2000 to 2010, excluding the year 2004. However, this dataset estimates use for all ten Muskingum River locks and dams and was not adjusted to reflect use at the seven proposed Project locks and dams. Likewise, it is estimated that if visitors or boats use multiple facilities in the same day (i.e. locks through multiple dams while in transit) the boat or visitors will be counted multiple times. These data are based on visual observation, including direct counts of boats locking through and visual estimates. Counting recreational participants is not the primary responsibility of the Lockmasters and this facility use data are estimated to have relatively high error levels compared to dedicated creel surveys. However, for the purposes of identifying general recreational use patterns it is suitable for the DLA.

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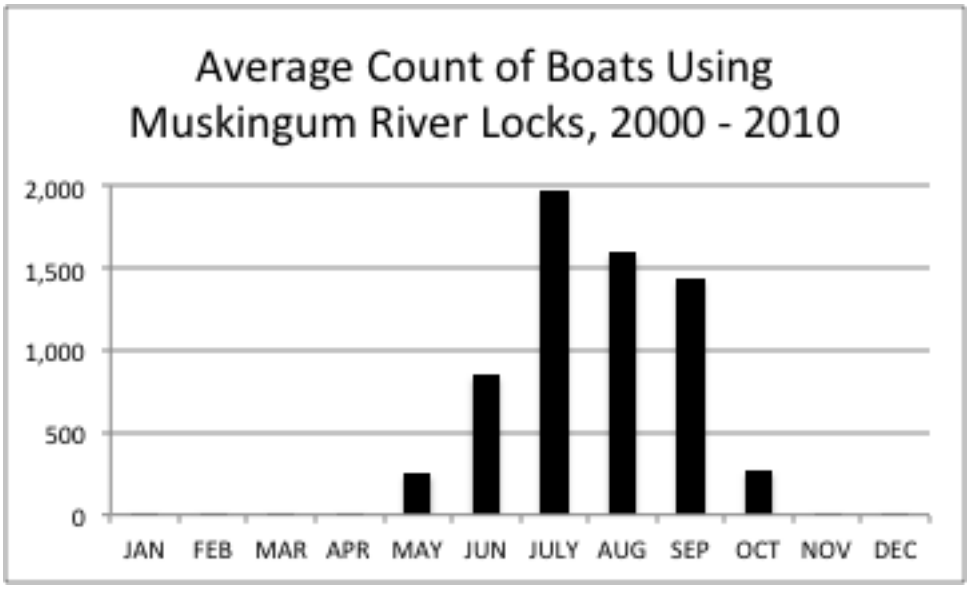

Figure E.1.6-2. Average Lock Usage on the Muskingum River (2000-2010) (Source: ODNR, 2011a.)

There are no horsepower restrictions on the Muskingum River. According to ODNR, fishing boats, houseboats, pontoon boats, canoes, kayaks, and rowboats are frequently used. The ODNR Division of Watercraft performs enforcement of boating laws and rules. The Muskingum River does not contain any whitewater sections, though rapids do exist at immediately downstream of several dams. At these dams, the lock is connected to a canal that extends past the rapids.

Under State of Ohio water quality regulations, the Muskingum River is designated a Primary Contact Recreation waterbody. This use designation assigns bacterial water quality criteria to the river. During the 2006 Biological and Water Quality Assessment, sampling found two of fifteen sites in non-attainment status. This indicates that bacterial levels were higher than the state standard for waters used for activities where humans come in direct contact with waters, such as swimming and wading. The two sites found to be in non-attainment were the McConnelsville boat ramp, which is near FFP's proposed Malta/McConnelsville Lock and Dam Project, and SR 339 in Beverly, OH, which is near FFP's proposed Beverly Lock and Dam Project.

E.1.6.1.2 Recreational Fishing Opportunities

Fishing represents an important outdoor recreation activity on the Muskingum River and is closely related to boating. According to the ODNR use data recreational fishing from shore at the ten Muskingum River locks and dams are highest from May through October (Figure E.1.6-3).

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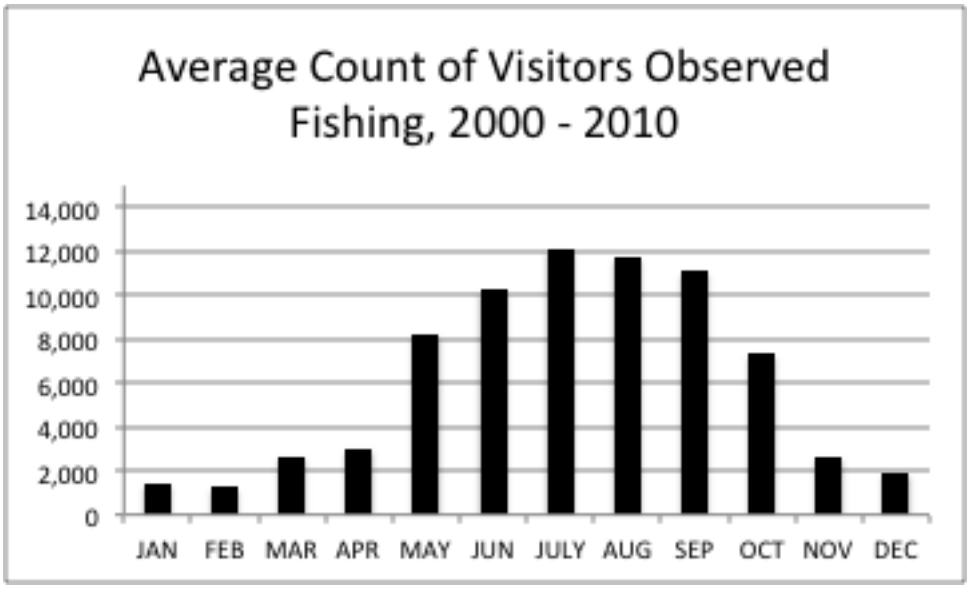

Figure E.1.6-3. Average Number of Shore at the Muskingum River Locks and Dams (Source: ODNR, 2011)

The ODNR provides a fishing forecast containing general ratings (i.e., excellent, good, fair, and poor) for the Licking River and ten pools on the Muskingum River (see Appendix 5K-1). The following species are reported in the fishing forecast:

- Bluegill
- Largemouth bass
- Spotted bass
- Crappie
- Channel catfish
- Flathead catfish
- White bass
- Sauger
- Saugeye
- Walleye
- Hybrid striped bass

The Muskingum River is particularly noted for its population of flathead catfish. These fish are common throughout the river and may be up to 30 pounds. The spillways below the ten dams are typically the best locations to catch flathead catfish. Fishing from shore and from boats are both common on the Muskingum River. Fishing is permitted from shore at the lock sites, however the public is prohibited from fishing from the lock walls.

Seven fish species, including channel and flathead catfish, while bass, saugeye, white bass, carp, and freshwater drum are under a fish consumption advisory due to PCB and mercury pollution on the Muskingum River. These advisories are intended to warn recreational fishermen that fish should be consumed at low rates due to pollutants that have accumulated in fish tissue.

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E.1.6.1.3 Land-Based Recreational Opportunities

There are significant land based recreational opportunities in the Muskingum River watershed. The ODNR Division of Real Estate and Land Management geographic database lists 17 outdoor recreational properties within a ten-mile buffer zone around the Muskingum River in the Project areas (Table E.1.6-1). In addition, there are several parks and wildlife reserves owned and managed by entities other than ODNR (Table E.1.6-2).

Recreational Area	Outdoor Recreation Opportunities[1]
Blue Rock State Park	Camping, boating on Culter Lake, fishing, hiking, swimming, hunting
Boord State Nature Preserve	Hiking
Burr Oak State Park	Lodge, cottages, camping, boating, fishing, swimming, hiking, hunting,
Dillon State Park	Cottages, camping, boating, swimming, fishing, hiking, disk golf, archery, hunting
Dillon State Wildlife Area	Hunting, fishing, hiking, boating, bird watching
Gifford State Forest	Hiking, horseback riding, camping, all purpose vehicle use
Meiners Wildlife Area	Hunting
Monroe Basin Wildlife Area	Hunting, fishing
Muskingum River Parkway State Park	Camping, boating, fishing, includes Ellis Lock and Dam and Luke Chute Lock and Dam
Ohio River Lock & Dam 18 Wildlife Area	Fishing
Powelson Wildlife Area	Hunting, fishing
Simco Wetlands Wildlife Area	Wildlife observation
Tri-valley Wildlife Area	Hunting
Wolf Creek Wildlife Area	Hunting, fishing
Woodbury Wildlife Area	Hunting, fishing, wildlife viewing

[1]Recreational opportunities listed here are listed by ODNR as potential activities for the property, other activities may occur.

Table E.1.6-1. State Owned Recreation Areas Within 10 miles of Muskingum River Projects (Source: ODNR, 2010)

Resource Name	Location	Managed By	Primary Outdoor Recreation Opportunities
Buckeye Trail	1,444 mile trail throughout Ohio	Buckeye Trail Association	Hiking
J. Frank Demster Memorial Park	Malta	City of Malta	Picnics, boat launch and docks on Muskingum River
ReCreation Land	Muskingum / Morgan counties	AEP	Camping, fishing, hiking, hunting, horseback riding
The Wilds	Guernsey County	The Wilds, a non-profit	Hiking, mountain biking, wildlife observation
Boughton Wildlife and Education Area	Washington County	Boughton Foundation, a non-profit	Hiking, wildlife observation, disk golf

Table E.1.6-2. Additional Recreational Opportunities in Area of Muskingum River Projects (Source: ODNR, 2010)

A large amount of recreational activity takes place on private land. According to the U.S. Fish and Wildlife Service's (USFWS) survey of nationwide hunting, fishing, and wildlife viewing activity, approximately 57 percent of hunters used privately owned land exclusively.

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Parking, restrooms, picnic areas, and open space are commonly found at each of the Muskingum River Hydroelectric Projects sites. These sites are used for recreational activities both on their own, such as viewing the river or picnicking, and in support of boating and fishing. According to ODNR use data, monthly use of the land-based recreational facilities is highest from May through September, based on picnic facility use as an indicator of land-based recreational usage. (Figure E.1.6-4).

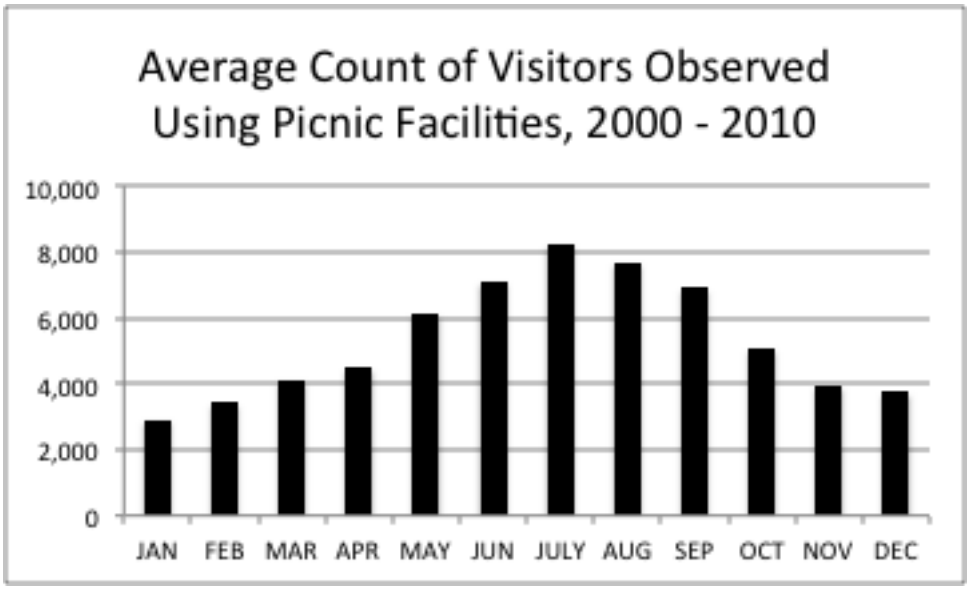

Figure E.1.6-4. Average Count of Visitors Observed Using Picnic Facilities by Month (Source: ODNR, 2011a)

E.1.6.2 Project Resources

All of the dams at which FFP's Projects are proposed include an operable lock. The passage through each dam is facilitated with hand-operated locks staffed by an ODNR lock technician. Recreational boating facilities exist at each of the proposed project dams. Restrooms, parking, docks, boat ramps, and carry-in accesses are found at several of the dams.

A Recreation Resources Management Plan (RRMP) has been developed to address Projects effects on existing recreational access in the Project Areas both during construction and long term. Additional discussion of this survey is presented in Section E.2.6, and the survey report (FFP, 2012c) is provided in Appendix C-8.

E.1.6.2.1 Zanesville L&D Water Power Project

Recreational boating at the Zanesville L&D is supported by several facilities. Boaters may enter the canal on the river left (east) side of the river, passing under the historic Y Bridge, and proceed down the approximately 0.75 mile long canal to the tandem lock for passage to the downstream portion of the river. The relatively long canal allows for boaters to avoid the shallow rapids at the confluence of the Muskingum and Licking Rivers. The Zanesville L&D includes docking facilities, parking, and drinking water (ODNR, 2006). Docks are found immediately

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upstream of the lock. According to ODNR facility use data, the Zanesville L&D averaged 705 boats locking through per year from 2000 through 2003 (ODNR, 2011a).

The Zanesville L&D features a popular multi-use path along the former towpath between the river and canal. In the direct vicinity of the proposed Zanesville L&D Water Power Project the multi-use path is unpaved and features open park space (Photo E.1.6-1). According to ODNR facility use data, the Zanesville L&D area averaged 15,312 visitors observed using picnic facilities per year from 2000 through 2003.

Across the river from the proposed Zanesville L&D Water Power Project lies the Putnam Landing recreational area. This park includes docking facilities, parking, restrooms, picnic areas, and carry-in boat access. Recreational fishing from shore occurs in the canal and in the river throughout publicly accessible areas at the Zanesville L&D and the Putnam Landing recreation area. According to ODNR facility use data, the Zanesville L&D area averaged 13,621 visitors observed fishing per year from 2000 to 2003.

Photo E.1.6-1. Multi-Use Path and Open Park Space Near Proposed Zanesville Project (Source: FFP)

E.1.6.2.2 Philo Lock & Dam Water Power Project

The Philo locks are located river right (west side). Associated boating facilities such as docks or put-in access are not located at this site (ODNR, 2006). The ODNR park facility located at the locks features parking and picnic tables, with views of the river and historic lockmaster house. According to ODNR facility use data, the Philo L&D averaged 1,866 boats locking through per year from 2000 through 2003 (ODNR, 2011a). A yearly average of 3,747 people were estimated as using picnic facilities and 6,708 people were estimated fishing at the facility.

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The proposed Philo L&D Water Power Project will be located river left (east side), the current site of an approximately 1.2 acre park. This park is located on land owned by American Electric Power (AEP). This park includes a parking area and is used for picnics, and shore fishing.

E.1.6.2.3 Rokeby Lock & Dam Water Power Project

The Rokeby locks are located river left (east side). Associated boating facilities at the site include dockage, carry-in access, parking, restrooms, picnic tables, and primitive camping for through-boaters (ODNR, 2006). The ODNR park at the lock features views of the river and a historic lockmaster house. According to ODNR facility use data, the Rokeby L&D averaged 1,648 boats locking through per year from 2000 through 2003 (ODNR, 2011a). A yearly average of 6,821 people were estimated as using picnic facilities and 3,382 people were estimated fishing at the facility.

The proposed Rokeby L&D Water Power Project will be located river right (west side). This land is undeveloped woodland owned by the ODNR and private entities. During FFP site reconnaissance, shore fishing was observed at the dam's west embankment and in the shoreline section downstream of the dam. However access to the shoreline is not maintained.

E.1.6.2.4 Malta/McConnelsville Lock & Dam Water Power Project

The upstream entrance to the canal leading to the McConnelsville locks is located river left (east side). Associated boating facilities at the site include dockage, carry-in access, parking, restrooms, picnic tables, and primitive camping for through-boaters (ODNR, 2006). The canal is separated from the river by a public park. According to ODNR facility use data, the McConnelsville L&D averaged 1,991 boats locking through per year from 2000 through 2003 (ODNR, 2011a). A yearly average of 20,401 people were estimated as using picnic facilities and 18,044 people were estimated fishing at the facility. The proposed Malta/McConnelsville L&D Water Power Project will be located river right (west side). The land adjacent to the proposed Project land is undeveloped shoreline.

E.1.6.2.5 Beverly Lock & Dam Water Power Project

The upstream entrance to the canal leading to the Beverly locks is located river left (east side). Associated boating facilities at the site include dockage, carry-in access, parking, restrooms, picnic tables, and primitive camping for through-boaters (ODNR, 2006). The canal is separated from the river by a wooded island. According to ODNR facility use data, the Beverly L&D averaged 603 boats locking through per year from 2000 through 2003 (ODNR, 2011a). A yearly average of 12,530 people were estimated as using picnic facilities and 6,302 people were estimated fishing at the facility. The proposed Beverly L&D Water Power Project will be located river right (west side). The land adjacent to the proposed Project land is undeveloped shoreline owned by private entities.

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E.1.6.2.6 Lowell Lock & Dam Water Power Project

The upstream entrance to the canal leading to the Lowell locks is located river left (east side). Associated boating facilities at the site include dockage, carry-in access, parking, and primitive camping for through-boaters (ODNR, 2006). The canal is separated from the river by a private land which features residential and agricultural usage. According to ODNR facility use data, the Lowell L&D averaged 892 boats locking through per year from 2000 through 2003 (ODNR, 2011a). A yearly average of 7,344 people were estimated as using picnic facilities and 7,343 people were estimated fishing at the facility. The proposed Lowell L&D Water Power Project will be located river left (east side). The land adjacent to the proposed Project land is residential development, agricultural field, and shoreline. Residents currently use the shoreline for recreational activities such as swimming and fishing.

E.1.6.2.7 Devola Lock & Dam Water Power Project (P-13405)

The Devola locks are located river left (east side). Associated boating facilities at the site include carry-in access, parking, restrooms, and primitive camping for through-boaters (ODNR, 2006). According to ODNR facility use data, the Rokeby L&D averaged 1,266 boats locking through per year from 2000 through 2003 (ODNR, 2011a). A yearly average of 12,431 people were estimated as using picnic facilities and 15,991 people were estimated fishing at the facility. The proposed Devola L&D Water Power Project will be located river right (west side). This land is undeveloped shoreline owned by the ODNR and private entities.

E.1.6.3 Recreational Usage and Trends

In 2008 ODNR updated the Ohio's Statewide Comprehensive Outdoor Recreation Plan (SCORP) (ODNR, 2008). This report subdivided the state into five regions, with FFP's proposed Project Areas included within the southeast region. Outdoor recreational lands represent a relatively large portion of Ohio's total recreational lands. Two counties rank in the top five for outdoor recreational acreage (Table E.1.6-3).

County	Outdoor recreation Acres	State ranking of counties	Percent total acres for outdoor recreation	State ranking of counties	Outdoor recreation acres per 1,000 residents	State ranking of counties
Morgan	37,253	55th	2.7%	7th	2,514	2nd
Muskingum	54,229	4th	3.9%	3rd	630	15th
Washington	42,082	5th	3.0%	6th	680	13th

Table E.1.6-3. Outdoor Recreation Acreage in the Counties Containing Muskingum River Projects

(Source: Ohio SCORP, 2008)

In support of Ohio SCORP (2008), a recreational trends study that used focus groups, web based surveys, an advisory group, and a mail survey was performed to produce information on the status of outdoor recreation and stakeholder needs. The study investigated the types of activities

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that were gaining popularity, barriers to recreation, planning issues, and funding. The study was divided among five regions in Ohio, the Project area falls within the southeast region.
According to Ohio SCORP (2008), participation the following activities appears to be increasing: mountain biking, kayaking, ATV use, horseback riding, geo-catching, recreational vehicle camping, hunting from boats, fishing, skateboarding, rock climbing, and bird watching. Swimming in lakes, hunting in general, and tent camping appear to be decreasing.

Barriers to recreation in southeastern Ohio include a shortage of flat land suitable for athletic fields. Ohio SCORP (2008) found that facilities such as ball fields tend to be overcrowded. In addition, a lack of information about recreational opportunities and limited transportation to facilities was seen as a barrier to public outdoor recreation participation. Obstacles that recreation provides face are primarily related to lack of adequate funding.

Southeast Ohio stakeholders identified increased funding as the most pressing need for outdoor recreation providers. Acquisition of lands for hunting, open space preservation, watershed protection, and trail connections also received high priority ranking. The need for high quality, informative website to convey outdoor recreation information was also mentioned. Planning issues for outdoor recreation in southeast Ohio include a need for new amenities, land acquisition, and planning for corridors and resource connectivity.

Outdoor recreation providers recognize the need for more ATV areas in southeast Ohio. However, there is also a high priority on passive forms of recreation and concern for those seeking quiet areas to walk, bird watch, and bike.

