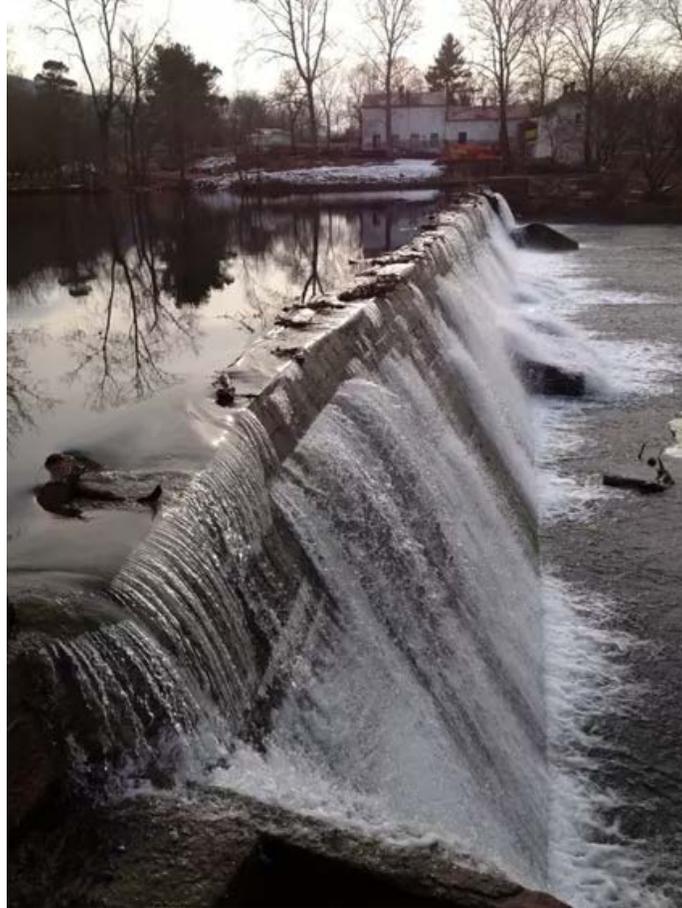


**Burnshire Hydroelectric Facility
Application to the Low Impact Hydropower Institute**



Submitted by:
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Table of Contents

Introduction and History	3
Facility Description.....	3
Standards Selection.....	8
Supporting Information.....	10
Ecological Flow Standard for Zone 1 – Impoundment.....	10
Ecological Flow Standard for Zone 2 – Downstream.....	11
Water Quality Standard for Zone 1 - Impoundment.....	12
Water Quality Standard for Zone 2 – Downstream.....	14
Upstream Fish Passage Standard for Zone 1 – Impoundment.....	14
Upstream Fish Passage Standard for Zone 2 – Downstream.....	15
Downstream Fish Passage Standard for Zone 1 - Impoundment.....	16
Downstream Fish Passage Standard for Zone 2 - Downstream.....	17
Watershed and Shoreline Protection Standards for Zone 1 – Impoundment.....	18
Watershed and Shoreline Protection Standards for Zone 2 – Downstream.....	18
Threatened and Endangered Species Protection for Zone 1 - Impoundment	19
Threatened and Endangered Species Protection for Zone 2 - Downstream	20
Cultural and Historic Resources Standards for Zone 1 – Impoundment	20
Cultural and Historic Resources Standards for Zone 2 - Downstream.....	21
Recreational Resources Standards for Zone 1 - Impoundment.....	22
Recreational Resources Standards for Zone 2 - Downstream.....	23
Sworn Statement and Waiver Form.....	24
Contacts Form.....	26
Agency Contacts	27
Appendices.....	28
Appendix A. Referenced Material	28
Appendix B. Research Summary.....	29
Appendix C. Supporting Photographs of Site	30
Appendix D. Overhead View and Upstream/Downstream River Obstructions	33

Introduction and History

This is the application to the Low Impact Hydropower Institute (LIHI) for certification of Burnshire Hydroelectric, LLC.

This site first began as a grist mill known as Old Rush's Mill. It was purchased by Dr. J. I. Triplett circa 1870's. Dr. Triplett transformed the grist mill into the first source of electric power for the town of Woodstock. A flood in 1924 subsequently destroyed the original powerhouse leaving only the foundation along the dam. This flood prompted the owner to replace the turbines with three hydro turbines to provide the first electricity for the town of Woodstock in 1921 and expanding to other areas in 1923.

After decades of operation, the facility was purchased by VEPCO in 1956, now known as Dominion Energy, and was decommissioned. The facility languished for decades. The energy supply crisis in the 1970's, along with deregulation of the power industry, caused the Public Utility Regulatory Policies Act (PURPA) to be enacted in 1978. The site was then purchased and power generation at the site was restored in the late 1980's. A decade later, the site again became inactive and power generation ceased. The current owner/operator purchased the site in 2012. Since then, all three turbines have been restored and one propeller turbine is generating power. The second propeller turbine will be fully powered by the end of 2019. The third turbine is slated to be generating power in the near future.

Facility Description

The Burnshire Hydroelectric facility was exempted from licensing by the Federal Energy Regulatory Commission (FERC) and was assigned as Project No. P-3287 in 1982. That exemption was transferred to the current owner in 2012 and is monitored by FERC on a three-year inspection cycle. The site is run-of-river with a 13.1-foot low hazard (as deemed by FERC) dam. It is located on the North Fork of the Shenandoah River, near the town of Woodstock, Virginia. The power house has three Leffel turbines installed and they were inspected by Leffel in 2013. From the inspection it was determined that parts likely have been mixed and matched over the years but the core components are two Leffel B-2/4 propeller turbines and a smaller Leffel 21-Z Francis turbine.

The site is located in rural Shenandoah County, Virginia and is surrounded by farm land and limited residential areas. The site can be located by searching in Google Maps for "Burnshire Dam." Figure 13 located in Appendix D, displays an overhead view of the site.

Table 1. Facility Description Information for Burnshire Hydroelectric Facility.

Information Type	Variable Description	Response
Name of the Facility	Facility name	Burnshire Hydroelectric LLC
Location	River name	North Fork Shenandoah River
	River basin name	Shenandoah River Basin
	Nearest town, county, and state	Woodstock, Shenandoah County, Virginia
	River mile of dam above next major river	Approx. river mile 41.7; continuation where North fork combines with South fork to form the Shenandoah river in Front Royal, VA.
	Geographic latitude	38° 52' 31.7" N
	Geographic longitude	-78° 27' 59.7" W
Facility Owner	Application contact names:	R. Lee Harvey, Burnshire Hydroelectric LLC. Application prepared by John Williams, James Madison University
	- Facility owner	R. Lee Harvey, Burnshire Hydroelectric LLC.
	- Operating affiliate	N/A
	- Representative in LIHI certification	Owner
Regulatory Status	FERC Project Number , issuance and expiration dates	P-3287, Exemption: September 22, 1982, Expiration: N/A
	FERC license type or special classification	Exemption
	Water Quality Certificate identifier and issuance date, plus source agency name	No water quality certification was issued.
	Hyperlinks to key electronic records on FERC e-library website (e.g., most recent Commission Orders, WQC, ESA documents, etc.)	https://www.federalregister.gov/documents/2012/03/02/2012-5107/american-land-company-llc-burnshire-hydroelectric-llc-notice-of-transfer-of-exemption FERC has no record of the original exemption on their e-library. A transfer of exemption from 1982 is provided as attachment 2 within the application package.
Power Plant Characteristics	Date of initial operation	March 2, 2012
	Total name-plate capacity (MW)	0.232 MW

