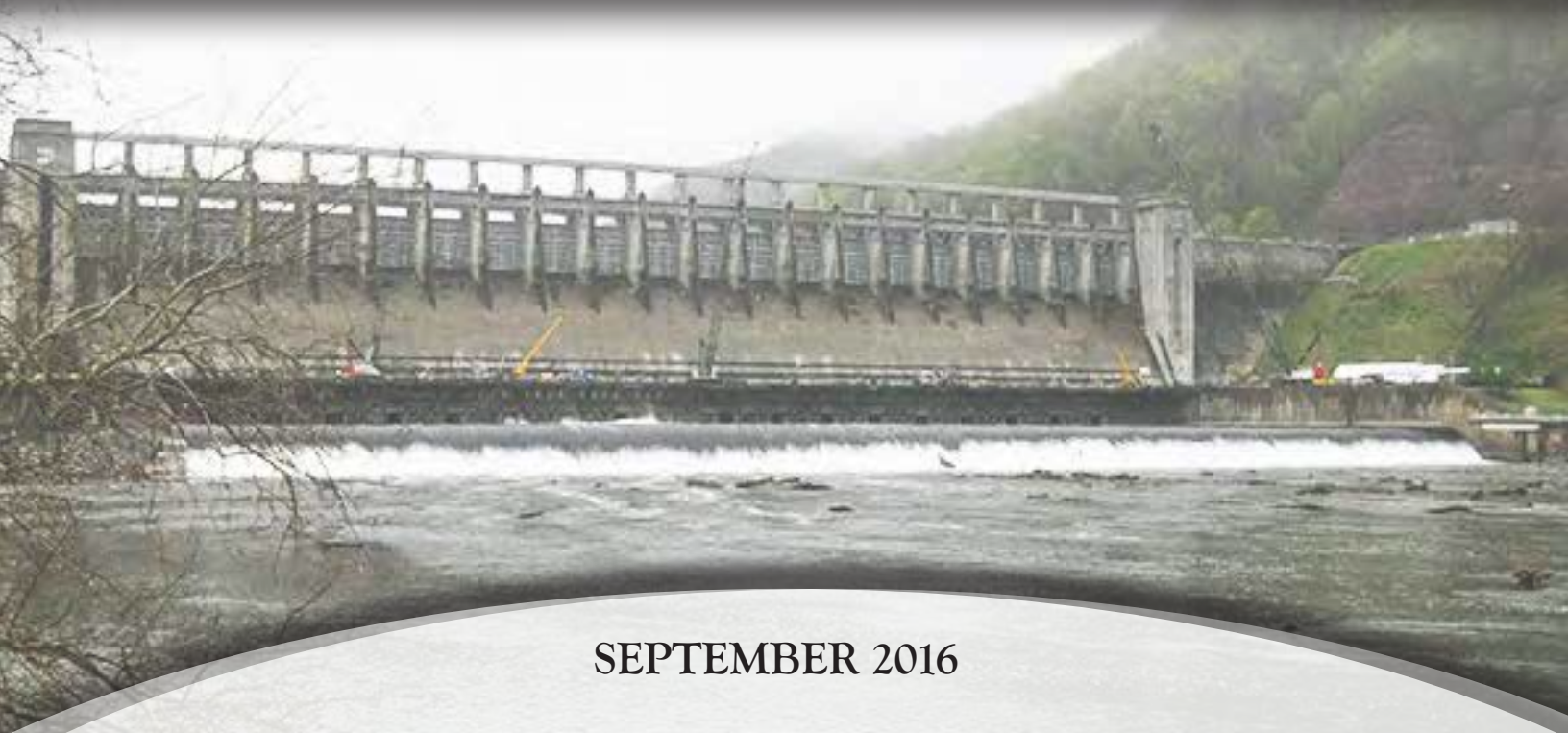
SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

BLUESTONE DAM SAFETY MODIFICATION

HINTON, WEST VIRGINIA

VOLUME II: APPENDICES A through G



SEPTEMBER 2016

U.S. Army Corps
of Engineers
Huntington District

Volume II: Appendices A through G

Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia

U.S. Army Corps of Engineers
Huntington District
Huntington, West Virginia

September 2016

Appendix A

PUBLIC INVOLVEMENT

ADDRESSES: You may submit comments, identified by OMB Control Number 0704–0225, using any of the following methods:

○ *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.

○ *E-Mail: dfars@mail.mil.* Include OMB Control Number 0704–0225 in the subject line of the message.

○ *Fax:* (571) 372–6094.

○ *Mail:* Defense Acquisition Regulations System, Attn: Ms. Lesa Scott, OUSD(AT&L)DPAP/DARS, Rm. 3B855, 3060 Defense Pentagon, Washington, DC 20301–3060.

Comments received generally will be posted without change to *http://www.regulations.gov*, including any personal information provided.

FOR FURTHER INFORMATION CONTACT: Ms. Lesa Scott, at (571) 372–6104. The information collection requirements addressed in this notice are available on the World Wide Web at: *http://www.acq.osd.mil/dpap/dars/dfarspgi/current/index.html.* Paper copies are available from Ms. Lesa Scott, OUSD(AT&L)DPAP(DARS), Room 3B855, 3062 Defense Pentagon, Washington, DC 20301–3062.

SUPPLEMENTARY INFORMATION:

Title, Associated Form, and OMB Number: Defense Federal Acquisition Regulation Supplement (DFARS) Part 204, Administrative Matters, and related clauses at DFARS 252.204; DD Form 2051, Request for Assignment of a Commercial and Government Entity (CAGE) Code, and DD Form 2051–1, Request for Information/Verification of Commercial and Government Entity (CAGE) Code; OMB Control Number 0704–0225.

Needs and Uses: DoD uses this information to control unclassified contract data that is sensitive and inappropriate for release to the public; and to facilitate data exchange among automated systems for contract award, contract administration, and contract payment by assigning a unique code to each DoD contractor.

Affected Public: Businesses and other for-profit entities and not-for-profit institutions.

Number of Respondents: 12,895.

Responses per Respondent: 1.

Annual Responses: 12,895.

Average Burden per Response: Approximately 1.0 hour.

Annual Response Burden Hours: 13,418.

Reporting Frequency: On occasion.

Summary of Information Collection

DFARS 204.404–70(a) prescribes use of DFARS Clause 252.204–7000, Disclosure of information, in contracts that require the contractor to access or generate unclassified information that may be sensitive and inappropriate for release to the public. The clause requires the contractor to obtain approval of the contracting officer before release of any unclassified contract-related information outside the contractor's organization, unless the information is already in the public domain. In requesting this approval, the contractor must identify the specific information to be released, the medium to be used, and the purpose for the release.

DFARS 204.7207 prescribes use of the DFARS provision 252.204–7001, Commercial and Government Entity (CAGE) Code Reporting, in solicitations when CAGE codes for potential offerors are not available to the contracting officer. The provision requires an offeror to enter its CAGE code on its offer. If an offeror does not have a CAGE code, the offeror may request one from the contracting officer, who will ask the offeror to complete section B of DD Form 2051, Request for Assignment of a Commercial and Government Entity (CAGE) Code.

Manuel Quinones,

Editor, Defense Acquisition Regulations System.

[FR Doc. 2013–28233 Filed 11–22–13; 8:45 am]

BILLING CODE 5001–06–P

DEPARTMENT OF DEFENSE

Department of the Army, Corps of Engineers

Intent to Prepare an Environmental Impact Statement for the Dam Safety Modification Report, Bluestone Dam, Hinton, Summers County, WV

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DoD.

ACTION: Notice of Intent.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA), the U.S. Army Corps of Engineers (Corps), Huntington District will prepare a supplemental Environmental Impact Statement (EIS) to disclose potential impacts to the natural, physical, and human environment resulting from modifications to Bluestone Dam. The original EIS was published in 1998 and a Record of Decision (ROD) was signed in 1999 concluding the NEPA process allowing the Corps to initiate implementation of the Bluestone Dam Safety Assurance (DSA) Project. When completed, the current modifications under construction will strengthen the dam's stability and allow for increased discharge capacity through the use of hydropower penstocks substantially reducing risk. However, physical modeling and expert analysis conducted during project construction has indicated the downstream bedrock is vulnerable to an unacceptable degree of erosion during high flow events. The Corps has also recognized potential for unacceptable erosion associated with overtopping of areas of the dam not designed to be overtopped. After a full consideration of alternatives, this supplemental EIS will recommend additional modifications to address such risks and to achieve acceptable risk levels.

DATES: A public scoping meeting will be held on December 5, 2013.

ADDRESSES: Send written comments and suggestions concerning this proposed project to Jonathan J. Aya-ay, Planning Branch, U.S. Army Corps of Engineers, Huntington District, 502 Eighth Street, Huntington, WV 25701–2070. Telephone: 304–399–5276. Electronic mail: *BluestoneDamPublicComments@.usace.army.mil.* Requests to be placed on the mailing list should also be sent to this address.

FOR FURTHER INFORMATION CONTACT: Andrew N. Johnson, Environmental Analysis Section, U.S. Army Corps of Engineers, Huntington District, 502 Eighth Street, Huntington, WV 25701–2070. Telephone: 304–399–5189. Electronic mail: *andrew.n.johnson@usace.army.mil.*

SUPPLEMENTARY INFORMATION:

1. *Authority:* Investigation and justification for dam safety modifications at completed Corps of Engineers projects is authorized under Section 2033 of the Water Resources Development Act of 2007 (Pub. L. 110–114).

2. *Background:* a. Guidance for this study is provided in USACE Engineer Regulation (ER) 1110–2–1156 (October 2011). This guidance details agency policy and procedures for the study and implementation process addressing dam safety issues.

b. Bluestone Lake is a multipurpose component of the Kanawha River basin system which provides for flood control, recreation, power development, low flow augmentation, and fish and wildlife enhancement. The project began operation in 1949 and helps control a 4,565 square mile drainage area.

c. The ROD, signed in 1999, completed the NEPA process for the DSA project permitting the Huntington District to begin detailed design and

subsequent construction of the recommended alternative which included a 13 foot cantilever wall on top of the dam, an additional concrete monolith on the east abutment, a floodgate closure across WV Rt. 20, removable closures at each end of the spillway, high strength anchors placed into the dam itself, massive concrete blocks placed against the downstream face of the dam, and a pavement for scour protection downstream of the hydropower penstocks. Ongoing construction on these measures will likely continue through the year 2020.

d. Physical modeling and expert analysis conducted during project construction has shown that the downstream bedrock is vulnerable to erosion during high flow events as a result of deficiencies with the current stilling basin configuration. This potential erosion creates an unacceptable level of risk according to guidelines established in Chapter 5 of ER 1110–2–1156, under which this study is being conducted.

e. The supplemental EIS and Dam Safety Modification report (DSMR) will consider the structural integrity of the dam, its ability to accommodate flood waters as well as transportation, noise, terrestrial, aquatic, economic, environmental justice and cultural resource issues associated with the performance of the dam. The supplemental EIS and DSMR will recommend any modifications necessary to ensure the long-term safe performance of the structure as originally intended.

f. Modifications to meet current acceptable risk guidelines per ER 1110–2–1156 may include, modification of the existing stilling basin, modification of other dam components, construction of an alternative/auxiliary stilling basin, construction of an alternative/auxiliary spillway and non-structural measures or other actions to prevent overtopping. The No Action alternative will also be considered. As required by NEPA and Corps of Engineers planning guidance, the No Action alternative will form a benchmark from which alternatives are evaluated and compared.

3. *Public Participation:* a. The Corps of Engineers will conduct a public scoping meeting on December 5, 2013 to gain input from interested agencies, organizations, and the general public concerning the content of the supplemental EIS, issues and impacts to be addressed in the supplemental EIS, and alternatives that should be analyzed. The meeting will be held from 6:00 p.m. to 9:00 p.m. at the Summers County Memorial Building, 97 Park Avenue, Hinton, WV 25951.

b. The Corps invites full public participation to promote open communication and better decision-making. All persons and organizations that have an interest in the Bluestone Dam Project are urged to participate in this NEPA evaluation process. Assistance will be provided upon request to anyone having difficulty with learning how to participate.

c. Public comments are welcomed anytime throughout the NEPA process. Formal opportunities for public participation include: (1) Public meeting/s to be held near the community of Hinton; (2) Anytime during the NEPA process via mail, telephone or email; (3) During Review and Comment on the Draft EIS; and (4) Review of the Final EIS. Schedules and locations will be announced in local news media. Interested parties should submit contact information to be included on the mailing list for public distribution of meeting announcements and documents (See **ADDRESSES**).

4. *Schedule:* The Draft Supplemental Environmental Impact Statement is tentatively scheduled to be released for public review and comment in June 2015. The Final Report and Final EIS are tentatively scheduled to be completed in October 2015.

Brenda S. Bowen,

Army Federal Register Liaison Officer.

[FR Doc. 2013–28031 Filed 11–22–13; 8:45 am]

BILLING CODE 3720–58–P

DEPARTMENT OF DEFENSE

Department of the Navy

Meeting of the U.S. Naval Academy Board of Visitors

AGENCY: Department of the Navy, DoD.

ACTION: Notice of Partially Closed Meeting.

SUMMARY: The U.S. Naval Academy Board of Visitors will meet to make such inquiry, as the Board shall deem necessary, into the state of morale and discipline, the curriculum, instruction, physical equipment, fiscal affairs, and academic methods of the Naval Academy. The executive session of this meeting from 11:00 a.m. to 12:00 p.m. on December 9, 2013, will include discussions of disciplinary matters, law enforcement investigations into allegations of criminal activity, and personnel issues at the Naval Academy, the disclosure of which would constitute a clearly unwarranted invasion of personal privacy. For this reason, the executive session of this meeting will be closed to the public.

DATES: The open session of the meeting will be held on December 9, 2013, from 8:30 a.m. to 11:00 a.m. The closed session of this meeting will be the executive session held from 11:00 a.m. to 12:00 p.m.

ADDRESSES: The meeting will be held in Alumni Hall at the United States Naval Academy in Annapolis Maryland. The meeting will be handicap accessible.

FOR FURTHER INFORMATION CONTACT: Lieutenant Commander Matt Cady, USN, Executive Secretary to the Board of Visitors, Office of the Superintendent, U.S. Naval Academy, Annapolis, MD 21402–5000, 410–293–1503.

SUPPLEMENTARY INFORMATION: This notice of meeting is provided per the Federal Advisory Committee Act, as amended (5 U.S.C. App.). The executive session of the meeting from 11:00 a.m. to 12:00 p.m. on December 9, 2013, will consist of discussions of law enforcement investigations into allegations of criminal activity, new and pending administrative/minor disciplinary infractions and nonjudicial punishments involving the Midshipmen attending the Naval Academy to include but not limited to individual honor/conduct violations within the Brigade, and personnel issues. The discussion of such information cannot be adequately segregated from other topics, which precludes opening the executive session of this meeting to the public. Accordingly, the Secretary of the Navy has determined in writing that the meeting shall be partially closed to the public because the discussions during the executive session from 11:00 a.m. to 12:00 p.m. will be concerned with matters coming under sections 552b(c)(5), (6), and (7) of title 5, United States Code.

Dated: November 19, 2013.

N.A. Hagerty-Ford,

Commander, Office of the Judge Advocate General, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. 2013–28085 Filed 11–22–13; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF EDUCATION

[Docket No. ED–2013–ICCD–0123]

Agency Information Collection Activities; Submission to the Office of Management and Budget for Review and Approval; Comment Request; Lender's Request for Payment of Interest and Special Allowance—LaRS

AGENCY: Federal Student Aid (FSA), Department of Education (ED).

ACTION: Notice.

WEST VIRGINIA
Division of Culture and History

The Culture Center
1900 Kanawha Blvd., E.
Charleston, WV 25305-0300
Randall Reid-Smith, Commissioner
Phone 304.558.0220 • www.wvculture.org
Fax 304.558.2779 • TDD 304.558.3562
EEO/AA Employer

December 17, 2013

Jonathan J. Aya-ay
Planning Branch
U.S. Army Corps of Engineers
Huntington District
502 Eighth Street
Huntington, WV 25701

RE: Bluestone Dam Safety Modification Project
FR#: 14-188-SU

Dear Mr. Aya-ay:

We have reviewed the above referenced project to determine potential effects to cultural resources. As required by Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties," we submit our comments.

We have reviewed the above referenced intent to prepare a Supplemental Environmental Impact Statement (EIS) and Dam Safety Modification Report (DSMR) for the Bluestone Dam. Please keep in mind the Bluestone Dam was previously determined eligible for inclusion the National Register of Historic Places. We look forward to reviewing the new EIS and DSMR

We appreciate the opportunity to be of service. If you have questions regarding our comments or the Section 106 process, please contact Ernest Blevins, Structural Historian, at (304) 558-0240.

Sincerely,

Susan M. Pierce
Deputy State Historic Preservation Officer

SMP/EEB

United States Department of the Interior
NATIONAL PARK SERVICE

NEW RIVER GORGE NATIONAL RIVER
GAULEY RIVER NATIONAL RECREATION AREA
BLUESTONE NATIONAL SCENIC RIVER
104 Main Street
P.O. Box 246
Glen Jean, West Virginia 25846

IN REPLY REFER TO:

December 19, 2013

A3815 (NERI)

Natalie J. McKinley
CELRH-PM-PD-F
U.S. Army Corps of Engineers
Huntington District
502 Eighth Street
Huntington, WV 25701-2070

RE: Scoping Comments for Bluestone Dam Safety Modification Project

Dear Ms. McKinley:

The National Park Service (NPS) is providing the following comments to the U.S. Army Corps of Engineers (Corps) in response to the notice to prepare a supplemental Environmental Impact Statement (EIS) for the Dam Safety Modification Report at Bluestone Dam and the request for scoping comments. It is our understanding that the Corps has initiated implementation of the Bluestone Dam Safety Assurance Project and has completed several phases, which should strengthen the dam's stability and allow for increased discharge capacity through the use of hydropower penstocks. Further, physical modeling and expert analysis conducted during the project construction has indicated the downstream bedrock is vulnerable to erosion during high flow events and there is the potential for unacceptable erosion associated with overtopping of areas of the dam not designed to be overtopped. The Corps intends to prepare the supplemental EIS and Dam Safety Modification Report to consider the structural integrity of the dam, its ability to accommodate flood waters as well as transportation, noise, terrestrial, aquatic, economic, environmental justice and cultural resource issues associated with performance of the dam.

The NPS has two units of the National Park System that will be potentially affected by the Bluestone Project. The New River Gorge National River lies approximately 2.8 miles downstream of the Bluestone Dam along the New River and extends downstream approximately 52 miles from Hinton to the New River Gorge Bridge and Hawks Nest State Park. The Bluestone National Scenic River lies approximately 5.0 miles upstream of the Bluestone Dam along the Bluestone River and extends upstream approximately 11.1 miles. The Bluestone National Scenic River lies upstream of the Bluestone State Park and overlaps approximately 4.1 miles of Pipestem Resort State Park.

TAKE PRIDE IN AMERICA

Any actions taken at the dam, whether short-term construction or long-term operations, that affect the quantity and quality of the water released from the dam are likely to impact the natural, cultural, scenic and recreational values located downstream on the New River. Any actions taken at the dam that cause the Bluestone Lake elevation to rise above the normal summer pool elevation of 1410 feet are likely to inundate and potentially impact the Bluestone National Scenic River.

The enabling legislation of both park units calls for the cooperation and coordination of the Secretary of Interior with the Secretary of the Army as well as State and local government authorities "to facilitate the protection of biological resources and recreational use" for the purpose of "providing for coordinated development and promotion of recreation resources of regional or national significance."

The New River Gorge National River was established by the National Parks and Recreation Act of 1978 (P.L. 95-625) stated in part,

> Sec. 1101. For the purpose of conserving and interpreting outstanding natural, scenic, and historic values and objects in and around the New River Gorge and preserving as a free-flowing stream an important segment of the New River in West Virginia for the benefit and enjoyment of present and future generations...
> Sec. 1110. The Secretary of the Army shall cooperate with the Secretary of the Interior concerning the water requirements of the national river. The Secretary of the Army shall provide for release of water from the Bluestone Lake project consistent with that project's purposes and activities in sufficient quantity and in such a manner to facilitate protection of biological resources and recreational use of the national river.

The West Virginia National Interest River Conservation Act of 1987 (P.L. 100-534) stated in part,

> The purpose of this Act is to provide for the protection and enhancement of the natural, scenic, cultural, and recreational values on certain free-flowing segments of the New, Gauley, Meadow, and Bluestone Rivers in the State of West Virginia for the benefit and enjoyment of present and future generations.
>
> Several tributaries of the New River in West Virginia also possess remarkable and outstanding features of national significance. The segment of the Gauley River below Summersville Dam has gained national recognition as a premier whitewater recreation resource. The lower section of the Bluestone River and the lower section of the Meadow River possess remarkable and outstanding natural, scenic, and recreational values due to their predominantly undeveloped condition,
>
> Title I – New River Gorge National River, Sec 104. Flow Management. (a) Findings – The Congress finds that adjustments of flows from Bluestone Lake project during periods of low flow are necessary to respond to the congressional mandate contained in section 1110 of this Act and that such adjustments could enhance the quality of the recreational experience in the segments of the river below the lake during these periods as well as protect the biological resources of the river.

> Title III – Bluestone National Scenic River, Sec. 304. Designation of Lower Bluestone River. The segment in Mercer and Summers Counties, West Virginia, from a point approximately two miles upstream of the Summers and Mercer County line down to the maximum summer pool elevation (one thousand four hundred and ten feet above mean sea level) of Bluestone Lake as depicted on the boundary map entitled 'Bluestone Wild and Scenic River'...to be administered by the Secretary of the Interior as a scenic river.
>
> Nothing in the designation of the segment referred to in this paragraph shall affect or impair the management of the Bluestone project or the authority of any department, agency, or instrumentality of the United States to carry out the project purposes of that project as of the date of enactment of this paragraph.

The Corps has suggested that additional project modifications are necessary to handle high flow events. This may include modifications to the existing stilling basin and/or other dam components, construction of an alternative/auxiliary stilling basin, construction of an alternative spillway, or non-structural measures or other actions to prevent overtopping.

The NPS would like to see a clarification of what the Corps considers a "high flow" event and provide a detailed analysis of how and what park resources would be affected. Currently the NPS considers 100,000 cfs a fairly common "high flow" event whereby some developed facilities, including campsites, boat ramps, roads and parking areas, are temporarily flooded. It is our understanding that the current maximum release at Bluestone Dam is 66,000 cfs and when combined with the Greenbrier River has reached 90-100,000 cfs several times in the last few years. Flows of a greater magnitude will progressively impact more park facilities, including campgrounds, restrooms, maintenance facilities, employee housing, and visitor centers. There are also many communities, including Hinton, Sandstone, and Meadow Creek, and areas of private housing along the river that likely would suffer catastrophic losses at 200,000 cfs. At the December 5th public meeting, Corps representatives said the Bluestone Dam was originally designed to handle inflows of 400,000 cfs and they were currently planning for high flow events of twice that volume. If the Corps operated as a run-of-the-river facility and bypassed 400,000 cfs or even more water through a newly constructed spillway, the damage downstream would be huge. The NPS recommends the rigorous development of non-structural measures like evacuation planning, development of a better flood warning system, and the evaluation of the cost effectiveness of relocating downstream structures.

The NPS highly recommends that the issue of adequate storage capacity and the reasonable project life of the dam and reservoir be evaluated. It appears that the dam will be approaching 80 years old by the time the additional modifications are completed in 2020. A member of the public voiced concerns at the public meeting that the reservoir is silted in and that dredging has been requested but not conducted. Some have suggested raising the height of the dam but already the flood control pool elevation of 1520 feet inundates the Bluestone River, causes substantial flooding of facilities at Bluestone State Park, and backs the lake upstream about nine miles to the Pipestem Resort State Park.

The segment of Bluestone National Scenic River is largely undeveloped and has few NPS facilities (parking area, launch ramp, trail, foot-bridge across the Little Bluestone) but substantial and long-term inundation would adversely impact it's remarkable and outstanding natural, scenic, and recreational values. Inundation is also more likely should Corps operations require holding back flows during the construction phase.

The NPS has many concerns about the potential impacts of additional construction and the future operations of the Bluestone Dam. We appreciate the opportunity to comment early in the project scoping process. We look forward to continued discussions with you concerning the preparation of the supplemental EIS and look forward to reviewing the Draft EIS. Should you have any additional questions, please do not hesitate to contact me again via email (trish_kicklighter@nps.gov), letter, or phone at (304)465-6508.

Sincerely,

Patricia Kicklighter

Patricia Kicklighter
Superintendent

cc: Kevin R. Mendik
Mary K. Morrison

From: Bennett, Danny A
To: McKinley, Natalie LRH
Subject: [EXTERNAL] Scoping for Bluestone Dam Safty Modification
Date: January 02, 2014 11:20:05 AM

Natalie,

I am a coordination biologist with WVDNR and I have been assigned to coordinate our comments on this project for our agency. Unfortunately, I was unable to attend the meeting on Dec 5. I would greatly appreciate it if you would forward me any materials presented. I have been coordinating with FWS on the HEP analysis below the dam but have not seen any “official” materials on the range of possible alternatives that the COE may be considering to mitigate for the risk of catastrophic dam failure. I know we are very early in the process and I look forward to working with you on this project as it proceeds.

Danny Bennett

Danny A. Bennett

Coordination Biologist

Elkins Operations Center

219/250 S, Ward Road

Elkins, WV 26241

Office: (304) 637-0245

From: Gunnoe, Grant [grant.gunnoe@cityofcharleston.org]
Sent: December 03, 2013 1:59 PM
To: McKinley, Natalie LRH
Subject: [EXTERNAL] Bluestone Meeting

I received your letter that was sent to Mayor Jones in reference to the meeting being held on December 5th in Summersville dealing with the Bluestone
planning process. I will not be able to attend do to other commitments but as
the Emergency Manager for the City of Charleston I would like to be notified
of any additional meetings or information relating to the Bluestone Dam planning process that you feel would be helpful to our area.

Thanks

Grant K. Gunnoe, Sr.

Director

Homeland Security & Emergency Management

City of Charleston

West Virginia

304-348-8130

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This e-mail and any attachments are confidential and may be protected by legal privilege. If you are not the recipient, be aware that any disclosure, copying, distribution or use of this e-mail or any attachment is prohibited. If you have received this e-mail in error, please notify us immediately by returning it to the sender and delete this copy from your system. Thank you for your cooperation.

BEFORE THE ARMY CORPS OF ENGINEERS

* * * * * * * * * *

PUBLIC MEETING

* * * * * * * * * *

BEFORE: Natalie McKinley

HEARING: Thursday, December 5, 2013
6:59 p.m.

LOCATION: Summers County
Memorial Building
97 Park Avenue
Hinton, WV 25951

WITNESSES: Audience Member

Reporter: Guy Starrett

ORIGINAL

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1 I N D E X

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3 STATEMENT

4 By Audience Member 4

5 CERTIFICATE 5

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P R O C E E D I N G S

AUDIENCE MEMBER:

I'm an anonymous citizen. And I live in Bell Point. And I would like to see the traffic of the trucks taking an alternate road besides Miller Avenue. I saw a boulder about three feet tall fall out of a truck and it just laid in the road until a bulldozer came and picked it up. And I don't think that's safe in our community.

And our community has a community emergency response team, CERT. And we're going to focus on implementing an evacuation plan. And I hope that we can get some funding from the dam project to make sure that our citizens will be safe in the event of a flood.

* * * * * * * *

MEETING CONCLUDED AT 7:00 P.M.

* * * * * * * *

CERTIFICATE

I hereby certify, as the stenographic reporter, that the foregoing proceedings were taken stenographically by me, and thereafter reduced to typewriting by me or under my direction; and that this transcript is a true and accurate record to the best of my ability.

Court Reporter

Completion Of This Form Or Any Of Its Entry Fields Is Entirely Voluntary
Information Provided May be Subject To Publication

BLUESTONE DAM SAFETY MODIFICATION REPORT
PUBLIC SCOPING
COMMENT CARD:

Name(s): _____
Affiliation / Organization: _____
Mailing Address: Street: _____
PO Box: _____ Apartment / Suite #: _____
City: _____
State: _____ Zip Code: _____

Daytime Phone #: _____
Email Address: _____

Comments / Questions / Concerns / Suggestions:

Heard From locals
You have lost of community For several years and now we are talking 2025. The original Dam Did Not take this long to build.

Economic Impact is Nice. *

Constant Noise & Dirt & Dust Above Normal In our quiet community.

Is the access Road at the New Bridge going to be made.

Is It Really necessary?

Can you build us a New Ball Park to Replace our Current ball park SOON!

Do you wish to be included on an email distribution list? Yes___ No✓

Do you wish to be included on a mail distribution list? Yes___ No✓

MAIL COMMENTS TO: OR
Attention: Natalie McKinley (Bluestone)
U.S. Army Corps of Engineers
CELRH-PM-PD-F
502 Eighth Street
Huntington, West Virginia 25701-2070

EMAIL COMMENTS TO:
BluestoneDamPublicComments@usace.army.mil
Please put the words: **Bluestone Comments** in the subject line.
CALL NATALIE MCKINLEY (Lead Planner):
(304) 399-5842
CALL PUBLIC AFFAIRS: (304) 399-5353

Completion Of This Form Or Any Of Its Entry Fields Is Entirely Voluntary
Information Provided May be Subject To Publication

Federal Agencies and Officials

The Honorable Joe Manchin
United States Senate
900 Pennsylvania Avenue, Suite 629
Charleston, West Virginia 25302

The Honorable Jay Rockefeller
United States Senate
220 North Kanawha Street, Suite 1
Beckley, West Virginia 25801-4514

The Honorable Nick Rahall
United States House of Representatives
District 3
109 Main Street
Beckley, West Virginia 25801

The Honorable Shelley Moore Capito
United States House of Representatives
District 2
4815 MacCorkle Avenue, SE
Charleston, WV 25304

U.S. Environmental Protection Agency
Region III
1060 Chapline Street
Wheeling, West Virginia 26003

Mr. Kevin Wickey
State Conservationist
U.S. Department of Agriculture
Natural Resources Conservation Service
West Virginia State Office
1550 Earl Core Road, Suite 200
Morgantown, WV 26505

U.S. Department of Agriculture
Natural Resources Conservation Service
Beckley-South Area Office
465 Ragland Road
Beckley, WV 25801

Mr. John Schmidt
Field Supervisor
U.S. Fish and Wildlife Service
West Virginia Field Office
694 Beverly Pike
Elkins, West Virginia 26241

Ms. Patricia Kicklighter
Park Superintendent
U.S. Department of Interior
National Park Service
New River Gorge
P.O. Box 246
Glen Jean, West Virginia 25846

State Agencies and Officials

The Honorable Earl Ray Tomblin
Governor of West Virginia
1900 Kanawha Boulevard, East
Charleston, West Virginia 25305

Mr. Randy Huffman
Cabinet Secretary
West Virginia Department of Environmental Protection
601 57th Street, Southeast
Charleston, West Virginia 25304

Mr. Frank Jezioro
Director
West Virginia Division of Natural Resources
324 Fourth Avenue
South Charleston, WV 25303

Ms. Susan Pierce
Deputy State Historic Preservation Officer
West Virginia State Historic Preservation Office
1900 Kanawha Boulevard, East
Charleston, WV 25305

Mr. Paul A. Mattox, Jr.
Cabinet Secretary
West Virginia Department of Transportation
1900 Kanawha Boulevard, East
Building 5
Charleston, WV 25305

Mr. Jimmy Gianato
Director / Homeland Security Advisor
West Virginia Division of Homeland Security
and Emergency Management
1900 Kanawha Boulevard, East
Building 1, Room EB-80
Charleston, WV 25305

The Honorable Ronald Miller
West Virginia State Senate
District 10
Room 229W, Building 1
State Capitol Complex
Charleston, WV 25305

The Honorable William R. Laird IV
West Virginia State Senate
District 10
Room 229W, Building 1
State Capitol Complex
Charleston, WV 25305

The Honorable Roy Cooper
West Virginia House of Delegates
District 28
Room 226E, Building 1
State Capitol Complex
Charleston, WV 25305

The Honorable John D. O'Neal IV
West Virginia House of Delegates
District 28
Room 226E, Building 1
State Capitol Complex
Charleston, WV 25305

Mr. Jesse O. Guills
Greenbrier County State Representative
Room 200W, Building 1
1900 Kanawha Blvd., East
Charleston, WV 25305

County Agencies and Officials

The Honorable Joe Blankenship
Mayor of Hinton
322 Summers St.
Hinton, WV 25951

The Honorable Lloyd W. Lightner
President, Board of Commissioners of
Summers County
120 Ballengee Street
Hinton, WV 25951

Putnam County Commissioners' Office
3389 Winfield Rd. #2
Winfield, WV 25213

Mason County Commission
200 Sixth Street
Point Pleasant, WV 25550

The Honorable Kent Carper
President, Kanawha County Commission
PO Box 3227
Charleston, WV 25336

Raleigh County Commission
116 1/2 Heber Street
Beckley, WV 25801

The Honorable Matthew D. Wender
President, Fayette County Commission
PO Box 307
Fayetteville, WV 25840

Mr. Larry Zuspan
Administrator, Kanawha Putman
Emergency Planning Committee
113 Lakeview Drive
Charleston, WV 25313

Mr. Gary Steve Lipscomb
Director, Office of Emergency Management
Summers County
120 Ballengee Street
Hinton, WV 25951

The Honorable Danny Jones
Mayor of Charleston
P.O. Box 2749
Charleston, WV 25330

AFFIDAVIT OF PUBLICATION

BECKLEY NEWSPAPERS

BECKLEY, WEST VIRGINIA 25801

DECEMBER 5, 2013

STATE OF WEST VIRGINIA
COUNTY OF RALEIGH, to wit:

I, Tara Meyer, being duly sworn upon my oath, do depose and say that I am Legal Advertising Manager for Beckley Newspapers, a corporation, publisher of the newspaper entitled The Register-Herald, an Independent newspaper; that I have been duly authorized by the board of directors of such corporation to execute this affidavit of publication; that such newspaper has been published for more than one year prior to publication of the annexed notice described below; that such newspaper is regularly published daily for at least fifty weeks during the calendar year, in the municipality of Beckley, Raleigh County, West Virginia; that such newspaper is a newspaper of "general circulation" as that term is defined in article three, chapter fifty-nine of the Code of West Virginia, 1931, as amended, within the publication area or areas of the aforesaid municipality and county; that such newspaper averages in length four or more pages, exclusive of any cover, per issue; that such newspaper is circulated to the general public at a definite price of consideration; that such newspaper is a newspaper to which the general public resorts for passing events of a political, religious, commercial and social nature, and for current happenings, announcements, miscellaneous reading matters, advertisements and other notices; that the annexed notice

of PUBLIC NOTICE
(Description of notice)

was duly published in said newspaper once a week for THREE successive weeks (Class I), commencing with the issue of the 20TH day of NOVEMBER, 2013, and ending with the issue of the 5TH day of DECEMBER, 2013, that said annexed notice was published on the following dates: NOVEMBER 20, 23, 27, 30 AND DECEMBER 5, 2013 and that the cost of publishing said annexed notice as aforesaid was $[redacted]

Signed Tara Meyer
Tara Meyer
Legal Advertising Manager
Beckley Newspapers

Taken, subscribed and sworn to before me in my said county this:
DECEMBER 5, 2013

My commission expires March 27, 2021

Notary Public of Raleigh County,
West Virginia

COPY OF PUBLICATION

PUBLIC NOTICE
US Army Corps of Engineerings
Huntington District

Date:
November 7, 2013
Closing Date:
December 5, 2013

Please address all comments and inquires to:
U.S. Army of Engineers,
Huntington District
ATTN:
Natalie McKinley
CELRH-PM-PD-F
502 Eighth Street
Huntington,
West Virginia
25701-2070
Phone: (304) 399-3842

Bluestone Dam Safety Modification Report Agency and Public Scoping Meeting

WHO IS INVITED? Agencies and individuals who have an interest and/or concerns about the authorized modification project at Bluestone Dam, located in Summers County, West Virginia.

WHY? Pursuant to the National Environmental Policy Act (NEPA), the U.S. Army Corps of Engineers (Corps), Huntington District will prepare a supplemental Environmental Impact Statement (EIS) to disclose potential impacts to the natural, physical, and human environment resulting from modifications to Bluestone Dam.

The original EIS was published in 1998 and a Record of Decision (ROD) was signed in 1999 allowing the Corps to initiate implementation of the Bluestone Dam Safety Assurance (DSA) Project. When completed, the modifications currently under construction will strengthen the dam's stability and allow for increased discharge capacity through the use of hydropower penstocks substantially reducing risk. However, physical modeling and expert analysis conducted during project construction has shown that the downstream bedrock is vulnerable to erosion during high flow events as a result of deficiencies with

CHARLESTON NEWSPAPERS
P.O. Box 2993
Charleston, West Virginia 25330
Billing 348-4898
Classified 348-4848
1-800-WVA-NEWS

LEGAL ADVERTISING INVOICE

INVOICE DATE	12/06/13
ACCOUNT NBR	094746105
SALES REP ID	0998
INVOICE NBR	881724001

BILLED TO

US ARMY CORPS OF ENGINEERS
502 EIGHTH STREET
HUNTINGTON WV 25701 USA

Please return this portion with your payment. AMOUNT PAID: _____

Make checks payable to: Charleston Newspapers

CHARLESTON NEWSPAPERS
P.O. Box 2993
Charleston, West Virginia 25330
Billing 348-4898
Classified 348-4848
1-800-WVA-NEWS
FEIN 55-0676079

INVOICE DATE	12/06/13
ACCOUNT NBR	094746105
SALES REP ID	0998
INVOICE NBR	881724001

Legal pricing is based upon 63 words per column inch.
Each successive insertion is discounted by 25% of the first insertion rate.
The Daily Mail rate is $.13 per word, the Charleston Gazette rate is $.14 per word, and the Metro Putnam rate is $.13 per word.