Another comprehensive source of information on outdoor recreational activity in Ohio is USFWS's survey of hunting, fishing, and wildlife viewing activity. Every five years, USFWS conducts the survey of outdoor recreationalists nationwide. The survey includes information on recreational activity on both public and private land. Specifically, it includes information on the number of fishing, hunting, and wildlife viewing trips in each state. It also includes detailed state-level expenditure profiles for recreationalists in all three categories. Since USFWS does not geographically specify the data at a level more detailed than state totals, FFP consulted the document as an overview of activities but was not able to derive specific figures for recreational use on the Muskingum River itself.

The Muskingum County Comprehensive Plan addresses several aspects of outdoor recreation. The Comprehensive Plan states the following recreational goals for Muskingum County: (1) Increase the amount and diversity of parks and open space; (2) Provide dedicated source of funding for acquisition and maintenance of parks and green space; and (3) Create local, regional, and statewide partnerships to further recreation in the county.

Washington County has a similar Comprehensive Plan and addresses recreation under Community Resources. It identifies the following strategies for furthering recreational opportunities: (1) Develop bike/recreation along the Ohio, Muskingum, and Little Muskingum Rivers; (2) Promote recreational activities such as kayaking, canoeing, and camping activities on the Little Muskingum River; (3) Encourage recreational activities that tie into the lock system on the Muskingum River; (4) Plan for increased utilization of the rivers as a public recreation

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resources; (5) Promote Recreation and Parks plan in Marietta Township. A comprehensive plan for Morgan County is being prepared; but does not exist at this time.

E.1.7 Cultural Resources

E.1.7.1 Regional Archaeological and Historic Resources

E.1.7.1.1 Archeological

Paleo-Indian Period

The Paleo-Indian period spanned from 12,000 BP -9,600 BP, and is recognized as the earliest recorded occupations of the region (Mannik & Smith Group Inc (M&SG), 2012). The earliest Paleo-Indian inhabitants of North America were the Clovis culture (ca. 11,500 B.P. to 10,000 B.P., and numerous Clovis sites have been identified in Ohio and other eastern states (Ohio Historical Society [OHS] 2009).

Paleo-Indians were nomadic groups that moved throughout the region foraging on the diverse resources available in the various ecosystems of the un-glaciated plateau region that encompasses present day Ohio (M&SG 2012). It is believed that Paleo-Indian bands moved within a defined geographic range concurrent with the migratory cycles of large herd animals (Gramly 1988; Stothers 1996; Stothers and Abel 1991, M&SG, 2012). As the Paleo-Indian Period progressed, the tribes are believed to have adapted to rely more on the game species available in a smaller geographic area (M&SG, 2012). In the late Paleo-Indian period the Plano culture replaced the Clovis culture throughout North America. Plano tribes were also foragers and game hunters (M&SG, 2012).

Archaeological records of early Paleo Indian sites include characteristic fluted and unfluted lanceolate spear points. These points were made from a variety of materials, evidence of the tribes' mobility. Later Paleo-Indian spear points were made from local materials, which indicates a less mobile culture (Irwin and Wormington 1970; Kelly and Todd 1988; M&SG, 2012).

The Archaic Period

The Archaic Period spanned from 9600 B.P. to 2500 B.P, and is subdivided into the Early Archaic, Middle Archaic, and Late Archaic Periods. The Archaic Period is characterized by a gradual shift from a highly mobile hunting and gathering subsistence strategy, toward a more sedentary foraging strategy. Trade and exchange between groups developed during the Archaic Period, as populations grew and competition for resources increased. Ceramics and tools developed during the Archaic Period. (M&SG, 2012)

While Early Archaic (10,000 – 8000 B.P.) populations in Ohio continued to hunt large game, the period is also identified by an increase in use of local resources and foods, including smaller game, fish and nuts (Munson 1988; Neusius 1986; OHS 2009). This trend towards a more sedentary subsistence strategy is accompanied by an evolution of the types of tools used. Early

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Archaic artifacts are diverse in style and function, and include spear points as well as gravers, scrapers, and notched knives (M&SG, 2012). Archeologists believe that there was in an influx of populations to Ohio from the south during the Early Archaic period, evidenced by an increased use of non local materials to make various tools and points (Stothers 1996; Stothers et al. 2001).
Middle Archaic Period (8000 – 5000 B.P.) sites are not common in the Ohio region, but artifacts from limited sites from this time period indicate a move towards a reliance on seasonally available resources such as grains, nuts, fish, and small game that could be found in the local riverine and lacustrine areas (M&SG, 2012). Tools changed during this time and are typified by an increase in ground and polished stone tools, grooved axes, celts, adzes, and mortars and pestles (M&SG, 2012). Barbed harpoon tips, awls, and fishhooks made from bone have also been found (Ellis et al. 1990; Stothers et al. 2001).

Numerous Late Archaic Period (5000 – 2500 B.P.) sites have been identified in the region. As populations increased during this Period, settlement patterns, subsistence activities, mortuary rituals and trade systems advanced Individual settlements were larger and more permanent in nature while seasonal living and gathering patterns evolved. Band groups came together during the warmer seasons to capitalize on spawning fish runs, and for trade. In the colder seasons groups dispersed to the interior forested uplands where nuts and deer were available through the winter (M&SG, 2012).

Two cultures are generally recognized to have inhabited the Midwest during the Late Archaic Period: the Glacial Kame culture and the Red Ocher culture. Named for their unique burial practices, the Glacial Kame culture occupied northwestern Ohio, parts of neighboring states, and southern Ontario, while the Red Ocher culture occupied western Ohio and parts of Indiana, Illinois, Michigan, Minnesota, Wisconsin and Ontario (OHS 2009).

The Woodland Period (2500 – 1000 B.P)

The Woodland Period is also commonly divided into Early, Middle, and Late sub-Periods. This Period saw an expansion of trade and exchange patterns, the development of ceramics, and a continuation of the trend towards more sedentary and organized settlements. The development of ceramics is believed to have occurred simultaneous with numerous cultural changes, including an increasing dependence on agriculture, and changes in food storage and preparation practices. While the development of ceramics was long considered to have begun in the Woodland Period, the more current belief is that they began to develop in the late Archaic Period, and are associated with the transition between these periods (M&SG, 2012).

The Early Woodland Period (2500 – 2000 B.P.) is associated with the Adena culture in southern Ohio. The Adena culture, similar to the later Hopewell culture, is not a discrete group of people, but rather a culture with distinct burial and trade practices, (Fagan, 1992). The Adena were more sedentary than the Late Archaic people. Artifacts commonly associated with the Adena are stemmed projectile points with weak shoulders, ceramic vessels with flat bottoms and lug handles, drills, scrapers, and a variety of ornamental and ceremonial materials (Tuck, 1978). The Adena are believed to be responsible for the earliest earthworks and burial mounds in southern Ohio, which often contain cut mica, copper, beads, gorgets, and shells (M&SG, 2012).

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The Hopewell culture is commonly associated with the Middle Archaic Period (2000-1500 B.P) in Ohio. The Hopewell had an increased reliance on agriculture, and artifacts from this period indicate a subsistence strategy linked to the seasonally available resource The Hopewell are also associated with numerous complex earthworks found in Ohio. Artifact evidence from this period suggests the population was increasing and developing greater social organization (Pacheco 1996). The trade of more exotic materials also increased during the Middle Woodland Period. Artifacts made form materials from the Upper Peninsula of Michigan (copper), the Gulf Coast (shell and shark teeth), and the Carolinas n=(mica) are found in Middle Archaic Period sites (M&SG, 2012).

The Hopewell culture declined in the Late Woodland period (1500-1000 B.P.), while larger villages developed supported by a growing reliance on agriculture, notably corn. Resource diversity increased during this period, although use of aquatic resources was less prevalent in southern Ohio than in other areas of the Midwest. Palisades or ditches were sometimes constructed around these villages. Construction of large ceremonial earthworks declined in the Late Woodland, with burials more commonly occurring in existing, older mounds or small stone mounds (M&SG, 2012).

Artifacts of this period include small triangular points, scrapers, mortars and pestles, celts, and hoes. The use of earthen ovens for steaming or baking food first occurred in this period, and the bow and arrow emerged (Seeman and Dancey 2000).

After 500 A.D, the beginning of the Late Woodland Period, northerly regions of Ohio that drain into the St. Lawrence system and the Atlantic Ocean followed a Great Lakes cultural tradition. The southern regions of Ohio (draining into the Ohio-Mississippi-Gulf Coast system) more closely resembled the Mississipian, or Fort Ancient, traditions of West Virginia, Kentucky and southern Indiana (Prufer and Spurlock 2006). Continued population growth, large villages, and subsurface storage pits are common from the Mississippian period in southern Ohio (M&SG, 2012).

Fort Ancient (1000 B.P. – contact)

The Fort Ancient Mississippian cultural group inhabited southeastern Indiana, northern Kentucky, southern Ohio, and eastern West Virginia. Five geographically-oriented groups are recognized in the Fort Ancient culture based on the materials and lithic tool type they used: the Baum Focus (in south-central Ohio), the Feurt Focus (in south-central Ohio and northern Kentucky), the West Virginia Focus, the Madisonville Focus (in southeastern Indiana, southwestern Ohio, and northern Kentucky), and the Anderson Focus (in southwestern Ohio, concentrated in the Little Miami River drainage) (Griffin 1943).

Fort Ancient villages were primarily located along the Ohio River and its major Tributaries, and often were organized around a central plaza and surrounded by palisades. Semi-subterranean pit houses that provided cooler temperatures in the summer and warmer temperatures in the winter were also common. The Fort Ancient people did not use burial mounds after approximately 700 B.P, but rather and began burying their deceased in the villages (M&SG, 2012).

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E.1.7.1.2 Historic

Early European Presence in the Ohio Territory

The first European influence in the Ohio Territory was the migration west of the Iroquois, armed by Dutch and English traders, who drove native Ohio tribes such as the Erie, Miami (in western Ohio), and Shawnee (in southern Ohio) out of the state. After 1765 the Ohio Territory was sparsely inhabited, until Detroit became a major center for the fur trade and the seat of European political and military power in the region circa 1700. The Iroquois retreated back east during this period, and the Ohio territory once again had a substantial Native American population. (Wheeler-Voegelin 1974; Pratt 1977; Edmunds 2005, M&SG, 2012)

Throughout most of the 1700s the Native Americans of the Ohio Territory aligned with either the British or the French, depending on which side posed more of a threat to the tribes. Early on, the Delaware were allies with the French, trading furs for cookware and guns. The English and the French were competing for control of North America during the 1740s and through the French and Indian War (1754-1763). The Delaware aligned with the English during this time, and throughout the Revolutionary War. The 1763 Treaty of Paris ended the French and Indian War (M&SG, 2012).

After the Revolutionary War, Euro-American settlements increased in the Ohio Region, and often were in conflict with the Delaware. In 1791 “the Big Bottom Massacre” occurred along the Muskingum River in Morgan County, upstream of the Luke Chute Lock and Dam. In this attack the Delaware killed 14 settlers. This and other conflicts precipitated the Battle of Fallen Timbers in 1794, in which US troops defeated the Delaware and other Ohio tribes. Subsequently, the Delaware surrendered most of their Ohio lands in accordance with the Treaty of Greeneville in 1795. The Greenville Treaty Line, which is now the Ohio and Indiana border, became the border between U.S. and Native American territory The Delaware were forced by the American government to relinquish their remaining lands in Ohio and move west of the Mississippi River in 1829 (M&SG, 2012).

Muskingum River Valley Region

There was little, if any Euro-American settlement of the Muskingum River Valley Region until after the Revolutionary War. The settlement of the Muskingum River region began with the construction of Fort Harmar in 1785 at the juncture of the Ohio and Muskingum Rivers. Settlers arrived in 1788 as part of the Ohio Company of Associates, and built two additional forts across the Muskingum River from Fort Harmar (M&SG, 2012).

Following the Treat of Greenville in 1795 several settlements were created in the valley region, beginning with Zanesville (1797) and Coshocton (1799). Other towns developed over the following 25 years, including Beverly and McConnelsville. This growth required improved water transportation in the valley for trade (M&SG, 2012).

The history of this region is very much linked to its development as a navigational waterway, and its strategic location as a link between the Ohio and Erie Canal and the Ohio River. In 1827

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the Ohio General Assembly commissioned a study to improve navigation on the Muskingum River from the Ohio and Erie Canal to Marietta. In 1829, a three mile canal in Dresden was build, connecting the Ohio and Erie Canal and the Muskingum River. This was the beginning of what would be known as "The Muskingum Improvement" (M&SG, 2012).

The Muskingum Improvement was officially approved in 1836 as a working branch of the Ohio canal system. Construction took place from 1837 and, 1841, during which 11 dams, 5 bypass canals and 12 locks were constructed between Symmes Creek and Marietta. This slackwater navigation system is known as the oldest system of its kind in the United States (M&SG, 2012).

The Muskingum Improvement was expected to increase economic growth in the Muskingum River Valley Region and create new cities and bring workers to the area. This growth did not occur but the navigation system did prove to be a reliable transportation route from 1842 to 1853, until the railroads increased their presence in the region, thereby reducing the movement of goods via the river. The floods of 1913 severely damaged most of Ohio's canal system, and repairs were not completed until 1918. By this time, railroads and trucks were being used extensively, and there was no need for commercial navigation on the river (M&SG, 2012).

E.1.7.2 Project Historic and Archaeological Resources

E.1.7.2.1 Archeological

Previously the OHPO online resource mapping system [OHPO, 2010a] identified only one known archeological site in proximity to the seven Muskingum River Projects. However, a cultural resources study was conducted by qualified archeologists for FFP in support of the FERC licensing of its Muskingum River Projects. This study identified additional resources near some of the Project sites, as discussed in Section E.2.7 of this Application.

E.1.7.2.2 Historic

<u>Muskingum River Navigation Historic District</u>

The Muskingum River locks and dams at which FFP proposes to locate its Projects are all included within a single site that was listed in the United States Park Service's National Register of Historic Places (National Register) in 2006. The National Register designated the entire length of the Muskingum River as one inclusive site of historical significance, known as the Muskingum River Navigation Historic District (Historic District or District). The Nomination Form (OHPO, 2010b) defines the Historic District as "the low water mark that lies wholly within the banks of the Muskingum River." Located within the Historic District are 62 permanent structures, including locks, dams, by-pass canals, bridges, four islands that the by-pass canals created, one islet, two river boats, and seven buildings. The Muskingum lock and dam system was built throughout the first half of the 19th century to create navigable pools for boat travel (OHPO, 2010b). The primary features of the District, the lock chambers, were constructed between 1837 and 1841 out of ashlar sandstone. Although these chamber walls have been partly reconstructed over the years, they were rebuilt using the original materials, which had been salvaged.

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In addition to the locks, the District also features the nation's largest collection of intact operable wooden gates. These gates are also notable for being among the widest miter gates ever built in the United States. When repairs were needed, they were made in a manner that maintained the characteristics of the original gates. Late twentieth century repairs involving the replacement of old, leaking gates have occurred at Malta/McConnelsville, and at Devola; these gates were rebuilt using Douglas fir lumber with the same joinery and hardware as those built in the 1880s. These replicas preserve the main design that distinguished these smaller scale towpath canal lock gates from the steel gates that became prevalent around 1900.

Another notable feature of the District is the diversity of valve technology used. Valves provide the means with which the lock can be filled and emptied. The originally installed balance-valves, were replaced by the USACE with, side valves and later cylinder valves. The cylinder valves used at the Muskingum River's locks were the first installed in any American locks.

The District was owned by the State of Ohio until 1861, when Ohio leased all of its canals, including the Improvement, to private contractors. In 1877 control of the Improvement reverted back to the State, until 1885, when the Ohio Assembly voted to cede it to the federal government. While under USACE control, the Improvement underwent numerous repairs. Among them, a new dam was completed at Marietta in 1895, and in 1896, a replacement lock was completed at Philo. In 1910, the Symmes Creek Lock and Dam was replaced by the Ellis Lock and Dam In 1958, the USACE transferred the system back to the State of Ohio, in whose hands it remains today.

The locks and dams suffered significant damage due to flooding in the spring of 1913 and the system was not fully repaired until 1918. By then rail and truck transportation were the preferred method for shipping and use of the Muskingum for routine commercial navigation ceased. The area once known as the Improvement is now most commonly referred to by its current names, the Muskingum River Parkway State Park, or the Muskingum Navigation Historic District. The District's locks and dams remain functional, for recreational watercraft

Dams

Below is a description of each dam's history, as presented in the National Register Nomination (OHPC, 2010b):

- *Zanesville Dam:* This dam is located 10 miles south of the Ellis Lock and Dam and is 498 feet in length, fourteen feet shorter than its original width. In 1950, the USACE removed the original timber crib dam and replaced it with a sheetpile cellular dam with concrete fill.

- *Philo Dam:* This dam is located 10 miles below Zanesville and is 730 feet long. It is located in an isolated area of the valley, across from the community of Duncan Falls; it was built on the location of the former Taylorsville lock, dam and canal, which had been built in 1828. The Philo Dam was one of four dams repaired between 1902 and 1922 with new or patched concrete caps and foundations to ensure that the river pool levels would remain constant for navigational purposes.

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- *Rokeby Dam:* This dam is located in a rural area of Morgan County. The Rokeby Dam was constructed between 1837 and 1841 during original Improvement construction period. Originally a slope dam, it was converted to a step dam following an 1847 flood, but was reconstructed as a slope dam when the Improvement was transferred to the USACE in 1887. Between 1902 and 1922, a concrete cap was added.

- *Malta/McConnelsville Dam:* Work on this dam was begun in 1830 by Robert McConnel and was completed two years later. The original dam (of the slope type) consisted of brush and rubble stone, and was improved upon during the 1837-1841 construction period. After the 1847 flood, this dam was converted to a step dam. However, between 1887-1891, the USACE rebuilt it again as a slope dam. The foot of the dam is uneven because of electric plant foundations on the west side of the river. Sheetpile was added to the base of the dam on the east side, and a partial concrete cap was added by the USACE. The McConnelsville Dam is 472 feet long, leaving it 4 feet shorter than its original width.

- *Beverly Dam:* This dam was built between 1837 and 1841 and was improved by the USACE between 1887 and 1891. It was originally 459 feet long, and has since been lengthened to 535 feet. It is located 9.5 miles downstream from Luke Chute.

- *Lowell Dam:* This dam was constructed between 1837 and 1841 and improved between 1887 and 1891. It is currently 840 feet in length, making it only two feet longer than the original dam. It is located 11 miles below Beverly.

- *Devola Dam:* This dam was named for the Devol family, one of the first families to settle in the area. Located 7 miles below Lowell, this dam was constructed between 1837 and 1841, and was originally 433 feet long. Between 1887 and 1891 the USACE increased the structure's length to its present 587 feet. In 1987 it was again repaired, this time by installing a line of sheet piling along the downstream toe of the dam to prevent undermining of the original wood cribbing.

Locks

With the exception of the double locks at Zanesville, all other locks are single chamber locks that measure 175 feet long by 36 feet wide with an overall length of 184 feet. The interior lock walls are constructed of ashlar sandstone, and are backed by rubble stone work. At each end of the chambers are two hand-operated wooden miter gates, all 21.5 feet wide. They are among the widest wood miter gates ever constructed in the United States, and remain today as rare specimens of gates of this type. They have been continuously maintained using 19th century joinery introduced in the 1880s by the USACE, and, according to the Nomination Form, the joinery is the most visible character-defining element of the locks. The locks are especially valuable in that they have been preserved in such a way that their main features distinguish them as smaller, tow-path canal lock gates from the steel gates which became prevalent in the early 1900s.

Over the years, there has been moderate loss of construction detail in the locks as some of the original locks' wooden joinery and vertical heel and toe posts no longer remain. In some cases,

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vertical let-in iron straps and wooden spacers replaced their original mortise-and-tenon framing. In addition, adjustable iron braces, front and back, terminating at the upper hinge in the turnbuckles, were added to help maintain in square and cantilever the gates. Although the upper and lower hinge designs technologically remained the same, cut sandstone hollow quoins that formed the water seal were replaced by an iron casting bolted into the masonry. Today, all Muskingum River locks operate as they did in 1891.

The unusual width of the miter gates posed engineering challenges, particularly in gate operation. Their initial operation, by use of geared drum winches and chains, eventually gave way primarily to rack and pinion devices, which consist of a long tooth rail attached to the lock gate and engaged in a circular horizontal gear.

At an unknown date, blue and white encaustic tile depth indicators were added to some of the abutments. They replaced narrow depth indicator strips, and, in addition to enhancing the locks aesthetically, they provide a more easily legible indicator of water depth. Other aesthetic changes that the locks have undergone include the addition of a skim coat of concrete, scored to look like the original sandstone, to the interior of some lock walls, and also the installation of black metal fences atop lock walls, which enable safer access for sightseeing

By-Pass Canals

At four dam sites, by-pass (sometimes called side-cut) canals were dug to avoid rapids or shallow waters in the river. The oldest of the four, which has undergone extensive renovations, was build at Zanesville. The other three sites containing by-pass canals are at McConnelsville, Beverly, and Lowell, built during the Improvement construction era of 1837-1841. At one point, a canal was built at Philo, but, due to its length, its upkeep required constant dredging; it was abandoned when a replacement lock was completed in 1896. Today, a portion of this disused canal remains visible from the bridge crossing at Philo.