Information Type	Variable Description	Response
	Average annual generation (MWh)	1400 MWh
	Number, type, and size of turbines, including maximum and minimum hydraulic capacity of each unit	Two Leffel 27-B4 propeller turbines with original faceplate capacity 145HP each and one Leffel 21-Z Francis with original faceplate capacity of 85HP.
	Modes of operation (run-of-river, peaking, pulsing, seasonal storage, etc.)	Run-of-river
	Dates and types of major equipment upgrades	Ongoing starting in 2012 includes rebuild of three turbines and addition of permanent magnet generator to one turbine.
	Dates, purpose, and type of any recent operational changes	Resumption of power generation; approval of interconnection by Dominion 6/29/2016
	Plans, authorization, and regulatory activities for any facility upgrades	There are no plans for facility upgrades
Characteristics of Dam, Diversion, or Conduit	Date of construction	Built as a grist mill in the late 1800s
	Dam height	13.1 feet, 670 feet above sea level
	Spillway elevation and hydraulic capacity	No separate spillway
	Tailwater elevation	656.8 feet above sea level See Survey and Benchmark by surveyor (Attachment 8)
	Length and type of all penstocks and water conveyance structures between reservoir and powerhouse	Forebay is 150 feet long,
	Dates and types of major, generation-related infrastructure improvements	Ongoing; first generator put online approx. 7/2016
	Designated facility purposes	Hydropower
	Water source	North Fork of the Shenandoah River
	Water discharge location or facility	North Fork of the Shenandoah River
Characteristics of Reservoir and Watershed	Gross volume and surface area at full pool	200 acre-feet
	Maximum water surface elevation (ft. MSL)	670 ft. MSL
	Maximum and minimum volume and water surface elevations for designated power pool, if available	670 ft. MSL
	Upstream dam(s) by name, ownership, FERC number (if applicable), and river mile	- Chapman Dam RM 8 FERC P-6898, owned by the Shenandoah Hydro Co. - Edinburgh RM 58.8 - Timberville RM 84.9

Information Type	Variable Description	Response
	Downstream dam(s) by name, ownership, FERC number (if applicable), and river mile	- Winchester Dam RM 6.5 - Warren 750kW FERC P-2391, not operating, owned by Harbor Hydro Holdings LLC
	Operating agreements with upstream or downstream reservoirs that affect water availability, if any, and facility operation	N/A
	Area inside FERC project boundary, where appropriate	10.722 acres, see Attachment 8- 2012 Survey
Hydrologic Setting	Average annual flow at the dam	160 CFS
	Average monthly flows in CFS	JAN 401, FEB 191, MAR 218, APR 511, MAY 1290, JUN 275, JUL 127, AUG 116, SEP 59, OCT 82, NOV 126, DEC 68
	Location and name of relevant stream gauging stations above and below the facility	Upstream gauge: Mount Jackson, VA USGS 01633000 Downstream gauge: Strasburg, VA USGS 01634000
	Watershed area at the dam	639 sq. miles (Averaged between USGS gauge data at Strasburg and Mount Jackson)
Designated Zones of Effect	Number of zones of effect	2
	Upstream and downstream locations by river miles	N/A; both zones much less than one mile
	Type of waterbody	Zone 1: Impoundment Zone 2: Downstream
	Delimiting structures	N/A
	Designated uses by state water quality agency	Water quality standards designate uses for waters. There are six designated uses for surface waters in Virginia: <ul style="list-style-type: none"> • Aquatic life • Fish consumption • Public water supplies (where applicable) • Recreation (swimming) • Shell fishing • Wildlife
Additional Contact Information	Names, addresses, phone numbers, and e-mail for local state and federal resource agencies	See attached LIHI Facility Contact Form

Information Type	Variable Description	Response
	Names, addresses, phone numbers, and e-mail for local non-governmental stakeholders	See attached LIHI Facility Contact Form
Photographs and Maps	Photographs of key features of the facility and each of the designated zones of effect	See Appendix C, Figure 1 through 3
	Maps, aerial photos, and/or plan view diagrams of facility area and river basin	See Appendix D and attached 2012 Survey

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Standards Selection

The Burnshire Hydroelectric project site has two designated zones of effect for this application. Zone 1, the impoundment, see Figure 1 left panel, is defined at the upstream start of the impoundment (dam) where the water flows into the turbines. Impoundment zone extends 130 feet from the dam face upstream. Zone one extends 500 feet upriver where the river begins to curve. This zone border was roughly determined by a student research project in 2016 and defined by the location where the river bottom sounding (measured with a simple string and weight) water elevation and topography would normalize if no dam existed.

Zone 2, the downstream reach, see Figure 1 right panel, is defined by the area extending from the outlet of the power house, downstream to where the tailrace outflow stream meets the end of a wall in the tailrace. The tailrace outflow then merges with the main channel river flow approximately 100 feet from the power house.