ISSUE DATE	AD TYPE	PUB	DESCRIPTION REFERENCE NBR PURCHASE ORDER #	AD NUMBER	AD SIZE TOTAL RUN	RATE	GROSS AMOUNT	NET AMOUNT
11/20	LEGF	GZ	11/20,11/23,11/27,11 881724001 PREPAID ORDER	0547989	1X1075 10.75	8.82	[redacted]	
11/20	LEGF	DM	11/20,11/23,11/27,11 881724002		1X1075 10.75	8.19		
11/23	LEGR	SA	11/20,11/23,11/27,11 881724003 LEGAL DISCOUNT 25%		1X1075 10.75	17.01		

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The study team desires your input on alternatives are being formulated and evaluated in preparation for the supplemental EIS. The supplemental EIS is tentatively scheduled to be released for public review and comment in 2015.

WHEN AND WHERE? [illegible] below:

OFFICIAL SEAL
State of West Virginia
PRILLAMAN
Ohio Street
Charleston, WV 25309
expires April 12, 2021

was duly published in said newspaper(s) [illegible]

Subscribed and sworn to before me this 9th day of December, 2013

Notary Public of Kanawha County, West Virginia

CHARLESTON NEWSPAPERS

P.O. Box 2993
Charleston, West Virginia 25330
Billing 348-4898
Classified 348-4848
1-800-WVA-NEWS

LEGAL ADVERTISING INVOICE

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BILLED TO

US ARMY CORPS OF ENGINEERS
502 EIGHTH STREET
HUNTINGTON WV 25701 USA

Please return this portion with your payment. AMOUNT PAID: _____

Make checks payable to: Charleston Newspapers

CHARLESTON NEWSPAPERS

P.O. Box 2993
Charleston, West Virginia 25330
Billing 348-4898
Classified 348-4848
1-800-WVA-NEWS
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11/23	LEGR	SA	11/20,11/23,11/27,11 881724003 LEGAL DISCOUNT 25%		1X1075 10.75	17.01		

State of West Virginia,

AFFIDAVIT OF PUBLICATION

I, Lisa R. Hagwater of

OFFICIAL SEAL
Notary Public, State of West Virginia
MARY T PRILLAMAN
5508 Ohio Street
South Charleston, WV 25309
My commission expires April 12, 2021

do solemnly swear that the legal notice of:

was duly published in said newspaper(s) at the stated price for the respective newspaper(s) and during the dates listed below:

Subscribed and sworn to before me this 9th day of December, 2013

Mary T. Prillaman

Notary Public of Kanawha County, West Virginia

HO IS INVITED? ıncies and individuals) have an interest ıur concerns about the horized modification ıject at Bluestone Dam, ated in Summers Coun- West Virginia.

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WHEN AND WHERE? A public workshop/open house will be held at the Summers County Memori- al Building, located at 97 Park Avenue, Hinton, WV 25951 on December 5, 2013 from 6:00 to 9:00pm.

FORMAT? The meeting will consist of a presenta- tion and various displays covering the topics of Plan Formulation, Economics, Environmental, and Engi- neering. Staff will be available to discuss is- sues, receive comments and suggestions, and an- swer questions on the study scope.

Please come at your convenience during public

LEGAL ADVERTISEMENT

workshop/open house hours.

WHY SHOULD YOU ATTEND? This is your opportunity to provide your views, express your concerns, and to be sure your interests are heard and considered. Representatives from the Corps will be available to discuss issues, receive comments, and answer questions on the study scope. If you are unable to attend the meeting, please feel free to submit your ideas and thoughts in writing to: Natalie McKinley, CELRH-PM-PD-F, U.S. Army Corps of Engineers, Huntington District, 502 Eighth Street, Huntington, West Virginia 25701-2070.

(547999)

I, Fred Long, publisher of Hinton News a newspaper in Summers County, West Virginia do hereby certify that the annexed Notice was published in said newspaper for two successive times on the following dates, Nov. 26 and Dec. 3, 2013

THE PRINTERS FEE THEREFORE IN [redacted]

Given under my hand this 4 day of December, 20 13

Publisher

State of West Virginia)

County of Summers) to wit:

Subscribed and sworn to before me this 4 day of December, 20 13

My Commission expires January 17, 2015

NOTARY PUBLIC - OFFICIAL SEAL
STATE OF WEST VIRGINIA
NELLIE M. ROBERTSON
406 Cedar Ave., Hinton WV 25951
My commission expires: 1-17-2015

Notary Public

COPY OF PUBLICATION FROM THE HINTON NEWS

LEGAL NOTICE

Bluestone Dam Safety Modification Report Agency and Public Scoping Meeting

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HN Nov. 26, Dec. 3

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Nellie M. Robertson

Notary Public

COPY OF PUBLICATION FROM THE HINTON NEWS

OFFICIAL SEAL
NOTARY PUBLIC
STATE OF WEST VIRGINIA
NELLIE M. ROBERTSON
406 CEDAR AVENUE
HINTON, WV 25951
My commission expires January 17, 2015

Eva Mevey Ministries. Let's get this WV girl to the Opry!

DONATIONS OF BOOKS

Ascension Episcopal Church is in need of books for their Free Books For Kids program. We would appreciate any donation of books for children of all ages, from pre-school to high school. No text books please. We have served Summers County with this program since August of 1993, and have given over 20,000 books to children of all ages. All donations would be greatly appreciated.

Call Joanne Duvall at 304-466-3358 for info.

Princeton, WV., Every Sat.
9:00 a.m. - 11:00 a.m.
Big Lots across from Princeton High School

Pearisburg, Va., Every Sat. 12:00 p.m. - 1:30 p.m.
Seven Day Market

Pence Springs, WV., Every Sun. 9:00 a.m. - 11:00 a.m.
Pence Springs Flea Market

Sam Black Church- General Store across for Old Exxon,
Every Sun. 12:00 p.m. - 2:00 p.m.

We Pay Cash - No Lot Too Small Or Large

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HN Nov. 26, Dec. 3

Bluestone Dam Safety Public Scoping Meeting

Lisa Morgan, Project Manager

Natalie McKinley, Lead Planner

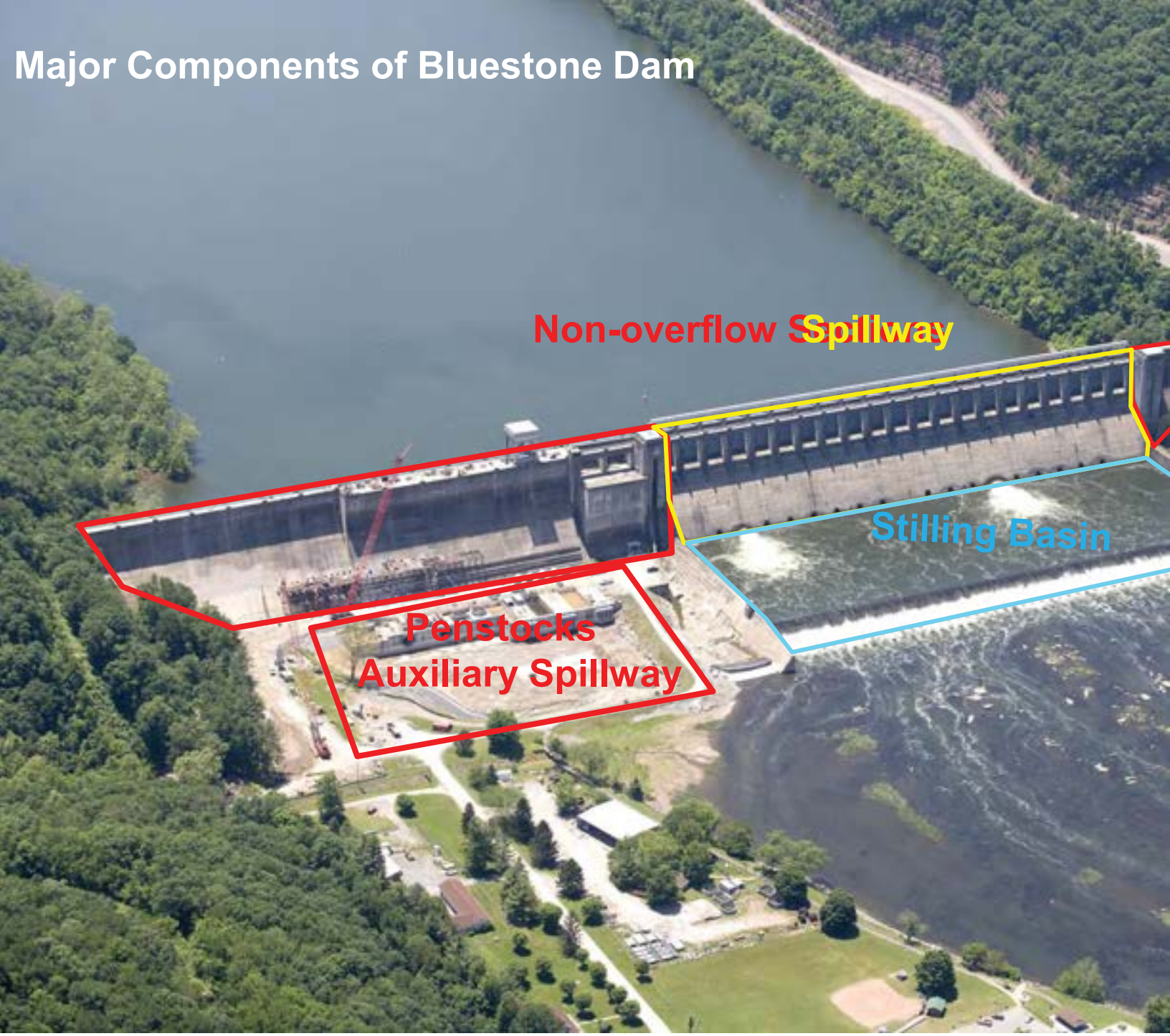
For Official Use Only

Tonight's Agenda

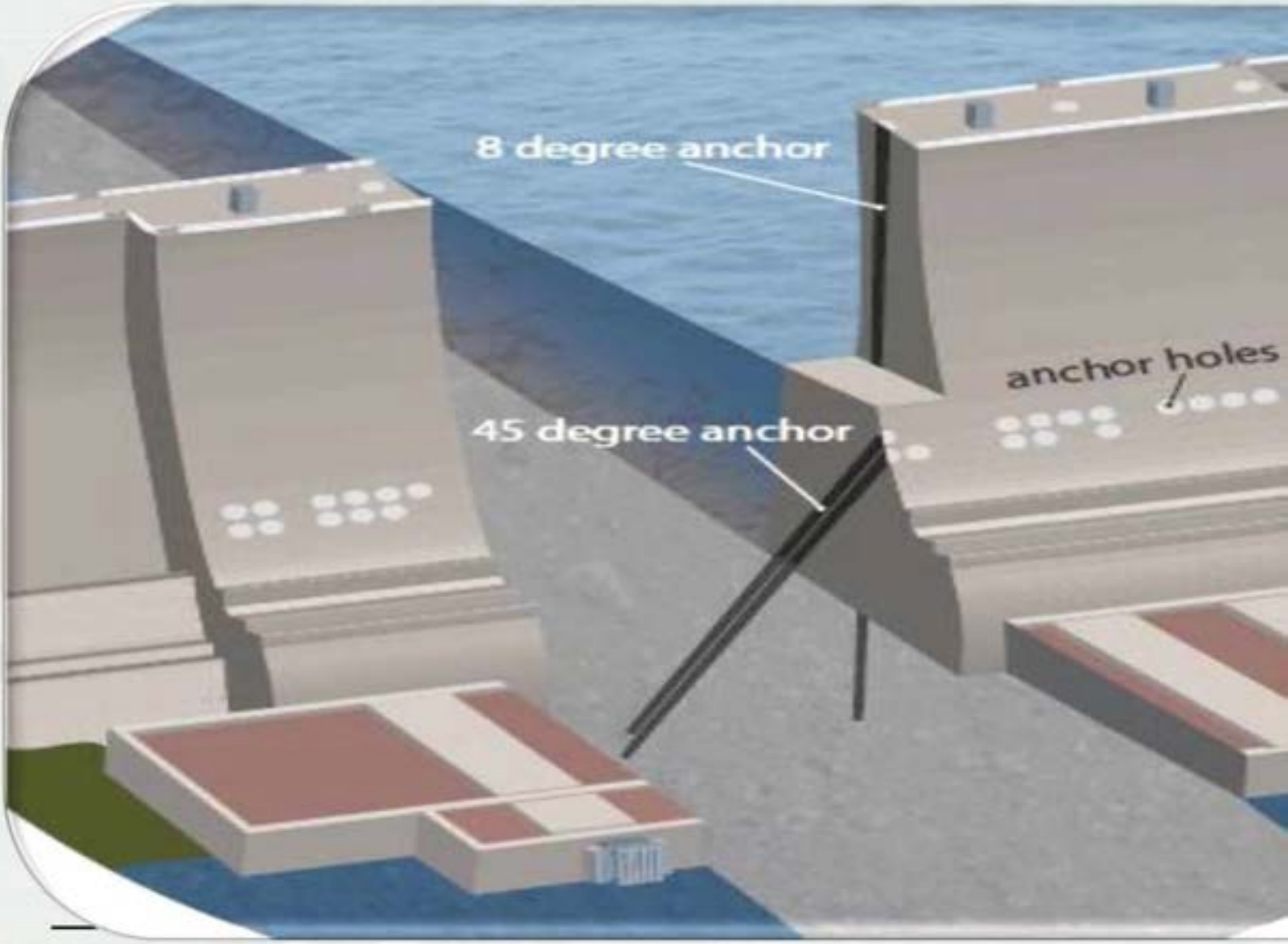
- Project Overview
- Dam Safety Construction History
- New Study
- Public Input
- Workshop

New River
Greenbrier R
Bluestone Dam

Major Components of Bluestone Dam



Anchoring (Under Construction)



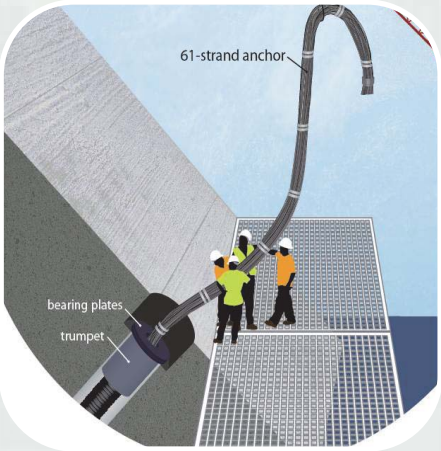
BUILDIN

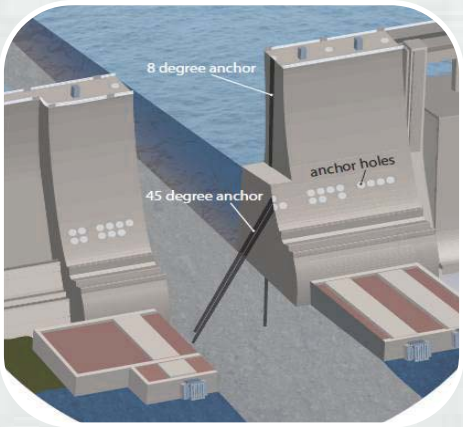
Penstock Auxiliary Spillway
(Under Construction)

Penstock Auxiliary Spillway
(Under Construction)

BUILDIN

Construction Phasing





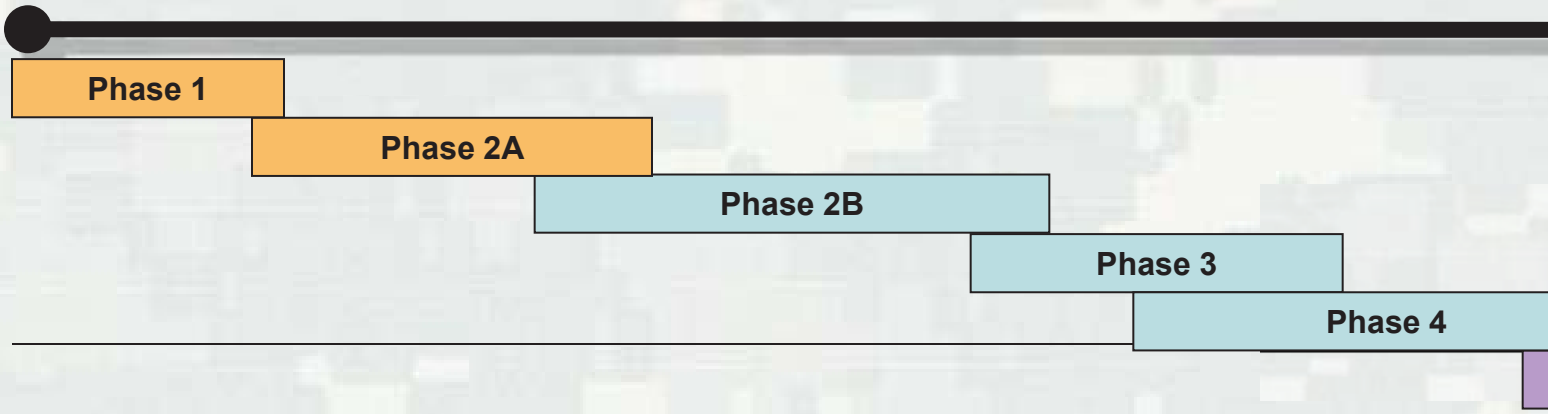
Phase 2B
2005-2011

Phase 3
2010-2015+

Phase 4
2012-2020

P
2

2000 2004 2006 2010 2015

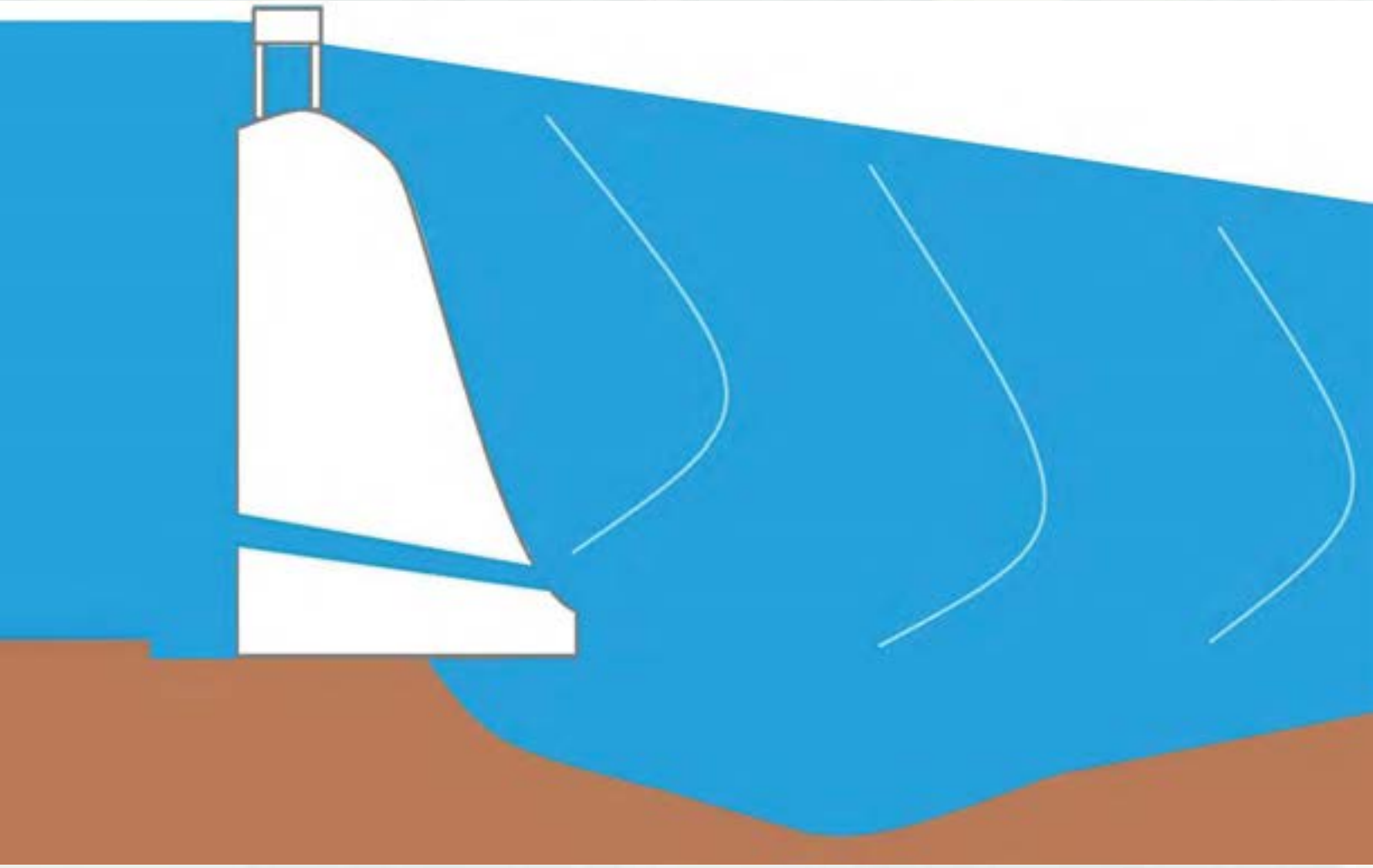


Remaining Concerns

- Project needs modifications to bring it up to current standards

- Issues
  - Potential Scour
  - Extreme Floods Overtop Dam

Dam Scour Failure



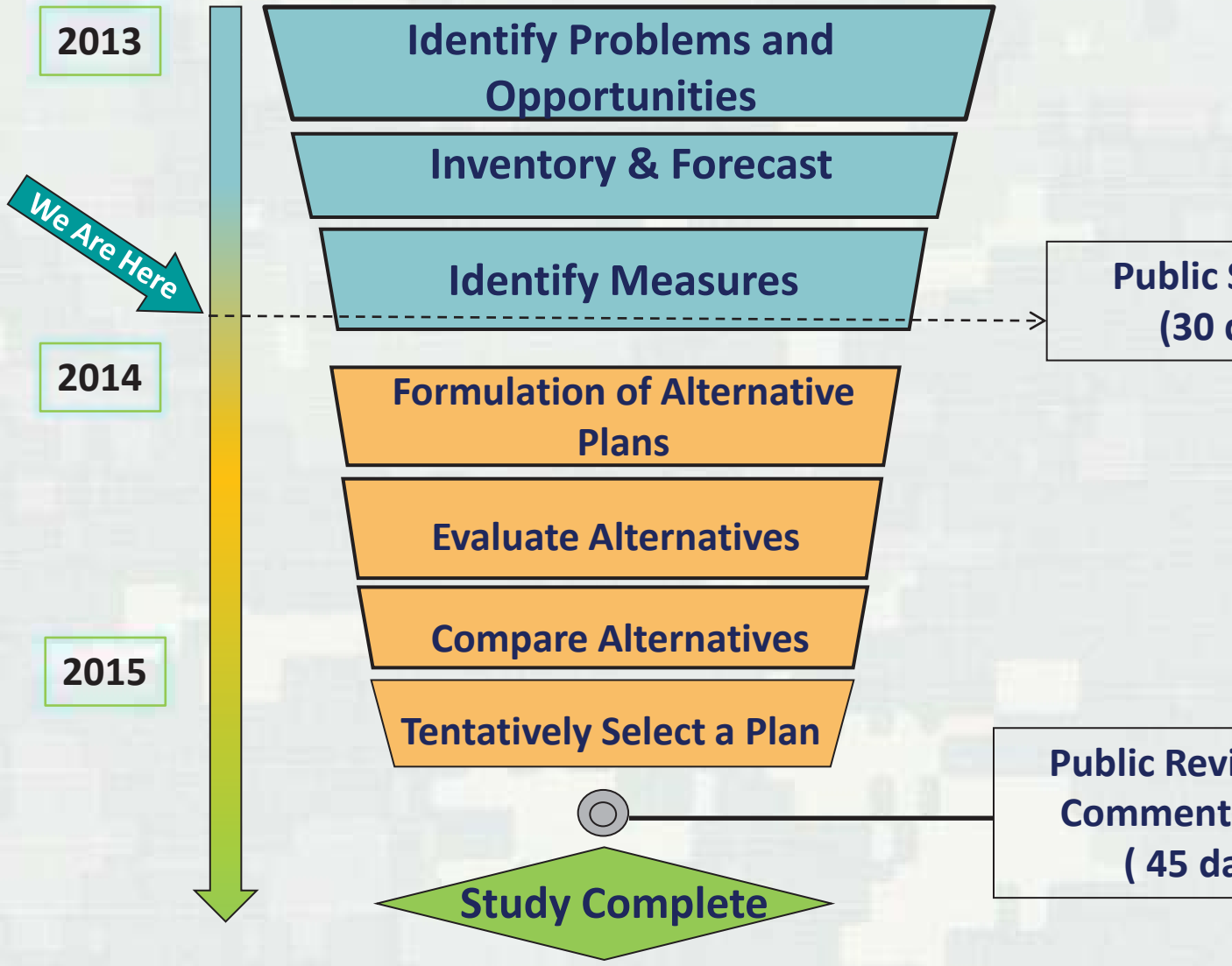
BUILDIN

Unlined Stilling Basin

Dam Safety Modification Stu

- New Study Phase
- Supplement to the 1998 study
- Consider remaining issues
- Develop a plan

Study Process



What is Scoping?

- Informs public of upcoming study and invi
  participation
- Solicits public input on issues that should
  included in the study
- Identifies issues that may be eliminated fr
  detailed analysis within the study

How To Comment?

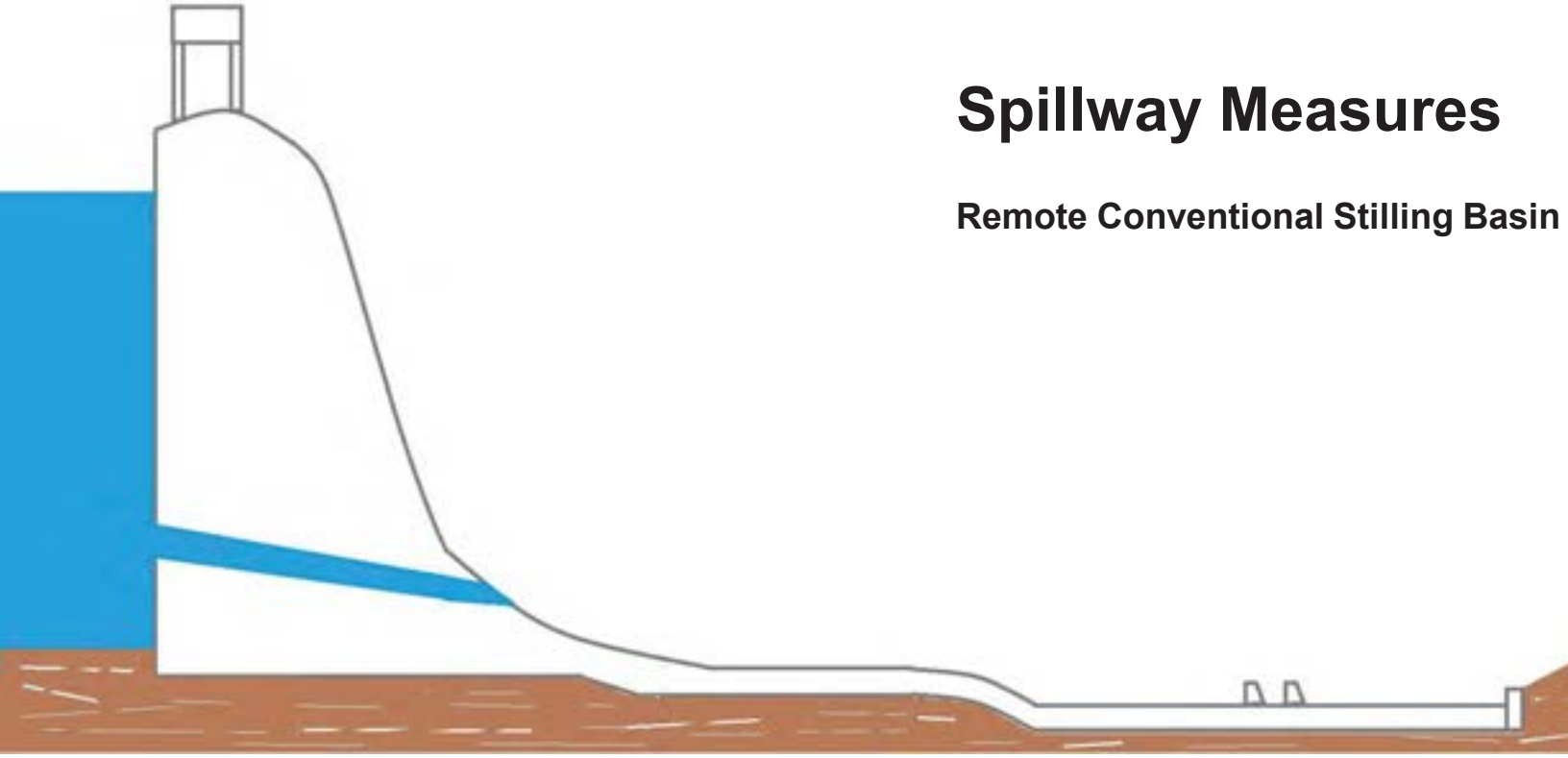
- Court Reporter
- Comment Cards
- U.S. Mail
- Email
- Telephone

What is Important to You?

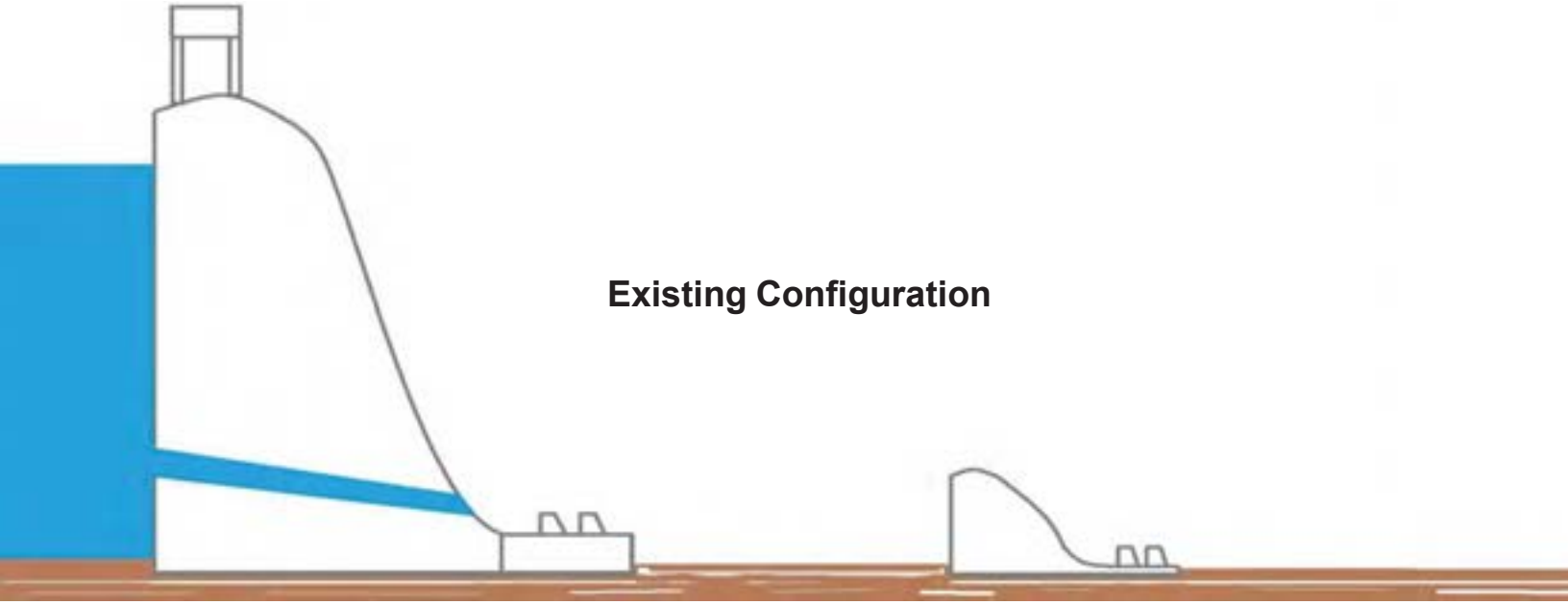
- Community
- Safety
- Tourism
- Recreation
- Fishing
- Wildlife
- Fixes

Spillway Measures

Remote Conventional Stilling Basin



Existing Configuration



Remote Spillway

Parapet Wall

Nonstructural Measures

- Run of river
- Reduce/Remove the recreation pool
- Relocation of downstream structures
- Flood warning system
- Evacuation plan

Workshops

- Problems With the Dam
- Fixes For the Dam
- Study Process
- Environmental
- Court Reporter
- Flood Consequences

From:	Wilburn, Megan B LRH
To:	Lennon, Tiernan; Bennett, Danny A; Scott, Mark T; Reip, Wilma; susan.m.pierce@wv.gov; Martinsen, Jessica
Cc:	Rutherford, Rebecca A LRH (Rebecca.A.Rutherford@usace.army.mil); McKinley, Natalie LRH; Smith, Aaron O LRH; Bonifacio, Lloyd D LRH; Moore, Brandon K LRH; Daugherty, Travis R LRH
Subject:	Bluestone DSMS Inter-agency Meeting (UNCLASSIFIED)
Date:	Wednesday, May 18, 2016 11:37:00 AM

CLASSIFICATION: UNCLASSIFIED

Good Afternoon,

The US Army Corps of Engineers, Huntington District is in the middle of dam safety modification study for Bluestone Dam at Hinton, West Virginia. As part of this study we are in the process of supplementing and updating our Environmental Impact Statement (EIS) which was approved in 1998. We are currently in the process of drafting the supplemental EIS on an accelerated schedule and would find it most beneficial to have an onsite meeting with your office. During the meeting, we would provide everyone with a briefing of our project and current alternatives/plans and answer any questions and gain your feedback.

We are currently looking at having the meeting at Bluestone Dam, near Hinton, WV on May 31st, 2016 from 12pm-3pm. We are also going to have a webinar option available for those who will not be able to attend in person. Please let me know if you will be available to attend or participate via webinar/conference call. More information about the meeting will follow.

Thank you,

Megan Wilburn
Planning Branch - Environmental Analysis Section
CELRH-PM-PD-R
US Army Corps of Engineers
Huntington District
502 8th Street
Huntington, WV 25701
304-399-5797

CLASSIFICATION: UNCLASSIFIED

From: Wilburn, Megan B LRH
To: "Sindelar, William"; "claire_rozdilski@nps.gov"
Cc: Rutherford, Rebecca A LRH (Rebecca.A.Rutherford@usace.army.mil)
Subject: FW: Bluestone DSMS Inter-agency Meeting (UNCLASSIFIED)
Date: Thursday, May 26, 2016 2:27:00 PM
Attachments: Bluestone RE"s Office.jpg

CLASSIFICATION: UNCLASSIFIED

Good Afternoon!

I just wanted to send a reminder of the inter-agency meeting that is scheduled for May 31, 2016 from 12pm-3pm at Bluestone Dam Resident Engineer's (RE) Office. The RE Office is located on the RT 20 side of Bluestone Dam and the following coordinates can be used in a GPS device (37.641324, -80.889412). A map is attached to get a general idea of the location.

Below is the call-in information for the webinar.

Phone/Web Meeting Number: 888-808-6929
Access Code: 9205521
Host Password: 1805
http://www.webmeeting.att.com

Please let me know if you have any questions.