Lock Chamber Valve Characteristics

A prevalent type of water valve used on medium and low head locks is known by three different names: the wicket, balanced, or butterfly valve. On the Muskingum, this type was gradually phased out in the late 1800s by the USACE in favor of a French designed cylinder, or drum, valve. The cylinder valves were able to more quickly fill and drain the locks than the wicket valves.

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E.1.8 Scenic and Aesthetic Resources

E.1.8.1 Zanesville Lock and Dam

Zanesville Dam is located in the City of Zanesville, adjacent to low and medium density development. It features a long and narrow island formed by the bypass canal and the Muskingum River. The towpath and historic locks are owned by the ODNR and used as a public park. Much of the island are open to the public, with a parking lot and a grassy area. Scenic opportunities include views from the Marietta Street Bridge and from the canal side from the rear of industrial properties in the 7th Street, 8th Street, and Marietta Street areas. Across the river from the proposed Zanesville Project (river right) lies Putnam Landing Park. This park is situated in a mostly industrial area, and has a tree-lined view of river just below the Marietta Street Bridge. The canal island offers a tree lined view across the river. The proposed Project powerhouse location is shown in Photo E.1.8-1.

Photo E.1.8-1. Zanesville Project Proposed Powerhouse Location (Source: FFP)

E.1.8.2 Philo Lock and Dam

The Philo Lock and Dam is surrounded by residential development. The Bridge Street Bridge, located next to the dam, allows for a full view of the lock and spillway. On the lock side there is a grassy area near the lock house, off County Route 6, though parking access is limited. The lock itself is located above the spillway it obscures the spillway. The property around the lock area is owned by American Electric Power (AEP) and has restricted accessibility. The proposed Project powerhouse location is shown in Photo E.1.8-2.

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Photo E.1.8-2. Philo Project Proposed Powerhouse Location (Source: FFP)

E.1.8.3 Rokeby Lock and Dam

Rokeby Dam is located in a rural area of Morgan County. There is low density residential development opposite the dam along State Route 60. The area adjacent to the powerhouse is undeveloped forest. The park on the lock side (river left) allows an unobstructed view of the proposed powerhouse location. Downstream, below the spillway, Ohio route 669 has significant clear line of sight to the spillway. Upstream, there are houses several hundred feet up the road, most of which are across the road from the river, again there are trees and distance obscuring their views of the spillway. The proposed Project powerhouse location is shown in Photo E 1.8-3.

Photo E.1.8-3. Rokeby Project Proposed Powerhouse Location (Source: FFP)

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E.1.8.4 Malta / McConnelsville Lock and Dam

The Malta/McConnelsville Project is located across the river from the McConnesville town center (river left). This side of the river includes an island formed by the canal leading to the locks. This island forms a park with a clear view of the opposite bank. The proposed powerhouse location is adjacent to residential and forested land. Upstream of the dam city streets are screened by trees. At the spillway there is limited traffic pulloff and a screen of trees between a train track and the river. Downstream, below the spillway, the road has significant clear line of sight to the dam. Upstream, in the Malta area, there are houses several hundred feet up the road, most of which are across the road from the river. The proposed Project powerhouse location is shown in Photo E 1.8-4.

Photo E.1.8-4. Malta/McConnelsville Project Proposed Powerhouse Location (Source: FFP)

E.1.8.5 Beverly Lock and Dam

The Beverly Project area is primarily agricultural land with low density residential development. The by-pass canal at this site is visible from State Route 60, north of the Village of Beverly. An island approximately ½ miles in length and 150 feet in width sits parallel to the canal. As recently as the 1970s, it contained several buildings, but all are now gone. The lock is visible from Beverly, Ohio, while the spillway is totally obscured by the island. Access to the island is available only from the lock, and it is limited to authorized individuals. Just above the island, there is limited visibility of the spillway from Ohio Route 60, and this visibility is available only if a driver pulls off on the berm and walks down past the trees, on private property. On the shore opposite the island the lock and dam are not visible without walking across private property, through a heavily wooded area, several hundred feet off County Road 102, with a farm field

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between the road and the trees. The proposed Project powerhouse location is shown in Photo E 1.8-5.

Photo E.1.8-5 Beverly Project Proposed Powerhouse Location
(Source: FFP)

E.1.8.6 Lowell Lock and Dam

The Lowell Project area is primarily agricultural land with low density residential development. The by-pass canal at Lowell runs parallel to State Route 60 before it connects to the lock. The canal leading to the locks creates Buell's Island, which is the largest of the Muskingum's islands. The proposed powerhouse location is on the island (river left) at the dam. The island contains low density residential development and agricultural fields. The shoreline opposite the proposed powerhouse site contains trees and is private property. The proposed Project powerhouse location is shown in Photo E 1.8-6.

Photo E.1.8-6. Lowell Project Proposed Powerhouse Location
(Source: FFP)

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E.1.8.7 Devola Lock and Dam

Located seven miles below Lowell, Ohio, the Devola Lock and dam are situated in a rural setting near roads and light residential development. Visual access from the lock side of the river is available only from a parking lot located next to the lock and from downstream along the river. Upstream, the shore is fenced. There is an open field adjacent to the dam, and there are no buildings with a view of the spillway. The lock itself is higher than the level of the spillway, and it limits the view of the spillway. Township Road 32 and a train track are located on the opposite shore. At the spillway itself, there is no traffic pulloff, and there is a screen of trees between the train track and the river. Downstream, below the spillway, where the road turns from its course heading towards the river to heading upstream along the river, there is a small service area that allows vehicles to stop and view the spillway. Upstream, there are houses several hundred feet up the road, most of which are across the road from the river. The proposed Project powerhouse location is shown in Photo E 1.8-7.

Photo E.1.8-7. Devola Project Proposed Powerhouse Location (Source: FFP)

E.1.9 Soils and Geology

E.1.9.1 Topography, Bedrock and Surficial Geology

The Muskingum River flows through the Allegheny Plateau physiographic region, with headwaters in the glaciated portion. The region is considered to be the foothills of the Appalachian Mountains. The Muskingum River Projects fall within the unglaciated region of the Allegheny Plateau, which is characterized by steep hillsides and valleys, which decrease in relief in the northwest direction. The area is drained by many small stream valleys and exhibits a dendritic drainage pattern. Most ridges have elevations between 800 and 1,000 feet above sea level. River valleys are typically ½ to 1½ miles wide (ILGARD, 2005).

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The geologic development of the region is dominated by the formation of the Appalachian Mountains, which are among the most ancient mountain ranges in the world, and the much more recent glaciation which occurred during the Late Pleistocene (650,000 years before present). The Appalachian Mountains were formed 480 million years before present but were repeatedly eroded and uplifted over time, the last of which occurred during the early to the middle Miocene (approximately 15 million years before present). During the Quarternary Period (1.6 million years to present time) much of Ohio experienced repeated periods of glaciation, however the area of the Muskingum River Projects remained unglaciated. The bedrock topography coincides with the present day land surface topography. The bedrock formations dip generally to the southeast about 20 to 40 feet per mile. Bedrock in the Project Area is from the Mississippian, Pennsylvanian, and Permian periods. More detailed stratigraphy reveals interbedded sandstones and shales with some coal and clay beds and occasional limestone formations. Deeper bedrock stratigraphy consists of Mississippian, Middle-Upper Devonia, and Lower Devonian formations (ILGARD, 2005).

The area in FFP's proposed Project region remained unglaciated during the last glacial age; however the headwaters of the Muskingum River extend into glaciated areas. The Illinoian glaciation did extend into the valleys of Muskingum County, resulting in valley scour and the deposition of glacial till in the northwest corner of the Project Area. River valleys in southeast Ohio carried glacial meltwater away from the ice front and toward the Ohio River during glacial retreat. Large amounts of glacial meltwater caused valleys to fill with unconsolidated outwash deposits. Valleys in southeastern Ohio frequently contain thick deposits of clay and silt that accumulated on the bottoms of lakes that formed during glacial retreat (Coogan, 1996).

Aquifers in the region can be divided into two categories: (1) surficial aquifers consisting of unconsolidated deposits, and (2) aquifers in consolidated rocks. Unconsolidated sand and gravel frequently found in river valleys represent the most productive aquifers in the region. They commonly range from 25 to 200 feet in thickness, but may exceed 300 feet thick. Aquifers in consolidated rocks store water primarily in interconnected fractures. Impermeable layers can lead to perched water tables and groundwater discharge to springs (USGS 1995).

E.1.9.2 Soils

Soils in the Muskingum River Projects area fall within two soil regions: (1) the Gilpin-Upshur-Lowell-Guernsey region, which is found in Muskingum and northern Morgan counties, and (2) the Coshocton-Westmoreland-Berks region, which is found in Morgan and Washington counties. Soil region names are determined by the most common soil series in that area (ILGARD, 2005). The ten most common soil associations in the Lower Muskingum watershed are described in the following Table E.1.9-1.

Soils in the Project region were slowly formed directly from bedrock, mainly from sandstone and shale, with limited sections forming from limestone or limy shale. The soils are acidic, often are low in organic matter, and low in natural fertility. This makes much of the land in the Project region unsuitable for farming, leading to a land cover dominated by deciduous forest. The land usually is in either pasture or forest (ILGARD, 2005).

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Soil Association	Physical Characteristics				Use	Major Management Concerns
	Slope	Drainage	Parent Material	Depth		
Westmoreland-Berks-Guernsey	Strongly sloping to very steep	Well and moderately well drained	Colluvium/ residuum from Siltstone and clay shale	Deep and moderately deep	Woodland, pasture	Erosion, slippage, and drainage
Lowell-Gilpin-Guernsey	Moderate to very steep	Well to moderately well drained	Residuum/ colluviums from limestone, siltstone, etc.	Moderate to very deep	Woodland, pasture, cropland	Erosion, drainage, slippage, slope
Giplin-Upshur	Moderate to very steep	Well drained	Residuum from sandstone, siltstone, shale	Moderate to very deep	Pasture, woodland, cropland	Slope, droughtiness, depth, slippage, erosion
Lowell-Giplin	Strongly sloping to steep	Well drained	Colluviums and residuum from limestone, siltstone, etc.	Deep and moderately deep	Woodland, pasture, cropland	Slope, erosion, droughtiness, high shrink/swell potential, slippage, depth
Upshur-Vandalia	Steep to very steep	Well drained	Residuum and colluviums from shale		Pasture, cropland, woodland	Slope, slippage, very slow or slow permeability, erosion
Morristown-Lowell-Gilpin	Nearly level to very steep	Well drained / moderately well drained	Calcareous material, colluviums and residuum from limestone, siltstone, etc.	Deep and moderately deep	Woodland, pasture, cropland	Erosion, slippage, slope, droughtiness, compaction, surface ponding, stoniness, moderately slow permeability
Upshur-Gilpin-Zanesville	Nearly level to very steep	Well drained / moderately well drained	Loess, colluvium, and residuum from shale, siltstone, and sandstone	Deep and moderately deep	Woodland, pasture, cropland	Slope, moderately slow or slow permeability, high shrink/swell potential, droughtiness, seasonal wetness, erosion, slippage, depth
Chagrin-Mentor-Chili	unknown	Poorly drained	Water laden material on floodplains and terraces	Unknown	Floodplain	Flooding
Tioga-Nolin-Newark	Nearly level	Well drain/ somewhat poorly drained	Alluvium	Deep	Cropland	Flooding
Chavies-Nolin-Conotton	Nearly level to strongly sloping	Well drained	Alluvium and stratified gravelly outwash	Very deep	Cropland and urban development	Droughtiness, erosion, flooding

Table E.1.9-1. Dominant Soil Associations Found Within in the Project Area (Source: LMRWMP, 2005)

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The Muskingum River is directly adjacent to three soil associations in most of the Project Area: (1) the Tioga-Nolin-Newark association, (2) the Chavies-Nolin-Conotton association, and (3) the Chagrin-Mentor-Chili association. The development and characteristics of these soils is closely connected to the river since they primarily consist of alluvium and are greatly impacted by flooding. These soils have low to moderate erodability, low organic matter, and moderate hydraulic conductivity. They are frequently used for agricultural purposes because of their high fertility compared to the soils in steeply sloped areas that dominate the watershed.

E.1.9.3 Significant Geologic and Soil Resources

Coal has been mined in Ohio since the mid-1800s and is the region's primary mineral resource. Ohio is the third largest coal-consuming state in the nation, consuming about 62 million tons per year. Ohio ranks thirteenth in the nation in coal production, and seventh in terms of demonstrated coal reserves, with approximately 23.3 billion short tons, or 4.7% of the nation's total coal reserves. Approximately 60 separate seams of coal have been identified in Ohio; of these seams, about 15 are currently mined. Coal-bearing rocks consist dip about 30 feet per mile towards the southeast, so coal may be found at considerably greater depths moving towards the southeast (Ohio Division of Geologic Survey, 2008).

In addition to coal, the region has historically been a source of limestone, clay, shale, sand, gravel, sandstones, and salt. Small-scale oil and gas mining also exists in the region.

E.1.9.4 Reservoir Shorelines and Streambanks

E.1.9.4.1 Steepness, Composition, and Vegetative Cover

The Muskingum River from Ellis L&D (RM 85.9) to Devola L&D (RM 5.8) experiences an elevation drop of 1.2 feet per river mile. Smaller tributaries in the watershed exhibit much higher stream slopes; for instance Meigs Creek and Big Run (second order tributaries) have an average fall of 10.7 feet per mile and 45.2 feet per mile, respectively (ODNR, 2001).

Shoreline composition varies along the length of the river based on nearby land use and river characteristics. In general, the shoreline is vegetated adjacent to agricultural and non-urbanized lands. Trees and shrubs make a vegetated buffer zone in between the river and nearby fields and roads (Photo E.1.9-1). Shoreline surfaces frequently consist of interspersed boulders in addition to vegetated soil and sediment, or sandy deposits (Photo E.1.9-2). The overall watershed land use is largely forest, and throughout much of the river deciduous forest continues up to the riverside. Channelization and shoreline development occurs where the river flows through urbanized regions such as Zanesville and Marietta. In these areas there are fewer trees along the shoreline, and banks are largely covered in grass or are cement embankments. In the immediate vicinity of the proposed Projects shorelines are channelized (Photo E.1.9-3). Shorelines are made of concrete embankments used to support the lock structure.

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Photo E.1.9-1. Representative Section of Vegetated Shoreline Near Beverly L&D (Source: FFP)

Photo E.1.9-2. Representative Section of Rocky Streambed and Shoreline Sear Luke Chute L&D (Source: FFP)

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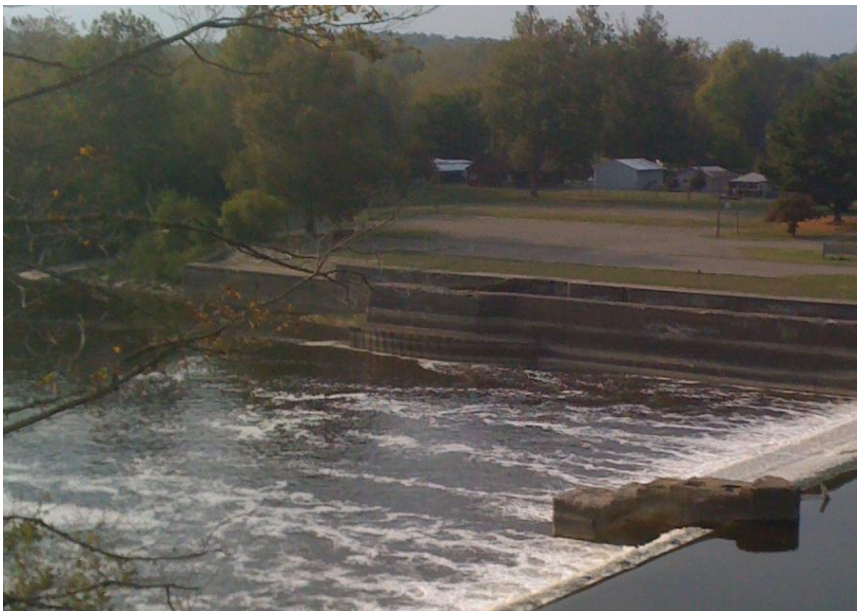

Photo E.1.9-3. Concrete Embankments at Philo L&D
(Source: FFP)

E.1.9.4.2 Existing Soil Stability

Areas of southeastern Ohio are subject to severe slope failure. Rotational slump, earthflow, and rockfall may occur in areas characterized by steep slopes and high relief. The most slide-prone rocks in eastern Ohio are red mudstones originating from the Pennsylvanian and Permian ages. These rocks may lose strength when wet, resulting in rotational slumps or earthflows. Approximately 85% of slope failures in the region occur in red mudstones of the Pennsylvanian-age Conemaugh and Monongahela groups. Rockfalls commonly occur in steep topography where thick, massive sandstones form cliffs (ODNR, 1995).

The Muskingum River valley in the vicinity of the Projects is generally 0.5 to 1.5 miles wide. Therefore, high slope earthflows and rock flows do not pose a direct threat to hydroelectric generation or dam safety. There may be secondary impacts due to slope failure causing increased erosion and sedimentation in the watershed. This increases sedimentation in the Muskingum River and its tributaries, and decreases water quality.

E.1.10 Socioeconomics

E.1.10.1 Regional Overview

FFP's nine proposed Project sites on the Muskingum River are located within three southeastern Ohio counties: Muskingum County, Morgan County, and Washington County. The southeastern portion of Ohio is generally characterized as being a part of Appalachia, and, indeed, these three counties fall within the purview of the Appalachian Regional Commission (ARC). The ARC is a partnership between the federal government and the governments of the eleven Appalachian states, and its mission is to work with the people of the Appalachian region to promote economic

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development in the region. The ARC consists of 420 member counties, and all three project counties are members. The ARC assigns a socioeconomic status to each of its member counties, and bases its determination on a combination of factors including per capita income, unemployment rate, and poverty rate compared to the national average. According to the ARC, Washington and Muskingum Counties falls within the categorization of "transitional," while Morgan County has been classified as "distressed." The ARC defines "transitional" counties as "counties that are worse than the national average on at least one of the three indicators, but do not meet criteria for 'At-Risk' or 'Distressed.'" "Distressed" counties are counties that "have at least twice the national poverty rate and have a per capita market income 67% of the national average or a three-year average unemployment rate that is twice the national average." "Distressed" is the ARC's most severe of its five categories, while "transitional" is the third of five (ARC, 2010).

The Appalachian region has historically been associated with elevated levels of poverty and unemployment. Today, the unemployment rates of the three project counties remain higher than the nationwide unemployment rate. In 2007, the unemployment rates of Muskingum, Morgan, and Washington Counties were 7.8%, 9.3%, and 5.1%, respectively. By contrast, the national unemployment rate in 2007 was 4.6%. (Fedstats, 2010a, 2010b and 2010c)

Appalachian Ohio also suffers from an elevated poverty level, particularly Morgan County. In 2007, roughly 13% of the U.S. population lived below the poverty level; in the same year, the poverty levels of Muskingum, Morgan, and Washington Counties were 16.4%, 20.2%, and 13.5%, respectively. As these figures indicate, Morgan County suffers from relatively high levels of both unemployment and poverty (Fedstats, 2010a, 2010b and 2010c)

In Washington and Muskingum Counties, the manufacturing and health care industries provide the largest two sources of employment, while the retail trade accounts for a substantial number of jobs, as well. Neither county is home to a significant amount of commercial farming or fishing, as agricultural activity accounts for a relatively negligible percentage of the workforce. Morgan County, which lags behind the others in most economic categories, contains a negligible number of manufacturing jobs and contains relatively small retail and health care sectors. Morgan County does boast a commercial agricultural sector, however, which employs roughly 9% of its population. The predominant crops of all three counties include corn and soybeans (City-Data.com. 2010a, 2010b and 2010c

Demographic data for each of the three counties that the Muskingum River Projects will be located in are presented in the following sections.

E.1.10.2 Muskingum County, Ohio

Muskingum County, Ohio was organized in 1804. Its county seat is Zanesville. Muskingum County had an estimated 2008 population of 85,087 (Fedstats, 2010a). This was a 0.6% increase from the census in 2000 (Census, 2010a) when:

- the county covered 664.63 square miles of land area;
- averaging 127.2 persons per square mile;
- there were 32,518 households;

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- the average household size was 2.53 persons;
- 73.5% of residents owned their own homes;
- 80.6% of those 25 years old or more were high school graduates; and
- 12.6% had earned at least a Bachelor's degree.