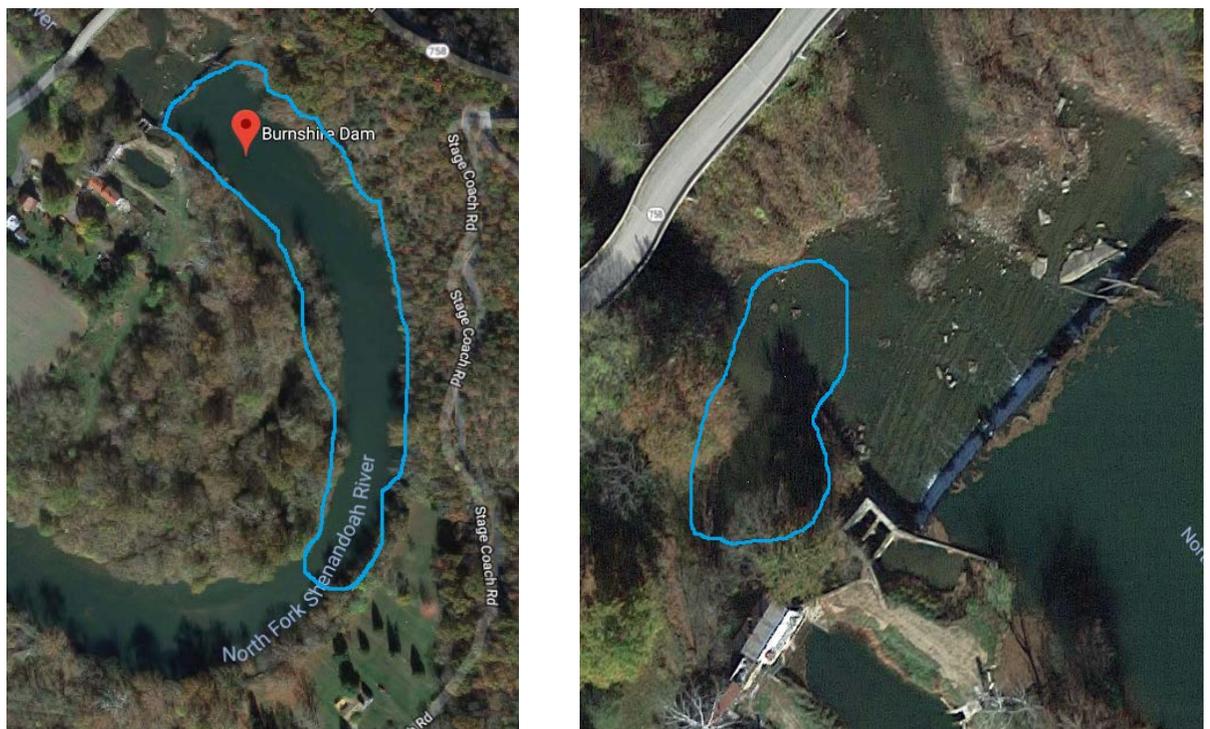


Figure 1. Upstream--LEFT (Zone 1) and Downstream—RIGHT (Zone 2) Zone of Effect

Table 2. LIHI standards selected for Zone of Effect No. 1 - Impoundment

Criterion		Alternative Standards				
		1	2	3	4	Plus
A	Ecological Flow Regimes	X				
B	Water Quality	X				
C	Upstream Fish Passage	X				
D	Downstream Fish Passage	X				
E	Watershed and Shoreline Protection	X				
F	Threatened and Endangered Species Protection	X				
G	Cultural and Historic Resources Protection	X				X
H	Recreational Resources	X				

Table 3. LIHI standards selected for Zone of Effect No. 2 - Downstream

Criterion		Alternative Standards				
		1	2	3	4	Plus
A	Ecological Flow Regimes	X				
B	Water Quality	X				X
C	Upstream Fish Passage	X				
D	Downstream Fish Passage	X				
E	Watershed and Shoreline Protection	X				
F	Threatened and Endangered Species Protection	X				
G	Cultural and Historic Resources Protection	X				X
H	Recreational Resources	X				

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Supporting Information

Ecological Flow Standard for Zone 1 – Impoundment

Criterion	Standard	Instructions
A	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Confirm the location of the powerhouse relative to other dam/diversion structures to establish that there are no bypassed reaches at the facility. • If Run-of-River operation, provide details on how flows, water levels, and operation are monitored to ensure such an operational mode is maintained. • In a conduit project, identify the water source and discharge points for the conduit system within which the hydropower plant is located. • For impoundment zones only, explain how fish and wildlife habitat within the zone is evaluated and managed – NOTE: this is required information, but it will not be used to determine whether the Ecological Flows criterion has been satisfied. All impoundment zones can apply Criterion A-1 to pass this criterion.

Source and Date: FERC Exemption September 22, 1982 (Attachment 2), U.S. Fish and Wildlife Service, State Fish and Wildlife Agency. FERC Transfer of Exemption, March 2, 2012 (Attachment 3).

Burnshire operates as a true run-of-river facility. This is possible due to the unique generation and power electronics equipment that allows variable speed/flow operation of the turbine/generator unit¹. Burnshire uses a permanent magnet generator (PMG) coupled to a four-quadrant inverter that allows continuous power generation from full wicket gate opening to 5% open. This is an innovative solution that allows matching available river flow to outflow while still allowing generation and is an active area of formal industry research and development being completed by Burnshire². River flow is indirectly measured by the water elevation using multiple in channel pressure gauges installed and monitored by Burnshire (a confirmatory backup monitor is located in the forebay). If a measured river level decreases, wicket gates are adjusted to decrease water flow through the turbines. If river flow increases, wicket gates are opened to produce more power or additional turbines can be started with the same river level monitoring feedback mechanism. As previously mentioned, the PMG coupled to the four-quadrant inverter allows dynamic and adaptive river flow management and power production across a wide range of flow variation. The flow vs operation range data is proprietary but can be provided to LIHI under separate document if needed. As well, see appendix B and attachment 11 for more information.

¹ Burnshire is one of only five hydropower sites known in the USA that uses power electronics technology for variable flow and power production.

² A technology report submitted by Burnshire has been selected for presentation in July, 2019 at Hydrovision International in Portland, OR

Ecological Flow Standard for Zone 2 – Downstream.

Criterion	Standard	Instructions
A	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Confirm the location of the powerhouse relative to other dam/diversion structures to establish that there are no bypassed reaches at the facility. • If Run-of-River operation, provide details on how flows, water levels, and operation are monitored to ensure such an operational mode is maintained. • In a conduit project, identify the water source and discharge points for the conduit system within which the hydropower plant is located. • For impoundment zones only, explain how fish and wildlife habitat within the zone is evaluated and managed – NOTE: this is required information, but it will not be used to determine whether the Ecological Flows criterion has been satisfied. All impoundment zones can apply Criterion A-1 to pass this criterion.

Source and Date: FERC Exemption September 22, 1982, U.S. Fish and Wildlife Service, State Fish and Wildlife Agency. FERC Transfer of Exemption, March 2, 2012.

Burnshire operates as a true run of the river facility. This is possible due to the unique generation and modern equipment that allows variable speed/flow operation of the turbine/generator unit. Burnshire uses a permanent magnet generator (PMG) coupled to a four-quadrant inverter that allows continuous generation from full wicket gate opening to 5% open. This is an innovative solution that matches incoming river flow to outflow while still allowing generation and is an active area of research and development. River inflow is measured indirectly via multiple in channel pressure gauges that monitor for drops in surface elevation. Adverse stream effects from water surging can occur when the river flow drops below 200 CFS, usually during the summer. During these times, in addition to the automated controls, daily human review of USGS upstream and downstream flow data takes place to confirm that Burnshire is matching river flow and not affecting the impoundment elevation. If a measured river level decreases the wicket gates are adjusted to decrease water flow into the facility and through the turbines. If river flow increases the wicket gates are opened to produce more power or additional turbines can be started with the same river level monitoring feedback mechanism.

Water Quality Standard for Zone 1 - Impoundment.

Criterion	Standard	Instructions
B	1	Not Applicable / De Minimis Effect: <ul style="list-style-type: none">• If facility is located on a Water Quality Limited river reach, provide an agency letter stating that the facility is not a cause of such limitation.• Explain rationale for why facility does not alter water quality characteristics below, around, and above the facility.

Source and Date: Virginia Department of Environmental Quality, Water Quality Map 2016 <https://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2016305b303dIntegratedReport.aspx>. Virginia Final 2016 305(b)/303(d) Water Quality Assessment Integrated Report.

The Virginia Department of Environmental Quality (VA DEQ) has numerous water monitoring stations positioned along the North Fork of the Shenandoah River. One is located in the tailrace of the Burnshire facility (operated by the National Weather Service Advance Hydrologic Prediction Service). This station has an ID of 1BNFS043.06. The data from this station, along with others operated by the USGS National Water Information System, is grouped together and displayed on a GIS map on the Virginia DEQ website and can be monitored remotely.

Water quality in the state of Virginia is based on whether or not the water can fulfill all six of the designated uses for waters. These six designated uses are aquatic life, fish consumption, public water supplies (where applicable), recreation (swimming), shell fishing, and wildlife. The river in the project vicinity is not impaired for water quality as it does not appear on the most recent state lists of impaired waters in the state water quality standard designated uses for waters.

There are three categories of river quality: *fully supporting*, *insufficient information*, and *not supporting*. This references whether the water supports the water quality standards appointed by the Virginia DEQ. The project area is listed as “fully supporting” the applicable designated uses on the 2016 Water Quality Map (Figure 2). Using the hyperlink above, one is able to search for Woodstock, VA, then select “monitoring stations” and “2016 Rivers” to verify “fully supporting” designation.