Thank you,

Megan Wilburn
Planning Branch - Environmental Analysis Section CELRH-PM-PD-R US Army Corps of Engineers Huntington District
502 8th Street
Huntington, WV 25701
304-399-5797

-----Original Message-----
From: Wilburn, Megan B LRH
Sent: Wednesday, May 18, 2016 11:38 AM
To: Lennon, Tiernan <tiernan_lennon@fws.gov>; Bennett, Danny A <Danny.A.Bennett@wv.gov>; Scott, Mark T <Mark.T.Scott@wv.gov>; Reip, Wilma <wilma.reip@wv.gov>; susan.m.pierce@wv.gov; Martinsen, Jessica <martinsen.jessica@epa.gov>
Cc: Rutherford, Rebecca A LRH (Rebecca.A.Rutherford@usace.army.mil) <Rebecca.A.Rutherford@usace.army.mil>; McKinley, Natalie LRH <Natalie.J.Mckinley@usace.army.mil>; Smith, Aaron O LRH <Aaron.Smith@usace.army.mil>; Bonifacio, Lloyd D LRH <Lloyd.D.Bonifacio@usace.army.mil>; Moore, Brandon K LRH <Brandon.K.Moore@usace.army.mil>; Daugherty, Travis R LRH <Travis.R.Daugherty@usace.army.mil>
Subject: Bluestone DSMS Inter-agency Meeting (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Good Afternoon,

The US Army Corps of Engineers, Huntington District is in the middle of dam safety modification study for Bluestone Dam at Hinton, West Virginia. As part of this study we are in the process of supplementing and updating our Environmental Impact Statement (EIS) which was approved in 1998. We are currently in the process of drafting

the supplemental EIS on an accelerated schedule and would find it most beneficial to have an onsite meeting with your office. During the meeting, we would provide everyone with a briefing of our project and current alternatives/plans and answer any questions and gain your feedback.

We are currently looking at having the meeting at Bluestone Dam, near Hinton, WV on May 31st, 2016 from 12pm-3pm. We are also going to have a webinar option available for those who will not be able to attend in person. Please let me know if you will be available to attend or participate via webinar/conference call. More information about the meeting will follow.

Thank you,

Megan Wilburn
Planning Branch - Environmental Analysis Section CELRH-PM-PD-R US Army Corps of Engineers Huntington District
502 8th Street
Huntington, WV 25701
304-399-5797

CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED

From:	Wilburn, Megan B LRH
To:	"Lennon, Tiernan"; "Bennett, Danny A"; "Scott, Mark T"; Reip, Wilma; "Magerr.Kevin@epa.gov"; Martinsen, Jessica; "susan.m.pierce@wv.gov"; "Lee Walker"; "Nicole Forsyth (nforsyth@gecinc.com)"; "Sindelar, William"; "claire_rozdilski@nps.gov"; "nancy.dickson@wv.gov"; "Jay.Jani@EngConsultSvcs.com"; "ecarter@gecinc.com"
Cc:	Rutherford, Rebecca A LRH (Rebecca.A.Rutherford@usace.army.mil); Smith, Aaron O LRH; McKinley, Natalie LRH; Parker, Rodney D LRH; Wheeler, Scott A LRH
Subject:	Bluestone Inter-Agency Meeting Follow-up (UNCLASSIFIED)
Date:	Wednesday, June 01, 2016 9:34:00 AM
Attachments:	BLN PHASE 5 CWL 19 MAY 2016.pdf BLN PHASE 5 CWL 19 MAY 2016.kml Bluestone_Draft_Mitigation_Plan.pdf

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CLASSIFICATION: UNCLASSIFIED

Good Morning,

Thank you all for attending our meeting yesterday and again we apologize for the technical difficulties. The meeting went great and I hope that you were able to get a better understanding of the Bluestone project as we were able to better understand your concerns about it. Please if you have any further concerns that you think about or ideas that we could use, do not hesitate to contact either Rebecca Rutherford (Rebecca.A.Rutherford@usace.army.mil) or I (Megan.B.Wilburn@usace.army.mil). We would love to hear from you.

As requested, I have attached the CWL in both PDF and kml file along with yesterday's powerpoint presentation.

Below is the email address that was set up to received questions and comments from the public. Please, if you have any public concerns or question give them this email address and one of us will answer them directly.

BluestoneDamDSA@usace.army.mil

Thank you again for all of your time and cooperation!

Megan Wilburn
Planning Branch - Environmental Analysis Section
CELRH-PM-PD-R
US Army Corps of Engineers
Huntington District
502 8th Street
Huntington, WV 25701
304-399-5797

CLASSIFICATION: UNCLASSIFIED

Inter-Agency Meeting 5-31-2016		
Agency	**Name**	**Email**
WV USFWS	Tiernan Lennon	tiernan_lennon@fws.gov
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WVDNR	Mark Scott	Mark.T.Scott@wv.gov
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WVDEP	Nancy Dickson	
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USACE - US Army Corps of Engineers
WV USFWS - West Virginia US Fish and Wildlife Service
USEPA - US Environmental Protection Agency
NPS - National Park Service
WVSHPO - West Virginia State Historic Preservation Office
ECS-GEC JV - ECS-GEC Joint Venture Contractor
WVDNR - West Virginia Department of Natural Resources
WVDEP - West Virginia Department of Environmental Protection

Bluestone Dam

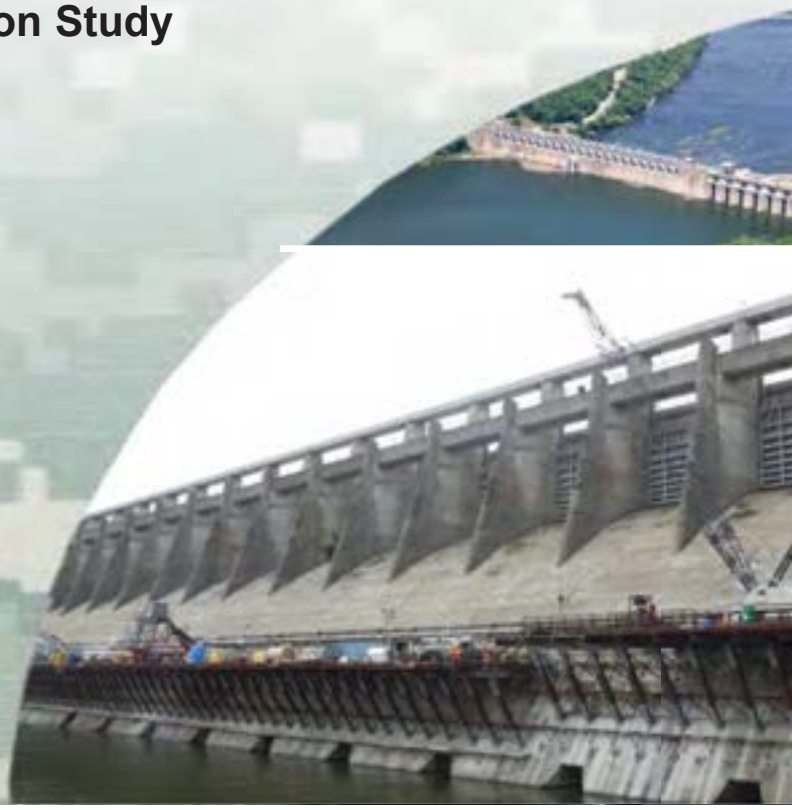
Dam Safety Assurance Project

Supplementary Dam Safety Modification Study
Environmental Impact Statement

Briefed to: Federal State Agencies

31 May 2016

Prepared By:
Project Delivery Team
Huntington District,
Great Lakes and Ohio River Division



U.S.ARMY

US Army Corps of Engineers
BUILDING STRONG®

Presentation Purpose

- Introduce USACE & Bluestone Dam
- Brief Update on Construction Progress
- Focus Supplementary Dam Safety Study EIS

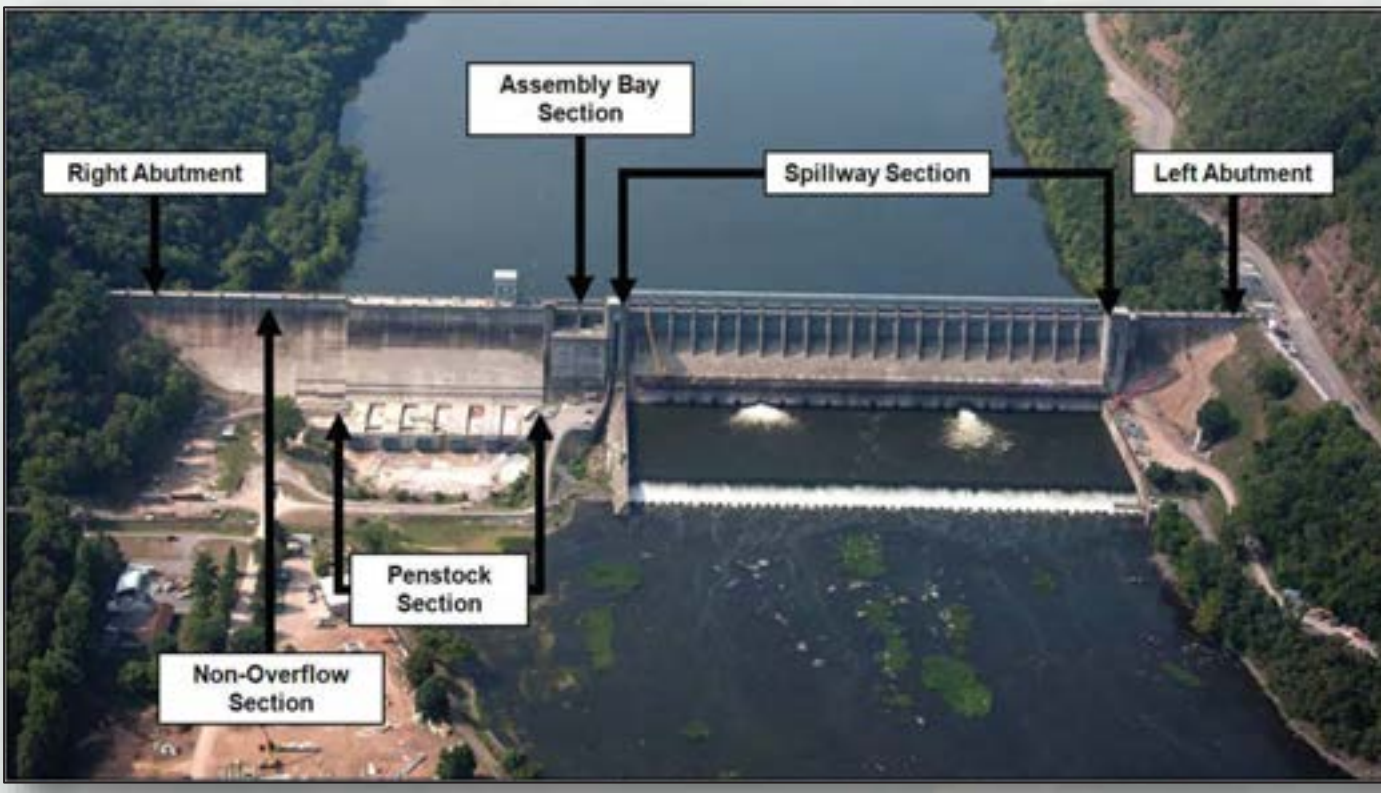
Where in the World Is Bluestone?

Justification for Continued Federal Inves

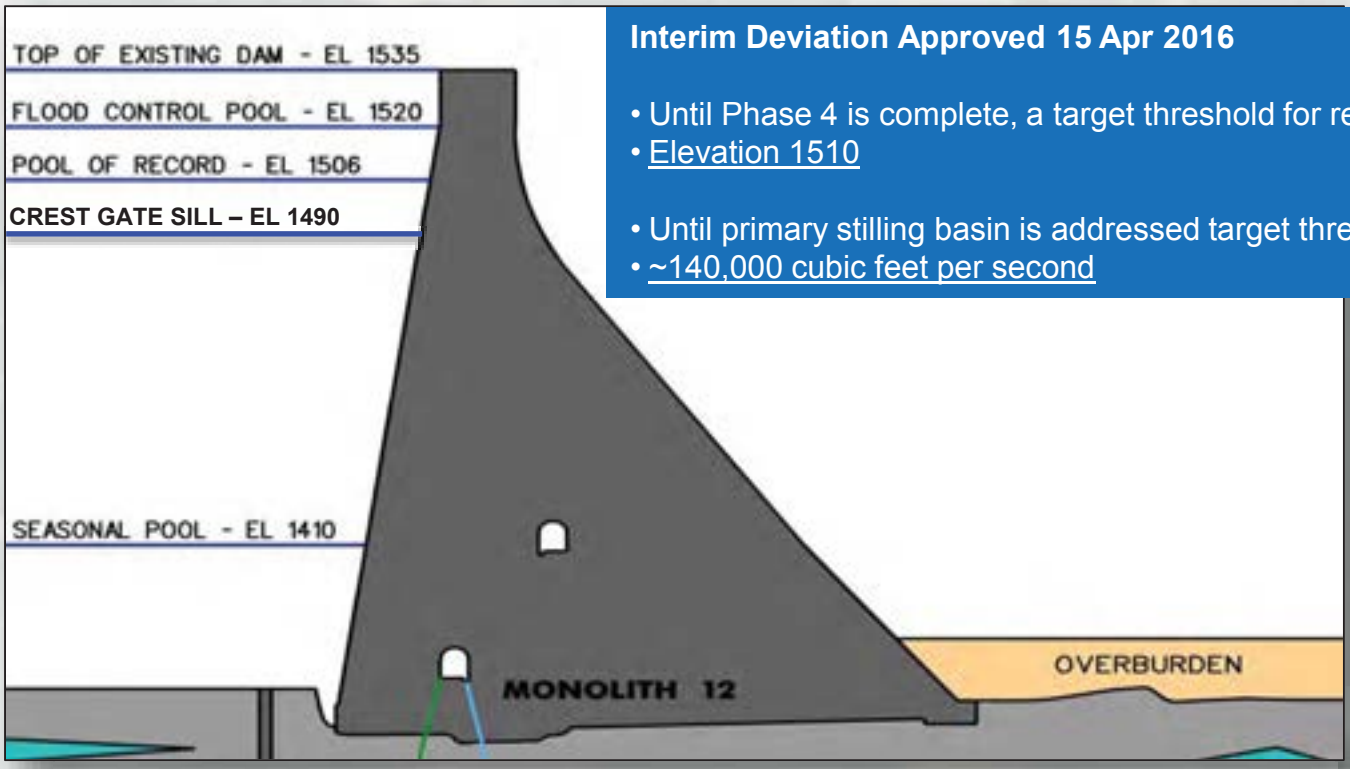
- $100M+ annual benefits (2014 price leve
- Significant incremental breach consequences
  - ▶ Population at Risk ~200,000

$5.8B C
Damages

How Does Bluestone Dam Work?



Bluestone Dam Reducing Flood Ris



Interim Deviation Approved 15 Apr 2016

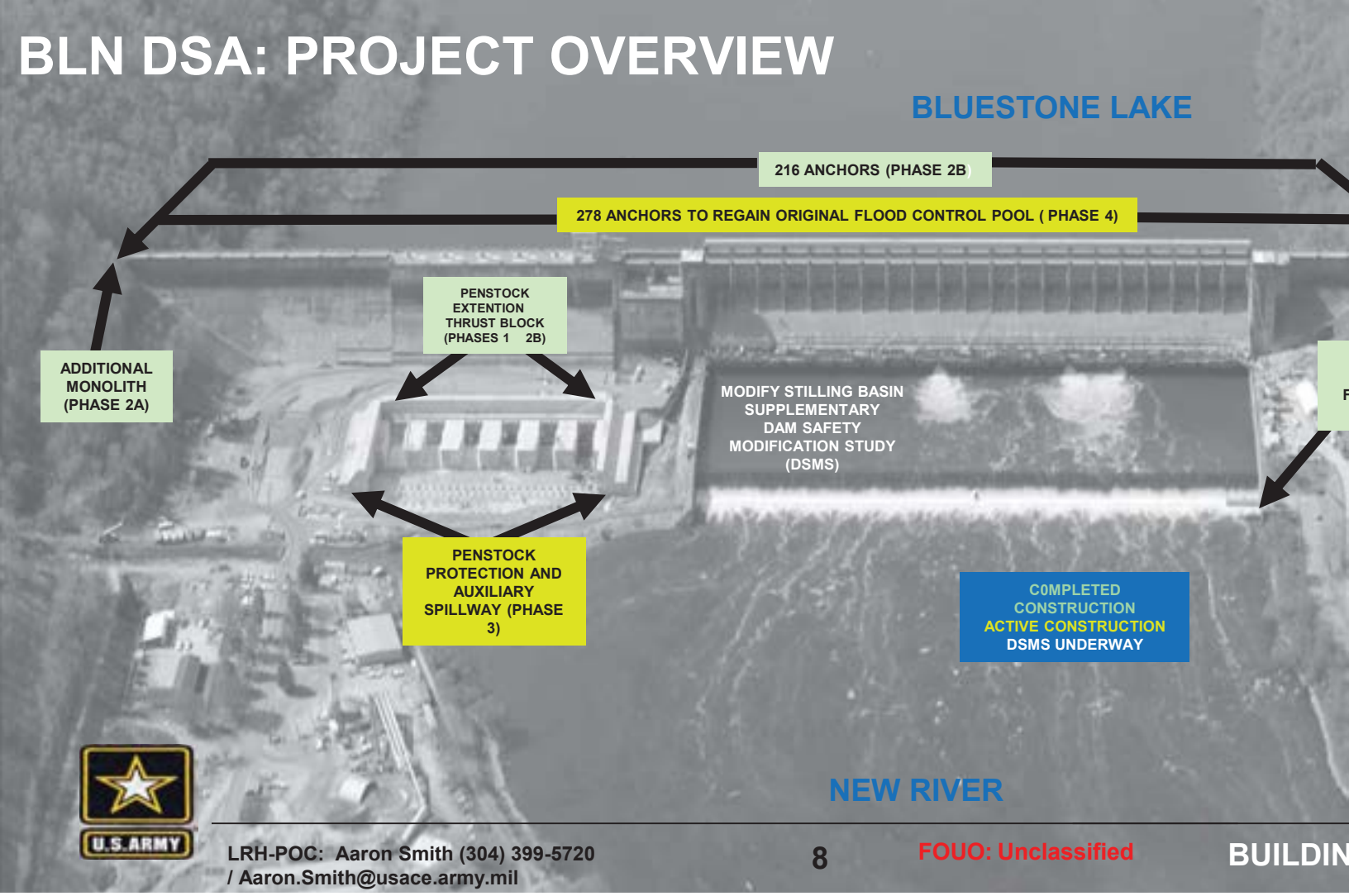
- Until Phase 4 is complete, a target threshold for re
- Elevation 1510

- Until primary stilling basin is addressed target thre
- ~140,000 cubic feet per second

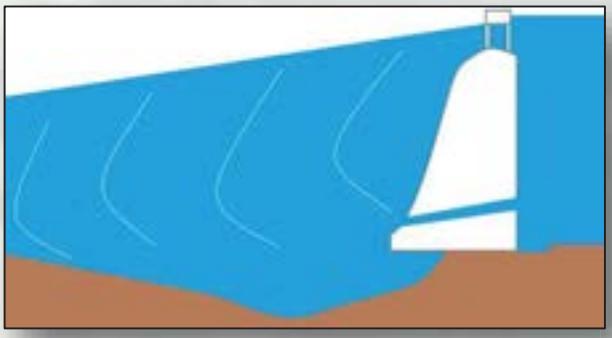
1998 Dam Safety Assurance Study Fin

- New Science / Better Data Indicates
  - The dam is significantly hydrologically deficient
  - The dam can only safely discharge or pass less than half the am water it may have to in an extreme flood (PMF)
  - Extreme floods would overtop the dam by ~ 22ft
  - During lesser flood events, the underlying rock could destabilize Dam monoliths could slide while retaining flood waters, causing a uncontrolled breach

BLN DSA: PROJECT OVERVIEW



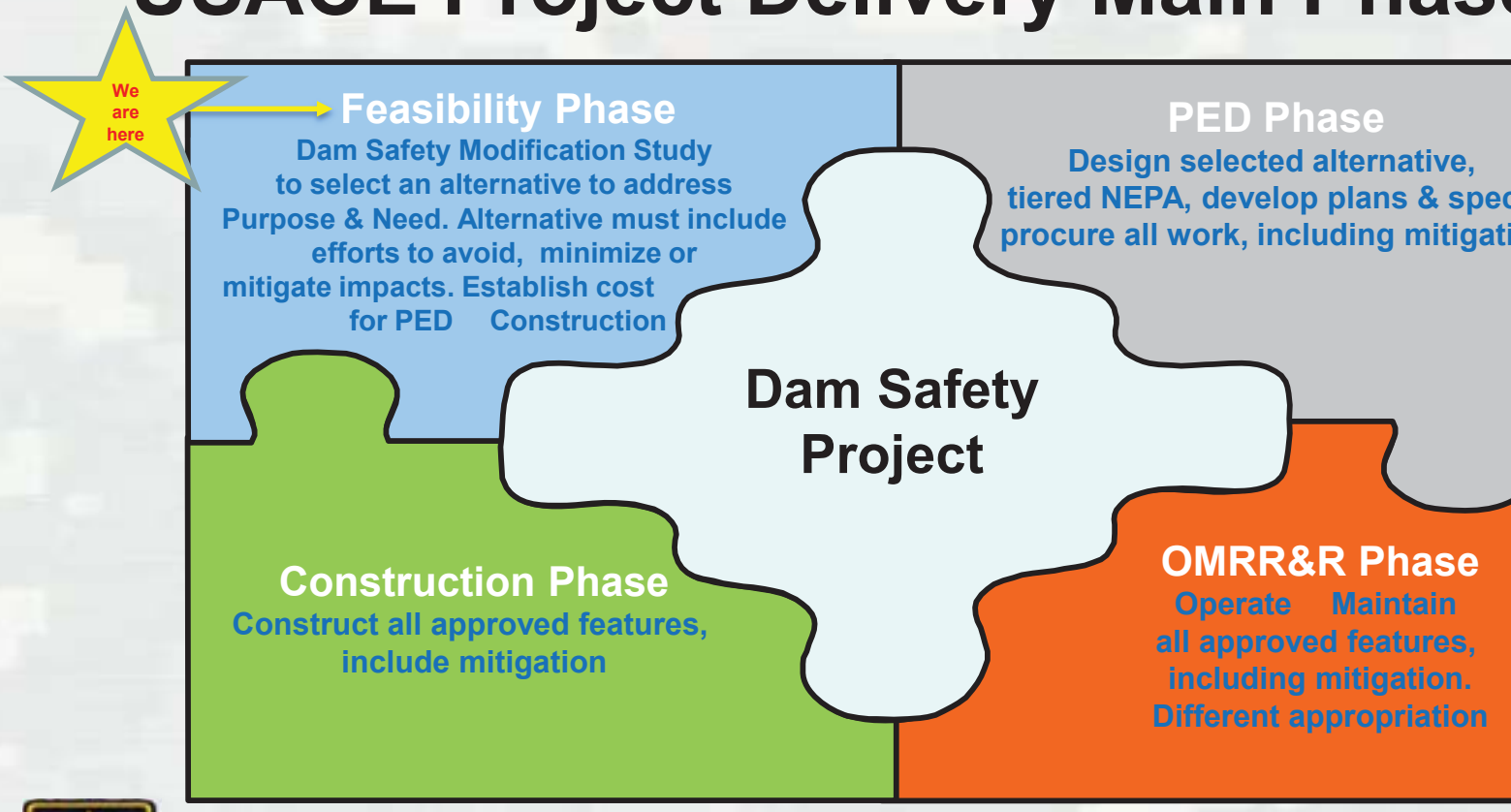
Current Concern



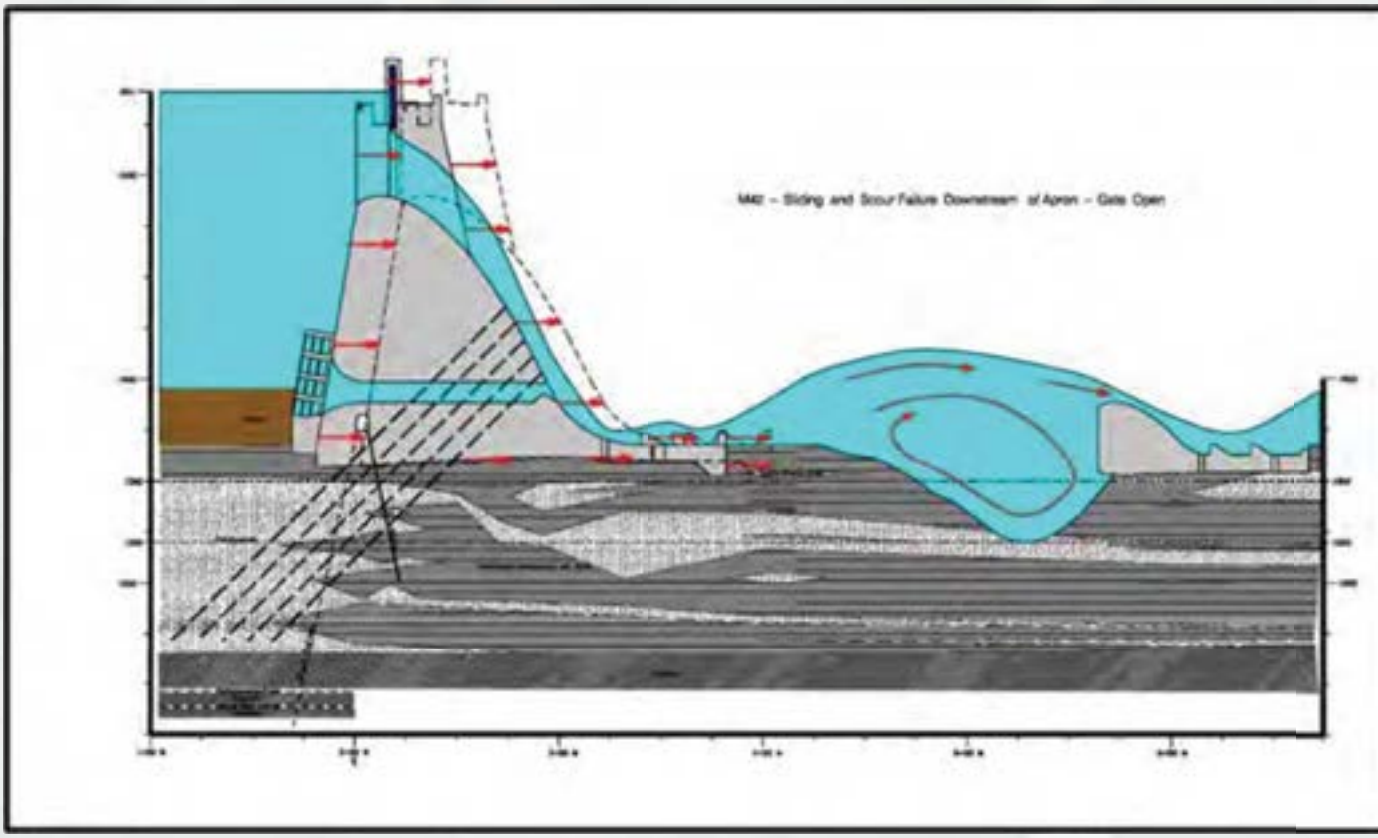
USACE Dam Safety Program

- ER 1110-2-1156; Safety of Dams Policies and Procedures
- All USACE dams classified according to risks (DSAC 1-5)
- Bluestone Dam DSAC 2 (High)
  - Risks above USACE Tolerable Risk Guidelines
  - Even after Phase 4 is complete
- Conduct study ID plan to reduce life safety risks below Tolerable Risk G
  - Formulate Alternatives,
  - Evaluate & Compare Alternatives
  - Identify Tentatively Select an Preferred Alternative
  - Complete sufficient design to have a stable cost estimate for funding purposes
  - Report review and approval

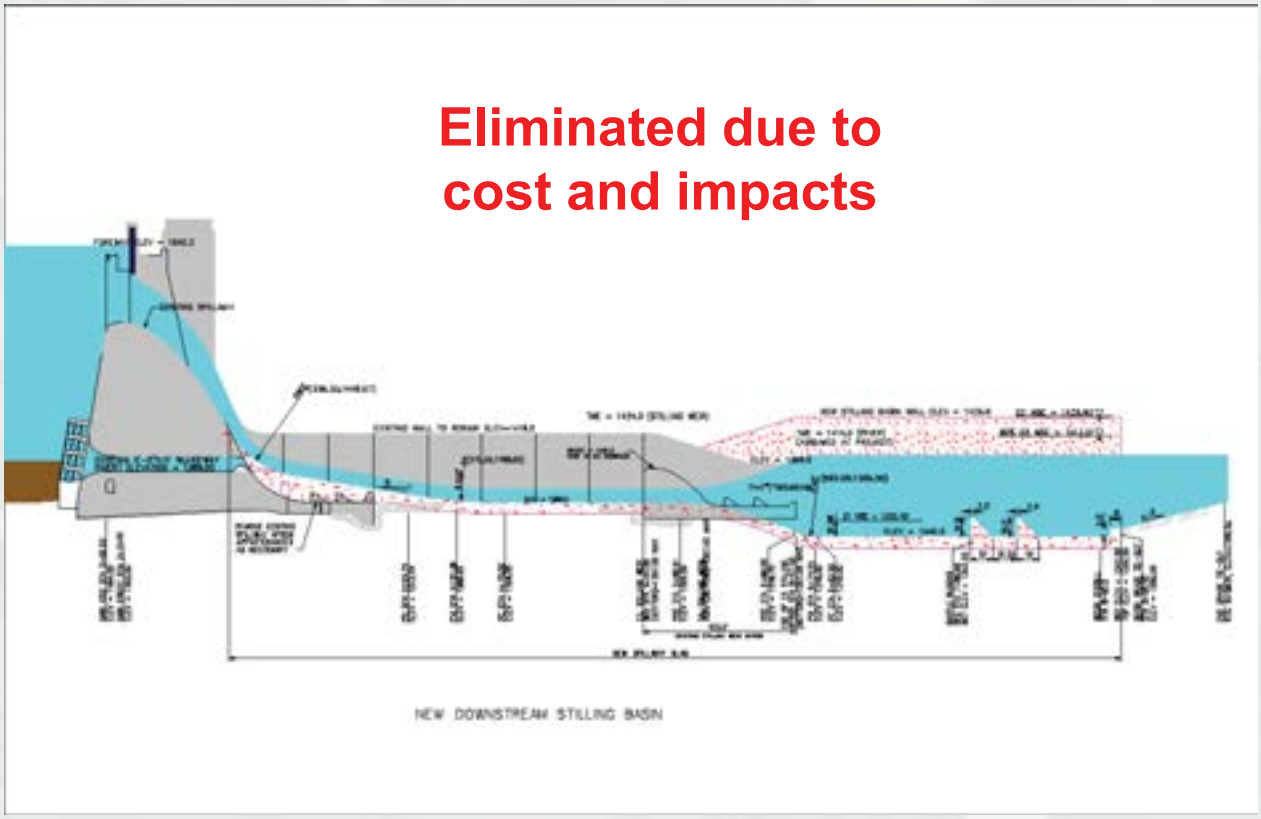
USACE Project Delivery Main Phase



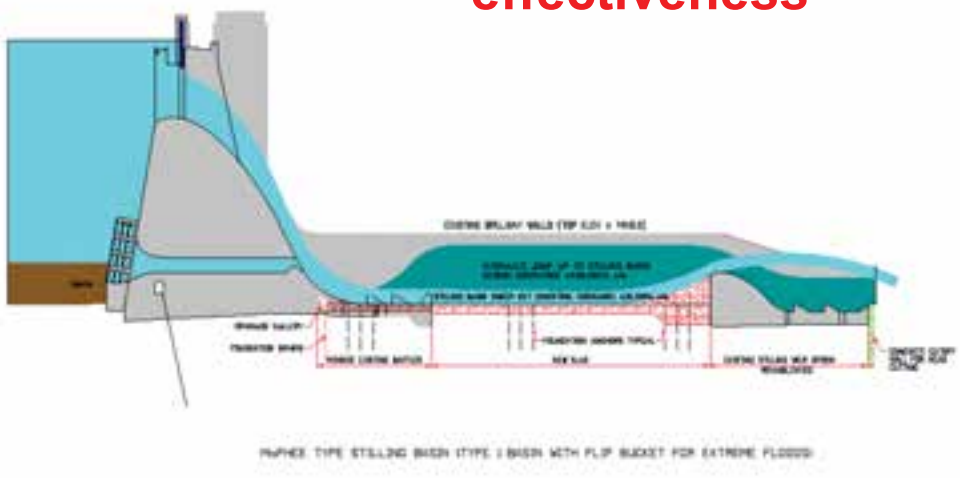
Problem Spillway Scour



Solution: New Stilling Basin – Go Downs



Solution: New Stilling Basin – Flip Bu



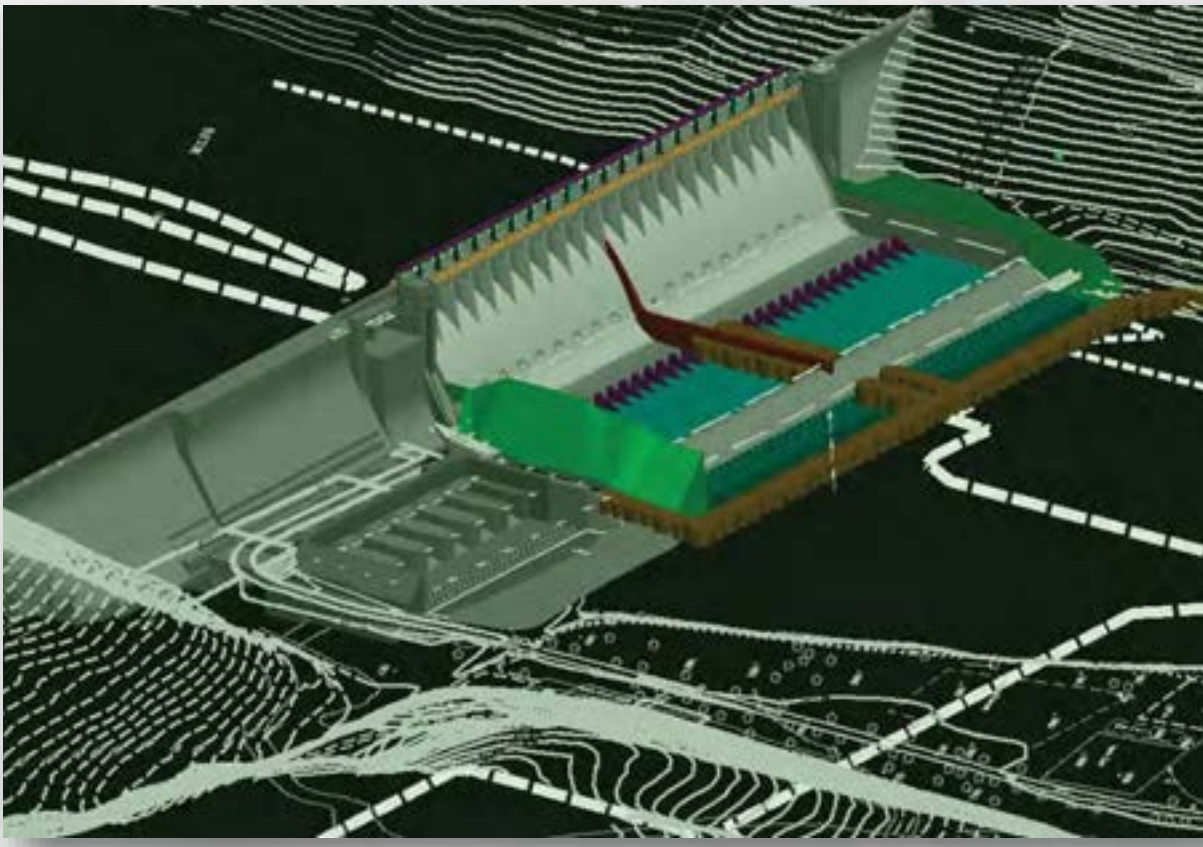
Eliminated due effectiveness

Concept of Tentatively Selected Pla

Tentatively Selected Plan Effective

Avoided & Minimized Impacts

Stays within footprint of dam

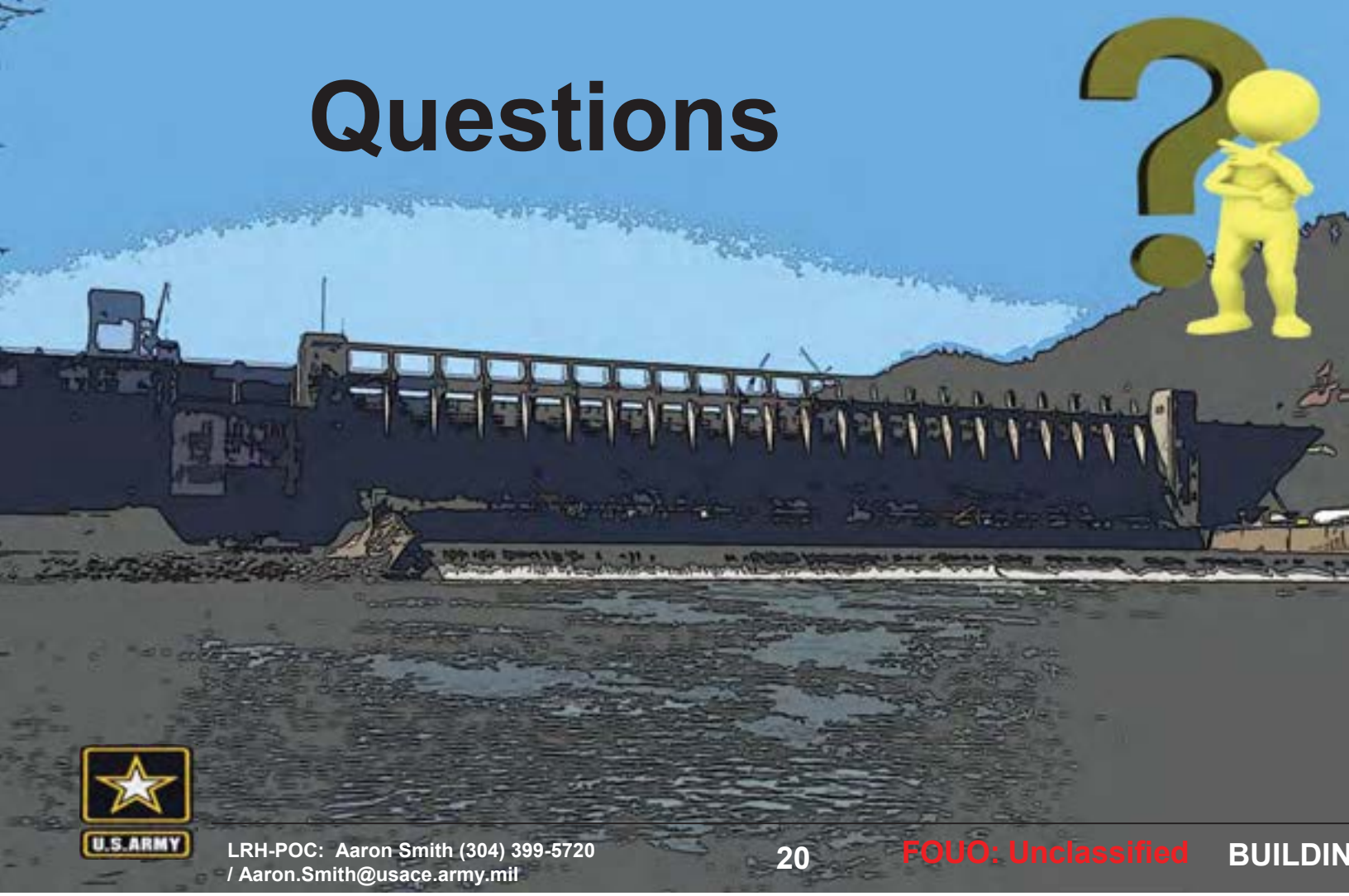


LRH-POC: Aaron Smith (304) 399-5720
/ Aaron.Smith@usace.army.mil

FOUO: Unclassified

Supplementary EIS Schedule Overview

Questions



LRH-POC: Aaron Smith (304) 399-5720
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FOUO: Unclassified

Appendix B

STATE IMPERILED PLANT SPECIES

Appendix B: State Imperiled Plant Species of the Bluestone National Scenic River, New River Gorge National River, and the Gauley River National Recreation Area

Legend:

State Ranks
State ranks are assigned by the West Virginia Natural Heritage Program and refer to the conservation status within West Virginia.