In 2007, white persons constituted 93.9% of the population of Muskingum County. Minority population groups include black persons (4% of the population), persons of Hispanic or Latino origin (0.5% of the population), and Native Americans (0.2% of the population) (Census, 2010a,).

The median resident age in Muskingum County is 36.5 years, which is above the state average of 36.2 years (Census, 2010a),

In December 2009, the cost of living index in Muskingum County was 77.7, which is low compared to the U.S. average of 100 (Fedstats, 2010a).

According to 2007 data for Muskingum County (Fedstats, 2010a):

- the median household income was $40,447;
- 16.4% of the population lived below the poverty level;
- the civilian labor force was 39,086 persons;
- the unemployment rate was 7.8%; and
- federal spending totaled $7,207 per capita.

Major employment sectors in Muskingum County as of 2002 are listed in Table E.1.10-1.

Sector	Employees	Payroll (annual)	Value of sales, shipments, or receipts
Manufacturing	7,530	$ 267,103,000	$ 1,226,386,000
Retail trade	4,961	$ 85,584,000	$ 922,196,000
Accommodation & food services	3,360	$ 30,810,000	$ 107,177,000
Health care & social assistance	5,964	$ 186,182,000	$ 412,854,000

Table E.1.10-1. Major Employment Sectors in Muskingum County as of 2002
(Source: Citi-Data.com, 2010a)

Farms in Muskingum County average 158 acres and sell an average of $20,961 in products annually. More than half (61.44%) of the value of total agricultural sales is the value of livestock, poultry, and their products. Over 90% of farms are operated by a family or an individual. The most commonly harvested crops are listed in Table E.1.10-2.

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Crop	Acres Harvested
Corn for grain	11,187
All wheat for grain	1,679
Soybeans for beans	15,329
Vegetables	135
Land in orchards	201

Table E.1.10-2. Major Crops of Muskingum County (Source: City-Data.com, 2010a)

E.1.10.3 Morgan County, Ohio

Morgan County, Ohio was organized in 1817. Its county seat is McConnelsville. Morgan County had an estimated 2008 population of 14,510. This was a 2.6% decrease from 2000 (Census, 2010b) when:

- the county covered 417.66 square miles of land area;
- averaging 35.6 persons per square mile;
- there were 5,890 households;
- the average household size was 2.50 persons;
- 78.3% of residents owned their own homes;
- 80.6% of those 25 years old or more were high school graduates; and
- 9.1% had earned at least a Bachelor's degree.

In 2007, white persons constituted 93.2% of the population or Morgan County. Minority population groups include black persons (3.7% of the population), persons of Hispanic or Latino origin (0.4% of the population), and Native Americans (0.4% of the population) (Fedstats, 2010b).

According to 2007 data in Morgan County (Fedstats, 2010b):

- the median household income was $33,087;
- 20.2% of the population lived below the poverty level;
- the civilian labor force was 5,775 persons;
- the unemployment rate was 9.3%; and
- federal spending totaled $11,892 per capita.

The median resident age in Morgan County is 38.9 years, which is above the state average of 36.2 years (Fedstats, 2010b).

In December 2009, the cost of living index in Morgan County was 76.0, which is low compared to the U.S. average of 100 (Fedstats, 2010b).

Major employment sectors in Morgan County as of 2002 are listed in Table E.1.10-3.

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Sector	Employees	Payroll (annual)	Value of sales, shipments, or receipts
Retail trade	295	$ 4,139,000	$ 48,446,000
Accommodation & food services	198	$ 1,539,000	$ 4,652,000
Health care & social assistance	319	$ 5,313,000	$ 10,345,000

Table E.1.10-3. Major Employment Sectors in Morgan County as of 2002
(Source: City-Data.com, 2010b)

Farms in Morgan County average 197 acres and sell an average of $18,294 in products annually. More than half (73.68%) of the value of total agricultural sales is the value of livestock, poultry, and their products. Over 90% of farms are operated by a family or an individual. The most commonly harvested crops are listed in Table E.1.10-4.

Crop	Acres Harvested
Corn for grain	3,030
All wheat for grain	514
Soybeans for beans	1,202
Vegetables	39
Land in orchards	39

Table E.1.10-4. Major Crops of Morgan County
(Source: City-Data.com, 2010b)

E.1.10.4 Washington County, Ohio

Washington County, Ohio was organized in 1788. Its county seat is Marietta. Washington County had an estimated 2008 population of 61,567 (Fedstats, 2010c). This was a 2.7% decrease from 2000 (Census, 2010c) when:

- the county covered 635.15 square miles of land area;
- averaging 99.6 persons per square mile;
- there were 25,137 households;
- the average household size was 2.45 persons;
- 76.3% of residents owned their own homes;
- 84.5% of those 25 years old or more were high school graduates; and
- 15.0% had earned at least a Bachelor's degree.

In 2007, white persons constituted 97.1% of the population of Washington County. Minority population groups include black persons (1.1% of the population), persons of Hispanic or Latino origin (0.6%), and Native Americans (0.2%) (Fedstats, 2010c).

The median resident age in Washington County is 39.1 years, which is above the state average of 36.2 years (Fedstats, 2010c).

In December 2009 the cost of living index in Washington County was 76.7, which is low compared to the U.S. average of 100 (Fedstats, 2010c).

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According to 2007 data, in Washington County (Fedstats, 2010c):

- the median household income was $39,502;
- 13.5% of the population lived below the poverty level;
- the civilian labor force was 33,217 persons;
- the unemployment rate was 5.1%; and
- federal spending totaled $7,763 per capita.

Major employment sectors in Washington County as of 2002 are listed in Table E.1.10-5.

Sector	Employees	Payroll (annual)	Value of sales, shipments, or receipts
Manufacturing	5,009	$ 215,224,000	$ 1,837,653,000
Retail trade	3,122	$ 50,891,000	$ 557,611,000
Accommodation & food services	1,907	$ 19,111,000	$ 68,674,000
Health care & social assistance	3,855	$ 101,291,000	$ 244,854,000

Table E.1.10-5. Major Employment Sectors in Washington County as of 2002
(Source: City-Data.com, 2010c)

Farms in Washington County average 149 acres and sell an average of $19,380 in products annually. More than half (58.02%) of the value of total agricultural sales is the value of livestock, poultry, and their products. Over 90% of farms are operated by a family or an individual. The most commonly harvested crops are listed in Table E.1.10-6.

Crop	Acres Harvested
Corn for grain	8,997
All wheat for grain	1,623
Soybeans for beans	6,136
Vegetables	695
Land in orchards	375

Table E.1.10-6. Major Crops of Washington County
(Source: City-Data.com, 2010c)

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E.2 Project Effects, Agency Recommendations, Studies Conducted and Measures Proposed by the Applicant (18 CFR 4.61(d) (2) (ii))

E.2.1 Botanical Resources

E.2.1.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.1.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. As a result of their review of the PAD, the following agencies provided written comments and study requests related to botanical resources in the Project area.

- ODNR (letter dated January 3, 2011, Appendix A): Requested an assessment of potential effects on wetlands.

E.2.1.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

In response to the licensing studies requested by Agencies and Stakeholders, FFP conducted a Wetlands Delineation Survey: The results of this survey are discussed below. The final study plan and draft report are provided in Appendices B and C, respectively. Comments received on the draft survey report will be addressed in the final report, which will be included with the FLA.

Wetlands Delineation Survey

The purpose of this survey was to delineate wetlands in the Project's areas of potential effect (APE). The wetlands survey was conducted by EMH&T on August 30, 2011 and September 2, 2011 using standard wetlands delineation procedures in which assessments of plant community types, soil types, and hydrologic conditions are used to delineate areas that are functional wetlands. Such wetlands may include previously mapped areas (e.g., included in the USFWS's National Wetlands Inventory), or previously unidentified and unmapped areas.

In the Lowell Lock and Dam Project area, the study area consisted of the Muskingum River, forested river banks, an agricultural field near the river, and a commercial site north of the river. The study area contains approximately 8.8 acres of the Muskingum River, a USACE jurisdictional Section 10 waterway. No other potentially jurisdictional waters, including wetlands, were observed.

E.2.1.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft study reports contained in Appendix C for review by agencies and interested organizations. Comments received related to Project effects on botanical resources will be addressed in the FLA.

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E.2.1.2 Project Effects

Potential Project effects on botanical resources include: (1) effects on wetland species located in and adjacent to USCAE jurisdictional waterways due to erosion and sedimentation during construction; (2) effects on terrestrial botanical communities that are located along new transmission line corridors; and (3) the inadvertent introduction or spread of invasive and noxious plant species.

Wetlands

The Wetland Delineation survey did not document any wetlands or USACE jurisdictional waters in the Project area other than the river itself and the manmade canal, which is jurisdictional because it is hydraulically connected to the river. Project effects on botanical resources in USACE jurisdictional wetlands and waterways will therefore be limited to construction related effects on aquatic and riparian plant communities in and along the river. Such effects will be temporary and can be minimized by implementing required state and federal best management practices for erosion and sedimentation control, including shoreline stabilization measures, during construction.

Transmission Line Communities

The Project will require construction of a new transmission line that connects to the nearest available local utility substation. Wherever possible this transmission line corridor will travel along roadways and existing transmission line routes, and existing poles will be used when feasible. Therefore, much of the line route will travel through areas where the botanical communities have already been disturbed (i.e., roadsides) and the extent of new intrusions on such communities will be minimized. In areas where a new line route must be established, the extent of the areas to be disturbed during construction will be minimal, and permanent effects will be limited to the width of the line and pole, with some clearance on either side for future maintenance. Importantly, once construction is complete new vegetation can re-establish in these areas.

However, in order to maintain access to the line, and for line safety purposes, a corridor will be maintained along the line where large growth will be regularly removed. Vegetation control measures to be implemented along the transmission corridor should be developed in consultation with agencies in order to ensure minimal effects on adjacent plant communities.

Invasive and Noxious Plant Species

Invasive and noxious plants species can be easily spread through improper construction practices. Equipment brought in from other locations can carry seeds and plant parts, which may result in new invasive species being introduced. The introduction and spread of such species can be managed and minimized by implementing appropriate best management practices during construction and during all future transmission line maintenance activities at the Project.

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E.2.1.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of botanical resources in order to avoid and/or mitigate for the potential Project effects identified in Section E.2.1.2

Erosion and Sedimentation and Control Plan

An erosion and sedimentation control plan, to be implemented during Project construction, will be required by the FERC, the USACE, and the State of Ohio under their respective regulatory approval processes. Prior to the start of construction, FFP will develop the plan in consultation with all of these agencies, and the plan will address the relevant erosion and sedimentation control requirements of all agencies in one document. This plan will include all provisions necessary to minimize erosion and sedimentation during Project construction and to stabilize banks post-construction.

Transmission Line Corridor Management Plan

After completion of Project Construction FFP will develop a Transmission Line Corridor Management Plan. This plan will be developed in consultation with FERC, the USACE, and ODNR, and it will detail procedures to be implemented to control vegetation along any newly created transmission line corridors that are developed as part of the FERC-licensed Project.

Invasive Species and Noxious Weed Control Plan

FFP will also prepare an Invasive Species and Noxious Weed Control Plan that will delineate the procedures that will be followed to minimize the introduction or spread of invasive species and noxious weeds during Project construction, and during future transmission line maintenance activities. The plan will be developed prior to the start of Project construction, in consultation with FERC, the USACE, and ODNR.

E.2.2 Wildlife Resources

E.2.2.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.2.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. As a result of their review of the PAD, the following agencies provided written comments and study requests related to wildlife resources in the Project area.

- USFWS (letter dated December 16, 2010, Appendix A): Requested an assessment of potential Indiana bat and mussel effects.
- ODNR (letter dated January 3, 2011, Appendix A): Requested an assessment of potential Indiana bat, eastern spadefoot and mussel effects

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- Friends of the Lower Muskingum River (letter dated March 12, 2011, Appendix A): Requested an assessment of potential mussel effects.

E.2.2.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

In response to the licensing studies requested by Agencies and Stakeholders, FFP conducted the following studies related to wildlife resources:

- Indiana Bat Habitat Survey
- Eastern Spadefoot Survey
- Mussel Survey

The results of these studies are discussed below. The final study plans and draft reports are provided in Appendices B and C, respectively. Comments received on the draft study reports will be addressed in the final reports, which will be included with the FLA.

Indiana Bat Habitat Survey

Indiana bats are a federally and state listed endangered species. The purpose of this survey was to delineate potential Indiana bat roosting habitat in the areas of potential effect for the Project.

The Indiana bat is found in Ohio during the summer months through September. Preferred roosting habitat includes living or dead trees with large cavities, cracks, or exfoliating bark (Clark, B.K., et. al, 1987).

The study included the area within the proposed Project boundary. This boundary encompasses the land where the powerhouse and transmission line will be constructed, and any other lands necessary for routine operations and access. EMH&T visited each study area to identify potential primary or alternative roost trees based on the type and amount of observed bat habitat characteristics.

Potential Indiana bat roosting habitat was identified within the proposed Lowell Lock and Dam Project area. Four alternate roost trees were identified (EMH&T, 2012).

Eastern Spadefoot Survey

The eastern spadefoot, a toad-like member of the family *Scaphiopodidae*, is protected as an Endangered Species by the Ohio Division of Wildlife. The purpose of this study was to assess whether habitat for the eastern spadefoot exists in the Project area.

The eastern spadefoot inhabits areas with sandy or loose loam that is sufficiently friable to enable them to burrow. In Ohio, soils fitting this description are often deposited on terraces, most frequently on the inside of large meanders in rivers. The species inhabit open woods, fields where the canopy is open or along the edges of woodlands. There must also be hydric soils within approximately 900 meters of their burrowing site that are capable of holding breeding pools of water for several weeks. Eastern spadefoots spend most of their time burrowed into

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sandy soils and do not venture far from their burrows except to reproduce. Breeding typically occurs on rainy nights between late March and August.

This study evaluated the potential for eastern spadefoot to occur in the Project area based on known habitat preferences. The surveys were conducted using a protocol developed for, and accepted by, the ODNR. Four primary indicators of eastern spadefoot habitat were examined. These include (1) the presence of suitable breeding sites at or within one half of a mile from the subject site; (2) the presence of an open canopy or open woodland habitat; (3) ground cover that can support sufficient spadefoot prey (insects and other small invertebrate animals); and (4) the presence of friable soils (sand or loam). These habitat criteria were rated, and the ratings were used to determine whether presence/absence surveys are recommended prior to Project construction.

The habitat around the Lowell Lock and Dam Project site was not suitable for the eastern spadefoot, and a presence/absence survey was not recommended for this sites. Either the physical habitat would not provide for this species' needs or it has been severely altered by development or agriculture (Davis, 2012).

Mussel Survey

Sixty-three taxa of unionid species have been reported to occur in the lower Muskingum River (Zanesville to the Ohio River), with 33 of these species having been reported since 1990. Scattered occurrences have been documented throughout the upstream pools (Zanesville to Luke Chute), but beds occur downstream the dams in the Luke Chute to Devola reach. To document unionid communities in the Project area, sampling was conducted by Ecological Specialists, Inc during the late summer of 2011 (ESI, 2012).

The study area for the Lowell Project extended from 500m upstream of the dam to 1000m downstream of the dam. Since only a few isolated specimens were collected upstream of the dam, so no additional sampling was conducted in this reach. Qualitative and quantitative samples were collected by divers to characterize unionid communities in beds downstream of Lowell dam.

Water quality, fish host distribution, and complex hydraulic factors such as shear stress and relative substrate stability all affect the distribution of unioids. While water quality and fish host distribution are not expected to be adversely affected by the Project, localized changes in hydraulic conditions that are expected to occur post-construction may affect habitat conditions (substrate and depth) and shear velocities. Therefore, existing substrate and depth conditions were documented during the 2011 sampling. Shear velocity, was modeled by FFP (FFP, 2012) during low (1000 cfs), normal (3300 to 4400 cfs), and high discharges (40,000 cfs) under existing and proposed conditions.

Existing shear velocities were qualitatively compared to the unionid distribution documented in the 2011 field study, and some correlation between unionid distribution and shear velocity patterns downstream of the dam was evident. Therefore, the modeled shear velocities under proposed conditions were qualitatively compared to existing conditions to estimate whether

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changes in hydraulic conditions could affect relative substrate stability, and subsequently, unionid distribution.

Brail samples were collected from approximately 100 to 600m upstream of Lowell dam and from 50 to 1000m downstream of the dam. Upstream of the dam substrate was primarily loose undulating sand and silt mid channel, deep silt along the left bank, and boulder, cobble, and silt along the right bank. Depth ranged from 3.7 to 4.3m. No unionids were found upstream of the dam in 2011. No unionids were collected within 1 mile upstream of Lowell dam in 1992 and none have been reported within 1 mile of the dam from other studies (ESI, 2012).

Upstream of the dam, model results indicate that shear velocity throughout the study area is <0.005m/sec during low discharge. Even at normal flow (3630cfs), shear velocity is <0.014 throughout the area. This likely explains the thick silt accumulation on the substrate. Even during high discharge, shear velocity is <0.08m/sec throughout the upstream study area (ESI, 2012).

A few changes in shear velocity distribution will occur upstream of the Lowell dam. Under low flow, shear velocity will increase slightly near the powerhouse, but will remain <0.01m/sec. The biggest difference may occur at normal flow (3630cfs). Shear velocity along the right bank will increase from <0.014m/sec to >0.014m/sec along the right portion of the channel and into the powerhouse. The area next to the bank may increase to >0.04m/sec. Under high discharge, shear velocity should be similar to existing conditions with the exception of a few areas mid channel that could increase from 0.06 to 0.08m/sec under existing conditions to 0.08 to 0.15m/sec with the powerhouse in place (ESI, 2012).

Downstream of the dam, substrate was cobble, gravel and sand throughout much of the area, including the area immediately downstream of the dam. The poorest substrate occurred along the right bank, where substrate was boulder and cobble upstream of the island, and sand with detritus and woody debris to the left of the island. Substrate was also sandier along the shallow left descending bank and downstream of the bridge. Depth upstream of the bridge ranged from 0.3 to 3.0m. Scour holes filled with woody debris prevented sampling under the bridge, but downstream depths ranged from 1.2m near the right bank to 5.5m near the left bank (ESI, 2012).

A unionid bed occurs from the dam to upstream of the bridge primarily in the left 2/3rds of the channel. This bed has existed for decades. The bed starts approximately 50m and 125m downstream of the dam on the left side and center of the channel, respectively. Fewer unionids occurred along the right bank and downstream of the bridge than in the rest of the study area due to the sandier nature of the substrate. A total of 687 unionids representing 16 live species were collected in this bed. Density averaged 10.4 (±2.3) unionids/m2. Recruitment was higher in this bed than other areas, as 37.5% of the unionids in quantitative samples were ≤5 years old. The percentage of the community >15 years old was also less than other areas (11.5%). Young *Q. p. pustulosa*, *O. reflexa*, and *Truncilla* spp. were particularly abundant. However, ten of the 16 species collected were not represented by young unionids (ESI, 2012).

Amblema p. plicata (43.5%), *O. reflexa* (31.3%), *Q. p. pustulosa* (11.2%), and *P. cordatum* (5.8%) were the most abundant species. One *C. stegaria* (17 years old) was found, and this species has not been reported in this bed since 1969. Other Ohio T&E species at this site included *M. nervosa*, *P. sintoxia*, *E. lineolata*, *T. donaciformis*, and *T. truncata*. *Truncilla*

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truncata has not been reported in this bed since 1934, although it occurs downstream near the Devola dam (ESI, 2012).

Under existing conditions, shear velocity at low flow is least (<0.005m/sec) in the shallow area to the left of the island along the right bank and downstream of the bridge. Most of the remaining area has shear velocity between 0.005 and 0.014m/sec during low flow. However a few areas of higher shear velocity occur just downstream of the dam (0.02m/sec) and to the left of the large island (0.014 to 0.020m/sec). The area of slightly higher shear velocity at low flow seems to correspond with the distribution of unionids at this site. Under normal flow conditions (3700cfs), shear velocity is between 0.014 and 0.040m/sec in most of the area. Slower areas occur in the upstream area along the left bank and along the banks in the downstream section of the study area. During high discharge, shear velocity is lowest along the upstream right and left banks and around the island. Most of the upstream portion of the area has shear velocity between 0.04 and 0.06m/sec, and this increases to 0.06 to 0.08m/sec in the downstream portion of the study area (ESI, 2012).
Slight increases in shear velocity are expected with hydropower, primarily in the upstream few hundred meters downstream of the dam. Under low flow, the area with shear velocity between 0.014 and 0.04m/sec may increase within the upstream half of the unionid bed.. Under normal flow (3700cfs), shear velocity may be less in the upstream right portion of the channel, but increase slightly immediately downstream of the powerhouse (see Figure 3-49). This effect however is expected to be limited to within 200m of the powerhouse, with the exception of a few spots along the banks. Under high discharge, shear velocity could increase from between 0.04 and 0.06m/sec to between 0.06 and 0.08m/sec in a wider band in the upstream portion of the unionid bed (ESI, 2012).