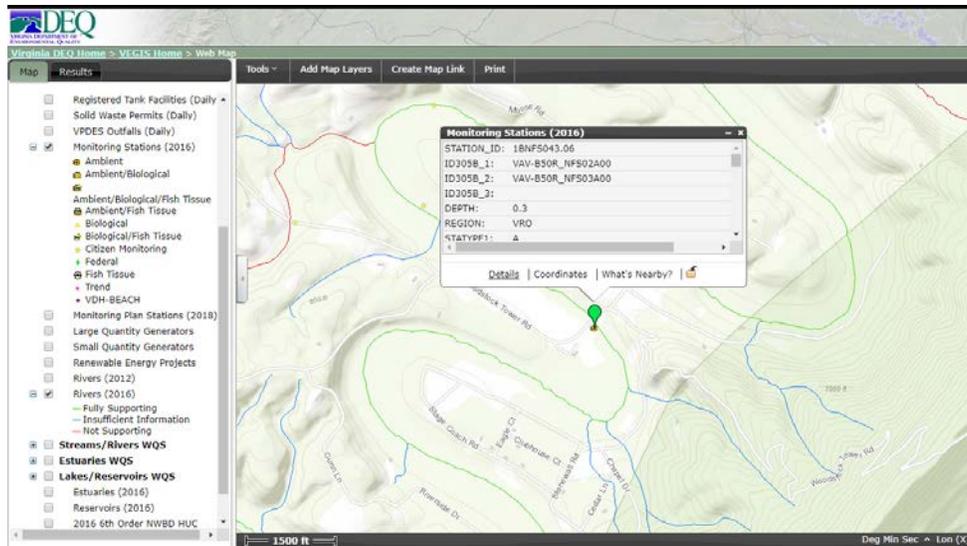


Figure 2. Map of North Fork water quality from the VA. DEQ. Link to the map: https://apps.deq.virginia.gov/mapper_ext/default.aspx?service=public/2016_adb_anyuse

PLUS:

Gabion walls with backing geotextile were installed along the water inlet pathway to reduce silting and water clouding that occurred with the existing earthen embankments. Prior to this improvement, there was no engineered water pathway but instead only earthen embankments which allowed silting and clouding downstream during start up and shut down of the turbines. The forebay improvement project was completed in the summer of 2017, cost the operator more than \$50,000, and was not required by any oversight agencies. The installation successfully decreased silting after forebay draining while stabilizing runoff and creating a micro habitat for vegetation and fauna in the forebay. Burnshire continues to monitor for silting, but this is unlikely due to the geotextile lining behind the gabion wall. Figure 12 located in Appendix C shows a recent photo of the gabion walls taken in 2018, as well as an earlier year's comparison photograph of the original earthen embankments.

Ongoing research is taking place with local stakeholders, specifically the town of Strasburg water authority, to study what if any measures or actions Burnshire can take during an extreme drought emergency to assist downstream water users. This ongoing effort was initiated by Burnshire and is not a requirement of any regulatory agency. To date, Burnshire along with students from VA Tech and James Madison University have completed a study on the conservation of water for towns downstream in cases of drought conditions and how Burnshire could supply emergency water flow in a severe drought or environmental emergency (see Attachment 10). Future studies that are just now forming will include more accurate river modeling with assistance from Virginia DEQ hydrologist Robert Burgholzer.

Water Quality Standard for Zone 2 – Downstream.

Criterion	Standard	Instructions
B	1	Not Applicable / De Minimis Effect: <ul style="list-style-type: none">• If facility is located on a Water Quality Limited river reach, provide an agency letter stating that the facility is not a cause of such limitation.• Explain rationale for why facility does not alter water quality characteristics below, around, and above the facility.

Source and Date: Virginia Department of Environmental Quality, Water Quality Map 2016.

The water quality standard for Zone 2 was the same as Zone 1.

Upstream Fish Passage Standard for Zone 1 – Impoundment

Criterion	Standard	Instructions
C	1	Not Applicable / De Minimis Effect: <ul style="list-style-type: none">• Explain why the facility does not impose a barrier to upstream fish passage in the designated zone.• Document available fish distribution data and the lack of migratory fish species in the vicinity. If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

Source and Date: Virginia Dept. of Game and Inland Fisheries, Environmental Services Biologist, Ernie Aschenbach, email explaining operation recommendation, 1/20/2012. DGIF website page on the North Fork of the Shenandoah River, <https://www.dgif.virginia.gov/waterbody/shenandoah-river-north-fork/>.

The only migrating species that may be present is the American eel. Once in the upstream reach, there is no barrier to prohibit further upstream passage of fish from the project until the Chapman dam several miles upstream.

Upstream Fish Passage Standard for Zone 2 – Downstream

Criterion	Standard	Instructions
C	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Explain why the facility does not impose a barrier to upstream fish passage in the designated zone. • Document available fish distribution data and the lack of migratory fish species in the vicinity. <p>If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.</p>

Source and Date: Virginia Dept. of Game and Inland Fisheries, Environmental Services Biologist, Ernie Aschenbach, email explaining operation recommendation, 1/20/2012. Virginia Dept. Of Game and Inland Fisheries website, Shenandoah, Cow Pasture, and James River Fish Kills Update <https://www.dgif.virginia.gov/waterbody/shenandoah-river-north-fork/>. Chesapeake Fish Passage Prioritization Report by The Nature Conservancy and associated mapping, 7/1/2013, report link - http://maps.freshwaternet.org/chesapeake/plugins/barrier-prioritization-proto2/images/ChesapeakeFishPassagePrioritization_Report.pdf, mapping link (search Woodstock, VA) - <http://maps.freshwaternet.org/chesapeake/#>.

There are no downstream migrating species in the North Fork except the American eel. FERC required that Virginia DGIF issue an input statement prior to transfer of the exemption to Burnshire in 2012. There are existing instream barriers in place downstream of the project and there has been no indication that the American Eel is present at Burnshire that requires upstream passage. However, DGIF was contacted via email and stated that the American eel is still present in the river despite these existing upstream and downstream barriers. The nearest upstream barrier is Chapman dam which is approximately eight river miles away from the facility. Figure 14 shows the barriers in relation to Burnshire. To resolve this conundrum, LIHI recommended using the 2013 Chesapeake Fish Passage Prioritization by the Nature Conservancy (Freshwater Network application) to add clarity. This data resource does not show any migratory species in the North Fork of the Shenandoah River, see Figure 3 below (abstracted) and Appendix A., attachment 15 and attachment 17. We do not dispute DGIF, but in our experience we have not encountered any eels. Regardless, Burnshire voluntarily complies with the agency recommendation.