Rank Definition

S1: Five or fewer documented occurrences, or very few remaining individuals within the state. Extremely rare and critically imperiled; or because of some factor(s) making it especially vulnerable to extirpation.
S2: Six to 20 documented occurrences, or few remaining individuals within the state. Very rare and imperiled; or because of some factor(s) making it vulnerable to extirpation.
S3: Twenty-one to 100 documented occurrences. May be somewhat vulnerable to extirpation.
S4: Common and apparently secure with more than 100 occurrences.
S5: Very common and demonstrably secure.
SH: Historical. Species which have not been relocated within the last 20 years. May be rediscovered.
B: Breeding population
N: Non breeding population

Global Ranks

Global ranks are assigned by NatureServe and refer to the conservation status across the global range of the element.

Rank Definition

G1: Critically Imperiled - At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2: Imperiled - At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3: Vulnerable - At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4: Apparently Secure - Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5: Secure - Common; widespread and abundant.
GNR: Not ranked

Rank Qualifiers
?: Denotes inexact numeric rank
Q: Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the

inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.

Infraspecific Taxon Conservation Status Ranks

T#: The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.

Park Occurrences:

B: Bluestone National Scenic River
NR: New River Gorge National River
GR: Gauley River National Recreation Area

Sources:

New England Wild Flower Society. 2016. GoBotany Database (https://gobotany.newenglandwild.org/). c/o New England Wild Flower Society, Framingham, MA.

Virginia Botanical Associates. 2016. Digital Atlas of the Virginia Flora (http://www.vaplantatlas.org). c/o Virginia Botanical Associates, Blacksburg, VA.

USFWS. 2014. Final Planning Aid Letter, Bluestone Dam Safety Project.

Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
climbing fumitory/ allegheny vine	Adlumia fungosa	S2?	G4	NR, GR	wooded or rocky slopes
smallfruit agrimony	Agrimonia microcarpa	S1	G5	B	shallow wooded ravines
Lillydale onion	Allium oxyphilum	S2	G2Q	B	Rocky woods and outcrops
bushy bluestem	Andropogon glomeratus var. glomeratus	S2	G5T5	GR	riverbanks, wetland edges, woodlands
Canadian anemone	Anemone canadensis	S1	G5	B	floodplain openings
dwarf anemone/nightcaps	Anemone quinquefolia var. minima	S2	G5T3	NR, B	woodland borders
hairy rock-cress	Arabis hirsuta var. pycnocarpa	S2	G5	NR	dry forests, bluffs
spreading rock-cress	Arabis patens	S2	G3	NR	shaded outcrops and floodplains
purple needlegrass/ arrowfeather threeawn	Aristida purpurascens var. purpurascens	S1	G5	NR	flat rocks/old fields
blue wild indigo/ wild false indigo	Baptisia australis var. australis	S3	G5TNR	GR, B, NR	floodplain openings
American barberry	Berberis canadensis	S1	G3	B	barrens and clearings
grass pink	Calopogon tuberosus var. tuberosus	S1	G5	NR	bogs and seeps
eastern sweetshrub	Calycanthus floridus var. glaucus	SH	G5T5	B	mesic slope forests
bitter cress	Cardamine flagellifera	S1S2	G3	NR	floodplain forests
Blue Ridge bittercress	Cardamine flagellifera var. flagellifera	S2	G3	B	rocky forests, streambanks
summer sedge	Carex aestivalis	S2	G4	GR, NR	sandstone cliffs
glomerate sedge	Carex aggregata	S2	G5	B	mesic to dry forests; distrubed floodplains

Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Appalachian sedge	Carex appalachia	S2	G4	NR	shaded rock outcrops
brome-like sedge	Carex bromoides ssp. bromoides	S3	G5T5	GR	floodplain forests
Carey s sedge	Carex careyana	S1	G4	NR	floodplain forests
bearded sedge	Carex comosa	S2	G5	NR	marsh, wet meadow
Cumberland's sedge	Carex cumberlandensis	S1	GNR	NR, B, GR	floodplain forests
Emory s sedge	Carex emoryi	S2	G5	B, NR, GR	riverbanks
pubescent sedge	Carex hirtifolia	S2	G5	B	floodplain forests
inland sedge	Carex interior	S1	G5	NR	seeps, wet meadows
spreading sedge	Carex laxiculmis var. copulata	S1	G5T3T5	NR	flooodplain forests
midland sedge	Carex mesochorea	S2	G4G5	NR	upland forests and clearings
troublesome sedge	Carex molesta	S3	G4	B, NR, GR	floodplain openings
black-edge sedge	Carex nigromarginata	S3	G5	NR	woodland edges
greater straw sedge	Carex normalis	S3	G5	B	floodplain forests
wesk stellate sedge	Carex seorsa	S1	G4	NR, GR	wet flatwoods
bent sedge	Carex styloflexa	S1	G4G5	NR	streambanks, floodplain forests
praire straw sedge	Carex suberecta	S1	G4	NR	flat rock pools
quill sedge	Carex tenera	S1	G5	B	forests, meadows
shaved sedge	Carex tonsa var. rugosperma	S2S3	G5	NR	dry forests and clearings
cattail sedge	Carex typhina	S2	G5	B, NR	wet ditches/ floodplains
pretty sedge	Carex woodii	S2	G4	B, NR	middle to high elevation forests

Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
slender day-flower	Commelina erecta var. angustifolia	S2	G5	NR	flat rocks
spring coralroot	Corallorhiza wisteriana	S1	G5	NR	dry, rocky forest
star tickseed	Coreopsis pubescens var. robusta	S2	G5?T3T5	NR	floodplain openings
northern croton	Croton glandulosus var. septentrionalis	S3	G5T5	NR	fields, roadsides
pretty dodder	Cuscuta indecora var. neuropetala	S1	G5T5	NR	flat rocks
Fraser's cymophyllus/sedge	Cymophyllus fraserianus	S3	G4	GR, NR	cove forests
reflexed flatsedge	Cyperus refractus	S3	G5	NR	dry floodplain woods
awned cyperus	Cyperus squarrosus	S3	G5	NR	reservoir shores
downy danthonia	Danthonia sericea	S1	G5?	GR, NR	outcrops, clearings, roadsides
fewflower ticktrefoil	Desmodium pauciflorum	S1	G5	GR, NR	mesic woods
sand tick-trefoil	Desmondium lineatum	S1	G5	NR	forest edges
hemlock rosette grass/ American panic grass	Dichanthelium acuminatum ssp. columbianum	S1	G5T5	GR, NR	openings, roadsides
slender crabgrass	Digitaria filiformis	S1	G5	GR	dry clearings, outcrops
flat-stemmed spike-rush	Eleocharis compressa	S2	G4	NR	flat rocks
matted spike-rush	Eleocharis intermedia	S1	G5	NR	flat rocks
common spikerush/ creeping spikerush	Eleocharis palustris	S3	G5	B/NR	rivershores
yellow buckwheat	Eriogonum allenii	S2	G4	NR	shale barrens
Godfrey s thoroughwort/ godfrey s boneset	Eupatorium godfreyanum	S2S3	G4	GR, NR	clearings, roadsides
vervain thoroughwort	Eupatorium pilosum	S2	G5	NR	wet flatwoods, clearings

Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
annual fimbry	Fibristylis annua	S1	G5	NR	flat rocks
downy milkpea	Galactia volubilis	S2	G5	NR	floodplain openings
Appalachian gentian	Gentiana austromontana	S1	G3	NR	middle to high elevation forests
lesser rattlesnake plantain	Goodyera repens	S1S2	G5	B	hemlock forests
false Indian plaintain	Hasteola suaveolens	S3	G3	B	floodplain forests
Bicknell's forstweed	Helianthemum bicknelii	S1	G5	GR	prairie
Canada frostweed	Helianthemum canadense	S2	G5	NR	open woods, clearings
low frostweed	Helianthemum propinquum	S1	G4	GR	meadows, barrens
smooth sunflower	Helianthus laevigatus	S2	G4	B, NR, GR	open forests, clearings, roadsides
fewleaf sunflower/ McDowell sunflower	Helianthus occidentalis ssp. occidentalis	S2	G5T5	GR, NR	floodplain openings
Rough alumroot	Heuchera americana var. hispida	S2	G5	B	rocky forests, outcrops
halbred-leaved mallow	Hibiscus laevis	S2	G5	NR	muddy riverbank
coppery St. John's-wort	Hypericum virgatum	S1	G4?	NR	high flat rocks
butternut	Juglans cinerea	S3	G3G4	B, GR	mesic woods
forked rush	Juncus dichotomus	S1	G5	B, NR	streamside bars
narrowleaf pinweed	Lechea tenuifolia	S1	G5	GR	clearings, roadsides
valdivia duckweed	Lemna valdiviana	S3	G5	B	aquatic
Northern blazing star	Liatris scariosa var. nieuwlandii	S1	G5	GR	barrens, outcrops, roadsides
Appalachian blazing star	Liatris squarrulosa	S1	G4G5	GR	prairie
Turgid gay-feather	Liatristurgida	S2	G3	GR	cliffs
American fly honeysuckle	Lonicera canadensis	S2	G5	B	middle to high elevation forests

Common Name	Scientific Name	State Rank	Global Rank	Park Occurences	Primary Habitat
American climbing fern	Lygodium palmatum	S3	G4	GR	upland and floodplain forests
southern yellow loosestrife	Lysimachia tonsa	SH	G4	B	upland forests
winged-loosestrife	Lythrum alatum var. alatum	S2	G5T5	NR	riverside prairies, flood-scoured bars
starflower false Solomon's-seal	Maianthemum stellatum	S2	G5	NR	riverside bars, floodplain forests
Monongahela Barbara's buttons	Marshallia grandiflora	S2	G2	GR	streambanks , gravel bars
two-flower melic grass	Melica mutica	S2	G5	NR	mesic floodplain
wild bergamot	Monarda fistulosa ssp. brevis	S1	G5T1	B, GR	open shale banks
largeseed forget-me-not	Myosotis macrosperma	S2	G5	B, GR, NR	floodplain forests
slender water nymph	Najas gracillima	S2	G5?	NR	aquatic
evening-primrose	Oenothera pilosella	S2	G5T5?	NR	distrubed landscape
balsam groundsel	Packera paupercula	S2	G5	GR	barrens, riverside prairies
red pine	Pinus resinosa	S1	G5	NR	barrens, riverside prairies
blackseed needlegrass	Piptochaetium avenaceum	S1	G5	NR	flat rocks
yellow fringed orchid	Platanthera ciliaris	S3	G5	NR	boggy flatwoods, roadsides
small purple-fringe orchid	Platanthera psycodes	S1	G5	NR	mesic high-elevation forests, wet meadows
drooping bluegrass	Poa saltuensis	S1	G5	NR	roaky woodlands, barrens
rose pogonia	Pogonia ophioglossoides	S2	G5	NR	bogs, boggy clearings
Curtiss milkwort	Polygala curtissii	S2	G5	GR, NR	clearings and edges

Common Name	Scientific Name	State Rank	Global Rank	Park Occurences	Primary Habitat
water smartweed	Polygonum amphibium var. emersum	S2S3	G5T5	NR	aquatic or waterlogged soils
Allegheny plum	Prunus alleghaniensis var. alleghaniensis	S3	G4T4	B	shale barrens
eastern sandcherry	Prunus pumila var. depressa	S1	G5T5	GR	river scoured meadows
Loomis' mountain-mint	Pycnanthemum loomisii	S2	G4?	NR	flooplain woods
Torrey s mountain-mint	Pycnanthemum torrei	S1	G2	NR	flat rocks
Pennsylvania buttercup	Ranunculus pensylvanicus	S1	G5	NR	stream banks, wet clearings
low spearwort	Ranunculus pusillus var. pusillus	S1	G5T4?	NR	flat rock wet areas
globe beaksedge/rush	Rhynchospora recognita	S2	G5?	GR, NR	wet meadows, bogs
prickly currant	Ribes lacustre	S2	G5	B	rock outcrops and forests
Smooth rose	Rosa blanda var. blanda	S2	G5	GR	roadsides
orange coneflower	Rudbeckia fulgida var. fulgida	S2	G5T4?	GR	barrens, clearings meadows
shining willow	Salix lucida ssp Lucida	S1	G5T5	NR	montane alluvial bottom
Carey saxifrage	Saxifraga careyana	S3	G3	NR	wet meadow, mountains
weakstalk bulrush	Schoenoplectus purshianus	S3	G4G5	NR	sandy rivershores, wet meadows
smooth rock skullcap	Scutellaria saxatilis	S2	G3	B, NR	moist rocky woods
Virginia cress	Sibara virginica	S2?	G5	NR	distrubed areas
Virginia mallow	Sida hermaphrodita	S2	G3	NR	road openings
snowy campion	Silene nivea	S1	G4	NR	flood-scoured riverbanks

Common Name	Scientific Name	State Rank	Global Rank	Park Occurences	Primary Habitat
Virginia cup-plant	Silphium perfoliatum var. connatum	S1	G5T3T4	NR	floodplain forests
Rand's goldenrod	Solidago simplex ssp. randii var. racemosa	S2	G5T3?	GR, NR	river shore outcrops
Virginia meadowsweet	Spiraea virginiana	S1	G2	B, GR	rocky riverbank
shining ladies'-tresses	Spiranthes lucida	S1S2	G5	GR	moist open riverbanks
oval ladies'-tresses	Spiranthes ovalis var. erostellata	S1	G5?T4?	NR	floodplain forests
little ladies'-tresses	Spiranthes tuberosa	S3	G5	NR	dry open forests
spring ladies'-tresses	Spiranthes vernalis	S3	G5	GR	meadows, roadsides
rough dropseed	Sporobolus clandestinus	S1	G5	NR	flat rocks
heartleaf hedgenettle/ Nuttall's hedge-nettle	Stachys nuttallii	S3	G5?	B, GR, NR	flat rocks
smooth hedgenettle	Stachys tenuifolia	S3	G5	B, NR	floodplain forests
smooth blue aster	Symphyotrichum laeve var. concinnum	S2	G5T4	GR	steep slopes, shale barrens
Canada yew	Taxus canadensis	S2S3	G5	B	cliffs, rocky forests
mountain meadow-rue	Thalictrum clavatum	S2	G4	GR, NR	rocky stream banks; wet cliffs
White cedar	Thuja occidentalis	S2	G5	B	cliffs/old riverbed
buffalo clover	Trifolium reflexum	S1	G3G4	B	disturbed woodlands
nodding pogonia	Triphora trianthophora	S2	G4	NR	floodplain forests
Nannyberry	Viburnum lentago	S1S2	G5	GR	streambanks
downy arrowwood	Viburnum rafinesquianum	S2	G5	B	dry slopes
rusty blackhaw	Viburnum rufidulum	S1	G5	B, NR	dry forest
Appalachian violet	Viola appalachiensis	S3	G3	GR	barrens and forests

Common Name	Scientific Name	State Rank	Global Rank	Park Occurences	Primary Habitat
sand grape	Vitis rupestris	S2	G3	B, NR	flood-scoured riverbanks

Appendix C

STATE IMPERILED WILDLIFE SPECIES

Appendix C

STATE IMPERILED WILDLIFE SPECIES OF THE BLUESTONE NATIONAL SCENIC RIVER, NEW RIVER GORGE NATIONAL RIVER, AND THE GAULEY RIVER NATIONAL RECREATION AREA

Legend:

State Ranks
State ranks are assigned by the West Virginia Natural Heritage Program and refer to the conservation status within West Virginia.

Rank Definition

S1: Five or fewer documented occurrences, or very few remaining individuals within the state. Extremely rare and critically imperiled; or because of some factor(s) making it especially vulnerable to extirpation.
S2: Six to 20 documented occurrences, or few remaining individuals within the state. Very rare and imperiled; or because of some factor(s) making it vulnerable to extirpation.
S3: Twenty-one to 100 documented occurrences. May be somewhat vulnerable to extirpation.
S4: Common and apparently secure with more than 100 occurrences.
S5: Very common and demonstrably secure.
SH: Historical. Species which have not been relocated within the last 20 years. May be rediscovered.
B: Breeding population
N: Non breeding population

Global Ranks
Global ranks are assigned by NatureServe and refer to the conservation status across the global range of the element.

Rank Definition

G1: Critically Imperiled - At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2: Imperiled - At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3: Vulnerable - At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4: Apparently Secure - Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5: Secure - Common; widespread and abundant.
GNR: Not ranked

Rank Qualifiers
?: Denotes inexact numeric rank
Q: Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.

Infraspecific Taxon Conservation Status Ranks

T#: The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.

Park Occurrences:

B--Bluestone National Scenic River
NR--New River Gorge National River
GR -- Gauley River National Recreation Area

Sources:

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Taxa Category	Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Amphibian	Jefferson's salamander	*Ambystoma jeffersonianum*	S2	G4	B, NR, GR	terrestrial: upland forests
Amphibian	green salamander	*Aneides aeneus*	S3	G3G4	B, NR, GR	terrestrial: rock crevices
Amphibian	Eastern hellbender	*Cryptobranchus alleganiensis*	S2	G4	GR	aquatic: rivers with flat rocks
Amphibian	black-bellied salamander	*Desmognathus quadramaculatus*	S3	G5	B, NR, GR	aquatic: rivers and streams
Amphibian	cave salamander	*Eurycea lucifuga*	S3	G5	B, NR, GR	riparian: caves and forest overstory
Amphibian	Midland mud salamander	*Pseudotriton montanus diastictus*	S1	G5	NR	riparian: soft mud burrows on banks
Amphibian	Northern red salamander	*Pseudotriton ruber*	S3	G5	B, NR, GR	riparian: under logs, leaf litter
Bird	Cooper's hawk	*Accipiter cooperii*	S3	G5	B, NR, GR	forests, nests in trees
Bird	sharp-shinned hawk	*Accipiter striatus*	S3	G5	B, NR, GR	forests, nests in horizontal limb next to tree trunk
Bird	spotted sandpiper	*Actitis macularia*	S3B	G5	B, NR, GR	riparian, ground nesting
Bird	grasshopper sparrow	*Ammodramus savannarum*	S3B	G5	B, NR	grasslands, ground nesting
Bird	green-winged teal	*Anas crecca*	S2N	G5	B, NR, GR	marsh, ground nesting
Bird	American black duck	*Anas rubripes*	S2BS4N	G5	B, NR, GR	marsh, ground nesting
Bird	great blue heron	*Ardea herodias*	S3BS4N	G5	B, NR, GR	marsh, tree and ground nesting
Bird	American bittern	*Botaurus lentiginosus*	S1BS1N	G4	B, NR, GR	marsh, ground nesting

Taxa Category	Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Bird	Swainson's thrush	*Catharus ustulatus*	S3B	G5	B, NR, GR	forests, nest in forest understory
Bird	Northern harrier	*Circus cyaneus*	S1BS3N	G5	B, NR, GR	open floodplain, ground nesting
Bird	black-billed cuckoo	*Coccyzus erythropthalmus*	S3	G5	B, NR, GR	forests, tree nesting
Bird	Eastern wood peewee	*Contopus virens*	S5B	G5	B, NR, GR	forests, tree nesting
Bird	black vulture	*Coragyps atratus*	S3BS4N	G5	B, NR, GR	open woodland, cliff nesting
Bird	cerulean warbler	*Dendroica cerulea*	S4B	G4	B, NR, GR	bottomland forests, nests in horizontal limb of a deciduous tree in mid- to upper-canopy
Bird	yellow-rumped warbler	*Dendroica coronata*	S3BS3N	G5	B, NR, GR	nests in shrubs or in the lower branches of pine or cedar trees
Bird	prairie warbler	*Dendroica discolor*		G5	B, NR, GR	open woodland, shrub nesting
Bird	Blackburnian warbler	*Dendroica fusca*	S3B	G5	B, NR, GR	woodland, tree nesting
Bird	bobolink	*Dolichonyx oryzivorus*	S3B	G5	B, NR, GR	flooded meadows, tall grass, ground nesting
Bird	Acadian flycatcher	*Empidonax virescens*	S5B	G5	B, NR, GR	riparian, tree nesting

Taxa Category	Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Bird	horned lark	*Eremophila alpestris*	S2BS3N	G5	B, NR, GR	fields, open cultivated areas, ground nesting
Bird	peregrine falcon	*Falco peregrinus*	S1BS2N	G4	B, NR, GR	nests in cliffs or manmade structures
Bird	American coot	*Fulica americana*	S1BS3N	G5	B, NR, GR	rivers, floating nests
Bird	bald eagle	*Haliaeetus leucocephalus*	S2BS3N	G5	B, NR, GR	forests near river, nests in tall trees or structures
Bird	worm-eating warbler	*Helmitheros vermivorus*	S5B	G5	B, NR, GR	hillside forests, ground nesting
Bird	wood thrush	*Hylocichla mustelina*	S5B	G5	B, NR, GR	forests, nests in fork or horizontal branch 2 to 15 meters above the ground
Bird	Swainson's warbler	*Limnothlypis swainsonii*	S3B	G4	B, NR, GR	floodplain forests, nests in dense understory
Bird	hooded merganser	*Lophodytes cucullatus*	S1BS4N	G5	B, NR, GR	riparian, cavity nesting
Bird	red-headed woodpecker	*Melanerpes erythrocephalus*	S2BS3N	G5	B, NR, GR	open woodland, nests in dead trees or dead parts of live trees
Bird	osprey	*Pandion haliaetus*	S2B	G5	B, NR	riparian, nests in snags or treetops
Bird	cliff swallow	*Petrochelidon pyrrhonota*	S3B	G5	B, NR, GR	riparian, cliff nesting

Taxa Category	Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Bird	vesper sparrow	*pooecetes gramineus*	S3BS2N	G5	B, NR, GR	open habitats with grass, ground nesting
Bird	prothonotary warbler	*Protonotaria citrea*	S2B	G5	B, NR, GR	bottomland forests, cavity nesting
Bird	bank swallow	*Riparia riparia*	S2B	G5	B, NR, GR	riparian, burrow nests in banks and bluffs
Bird	American woodcock	*Scopolax minor*	S4BS4N	G5	B, NR, GR	forest, ground nesting
Bird	Louisiana waterthrush	*Seiurus motacilla*	S5B	G5	B, NR, GR	riprian, nests in cavities on stream banks, under fallen logs, or within roots of an upturned tree.
Bird	yellow-bellied sapsucker	*Sphyrapicus varius*	S1BS3N	G5	B, NR, GR	bottomland forests and edge habitat, nests in cavities
Bird	dickcissel	*Spiza americana*	S2B	G5	BR, NR	grassland, ground nesting
Bird	field sparrow	*Spizella pusilla*	S4BS4N	G5	B, NR, GR	open woods, nests on ground or in bushes
Bird	golden-winged warbler	*Vermivora chrysoptera*	S2B	G4	B, NR	open woods, nests on ground or in a low bush

Taxa Category	Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Bird	blue-winged warbler	*Vermivora pinus*	S4B	G5	B, NR	open woods, nests on ground or in a low bush
Bird	Nashville warbler	*Vermivora ruficapilla*	S1B	G5	B, NR, GR	forest, ground nesting
Bird	Canada warbler	*Wilsonia canadensis*		G5	B, NR, GR	forest, ground nesting
Mammal	Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	S1	G3G4	B, NR, GR	caves/trees
Mammal	least shrew	*Cryptotis parva*	S2	G5	B, NR, GR	open fields
Mammal	silver-haired bat	*Lasionycteris noctivagans*	S2	G5	B, NR, GR	winter: caves; summer: trees
Mammal	Eastern red bat	*Lasiurus borealis*		G5	B, NR, GR	trees
Mammal	hoary bat	*Lasiurus cinereus*		G5	B, NR, GR	trees
Mammal	Eastern small-footed bat	*Myotis leibii*	S1	G3	B, NR, GR	hemlock forests
Mammal	Allegheny woodrat	*Neotoma magister*	S3	G3G4	B, NR, GR	caves, rock outcrops, riverbank boulders
Mammal	evening bat	*Nycticeius humeralis*	S1	G5	B, NR, GR	trees
Mammal	golden mouse	*Ochrotomys nuttalli*	S2	G5	B, NR, GR	ground nesting
Mammal	long-tailed shrew	*Sorex dispar*	S2S3	G4	B, NR, GR	high elevation
Mammal	pygmy shrew	*Sorex hoyi*	S2S3	G5	B, NR, GR	subterranean tunnels
Mammal	Southern bog lemming	*Synaptomys cooperi*	S3	G5	B, NR, GR	burrows
Mammal	meadow jumping mouse	*Zapus hudsonius*	S3	G5	B, NR, GR	burrows, streamside brush
Reptile	Worm snake	*Carphophis amoenus*	S3	G5	GR	burrows, debris, snags

Taxa Category	Common Name	Scientific Name	State Rank	Global Rank	Park Occurrences	Primary Habitat
Reptile	timber rattlesnake	*Crotalus horridus*	S3	G4	NR, GR	rock outcrops, high ridges
Reptile	broad-headed skink	*Eumeces laticeps*	S2	G5	NR, GR	tree trunks
Reptile	wood turtle	*Glyptemys insculpta*	S3	G4	NR, GR	riparian
Reptile	rough green snake	*Opheodrys aestivus*	S2	G5	B, NR, GR	riparian vegetation
Reptile	river cooter	*Pseudemys concinna*	S2	G5	NR, GR	river

Appendix D

USFWS – PRELIMINARY HABITAT EVALUATION PROCEDURES REPORT

DRAFT

PRELIMINARY HABITAT EVALUATION PROCEDURES REPORT

BLUESTONE DAM SAFETY PROJECT

October 2013

U.S. Fish and Wildlife Service

West Virginia Field Office

Elkins, West Virginia

Background

The Bluestone Dam is located on the New River, 1.5 miles upstream of the City of Hinton in Summers County, West Virginia. The Bluestone Dam is a concrete gravity structure with an overall length of 2,060 feet and maximum height of 165 feet above the streambed. The total design discharge capacity of the dam is 430,000 cubic feet per second (cfs). When the dam was planned in the 1930's, this discharge capacity was based upon a hypothetical flood created by shifting the center of the July 1916 hurricane storm to the New River drainage basin. Since the construction of the dam, new data has become available. The U.S. Army Corps of Engineers Huntington District (Corps) now estimates that the Probable Maximum Flood (PMF) for the New River Basin has a peak flow of 1,086,000 cfs, which is double the peak of the original design flow. This design flood was generated by coupling recent National Weather Service precipitation estimates with detailed terrain, soil, and runoff data (Corps 2013b).

A plan was approved as described in the 1998 Dam Safety Assurance (DSA) Evaluation Report and is currently being implemented to modify Bluestone Dam to safely withstand the PMF. When this construction project is completed it will strengthen the dam's stability and allow for increased discharge capacity through the use of hydropower penstocks (Corps 2013b). However, there was speculation as to whether or not increased discharge in the streambed would lead to scour of the dam foundation and downstream habitat leading to dam failure. A Baseline Risk Assessment, completed by the Corps in 2013, determined that scour, overtopping, and spillway gate reliability posed unacceptable risk for the dam. Given the total risk associated with these failure modes, the Corps was directed to prepare a supplemental report to formulate new alternative risk management plans. In accordance with the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e) and in support of this new study, the U.S. Fish and Wildlife Service (Service) cooperated with the West Virginia Division of Natural Resources (WVDNR) and the Corps in 2013 to conduct an evaluation of terrestrial and riverine habitat types immediately downstream of the Bluestone Dam.

This document is intended to characterize current environmental conditions in the tailwater area immediately below the dam. This information will serve as the baseline environmental condition for the new supplemental DSA report and will be used to formulate alternative risk management plans. The second phase of the analysis will calculate mitigation requirements, once project alternatives for detailed study have been identified.

Figure 1. Bluestone Dam

Introduction

Habitat Evaluation Procedures (HEP), as detailed in the Service's 1980 manual (ESM 102), were used for this effort. An interagency biologist team conducted a field review and collected data for this project on September 10 - 13, 2013. The HEP field team consisted of Andrew Johnson of the Corps Huntington District, Laura Hill of the Service, John Schmidt of the Service, and Tiernan Lennon of the Service. Danny Bennett of the WVDNR assisted in planning the HEP and interpreting the data. This report was prepared by Tiernan Lennon of the Service through coordination and cooperation with the above referenced HEP team.

Four sites were selected for field survey as part of this evaluation: the three riparian habitat sites (RP Sites 1, 2, and 3); and the riverine habitat site (R Site 1).

HEP requires the use of Habitat Suitability Index (HSI) models developed for indicator species that best represent groups of species that use the habitats. Species models for this evaluation were selected in collaboration with the HEP team. Species selected for habitat evaluation of the riparian sites included the mink (*Mustela vison*), black-capped chickadee (*Parus atricapillus*), and yellow warbler (*Dendroica petechia*l). The riverine site species included the smallmouth bass (*Micropterus dolomieui*) and common shiner (*Notropis cornutus*).

Riparian habitat on the right (river right) descending bank varied greatly from areas of naturalized vegetation to a managed city park lacking sufficient vegetation. In that situation, separate HSI values were calculated for each habitat type (RP Site 1 and 2). Habitat measurements were collected at each site based on the HEP model requirements for each species. Metrics for a total of 21 variables were compiled from the riparian and riverine habitats as part of this evaluation. These variables were measured or estimated along transects and/or points within each habitat type. When incorporated into

the species habitat models, the resultant metrics are used as indicators of habitat condition or value. Baseline habitat conditions are expressed as a numeric function (HSI value) ranging from 0 to 1.0, where 0 represents no suitable habitat for an indicator species and 1.0 represents optimum conditions for the species. This report provides HSI values for the indicator species in the tailwater area. The second phase of the analysis will calculate habitat units by multiplying the HSI value by the aerial extent of the assessed habitat.

Habitat Mapping

Riverine and riparian habitat types were separated using field data and observations. The data were analyzed and maps were generated using Geographic Information System (GIS) applications (Figures 2, 3, and 4). The mapping effort was conducted by Elizabeth Stout of the Service.

The overall project area contains three riparian sites and one riverine site. Each site was divided into transects and habitat measurements were averaged due to the general homogeneity of the assessed habitat. Transect locations and habitat measurements are provided in Table 1.

Figure 2. Riverine Habitat Transect Map.

Figure 3. Habitat Map for Riparian Sites 1 & 2.

Figure 4. Habitat Map for Riparian Site 3.

Table 1. HEP habitat site descriptions and field transect locations.

Evaluation Site	Transect No.	Transect Length (m)	Site Size (acres)	HEP Habitat Code	Site Description
RP-1	# of transects 8	N/A	1.8 ac	Riparian (RP)	Managed riparian habitat - scattered trees and shrubs
RP-2	# of transects 33	N/A	1.4 ac	Riparian (RP)	Managed riparian habitat – fair vegetative cover
RP-3	# of transects 29	N/A	2.5 ac	Riparian (RP)	Dense riparian cover
R-1	1A	387.8 m	125 ac	Riverine (R)	Riffle area - gravel, cobble, and boulder
R-1	1B	375.9 m	125 ac	Riverine (R)	Riffle area - gravel, cobble, and boulder
R-1	1C	62.4 m	125 ac	Riverine (R)	Pool-like area
R-1	1D	170.7 m	125 ac	Riverine (R)	Pool-like area
R-1	1E	353.2 m	125 ac	Riverine (R)	Riffle area – gravel, cobble, and boulder

Site Descriptions

All sites assessed are located in the tailwaters within the vicinity of the proposed dam modification project near the City of Hinton in Summers County, West Virginia. Each site is described in more detail below. The study area for this report extended from the dam downstream 0.82 river miles to the Route 3 Bridge. Sites were divided based on location, habitat type, and homogeneity of habitat. Within each of the 4 sites (3 riparian and 1 riverine), habitats were considered homogenous.

Riparian Site No. 1 (RP-1)

Riparian Site 1 consists of approximately 1.8 acres located along the right descending bank of the river (river right) (Fig.3). Land use at this site is primarily for fishing access, with an active construction zone adjacent to the dam at the time of field data collection. A riparian zone of poor quality habitat, consisting of a few scattered trees and shrubs, is present along this portion of the New River (Fig. 5).

Transects were established (every 10 meters) throughout the entire 80 meter length of Riparian Site 1 for the HEP analysis in order to assure a complete sample of the habitat at the site. Unlike other sites on Figure 3, Site 1 is shown with the yellow transect lines. This site is continually maintained and mowed by

the City of Hinton, so shrubby vegetation at this site was scarce. Site 1 had too few scattered trees to be considered good riparian habitat for the selected evaluation species.

The dominant tree species at this site were River Birch (*Betula nigra*), American Sycamore (*Platanus occidentalis*), Eastern Red Cedar (*Juniperus virginiana*), and Tree of Heaven (*Ailanthus altissima*). A full list of the species observed in the entire study area is shown in Appendix B.

Figure 5. Riparian Site #1.

Riparian Site No.2 (RP-2)

Site 2 consists of approximately 1.4 riparian acres located river right and primarily alongside Hinton City Park (Fig.3). Land use at this site is dominated by narrow bands of riparian forest and shrubs (Fig.6).

Transects were established every 10m throughout the entire 335.0 m length of Site 2 for the HEP analysis in order to assure a complete sampling of habitats at this site. The quality of natural habitat is better than RP Site 1, since it meets more of the requirements for the selected evaluation species.

The dominant tree species at this site were River Birch, American Sycamore, Tree of Heaven, Black Cherry (*Prunus serotina*), Sugar Maple (*Acer saccharum*), Mulberry (*Morus spp.*), Box elder (*Acer negundo*), Willow (*Salix spp.*), American elm (*Ulmus americana*), and Tulip Tree (*Liriodendron tulipifera*) (Appendix B).

Figure 6. Riparian Site #2.

Riparian Site No. 3 (RP-3)

This riparian site consists of approximately 2.5 acres located on the left descending bank downstream of the dam (river left) extending from the fishing pier to the end of the Corps property line along the fishing pier access road (Fig. 4). Land use at this site is dominated by a long narrow band of steep, dense riparian cover (Fig. 7).

Transects were established (every 10 m) throughout the 292.6 meter length of Site 3 for the HEP analysis in order to assure a complete sampling of habitat at the site (Fig.4). Site 3 had a mix of dense shrub cover and mature tree stands.

The dominant tree species at this site were River Birch, American Sycamore, Tree of Heaven, Black Cherry, Sugar Maple, Mulberry, Box elder, American elm, Tulip Tree, Red Bud (*Cercis canadensis*), Honey Locust (*Gleditsia Triacanthos*), Slippery Elm (*Ulmus rubra*), and Silk Tree (*Albizia spp.*)(Appendix B).