E.2.2.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA, and the draft study reports contained in Appendix C, for review by agencies and interested organizations. Comments received related to Project effects on wildlife resources will be addressed in the FLA.

E.2.2.2 Project Effects

Potential Project effects on wildlife resources include: (1) effects on Indiana bat nesting habitat during Project construction and during future transmission line maintenance; (2) effects on the eastern spadefoot during Project construction; (3) effects in mussels during Project construction and due to permanent changes in hydraulic conditions in the river reach downstream of the dam; (4) effects on mussel habitat due to changes in sediment transport and deposition; (5) effects on wildlife habitat located along any new transmission corridors; (6) transmission line effects on raptor/bird of prey species; and (7) the inadvertent introduction or spread of invasive species.

Indiana Bat Nesting Habitat

Indiana bat primary or alternate nesting trees occur in the Project area. These trees should be protected, during both Project construction and future transmission line maintenance; through the implementation of measures recommended by state and federal resource agencies. This include

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limiting the time of year that trees are removed to periods when bats are less likely to be roosting in this area.

Eastern Spadefoot

Extensive eastern spadefoot habitat was not documented in the Project area. However, in the event that this species is present in the Project area, construction related effects can be minimized by limiting heavy construction traffic at night following major rain events in the summer, when this species is most likely to roam away from its burrow.

Mussels

A few changes in shear velocity distribution will occur upstream of the Lowell dam. However, these changes should not affect unionids, as no unionids seem to occur upstream of this dam (ESI, 2012).

Downstream of the dam, the powerhouse will be built in the left corner of the dam. Unionids occur within 50m of the dam along this bank. Unionids within this area could be directly affected during construction (ESI, 2012).

Slight increases in shear velocity are expected under proposed conditions, primarily in the upstream few hundred meters downstream of the dam. These changes in shear velocity are expected to be minor, and their effects on the unionid community (if any) should be limited to within the upstream few hundred meters of the unionid bed (ESI, 2012).

Sediment Transport and Stream Bank Erosion

Stream bank erosion and sediment transport could affect riparian and aquatic wildlife habitat in the Project area. Shear velocity is an indicator of the potential for stream bank erosion and sediment transport, as higher values are associated with movement (erosion) of larger and heavier particles. A review of the shear velocities around the Project during high flows reveals that the stream banks in the existing condition are able to withstand shear velocities in excess of 0.08 m/s for short periods of time without showing evidence of erosion. The model of proposed conditions at high flows reflects no change in the magnitude of the shear velocities encountered along the river banks. At the high flows, the discharge exceeds the hydraulic capacity of the plants and most of the water flows over the spillway, thereby approximating the existing condition. During low flow periods the values of shear velocity along the river banks are less than 0.01 m/s for existing and proposed conditions, with the exception of 15 m around the powerhouses where the shear velocity is 0.02 – 0.05 m/s. In all cases, the shear velocity is below the identified critical value of 0.08 m/s. During normal operation, represented by the mid flow case, the proposed condition has the same (or lower) values of shear velocity along the banks than the existing condition. Therefore, the Project is not expected to cause increased stream bank erosion that would have an adverse effects on riparian and aquatic wildlife habitat.

Analysis of the changes to shear velocity was also used to assess the potential for changes in sediment transport under proposed conditions. Overall, the Project may change current sediment movement patterns in the immediate vicinity of the dam and new powerhouse, but the changes

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will be very localized and represent minor alterations of existing conditions not a significant increase in sediment transport. Upstream of the Lowell Project area, the bed movement will be similar except there will likely be a shift to the left side of the channel. Downstream, for most of the channel the conditions won't change enough to affect the bed except for through the island area, where here could be some scour of gravels and fines.

Transmission Corridor Wildlife Habitat

The Project will require construction of a new transmission line that connects to the nearest available local utility substation. Wherever possible this transmission line corridor will travel along roadways and existing transmission line routes, and existing poles will be used when feasible. Therefore, much of the line route will travel through areas where the wildlife habitat has already been disturbed (i.e., roadsides) and the extent of new intrusions on wildlife habitat will be minimized. In areas where new line routes must be established, the extent of the areas to be disturbed during construction will be minimal, and permanent effects will be limited to the width of the line and pole, with some clearance on either side for future maintenance. Importantly, once construction is complete new habitat can re-establish in these areas. However, in order to maintain access to the line, and for safety purposes, a corridor will be maintained along the line where large growth will be regularly removed. Maintenance measures to be implemented along the transmission corridor should be developed in consultation with agencies in order to ensure minimal effects on wildlife habitat.

Transmission Line Effects on Avian Species

The new transmission line proposed as part of this Project could pose injury and mortality risks for birds of prey that perch or nest on the lines, poles and transformers. Such risks can be minimized by considering the potential for avian interaction in Project designs and incorporating relevant protection measures. The Edison Electric Institute's Avian Power Line Interaction Committee (APLIC) and the U.S. Fish and Wildlife Service (USFWS) have developed guidelines for preparing Avian Protection Plans that delineates a program designed to reduce risks that result from avian interactions with electric facilities. An Avian Protection Plan should be developed for this Project to minimize potential avian interaction effects.

Invasive Species

Invasive species can be spread through improper construction practices. Equipment brought in from other locations can harbor species of mussels and insects, which may result in new invasive species being introduced. The introduction and spread of such species can be managed and minimized by implementing appropriate best management practices during construction and during all future transmission line maintenance activities at the Project.

E.2.2.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of wildlife resources in order to avoid and/or mitigate for the effects identified in Section E.2.2.2.

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Indiana Bat Protection

Roosting trees within the Project area could be affected during Project construction. FFP will follow UFSWS recommended protection measures, including avoiding removal or disturbance of the identified trees during construction whenever possible. If any of these trees need to be removed for construction of the powerhouse and transmission line, or to facilitate safe site access, they will be removed during the winter (October 1 to March 31) when Indiana bats are not roosting.

Future Project operations after construction are expected to have no effect on Indiana bat roosting in the Project area. However, the long term maintenance procedures for the transmission lines (discussed below) will delineate the location of known Indiana bat roosting trees, so that future disturbance or removal of these trees can be avoided to the extent practical and unless they pose a safety risk to the Project or the public.

Eastern Spadefoot Protection

Extensive eastern spadefoot habitat was not documented in the Project area. However, in the event that this species is present in the Project area, construction related effects will be minimized by limiting heavy construction traffic at night (8 pm to 6 am) following major rain events (>1 inch in 1 hr or 2 inches over 24 hours) that occur from May 15 through October 31.

Construction and Long Term Operations Effects on Mussels

Some potential effects to existing mussel communities downstream of the Project may occur due to construction or long term Project operations. FFP will consult further with the ODNR and USFWS regarding appropriate protection and/or mitigation measures for affected mussel communities.

Erosion and Sedimentation and Control Plan

An erosion and sedimentation control plan, to be implemented during Project construction, will be required by the FERC, the USACE, and the State of Ohio under their respective regulatory approval processes. Prior to the start of construction, FFP will develop the plan in consultation with all of these agencies, and the plan will addresses the relevant erosion and sedimentation control requirements of all agencies in one document. This plan will include all provisions necessary to minimize erosion and sedimentation during Project construction and to stabilize banks post-construction.

Transmission Line Corridor Management Plan

After completion of Project construction FFP will develop a Transmission Line Corridor Management Plan. This plan will be developed in consultation with the FERC, the USACE, and ODNR, and it will detail procedures to be implemented to control vegetation while minimizing effects on adjacent wildlife habitats along any newly created transmission line corridors that are develop as part of the FERC-licensed Project. In addition, the plan will delineate the location of

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known Indiana bat roosting trees, so that future disturbance or removal of these trees can be avoided to the extent practical and unless they pose a safety risk to the Project or the public.

Avian Protection Plan

FFP will develop an Avian Protection Plan for this Project. The Plan will be developed consistent with APLIC and USFWS guidelines, and will identify protection measures that will be incorporated in the project design. Measures that will be implemented in the future in association with transmission facility maintenance activities will also be addressed in the Plan. The plan will be developed in consultation with USFWS and ODNR after issuance of the FERC license, but prior to final Project design.

Invasive Species and Noxious Weed Control Plan

FFP will also prepare an Invasive Species and Noxious Weed Control Plan that will delineate the procedures that will be followed to minimize the introduction or spread of invasive species and noxious weeds during Project construction, and during future transmission line maintenance activities. The plan will be developed prior to the start of Project construction, in consultation with the FERC, the USACE, and ODNR.

E.2.3 Fisheries Resources

E.2.3.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.3.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. As a result of their review of the PAD, the following agencies provided written comments and study requests related to fisheries resources in the Project area.

- USFWS (letter dated December 16, 2010, Appendix A): Requested an assessment of the likelihood that impingement and entrainment of fish will occur, and whether this could have an adverse effect on resident fish populations.

- ODNR (letter dated January 3, 2011, Appendix A): Requested an assessment of the likelihood that impingement and entrainment of fish will occur, and whether this could have an adverse effect on resident fish populations.

E.2.3.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

In response to the licensing studies requested by Agencies and Stakeholders, FFP conducted the following studies related to fisheries resources:

- Desktop Entrainment Study
- Project Hydraulic Study

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The results of these studies are discussed below. The final study plans and draft reports are provided in Appendices B and C, respectively. Comments received on the draft study reports will be addressed in the final reports, which will be included with the FLA.

Desktop Entrainment Study

Operation of hydroelectric projects can result in the sporadic impingement and entrainment of fish, and fish passing through the turbines can be subject to the risk of injury or mortality. The number of fish impinged or entrained at a project is related to a variety of physical factors near the dam and powerhouse, such as flow rate, intake depth, intake approach velocities, trash rack spacing, and proximity to fish habitat. Biotic factors also affect entrainment, including diurnal and/or seasonal patterns of fish migration and dispersal, fish size and swimming capabilities, life history requirements, and density-dependent influences (e.g., resource availability) on fish populations in upstream habitats.

In addition, survival of turbine entrained fish depends on the physical characteristics of the turbine system, such as head, turbine size and design, runner speed, wicket gate openings, number of runner blades, runner blade angle, gap size, and water flow through the turbine. Many of these factors can be causes of mechanical injury. Therefore, it has been generally accepted that survival depends on size, physiology, and behavior of entrained fish, as it relates to the sources of mechanical injury described above.

A qualitative assessment was conducted to assess fish impingement and entrainment, and turbine survival through the proposed Project (HDR, 2012). This assessment utilized a 5-step rating system developed by EPRI (1997a). A range of “low” to “high” monthly risk of entrainment was assigned to each species based on the target species seasonal entrainment rates EPRI (1997a), species periodicities, relative composition, and expected distributions within a given pool.

Table E.2.3-1 provides the individual metric scores and total scores for each of the seven Muskingum River Projects. The scoring results suggest differences in the relative potential of the Projects to affect fisheries resources. Entrainment potential rated the highest for the Zanesville and Rokeby Projects as compared to the other five Projects. Zanesville was relatively high due to its location in a shallow intake canal and high annual plant factor. Rokeby was relatively high due to its location off of the spillway within an excavated channel, close proximity to the shoreline, high plant factor, and high catch per unit effort (CPUE). Beverly also ranked fairly high due to a similar setup to Rokeby, high annual plant factor, but had about half of the CPUE. It should be noted that these metrics were developed for conventional hydroelectric projects that impound large bodies of water and have relatively deep forebays that stratify, and reservoirs with relatively long retention times. Although not wholly comparable, the transferability of the metrics and scoring criteria to these run-of-river, low head, lock and dam projects is used here merely as another tool to assess differences and similarities between these Projects (HDR, 2012).

The Duke Energy Catawba-Wateree Entrainment Study (GeoSyntec 2005), from which these methods were derived, had a range of scores between 10 and 22. The Duke study also included two metrics to assess fish densities, littoral fish density and limnetic fish density. The analysis for the Muskingum Projects only used one metric for fish density (Pool Fish Density), due to the lack of a truly limnetic forebay at the Projects, and hydroacoustic surveys to assess limnetic fish

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density. If this metric is removed from Duke study results, a range of scores between 9 and 17 results. Comparatively speaking, the Muskingum Projects show a similar to slightly higher risk of entrainment due to the riverine environment in which they will be developed, and run-of-river operations. This scoring does not consider flow distributions around the Projects; however, which may likely reduce entrainment potential due to alternate passage routes for fish. This is discussed further below (HDR, 2012).

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Metric[a]	Zanesville		Philo		Rokeby		Malta		Beverly		Lowell		Devola	
	Value	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
Forebay Configuration	C	5	OB	3	C	5	O	1	C	5	OB	3	OB	3
Depth of Intake (ft)[b]	5	5	39	1	39	1	39	1	39	1	39	1	39	1
Total Hydraulic Capacity (cfs)	1,150	1	5,500	3	5,500	3	5,500	3	5,500	3	5,500	3	5,500	3
Annual Plant Factor (%)	70	5	61	5	49	5	62	5	68	5	71	5	59	5
Project Pool Fish Density (fish/hr)	697	3	580	3	1,243	5	750	3	517	3	328	1	316	1
Total Score	**19**		**15**		**19**		**13**		**17**		**13**		**13**	

[a]Metric scoring of physical, operational, and turbine parameters based on information provided in Exhibit A Metric scoring of Project Pool fish density based on combined boat electrofishing CPUE (fish/hr) for the Project Pool sites (OEPA 2006).
C = canal forebay or excavation required outside of spillway close to bank; OB = open intake on current spillway close to bank; O = open intake on current spillway not close to bank;
[b]Based on minimum depth of intake provided in Exhibit A

Table E.2.3-1. Metric Scoring For Indices Of Relative Entrainment Potential Between The Muskingum River Projects (Source: HDR 2012)

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Table E.2.3-2 provides monthly turbine entrainment potential for the target species based on the EPRI (1997a) five-tier qualitative method. It is expected that monthly entrainment risks for target species will be fairly similar between Projects (HDR, 2012).

Rationale for determining whether a species may show a "low" or "high" risk of entrainment is based on the target species seasonal entrainment rates (EPRI (1997a)), species periodicities, relative composition, and expected distributions within a given pool. For example, gizzard shad have relatively high entrainment rates for all seasons in the EPRI (1997a) database, particularly in winter and fall months when "cold stress" lethargy may cause spikes in entrainment. They also happen to be one of the more abundant species in the Project pools, and will likely occupy both lotic and lentic habitats within a given pool. Spawning typically occurs in May, and young life stages such as eggs, larvae and fry may be susceptible to entrainment during the summer months. Such rationale was used for all species to assign qualitative risks of entrainment. As a result, qualitative ratings ranging from "moderate" to "high" were assigned to represent gizzard shad monthly entrainment potential. Likewise, a rating of "low" was assigned to the Eastern sand darter for all months, primarily due to the species rarity in the system. Also, species that tend to favor lotic habitats, such as stonecat, and those that might possess small home ranges within a given Project pool were assigned a "low" entrainment potential. Most all species received a higher score during the 60-day post spawning period when young life stages may be present (HDR, 2012).

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Target Species	Qualitative Rating of Monthly Entrainment Potential*											
	January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Bluegill	L	L	L-M	L-M	L-M	M	M	M	M	M	L-M	L
Blue Sucker	L	L	L	L	L-M	L-M	L-M	L-M	L	L	L	L
Channel catfish	L-M	L-M	L-M	L-M	L-M	M	M	M	L-M	L-M	L-M	L-M
Eastern sand darter	L	L	L	L	L	L	L	L	L	L	L	L
Emerald shiner	L-M	L-M	L-M	L-M	M	M	M	M	M	M	L-M	L-M
Flathead catfish	L	L	L	L	L	L-M	L-M	L-M	L	L	L	L
Freshwater drum	L	L	L	L	L	L	L	L	L-M	L-M	L-M	L
Gizzard shad	H	H	M	M	M-H	M-H	M-H	M-H	M-H	M-H	H	H
Logperch	L	L	L	L-M	L-M	L-M	L-M	L-M	L	L	L	L
Longnose gar	L	L	L	L	L	L-M	L-M	L-M	L	L	L	L
River redhorse	L	L	L	L	L-M	L-M	L-M	L	L	L	L	L
Saugeye	L	L	L	L-M	L-M	L-M	L-M	L-M	L	L	L	L
Smallmouth bass	L	L	L	L	L	L-M	L-M	L-M	L	L	L	L
Spotted bass	L	L	L	L	L	L-M	L-M	L-M	L	L	L	L
Stonecat madtom	L	L	L	L	L	L	L	L-M	L-M	L-M	L	L
White bass	L	L	L	L-M	L-M	L-M	L-M	L-M	L	L	L	L
White crappie	L	L	L	L	L	L-M	L-M	L-M	L-M	L-M	L-M	L

*L (low), L-M (low-moderate), M (moderate), M-H (moderate-high), H (high)

Table E.2.3-2. Range Of Monthly Turbine Entrainment Potential For The Target Species (Source: HDR 2012)

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Fish mortality as a result of entrainment may be more related to fish size than the type of species (Franke et al. 1997; Winchell et al. 2000). Three length categories of fish (≤ 6 inches, ≤ 10 inches, and > 10 inches) were analyzed in the EPRI (1997a) turbine passage survival study. The survival estimates in Figure E.2.3-1 represent mean immediate survival for these length groups based on the number of recovered fish in tests with control survival rates of 90% or higher (clupeids at 75% and higher) at 15 projects with Kaplan or propeller type turbines. Mean survival of fish for all size categories appears relatively consistent at 80-100% regardless of turbine characteristics. Fish mortality through Kaplan and propeller type turbines tends to be lower than for Francis turbines, which is potentially related to the use of Kaplan units at projects with lower heads, larger hydraulic capacities, and lower rotational speeds (EPRI 1992).

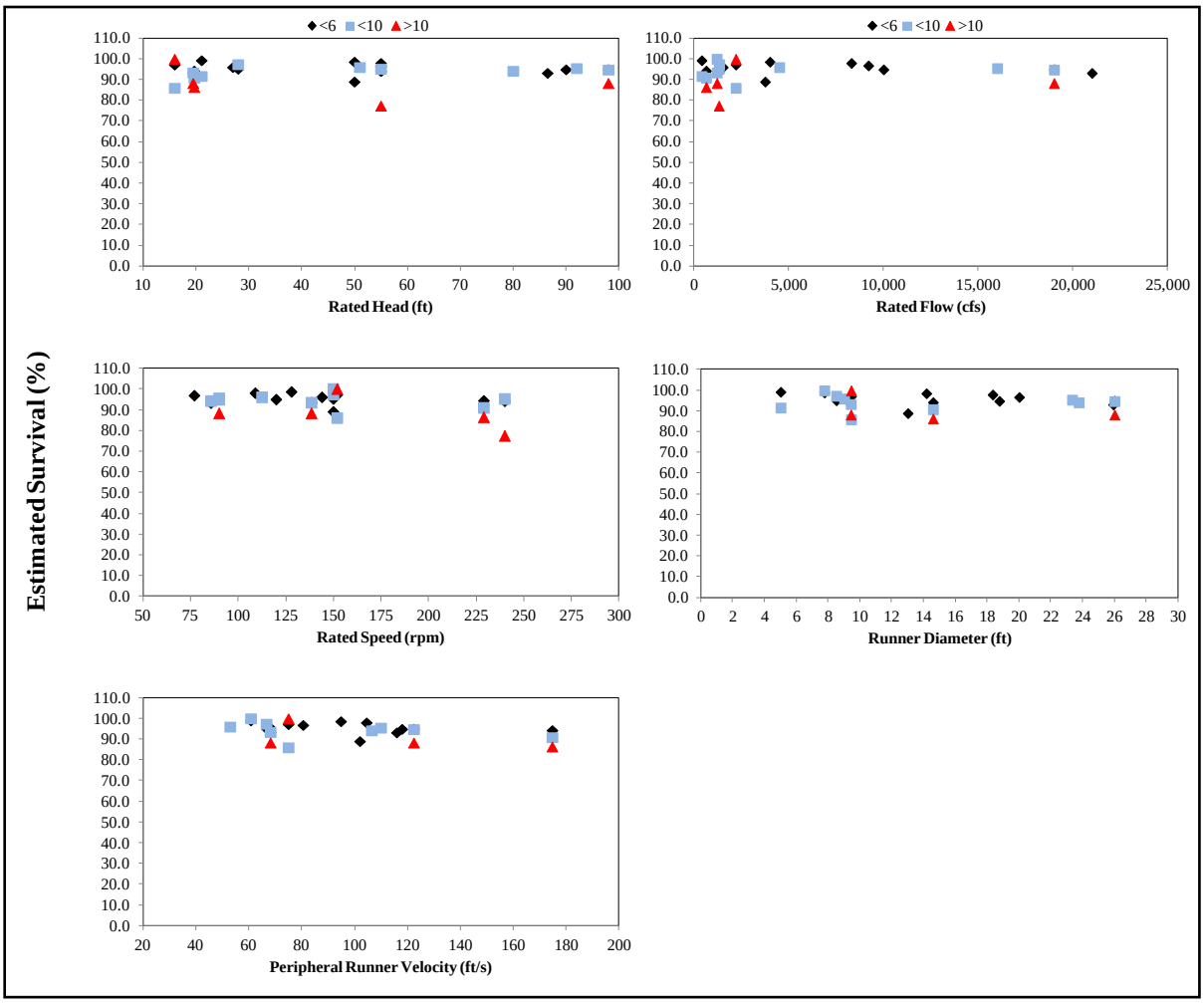

Figure E.2.3-1. Mean Fish Passage Survival Estimates In Relation To Kaplan/Propeller Type Turbine Characteristics

(Source: From EPRI (1997a) In HDR, 2012)

Because of the limited sample sizes of the target species in the EPRI (1997a) turbine passage survival database, and the fact that survival is more dependent on fish size rather than species, mortality estimates at the proposed Projects were determined from the mean mortality rates for

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fish size classes at these 15 sites (Table E.2.3-3). Due to these limitations using the EPRI database and unrealistically higher survival rates for larger versus smaller fish, a blade strike analysis was conducted to provide a more accurate, site specific, and objective calculation of fish survival rates expected at each Project. This included model runs for multiple fish sizes expected to be entrained.