Diadromous Fish			
Downstream Alewife	None Documented	Downstream Striped Bass	None Documented
Downstream Blueback	None Documented	Downstream Atlantic Sturgeon	None Documented
Downstream American Shad	None Documented	Downstream Shortnose Sturgeon	None Documented
Downstream Hickory Shad	None Documented	Downstream American Eel	None Documented
One or More DS Anadromous Species	None Documented	# Diadromous Sp Dnstrm (incl eel)	0
Resident Fish and Rare Species		Stream Health	
Barrier is in EBTJV BKT Catchment	No	Chesapeake Bay Program Stream Health	FAIR
Barrier is in Modeled BKT Catchment (DeWeber)	No	MD MBSS Benthic IBI Stream Health	N/A
Barrier Blocks an EBTJV Catchment	No	MD MBSS Fish IBI Stream Health	N/A
Barrier Blocks a Modeled BKT Catchment (DeWeber)	No	MD MBSS Combined IBI Stream Health	N/A
Native Fish Species Richness (HUC8)	28	VA INSTAR mIBI Stream Health	Very High
# Rare Fish (HUC8)	0	PA IBI Stream Health	N/A
# Rare Mussel (HUC8)	3		
# Rare Crayfish (HUC8)	0		
Globally rare or fed listed fish/mussel sp HUC12	No	Rare fish or mussel sp in HUC12	Yes
Globally rare or fed listed fish/mussel sp in upstream or downstream functional network	No	Rare fish or mussel in upstream or downstream functional network	Yes

Metric descriptions can be found at:

http://52.53.143.233/chesapeake-dev/plugins/barrier-prioritization-prot02/images/Metric_Glossary.pdf



Figure 3 2013 Nature Conservancy report abstracted indicating no American eel downstream. Full document attached in Appendix A, Attachment 15

Downstream Fish Passage Standard for Zone 1 - Impoundment

Criterion	Standard	Instructions
D	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Explain why the facility does not impose a barrier to downstream fish passage in the designated zone, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines). • For riverine fish populations that are known to move downstream, explain why the facility does not contribute adversely to the sustainability of these populations or to their access to habitat necessary for successful completion of their life cycles. • Document available fish distribution data and the lack of migratory fish species in the vicinity. • If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

Source and Date: Virginia Dept. of Game and Inland Fisheries, Environmental Services Biologist, Ernie Aschenbach, Email explaining operation recommendation, 1/20/2012. Virginia Dept. Of Game and Inland Fisheries website, Shenandoah, Cow Pasture, and James River Fish Kills Update <https://www.dgif.virshgini.gov/waterbody/shenandoah-river-north-fork/>

Recommendation: It was recommended not to direct water through the turbines for the purpose of hydroelectric power generation during the nightly out-migration of adult American eels from September through December of any given year. This was a suggestion from DGIF and not a formal requirement.

There are existing barriers upstream and downstream of the project. As previously mentioned, our research using the LIHI recommended 2013 Chesapeake Fish Passage Prioritization by the Nature Conservancy (Freshwater Network application) does not show any migratory species in the North Fork of the Shenandoah River, see Appendix A., attachment 15 and attachment 17. Burnshire voluntarily complies with the agency recommendation just in case they are present.

Currently, other fish species that occupy the North Fork are bullhead catfishes, trout, killifishes, minnows, suckers, sculpins, perches, sunfishes, black bass, fallfish, rock bass, and muskellunge. This is referenced on the DGIF website. Water flow through the facility passes through trash racks with a FERC recommendation of one-inch bar spacing which promotes fish safety. Further, the water velocity at the trash racks is less than the FERC two foot per second criteria which also reduces fish entrainment and promotes fish safety. This recommendation was mentioned by FERC in a discussion during the annual inspection and it is further referenced in the LIHI Glendale application (dated at July 9, 2013) which includes references from FERC, the EPA, and the US Fish and Wildlife agency regarding trash rack spacing (1”) and water velocity at the trash racks (<2 fps).

Downstream Fish Passage Standard for Zone 2 - Downstream.

Criterion	Standard	Instructions
D	1	<p><u>Not Applicable / De Minimis Effect:</u></p> <ul style="list-style-type: none"> • Explain why the facility does not impose a barrier to downstream fish passage in the designated zone, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines). • For riverine fish populations that are known to move downstream, explain why the facility does not contribute adversely to the sustainability of these populations or to their access to habitat necessary for successful completion of their life cycles. • Document available fish distribution data and the lack of migratory fish species in the vicinity. <ul style="list-style-type: none"> • If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

Source and Date: Virginia Dept. of Game and Inland Fisheries, Environmental Services Biologist, Ernie Aschenbach, Email explaining operation recommendation, 1/20/2012.

Once in the downstream reach, there is no barrier to prohibit downstream passage of fish from the project therefore downstream migratory species are not impacted by the project.

Watershed and Shoreline Protection Standards for Zone 1 – Impoundment

Criterion	Standard	Instructions
E	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • If there are no lands with significant ecological value associated with the facility, document and justify this (e.g., describe the land use and land cover within the project boundary). • Document that there have been no Shoreline Management Plans or similar protection requirements for the facility.

Source and Date: Virginia Outdoors Foundation, U.S. Geological Survey GIS Map of protected land in Virginia. Received from VOF on October 23, 2018.

There are no lands within Zone 1 deemed of significant ecological value. Some lands adjacent to the project have protected status and are shown in Appendix A, Attachment 7. These lands, included on a map from the Virginia Outdoors Foundation, are protected under management plans. The map also shows a Burnshire Bridge Slopes NF Special Biological Area that contains 8 acres of Central Appalachian Shale Barren, but this is outside of the project boundary. It should also be noted that the segment of the North Fork from Burnshire Bridge to the Route 55 crossing in Strasburg, Virginia is designated under the state’s scenic river system. The portion of the river going through the project boundary has a wooded riparian buffer. Land within immediate vicinity of the project is predominately rural and agricultural.

Watershed and Shoreline Protection Standards for Zone 2 – Downstream

Criterion	Standard	Instructions
E	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • If there are no lands with significant ecological value associated with the facility, document and justify this (e.g., describe the land use and land cover within the project boundary). • Document that there have been no Shoreline Management Plans or similar protection requirements for the facility.

Source and Date: Virginia Outdoors Foundation, U.S. Geological Survey GIS Map of protected land in Virginia. Received from VOF on October 23, 2018.

Same as Zone 1. There are no lands within Zone 2 deemed of significant ecological value. Some lands adjacent to the project have protected status and are shown in Appendix A, Attachment 7. These lands, included on a map from the Virginia Outdoors Foundation, are protected under management plans. The map also shows a Burnshire Bridge Slopes NF Special Biological Area that contains 8 acres of Central Appalachian Shale Barren, but this is outside of the project boundary. It should also be noted that the segment of the North Fork from Burnshire Bridge to the Route 55 crossing in Strasburg, Virginia is designated under the state’s scenic river system. The

portion of the river going through the project boundary has a wooded riparian buffer. Land within immediate vicinity of the project is predominately rural and agricultural.

Threatened and Endangered Species Protection for Zone 1 - Impoundment

Criterion	Standard	Instructions
F	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Document that there are no listed species in the facility area or affected riverine zones downstream of the facility. • If listed species are known to have existed in the facility area in the past but are not currently present, explain why the facility was not the cause of the extirpation of such species. • If the facility is making significant efforts to reintroduce an extirpated species, describe the actions that are being taken.

Source and Date: The U.S. Fish and Wildlife Service GIS mapping site for Critical Habitat for Threatened and Endangered Species. Last modified on September 28, 2018.

The source used for this criterion was a map from the U.S. Fish and Wildlife Services. The map highlights specific geographic areas that contain features essential for the conservation of a threatened or endangered species that may require special management and protection. Figure 4 below displays the GIS map including the Burnshire site. Based off the legend, there are no final or proposed critical habitats for endangered species near the facility.

Another source used was the Virginia Department of Conservation and Recreation. Threatened and endangered species were searched using their Virginia Natural Heritage Database. The project lies within the Narrow Passage Creek-North Fork Shenandoah River sub watershed. The search showed that there were no threatened or endangered species in the project boundary.