Figure 7. Riparian Site #3.

Riverine Site No. 1 (R-1)

Riverine Site 1 is approximately 0.82 river miles (125 ac), stretching from the Bluestone Dam downstream to the Route 3 Bridge (Fig.2). The riffle-run habitat in Site 1 is of high quality; the dominant substrate consists of gravel, cobble, and boulders (Fig.8).

Five lateral transects were run within the 0.82 mile length of R-1 Site. Transects A, B, and E were very similar in substrate type and were classified as riffle-run areas. Transects C and D were setup across the only pool-like habitat within the project area at the time of the survey (Fig.2). Transects measurements can be found in Table. 1.

Figure 8. Riverine Site # 1.

Species Selection and HSI Models

In order to encompass the habitat needs of multiple species in the project area an ecological guilding approach was used. The evaluation species used in this HEP were selected to represent groups of species that exploit the same or similar resource needs; for example, species that share certain habitats or characteristics for breeding, feeding, or sheltering. Representative species were selected based on the following criteria:

1. Species that are anticipated to be sensitive to proposed land and water use changes
2. Species that perform a key role in a community for their part in nutrient cycling or energy flow
3. Species that represent groups of species which share a common environmental resource
4. Species that are familiar to the public
5. Availability of species HEP models approved by the COE

The initial step in selecting appropriate models was to determine which species could potentially occur within or near the project area based on their habitat requirements. A list of potential evaluation species was assessed and discussed amongst the HEP team to determine which species would best represent the project area. The species were selected for their representation of riverine or riparian habitat types. The guilding approach was used to determine final evaluation species. Riverine species were selected based on feeding guild; one predatory game fish and one forage fish. Terrestrial species were selected based on breeding stratum, ranging from the ground layer to the tree layer. The selected evaluation species for the riverine habitat were the smallmouth bass and common shiner; the yellow warbler, mink, and black-capped chickadee were selected for the terrestrial habitat (Table 2).

Table 2. Pertinent selection criteria for HEP species.

Species	Habitat Type	Class	Feeding Guild	Breeding Stratum	References
Smallmouth Bass	Aquatic	Fish	Vert. /Invert. Carnivore	Pools with Rock/gravel/sand or by debris/structure	Edwards et al. (1983)
Common Shiner	Aquatic	Fish	Omnivore	Shallow riffles on gravel/sand	Trial et al. (1983)
Mink	Riparian	Mammal	Carnivore	Ground layer	Allen (1986)
Yellow Warbler	Riparian	Avian	Insectivore	Shrub layer	Schroeder (1982)
Black-capped Chickadee	Riparian	Avian	Insectivore/herbivore	Tree layer	Schroeder (1983)

Species and Model Descriptions

Smallmouth bass commonly occur in large clear lakes and reservoirs with rocky shorelines, as well as in perennial streams with bottoms comprised of gravel beds, large boulders, rubble, or bedrock. These are the preferred substrates for smallmouth bass to build their nests for spawning, and provide shelter to juveniles and adults. Smallmouth bass are sight feeders and choose their prey based on relative abundance and availability. Smallmouth bass typically eat smaller fish, crayfish, insects, and amphibians. Smallmouth bass prefer a water temperature of about 21°C. They also require at least 6 mg/L of dissolved oxygen and a pH range of 5.7-8.6 for optimal growth.

For the smallmouth bass, the HEP team approved the use of the blue book's additional habitat model, which consisted of the variables most essential in providing smallmouth bass with optimum riverine conditions. The HEP team agreed that this model gave the smallmouth bass a more appropriate HSI score when compared to the full blue book model and Pennsylvania modified model (PAM). Model variables for the smallmouth bass include:

Cover/Reproduction/Feeding

- Clear (≤ 25 JTU[1]) water
- Stream gradient between 0.75 and 4.7 meters/kilometer (m/km)
- At least 25% pools
- At least 25% cover and/or > 1m depth in the pools
- Warm summer water temperatures, 21 -29°Celsius (°C)
- Gravel, rubble, or boulder substrate

Common shiners are found in small and medium-sized streams with clear, cool water, and a moderate current. These shiners prefer unvegetated gravel to rubble bottoms; they frequent pools in streams more often than rapids. They excavate depression nests in gravel or sand; most nests are built in riffles 13 to 44 mm deep. Common shiners are omnivorous, feeding on nearly equal amounts of plant and animal matter. The common shiner model was selected to represent the New River shiner (*Notropis scabriceps*), an endemic species in the New River that has similar habitat requirements as the common shiner.

For the common shiner, the HEP team approved the use of the blue book's additional habitat model, which consisted of the variables most essential in providing common shiner with optimum riverine conditions. The HEP team agreed that this model gave the common shiner a

[1] The Jackson turbidity unit (JTU) is roughly the same as a Nephelometric turbidity unit (NTU): a measure of turbidity in a water sample.

more appropriate HSI score when compared to the full blue book model. Model variables for the common shiner include:

Water Quality

- Maximum summer water temperature persisting for longer than 1 week (below 25˚C is optimal)
- Minimum pH between 6.5 and 8.5
- Average turbidity (clear < 30 JTU)

Food/Cover

- Percent pools – interspersed with riffle areas for spawning (1:1 pool-riffle ratio is optimum)
- Predominant pool class- moderate size and depth, commonly found below falls or riffle-run areas; 5-30% of bottom obscured by depth or turbulence

We note that the additional model in the HSI blue book for common shiner has a minor error. The number of variables for the common shiner should be 5 instead of 4; percent pools and predominant pool class should be separate variables. Therefore the HSI value was derived by dividing the number of variables present by 5 (rather than by 4).

The mink is a predatory semi-aquatic mammal that is associated with streams and riverbanks. The species' diet is highly variable, and depends on season, availability of prey, and habitat type. Typical food items include aquatic species such as fish and crayfish, semi-aquatic or aquatic mammals such as muskrat, or terrestrial species such as rabbits and rodents. Mink prefer areas with brushy or woody cover adjacent to aquatic habitats, and generally avoid open or exposed areas. Snags, large rocks, debris and aquatic vegetation also provide foraging cover. Mink select den sites that are close to preferred foraging areas. Dens usually consist of log jams, fallen branches, and other debris. Blue book mink model variables tailored to riverine habitat types include:

Water/Cover

- Percent of year with surface water present
- Percent shoreline cover within 1 meter of water's edge
- Percent canopy cover of trees and shrubs within 100 m of water's edge

The yellow warbler prefers wet habitats with abundant shrubs or small trees. They are commonly found inhabiting marshes, swamp edges, hedgerows, aspen groves, and willow swamps. Yellow warblers primarily eat insects off the foliage of deciduous trees on smaller

limbs. For nesting, warblers prefer hydrophytic shrubs or trees between 3 and 8 feet from the ground, with closed canopy cover. Blue book model variables for the yellow warbler include:

Cover/Reproduction

- Percent deciduous shrub crown cover
- Average height of deciduous shrub canopy
- Percent of deciduous shrub canopy comprised of hydrophytic shrubs

Black-capped chickadees are found in forested wetlands, deciduous, coniferous, and mixed forests. Chickadees are cavity nesters seeking out soft cavities in dead or hollow trees. They will nest anywhere from 1 to 15 feet from the ground. Chickadees are insectivorous, feeding from the ground to the tree tops. They are primary predators of the gypsy moth. Blue book model variables for the black-capped chickadee include:

Breeding

- Number of snags per acre with diameter at breast height (dbh) of 4 to 10 inches

Feeding

- Tree canopy closure
- Average height of overstory trees
- Shrub crown cover

Methods

The limits of the terrestrial study area were from the base of the dam, river right, to the end of the public park in Hinton. The river left study area boundaries stretched from the fishing pier to the end of COE property, marked by a sign along the access road. The limits of the riverine study area were from the base of the dam downstream to the Route 3 Bridge. Terrestrial and riverine measurements were only taken immediately within the project area instead of in all four reconnaissance areas leading to the Ohio River. At this early stage of project planning, we assumed direct and indirect impacts would only occur directly below the dam in the tailwaters (Fig. 2, 3, 4). However, additional field work may be necessary in other locations due to the potential for new risk management plans that were not considered when this effort was originally scoped. Those future assessments may include areas that are not appropriate for evaluation with these current riverine and riparian species models.

For measurements in riparian habitats, linear transects were established perpendicular to the bank every 10 meters and variable measurements were recorded and averaged to get an overall representative value for each variable, such as: percent canopy closure, average height

of overstory trees, average height of deciduous shrub canopy, and percent shoreline cover. Percent shrub crown cover and percent shrub canopy comprised of hydrophytic shrubs were measured using the line intercept technique (Mitchell and Hughes 1995). The number of snags per acre with a DBH of 4 to 10 inches was determined by walking the site and measuring the circumference of suitable snags and then calculating DBH. Average height of overstory trees was determined by selecting the tallest tree on each linear transect and estimating its height with a clinometer. Percent shoreline cover and percent canopy closure were estimated visually by the HEP team.

Riverine measurements were taken at four different transects across the width of the river between the dam and the Route 3 Bridge. Dominant substrate was recorded every 10 meters, while average depth and pool class were recorded at two sites that were classified as pool-like areas. Dissolved oxygen, water temperature, pH, and alkalinity scores were determined by using previously collected water quality data from the Department of Environmental Protection water quality monitoring station 1.2 miles downstream of the dam (the closest water quality monitoring station). Ten years of water quality data (2003-2012) was assessed and averaged to determine HSI scores (Appendix C). Turbidity was measured on site using a TB200 Portable Turbidimeter.

Acreage measurements for each evaluation area, distances between adjacent cover types, and stream gradients were measured from USGS topographic maps, or from GIS analysis of the previously constructed habitat maps of the project area.

Terrestrial and aquatic field data were gathered on September 10 – September 13, 2013.

Results and Discussion

The results of this HEP reflect the conditions in the project area in a discreet amount of time. A few of the variables will fluctuate throughout the year. For example, at riparian sites 1 and 2 mowing had just occurred and this affected variable scores that were associated with vegetation. Riverine variables associated with pools received low scores because there were no actual pools within the project area. The water levels in the tailwaters were unusually high this year throughout the summer, due to increased regional precipitation, which prevented the HEP team from measuring the study area during normal flows. The altered water levels made it difficult to distinguish between riffle-run areas and pool-like areas.

Within each site, transect and/or point measurements for a given variable (e.g., percent canopy cover) were averaged to get an overall representative value. Each variable was then assigned a score based on the species' habitat requirements and preferences as set forth in the applicable HSI model. These variable value scores were then used to derive a Habitat Suitability Index

score for each species (Appendix A). As noted previously, these HSI scores range from 0 – 1.0 and are used as an index to the suitability of the habitat for that species.

Riparian

Riparian Site # 1 received consistently low scores for all evaluation species due to the poor quality of the habitat (Table 3). Site # 1 had few trees and shrubs and was adjacent to an on-going construction project (which was approved in the 1998 Dam Safety Assurance Evaluation Report and is currently in Phases 3 and 4 of construction). The purpose of Phase 3 is to reduce the risk of scour and threat to the stability of the dam in the event the penstocks are used to increase discharge capacity. Phase 4 of work includes installing over 200 high strength steel anchors in the spillway and non-overflow monoliths (Corps 2013a).

Table 3. Overall terrestrial HSI scores for RP- 1, 2, and 3.

HSI Model	**Riparian Site # 1**	**Riparian Site # 2**	**Riparian Site # 3**
Black-capped chickadee	0.48	0.86	1.0
Yellow Warbler	0.0	0.33	0.32
Mink	0.0	0.55	1.0

Site # 2 is located alongside of a park and is distinguished from Site #1 due to the presence of more trees and shrubs. The overall large size of trees and high number of snags within site #2 contributed to higher scores for the black-capped chickadee and yellow warbler than at site # 1. The increase in cover sites near the water's edge helped improve the HSI score for the mink from 0 at site #1 to 0.55 at site # 2 (Table 3). The presence of a copse of willow trees contributed to the increased yellow warbler score at site #2 versus site # 1.

Site # 3 is located on river left opposite of sites #1 and #2. The site received overall scores of 1.0 for the black-capped chickadee and mink due to the abundance of canopy cover, snags, shrub cover, and suitable tree heights. Percent shoreline cover within 1 meter of water's edge was estimated to be 100% for the mink. At Site # 3 the yellow warbler received a low score because 0 % of the shrub canopy was comprised of hydrophytes; one common feature of yellow warbler habitat is the presence of various species of willows (Lowther et al. 1999).

Riverine Habitat

Two species were evaluated for the riverine portion of the habitat. The overall HSI for the smallmouth bass in the tailwaters was 0.83 (Table 4). The clear (≤ 25 JTU) water, stream gradient of 1.5 m/km, more than 25 % cover, summer temperature of approximately 22.58˚ C, and gravel, rubble, or boulder substrate represents almost ideal conditions for this species, which is consistent with the popularity of the area by bass fisherman. The common shiner scored a 0.80 for overall HSI in the tailwaters (Table 4). [redacted]. The common shiner model required pools with moderate size and depth, commonly found below falls or riffle-run areas, interspersed with riffle areas for spawning (1:1 pool-riffle ratio). The presence of instream cover, provided by boulders and fractured bedrock cavities, contributed to the high score for smallmouth bass (Appendix A).

Table 4. Overall aquatic HSI scores for smallmouth bass and common shiner (R-1)

HSI Model	**HSI Score**
Smallmouth Bass	0.83
Common Shiner	0.80

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APPENDIX A

Habitat Suitability Index Value

Riparian Site # 1

Location: River right, extending along 80 m of shoreline below the dam.

Black-capped Chickadee

Variable	Average	HSI Score
Number of snags per acre with dbh of 4 to 10 inches	2	1.0
Tree canopy closure	34%	0.7
Average height of overstory trees	38.3 ft.	0.75
Shrub crown cover	0%	0.0
Food HSI		**0.48**
Breeding HSI		**1.0**
	Overall HSI	**0.48**

Yellow Warbler

Variable	Average	HSI Score
Percent deciduous shrub crown cover	0%	0.0
Average height of deciduous shrub canopy	0 m	0.0
Percent of deciduous shrub canopy comprised of hydrophytic shrubs	0%	0.0
	Overall HSI	**0.0**

Mink

Variable	Average	HSI Score
Percent of year with surface water present	100%	1.0
Percent canopy cover of trees and shrubs within 100 m of the wetland's edge	34%	0.5
Percent shoreline cover	0%	0.0
Water HSI		**1.0**
Cover HSI		**0.0**
	Overall HSI	**0.0**

Summary: Overall HSI for Site #1

Black-capped Chickadee	**0.48**
Yellow Warbler	**0.0**
Mink	**0.0**

Riparian Site # 2

Location: River right, entire length of city park along the shore line.

Black-capped Chickadee

Variable	Average	HSI Score
Number of snags per acre with dbh of 4 to 10 inches	> 2	1.0
Tree canopy closure	32%	0.65
Average height of overstory trees	54ft.	1.0
Shrub crown cover	18.3%	0.95
Food HSI		**0.86**
Breeding HSI		**1.0**
	Overall HSI	**0.86**

Yellow Warbler

Variable	Average	HSI Score
Percent deciduous shrub crown cover	18.3%	0.25
Average height of deciduous shrub canopy	2 m	1.0
Percent of deciduous shrub canopy comprised of hydrophytic shrubs	36%	0.43
	Overall HSI	**0.33**

Mink

Variable	Average	HSI Score
Percent of year with surface water present	100%	1.0
Percent canopy cover of trees and shrubs within 100 m of the wetland's edge	32%	0.45
Percent shoreline cover	68%	0.68
Water HSI		**1.0**
Cover HSI		**0.55**
	Overall HSI	**0.55**

Summary: Overall HSI for Site #2

Black-capped Chickadee	**0.86**
Yellow Warbler	**0.33**
Mink	**0.55**

Riparian Site #3

Location: River left, from fishing pier to end of Corps property line.

Black-capped Chickadee

Variable	Average	HSI Score
Number of snags per acre with dbh of 4 to 10 inches	6	1.0
Tree canopy closure	75.5%	1.0
Average height of overstory trees	51.6 ft.	1.0
Shrub crown cover	56.9%	1.0
Food HSI		**1.0**
Breeding HSI		**1.0**
	Overall HSI	**1.0**

Yellow Warbler

Variable	Average	HSI Score
Percent deciduous shrub crown cover	56.9%	1.0
Average height of deciduous shrub canopy	2 m	1.0
Percent of deciduous shrub canopy comprised of hydrophytic shrubs	0%	0.1
	Overall HSI	**0.32**

Mink

Variable	Average	HSI Score
Percent of year with surface water present	100%	1.0
Percent canopy cover of trees and shrubs within 100 m of the wetland's edge	75.5%	1.0
Percent shoreline cover	100%	1.0
Water HSI		**1.0**
Cover HSI		**1.0**
	Overall HSI	**1.0**

Summary: Overall HSI for Site #1

Black-capped Chickadee	**1.0**
Yellow Warbler	**0.32**
Mink	**1.0**

Riverine Habitat Data

Location: From dam 0.82 miles downstream to Route 3 Bridge.

Smallmouth Bass

Variable	Present or Not Present
V9: Maximum monthly average turbidity level during the summer (≤ 25 JTU)	Present
V15: Stream gradient within representative reach (between 0.75 and 4.7 m/km)	Present
V2: Percent pools (at least 25%)	Not Present
V5: Percent cover in the form of boulders, stumps, dead trees, and crevices (adults) or vegetation and rocks (fry) (at least 25% cover)	Present
V10,V11,V12,V13: Water temperature in selected habitat during the summer (21-29˚C)	Present
V1: Dominant substrate type (gravel, rubble, or boulder substrate)	Present
Total HSI	**0.83**

HSI = number of above criteria present/6

HSI = 5/6

Common Shiner

Variable	Present or Not Present
V3: Average turbidity (<30 JTU)	Present
V7: Predominant pool class (B- moderate size and depth, commonly found below falls or riffle-run areas; 5-30% of bottom obscured by depth or turbulence)	Present
V1: Maximum summer temperature persisting for longer than 1 week (below 25˚C)	Present
V2: Least suitable pH level occurring during the year (between 6.5 and 8.5)	Present
V5: Percent pools(1:1 pool-riffle ratio)	Not Present
Total HSI	**0.80**

HSI = number of above criteria present/5

HSI = 4/5

APPENDIX B

Terrestrial and Riverine Species Present in the Tailwater Area

Riparian

River Birch (*Betula nigra*)[1]	American Sycamore (*Platanus occidentalis*)[1]
Eastern Red Cedar (*Juniperus virginiana*)[1]	Black Cherry (*Prunus serotina*) [1]
Sugar Maple (*Acer saccharum*)[1]	American elm (*Ulmus americana*)[1]
Mulberry (*Morus spp.*)[1]	Box alder (*Acer negundo*) [1]
Tree of Heaven (*Ailanthus altissima*)[1]	Autumn Olive (*Elaeagnus umbellata*)[1]
Tulip Tree (*Liriodendron tulipifera*)[1]	Willow (*Salix spp.*)[1]
Red Bud (*Cercis canadensis*)[1]	Wild Grape (*Vitis spp.*)[1]
Wood Duck (*Aix sponsa*)[1]	Osprey (*Pandion haliaetus*)[1]
Great Blue Heron (*Ardea Herodias*)[1]	Honey Locust (*Gleditsia Triacanthos*)[1]
Slippery Elm (*Ulmus rubra*)[1]	Silk Tree (*Albizia spp.*)[1]
Poison Ivy (*Toxicodendron radicans*)[1]	Song Sparrow (*Melospiza melodia*)[1]
Eastern chipmunk (*Tamias striatus*)[1]	Canada goose (*Branta canadensis*[1]
American Goldfinch (*Carduelis tristis*)[1]	Mallard (*Anas platyrhynchus*)[1]

Riverine

Northern Hogsucker (*Hypentelium nigricans*)[1]	Green Sunfish (*Lepomis cyanellus*)[2]
Smallmouth Bass (*Micropterus dolomieu*)[1]	Channel Catfish (*Ictalurus punctatus*)[2]
Flathead Catfish (Pylodictis olivaris)[2]	Largemouth Bass (Micropterus salmoides)[2]
Rock Bass (*Ambloplites rupestris*)[2]	Central Stoneroller (*Campostoma anomalum*)[2]
Rainbow Darter (*Etheostoma caeruleum*)[2]	Whitetail Shiner (*Cyprinella galactura*)[2]
Spotfin Shiner (*Cyprinella spiloptera*)[2]	Greenside Darter (*Etheostoma blennioides*)[2]
Variegate Darter (*Etheostoma variatum*)[2]	Brook Silverside (*Labidesthes sicculus*)[2]
Redbreast Sunfish (*Lepomis auritus*)[2]	Bluegill (*Lepomis macrochirus*)[2]
White Shiner (*Luxilus albeolus*)[2]	Spotted Bass (*Micropterus punctulatus*)[2]

[1] Direct observation during the September 10 – 13, 2013 HEP field work
[2] Species was present in the tailwater study area during an electrofishing survey conducted by the Corps in 2004

Bigmouth Chub (*Nocomis platyrhynchus*)[2]

Rosyface Shiner (*Notropis rubellus*)[2]

Margined Madtom (*Noturus insignis*)[2]

Roanoke Darter (*Percina roanoka*)[2]

White Crappie (*Pomoxis annularis*)[2]

Longnose Dace (*Rhinichthys cataractae*)[2]

Spottail Shiner (*Notropis hudsonius*)[2]

Telescope Shiner (*Notropis telescopus*)[2]

Sharpnose Darter (*Percina oxyrhynchus*)[2]

APPENDIX C

Water Quality Graphs for the New River

1.2 miles downstream of Bluestone Dam

Appendix E

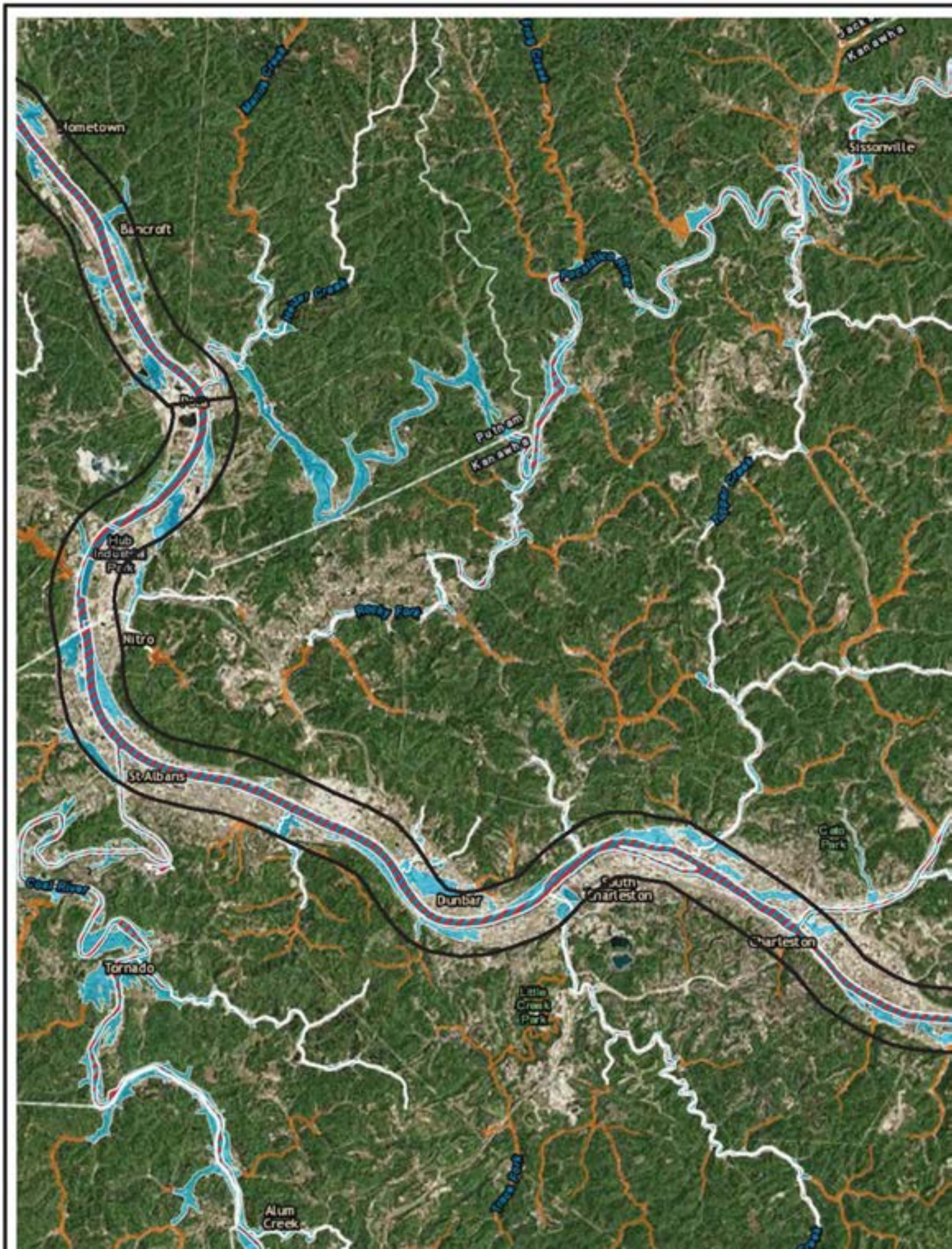
100-YEAR FLOODPLAINS

MAP ZONE DESCRIPTIONS

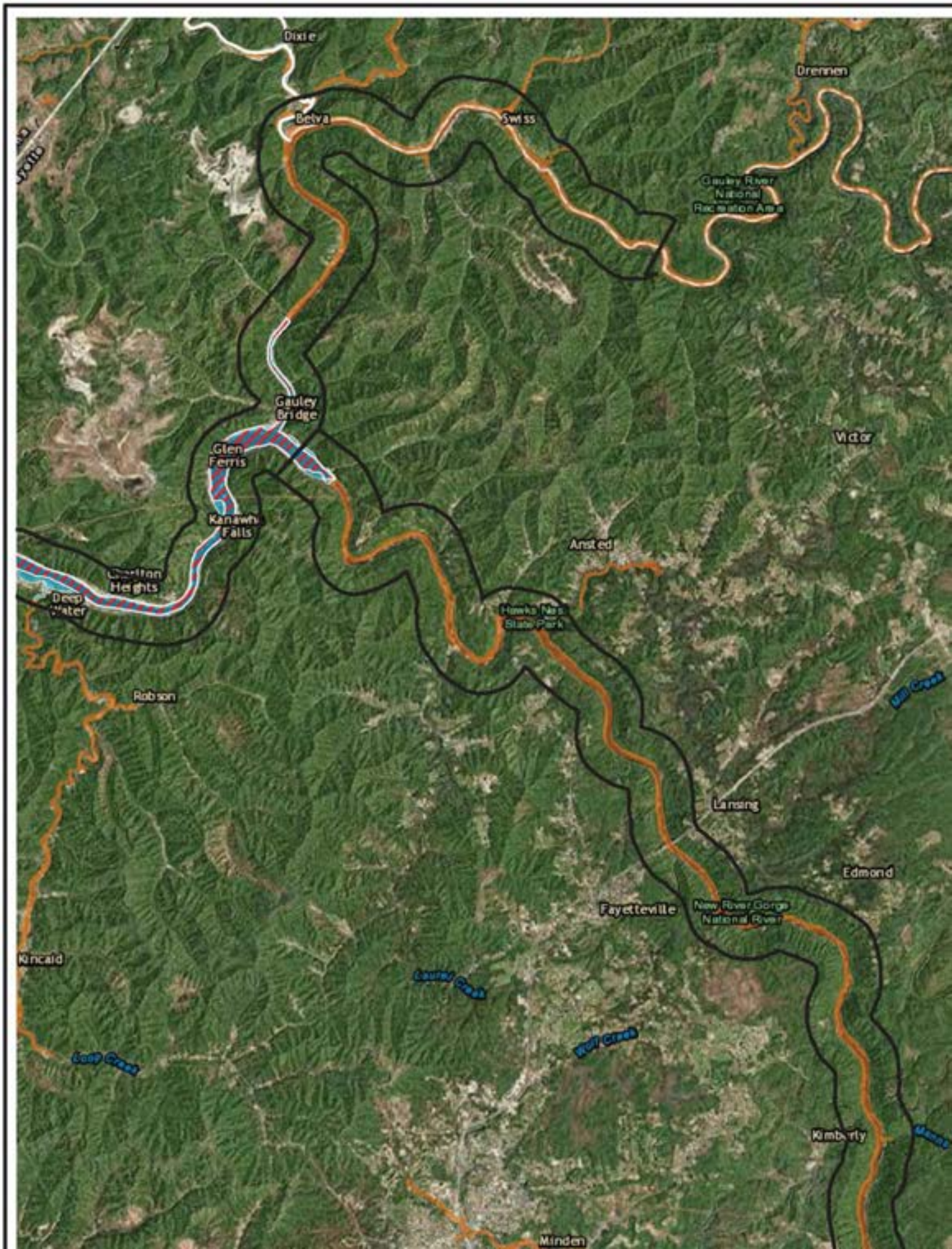
Zone	Description
A	100-year floodplain. The base floodplain mapped by approximate methods, i.e., Base Flood Elevations are not determined.
AE	The base floodplain where base flood elevations are provided.
AH	Shallow flooding base floodplain. BFEs are provided.
AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.

Source: FEMA. 1998. Managing Floodplain Development Through the National Flood Insurance Program. http://www.fema.gov/media-library-data/20130726-1535-20490-8858/is_9_complete.pdf (Accessed on June 18, 2016)

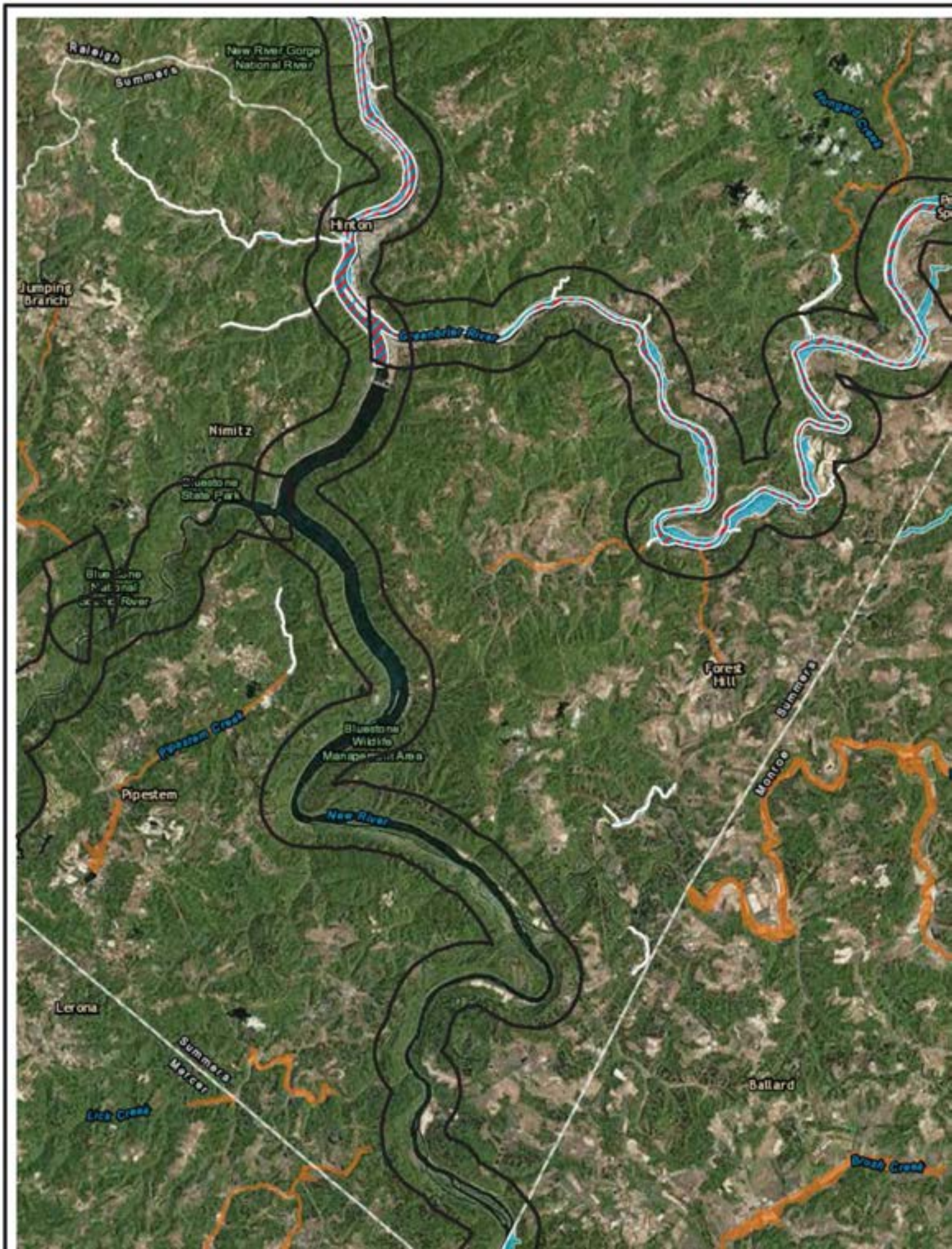
Point Pleasant
Henderson
Turtle Creek
Kanawha River
Leon
Southside
Hurricane Creek
Ashton
Buffalo


Hometown
Bancroft
Sissonville
Putnam
Kanawha
Hub Industrial Park
Nitro
St Albans
Dunbar
South Charleston
Charleston
Tornado
Alum Creek

Coonskin Park
Mill Creek
Campbells Creek
Witcher Creek
Blount
Mammoth
Cedar Grove
Chesapeake
East Bank
Pratt
Cabin Creek
Winifrede
Gallagher
Miami


Dixie
Drennen
Belva
Swiss
Gauley River National Recreation Area
Gauley Bridge
Glen Ferris
Kanawha Falls
Victor
Ansted
Hawks Nest State Park
Robson
Mill Creek
Lansing
Edmond
Fayetteville
New River Gorge National River
Kincaid
Laurel Creek
Wolf Creek
Loop Creek
Kimberly
Minden

Layland
Fayette
Raleigh
Laurel Creek
New River
Meadow Bridge
Fayette
Meadow Creek
Meadow Creek
Summers
Sandstone
Beaver
Glade Creek
Glade Springs Golf & Country Club
Raleigh
Raleigh
Summers
New River Gorge National River
Shady Spring
White Oak
Hinton
Cool Ridge
Jumping Branch
Greenbrier River
Nimitz
Little Bluestone River
Bluestone State Park


Raleigh
Summers
New River Gorge National River
Hinton
Jumping Branch
Greenbrier River
Nimitz
Bluestone State Park
Bluestone National Scenic River
Forest Hill
Summers
Monroe
Pipestem Creek
Bluestone Wildlife Management Area
Pipestem
New River
Lerona
Summers
Mercer
Ballard
Lick Creek
Brush Creek

Appendix F

CLIMATE CHANGE DATA

Draft - Bluestone DSMS Future without Action Condition - Potential Future Effects of Climate Change in the Kanawha and New River Watershed

Guidance for Incorporation of Climate Change Effects in Water Resources Planning - Executive Order (E.O.) 13653 and in particular Section 5 (iii) of that EO copied here for reference: *iii. "a description of how any climate change related risk identified pursuant to paragraph (i) of this subsection that is deemed so significant that it impairs an agency's statutory mission or operation will be addressed, including through the agency's existing reporting requirements;"* requires that Federal agencies describe any climate change related risks that may impair an agency's mission or operation, including through that agency's existing reporting requirements. The Bluestone Lake Dam Safety Modification Study Phase 5 report and associated NEPA documents fall under that agency reporting requirement. ECB 2014-10 (May 2014) Section 2.a. specifies that a qualitative analysis of potential effects of climate change for the purpose of enhancing climate preparedness and resilience during hydrologic analyses doesn't apply to dam safety projects.

However, construction of the future without project condition (FWAC) narrative and associated evaluation parameters that would be used to evaluate project alternatives requires an honest assessment of all future conditions. The inclusion of credible (given the levels of uncertainty present in GCM models) modeling outputs for the project area from USACE-vetted climate models that indicate a range of possible climatic conditions extending through the period of analysis is a prudent step in developing the FWAC narrative and merits consideration as a factor in assessing potential project impacts and mitigation options.

Future Without Action Condition (FWAC) – Per ER 1105-2-100 and the Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies, the Corps of Engineers is required as part of the Civil Works water resources planning process to forecast future conditions that any formulated alternative including the no action alternative must continue to function within during the period of analysis (typically 50 years from the start of project operation). Evaluation of alternatives requires an assessment of each alternative's performance through an array of hypothetical future conditions in order to prioritize alternative courses of action, including the option of taking no action. The future without action condition is required to be an honest, credible and defensible description of environmental, social, economic, cultural, and climatic conditions that may exist during the period of analysis and that any and all alternatives are evaluated against. Several methods of developing the FWAC are available to Corps planners including simple trend analysis, modeling and scenario building. The Corps of Engineers Guide to Constructing the Without Project Scenario (IWR Report 2012-R-03) describes agency-accepted methods for developing the without project narrative.