Fish Length (in)	N [1]	Mean Survival Rate[2]
< 4	19	0.93
4 – 8	74	0.93
8 – 15	23	0.96
> 15[3]	1	0.96

NOTE: [1]The number of trials used to calculate a mean. Trial data points were based on replicate sampling at a given site where multiple fish were tested for a given species; [2]This includes all fish species studied at the 15 sites with control fish survival > 90 percent and 75 percent for clupeids; [3]Only one project (Herrings) tested fish in the >15 in size group, of which only American eel were tested. Because of their unique body shape, ability to pass through turbines unharmed, and resulting lower than normal mortality rate, this value is likely higher than 0.04.

Table E.2.3-3. Mean Survival Rates Of Four Fish Size Classes Through Kaplan/Propeller Type Turbines

(Source, EPRI 1997a In HDR, 2012)

A total of 369 blade strike probability/survival estimates were calculated for each Project. Average survival estimates are included for each route of entry (edge of hub, mid-blade, and blade tip) and correlation factor combination, individual size groups, as well as all length classes as a whole. For example at Zanesville, the expected survival rate of a 10-inch fish entering near the edge of the turbine hub with a correlation factor of 0.10 is 93%. The average expected survival rate for a 10-inch fish passing through one of the Zanesville units, considering the multiple routes of entry and ways it may lay in the plane of revolution, is 91%. The overall average survival rate of all fish lengths, routes of passage, and plane angles for fish entering one of the Zanesville units is 81%. Zanesville showed the lowest survival rates of all Projects likely due to its smaller turbine sizes and higher rotational speeds. As expected, the other six Projects had very similar estimated survival rates (overall average of approximately 91%). Total gross head was the only varying parameter. As mentioned above, the maximum length used (41 inches) represents the largest sized fish of the target species (longnose gar) that may be expected to pass through the 2-inch trash rack spacing, and become susceptible to blade strike.

Entrainment and survival potential at the Muskingum River Projects will also vary based on river flow and routes of passage, which at times may include the spillway, powerhouse, and/or locks. Some mortality is likely to be occurring at the existing spillways, particularly under lower spill flow scenarios. Empirical data exists from 16 tests at six hydroelectric facilities, which estimated the survival of fish passing over spillways and through bypass sluices using the HI-Z Turb'N Tag methodology (Heisey et al. 1992). These studies found survival rates ranging from 88.3% to 100% depending on the species and the specifications of the projects and flows evaluated. However, the head differentials of most of these projects are all more than that proposed for the Muskingum Projects. Only the Crescent, New York Project had a head (13 ft) similar to those proposed for the Muskingum River Projects. The 48-hour survival of juvenile herring passed over the spillway at this project was 88.3%. Fish passing over the spillways at these traditional

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hydroelectric facilities are typically exposed to concrete aprons or other rough surfaces before reaching a downstream pool. It is likely that higher flows/lower gross head at the Muskingum Project spillways would allow fish to plunge into the next downstream pool without injury. As flows recede and gross head increases, spill mortality potential may likely increase due to the greater plunge distance and strike velocities, as well as the potential for abrasion or scraping.

E.2.3.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft study reports contained in Appendix C, for review by agencies and interested organizations. Comments received related to Project effects on fisheries resources will be addressed in the FLA.

E.2.3.2 Project Effects

Potential Project effects on fisheries resources include: (1) effects on near-shore fish habitat and water quality due to erosion and sedimentation during construction; (2) turbine impingement and entrainment; (3) effects on fish habitat due to permanent changes in hydraulic conditions; (4) effects on fish habitat due to changes in sediment transport and deposition; and (5) the inadvertent introduction or spread of invasive aquatic species.

Nearshore Fisheries Habitat

Project effects on fisheries resources could include erosion and sedimentation during construction in and adjacent to nearshore habitat, which would affect water quality and habitat conditions. Such effects will be temporary and can be minimized by implementing required state and federal best management practices for erosion and sedimentation control, including shoreline stabilization measures, during construction.

Turbine Impingement and Entrainment

The proposed Project is expected to create some degree of entrainment which will vary with river flow, species, season, and fish size/life stage. The majority of entrained fishes will likely be clupeids, sunfish, and young life stages, including eggs, fry, juveniles, and some young adults incapable of intake avoidance or exclusion by the trash racks. Larval and juvenile fish abundances and adult fish movements typically increase in the spring and summer months. Most larval (yolk-sac) fish can only adjust their vertical position in the water column and drift with river flow (Jenkins and Burkhead 1993). Fry (no yolk-sac) and juvenile fish possess escape or burst swim speeds capable of avoidance; however, adults are more successful in avoiding intake structures, and thus make up the minority of entrained fish at a given system (HDR, 2012).

Entrainment risk of the target species will vary by a number of factors, including species, life stage, season, swim speed, and project design. The qualitative entrainment assessment in this report utilized target species empirical entrainment rate data collected at various hydroelectric projects, species periodicities, their relative compositions in the Project pools, and general knowledge of habitat use to determine a monthly rating of low to high entrainment potential. Gizzard shad showed the highest risk of entrainment potential, particularly in winter months due

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to lethargy from cold stress and general high abundances. Other species ranged in entrainment potential from "low" to "moderate" based on seasonal empirical entrainment rate data, temporal early life stage presence, and relative compositions in the pools (HDR, 2012).

Entrained fish will experience lower mortality rates with the proposed Kaplan type turbines. Low fish mortality through Kaplan turbines is likely a result of the units being larger, typically operated at a lower head, having a larger hydraulic capacity, and lower rotational speeds (EPRI, 1992).

Entrainment potential can vary dramatically within and between river systems and years, based on natural variations in fish population dynamics, local abiotic and biotic variances, and hydroelectric project operations/designs. Although the total number of fish that could potentially be entrained through the Projects during a given year may be high, fish survival rates through Kaplan turbine units are also relatively high. Entrainment rates in river intake systems are typically higher than in reservoir intake systems; however, Muskingum River flows will exceed turbine capacities for approximately 50% of a given year, and allow an alternate route of spillway passage. Also, empirical evidence suggests that the majority of fish family entrainment compositions are comprised of clupeids and sunfishes. Species representing both of these families in the Muskingum River, such as gizzard shad and bluegill, typically possess rapid growth and maturation rates, high fecundity, and rapid recruitment (Jenkins and Burkhead 1993). Such characteristics may potentially offset effects from entrainment turbine mortality losses.

Given the combination of alternate fish passage options through the lock and/or spillway, and the high turbine entrainment survival rates for most of the species and size classes inhabiting the Muskingum River, the proposed Projects should have little to no adverse effect on fish populations.

Habitat Effects Due to Changes in Hydraulic Conditions

Permanent change in hydraulics will be minimal and primarily localized in the immediate area near the dam and proposed powerhouse.

The average change in impoundment water surface elevation between existing and proposed conditions is a decrease of approximately 1 ft which is not expected to have an adverse effect on fisheries habitat.

Results of the depth-averaged velocity modeling indicate that changes in depth averaged velocity will occur primarily in the vicinity of the dam and powerhouse. Changes in velocities are not expected to adversely affect fisheries habitat. However, increased velocities near the powerhouse intake, as evaluated in the fish entrainment study, will directly affect entrainment rates. Fish protection measures should be addressed in the project design (notably, the intake and trashracks).

Under existing conditions, shear velocity is higher near the deeper portions of the main channel and lower in the shallower areas near the banks. Under proposed conditions, during low and mid flows there is a general reduction in shear velocity around most of the length of dam structure

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due to the relocation of the main discharge to the powerhouse. Immediately around the powerhouse intakes and tailraces there are local increases of shear velocity. However, after 300 – 500 m there is little to no appreciable difference between existing and proposed conditions. Changes in shear velocities are not expected to adversely affect fisheries habitat.

Habitat Effects Due to Changes in Sediment Transport and Steam Bank Erosion

Stream bank erosion and sediment transport could affect aquatic habitat in the Project area. Shear velocity is an indicator of the potential for stream bank erosion and sediment transport, as higher values are associated with movement (erosion) of larger and heavier particles. A review of the shear velocities around the Project during high flows reveals that the stream banks in the existing condition are able to withstand shear velocities in excess of 0.08 m/s for short periods of time without showing evidence of erosion. The model of proposed conditions at high flows reflects no change in the magnitude of the shear velocities encountered along the river banks. At the high flows, the discharge exceeds the hydraulic capacity of the plants and most of the water flows over the spillway, thereby approximating the existing condition. During low flow periods the values of shear velocity along the river banks are less than 0.01 m/s for existing and proposed conditions, with the exception of 15 m around the powerhouses where the shear velocity is 0.02 – 0.05 m/s. In all cases, the shear velocity is below the identified critical value of 0.08 m/s. During normal operation, represented by the mid flow case, the proposed condition has the same (or lower) values of shear velocity along the banks than the existing condition. Therefore, the Project is not expected to cause increased stream bank erosion that would have an adverse effects on aquatic habitat.

Analysis of the changes to shear velocity was also used to assess the potential for changes in sediment transport under proposed conditions. Overall, the Project may change current sediment movement patterns in the immediate vicinity of the dam and new powerhouse, but the changes will be very localized and represent minor alterations of existing conditions not a significant increase in sediment transport. Upstream of the Lowell Project area, the bed movement will be similar except there will likely be a shift to the left side of the channel. Downstream, for most of the channel the conditions won't change enough to affect the bed except for through the island area, where here could be some scour of gravels and fines.

Invasive Aquatic Species.

Invasive aquatic plant and animal species can be spread through improper construction practices. Equipment brought in from other locations can carry seeds and plant parts, or animals, which may result in new invasive species being introduced. The introduction and spread of such species can be managed and minimized by implementing appropriate best management practices during construction at the Project.

E.2.3.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of fisheries resources in order to avoid and/or mitigate for the effects identified in Section E.2.3.2.

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Erosion and Sedimentation and Control Plan

An erosion and sedimentation control plan, to be implemented during Project construction, will be required by the FERC, the USACE, and the State of Ohio under their respective regulatory approval processes. Prior to the start of construction, FFP will develop the plan in consultation with all of these agencies, and the plan will addresses the relevant erosion and sedimentation control requirements of all agencies in one document. This plan will include all provisions necessary to minimize erosion and sedimentation during Project construction and to stabilize banks post-construction.

Fish Exclusions and Protection Measures

The Project design includes fish protection measures consistent with industry practices. Specifically, the intake has been designed to have an approach velocity of less than two feet per second at the intake rack which will reduce impingement potential. The rack itself will have 2 inch clear spacing to reduce the potential for fish entrainment. Lastly, fish survival has been considered in the selection of turbines for this Project. The proposed Kaplan units have relatively low runner speeds and large blade spacing, which will increase turbine survival for any fish that do enter the unit.

Invasive Species Control Plan

FFP will also prepare an Invasive Species and Noxious Weed Control Plan that will delineate the procedures that will be followed to minimize the introduction or spread of invasive species and during Project construction, and during future in-water maintenance activities. The plan will be developed prior to the start of Project construction, in consultation with the FERC, the USACE, and ODNR.

E.2.4 Water Quantity and Quality

E.2.4.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.4.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. As a result of their review of the PAD, the following agencies provided written comments and study requests related to water resources in the Project area.

- USFWS (letter dated December 16, 2010, Appendix A): Requested an assessment of potential water quality effects, focusing on dissolved oxygen and temperature.
- ODNR (letter dated January 3, 2011, Appendix A): Requested an assessment of potential water quality effects, focusing on dissolved oxygen and temperature.
- Friends of the Lower Muskingum River (letter dated March 12, 2011, Appendix A): Requested an assessment of potential water quality effects, focusing on dissolved oxygen.

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E.2.4.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

In response to the licensing studies requested by Stakeholders, FFP conducted the following studies related to water resources:

- Dissolved Oxygen and Temperature Study
- Project Hydraulic Study

The results of these studies are discussed below. The final study plans and draft reports are provided in Appendices B and C, respectively. Included in Appendix B is a summary of all comments received on the draft study plans. Comments received on the draft study reports will be addressed in the final reports that will be included with the FLA.

Dissolved Oxygen and Temperature Study

FFP's proposed hydroelectric Projects will be located at existing lock and dam sites, and there will be very few changes to existing conditions. However, in the future river flows will be routed through the powerhouse instead of over the dam spillway. Release of water over the spillway is believed to provide some opportunity for aeration, which could be important for maintaining water quality criteria during the summer low flow/high temperature periods. Routing flows through the powerhouse in the future, instead of releasing them via the spillway, could affect downstream dissolved oxygen concentrations during such periods.

Since post-construction conditions cannot be simulated for monitoring at this time, this study was not intended to assess future water quality effects of the Project. Rather, the purposes of this study were to:

- Determine whether spillway releases are currently providing aeration during summer low flow/high temperature periods
- Provide a baseline dataset of DO conditions upstream and downstream of the dam for future comparison to post – construction monitoring data.

Monitoring was conducted upstream and downstream of the dam at the proposed project sites during the summer of 2011. River flows during the summer of 2011 were above the historic median flows. Daily maximum and daily minimum air temperatures were near historic averages for the study period. While the conditions monitored were not representative of critical DO conditions, it does provide a baseline data set upstream and downstream of the dams that will be useful for future analysis of any changes to downstream DO conditions after construction of the Project.

Due to site access constraints monitoring could not be conducted at this Project during 2011. However, results of the monitoring conducted at other Muskingum River Projects provides some information that may be applicable to this Project.

The 2011 monitoring data does generally document slightly increased DO downstream of the dams throughout most of the monitoring period, with the exception of the Rokeby site. At

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Rokeby there is no appreciable difference in upstream and downstream DO concentrations during the monitoring period.

While there are clearly some differences in DO concentration upstream and downstream of the Zanesville, Philo, Malta and Devola sites, it is not clear whether this is related to spillway aeration. The downstream DO concentrations do not show any correlation to several higher flow rain events, during which spillage volumes, and thus spillage aeration potential, would have increased. This may be because the DO was already at or above saturation levels. Alternatively, DO enhancement due to spillage may be more effective at very low flows when the turbulence created by the water moving past the dam and substrate would more pronounced, and more likely to entrain ambient oxygen.

DO depletion in the impounded upstream reach is clearly more significantly affected by overnight algal photosynthetic respiration. The downstream reach is more free flowing and less likely to support the same algal biomass as the upstream reach, which is more pond-like. Thus, is it possible that the difference in upstream and downstream DO concentration are a result of greater overnight DO demand upstream in the impounded reach, rather than a result of spillway aeration.

Project Hydraulic Study

The Projects may cause localized changes in the velocity and directions of water flow, and water surface elevations. These changes could affect recreational navigation, mussel habitat, flood levels, sediment transport, stream bank stability, and other resources. FFP conducted a Hydraulic Modeling Study to provide the data needed to assess the potential effects that each Project may have on local resources.

Hydrology and bathymetry data for the modeling was obtained from USGS and other sources. In addition, FFP collected field data to augment the available bathymetric and water surface elevation data. Both one dimensional (HEC-RAS) and two dimensional (River 2D) modeling was undertaken. Existing and proposed conditions were assessed under various flow conditions depending upon the objectives of the particular analysis. HEC-RAS modeling was used to assess the area of Project effects (APE) and changes in water surface elevations (WSE). River 2D was used to assess changes in flow velocity, direction, and shear velocities.

Modeling results that are relevant to water resources are discussed below including:

- Analysis of changes in water surface elevations (WSEs)
- Analysis of changes in depth averaged velocities
- Analysis of changes in shear velocities

Results of the modeling were also used to support preparation of other studies, including the Recreational Resources Management Plan (RRMP) and Mussel Survey. Modeling results and related effects analyses are therefore also documented in those separate reports, and elsewhere in the license applications.

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Water Surface Elevation (WSE): The calibrated HEC-RAS model was used to develop water surface profiles for existing and proposed conditions under low, mid and high flow scenarios. The average change in water surface elevation between existing and proposed conditions is a decrease of approximately 1 ft. The decrease is approximately the same under low and mid flows. The Projects have a negligible effect on water levels under high flow conditions.

Depth-Averaged Velocity: Depth-averaged velocity results from the two-dimensional model were assessed to determine the change in velocities in each reach that will occur after Project construction. Table E2.4-1 provides the depth averaged velocity changes under proposed conditions in each reach studied.

Reach	Modeled Changes Under Proposed Conditions
Upstream of Zanesville	• At low flows the main flow will shifted towards the canal entrance on the left bank with an increase in depth average velocity to 0.4 m/s. • The proposed condition for mid and high flows show almost no difference from the existing conditions.
Zanesville – Philo Project Reach	• During low flows, there will be a decrease of flow velocity immediately downstream of Zanesville Dam • Immediately downstream of the powerhouse under mid flows there will be a localized increase of velocity to 0.2 m/s, for less than 100 m downstream. • Upstream of Philo dam, the main flow will shift towards the powerhouse intake on the left bank while the velocity range remains unchanged. • As the river discharge is increased the difference between existing and proposed condition is reduced, and at high flow there is almost no difference observed.
Philo – Rokeby Project Reach	• Downstream of Philo Dam, the proposed condition shows a displacement of the main flow towards the powerhouse tailrace under low and mid flows while the rage in velocity remains unchanged. • At high flow condition there is no significant change between existing and proposed condition after 200 m from the Philo powerhouse. • Upstream of Rokeby dam, the main flow will shift towards the powerhouse intake on the right bank while the velocity range remains unchanged. • As the discharge in the river increases, the difference between existing and proposed condition is reduced and at high flow there is almost no difference observed.
Rokeby - Malta Project Reach	• Downstream of Rokeby Dam, the proposed condition shows a displacement of the main flow towards the powerhouse tailrace on the right bank under low and mid flows. The rage in velocity is increased to 0.4 m/s at low flow and to 1.4 m/s at high flow. • At high flow condition there is no significant change between existing and proposed condition after 500 m from the Rokeby powerhouse. • Upstream of Malta Dam the main flow will be shifted towards the powerhouse intake on the right bank. The velocity range is increased to 0.2 – 1.9 m/s at low and high flow, respectively. • Under normal operating conditions the local increase of velocity is perceived on a distance of approximately 100 m upstream of the intake.
Below the Malta Project	• The proposed condition shows a displacement of the main flow towards the powerhouse tailrace on the right bank under low and mid flows. • The rage in velocity remains unchanged, however the location of the high velocity core is slightly moved closer to the discharge location near the powerhouse tailrace. • At all analyzed flow conditions there is no significant change between existing and proposed condition after 300 m downstream from the Malta powerhouse.

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Reach	• Modeled Changes Under Proposed Conditions
Above Beverly Project Reach	• The main flow will be shifted towards the powerhouse intake on the right bank. The velocity range remains unchanged. • Under normal operating conditions the local displacement of the flow is perceived on a distance of approximately 100 m upstream of the intake.
Beverly – Lowell Project Reach	• The proposed condition shows a displacement of the main flow towards the powerhouse tailrace on the right bank under low and mid flows. The rage in velocity is locally increased to 0.4 m/s at low flow and to 1.4 m/s at high flow. • At high flow condition there is no significant change between existing and proposed condition after 300 m downstream from the Beverly powerhouse. • Upstream of Lowell Dam the main flow will be shifted towards the powerhouse intake on the left bank. The velocity range is increased to 0.2 – 1.6 m/s at low and high flow, respectively. • There will also be a partial realignment of the flow path to accommodate for the relocation of the outflow. This flow realignment produces an increase in velocities on the right side of the main channel about 400 m upstream of the dam.
Lowell – Devola Project Reach	• Downstream of Lowell Dam the proposed condition shows a displacement of the main flow towards the powerhouse tailrace on the left bank under low and mid flows. The rage in velocity remains unchanged. • There is a localized increase in velocity around the powerhouse tailrace. This local increase in velocity at the powerhouse tailrace diminishes after 200 m due to convergence with the main river channel. • At high flow condition there is no significant change between existing and proposed condition after 300 m from the Lowell powerhouse. • Upstream of Devola Dam the main flow will be shifted towards the powerhouse intake on the right bank. The velocity range is increased to 0.5 – 2.1 m/s at low and high flow, respectively. • There will be an acceleration of the flow approaching the intake in the area 50 m around the intake location. Beyond this distance there is no noticeable departure from existing conditions.
Below the Devola Project Reach	• The proposed condition shows a displacement of the main flow towards the powerhouse tailrace on the right bank under low and mid flows. The rage in velocity remains unchanged. • There is a localized increase in velocity around the powerhouse tailrace that diminishes after 250 m • At high flow condition there is no significant difference between existing and proposed condition after 300 m from the powerhouse.