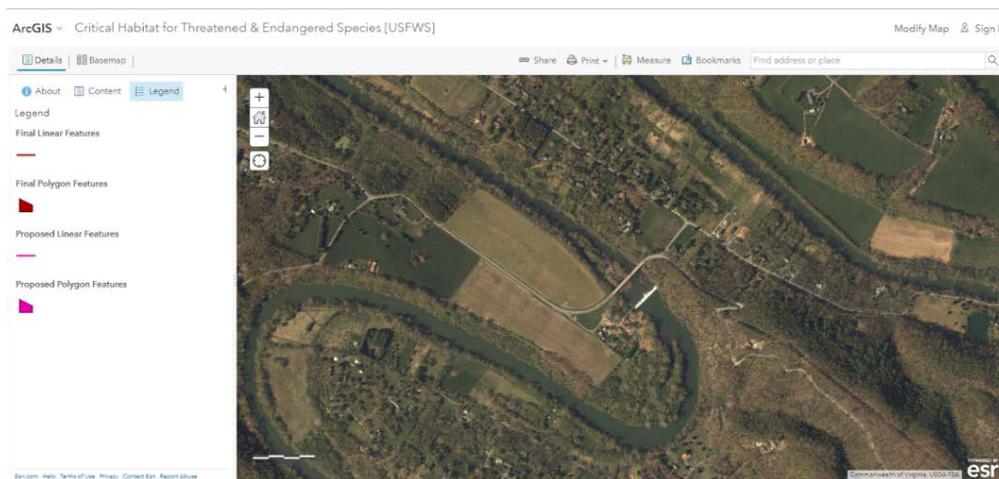


Figure 4. U.S Fish and Wildlife Services Endangered Species Map

Threatened and Endangered Species Protection for Zone 2 – Downstream

Criterion	Standard	Instructions
F	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Document that there are no listed species in the facility area or affected riverine zones downstream of the facility. • If listed species are known to have existed in the facility area in the past but are not currently present, explain why the facility was not the cause of the extirpation of such species. • If the facility is making significant efforts to reintroduce an extirpated species, describe the actions that are being taken.

Source and Date: The U.S. Fish and Wildlife Service GIS mapping site for Critical Habitat for Threatened and Endangered Species. Last modified on September 28, 2018.

Same as Zone 1. The source used for this criterion was a map from the U.S. Fish and Wildlife Services. The map highlights specific geographic areas that contain features essential for the conservation of a threatened or endangered species that may require special management and protection. Figure 4 above displays the GIS map including the Burnshire site. Based off the legend, there are no final or proposed critical habitats for endangered species near the facility. Zone 2 is clear of any critical habitats.

The Virginia Natural Heritage Database from the Department of Conservation and Recreation was also used for Zone 2 to evaluate if any threatened or endangered species were present. The project lies within the Narrow Passage Creek-North Fork Shenandoah River sub watershed, so this was the area used as a filter for the database search. The search showed that there were no threatened or endangered species in the project boundary.

Cultural and Historic Resources Standards for Zone 1 – Impoundment

Criterion	Standard	Instructions
G	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Document that there are no cultural or historic resources located on facility lands that can be affected by construction or operations of the facility. • Document that the facility construction and operation have not in the past adversely affected any cultural or historic resources that are present on facility lands.

Source and Date: Virginia Department of Historic Resources, Archaeological Site Record, October 1, 2018. Emails from the Virginia Department of Historic Resources, October 2, 2018.

The Burnshire dam itself is listed as a historic site by the Virginia Department of Historic Resources. Its record as a historic site states that demolition is a threat to the resource. The agency

performed a consultation when Burnshire underwent its FERC exemption in the 1980s. There are no review files in record of this consultation because DHR only maintains the file after 10 years if there is an adverse effect to historic properties. Per DHR:

“It doesn't look like we have any records of consultation for the exemption back in the 1980s. We do not keep review files after 10 years unless there is an adverse effect to historic properties. I would recommend that you submit to my attention a letter describing the reason for the review request, a description of the rehab work and future operations plan, and photographs of the existing dam and powerhouse (interior and exterior). I don't anticipate any problem with satisfying your request.”

A review request was then submitted to the agency and DHR responded, “...it is our opinion that the historic properties within the Area of Potential Effects will not be adversely affected by the proposed undertaking”. The full email can be seen in Appendix A, Attachment 9.

PLUS: The site is actively used by Virginia Tech and James Madison University engineering students as an active laboratory. As part of the didactic portion of the field lab sessions, extensive discussion regarding the history of the site is presented including the context that the site provided the first electricity to the Shenandoah Valley. The Burnshire Hydroelectric website extensively details the history of the site along with photos. <http://www.burnshirehydro.com/history>

Cultural and Historic Resources Standards for Zone 2 – Downstream

Criterion	Standard	Instructions
G	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> • Document that there are no cultural or historic resources located on facility lands that can be affected by construction or operations of the facility. • Document that the facility construction and operation have not in the past adversely affected any cultural or historic resources that are present on facility lands.

Source and Date: Virginia Department of Historic Resources, Archaeological Site Record, October 1, 2018. Emails from the Virginia Department of Historic Resources, October 2, 2018.

Same as Zone 1.

Recreational Resources Standards for Zone 1 - Impoundment

Criterion	Standard	Instructions
H	1	<p>Not Applicable / De Minimis Effect:</p> <ul style="list-style-type: none"> Document that the facility does not occupy lands or waters to which public access can be granted and that the facility does not otherwise impact recreational opportunities in the facility area.

Source and Date: Virginia Department of Conservation and Recreation, Virginia Outdoors Plan Mapper May 17, 2018 <http://www.dcr.virginia.gov/recreational-planning/vopmapper>. Virginia Department of Game and Inland Fisheries, Shenandoah River – North Fork, Facilities Description <https://www.dgif.virginia.gov/waterbody/shenandoah-river-north-fork/>. The Shenandoah County tourist website <https://visitshenandoahcounty.com/>

There are several other dams and low water bridges along the North River that affect navigability and boating activities upstream. There are several boat access locations upstream of the Burnshire facility. These locations include the community of Leisure Point (private) and Chapman’s Landing (public) which has a concrete boating ramp. Figure 6 below, displays the location of Chapman’s Landing in relation to the Burnshire Dam. Portage around the dam is not hindered or discouraged. FERC required warning signs are posted of “Dam Ahead” adjacent to the boat ramp at Burnshire site. The impoundment produced at the Burnshire dam creates a useable reservoir for deeper hull boats.



Figure 5 Downstream and Upstream low water bridges—LEFT and RIGHT, 5 and 3.5 river miles from dam

Because of the small size of the Burnshire project, the FERC exemption does not require or specify the project maintain recreational areas however, there is informal access for recreation across river from the project boundary that is privately owned by a different entity. The Shenandoah County tourist website states that it is a tight and steep, rocky trail along the edge of the Burnshire Bridge and is suitable for wading access and small, hand carried boats or canoes. Portage access is via a shared driveway adjacent to two privately owned homes. Although portage is allowed, this driveway is for use of the homeowners and those working at the Burnshire site so it is not designated for recreational use.