With respect to forecasting future climate conditions that may affect the effectiveness and efficiency of formulated alternative(s) during the period of analysis, current climate forecast methods rely on downscaled data from global circulation models (GCM) prescribed by the International Panel on Climate Change (IPCC). The IPCC has issued a series of global climate assessments (since 1990) that include updated modeling data based upon ongoing research results of global atmospheric, land and oceanic interactions, system response values, and global

observations of ongoing climate-related changes. Through a process known as downscaling, the global climate models have been restructured for application at finer geographic scales (i.e. ~12 km per grid square side). A number of bias-corrected, downscaled climate models have been archived by a consortium of Federal agencies, private laboratories and academic institutions including USACE, USGS, USBR, and NOAA[1]. Output data is available for mean monthly and daily precipitation and temperature for several emissions scenarios forecasted for multiple future time periods. As discussed below, this climate data has been accessed for several climate change studies of geographic areas that include the entire Kanawha and New River basins. The forecasted results from these studies provide a glimpse of what future with and without project climate conditions may prevail during the 50-year period of analysis during which an array of structural modifications and/or operational changes may be in effect at Bluestone Dam.

Project Area for Addressing Climate Change Effects – The defined project area consists of the area downstream of Bluestone Dam to the juncture of the Kanawha River and the Ohio River at Point Pleasant, WV and upstream from the dam through the boundary of the Federal lands acquired for the project and any flowage easements all the way to the farthest reaches of the New River Watershed in North Carolina. For the purposes of defining climate-induced changes to temperature, stream flow and rainfall intensity, the watershed of Bluestone Dam (4,565 m^2) extending into VA and NC and the downstream New River/Kanawha River to the Kanawha River gage at Charleston is herein identified as the project area. This entire area has been modeled by several climate change studies as discussed below.

Existing Regional Climate - Bluestone Dam and the affected area's mid-latitude position combined with the seasonal undulations of the northern jet stream makes this region susceptible to highly variable weather throughout the year. The watershed's climate is greatly influenced by oceanic (Gulf moisture) and atmospheric (Canadian air mass) interactions. Rhythmic fluctuations in El Niño and La Niña Pacific currents combined with variable North Atlantic Oscillation patterns also affect seasonal weather in the project region. Long-term predictions of weather in such a dynamic system are uncertain at best and model projections of future global climate change further exacerbate those uncertainties.

According to the Köppen climate classification system[2], the New River watershed and areas upstream of Bluestone Dam are located within the zones labeled "Dfb"[3] and "Dfa". These designations refer to a continental location that is fairly moist, and can experience either warm or cool summers depending upon site elevation. There are significant variations in topography and surface elevation within the New River watershed (i.e. Boone, NC at el. 3,333 and Hinton, WV at el. 1,463) that drive differences in seasonal temperatures by several degrees. The New River watershed experiences seasonal weather patterns with climatic conditions typical of all four seasons for the Mid-Atlantic and Southeast Regions of the United States. Variability in weather tends to be greater during the late winter, spring, and fall seasons within the watershed. Past

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[1] Climate modeling data for CONUS and territories is accessible by Corps personnel through the USACE Responses to Climate Change Program (IWR) web site.

[2] The Köppen Climate Classification system, established in 1918, is an accepted global climate classification system.

[3] The "Dfb" and "Dfa" designations translate to "D" – continental climate that can be found in the interior regions of large land masses. Total precipitation is not very high and seasonal temperatures vary widely, "f" - moist with adequate precipitation in all months and no dry season, and "a" - hot summers where the warmest month is over 22°C (72°F) and "b" - warm summer with the warmest month below 22°C (72°F), normally associated with C and D climates.

observations of climate data in the Ohio River basin have indicated a slight warming trend (increase in mean annual air temperature) since 1952 and a slight increase in precipitation during the fall season over that time period as well[4].

Climate Change Information - Information on climate change projections for this watershed can be found in three notable resources. The 3rd National Climate Assessment (2014) for the continental United States which is based upon the IPCC's 5th Assessment Report (CMIP5), the Climate Change and Hydrology Literature Synthesis for the US Army Corps of Engineers Missions in the United States (2015)[5] which is a compilation of study findings from multiple climate change studies (since 2004) completed for the HUC 2 Ohio River Basin (Region 05) and the Ohio River Basin Climate Change Impacts and Adaptation Draft Pilot Study (July 2015) sponsored by the USACE Institute for Water Resources (IWR).

Each of these three resources provide climate change projection information derived from ensembles of downscaled GCM models computed for different geographic scales. The finest geographic model scale was a 1/8th degree grid square[6] analysis (covering 698 small watersheds in the Ohio River basin) completed by IWR for the July 2015 Ohio River Basin pilot study. This study applied to the basin ensembles of GCM downscaled models archived by USACE, USGS, USBR, and NOAA that incorporated CMIP3 data[7] based on two emission scenarios (A1b and A2) encompassing three 30-year periods. The Ohio River Forecast Center[8] (OHRFC) used the Community Hydrologic Prediction System (CHPS) in combination with the Sacramento Soil Moisture Accounting Hydrologic Model to produce runoff and stream flow projections for 24 forecast points in the basin (see Figure ____). That stream flow data, presented as percent increases in mean annual and mean monthly[9] stream flow and decadal changes in mean annual air temperature in the Ohio River Basin pilot study, was modeled for the Kanawha River stream gage located downstream of Charleston, WV at Lat. 38°22'17", Long. 81°42'08" (see red star on Figure ____).

Since uncertainty in stream flow projections increases substantially as one moves into smaller watersheds located upstream from the mainstem Ohio River[10], the Kanawha River gage at Charleston was identified by the pilot study team as the optimum forecast point to assess future threats to the four major dams in the basin including Bluestone Dam[11]. Historic data from that gage was included in the base years flow analysis and future flow projections were produced for that gage point as well. The New River is estimated to contribute approximately 49.9% of the total average flow at that gage with the Greenbrier, Gauley and Elk rivers contributing the balance of the total flow.

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[4] NOAA 2013 presentation to USACE Pilot Study team on historic climate trends in Ohio River basin.

[5] USACE (2015). Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions - Ohio Region 05. Civil Works Technical Report, CWTS 2015-05, USACE, Washington, DC

[6] Each 1/8th grid square measures approximately 12km or 7.45 miles on each side.

[7] Coupled Model Intercomparison Project Phase 3 (CMIP3) data from the IPCC Fourth Assessment in 2007.

[8] The OHRFC is located at Wilmington, OH and is a facility of NOAA, seen at: http://www.weather.gov/ohrfc/

[9] The mean values for annual and monthly forecasts are the mean of the means of each year during the 30-year period and the mean of all mean values for each month over the 30-year period. The mean March maximum values are the mean of each March maximum value during the 30-year period.

[10] The runoff models used by the OHRFC are calibrated using a specific array of gage points; as the number of points feeding data into the model is reduced so likewise is the level of certainty of the forecast.

[11] Those dams include Claytor (HYDRO), Bluestone (FRM), Summersville (FRM) and Sutton (FRM).

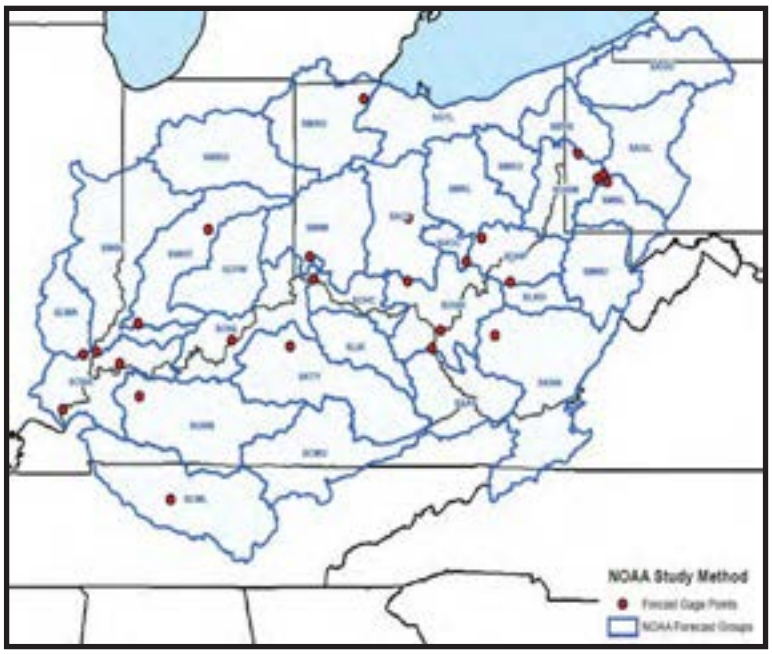

Figure _____ - OHRFC Forecast Points in the Ohio River Basin

Projected Changes in Air Temperature - The three referenced sources indicate the affected area which includes the New River below Bluestone Dam and the watershed above the dam extending into Virginia and North Carolina could generally experience annual mean summer temperatures that range between 3.0^{o} C and 4.0^{o} C higher by 2090 or between 3.9^{o} C and 5.7^{o} C during that same period in a separate study[12]. Information in the 3rd National Climate Assessment estimates that annual mean air temperatures in the Northeast region (includes WV) could rise between 4.5^{o} F and 10.0^{o} F by the 2080's[13]. Temperature projections in the Ohio River Basin Pilot Study suggested that mean annual air temperatures could rise by 0.5^{o} F per decade between 2011 and 2040 and 1.0^{o} F per decade between 2040 and 2099. These projected rates of increase could raise mean annual temperatures at the Kanawha River forecast point from a recorded annual mean of 53.7^{o} F in 2001 to 56.7^{o} F by 2040, 58.9^{o} F by 2070 and 62.3^{o} F by 2099. In each climate study referenced, mean annual temperatures are expected to rise in the project area. Air temperature increases of this magnitude are expected to result in increased water temperatures (more noticeable in lacustrine environments), increased precipitation in the form of rainfall rather than snow in the winter months and higher evaporation rates.

Generally speaking, increased water temperatures could adversely affect indigenous aquatic species that thrive in cool and cold water environments. Warmer waters could cause more frequent algae blooms in lakes receiving higher levels of nutrients – nutrients that provide a growth catalyst for these aquatic biota. Higher air and water temperatures could provide a suitable environment for invasive macro and micro invertebrates in Bluestone Lake and the New River as well as invasive terrestrial/vegetative species on Federal land surrounding Bluestone Lake. Increased likelihood of rainfall rather than snow due to higher winter temperatures (after

[12] USACE (2015). Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions - Ohio Region 05. Civil Works Technical Report, CWTS 2015-05, USACE, Washington, DC, pages 21-22
[13] Climate Change Impacts in the United States (2014), 3rd National Climate Assessment, Chapter 16 Northeast, page 374

leaf drop) could result in greater amounts of winter runoff and inflow into reservoirs such as Bluestone Lake (see below). Higher summer air temperatures could result in higher evaporation rates that can affect reservoirs with expansive surface areas like Bluestone Lake. Increasing air temperatures (lengthened growing season), increased rainfall (see below) and higher concentrations of CO^2 could lead to increased vegetation growth (increasing carbon sequestration capacity) in the watershed and associated higher transpiration rates.

Increased Heavier Downpours - Assessing the potential for high intensity storm events in the watershed and affected area requires consideration of the geographic location of the dam and its watershed with respect to the three states WV, VA and NC. Although the dam is located in Summers County, WV only 16% (730m^2) of the total catchment area of the dam (total of 4,600 m^2) is located in WV. The remaining 3,870 m^2 or 84% of the total catchment is located in VA (67 %) and NC (17 %).

Current climate change data sources[14] describing recent trends in heavy downpours and future potential for increasing storm intensity divide the continental US into six distinct regions (see Figure ___). Two of those regions, Northeast and Southeast, exhibit decidedly different trends in storm intensity and therefore point to differing expectations of the intensity of future storms that could affect the operation of Bluestone Dam during construction phases associated with the dam safety project and subsequent operations.

As chance would have it, the state of WV is included in the Northeast region and both VA and NC are included in the southeast region – that regional dividing line being located within the flood control pool of the Bluestone Dam project. The Northeast region shows a 71% increase in the past trend of frequency and intensity of heavy downpours since 1958 and the Southeast region exhibits a 27% increase in those downpours over that same period. Realistically for Bluestone Dam that percent increase is necessarily somewhere between those two figures, but in view of the percentages of catchment in each state shown above (WV at 16% verses VA/NC combining at 84%) that historic trend, a trend that influences inflow into Bluestone Dam, probably leans towards the lower end of a continuous scale between the two percentages.

That being said, the 3rd National Assessment (2014) includes data showing increasing trends in frequency and intensity of heavy downpours (defined as the heaviest 1% of all daily events) in many areas including the Northeast and Southeast regions. However, in that same source, future projections of heavier downpours (see Figure 2.19 and its caption) concentrate on a daily rainfall event that now occurs once in 20 years or the 1 in 20 year rainfall event. The 1 in 20 year event addresses shorter-duration, thunderstorm-related, local events rather than intensification of long-duration, high-volume regional storms (1% annual chance, 0.5% annual chance and longer recurrence events) that keep hydrologists awake at night. Figure _____ shows historic trends in regional differences for heavier downpours within several regions of the United States.

[14] Climate Change Impacts in the United States (2104), 3rd National Climate Assessment, Heavier Downpours Increasing, Figures 2.18 and 2.19.

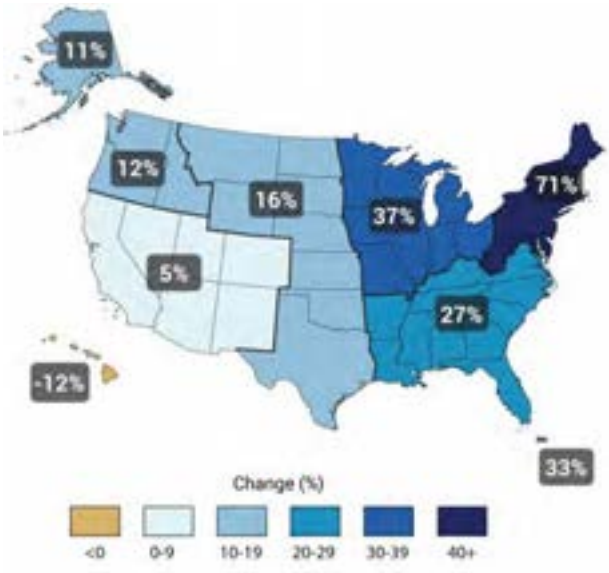

Figure 2.18: The map shows percent increases in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events) from 1958 to 2012 for each region of the continental United States. These trends are larger than natural variations for the Northeast, Midwest, Puerto Rico, Southeast, Great Plains, and Alaska. The trends are not larger than natural variations for the Southwest, Hawai'i, and the Northwest. The changes shown in this figure are calculated from the beginning and end points of the trends for 1958 to 2012. (Figure source: updated from Karl et al. 2009[21]).

Impacts from intensification of high-frequency storms surface as flash floods in small to moderate-sized urban and desert watersheds where life loss and economic damages are frequent affects. These higher-frequency, flash floods also impact stormwater management measures and facilities whose retention or infiltration capacity is normally designed for the 1 in 10 year or 1 in 20 year storm event. In general, climate models projecting higher air temperatures (warmer air can hold greater amounts of moisture) and increased seasonal (spring) precipitation, lend credence to the potential for heavier rainfall events in the future that would influence operations at the project both during and after construction. However, downscaled global circulation models are based upon global weather patterns and mega-scale atmospheric interactions that cannot predict the occurrence of local thunderstorm convection processes that spawn individual downpours or so called "training" thunderstorms and therefore accurately pinpointing future heavier events to a specific time period or geographic place (i.e. Bluestone Lake watershed) is speculative at best.

Precipitation and Stream Flow – Future changes in precipitation, runoff and resulting stream flow (hydrologic effects) are anticipated in each of the three reference sources. The 3rd National Climate Assessment discusses the potential for increased precipitation in the Northeast perhaps by as much as 5% to 20% greater precipitation (mainly in the winter months) and somewhat wetter in northern portions (including VA and NC) of the Southeast region.[15] Additional modeling studies project that as much as 140 mm (5.5 inches) of additional annual precipitation could fall across Region 5 (Ohio River Basin) during the

[15] Climate Change Impacts in the United States, 3rd National Climate Assessment, page 374.

period between 2071 and 2100 while other modeling completed for the Wabash River sub-basin (IL and IN) predicted changes in precipitation from the base period 1990-1999 to 2051-2060 ranging from -18.6% to 7.25% and between -20% and 16.2% for the future period 2086-2095.[16] Although not directly related to the Bluestone Dam region, this data shows the range of variability in future projections of precipitation. Similar variability (much drier fall and wetter spring) was shown for the Wabash River sub-basin in the following pilot study.

The Ohio River Basin Climate Change Impacts and Adaptation Pilot Study (July 2015), discussed in some detail above, developed a series of projections for future precipitation based upon ensembles of downscaled GCM's (CMIP3) for the basin using two emissions scenarios (A1b and A2) that encompassed three 30-year periods. That precipitation data was subsequently used by the Ohio River Forecast Center (NOAA) to estimate increases in runoff/streamflow for 24 forecast gage points in the basin. The runoff generation models considered soil moisture, air temperature, humidity levels, time of day (precipitation data were produced in 6-hour increments), evaporation and transpiration (leaf-on or leaf off situations) rates and month of year (solar orientation). One of the 24 forecast gage points is the Kanawha River gage at Charleston, WV. At that gage, approximately 49.9% of the water passing derives from the New River flowing out of Bluestone Dam.[17]

The projection results are noted as a percentage increase or decrease from the mean annual and mean monthly flows observed during the base years 1952 to 2001. In the pilot study, identifying threats to operating infrastructure, including those identified as being in poor or unsatisfactory condition[18] was a key objective, therefore projections for flood control structures such as Bluestone Dam concentrated on extreme high flow values normally associated with the spring season. However, for the purposes of the Bluestone DSMS, model projections for mean, minimum and maximum values are being provided on an annual basis and for both the wettest period (March) and the driest period (October) to give a more comprehensive overview of potential future stream flows driven by changed climate conditions. March was selected because of its seasonally high flows across the basin and October because of its seasonally low flows across the basin.

Table ____ shows the projected percent changes in streamflow measured against the base years recorded flows (1952-2001) during the three time periods modeled (2011-2040, 2041-2070, and 2071-2099). Of note in the data are the percentage increases in the October monthly mean and monthly maximum flows over the base years recorded flows. October is historically a very dry month in this region and stream flows are substantially lower during this season. The model projections indicate that future fall season precipitation and resulting flows could be 25% to 50% higher than previously experienced. This dry season increase in flows added to modest increases in the March mean (springtime) flows results in an increase in overall annual mean flows in the watershed above the Kanawha River gage.

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[16] USACE (2015). Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions - Ohio Region 05. Civil Works Technical Report, CWTS 2015-05, USACE, Washington, DC, pages 25-27.

[17] USACE-LRH Hydrology and Hydraulics estimate.

[18] "Poor" or "Unsatisfactory" performance are categories used in the National Inventory of Dams database and are similar to the USACE Dam Safety Action Categories (DSAC) system for dams.

Table ____ - Projected Percentage Changes in Flow at the Kanawha River gage[19]

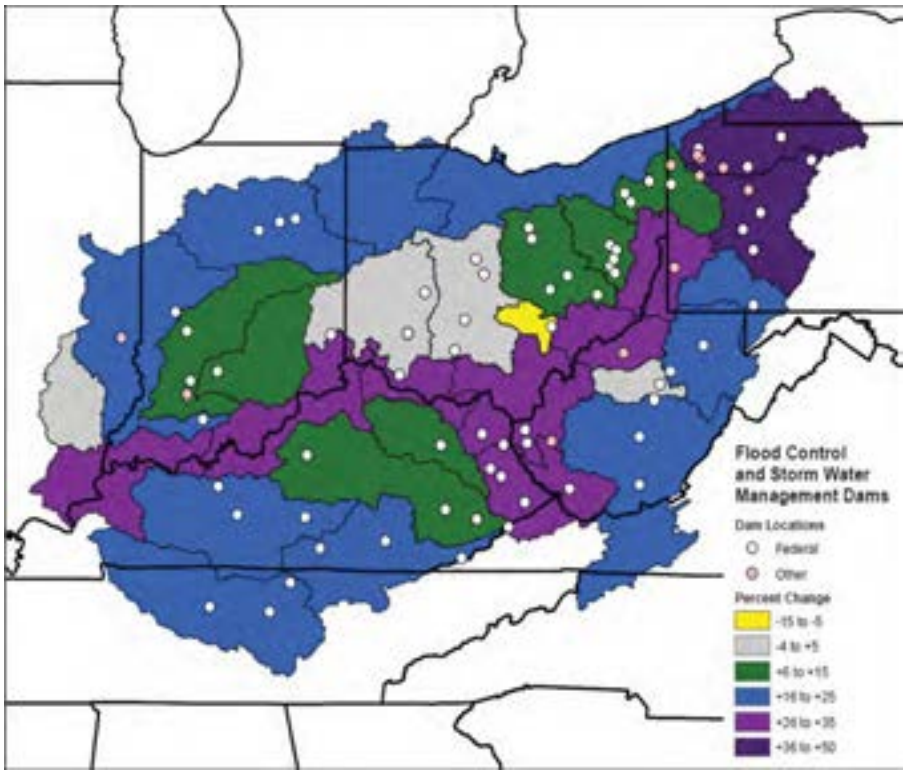
Data Category	Model Time Periods		
	2011–2040	2041–2070	2071–2099
Annual Mean[20]	+15% - +25%	+15% - +25%	+15% - +25%
Annual Minimum	+15% - +25%	+5% - +15%	+5% - +15%
Annual Maximum	+15% - +25%	+25% - +35%	+25% - +35%
March Mean	+5% - +15%	+5% - +15%	+5% - +15%
March Minimum[21]	-5% - +5%	-5% - +5%	-5% - +5%
March Maximum	+5% - + 15%	+15% - +25%	+15% - +25%
October Mean	+35% - +50%	+25% - +35%	+25% - +35%
October Minimum	+5% - +15%	-5% - +5%	-5% - +5%
October Maximum	+35% - +50%	+35% - +50%	+35% - +50%

Figure _____ shows the Ohio River Basin map of flood control dams (white and colored dots) having greater than 3,000 acre-feet of storage array across shaded watersheds produced by the Ohio River Forecast Center using climate model data from IWR. The coloration in each watershed represents the projected percent increase in precipitation (see figure legend) that is reflected as flow increases at various forecast points (gages). The Kanawha River gage at Charleston, WV is the forecast point for the mainstem Kanawha/New River watershed. This particular map displays the forecasted March mean maximum flows for the 30-year period of 2071-2099. Similar basin maps for all of the other time periods shown in Table ____ are available. The Bluestone Dam project and the Kanawha River gage (red star) locations have been noted on the map.

[19] Percentages listed are projected values greater than or less than stream flows recorded at the Kanawha River Gage at Charleston, WV between 1952 and 2001 on an annual or seasonal basis.

[20] The data are expressed as the mean of all mean values for each of the annual totals or seasonal totals through the entire time period. In other words the March maximum value is the mean value of all of the March monthly maximum values for each March over a 30-year period.

[21] Values ranging between -5% and +5% in the table represent no substantial change from the base years flow.



Bluestone Dam

Figure ____ - Forecasted March Maximum Flow Increases 2071-2099

Summary of Anticipated Climate Change Affects;

1) General trends: Meteorologists and climatologists at the Ohio River Forecast Center summarized their findings upon completion of the runoff/streamflow modeling[22] by expressing that despite some warming and increased precipitation in the fall season, climatic conditions during the period between 2011 and 2040 will closely resemble what has been experienced during the historic period 1952 to 2001. There will likely be drought and flood events in the basin as we have seen during those base years, but the consensus opinion was that those conditions wouldn't be more extreme (intensity or duration) than we have seen during the base years (1952-2001). However, after 2040, the Forecast Center indicated that increases in mean annual air temperature and associated increases or decreases in precipitation (depending upon one's location in the basin) may make flood events and drought conditions more extreme with measurable changes in the basin's overall mean annual air temperature and mean annual and seasonal precipitation amounts.
2) Temperatures: Downscaled model projections from current climate change studies indicate increased air temperatures within the affected area and the Bluestone Lake watershed of at least 0.5^{o} F per decade between 2011 and 2040 and at least 1.0^{o} F per decade between 2041 and 2099. At those rates, the mean annual air temperature at the Charleston gage could be 55.3^{o} F by 2020, 56.7^{o} F by 2040, 58.4^{o} F by 2050, 58.9^{o} F by 2070 and 62.3^{o} F by 2099[23]. It is likely this gradual warming will begin to

[22] Modeling completed for the Ohio River Basin Climate Change Impacts and Adaptation Pilot Study (2015)
[23] Recorded mean annual air temperature at the Kanawha River gage in Charleston, WV in 2001 was 53.8^{o} F and 54.7^{o} F in 2011.

raise water temperatures both within Bluestone Lake and downstream New River as well as free-flowing tributary streams (i.e. Greenbrier River and Gauley River). Warming waters may coerce some cool or cold water aquatic species to migrate out of the area enabling warm water species to thrive in the warmer aquatic habitat. Warming waters may also increase the potential for invasive aquatic species to migrate into these waters with increases in both frequency and duration of seasonal algae blooms. Some attenuation of rising New River surface water temperatures downstream of the dam may occur through releases of deeper, cooler water from Bluestone Dam.

3) Precipitation/Runoff and Stream flow: Downscaled model projections for the 2011 though 2099 time frame indicate increases in precipitation in the basin and resulting higher flows in the New River and other major tributaries to the Kanawha River system. Projected increases in stream flow at the Charleston gage indicate that the Bluestone Lake project could experience flows in the New River ranging from 5% to 25% higher in the spring season and between 5% and 50% higher in the fall season by 2070. Overall, the project could experience an increase in mean annual flows in the New River that are between 5% and 35% greater than those experienced between 1952 and 2001.

These stream flow projections for the Kanawha River gage also foretell higher mean annual and mean seasonal flows for the Greenbrier, Gauley, and Elk Rivers (the combination of which account for approximately 50.1% of the water flowing at that gage) under changing precipitation conditions as well. In addition, increases in precipitation within the New River/Kanawha River watershed may result in increased contamination from exposed non-point sources (nutrients, pesticides, herbicides, sedimentation from disturbed soils, contaminants from abandoned mined lands, and other disposal areas) into Bluestone Lake and the other lakes in the system. Due to warming air temperatures, it is likely that more annual precipitation will fall as rain rather than snow in the watershed and both the incidence and thickness of lake ice at Bluestone may steadily decrease throughout the three 30-year periods.

4) Intensification of Precipitation: Various climate change studies have shown a trend in heavier downpours over the last 30 years for the downstream affected area in WV and watershed of Bluestone Dam in VA and NC. These trends show considerable variation between the upper and lower reaches of the affected area. Future projections indicate the potential for more intense rainfall events in the 1 in 20 year event range leading to possible flash flooding on small tributary streams and urban areas in the affected area, but the modeling data from sources investigated does not indicate that longer duration rainfall events – events associated with the 1% annual chance, 0.5% annual chance, or longer recurrence events would be affected by these changes. Local atmospheric convection processes that lead to high-intensity thunderstorm development or “training storms” occur at too fine a geographic scale for downscaled global circulation models to accurately predict.

5) Summary of Forecasted Climate Changes and Associated Effects during FWAC Period of Analysis: In summary, based upon the downscaled modeling completed for the Ohio River Basin Climate Change and Adaptation Study (July 2015), mean

annual air temperatures will likely increase throughout the New River and Kanawha River watersheds during the FWAC period of analysis. Forecasted increases in mean annual air temperatures at the Kanawha River gage will likely be 0.6^{o} F by 2020, 2.0^{o} F by 2040, 3.7^{o} F by 2050, 4.2^{o} F by 2070, and 7.6^{o} by 2099[24].

Besides obvious effects of increasing temperatures throughout the four seasons (i.e. potentially more days exceeding 90 degrees in summer, warmer winter temperatures with more precipitation in the form of rain rather than snow and decreasing lake ice), increases in air temperature will begin to warm surface waters in Bluestone Lake, the New River, Claytor Lake and tributaries to the New River during the period of analysis. A shift in aquatic species composition in lakes and rivers within the basin may occur as a result of warming surface waters. Aquatic species commonly associated with cool-water environments would likely migrate upstream into cooler headwater streams at higher elevations in the basin. Warm-water fishes would become the predominant species in the lakes. In addition, warmer water temperatures may encourage invasive aquatic species (macro-invertebrates, fishes, mussels, vegetation, etc.) to migrate into these previously cool-water habitats thus competing with indigenous species for resources and habitat.

The incidence and duration of algae blooms due to combination of warmer water and ongoing introduction of nutrients and other pollutants into the lake from upstream locations (as a result of increased precipitation) could become problematic from a water quality standpoint. Warmer air temperatures could result in a lengthened recreation season at the project but unseasonably higher summer temps may also reduce day-use visitation during the hottest months. Warmer temperatures may also result in gradual shifts in vegetative species composition in the region and the introduction of invasive plants, insect pests and diseases that could be detrimental to the forest community within the 22,000 acres of the project.

The percent changes in mean annual and mean seasonal stream flow forecasted at the Kanawha River gage indicate the likelihood for an increase in stream flow in the New River throughout the FWAC period of analysis. This forecast includes a measure of uncertainty that is displayed as the range of percent of increase (10%) shown in each period of time. The current schedule of construction phases for the Bluestone Lake DSM indicates that the final phase ____ will likely be completed by _____. Based upon that anticipated ending date, the FWAC period of analysis would extend to the year _____ which is within the third 30-year period (2071 - 2099) of the available climate modeling data.

Table ____ displayed the forecasted percent changes in mean stream flow on an annual and seasonal (spring/March and fall/October) basis for the Kanawha River gage in Charleston, WV. That data indicates the annual mean precipitation and resultant runoff and stream flows may increase by as much as 15% to 25% during the two 30-year analysis periods 2041 to 2070 and 2071 to 2099. The table also indicates that much of this increase in annual mean flow may be due to increases in the fall

[24] Degree increases based upon the annual mean of recorded temperatures at that gage in 2011 of 54.7^{o} F.

(mean annual October flows 25% to 35% greater) rather than increases in the spring (mean annual March flows 5% to 15% greater).

Two other series of data show potentially significant increases in stream flow including the forecasted mean value of March (Spring) maximum flows in 2071 to 2099 (15% to 25% higher than the base years flows) and the mean of maximum October (Fall) flows[25] during that same period forecasted to be 35% to 50% greater than the base years recorded flows in that season. Although the increases in the October mean and maximum flows may be welcomed (sustained water supply and hydroelectric power capacity) during an otherwise dry portion of the water year when New River flows are traditionally lower, the 15% to 25% increase in mean maximum March flows (measurably greater that the base years flows) could be problematic during operation of Bluestone Dam, recreation at Bluestone Lake, and for at-risk communities located along the New River and its major tributaries that contribute to readings at the Kanawha River gage.

Although these forecasted mean higher spring flows do not directly affect modeled storms that generate the Probable Maximum Inflow (PMI) or flows that could endanger the stability and integrity of the dam structure in the future, they can have significant impacts on the project resources in the New River above the summer pool and affect lakeside recreation resources in the project. The increased frequency that critical elevations are reached or exceeded at the lake due to these forecasted changes could affect recreation usage and inundation-sensitive ecosystems bordering the lakeshore. Although forecasts of warming temperatures could lengthen the recreation season, higher incoming flows into Bluestone Lake could reduce usage of lakeside campgrounds and boat access points thus affecting visitation. Higher incoming flows could increase erosion of riverbanks and the many islands present within the project both in and upstream of the summer pool elevation. Both the sustainability of sensitive ecosystems and integrity of cultural resources sites existing along the river and on the islands could be at-risk from continued erosion due to these higher forecasted inflows. These additional environmental stressors could compound impacts occurring as a result of construction activities at the dam as well as future operational changes.

[25] As described earlier in this section but repeated here for emphasis, the mean of October maximum flows represents the mean value of all October mean maximum flows for each of the 30 October months during the three 30-year periods.

Appendix G

CULTURAL RESOURCES

WEST VIRGINIA
Division of Culture and History

The Culture Center
1900 Kanawha Blvd., E.
Charleston, WV 25305-0300
Randall Reid-Smith, Commissioner
Phone 304.558.0220 • www.wvculture.org
Fax 304.558.2779 • TDD 304.558.3562
EEO/AA Employer

December 17, 2013

Jonathan J. Aya-ay
Planning Branch
U.S. Army Corps of Engineers
Huntington District
502 Eighth Street
Huntington, WV 25701

RE: Bluestone Dam Safety Modification Project
FR#: 14-188-SU

Dear Mr. Aya-ay:

We have reviewed the above referenced project to determine potential effects to cultural resources. As required by Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties," we submit our comments.

We have reviewed the above referenced intent to prepare a Supplemental Environmental Impact Statement (EIS) and Dam Safety Modification Report (DSMR) for the Bluestone Dam. Please keep in mind the Bluestone Dam was previously determined eligible for inclusion the National Register of Historic Places. We look forward to reviewing the new EIS and DSMR

We appreciate the opportunity to be of service. If you have questions regarding our comments or the Section 106 process, please contact Ernest Blevins, Structural Historian, at (304) 558-0240.

Sincerely,

Susan M. Pierce
Deputy State Historic Preservation Officer

SMP/EEB

MEMORANDUM OF AGREEMENT
AMONG
THE U. S. ARMY CORPS OF ENGINEERS, HUNTINGTON DISTRICT,
THE WEST VIRGINIA STATE HISTORIC PRESERVATION OFFICER
REGARDING
THE BLUESTONE LAKE DAM SAFETY ASSURANCE AND DRIFT AND DEBRIS PROJECTS, SUMMERS COUNTY, WEST VIRGINIA

WHEREAS, the U. S. Army Corps of Engineers, Huntington District (Huntington District), proposes to modify the Bluestone Dam, located in Summers County, West Virginia; and,

WHEREAS, the Huntington District has determined that the modification of Bluestone Dam to comply with modern safety standards and to allow drift and debris to pass efficiently through the dam, will have an effect upon a property eligible for inclusion in the National Register of Historic Places (National Register) and has consulted with the West Virginia State Historic Preservation Officer (WVSHPO) pursuant to the regulations 36 CFR Part 800 implementing Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470 f);

NOW, THEREFORE, the Huntington District and the WVSHPO agree that the undertakings shall be implemented in accordance with the following stipulations in order to take into account the effects of the undertakings on historic properties.

Stipulations

The Huntington District shall ensure that the following measures are carried out:

1. Documentation of Bluestone Dam.

The Huntington District will develop a detail history of Bluestone Dam covering its planning, engineering, construction and its significance in the themes of law, politics, government, economics and conservation. The documentation will consist of a narrative report and include historic photographs, copies of original blueprints and designs, and photographs recording the structure's current internal and external appearance. The history will be reviewed and accepted by the WVSHPO.

2. Distribution of Documentation

Final copies of the documentation report will be distributed to the WVSHPO, Summers County Historic Landmarks Commission and Summers County Historical Society.

3. Public Outreach

Efforts will be made to inform the public about the significance of Bluestone Dam by revising the Corps web site to include historical information and historic photos of the dam, development of a brochure on the history of Bluestone Dam for distribution to visitors and school groups, and upgrade and improvement of displays at the Interpretive Center once these projects are complete.

4. Design

Incorporate into the Interpretative Center an area where visitors can view Bluestone Lake once the projects are completed.

5. Discoveries Without Prior Planning

If the Huntington District discovers historic properties or archeological sites without prior planning or unanticipated effects on historic properties or archeological sites are found after the Huntington District has completed the Section 106 process, the Huntington District will make reasonable efforts to avoid, minimize or mitigate adverse effects to such properties or sites pursuant to 36 CFR 800.13(b). If no construction has commenced, the Huntington District will consult with WVSHPO to resolve adverse effects pursuant to 36 CFR 800.6. If construction has commenced, the Huntington District will determine actions to take to resolve adverse effects, and notify WVSHPO within 48 hours of discovery. The notification shall describe the actions proposed by the Huntington District to resolve the adverse effects. WVSHPO shall respond within 48 hours of the notification and the Huntington District shall take into account his/her recommendations and carry out appropriate actions. The Huntington District will provide WVSHPO a report of the actions when they are completed pursuant to 36 CFR 800.13(b)3.

6. Summary Reports and Consultation

The signatories to this Agreement shall consult at least twice to review implementation of the terms of this Agreement. The review shall be three years and six years after the execution of this Memorandum of Agreement. Prior to each review, a report shall be provided by the Huntington District to the WVSHPO detailing how obligations pursuant to this Agreement have been carried out. If revisions to this Agreement are needed, the signatories to this Agreement shall consult to make such revisions in a manner consistent with 36 CFR Part 800.

7. Dispute Resolutions

Should the WVSHPO or the Huntington District fail to agree on the terms of this agreement the Huntington District shall, pursuant to 36 CFR 800.6(b)(v), request the Advisory Council on Historic Preservation (Council) to join the consultation and provide the Council with the documentation set forth in 36 CFR 800.11(g). If the Council decides to join the consultation, the Huntington District shall proceed in accordance with 36 CFR 800.6(b)2. If the Council decides not to join consultation, the Council will notify the Huntington District and proceed to comment in accordance with 36 CFR 800.7(c).