Table E.2.4-1 Depth Averaged Velocity in Each Reach Under Proposed Conditions (Source: FFP)

Shear Velocity Changes: Shear velocity is a property of the flow related to the shear stress exerted by the flow on the channel boundary. It is a useful variable in the assessment of potential changes related to sediment transport and stream bank erosion. Under existing conditions, shear velocity is higher near the deeper portions of the main channel and lower in the shallower areas near the banks. The highest values of shear velocity are associated with the highly turbulent areas in the vicinity of the dams and powerhouse structures. Other areas with high shear velocities are associated with steep gradients in the channel bed where the effective slope of the water surface is also steep (slopes of 0.5% – 1.0% can be hydraulically steep).

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For the proposed condition, during low and mid flows there is a general reduction in shear velocity around most of the length of dam structure due to the relocation of the main discharge to the powerhouse. Immediately around the powerhouse intakes and tailraces there are local increases of shear velocity. However, after 300 – 500 m there is little to no appreciable difference between existing and proposed conditions.

E.2.4.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft study reports contained in Appendix C, for review by agencies and interested organizations. Comments received related to Project effects on water resources will be addressed in the FLA.

E.2.4.2 Project Effects

Potential Project effects on water resources include: (1) effects on water quality due to erosion and sedimentation during construction; (2) temporary changes to hydraulic conditions during construction; and (3) permanent changes to hydraulic conditions.

Erosion and Sedimentation During Construction

Project effects on water resources could include erosion and sedimentation during construction in and adjacent to nearshore habitat, which would affect water quality. Such effects will be temporary and can be minimized by implementing required state and federal best management practices for erosion and sedimentation control, including shoreline stabilization measures, turbidity monitoring, and DO monitoring during construction.

Temporary Changes to Hydraulic Conditions

Construction-related hydraulic changes will be temporary and localized. Such effects are unavoidable in order to facilitate safe and efficient construction. However, the timing of such disturbances can be factored into the construction schedule and sequencing in order to avoid hydraulic changes during the recreation season and any sensitive fish spawning periods indentified by agencies.

Permanent Changes to Hydraulic Conditions

Permanent change in hydraulics will be minimal and primarily localized in the immediate area near the dam and proposed powerhouse.

The average change in impoundment water surface elevation between existing and proposed conditions is a decrease of approximately 1 ft which is not expected to have an adverse effect on water quality.

Results of the depth-averaged velocity modeling indicate that changes in depth averaged velocity will occur primarily in the vicinity of the dam and powerhouse. Changes in shear velocities are not expected to adversely affect water quality.

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Under existing conditions, shear velocity is higher near the deeper portions of the main channel and lower in the shallower areas near the banks. Under proposed conditions, during low and mid flows there is a general reduction in shear velocity around most of the length of dam structure due to the relocation of the main discharge to the powerhouse. Immediately around the powerhouse intakes and tailraces there are local increases of shear velocity. However, after 300 – 500 m there is little to no appreciable difference between existing and proposed conditions. Changes in shear velocities are not expected to adversely affect water quality.

E.2.4.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of water resources in order to avoid and/or mitigate for the effects identified in Section E.2.3.2.

Erosion and Sedimentation and Control Plan

An erosion and sedimentation control plan, to be implemented during Project construction, will be required by the FERC, the USACE, and the State of Ohio under their respective regulatory approval processes. Prior to the start of construction, FFP will develop the plan in consultation with all of these agencies, and the plan will addresses the relevant erosion and sedimentation control requirements of all agencies in one document. This plan will include all provisions necessary to minimize erosion and sedimentation during Project construction and to stabilize banks post-construction. The plan will also address turbidity and DO monitoring to occur during construction.

Construction Related Hydraulic Changes

The timing of hydraulic condition changes (disturbances in water levels and flows) will be factored into the construction schedule and sequencing in order to avoid hydraulic changes during the recreation season and any sensitive fish spawning periods identified by agencies.

E.2.5 Land and Water Uses

E.2.5.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.5.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. Except for comments related to recreational uses which are addressed in Section E.2.5, no agency comments or study requests were received related to potential project effects on land and water uses in the Project area.

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E.2.5.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

No studies related to potential Project effects on land and water uses in the Project area were requested by Agencies or Stakeholders. The RRMP, discussed further in section E.2.6, addresses Project effects on recreational land uses.

E.2.5.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft study reports contained in Appendix C for review by agencies and interested organizations. Comments received related to Project effects on land and water uses will be addressed in the FLA.

E.2.5.2 Project Effects

Potential Project effects on land and water uses include: (1) changes to existing recreational land uses; and (2) conversion of land use for new transmission line corridor.

Changes to Existing Recreational Land Uses

Construction of the Project powerhouse will result in a change of use of some existing recreational access lands in the immediate area of the new powerhouse. This effect is unavoidable, but will not preclude all current recreational access. Such effects can be mitigated by enhancing recreational facilities and access on remaining ODNR lands away from the powerhouse. The RRMP should address the loss of recreational access or facilities, both during construction and permanently, and identify plans for mitigating such effects.

Conversion of Land Uses for Powerhouse and Transmission Line Corridor

The Project will require construction of a new transmission line that connects to the nearest available local utility substation. Wherever possible this transmission line corridor will travel along roadways and existing transmission line routes, and existing poles will be used when feasible. Therefore, much of the line route will travel through a previously disturbed areas (i.e., roadsides) and the extent of new intrusions on existing land uses will be minimized. In areas where new lines routes must be established, the extent of the areas to be disturbed during construction will be minimal, and permanent effects will be limited to the width of the line and pole, with some clearance on either side for future maintenance.

However, in order to maintain access to the line, and for line safety purposes, a corridor will be maintained along the line where large growth will be regularly removed. Management measures to be implemented along the new transmission corridor should be developed in consultation with agencies in order to ensure minimal effects on adjacent land uses.

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E.2.5.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of land and water uses in order to avoid and/or mitigate for the effects identified in Section E.2.5.2.

Recreation Resources Management Plan

As discussed in Section E.2.6, a RRMP has been developed to address both construction related and long term effects on existing recreational facilities and uses in the Project area. A draft of this Plan is being distributed with the DLA, and comments received will be addressed in the final RRMP prior to filing with the FLA.

Transmission Line Corridor Management Plan

After completion of Project construction FFP will develop a Transmission Line Corridor Management Plan. This plan will be developed in consultation with the FERC, the USACE, and ODNR, and it will detail procedures to be manage newly created transmission line corridors that are develop as part of the FERC-licensed Project.

E.2.6 Recreational Resources

E.2.6.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.6.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. As a result of their review of the PAD, the following agencies provided written comments and study requests related to recreation resources in the Project area:

- ODNR (letter dated January 3, 2011, Appendix A): Requested an assessment of potential recreation effects and mitigation measures.
- Friends of the Lower Muskingum River (letter dated March 12, 2011, Appendix A): Requested an assessment of potential recreation effects.

E.2.6.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

In response to comments by Stakeholders and Agencies, FFP has prepared a RRMP to address project effects on existing recreational facilities and uses in the Project area. The final study plan and draft RRMP are provided in Appendices B and C, respectively. Comments received on the draft RRMP be will addressed in the final RRMP that will be included with the FLA.

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E.2.6.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft RRMP contained in Appendix C, for review by agencies and interested organizations. Comments received related to Project effects on recreational resources will be addressed in the FLA.

E.2.6.2 Project Effects

Potential Project effects on recreation resources include: (1) Public safety concerns during construction; (2) construction related effects on existing recreational facilities and uses; and (3) long term effects on exiting recreation facilities and uses.

Public Safety

Public safety is the primary concern when addressing how construction activities may temporarily affect recreational access in the Project area. The proposed Project will require construction activities such as installation of cofferdams, in-river and shoreline excavation, and shoreline modifications. Equipment and supplies will need to be transported to the site of the powerhouse and associated facilities. The extent of land disturbed will differ at different stages of construction. In addition to land based effects, construction may also create temporary changes to hydraulics in the immediate vicinity of the dams. This would occur mostly during periods of cofferdam installation and removal and when flow releases will need to be managed to allow safe in river access.

Ensuring the safety of the public will require some restrictions at the Project site during construction. Anticipated construction requirements (e.g., required lay down areas, sediment control structures) and site-specific conditions should be used to define the area within which public access must be restricted or excluded during construction.

Flows and water levels in the immediate area of the Project will be temporarily affected by the placement of a cofferdam at the Project intake and tailrace. A cofferdam will not be required for the entire construction period. Cofferdam hydraulic effects should be considered in the delineation of restricted public areas.

Construction Related Effects Existing Recreational Facilities and Uses

Construction and related public safety access restrictions will affect use of some existing recreational facility and uses in the Project area. A summary of construction related effects to each existing recreational facility or use is provided in Table E.2.6-1.

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Recreational Facility or Use	Temporary Construction Related Effects
Lowell Lock Park	No effects
Recreational boating through the lock	No effects
Shoreline fishing at the Lowell Lock Park	No effects

Table E.2.6-1. Lowell Recreational Facilities and Uses Construction Related Effects (Source: FFP)

Potential Long-Term Effects on Existing Recreation Facilities and Uses.

Potential long-term operational effects on each existing recreational facility or use in the Project area are listed in Table E.2.6-2.

Recreational Facility or Use	Project Operations Related Effects
Lowell Lock Park	No effects
Recreational boating through the lock	No effects
Shoreline fishing at the Lowell Lock Park	No effects

Table E.2.6-2. Lowell Recreational Facilities and Uses Potential Long Term Effects (Source: FFP)

Hydraulic modeling (FFP, 2012a) was conducted to assess flow velocity and direction under existing and proposed conditions and was used to assess the effects on recreational boating in the Project area. The magnitude of the Project's effects on flow velocity and direction is highest at low flows. At higher flows the effects of the Project are nearly undetectable due to the increased in-channel river velocity. Results of the hydraulic model show that flow velocities begin to exceed 1.6 feet per second (ft/s)(0.5 m/s) within an approximately 450 foot radius of the intake at 3,630 cfs and within the intake at 1,000 cfs.

The effects of flow velocity and direction changes on boating are anticipated to be minimal in the upstream pool. Velocities do not accelerate due to the Project operations near the lock entrance. The water adjacent to the dam is already a known boating danger, and the Project does not exacerbate the existing hazard. Likewise, the flow velocity and direction downstream of the Project will be similar to present conditions in the lock exit.

The Project will affect water surface elevations (WSE) in the pool upstream of the Lowell Dam. A net decrease in water surface elevations is expected in the pool above the Project. As river discharge rises and falls throughout the year the Project impact on WSE changes. However, the shallow point in the Lowell pool will still maintain a depth of approximately 5.5 feet under proposed conditions. Thus, WSE modeling shows that at the shallowest point in the pool the recreational boating will not be adversely affected.

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E.2.6.3 Measures Proposed by the Applicant

Public Safety Restriction Area (PSRA)

During construction the Project will have a Public Safety Restriction Area (PSRA). In order to ensure construction does not represent a public safety hazard, the construction PSRA will be bordered by temporary restriction measures such as metal ring-fencing. During construction FFP will comply with all relevant construction codes in order to ensure public safety. At each Project these areas may normally be accessible to the public or private property owners but may or may not be utilized for recreational purposes.

FFP estimates that the PSRA at each proposed Project will be in effect for one and a half years. Each of the seven proposed Projects is evaluated individually for effects due to construction restrictions for this length of time. Detailed construction planning, including scheduling of construction times, will occur after the licensing process. However, the following assessment of construction related effects will be used to develop the construction schedule and sequence of activities in order to minimize the extent and duration of construction related effects on existing recreational access to the extent feasible.

Mitigation for Construction Related Effects

There are no construction related effects to existing recreational facilities or uses in the Project area so no mitigation is required or proposed..

Potential Long-Term Effects on Existing Recreation Facilities and Uses.

There are no potential long-term operations effects on existing recreational facilities and uses in the Project area so no mitigation is necessary or proposed.

E.2.7 Cultural Resources

E.2.7.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.7.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. As a result of their review of the PAD, the following agencies provided written comments and study requests related to cultural resources in the Project area.

- ODNR (letter dated January 3, 2011, Appendix A): Requested an assessment of potential Cultural Resources effects.

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E.2.7.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

In response to the licensing studies requested by Stakeholders and agencies, FFP conducted a cultural resources study. The final study plan is provided in Appendix B.

The report details the locations of archeological sites and historic structures located in the Project area. Due to restrictions regarding the release of archeological site location data, the draft report has been distributed separately to the Ohio SHPO, ODNR and the FERC only. Comments received on the draft study report from these agencies will be addressed in the final report that will be included with the FLA.

E.2.7.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA for review by agencies and interested organizations. The draft report has been distributed separately to the Ohio SHPO, ODNR, and the FERC. Comments received related to Project effects on cultural resources will be addressed in the FLA.

E.2.7.2 Project Effects

Potential Project effects on cultural resources will be identified in the HPMP. The HPMP will be developed in consultation with the Ohio SHPO and will comply with applicable federal and state regulations regarding the protection of historic and archeological resources.

E.2.7.3 Measures Proposed by the Applicant

Measures specifically related to the protection of cultural resources will be identified in the HPMP. The HPMP will be developed in consultation with the Ohio SHPO and will comply with applicable federal and state regulations regarding the protection of historic and archeological resources.

E.2.8 Scenic and Aesthetic Resources

E.2.8.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.8.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. No studies related to potential Project effects on aesthetic resources in the Project area were requested by agencies or stakeholders. However, the following stakeholders and agencies provided written comments related to aesthetic resources in the Project area:

- Friends of the Lower Muskingum River (letter dated March 21, 2011, Appendix A): Expressed concern over the initial proposal of completely dewatering the spillway at each

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dam when river flows were less than the Project's hydraulic capacity (approximately 50% of the year).

- ODNR (letter dated January 3, 2011, Appendix A): Expressed concerns regarding the aesthetics of placing some of the powerhouse structures along the lock wall.

E.2.8.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

No studies specifically related to scenic and aesthetic resources were requested or conducted.

E.2.8.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft study reports contained in Appendix C, for review by agencies and interested organizations. Comments received related to Project effects on aesthetic resources will be addressed in the FLA.

E.2.8.2 Project Effects

Potential Project effects on aesthetic resources include: (1) addition of powerhouse and ancillary structures to the existing lock and dam site; and (2) reduction in flow over the spillway.

Project Aesthetics

The addition of a powerhouse and other ancillary structures will change the aesthetics of the existing lock and dam sites. Effects can be minimized by locating the powerhouse on the shoreline opposite the locks, and designing the buildings to blend with the surrounding structures.

Flow Reduction Over the Spillway

The Project will divert flows that are currently passed over the spillway for use in generation. However, flows will exceed turbine capacities approximately 50% of the year, primarily in the fall and spring. Thus, the spillway will continue to have flow passing over it approximately half the year. However, this will typically occur outside the summer recreation season, unless spillage is occurring due to river flows exceeding turbine capacities, or river flows being too low for unit operations.

The site is a popular summer recreational facility and stakeholders have noted that the lack of spillage could detract for the recreational experience. This could be mitigated by passing an aesthetic veiling flow over the spillway during the recreation season.

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E.2.8.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of aesthetic resources in order to avoid and/or mitigate for the potential Project effects identified in Section E.2.8.2

Project Design

The proposed powerhouse will be located on the shore opposite the lock, and will utilizes a low-profile design that blends with the existing structures to the extent feasible. In addition, the facilities will be designed to minimize the footprint of new buildings to the extent practical.

Aesthetic Veiling Flow

FFP is proposing to provide a veiling flow at the dam to maintain aesthetics during the recreation season. A flow equivalent to 1/2 inch of water (approximately 25.4 cfs) will be provided over the dam during the recreation season (May 15 through October 15). This will enhance aesthetics for people recreating in the Project area.

E.2.9 Geologic and Soil Resources

E.2.9.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.9.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. No agency comments or study requests were received related to potential Project effects on geologic and soil resources in the Project area. However, erosion and sedimentation control will be required during construction in compliance with state and federal regulations.

E.2.9.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

No studies related to potential Project effects on geologic and soil resources in the Project area were requested by agencies or stakeholders. However, FFP's hydraulic modeling did include an assessment of potential changes in sediment transport. The results of this study are discussed below. The final study plan and draft report are provided in Appendices B and C, respectively. Comments received on the draft study report will be will addressed in the final reports that will be included with the FLA.

Project Hydraulic Study- Sediment Transport and Stream Bank Erosion Assessment

Stream bank erosion and sediment transport could affect aquatic habitat in the Project area. Shear velocity is an indicator of the potential for stream bank erosion and sediment transport, as higher values are associated with movement (erosion) of larger and heavier particles. A review of the

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shear velocities around the Project during high flows reveals that the stream banks in the existing condition are able to withstand shear velocities in excess of 0.08 m/s for short periods of time without showing evidence of erosion. The model of proposed conditions at high flows reflects no change in the magnitude of the shear velocities encountered along the river banks. At the high flows, the discharge exceeds the hydraulic capacity of the plants and most of the water flows over the spillway, thereby approximating the existing condition. During low flow periods the values of shear velocity along the river banks are less than 0.01 m/s for existing and proposed conditions, with the exception of 15 m around the powerhouses where the shear velocity is 0.02 – 0.05 m/s. In all cases, the shear velocity is below the identified critical value of 0.08 m/s. During normal operation, represented by the mid flow case, the proposed condition has the same (or lower) values of shear velocity along the banks than the existing condition. Therefore, the Project is not expected to cause increased stream bank erosion that would have an adverse effects on aquatic habitat.

Analysis of the changes to shear velocity was also used to assess the potential for changes in sediment transport under proposed conditions. Overall, the Project may change current sediment movement patterns in the immediate vicinity of the dam and new powerhouse, but the changes will be very localized and represent minor alterations of existing conditions not a significant increase in sediment transport. Upstream of the Lowell Project area, the bed movement will be similar except there will likely be a shift to the left side of the channel. Downstream, for most of the channel the conditions won't change enough to affect the bed except for through the island area, where here could be some scour of gravels and fines.

E.2.9.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA and the draft study reports contained in Appendix C, for review by agencies and interested organizations. Comments received related to Project effects on geologic and soil resources will be addressed in the FLA.

E.2.9.2 Project Effects

Potential Project effects on geologic and soil resources include: (1) effects on sediment movement due to erosion and sedimentation during construction; and (2) permanent changes to hydraulic conditions.

<u>Erosion and Sedimentation During Construction</u>

Project effects on geologic and soil resources could include erosion and sedimentation during construction. Such effects will be temporary and can be minimized by implementing required state and federal best management practices for erosion and sedimentation control, including shoreline stabilization measures, during construction, including turbidity and DO monitoring during construction.

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Permanent Changes to Hydraulic Conditions

Permanent change in hydraulics will be minimal and primarily localized in the immediate area near the dam and proposed powerhouse.

The average change in impoundment water surface elevation between existing and proposed conditions is a decrease of approximately 1 ft which is not expected to have an adverse effect on geologic and soils resources.

Results of the depth-averaged velocity modeling indicate that changes in depth averaged velocity will occur primarily in the vicinity of the dam and powerhouse. Changes in these velocities are not expected to adversely affect geologic and soils resources.

Under existing conditions, shear velocity is higher near the deeper portions of the main channel and lower in the shallower areas near the banks. Under proposed conditions, during low and mid flows there is a general reduction in shear velocity around most of the length of dam structure due to the relocation of the main discharge to the powerhouse. Immediately around the powerhouse intakes and tailraces there are local increases of shear velocity. However, after 300 – 500 m there is little to no appreciable difference between existing and proposed conditions. Changes in shear velocities will change current sediment transport patterns, but will not exacerbate conditions. Similarly, changes in shear velocities will not cause an increase in stream bank erosion.

E.2.9.3 Measures Proposed by the Applicant

FFP is proposing the following measures specifically related to the protection of geologic and soil resources.

Erosion and Sedimentation and Control Plan

An erosion and sedimentation control plan, to be implemented during Project construction, will be required by the FERC, the USACE, and the State of Ohio under their respective regulatory approval processes. Prior to the start of construction, FFP will develop the plan in consultation with all of these agencies, and the plan will addresses the relevant erosion and sedimentation control requirements of these agencies in one document. This plan will include all provisions necessary to minimize erosion and sedimentation during Project construction and to stabilize banks post-construction.