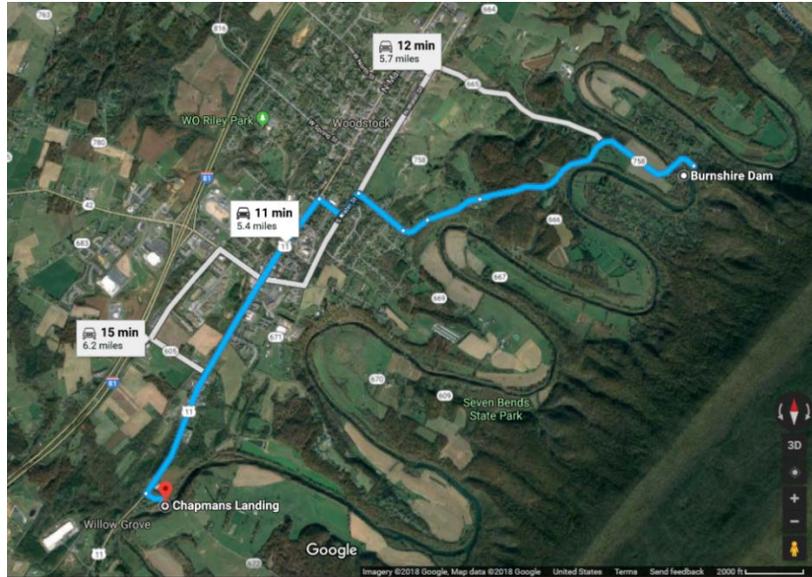


Figure 6. Map of trip from Chapman's Landing to Burnshire Dam

Recreational Resources Standards for Zone 2 – Downstream

Criterion	Standard	Instructions
H	1	Not Applicable / De Minimis Effect: <ul style="list-style-type: none"> Document that the facility does not occupy lands or waters to which public access can be granted and that the facility does not otherwise impact recreational opportunities in the facility area.

Source and Date: Virginia Department of Conservation and Recreation, Virginia Outdoors Plan Mapper May 17, 2018 <http://www.dcr.virginia.gov/recreational-planning/vopmapper>. Virginia Department of Game and Inland Fisheries, Shenandoah River – North Fork, Facilities Description <https://www.dgif.virginia.gov/waterbody/shenandoah-river-north-fork/>. The Shenandoah County tourist website <https://visitshenandoahcounty.com/>

Downstream of the facility is Deer Rapids which is a boating access point. Figure 7 below, displays a map of the location of Deer Rapids in relation to Burnshire Dam. Due to the shallow depth and speed of the water around Zone 2, it would be unlikely for boats to access this area to fish. Those seeking recreation can do so along the shore via walking path along the area.

Because of the small size of the Burnshire project, the FERC exemption does not require or specify the project maintain recreational areas however, there is informal access for recreation across river from the project boundary that is privately owned by a different entity. The Shenandoah County tourist website states that it is a tight and steep, rocky trail along the edge of the Burnshire Bridge and is suitable for wading access and small, hand carried boats or canoes. Portage access is via a shared driveway adjacent to two privately owned homes. Although portage is allowed, this driveway is for use of the homeowners and those working at the Burnshire site so it is not designated for recreational use.

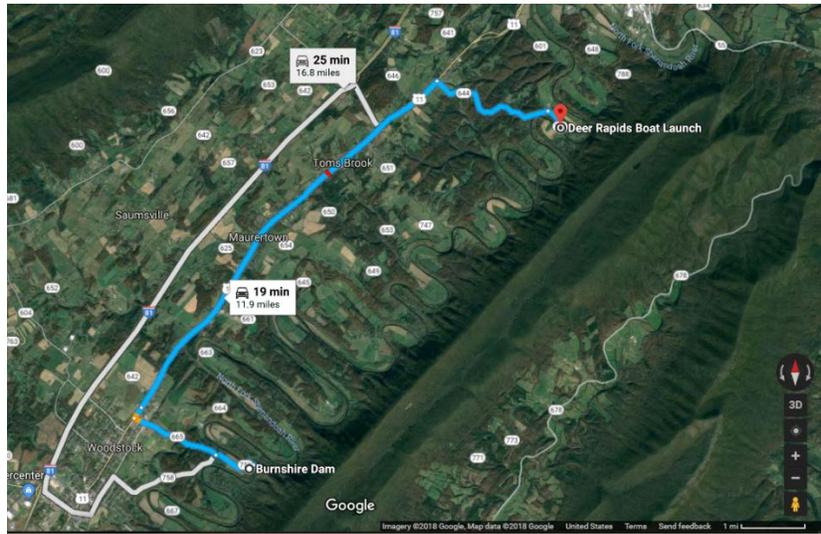


Figure 7. Map of trip from Deer Rapids Boat Launch to Burnshire Dam

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Sworn Statement and Waiver Form

SWORN STATEMENT

As an Authorized Representative of Burnshire Hydroelectric LLC, the Undersigned attests that the material presented in the application is true and complete.

The Undersigned acknowledges that the primary goal of the Low Impact Hydropower Institute's Certification Program is public benefit, and that the LIHI Governing Board and its agents are not responsible for financial or other private consequences of its certification decisions.

The undersigned further acknowledges that if certification of the applying facility is issued, the LIHI Certification Mark License Agreement must be executed prior to marketing the electricity product as LIHI Certified.

The undersigned Applicant further agrees to hold the Low Impact Hydropower Institute, the Governing Board and its agents harmless for any decision rendered on this or other applications, from any consequences of disclosing or publishing any submitted certification application materials to the public, or on any other action pursuant to the Low Impact Hydropower Institute's Certification Program.

PLEASE INSERT ONLY FOR PRE-OPERATIONAL CERTIFICATIONS (See Section 4.5.3):

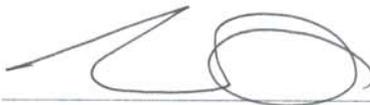
For applications for pre-operational certification of a "new" facility the applicant must also acknowledge that the Institute may suspend or revoke the certification should the impacts of the project, once operational, fail to comply with the certification criteria.

Company Name: Burnshire Hydroelectric, LLC

Authorize Representative Name: R. Lee Harvey, Jr.

Title: Owner/Operator

Authorized Signature: _____



Date: March 25, 2019

Contacts Form

Project Owner:	
Name and Title	Dr. Lee Harvey
Company	Burnshire Hydroelectric, LLC
Phone	(540) 465-1965
Email Address	leeharvey@outlook.com
Mailing Address	480 N Pifer Road Star Tannery, VA 22654
Project Operator (if different from Owner):	
Name and Title	N/A
Company	
Phone	
Email Address	
Mailing Address	
Consulting Firm / Agent for LIHI Program (if different from above):	
Name and Title	John Williams, Undergraduate Student
Company	James Madison University, School of Integrated Science and Technology
Phone	(804) 551-0460
Email Address	Johnwhw95@gmail.com
Mailing Address	
Compliance Contact (responsible for LIHI Program requirements):	
Name and Title	Same as above
Company	
Phone	
Email Address	
Mailing Address	
Party responsible for accounts payable:	
Name and Title	Same as above
Company	
Phone	
Email Address	
Mailing Address	

Agency Contacts

Agency Contact (Check area of responsibility: Flows __, Water Quality __, Fish/Wildlife Resources <u>X</u> , Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	Virginia Department of Game and Inland Fisheries
Name and Title	Ernie Aschenbach, Environmental Services Biologist
Phone	(804) 367-2733
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Mailing Address	4010 West Broad Street Richmond, VA 23230