Execution of this Memorandum of Agreement by the Huntington District and the WVSHPO, its submission to the Council, and implementation of its terms, is evidence that the Huntington District has afforded the Council an opportunity to comment on the Bluestone Dam Project and its effects on historic properties, and that the Huntington District has taken into account the effects of the project on historic properties.

IN WITNESS WHEREOF, the parties hereto have caused their respective names to be signed by their duly authorized officers:

By: _____ Date: 17 Aug 2000
John D. Rivenburgh
Colonel, Corps of Engineers

By: _____ Date: 9/7/00
State Historic Preservation Officer
West Virginia

WEST VIRGINIA DIVISION OF
CULTURE AND HISTORY

August 31, 2000

Mr. James S. Everman
Chief, Planning Division
Department of the Army
502 Eighth Street
Huntington, WV 25701

RE: Bluestone Dam Safety Assurance Project
FR#: 94-314-SU-14

Dear Mr. Everman:

We have reviewed the draft Memorandum of Agreement for the above mentioned project. As required by Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties," we submit our comments.

Enclosed please find the signed original of the MOA for the Bluestone Dam Safety Assurance Project. Once you make a copy for your records, mail the original to the Advisory Council on Historic Preservation at the following address:

Advisory Council on Historic Preservation
1100 Pennsylvania Avenue, NW
Suite 809
Washington, D.C. 20004

We appreciate the opportunity to be of service. *If you have questions regarding our comments or the Section 106 process, please call Marc Holma, Senior Structural Historian for Review and Compliance, at (304) 558-0220, Ext. 723.*

Sincerely,

Susan M. Pierce

Susan M. Pierce
Deputy State Historic Preservation Officer

SMP: mh

Enclosure (1)

HISTORIC DOCUMENTATION REPORT

BLUESTONE DAM

HINTON VICINITY, SUMMERS COUNTY, WEST VIRGINIA

March 15, 2002

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Bluestone Dam
Summary

Location:
Across the New River at Bluestone Lake,
Hinton Vicinity, Summers County, West Virginia

UTM Coordinates: 17 / 510058 / 4165954

Present Owner:
U.S. Army Corps of Engineers, Huntington District

Present Use:
Flood Control Dam

Date of Construction:
1942-1948

Designer:
U.S. Army Corps of Engineers, Huntington District

Contractors:
Dravo Construction Company, Primary Contractor

Significance: Bluestone Dam is a large concrete gravity structure located on the New River. The dam's construction created Bluestone Lake, which contributes to flood protection on the New and Kanawha Rivers and, ultimately, on the Ohio River. Planning and construction of the dam led to a lengthy court battle that was settled only through appeal to the United States Supreme Court. The high court's decision established the federal government's right to control dam construction and hydroelectric power generation on navigable waterways. The case also established the New River as a navigable stream, even though the river was too shallow to support commercial traffic. Bluestone Dam is also representative of the ambitious public works projects undertaken by the federal government during the 1930s and early 1940s, and its massive, streamlined design is reflective of the Art Deco and Art Moderne design philosophies of the 1930s and 1940s. Paul Cret, an architect known for designs of bridge abutments, dams and government buildings of the 1920s-1940s, was responsible for the aesthetic component of the dam's design. Along with Tygart Dam, Bluestone Dam is one of West Virginia's best examples of concrete gravity dams of the 1930s and 1940s. The dam's builders also utilized recently developed concrete technologies, including air entrainment and artificial chilling of mixing water.

Project The Huntington District, U.S. Army Corps of Engineers sponsored the recordation of Bluestone Dam. Historic documentation was completed by Hardlines Design Company, Roy A. Hampton III, Primary Investigator/Historian, Mary E. Crowe, Historian, Amy D. Case, Editor.

SECTION 1: INTRODUCTION

Bluestone Dam is an important historic resource, and the history of its planning, development, and construction stretches from the early years of the twentieth century, to the New Deal era of the 1930s, through World War II and into the first years of the postwar era. As early as 1911-1912, a privately constructed hydroelectric dam was first planned for this section of the New River. In the 1930s, conflict arose between plans to construct a federally owned and operated power-generating and flood control dam, and private plans to build a for-profit hydroelectric facility. This friction led to a court battle that ultimately made its way to the United States Supreme Court. The justices' landmark decision established federal jurisdiction over the development of dams in waterways across the United States.

It was 1941 before the lawsuits were settled and the U.S. Army Corps of Engineers Huntington District began constructing the dam, by which time the United States was on the brink of entering World War II. Construction of the first 35% of the dam by Dravo Construction Company during the war era is a complex story of delays caused by wartime materials shortages and the discovery of large amounts of weak foundation rock beneath the site of the main dam. At the beginning of construction in 1942, the War Production Board made completion of Bluestone Dam a top priority because of the need for hydroelectric power, but the board soon lowered the dam's priority rating. The construction delays eventually led the War Production Board to despair of ever completing the project in time to produce power for the industrial war effort, and construction on the dam halted in 1944. After a long hiatus, construction resumed in 1946 amid the economic and social adjustments of the post-World War II era. The proposed hydroelectric facilities of the dam, which made its construction a high priority at the beginning of World War II, were never built. Except for the installation of its crest gates, the dam was completed by the end of 1948. The crest gates were installed in 1952.

Bluestone Dam is an impressive example of the type of massive concrete gravity dams built by the federal government from the mid-1930s through the end of the 1940s. The dam impounds water that forms Bluestone Lake, which serves as an important recreational facility and tourist attraction in Summers County, West Virginia. Most importantly, the dam is part of the ring of flood control facilities that protects the Kanawha Valley and ultimately the Ohio River Valley from the devastating floods that once ravaged the region. Finally, the dam is an impressive engineering landmark that dominates the landscape of the New River below Hinton, and is a reminder of the extensive federal flood control efforts that began with the New Deal and continued during the post-World War II era.

Due to severe problems with driftwood and trash accumulation in Bluestone Lake behind the dam, Bluestone Dam will be significantly altered over the next few years. One of the most significant alterations will be the completion of a tunnel and gate tower in the dam that will allow driftwood and trash to be flushed through the dam during high water conditions. This improvement will lessen the buildup of trash on Bluestone Lake and

will help protect the falls and rapids of the New River below Bluestone Dam from being obstructed by the driftwood and other debris that are sometimes flushed through during low water conditions.

SECTION 2: DESCRIPTION OF BLUESTONE DAM AND LAKE

General

Bluestone Dam is a straight, concrete gravity structure, with an overall length of 2,048 feet and a maximum height of approximately 165 feet above streambed. The width of the dam at its crest is 16 feet, while the maximum base width of the dam measures 200 feet. The main body of the dam has 55 concrete monoliths. The dam contains 942,000 cubic yards of concrete and 7,800 tons of steel. The dam is located on the New River, approximately 64.8 miles above the river's mouth. The dam impounds water that creates a long, narrow lake that extends ten and one-half miles up the New River valley.

Fig. 1. 1937 Location Map, Bluestone Dam.
Shows location of Bluestone Dam in relation to major cities, towns, and rivers in the region.
(Huntington District, U.S. Army Corps of Engineers)

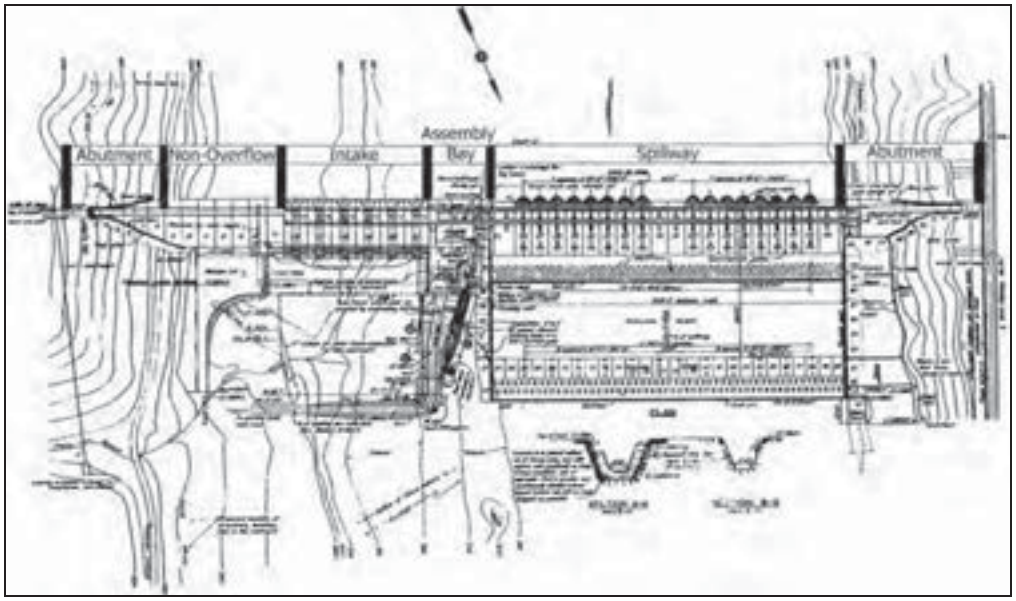

Fig. 2. Diagram of Sections of Bluestone Dam.
Adapted by Mary Crowe, Hardlines Design Company,
from 1936 plan of Bluestone Dam.

Detailed Description of Dam

The five major sections of Bluestone Dam are the east abutment, the non-overflow section, the intake section, the assembly bay area, the spillway, and the west abutment (see fig. 2). The east abutment is 201 feet long, and the non-overflow section measures 207 feet in length. The south slope of the non-overflow section is very steep, while the north slope is nearly vertical at the top but becomes more broadly sloped at the bottom. The east abutment and non-overflow sections are 16 feet wide at their crests. Directly west of this abutment is the 330-foot intake section of the dam, which features six "penstocks." These penstocks (see fig. 3) are large steel pipes that penetrate the concrete of the dam and that, if uncapped, would allow water to flow from the reservoir. The penstocks were intended to accommodate the six 30,000-kilowatt units for the hydroelectric plant originally planned for the dam, but this hydroelectric facility was never constructed. The penstocks are currently capped, to prevent water from flowing through them. This section of the dam is steeply vertical at the top and becomes more broadly sloped at the bottom on the north elevation. Immediately north of the penstocks is a small lagoon contained within an earth and rock dike. On top of this dike is an access road leading to the dam's main entrance at Pylon No. 2. The south face of this section of the dam has vertical walls that contain six bulkhead recesses, one for each of the penstocks.

Fig. 3. North Elevation of Dam, Intake Section Looking Southeast.
Five of the six penstocks are visible.

Fig. 4. North Elevation of Dam.
Detail with assembly platform section of dam at center.
Pylon No. 2 is visible at the right of the assembly platform.

West of the intake section is the dam's 142-foot wide assembly platform (see fig. 4). This section includes two concrete pylons and a multi-story assembly platform area. The assembly bay consists of the main door and entrance room on the first floor, storage rooms on the second floor, a machine room on the third floor, and the assembly platform on the roof. Pylon No. 1, on the east side of the assembly bay, contains a stairway leading from the machine room level to the top of the dam. Pylon No. 2, on the west side of the assembly bay, extends the entire height of the dam and contains an elevator and stairway. This pylon has recessed molded corners and a setback at the top that reinforces the Art Deco architectural lines of the dam. A trash chute also passes through Pylon No. 2, and an office and a control room with the electrical system's switchboard are located on the pylon's top floor. The trash chute in Pylon No. 2 dumps into a small channel positioned between the penstock lagoon and the main spillway.

West of the assembly platform area is the spillway section, which is the longest part of the dam (see fig. 5). This 790-foot structure features 16 sluices in the dam's base that can be opened to regulate the water level of Bluestone Lake. The sluices are concrete tubes that cut through the dam and that allow water to flow out of the reservoir. The sluice openings are located in the bottom portion of the north elevation of the dam, which is broadly sloped and curved. The south elevation of this section of the dam has a steep, nearly vertical slope. A semi-cylindrical reinforced concrete trash rack protects the entrances leading from the south elevation to each of the sluices.

Fig. 5. North Elevation of Dam Showing Spillway Section.

Operation of the reservoir is controlled through these 16 hydraulic sluices, which can release a total of 70,000 cubic feet of water per second when the reservoir is filled to an elevation of 1520 feet above mean sea level. Each sluice measures 5 feet 8 inches wide by 10 feet high. Each of the 16 sluices has two gates, one serving as the service gate and the other as an emergency gate that can be operated in the event that the service gate fails. The gate machinery is located in an operating gallery positioned just above the sluices (see fig. 6). In addition to the operating gallery, an inspection gallery runs the entire length of the dam beneath the sluices and a few feet above the foundation rock. A hydraulically powered hoist raises and lowers the gates to increase or decrease water flow through the sluice.

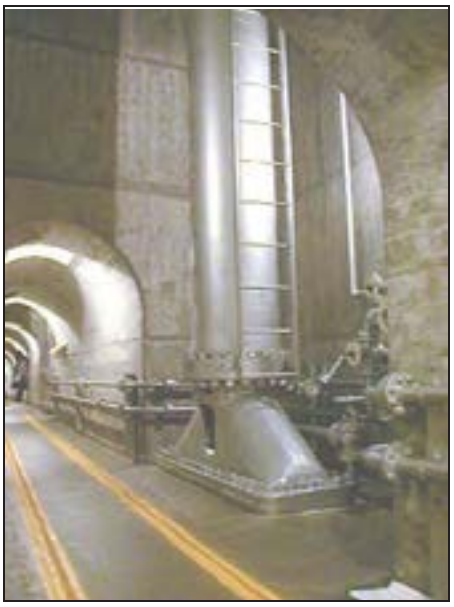

Fig. 6. View of Bluestone Dam Operating Gallery With Sluice Gate Hydraulic Hoist.

In their text on the design of dams, Hanna and Kennedy refer to sluice gates as “slide gates” and state:

> Slide gates are used for controlling the flow over spillways where the quantity of water to be handled is relatively small and the range of fluctuation is about 10 ft. or less. They are also used for relatively small discharges through outlets under heads up to about 120 ft. These gates are usually made of cast iron or cast steel in one piece or rolled-steel plates and sections. The frames of the cast gates are made of the same materials as the gate leaves, and the leaves are reinforced with horizontal and vertical ribs. The gates are operated with hoists.[1]

The sluices discharge into a stilling pool that extends 364 feet north of the dam. A 23-foot high stilling weir that extends the full width of the spillway section forms the northern edge of the stilling basin. Training walls approximately 50 feet in height flank both sides of the stilling basin. The stilling basin contains two sets of concrete baffles to slow the speed of the water, one set located just north of the sluices, and a second set positioned just north of the stilling weir. The spillway has a maximum discharge capacity of 430,000 cubic feet of water per second, and the spillway's stilling basin measures 798 feet wide by 347.5 feet in length.[2]

The spillway portion of the dam is also equipped with 21 steel crest gates at the top of the dam. Each of these crest gates measures 30 by 31 feet and can be opened to discharge excess floodwaters in extreme high water conditions. Each gate is supported on piers that are eight feet wide and that reflect Art Deco architectural influences in their curved, streamlined design. The crest gates are simple rectangular vertical lift gates, and an electric hoist lifts each gate individually via a series of cables attached to two pulleys at the top of the gate. An electric motor powers each gate machine, which consists primarily of a series of reduction gears, brake components, and other elements. A gantry crane, capable of moving along the entire length of the spillway and intake sections on top of the dam, moves emergency bulkheads and can raise and lower crest gates when the gate machinery is out of service.

Fig.7. Detail of Crest Gates and Gate Piers, North Elevation of Dam.

The west abutment section of the dam is 307 feet wide and includes a large multi-story pylon on its eastern edge. This third pylon is similar in external appearance to Pylon No. 2 and helps give the dam a sense of architectural balance. This third pylon contains storage rooms and a stairway. Two additional adits into the dam are situated in each abutment and lead to the dam's interior.[3]

The overall appearance of the dam is impressive, although the north elevation possesses much greater aesthetic appeal than the south elevation. The south elevation is fairly plain and functional in design, with nearly vertical walls punctuated mainly by the crest gates, the trash racks of the sluices, and the penstock bulkhead recesses. Like the north elevation, the south elevation is visually powerful in scale and massing, but lacks the north elevation's more pleasing composition and proportions. The long spillway section of the dam includes, on the north elevation, streamlined gate piers that thicken as they transition into the massive curved concrete ogee weir that makes up much of this portion of the dam. The curved weir surmounted by these tapering, streamlined gate piers lends a visually striking quality to this elevation.

Fig. 8. South Elevation of Dam, with Spillway Section in Foreground, Looking Northeast.

In contrast, the three tall pylons of the dam's north elevation counter the horizontality of the spillway section. The pylons feature sweeping vertical streamlined projections, corner recesses and distinctive setback tops. The arrangement of the spillway, the three pylons, and the projecting assembly platform section of the dam establishes a dynamic but balanced asymmetrical composition. Overall, the dam has a sense of mass that is related to the large scale, impressive height, and dramatic setting of the New River Valley and the surrounding hills. The proportions and Art Deco streamlining of the gate piers and pylons heighten the dam's scale and mass.

Fig. 9. North Elevation, Bluestone Dam.
View looking southeast from just north of west abutment.

Bluestone Lake and Surrounding State and Federal Lands

The purpose of Bluestone Dam is to store water in a large lake to prevent flooding along the New and Kanawha Rivers. Bluestone Lake is long and narrow in shape, and it extends approximately ten and one-half miles up the New River, and into the lower section of the Bluestone River. The depth of the reservoir at the dam reaches about 150

feet. The winter pool of the lake is approximately 9.5 miles long with a surface area of 1,800 acres. The winter pool stores an average of 36,500 acre-feet of water (an acre-foot is one acre of water one foot deep, or 325,850 gallons). The summer pool length of the reservoir is 10.7 miles, with a surface area of 2,040 acres and a storage capacity of about 36,500 acre-feet. Under maximum flood control storage pool conditions, the lake extends to 36.1 miles in length, spreads to a surface area of 9,180 acres, and contains a total of 631,000 acre-feet of water. The average pool level for the dam ranges between 1406 and 1410 feet above mean sea level, but at maximum capacity, the pool can rise to 1,520 feet above mean sea level.[4]

Federal property around Bluestone Lake has been designated as the Bluestone Wildlife Management Area. This area includes 17,632 acres of land and contains recreational facilities such as campgrounds and a rustic cabin area. A large area for public hunting has also been reserved at the upper end of the lake. A day and overnight camp operated by the Presbyterian Churches of West Virginia is also located within the area. The State of West Virginia has developed a portion of the federal land and adjacent state-owned lands as Bluestone State Park and Pipestem State Park. Bluestone State Park is located on the shores of Bluestone Lake, contains 25 cabins, 87 tent/trailer campsites, and provides boat rentals, hiking trails, and an accessible fishing pier. The U.S. Army Corps of Engineers manages operation of the dam and its immediate site, while the State of West Virginia, under a licensing agreement with the federal government, provides fish, wildlife, and forest management of lands around the lake in West Virginia. Federal lands located in Virginia are operated by the U.S. Army Corps of Engineers in cooperation with law enforcement and conservation officials of Virginia.[5]

Fig. 10. Bluestone Lake, Looking South from Top of Dam, March 2001.

SECTION 3: HISTORY OF BLUESTONE DAM: CONTEXT, PLANNING, AND DESIGN

Hinton, Summers County, and the New River Valley

Bluestone Dam is located in Summers County, West Virginia, near the county seat of Hinton, which is only about 15 miles from the border between Virginia and West Virginia. A mountainous topography dominates the area, which is punctuated by the New River gorge and other smaller valleys associated with the tributary streams of the New River watershed, including the Greenbrier and Bluestone Rivers. This area has a long history of occupation by humans, since the New River Valley provides the only natural pass through the Allegheny Mountains. Adena and Hopewell pottery has been found in the area, suggesting that these cultures inhabited the area. The Cherokee and Shawnee later occupied the region, when Euro-American explorers first penetrated the area.[6] A British expedition led by Thomas Batts and Robert Fallam reached the New River in 1671 and found evidence suggesting that earlier Euro-American traders had traveled through the valley.[7]

Euro-American settlement arrived slowly to this part of the New River Valley. Some New York settlers came to the area, but the French and Indian War decimated Euro-American settlements.[8] It was reported that the first Euro-American settlement in what is now Summers County may have been started by Andrew Culbertson of Pennsylvania around 1753.[9] There were many conflicts between Euro-American settlers and Native Americans during the 1760s and 1770s.[10] At the end of Lord Dunmore's War in 1774, the Cherokee ceded their claims to the area in the Treaty of Camp Charlotte. After these events, organized settlement of the area began in earnest in the 1770s, on the eve of the revolutionary war.[11] In the portion of the valley that is now part of Summers County, settlement proceeded slowly, and the area remained sparsely inhabited for many decades. The area was generally too rough and remote for most settlers.[12] Residents practiced subsistence farming here by the mid-nineteenth century, but the lack of good roads leading in and out of the area limited markets for surplus crops to the immediate vicinity.[13]

West Virginia achieved statehood in 1863, but Summers County was not established until 1871. Summers County was formed from parts of Monroe, Mercer, Greenbrier, and Fayette Counties by an act of the West Virginia State Legislature.[14] The county was named for George W. Summers (1807-1868), a noted legislator and jurist.[15] Hinton, the seat of government for Summers County, remained a very small community until the arrival of the Chesapeake and Ohio Railroad around 1870.[16] The disastrous 1878 flood damaged part of the town, but Hinton survived and was officially incorporated as a municipality under West Virginia law in 1880.[17] In 1868, area construction on the Chesapeake and Ohio Railroad encouraged the growth of Hinton and Summers County, as did the completion in 1878 of the Giles, Fayette and Kanawha Turnpike.[18] Local folklore also maintains that the legendary contest between John Henry and a steam drill occurred in 1872 during the construction of the Big Bend Railroad Tunnel in Summers County.[19]

With these developments, the transportation of livestock and crops to markets outside the immediate locale became more feasible. The raising of tobacco and hogs were soon the predominant economic activities that brought cash into the area. While coal mining was never widespread in Summers County, the migration of a large number of coal miners to surrounding communities created a larger market for agricultural products from Summers County. The coming of the railroad also encouraged industrial development by bringing jobs to the area and by introducing the timber industry into Summers County. The railroad allowed local farmers and craft workers to ship their goods to markets outside the area, and mass-produced goods from major urban areas could now be easily imported, replacing the handcrafted goods and materials that formerly dominated the region. [20]

The arrival of railroads led to a period of economic development in the area that lasted from about 1880 through the 1920s.[21] By 1908, Hinton featured a public school, wholesale hardware and grocery businesses, three banks, and three lumber and planning mills. The city also had extensive railroad facilities, including a two-story passenger depot, a freight depot, and a railway machine shop and roundhouse complex. It was reported that the C&O Railroad had invested over $1,000,000 in track, yards, and property in Hinton by 1908.[22] The population of Summers County in 1870 was reported as less than 4,000, but by 1880 it had grown to 9,033, and by 1900 it had reportedly grown to about 16,000.[23]

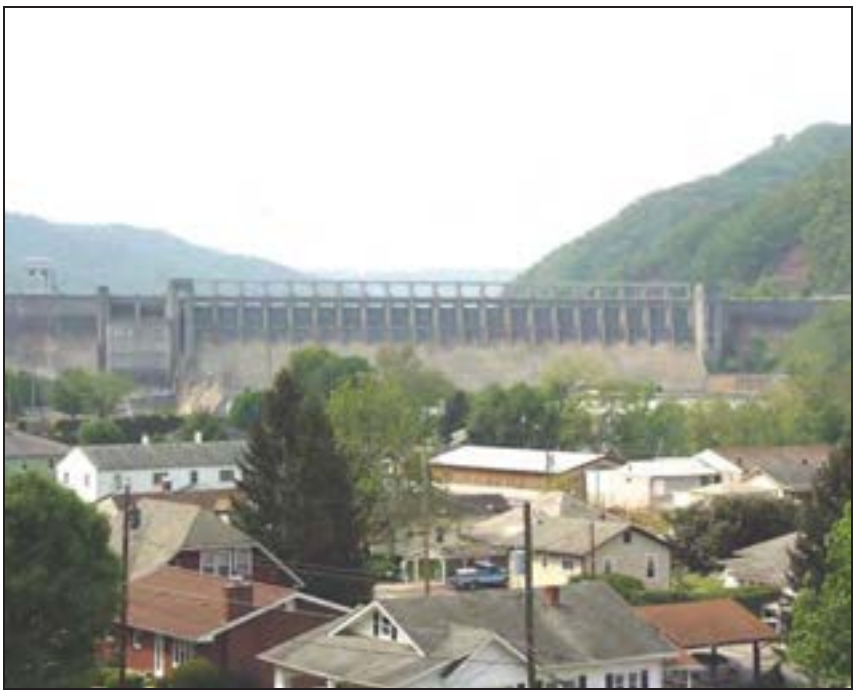

Fig. 11. View of the Bellepoint Residential Area of Hinton, with Bluestone Dam in Background.

However, Miller's 1908 *History of Summers County* indicated that the county was still predominantly agricultural at that time. The principal farm products were corn, wheat, rye, potatoes, oats, and grass. A number of sandstone quarries were operating in the area, producing both white and yellow sandstones, and a purplish brownstone. While the county had a number of stone quarries, it was not a major center for coal production, unlike other areas of the state. Only a few locations in Summers County were known to have coal deposits in 1908.[24]

Summers County continued to experience population growth in the early twentieth century. After 1930, possibly as the result of the economic hardships brought by the Great Depression, the population of Summers County began to decline.[25] In contrast, nearby counties of the New River basin experienced sharp population increases from 1930-1950, reflecting the growth of the coal industry. These counties, however, experienced a population decrease from 1950-1970, partly because of the increased mechanization of the coal industry.[26] The population of Summers County also declined during this period, bottoming out in the early 1970s. Growth returned to the area in the 1980s, and Summers County's population reached 15,875 residents by 1985. Much of this growth can be traced to the recreation and tourism industries.[27] The area currently benefits from tourism generated by recreational activities associated with Bluestone Lake, Pipestem State Park, and the nearby New River Gorge National Scenic River. Bluestone Lake is a popular fishing, hunting, and boating area, while the New River Gorge is a popular camping, hiking, and rafting destination.

Fig. 12. Current View of the New River, Looking North from Bluestone Dam. The scenic New River attracts tourists to Summers County each year.

Efforts to Construct a Private Hydroelectric Dam 1910-1936

While Bluestone Dam was eventually constructed by the U.S. Army Corps of Engineers and remains a federal facility today, private power companies originally planned to develop hydroelectric dams on the New River at the beginning of the twentieth century. A team of engineers designing a railroad line through the area may have generated the idea of building a hydroelectric power dam near the present Bluestone facility. By 1910, a group of residents in and around Hinton, West Virginia, commissioned drawings and a rough set of specifications for a dam. The inhabitants thought that the plans and specifications could be used to attract a utility company to the region to develop hydroelectric power. Based on the observations made by the railroad engineers, local residents chose a site about two miles upstream from the present Bluestone Dam and near the mouth of the Bluestone River.[28]

Hinton area residents presented their plan to the Appalachian Power Company, a private utility organized in May 1911 through the merger of different power plants along the New River.[29] The merger included a large number of coal-fired power plants, and the new company was capitalized at $25,000,000. Chartered in Richmond, Virginia, the company announced plans in June 1911 to build two hydroelectric dams on the New River in Pulaski County, Virginia, about 50 miles south of Hinton. Work began on a concrete dam near Grayson in Pulaski County on June 23, 1911. Apparently, the Appalachian Power Company had plans to build 11 or 12 additional dams at irregular intervals on the New River to produce large quantities of cheap electricity.[30]

The Appalachian Power Company showed immediate interest in building a hydroelectric dam at the Bluestone site. Geological testing at the Bluestone site soon revealed, however, that suitable foundation rock for the dam was located far beneath the surface at that location, complicating the construction of a dam there. The company identified a second possible site for the dam at Bull Falls, about nine miles upstream from the present Bluestone Dam.[31] In 1912, Appalachian Power sent a survey crew of engineers and laborers to Bull Falls and began negotiating for land for the future reservoir.[32] While the Bull Falls site was favorable in some ways, some engineers disliked its location above the mouth of the Bluestone River, because it would not take advantage of that river's flow to power the hydroelectric plant.[33]

The construction of a dam at Bull Falls did not advance beyond the survey stage, and state and federal governments meanwhile affirmed their jurisdiction over the construction of hydroelectric facilities. Perry and Lady's histories of Bluestone Dam claim that the passage of the West Virginia Water Power Act of 1913 halted work at Bull Falls. The Water Power Act allowed the state to regulate the rights, duties and powers of companies producing hydroelectric power, to authorize eminent domain powers for those companies, and to establish other regulations and policies. The legislation stated that all streams capable of producing electricity or other forms of power should be under the control and supervision of the state. The act also maintained, however, that the State of

West Virginia could not interfere with the federal government's authority over navigable streams. Perry states that the Appalachian Power Company tried to push through additional legislation permitting the company to build a Bull Falls dam without interference from the State of West Virginia. However, this legislation was not passed until 1929, with the approval of a compromise bill that facilitated hydroelectric development and protected the interests of the state.[34] A 1924 report written by a subsidiary of Appalachian Power only stated that the company applied to the Public Service Commission of West Virginia to develop a power dam in 1913. The Water Power Act was not mentioned.[35]

The West Virginia Power Company was formed in 1923 as a subsidiary of Appalachian Power to oversee planning and construction of the Bluestone/Bull Falls project. In late 1923, West Virginia Power commissioned Clark and Krebs, Engineers, of Charleston, West Virginia, to undertake a feasibility study and field investigation related to the proposed construction.[36] This study consisted of establishing a gauging station on the New River under the direction of the U.S. Geological Survey, re-checking older survey materials for accuracy, and revising area maps to reflect current conditions. The engineers undertook a survey of the New River between the Bluestone and Greenbrier Rivers to locate possible alternatives to the previously recommended dam site.

After considering potential alternatives, the company identified one site that warranted further investigation. The West Virginia Power Company referred to the originally selected dam site as the "Upper Site," which was Bull Falls. The report calls the selected alternative location the "Lower Site," which was the Bluestone site. The power company conducted further survey work at each of these sites, including core drilling to determine subsurface conditions. The field team also surveyed the land needed to accommodate reservoirs at each of the two locations. The goals of this survey were to assess the geological suitability of the land for a reservoir basin, the potential effect that the reservoir might have on the vicinity's mineral resources, and the value of the land that would be needed for the reservoir.[37] Finally, the team investigated the local availability of materials such as sand and quarry rock that would be necessary for the dam's construction. Given the extensive nature of this study, the West Virginia Power Company seems to have been very committed to building a hydroelectric dam on this portion of the New River.[38]

The West Virginia Power Company report of 1923 reflects the type of dam envisioned for the Bluestone project. The document describes the construction of a dam using "cyclopean concrete," a technique in which large, "cyclopean" limestone rocks or boulders were embedded in concrete during pouring.[39] This technique was a common construction option for early twentieth-century concrete dams, and was, for example, discussed in the planning of Liberty Lake Dam (Lower Girard Dam) near Youngstown, Ohio, in 1916-1917, although it was ultimately rejected. This method appears to have been a way to use concrete construction while retaining some of the stone masonry

techniques used in nineteenth-century dams. The cyclopean aggregate stones for the West Virginia Power Company dam were to have taken up about 25% of the dam's mass, with concrete making up the remaining 75%. Since concrete was relatively expensive in the 1920s, the insertion of large boulders in the concrete might have also been an economic measure.

Although the text of the 1923 report does not specify the exact type of dam, the description of cyclopean concrete suggests that the power company envisioned a concrete gravity dam. The report also included an elevation drawing of the proposed dam showing a large concrete gravity structure (see fig. 13). The drawing shows the north elevation of the dam, which was to feature a large powerhouse on the east side. The remainder of the dam was a long spillway area with three different sections. The east section of the spillway appears to have been planned with eight operable gates, while the west section would have featured 22 similar gates. In the center of this portion of the dam was a 13-gate section labeled as an "automatic spillway." The crest of the dam was somewhat higher in the "automatic spillway" section.[40]

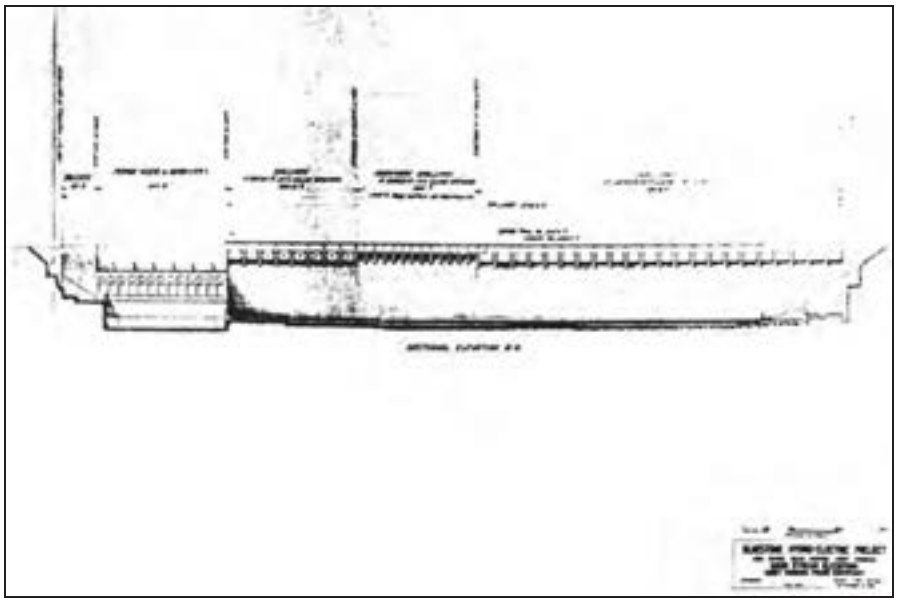

Fig. 13. Appalachian Power Company's Drawing of Proposed Bluestone Hydroelectric Dam (*Bluestone Development Report*, October 22, 1924).

Many builders of private power and reservoir dams during the 1920s selected buttress dam designs for their projects. Buttress dams consist of a series of piers supporting a thin, watertight concrete membrane. The thinness of a buttress dam's concrete columns and other elements required that these components be built using reinforced concrete, with steel rebar increasing the concrete's tensile strength. It is unclear why the West Virginia Power Company selected a gravity dam, but the site's geological conditions might have required this type of structure.

In 1923, engineer Major Milo P. Fox of the United States Army Corps of Engineers, Huntington District, held a series of hearings at Hinton, West Virginia, concerning the power company's application for a permit to build a 140-foot high dam on the New River, just above the present site of Bluestone Dam. Fox eventually recommended that the permit be granted because of the importance of the project in developing the area's power resources.[41] In the same year, the Federal Power Commission granted a preliminary permit to the West Virginia Power Company to develop hydroelectric power at the site.[42]

While the West Virginia Power Company conducted extensive studies related to construction of a dam at the Bluestone site, the company did not build a dam at this location during the 1920s. Perry states that the West Virginia Public Service Commission did not act on the company's permit application, and instead placed it on a "retired" docket until 1930.[43] This may explain why construction of the dam did not proceed in 1923, despite West Virginia Power's extensive surveying efforts.

In 1929, legislation amended the 1913 West Virginia Water Power Act and made it easier for the Appalachian Power Company and its subsidiary, the West Virginia Power Company, to build the Bluestone Dam project. The firm began developing detailed studies of the Bluestone site. U.S. Army Corps of Engineers sources indicate that the West Virginia Power Company completed additional core drilling at Bull Falls in 1929-1930. According to the Corps, the company determined that the Bull Falls site was geologically superior to the Bluestone site, but favored the larger reservoir capacity and easy access to railroad lines available at Bluestone.[44]

The West Virginia Power Company petitioned for a reinstatement of their application to build a dam at Bull Falls, and was allowed to submit an amended application that proposed complete utilization of the available fall within the portion of the New River affected by the project. The most sweeping amendment to the original West Virginia Power Company application was that the firm now proposed hydroelectric development at Bull Falls and at the present site of Bluestone Dam.[45] The company argued that the original plan for a single dam would interfere with Kanawha River navigation if the dam were operated in an economically feasible fashion.[46] In their amended application, West Virginia Power also envisioned construction of a third hydroelectric facility, the Claytor

Lake Dam at Radford, Virginia. Lady maintains that the coal industry, fearful of hydroelectric power development in the area, sued to delay construction of the West Virginia Power Company's Bluestone project. [47]

The West Virginia Power Company maintained that since the New River was not navigable, its hydroelectric dams could be built without the approval of the Federal Power Commission or other federal agencies. The U.S. Army Corps of Engineers and the Federal Power Commission argued, however, that the river was navigable, and that the construction of power dams on the New River was subject to federal regulation. This disagreement led to a lengthy court battle between the federal government and the West Virginia Power Company's parent organization, the Appalachian Power Company. This court battle delayed construction of a federal dam at the Bluestone site until 1942.[48] The Appalachian Power Company (now owned by American Electric Power) constructed a dam at Claytor Lake, but none was ever built at Bull Falls.