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E.2.10 Socioeconomic Resources

E.2.10.1 Agency Recommendations and Studies Conducted by the Applicant

E.2.10.1.1 Initial Stage Recommendations

FFP prepared a PAD and distributed it on November 30, 2010 to the appropriate resource agencies and other interested parties. Appendix A contains documentation of consultation. No agency comments or study requests were received related to potential Project effects on socioeconomic resources in the Project area.

E.2.10.1.2 Licensing Studies Conducted by the Applicants and Related Agency Consultation

No studies related to potential Project effects on socioeconomic resources in the Project area were requested by agencies or stakeholders or conducted by FFP.

E.2.10.1.3 Agency Comments and Recommendations in Response to Draft Application

FFP is distributing this DLA for review by agencies and interested organizations. Comments received related to Project effects on socioeconomic resources will be addressed in the FLA.

E.2.10.2 Project Effects

The Project as proposed will have no adverse effects on socioeconomic resources. Construction jobs, equipment and supply procurement from local sources whenever practical, and tax payments to the community will have positive effects on the local economy.

E.2.10.3 Measures Proposed by the Applicant

FFP is proposing no PM&E measures specifically related to socioeconomic resources in the Project area.

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E.3 Agency Consultation (18 CFR §4.61(d) (2) (iii))

Copies of all agency consultation, including letters, meeting minutes, telephone discussion notes and substantive electronic mail, are provided in Appendix A. The consultation appendix also includes a chronological listing of all correspondence to aid in locating documents. The following summary documents that FFP has complied with the FERC three stage consultation requirements for the TLP.

E.3.1 Initial Stage Consultation

FFP initiated Stakeholder consultation in advance of filing the Preliminary Permit Applications for the Muskingum River Projects in March, 2009, and continued early outreach during preparation of the PAD. FFP's early consultation included the U.S. Army Corps of Engineers (USACE), Huntington District, U.S. Fish and Wildlife Service (USFWS), Ohio Department of Natural Resources (ODNR), Ohio Environmental Protection Agency (OEPA) and the Ohio Historic Preservation Office (OHPO).

The PAD was filed with FERC and issued for agency review and comment on November 30, 2010. FFP also simultaneously filed its Notice of Intent (NOI) to file and original license application for the Project and a request for approval to use the TLP with FERC on November 30, 2010. FERC approved FFP's request to use the TLP on January 21, 2011.

FFP conducted Joint Agency Meetings (JAM) on March 8, 2011 in Zanesville, OH, March 9, 2011 in McConnelsville, OH, and March 10, 2011 in Beverly, OH. All comments received were addressed through studies and the analysis in this DLA. Copies of comments received are provided in Appendix A

The following Stakeholders submitted written comments on the PAD and study requests (Copies of all correspondence are contained in Appendix A):

Entity	Date Received
Peoria Tribe Indians of Oklahoma	12/8/2010
USFWS	12/16/2010
ODNR	1/3/2011
Miami Tribe of Oklahoma	3/28/2011
Friends of the Lower Muskingum River (FLMR)	3/21/2011
Hannahville Indian Community	4/5/2011

Table E.3-1. PAD Comments and Study Requests (Source: FFP)

E.3.2 Second Stage Consultation

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Second Stage studies were scoped and conducted in consultation with the relevant resource agencies and other Stakeholders. FFP issued draft study plans on July 1, 2011 for review. No comments on the draft study plans were received; however FFP did correspond with the ODNR on study methodology throughout their execution. The PSD included the following resource studies:

- Hydraulic Study
- Dissolved Oxygen Study
- Desktop Fish Entrainment and Survival Study
- Mussel Surveys and Impact Analysis
- Wetland Delineations Survey
- Indiana Bat Habitat Survey
- Eastern Spadefoot Habitat Survey
- Recreation Resources Management Plan
- Cultural Resources Survey

Copies of all correspondence are included in Appendix A, and the final study plans are provided in Appendix B.

Draft reports for all studies conducted are included in Appendix C of this DLA:

- Wetland Delineations Survey (Appendix C-1)
- Mussel Surveys and Impact Analysis (Appendix C-2)
- Eastern Spadefoot Habitat Survey (Appendix C-3)
- Indiana Bat Habitat Survey (Appendix C-4)
- Desktop Fish Entrainment and Survival Study (Appendix C-5)
- Hydraulic Study (Appendix C-6)
- Dissolved Oxygen Study (Appendix C-7)
- Recreation Resources Management Plan (Appendix C-8)
- Cultural Resources Survey (Volume IV- Non Public Information)

Each of these studies is presented and discussed in Sections E.1 and E.2 of this DLA.

FFP is complying with FERC second stage consultation requirements by issuing this DLA and draft study reports for 90-day agency review and comment. Prior to filing the Final License Application (FLA) with FERC, FFP will address all comments on the DLA and study reports. In the FLA, Appendix A will provide a summary of all comments received on the DLA draft study report and FFP's responses, or a reference to where the comment was addressed in the FLA and final study reports.

E.3.3 Agencies Provided with Copies of the License Application

A complete list of all agencies, tribes and interested parties that were provided copies of the DLA is contained in the Initial Statement.

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E.4 Comprehensive Plans and Other Resource Management Plans

E.4.1 FERC Comprehensive Plans

Section 10(a)(2)(A) of the Federal Power Act (FPA), 16 U.S.C. § 803(a)(2)(A), requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. Under 18 CFR § 4.38, each license applicant must identify relevant Plans and explain how and why a proposed project would or would not comply with such Plans. The Commission's Library of Comprehensive Plans contains twelve Plans for Ohio. As discussed below, FFP has reviewed the relevant Plans and has determined that FFP's Project will be consistent with these Plans.

In some cases, FFP has identified additional plans or updated versions of the Comprehensive Plans that have been filed with the Secretary of the Commission, which FFP has indicated below. Such additional plans or updated versions may be relevant as Resource Plans, though they are not deemed to be Comprehensive Plans until such time that they are approved by the Secretary of the Commission.

1. Environment Canada, U.S. Environmental Protection Agency, Ohio Environmental Protection agency, *et al.* 2004. Lake Erie LWMP (Lake Wide Management Plan) Report. April 2004.

    - FFP has determined that this Plan is not relevant to any proposed FFP project, because it pertains to a geographical area in which no proposed FFP projects are located.

2. National Park Service. The Nationwide Rivers Inventory. Department of the Interior, Washington, D.C. January 1982.

    - The Nationwide Rivers Inventory is a listing of more than 3,400 free-flowing river segments in the United States that are believed to possess one or more "outstanding remarkable" natural or cultural values judgment to be of more than local or regional significance. FFP has reviewed the Inventory for relevancy to FFP's proposed projects.
    - FFP has determined that this Plan is not relevant to any FFP Project, because it does not designate the Muskingum River.

3. Ohio Department of Natural Resources. 1991. Statewide River Inventory. Columbus, Ohio. August 1991.

    - The Ohio statewide river inventory identifies rivers and river segments designated by the Ohio Scenic Rivers Program as scenic, wild, or recreational. There are fourteen designated rivers encompassing 800 scenic river miles protected by the Scenic Rivers Act of 1968.

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- FFP has determined that this Plan is not relevant to any proposed FFP project, because it does not designate the Muskingum River as a member of the Ohio Scenic Rivers Program.

4. Ohio Department of Natural Resources. Ohio Statewide Comprehensive Outdoor Recreation Plan (SCORP): A Plan for the Future. Columbus, Ohio. July 2003.

- The goal of the Ohio SCORP is to guide outdoor recreation land acquisition, facility development, programming and management in the state of Ohio for a five-year planning period.
- Issues include planning, use of public lands, tourism and economic development, and youth and special population issues.
- FFP's proposed projects are consistent with the goals of the Ohio SCORP. FFP's projects are not located in any of the rivers in Ohio that are designated as National Wild and Scenic Rivers, or the fourteen rivers which are designated as falling within the Ohio Scenic Rivers Program.
- FFP has determined that this Plan is not the most current version of the Ohio SCORP, which was replaced by the 2008 SCORP. FFP has consulted the 2008 SCORP as a Resource Plan which is applicable to FFP's proposed projects, but which has not been filed as a Comprehensive Plan with the Commission.

5. Ohio Department of Natural Resources. 2004. Boating on Ohio Waterways Plan. Columbus, Ohio. May 2004.

- The goals of the Boating on Ohio Waterways Plan are: to find out, through a discovery process, what specific issues are most important to Ohio boaters; to further define those issues on a regional and waterway type basis; to analyze the existing distribution of boating opportunities in Ohio; to study boater input and existing boating opportunities in Ohio; to develop strategies and targeted recommendations to improve the boating experience relative to issues identified by Ohio boaters.
- FFP's proposed projects will be consistent with the Boating on Ohio Waterways Plan, as FFP intends to design its projects in order that they will not interfere with recreational boaters' use of the River in the Project areas. The design to be employed at the project sites will ensure that there is no danger to boaters or recreational fishing enthusiasts as a result of FFP's project operations, and in some respects that safety will be enhanced by the presence of the projects. At eight of the nine project sites, the power generating turbines are either integrated into the dam's spillway or are located adjacent to abutments opposite the dam's lock. In either configuration, boat traffic through the locks will be unaffected. At Zanesville Dam, where there is no lock and boat traffic instead bypasses the dam via a canal dug into the shore, FFP plans to configure the project to utilize an island between the canal and the river without impeding the canal's boat traffic.

6. Ohio Environmental Protection Agency. 1995. Cuyahoga River Remedial Action Plan. Twinsburg, Ohio. November 1995.

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- The Cuyahoga River Remedial Action Plan (RAP) was created by the Ohio Environmental Protection Agency (EPA) with a mission to plan and promote the restoration of the environmental quality of the Lower Cuyahoga River through the remediation of existing conditions, prevention of further pollution and degradation, and protection of the resource for future generations. It aims to remove the lower river, and the areas of concern that include tributaries adjacent to the river that drain directly to Lake Erie, from the list of degraded or endangered waterways that, in turn, contribute to the degradation of the Great Lakes.
- FFP has determined that this Plan is not relevant to any proposed FFP project, because it pertains to a geographical area in which no proposed FFP projects are located.

7. Ohio Environmental Protection Agency. 2003. Total Maximum Daily Loads for the Lower Cuyahoga River. Twinsburg, Ohio. September 2003.

    - FFP has determined that this Plan is not relevant to any proposed FFP project, because it pertains to a geographical area in which no proposed FFP projects are located.

8. Ohio River Basin Commission. 1978. Upper Ohio Main Stem Comprehensive Coordinated Joint Plan. Cincinnati, Ohio. January 1978.

    - FFP has determined that this Plan is not relevant to any proposed FFP project, because it pertains to a geographical area in which no proposed FFP projects are located.

9. Ohio River Basin Commission. 1978. Middle Ohio Main Stem Comprehensive Coordinated Joint Plan. Cincinnati, Ohio. January 1978.

    - FFP has determined that this Plan is not relevant to any proposed FFP project, because it pertains to a geographical area in which no proposed FFP projects are located.

10. Ohio River Basin Commission. 1976. Muskingum River Basin Comprehensive Coordinated Joint Plan. Cincinnati, Ohio. October 1976.

    - The Muskingum River Basin Plan's objective is to address the Muskingum River's primary issues covering a spectrum of areas of river management. These concerns include:
    - Water Quality, particularly in the area of acid mine drainage: drastic action had to be taken to curb the effects of the drainage of these mines, and this was identified as the primary water quality concern in the Plan.

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- Water Supply: the Plan outlines a strategy to undergo studies to determine whether the Muskingum River watershed and contains enough clean water to sustain the region's population well into the future.
- Transportation: the Plan states that the fact that the Muskingum River had been discontinued for commercial navigational purposes and is now used only by pleasure boaters, and stating the river's locks and dams had been turned over to the State of Ohio by the U.S. Army Corps of Engineers (USACE).
- Natural Areas, Historic Sites, Recreation: the Plan states that the Muskingum River Basin is almost fully developed for these functions, and points out that the area includes a rehabilitated system of locks and dams, a scenic highway, and a series of parks.
- Flood Damage: the Plan points out that the region has a series of reservoirs that were built to provide flood protection to the entire basin, and that this system has been successful in reducing average annual flood damages.
- Power: the Plan states that Muskingum River Basin contains seven fossil fuel plants and three small gas turbines with an installed generating capacity of 3,386.7 megawatts. It also states that there are no viable hydroelectric sites in the Muskingum Basin.
- FFP's proposed projects will be consistent with the objectives and recommendations of this Plan. FFP is committed to assessing the impacts that its projects will have on the Muskingum River, but does not anticipate them having any negative impact on the Muskingum River's water quality or on its availability to recreational boaters. FFP disagrees with the conclusion about the viability of hydroelectric sites in the Muskingum River Basin and is confident in the potential to generate clean, renewable energy from the flows of the Muskingum River.

11. U.S. Fish and Wildlife Service. 1988. The Great Lakes/St. Lawrence Basin: A component of the North American Waterfowl Management Plan. December 29, 1988.

    - FFP has determined that this Plan is not relevant to any proposed FFP project, because it pertains to a geographical area in which no proposed FFP projects are located.

12. U.S. Fish and Wildlife Service. Undated. Fisheries USA: the Recreational Fisheries Policy of the U.S. Fish and Wildlife Service. Washington, D.C.

    - Fisheries USA is the recreational fisheries policy of the U.S. Fish and Wildlife Service (USFWS). The policy is committed to the objectives of usability, sustainability, and action, and defines USFWS's stewardship role in management of the nation's recreational fishery resources.
    - USFWS's goals include the following: to ensure and enhance the quality, quantity, and diversity of recreational fishing opportunities; to develop and enhance partnerships between governments and the private sector for conserving and managing recreational fisheries; and to cooperate to maintain a healthy recreational fisheries industry.

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- FFP's proposed projects will not conflict with the Fisheries USA policy and the goals of the USFWS with respect to recreational fishing opportunities. FFP is committed to working in cooperation with USFWS to evaluate and mitigate significant effects of FFP's proposed projects on recreational fishing opportunities.

E.4.2 Other Relevant Resource Plans

In conducting its research and outreach to identify relevant Comprehensive Plans, FFP has identified additional plans which may be relevant to FFP's proposed Muskingum River projects as Resource Plans, but which have not been certified by the Secretary of the Commission as Comprehensive Plans. These Resource Plans include the following:

- The Institute for Local Government Administration and Rural Development (ILGARD) at Ohio University. 2005. Lower Muskingum River Watershed Management Plan: Meigs Creek Subwatershed. Athens, Ohio. January 2005.

- The Lower Muskingum River watershed Management Plan serves as a guide for the Friends of the Lower Muskingum River (FLMR) and its partners to improve and protect water quality in the watershed. The first section of the plan describes the entire Lower Muskingum River watershed and contains a definition of the watershed, historical and background information, watershed group organization and partners, natural resource inventory, water quality and water resource inventory, causes and sources of impairments, geographic information, cultural resources, and the physical attributes of streams and floodplains for the Lower Muskingum River.

- FFP's proposed projects will be entirely consistent with the goals of this Plan. FFP is committed to maintaining the integrity of the Muskingum River's water quality, and is working to ensure that its proposed projects do not have adverse environmental effects.

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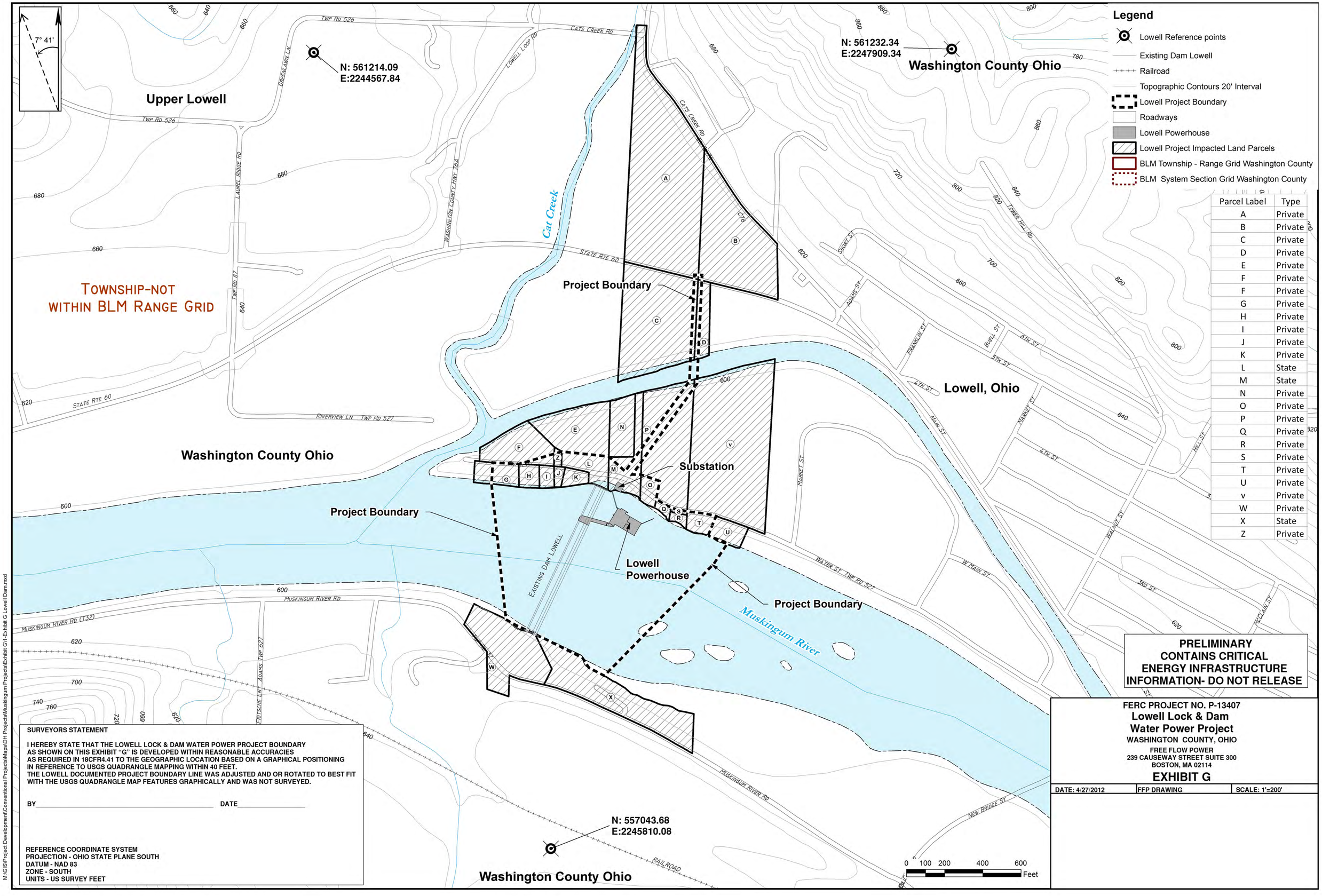
Exhibit G

Project Maps



Parcel Label	Type
A	Private
B	Private
C	Private
D	Private
E	Private
F	Private
F	Private
G	Private
H	Private
I	Private
J	Private
K	Private
L	State
M	State
N	Private
O	Private
P	Private
Q	Private
R	Private
S	Private
T	Private
U	Private
v	Private
W	Private
X	State
Z	Private

PRELIMINARY
CONTAINS CRITICAL ENERGY INFRASTRUCTURE INFORMATION- DO NOT RELEASE

SURVEYORS STATEMENT

I HEREBY STATE THAT THE LOWELL LOCK & DAM WATER POWER PROJECT BOUNDARY AS SHOWN ON THIS EXHIBIT "G" IS DEVELOPED WITHIN REASONABLE ACCURACIES AS REQUIRED IN 18CFR4.41 TO THE GEOGRAPHIC LOCATION BASED ON A GRAPHICAL POSITIONING IN REFERENCE TO USGS QUADRANGLE MAPPING WITHIN 40 FEET.
THE LOWELL DOCUMENTED PROJECT BOUNDARY LINE WAS ADJUSTED AND OR ROTATED TO BEST FIT WITH THE USGS QUADRANGLE MAP FEATURES GRAPHICALLY AND WAS NOT SURVEYED.

BY_____ DATE_____

REFERENCE COORDINATE SYSTEM
PROJECTION - OHIO STATE PLANE SOUTH
DATUM - NAD 83
ZONE - SOUTH
UNITS - US SURVEY FEET

FERC PROJECT NO. P-13407
Lowell Lock & Dam
Water Power Project
WASHINGTON COUNTY, OHIO
FREE FLOW POWER
239 CAUSEWAY STREET SUITE 300
BOSTON, MA 02114

EXHIBIT G

DATE: 4/27/2012	FFP DRAWING	SCALE: 1'=200'

M:\GIS\Project Development\Conventional Projects\Maps\OH Projects\Muskingum Projects\Exhibit G\1-Exhibit G Lowell Dam.mxd