Agency Contact (Check area of responsibility: Flows __, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources <u>X</u> , Recreation __):	
Agency Name	Virginia Department of Historic Resources
Name and Title	Roger W. Kirchen, Director of Review and Compliance Division
Phone	(804) 482-6091
Email address	Roger.kirchen@dhr.virginia.gov
Mailing Address	2801 Kensington Avenue Richmond, VA 23221

Agency Contact (Check area of responsibility: Flows __, Water Quality <u>X</u> , Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	Virginia Department of Environmental Quality
Name and Title	Tara Sieber, Water Quality Monitoring & Assessments Manager
Phone	(540) 574-7870
Email address	tara.sieber@deq.virginia.gov
Mailing Address	P.O. Box 3000 Harrisonburg, VA 22801

Agency Contact (Check area of responsibility: Flows __, Water Quality __, Fish/Wildlife Resources __, Watersheds <u>X</u> , T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	Virginia Outdoors Foundation
Name and Title	Laura Thurman, Easement Project Manager
Phone	(540) 886-2460
Email address	lthurman@vofonline.org
Mailing Address	103 E. Beverley Street Suite B Staunton, VA 24401

Appendices

Appendix A. Referenced Material

1. Department of the Army, Corps of Engineers Dredging Permit, April 5, 2012
2. Federal Energy Regulatory Commission Exemption, September 22, 1982
3. Federal Energy Regulatory Commission Transfer of Exemption, March 2, 2012
4. United States Environmental Protection Agency Guidance Letter, July 13, 2011
5. Virginia Department of Historic Resources, Archaeological Site Record, October 1, 2018
6. Virginia Department of Environmental Quality Dredging Permit, March 22, 2012
7. Virginia Outdoors Foundation, U.S. Geological Survey GIS Map of protected land in Virginia. Received from VOF on October 23, 2018.
8. Survey of the project site (2012)
9. Virginia Department of Historic Resources, Email from Roger W. Kirchen on November 16, 2018
10. JMU Capstone 2016 Senior Project Presentation Burnshire
11. Project Summary: Research into Variable Speed Operation in Hydroelectric
12. Virginia Tech Weekend Northern Virginia Daily Article
13. FERC Document for Dam & Above Sea Level Measurements
14. Email exchange between Burnshire--Lee Harvey and Virginia Dept. of Game and Inland Fisheries Environmental Services Biologist, Ernie Aschenbach
15. Chesapeake Fish Passage Prioritization – Dam Fact Sheet for Burnshire
16. Chesapeake Fish Passage Prioritization – Dam Fact Sheet for McCaffrey
17. The Nature Conservancy American Eel Map

Appendix B. Research Summary

Burnshire Hydroelectric conducts ongoing self and public funded research to find better ways to generate hydropower that are more efficient, less costly, and have less negative impact on the environment. Part of that research has been funded using USDA SBIR grants. The Small Business Innovation Research (SBIR) Program at USDA makes highly competitive grants that are awarded to qualified small businesses to support high quality, advanced concepts research related to scientific problems and opportunities in agriculture and renewable energy that could lead to significant public benefit if successful.

Burnshire completed one study in 2017 that tested variable speed generation in hydropower. The purpose of that study was to determine if using an inverter-based generation system, could variable speed operation be achieved. This research concluded that variable speed operation allows the turbine flow to be modulated while continuing to produce power. The benefits documented, in addition to operability, were that variable speed operation allowed the turbine speed to be adjustable from 5% to 105% of rated power. The results of this study will be presented at Hydrovision 2019.

A phase 2 follow through study is underway now and will be completed the third quarter of 2020. The benefits of this research will demonstrate paths forward in changing hydrologic environments, mostly caused by climate change, to allow hydropower to remain viable even when operated outside of original design specification. This innovative method will allow hydropower operators to operate with variable river flow. At the river level, continuous power generation will allow more natural river flow, less hydraulic surging downstream, more constant downstream water temperatures, and less downstream erosion damage. This will allow operation even in extremely low flow periods to maintain natural biological flow or if required, such as in an emergency, augment flow without the use of spill gates.

Our methods will also allow more deployment of hydropower at unpowered dams and sites that would otherwise not be financially viable. The equipment and process we have designed uses off the shelf industrial components that are UL certified and allow grid interconnection vis a vis UL1741 in a matter of months instead of years of power grid system studies.

Other research completed includes work with partner universities and has already yielded a path forward to develop a plan for emergency water release during an extreme drought emergency or hazardous materials incident in the riverine environment. This is an ongoing effort led by Burnshire but with high level collaboration involving Virginia state hydrologists and downstream stakeholders, specifically the town of Strasburg water authority. What has been discovered so far is that in an extreme drought emergency Burnshire can supply the town with water, using impounded water from the behind dam, for up to two weeks.

Appendix C. Supporting Photographs of Site



Figure 8. Leffel 27, B-4 propeller turbine (145 HP)



Figure 9. Oemer Permanent Magnet Generator allows variable flow operation



Figure 10. Tailrace and Retaining Wall located within Zone of Effect 2



Figure 11 Drained Forebay, Gabion embankment wall and trash racks

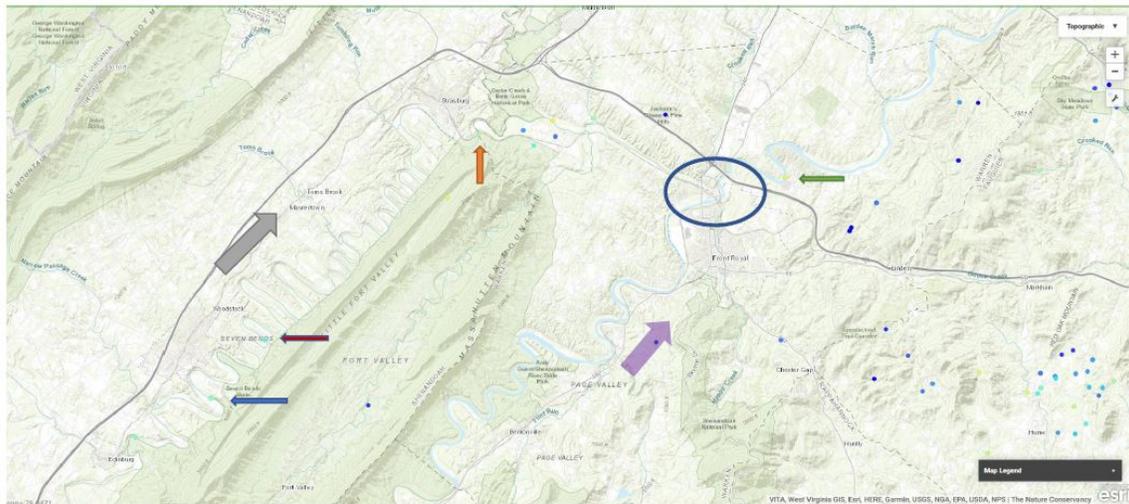


Figure 12. Earthen embankment water pathway prior to construction of the Gabion walls

Appendix D. Overhead View and Upstream/Downstream River Obstructions



Figure 13. Overhead View with overlay of Site



Legend:

- Blue arrow—Chapman Dam—upstream
- Red arrow—Burnshire Dam
- Orange Arrow—Strasburg water intake dam—downstream
- Green arrow—Warren Dam—downstream

Blue Oval—Confluence of the North Fork and South Fork to become the Shenandoah River—downstream.

- Purple arrow—South fork of Shenandoah River,
- Gray arrow—North fork of Shenandoah River.

Figure 14. Upstream and Downstream Obstructions