The West Virginia Power Company met federal opposition to its plans to build hydroelectric dams at Bluestone and Bull Falls, but two private hydroelectric dams were built on the New River in the 1930s. West Virginia Power's parent company, Appalachian Power, was able to construct Claytor Dam on the New River near Radford, Virginia, from 1937-1939. Between 1930 and 1936, the New-Kanawha Power Company built Hawk's Nest Dam on the New River 39 miles above Charleston, West Virginia. Hawk's Nest Dam cost $35 million, and contained a three-mile, thirty-foot tunnel that diverted part of the flow of the New River to a 135,000-horsepower capacity power plant that generated electricity for Union Carbide Corporation.[49]

Federal Reservoirs and Flood Control Program

The construction of Bluestone Dam was part of a federal campaign to construct reservoir dams, a trend that began in the 1920s and gained momentum during the 1930s and early 1940s. Presidential Executive Order 7183-A of September 12, 1935 authorized construction of Bluestone Dam. The facility was also part of a 14-reservoir plan for Ohio River Valley flood protection authorized by the Federal Flood Control Act of 1936.[50]

Flooding along major river valleys became an increasingly severe problem as urban populations grew along navigable rivers during the second half of the nineteenth century. As early as the 1850s, Charles Ellet proposed the construction of a series of storage reservoirs on the Ohio, Kanawha, Missouri and upper Mississippi basins to provide hydropower, benefit navigation, and control flooding. Congress, however, in 1857 rejected a series of detailed studies associated with the Ellet Plan, and engineer W. Milnor Roberts and Colonel William E. Merrill declared in 1870 that many of the engineering problems posed by the Ellett plan were unsolvable.[51]

One of the main objections Roberts and Merrill made to the Ellett plan was that Ellett proposed building reservoir dams over 100 feet high. Construction of high dams over running streams was a difficult undertaking in the post-Civil War era, and dam failures, most notably the 1889 collapse of the South Fork Conemaugh River Dam at Johnstown, Pennsylvania, lowered confidence in contemporary dam-building technology.[52]

The initial phase of federal involvement in reservoir dam construction came in 1902 with the National Reclamation Act. The Federal Bureau of Reclamation began building dams in the western United States to facilitate agricultural irrigation. The first multi-purpose high concrete dam built by the U.S. Army Corps of Engineers was Wilson Dam on the Tennessee River near Florence, Alabama, a dam begun in 1918 but only finished in 1926 because of interruptions related to World War I. Wilson Dam was intended to provide hydroelectric power and to provide extra water to maintain stable navigation pools on the Tennessee River Navigation System during low water conditions.[53]

While the U.S. Army Corps of Engineers began building Wilson Dam in 1918 for hydroelectric power and to provide water for the Tennessee River Navigation System, the Corps began constructing reservoir dams for flood protection only somewhat later. Federal revenue was limited during the nineteenth century, and the government hesitated to take on large and expensive flood control projects. The Corps of Engineers was involved in flood protection efforts during the nineteenth century, but these efforts were primarily directed towards the construction of flood control levees. However, a series of damaging floods in the early twentieth century, including the 1907 Pittsburgh flood, the Mississippi River floods of 1912, and the 1913 Miami River flood in Ohio, drew attention to the issue of flood control. Interest in the Ellett Plan was revived between 1907 and 1912, and the idea of building storage reservoirs on the Kanawha River was discussed. It was argued that dam technology had advanced considerably since Roberts and Merrill voiced their objections to the Ellett Plan, but a number of important figures, including Captain Frederick Alstaetter, the Wheeling District Engineer for the Corps of Engineers, still opposed the reservoir concept. General William Bixby, who served as Chief of Engineers for the Corps, believed that multi-purpose federal reservoirs could provide many benefits, but that the construction costs and expansion of federal powers needed to complete these projects could not be justified.[54]

Some progress was made towards federal involvement in flood control reservoir development in the early twentieth century. The Inland Waterways Commission was created in 1909 and recommended the development of a comprehensive federal plan for the nation’s rivers. In 1913, a severe flood damaged the central Ohio cities of Dayton, Columbus, Delaware, Zanesville, Chillicothe and Circleville. The flood also affected some communities along the Ohio River, including Parkersburg and Huntington, West Virginia. National attention once again focused on flood control, and the State of Ohio

passed a Conservancy Act in 1914 authorizing the formation of regional conservancy districts to deal with flooding and other water resource issues.[55] President Woodrow Wilson also ordered the formation of the Ohio River Flood Board to study the flooding problem and make recommendations. The board recommended that the authority of the federal government over rivers should be extended beyond navigation issues to include responsibility for flood control.[56]

The Ohio River Flood Board was also concerned that local governments might build flood control structures in a piecemeal fashion, without proper hydrological studies or consideration of the effects of these projects on nearby communities. The board recommended thorough river basin studies to gather reliable data that could be used for planning. In 1915, Congress approved a series of water resource studies for the Kanawha, Muskingum, and Scioto River basins, among other locations. The Corps of Engineers' Wheeling District submitted a report in 1916 that recommended the construction of storage reservoirs to protect the Kanawha Valley and identified 18 possible reservoir sites for future study. The United States' entry into World War I in 1917 then delayed implementation of the Kanawha study and other documents.

In the post-World War I climate of the early 1920s, there was new emphasis on the need to generate hydroelectric power. This led Congress to pass the Water Power Act of 1920.[57] In 1925, Congress directed the Chief of Engineers to produce cost estimates for the development of detailed water resource studies covering development of navigation, hydroelectric power and flood control in all of the nation's major river basins. The Chief of Engineers submitted cost estimates in 1926, and Congress approved them in 1927. Since the estimates were printed in House of Representatives Document No. 308, 68th Congress, these reports came to be known as the 308 Reports or the 308 Surveys.[58]

The 308 Reports outlined the development potential for each river basin for navigation, power production, and flood control. It represented a major shift by the U.S. Army Corps of Engineers from its past emphasis on navigation to a new focus that included multi-purpose water resource development. The 308 Surveys have been credited with laying the foundation for the ambitious water development programs that the U.S. Army Corps of Engineers undertook through the rest of the twentieth century.[59]

The 308 Surveys are important in the history of Bluestone Dam, since construction of the dam was one of four large storage reservoir projects recommended by Huntington District Engineer Major Fred W. Herman in a 308 Report covering the Kanawha River and submitted to Congress in 1932. The report stated that flooding in the Kanawha Valley, which had been damaging and costly in the past, could be significantly reduced by the construction of these reservoirs.[60] With industrial development and a growing population in the Kanawha Valley, construction of flood control reservoirs for the area

was an important priority. Congress nevertheless in 1932 still approved major flood control construction projects only if they also benefited navigation. Major Herman suggested that plans for private hydroelectric dams in the area could be modified to provide flood protection as well.[61] Eventually, Congressman John Kee of Bluefield, West Virginia, led a drive to build a federal reservoir dam on the New River in West Virginia for power production and flood control. Kee's efforts were opposed by some citizens of the area and by the Appalachian Power Company, which was trying to build a private hydroelectric dam at the Bluestone site.[62]

As debate continued over the construction of Bluestone Dam, progress was made in securing authorization for the first high concrete dam built in West Virginia by the U.S. Army Corps of Engineers. The New Deal's 1933 National Industrial Recovery Act (NIRA) allocated funds for the construction of dams and other public works projects to alleviate unemployment and to spur economic recovery from the Great Depression. The Public Works Administration (PWA) controlled construction of NIRA projects. The Pittsburgh Flood Commission lobbied the PWA to fund construction of nine dams that would relieve flooding in the Pittsburgh area.[63] In 1933, Major William Styer of the U.S. Army Corps of Engineers, Pittsburgh District, recommended construction of a reservoir dam on the Tygart River to assist in flood control and to provide supplemental water supply to the Monongahela River navigation system during low water. The PWA approved Styer's recommendation in October 1933 and allocated funding for the construction of Tygart Dam in January 1934. The first great concrete high dam of the Ohio River watershed flood protection system was then built near the town of Grafton in Taylor County, West Virginia, between 1934 and 1938. Funding and construction of Tygart Dam represented the first step in a long process to provide a series of reservoir dams that would eventually prevent billions of dollars in flood damage in cities along the Allegheny, Monongahela, Kanawha and Ohio Rivers. Authorization for the construction of Bluestone Dam came soon after construction began on Tygart Dam, but because of lawsuits and political wrangling, the actual building of Bluestone did not begin until 1942, four years after the completion of Tygart Dam. Construction at Bluestone was further interrupted during the United States' involvement in World War II, with the War Production Board's order on December 31, 1943 to bring work to a halt. Construction completely stopped in early 1944, and resumed only in January 1946.[64]

Early Huntington District Planning Studies and Field Surveys for Bluestone Dam 1935-1936

The U.S. Army Corps of Engineers first expressed interest in building a dam at the Bluestone site in 1932 as part of the 308 Report on flood control for the Kanawha River Valley. After strong lobbying by Congressman Kee and others, $164,000 was appropriated in August 1935 from federal emergency relief funds for surveys, foundation

exploration, and design work. Executive Order 7183-A of September 12, 1935 authorized the construction of Bluestone Dam for both flood control and power purposes. The executive order also allotted $1,000,000 of funds from the Emergency Relief Appropriation Act of 1935 for the Bluestone project. The executive order directed that $800,000.00 of the allocated funds were to be used for the acquisition of land necessary for the project.[65]

Perry indicates that a Huntington District survey party was sent to Hinton in 1935. A Lieutenant Lakin reportedly headed this party, which was first headquartered in the Hinton Post Office. After a short time in the post office, the survey team determined that it needed more space and received permission from the Elks to move their headquarters to the Hinton Elks Lodge. Perry reported that the survey party remained in the Hinton area until late 1936.[66]

The Huntington District survey party carefully examined the area along the New River above Hinton. Perry indicates that they submitted the following statement regarding the selected dam site:

> The final site chosen was approximately one mile above the Mouth of Greenbrier, three miles above the C&O Railroad station in Hinton. The New River has its sources in the Blue Ridge Mountains of North Carolina near the Tennessee line. The river flows northeasterly into Virginia, until it reaches the horseshoe curve near Radford, Virginia, where it turns northwest and flows in this general direction through West Virginia to its junction with the Gauley River to form the Great Kanawha, 91 miles above its mouth at Pt. Pleasant, West Virginia. Throughout its entire course the river flows through rugged, mountainous country. Its valley is narrow and the flood pain is a little wider than its river channel which varies form 200 to 1,000 feet in width. The grade of the riverbed is very steep and has an average slope of nine feet per mile for its entire 341 miles.
>
> The Bluestone Dam project was located in the section having the flattest slope, of four feet per mile. The Sandstone and shale formation for a distance of approximately 40 miles upstream from the site of the dam is flat shale while above and in adjacent country the rock sometimes stands on end. The Geological Survey Branch of the Department of the Interior has discovered that there is more water flowing in the New River below Radford Dam than at the Bluestone Dam site. There is the probability that the New River may be losing some of its water through the rock standing on end into subterranean streams. Sufficient data has not been collected to determine which direction the water may be flowing, but the

Geological Department is of the opinion that water is seeping through to the Greenbrier River but have no bona fide evidence to substantiate this theory.

The mean annual rainfall of the New River watershed above Hinton, for a period of 54 years, is 40 inches. The mean annual varies from 27 inches in 1930 to a maximum of 52 inches in 1901. The rainfall is heaviest in the upper region of the basin which has recorded some of the greatest precipitation on record in the country. In 1916 it is recorded, 23 inches of rain fell in 24 hours at Alta Vista Pass, North Carolina.

The average daily discharge of the river at the Bluestone Dam site is 6,000 second feet, the minimum recorded is 600 second feet and the maximum of 280,000 second feet occurred in 1901. The flood of 1878, which is recorded as the greatest flood on record discharged 276,000 second feet, but did more damage because the Greenbrier River was in flood stage at the same time. Historians state that the old Summers County Court House was located in the center of that part of Hinton now known as Bellepoint, and that water not only washed the Court House away, destroying all of the records but swept the entire valley of all buildings, principally farm houses and buildings. The Greenbrier River is over 100 miles in length. It originates in the northern part of the state, hence it is remote that both rivers should be in flood stage at the same time. For the purpose of design the Army Engineers estimated that the New River under the most severe rainfall conditions could produce a 24 hour run off amounting to 36,000 second feet, with a peak discharge of over 400,000 second feet. Computations made by private as well as governmental agencies indicate that the Bluestone Dam built to its entire height would hold back approximately 15 feet of water in the Kanawha River Valley below, during a flood of major proportions.

The lower 25 miles of the Bluestone Dam reservoir is unusually free of utilities and natural growth. There are no railroads or well improved highways, a comparatively small amount of agricultural land, no minerals or natural resources, and very little usable timber. In the upper end of the reservoir, 2 first class railroads, a steam power plant, a few bridges and towns are located at low elevations in the valley. The elevation of these improvements of 1520 is the controlling height to which the dam can be built, without considerable expense of relocation. The reservoir when filled to its crest will extend from Hinton, West Virginia, to Narrows, Virginia, a distance of about 36 miles. On the left bank the reservoir will extend up the Bluestone River a distance of 7 miles and on the right bank,

> Indian Creek will be inundated for a distance of 5 miles. Back water in other tributaries will be negligible. Considering its length the average width of the reservoir is small. The depth of the water at the dam will be 150 feet and the surface area at full pool will cover 9 thousand acres.
>
> The Army Engineers made extensive investigation of the dam foundation by core drilling 74 holes varying from 2 to 30 inches in diameter. The 30-inch holes were drilled to permit geologists to descend and obtain a true picture of the sandstone shale formation. One 30-inch hole in the right bank went to a depth of 60 feet below the rock surface.
>
> The dam will rest on hard, fine-grained sandstone from 60 to 90 feet thick and will tie into beds of shale, sandstone and impure beds of limestone at the abutments. The engineers and geologists are satisfied with the tests which indicate that the Bluestone Dam site is satisfactory for a high lift concrete gravity dam.
>
> In order to attempt to make the dam more attractive to electrical power consumers, a hydro-electric installation is provided. The engineers estimate that the dam when operated as a combined power and flood control project will eliminate approximately 82% of the flood damage on the New River and the Great Kanawha River below the dam. It will have additional benefit by storing a portion of its surplus run-off for purging the New River and Great Kanawha River, during summer periods of low water as well as helping to maintain the pool in the Ohio River. It will also provide for a steady flow of water to the 175,000 H.P. hydro-electric plant at Hawk's Nest, which suffered during the drought of the Summers, Fall, and Winter of 1934. The reservoir can also be deemed beneficial as a rest haven for migratory water fowl.[67]

As indicated above, Corps survey work at the Bluestone site during 1935-1936 included a large amount of core drilling to investigate the suitability of the area's bedrock for supporting a concrete gravity dam. Back at the Huntington District Office, reports on the hydroelectric potential of the site and the flood control needs of the area were being assembled. The Huntington District issued a definite project report on Bluestone on December 1, 1936, and adopted plans to construct a concrete gravity dam rising to a height of 165 feet above the streambed. This proposed dam was planned at that time to impound a minimum of 623,000 acre-feet of water. The height of the dam was limited by the need to avoid flooding a steam generating plant, a major highway, and a number of bridges in the upper portion of the reservoir area.[68] Most of the primary construction drawings for the dam are dated December 1936, and may have been completed at that time in connection with the December 1 issuance of the definite project report for Bluestone.

Some adjustments in the location of the dam were made based on the Huntington District's geological investigations. Core samples at the original proposed location of the axis of the dam revealed heavily weathered sandstone in areas close to the proposed location of the dam. This defect was serious enough that the proposed location for the axis of the dam was subsequently shifted 200 feet downstream. This shifted location would serve as the final site of the dam once construction started. Some core samples from the area were also subjected to laboratory analysis to determine the strength of the foundation stone. Although the site was ultimately deemed a suitable location for a high concrete dam, a large inflow of water occurred during drill testing of rock in the area proposed for the intake area of the dam. It was recommended that additional drill testing be completed in this area during construction.[69] In terms of geology, it was found that the area was composed of interstratified layers of shale and sandstone. Because of geological disturbances, it was determined that much of the rock in the area had vertical fissures and other gaps and crevices.[70]

Court Struggle 1935-1940

Even before the Huntington District began its planning and geological studies for Bluestone Dam in 1935-1936, two conflicting views had developed around the future of the New River in Summers County, West Virginia. In the early 1930s, the Appalachian Power Company was promoting plans through its subsidiaries, the West Virginia Power Company and the Virginia Power Company, to build two hydroelectric dams near what is now the Bluestone Dam site. The company also wished to build a third dam on the New River near Radford, Virginia.[71] In contrast, Congressman John Kee of Bluefield, West Virginia, had been leading a campaign in the early 1930s to promote construction of a multi-purpose federal dam at the Bluestone site that would generate hydroelectric power and serve as a flood control facility.[72] After years of litigation, the United States Supreme Court finally resolved this growing conflict in a decision that reaffirmed federal jurisdiction over the nation's waterways and river commerce, including navigation, hydropower development and flood control.

From the beginning of serious efforts to build the Bluestone Dam, a complex legal dispute arose over the definition of a stream's navigability and the extent of federal power to regulate dam construction on a given waterway. The Appalachian Power Company's position was that the New River was not a navigable waterway and therefore did not fall within the jurisdiction of the Federal Power Commission (FPC) as outlined in the commerce clause of the United States Constitution. Federal authorities disagreed, and in 1932 the Huntington District U.S. Army Corps of Engineers submitted a report to Congress in which Bluestone Dam was one of four large reservoirs recommended for flood control and power development in the Kanawha Valley.[73]

The dispute over the New River's navigability was rooted in earlier federal legislation. The River and Harbors Act of 1899 forbid the construction of any dam on navigable waters without the consent of the U.S. Congress. This legislation had the effect of tying federal regulation of rivers and streams to the issue of navigability. Then, in 1920, Congress enacted the Federal Water Power Act, which authorized the Federal Power Commission to license the construction of hydroelectric dams. The act stated that parties who wished to build a dam in a non-navigable stream needed to file a declaration of intent with the Federal Power Commission. The commission would investigate the project and determine whether or not it affected interstate or foreign commerce interests. If the commission determined that the dam would affect these interests, the party would have to obtain a federal license before construction could move forward. If the commission determined that these interests would be unaffected, permission would be granted to proceed with the project without a federal license.[74]

On June 25, 1925, the New River Development Company (an affiliate of American Gas and Electric, the parent company of Appalachian Power) filed a declaration with the Federal Power Commission to build a hydroelectric dam at Radford, Virginia. The commission asked that the Chief of Engineers of the U.S. Army Corps of Engineers submit a report on the project and its potential impact. This report stated that the New River was navigable, and that the dam at Radford, if not properly operated, could adversely affect navigation on the Kanawha River. The report recommended issuing a license for the project, as long as control was maintained by the United States. After the commission requested a second review of the project, the Chief of Engineers issued a second report concluding that the New River was not navigable in its present condition, and that the proposed power dam project would not adversely affect navigation on the Kanawha. After a number of hearings and meetings on the subject, the Federal Power Commission ruled that the New River was not "navigable" as this term was defined in the Federal Water Power Act, but that the project would affect the interests of interstate and foreign commerce. The commission tendered a license to the Appalachian Power Company in July 1927, but in April 1928, the company refused the license, stating that a number of conditions in the license were unrelated to navigation interests.[75]

In February 1930, the Appalachian Power Company stated that its Radford project was not within the jurisdiction of the Federal Power Commission, but also offered to accept a "minor part" license from the commission that would only regulate issues that would affect federal navigation interests. On December 22, 1930, the commission began functioning under new laws that gave it additional independence. In April 1931, the commission rejected the "minor part" license concept. In response, the Appalachian Power Company took legal action against the commission to restrain interference in the

use of the company's property, but the case was eventually dismissed. While this case was pending, the Federal Power Commission adopted a resolution stating that the New River was navigable from its mouth to Wilson Creek in Virginia.[76] The Appalachian Power Company had therefore already taken legal action at the beginning of the 1930s to avoid federal regulation of its proposed hydroelectric dam construction projects on the New River, and the navigability of the river was being debated as part of this conflict.

A number of events in the mid-1930s escalated the level of legal conflict over dam construction rights on the New River. Around June 1, 1934, the Appalachian Power Company began construction on a dam at Radford, Virginia. Federal authorities filed for an injunction against this dam's construction on May 6, 1935, arguing that the building of a dam on that site was permissible only under license from the Federal Power Commission (FPC). The government's attorneys argued further that the New River was navigable, that the power company's proposed dam would obstruct navigation and adversely affect commerce, and that Appalachian Power was in violation of the Rivers and Harbors Act and the Federal Water Power Act.[77] A ruling in federal district court found in favor of Appalachian Power, stating that the river was non-navigable and therefore not subject to the FPC's jurisdiction, that the company's dam would not impair the navigable capacity of the Kanawha or its tributaries, that the FPC's findings were subject to judicial review, and that the Commission's effort to impose licensing restrictions on the power company was unlawful.[78]

Meanwhile, the U.S. Army Corps of Engineers had been advocating construction of a federal hydroelectric and flood control dam at the Bluestone site. Executive and legislative measures promoted the federal position that the United States government exercised ultimate jurisdiction over the Bluestone project. The Roosevelt administration announced that the Bluestone Dam and Reservoir would provide flood control, hydroelectric benefits and a more even flow of water on the Kanawha River. According to the administration, this would improve navigation on the Kanawha, control flooding on the New, Kanawha and Ohio Rivers, and reduce pollution for downstream cities and towns. The sale of hydroelectric power generated by the dam would then offset the project's construction costs. On September 12, 1935, Roosevelt ordered the Secretary of War to proceed with the construction of a federal dam at the Bluestone site, using funds from emergency relief appropriations.[79] In addition to presidential authorization, Congress included appropriations for the Bluestone project in the Flood Control Acts of 1936 and 1938.[80] In 1936, the Huntington District set up a field office at Hinton, West Virginia, and began surveying conditions at the Bluestone site. Two Civilian Conservation Corps camps were also established in the area to provide labor for clearing the dam site of trees and other debris.[81] Construction on the new federal dam seemed to be under way.

The Appalachian Power Company quickly affirmed its opposition to the government's construction plans and insisted that the New River was not a navigable waterway. The West Virginia Power Company, a subsidiary of Appalachian Power, obtained its first injunction in 1936 to prevent the construction of a dam and reservoir by federal authorities. Specifically, when the government sought to condemn land for the dam in April 1936, the West Virginia Power Company obtained an injunction from the Southern West Virginia District Court forbidding the act of condemnation on grounds of unconstitutional delegation of powers.[82] Federal Judge George W. McClintic was responsible for the ruling against the government. The government then appealed the district court's decision to Federal Circuit Court. In September 1937, the circuit court ruled that the Flood Control Act of 1936 made the issue of the legality of federal construction of Bluestone Dam irrelevant. However, the West Virginia Power Company soon filed a suit challenging the circuit court's ruling.[83]

Meanwhile, in response to challenges to the government's authority to oversee and regulate dam construction over a United States waterway, the U.S. Army Corps of Engineers had been collecting evidence to demonstrate the navigability of the New River. This evidence included historical data showing that the river had been navigable since pioneer days, and a demonstration that the river had the potential to be developed into a waterway suitable for commercial navigation. The overall goal of federal efforts was to demonstrate that the 111-mile stretch of the New River from Allisonia, Virginia to Hinton, West Virginia, could be used for transportation and commerce.[84]

The Huntington District found extensive evidence that the New River had been used for transportation during the nineteenth century. The Corps documented that in 1812 Chief Justice John Marshall led a delegation down the New River to determine possible navigation improvements that would enable the New River to support steamboat traffic. In 1819 the Virginia Assembly commissioned a survey of the river that included a 55-mile upstream voyage from the mouth of the Greenbrier to the mouth of Sinking Creek. A surviving Civil War veteran volunteered his recollections that the Confederate Army used the New River to transport supplies, and in 1861 the General Assembly of Confederate Virginia appropriated $30,000 to improve river transport. An 1872 report by the Corps documented a mile-by-mile survey of the New River from above Allisonia to the mouth of the Greenbrier River, a study that was the basis for federal improvement plans of the 1880s. The Huntington District also produced records from the 1880s documenting that steamboats and keelboats had traveled on the New River at that time. Annual reports by the Chief of Engineers during the 1870s and 1880s supported the Corps' position that the New River was a navigable waterway. Improvements executed from 1877 to 1883, before the dominance of the railroad, opened the river to transportation by the iron and timber industries and decreased the isolation of some mountain communities by linking them to keelboat or steamboat lines.[85]

In a final demonstration, Patrick A. Gragnon and four other men ascended the New River in a sixteen-foot boat powered by an outboard motor. The team pushed off from Hinton, West Virginia, and landed at Allisonia, Virginia, after several days of rough travel. It was necessary to pull or push the boat for about one and one quarter miles traveling upstream, and for only a few hundred feet going downstream. The journey was undertaken in July 1936, when the river was at its normal summer low water stage. The Corps of Engineers cited this journey as evidence that the New River remained a navigable stream in 1936.[86] In 1939, the federal government made a second attempt to condemn the land needed for Bluestone Lake, but the West Virginia Power Company obtained a second injunction in federal district court to block the Corps of Engineers' construction plans. In September 1940, the case went to the United States Circuit Court of Appeals in Richmond, Virginia, where the appellate court concurred with the district court in declaring the New River non-navigable and therefore outside the FPC's jurisdiction.[87] As a result, lawyers for the two sides in the dispute argued *United States vs. Appalachian Power Company* before the United States Supreme Court on October 14 and 15, 1940.[88] While the evidence introduced was the same as in the previous two cases, the high court arrived at a different interpretation of the physical characteristics of the New River. The Supreme Court's majority decision referred to the "conventional rule that factual findings concurred in by two courts will be accepted by the Court unless clear error is shown."[89]

Nevertheless, a majority of the justices departed from this guideline on the grounds that standards of navigability were not absolute formulas always applicable to every waterway at all times, but that each case had to be considered in light of relevant public and private interests.[90] The court also emphasized that the actual condition of a waterway was not the only criterion by which its navigability should be judged, but that the potential for developing the river into a viable transportation route had to be taken into account: "To appraise the evidence of navigability on the natural condition only of the waterway is erroneous. Its availability for navigation must also be considered." The need to construct navigational aids to render a river feasible for transportation did not prevent a stream from being defined as navigable, and once rendered navigable, "a waterway remains so." The court went on to say that, "Nor is it necessary that the improvements should be actually completed or even authorized. The Power of Congress over commerce is not to be hampered because of the necessity for reasonable improvements to make an interstate waterway available for traffic. . . . It is merely that improvements make applicable to certain waterways the existing power over commerce."[91]

The high court therefore supported the idea of the federal government's eminent authority over the` nation's rivers, whether or not those streams were currently developed to their fullest potential. As for the lapse in the New River's development during the later nineteenth and twentieth centuries, the Court responded, "Even absence of use over long periods of years, because of changed conditions, the coming of the railroad or improved highways does not affect the navigability of rivers in the constitutional sense."[92] The

decision recognized the documentation offered by the U.S. Army Corps of Engineers regarding the river's development during the 1870s and 1880s as evidence of the waterway's navigability.[93] The Court also cited legal precedents affirming governmental sovereignty in cases involving authority over navigable waterways and the resolution of disputes over resources around or within those rivers.[94]

The ramifications of this important case extended far beyond the bounds of the New River projects, including Bluestone Dam, that were affected by the ruling. The court's decision prioritized federal control over the nation's waterways and over the actual or potential commerce exercised on those rivers. The ruling also confirmed the federal right of eminent domain in acquiring and developing the land necessary to support the transportation network and hydroelectric potential of the nation's waterways, and it established the federal government's central authority in decisions affecting flood control measures.

The case also had implications in the perennial issue of states' rights. Forty-one state governments including West Virginia, Virginia, and Kentucky, filed amicus briefs in the Supreme Court case supporting Appalachian Power's contention that the New River was not navigable and not under federal jurisdiction. The individual states maintained that regulation of rivers like the New that were not currently capable of supporting commercial navigation should be regulated by the states, and not be federal authorities. The Supreme Court decision meant that states no longer had primary authority to regulate rivers like the New, but would have to submit to federal oversight of these rivers.[95]

On December 16, 1940, the Supreme Court overturned the decision of the two lower federal courts and found that the New River remained a navigable waterway.[96] This decision supported the constitutionality of the federal government's construction of the Bluestone Dam and Reservoir and cleared the way for the Corps' acquisition of the construction site. On November 10, 1941, the Supreme Court refused the Appalachian Power Company's request for a rehearing of the case.

Appalachian Power lost the Supreme Court case and was barred from building a hydroelectric dam at Bluestone. However, the case did not stop the company from proceeding with plans for a hydroelectric dam on the New River at Radford, Virginia. In 1937, Appalachian Power began construction of Claytor Dam near Radford, and the dam's hydroelectric plant began operation on August 1, 1939. The Federal Power Commission did not grant a license for Claytor Dam until 1943, but the license was made retroactive to July 1, 1931. American Electric Power renewed the fifty-year license in 1981 and currently owns and operates Claytor Dam.[97]

Design of the Dam

Twentieth-Century Concrete Dam Types

Engineers of the Huntington District U.S. Army Corps of Engineers designed Bluestone Dam. The 1949 Final Report for the dam states that the dam was designed by the Engineering Division of the Huntington District under the direction of the Huntington District Engineer, assisted by a "board of eminent consultants."[98] The Chief of Engineers, U.S. Army, approved the design of the dam. The final report also states that the preliminary design and cost studies for the dam considered a number of design alternatives. All of the alternatives for the dam's construction were also concrete masonry dam types, including the multiple arch, massive buttress, and round-head buttress dam types. The report also states: "the selection of the straight gravity type dam was concurred in by all concerned with the design of the project, including all members of the Board of Consultants."[99]

Dams are generally divided into two major categories. The first type is the gravity dam, which resists water pressure by its sheer mass. Gravity dams are designed so that the buildup of earth, rock, concrete, or masonry is great enough that water stored behind the dam cannot push it downstream.[100] In contrast, the second major category of dams, the structural dam, contains much less material than a gravity dam of comparable size. Structural dams rely on their shape to provide stability, not on sheer bulk or mass. The major types of structural dams used in the United States are the arch dam, which is composed of a thin curved arch, and the buttress dam, which consists of a series of buttresses supporting a concrete membrane.[101] In the 1938 publication "The Design of Dams," the authors state that the various forms of buttress dams required less concrete than solid-gravity dams, could often be completed in less time, and were sometimes less expensive.[102] The authors describe solid gravity dams as the most prevalent type of concrete dam, except in cases where narrow canyon widths made an arch dam more practical.[103] Arch and buttress dams could be built using less concrete than a gravity dam, but arch dams were only suitable for locations where the dam spanned a narrow canyon with high walls, since the curve of an arch dam allows the pressure of the impounded water to be deflected toward the canyon walls.[104] A number of gravity dams are curved, such as Hoover Dam, but these examples are nonetheless gravity dams and not true arch dams, because their stability is based on bulk and mass rather than on their curved form.[105]

Buttress dams are similar to gravity dams in the way they function, but a buttress dam takes advantage of the vertical pressure of water on its upstream face to help stabilize the dam. Because of this design feature, a buttress dam can be built with a series of buttresses spaced between 15 to 70 feet apart as the main supports. The large amount of empty

space between the buttresses allows the construction of this type of dam with far less concrete than a gravity dam of similar size.[106] One problem with buttress dams was that the construction of concrete forms to build the multiple buttresses required a large amount of skilled carpentry work. While buttress dams used less concrete, they were nevertheless often more labor intensive to build. In general, buttress dams have most commonly been built in times when labor was cheap and materials such as concrete more expensive. In contrast, when labor costs are higher and concrete less expensive, the construction of concrete gravity dams becomes more economically feasible than building concrete buttress dams.

Buttress dams appear to have been built commonly in the 1920s, often by private water or power companies. Examples of buttress dams exist in Ohio near Youngstown (Girard Dam, 1917), and Toledo (Defiance Power Dam, 1913). In contrast, the numerous flood control dams built by the Pittsburgh District U.S. Army Corps of Engineers in western Pennsylvania and northern West Virginia during the 1930s and early 1940s were always massive gravity dams. A significant number of these dams were built of earth and rock fill, but many were examples of concrete gravity construction similar to Bluestone Dam.

Concrete Gravity Dams in West Virginia and the New River Valley

A number of concrete gravity dams were built in West Virginia and in adjacent portions of the New River Valley located in Virginia. Bluestone Dam and Hawk's Nest Dam are two major concrete gravity dams on the New River in West Virginia. West Virginia also possesses a number of concrete gravity dams on other rivers.

The first major concrete gravity flood control dam built by the Pittsburgh District U.S. Army Corps of Engineers was Tygart Dam, located near Grafton in Taylor County, West Virginia, northwest of Summers County. Tygart Dam has a maximum height of 234 feet above streambed, is 207 feet wide at its base, and is 1,921 feet long. The outlet works of the dam include ten sluices through the dam. Eight of the sluices are rectangular and are controlled via slide gates. The two additional sluices are each controlled by a 54" ring jet valve, backed up by an emergency slide gate.[107]

Construction on Tygart Dam began in 1934 and was completed in 1938. Tygart Dam was therefore under construction when preliminary drawings for Bluestone Dam were being drawn up in 1936.[108] After building earth and rock fill gravity dams at Tionesta and Crooked Creeks from 1938-1940, the Pittsburgh District returned to concrete gravity structures with Mahoning Creek Dam, constructed from 1939-1941. The Pittsburgh District also built a combined concrete and earth fill dam at Loyalhanna Creek from 1939-1942.[109] Berlin Dam, built by the Pittsburgh District between 1941 and 1943, was also a combination earth and concrete structure and featured a small four-bay section of crest gates similar in overall design to the crest gate section of Bluestone Dam.[110]

There are a number of differences between the dams at Bluestone and Tygart. One of the more significant differences is that Tygart Dam does not possess a set of crest gates, unlike Bluestone Dam. In place of crest gates, Tygart Dam has a 489-foot long uncontrolled gravity ogee spillway in the center of the dam. Tygart was constructed as a flood control facility and to augment water flow on the Monongahela River navigation system. The dam was not designed for hydroelectric power production, which probably explains the lack of crest gates. In contrast, Bluestone Dam was originally planned as a hydroelectric and flood control dam, and although a hydroelectric plant was never built, the dam is equipped with features such as penstocks and crest gates that would allow the dam to be fairly easily adapted to hydroelectric use. However, a number of design features developed for the Tygart Dam spillway and outlet works were adapted for use at Bluestone. While the dams are very different in many ways, the experiences of the Pittsburgh District in designing and constructing Tygart Dam appear to have influenced the Huntington District's design for Bluestone Dam.

While Tygart Dam was not equipped to provide hydroelectric power, two privately owned dams built on the New River in the 1930s were equipped to provide electric power. Hawk's Nest Dam, a concrete, 948-foot long gravity dam, was completed in 1936 on the New River about 30 miles east of Charleston. Hawk's Nest Dam is located approximately eight miles above the mouth of the New River and just below the mouth of Mill Creek. The dam is 60 feet in height and has a maximum storage capacity of 7323 acre-feet of water, compared to Bluestone's maximum capacity of 631,000 acre-feet. The dam diverts the waters of the New River through a four-mile tunnel that drops 165 feet to a hydroelectric generating plant. In 1976, Hawk's Nest Dam was owned by Union Carbide Company and was providing electricity to power a ferroalloy plant owned by Union Carbide in Fayette County, West Virginia.[111] The dam and hydroelectric plant are still privately owned and continue to provide electric power used by the metals industry.

While the Appalachian Power Company was unable to build its version of Bluestone Dam, it did complete Claytor Dam on the New River at Claytor Lake, near the town of Radford in Pulaski County, Virginia. Construction began on Claytor Dam in 1937 and was completed in 1939, at a total cost of about $11,000,000. The dam and lake were named after William Graham Claytor, who was Vice President and Director of the Appalachian Power Company. The general contractor for Claytor Dam was Rinehart and Dennis Company, and it was reported that approximately 230,000 cubic yards of concrete were used in construction of the dam. This dam is a concrete gravity structure 130 feet high, 1150 feet long, and 108 feet thick at its base. The dam features a hydroelectric plant that can generate 76,000 kilowatts of electricity. Like the plant envisioned for Bluestone Dam, the Claytor Dam hydroelectric plant is powered by lake waters traveling through a series of penstocks. The spillway section of the dam is somewhat similar in design to that at Bluestone, and it features a tall concrete ogee weir surmounted by nine steel crest gates measuring 50 feet by 28 feet. The dam produces hydroelectric power and

is owned today by Appalachian Power's successor company, American Electric Power (AEP). Claytor was the largest AEP hydroelectric facility until the construction of Smith Mountain Dam in 1965. Claytor Lake extends about 21 miles up the New River and is one of the largest lakes in Virginia. The lake can store about 232,000 acre feet of water.[112] While comparable in design to Bluestone, Claytor Lake Dam is lower in height, and is only about half as long as Bluestone Dam. It is unclear if Hawk's Nest and Claytor Dams had any influence on the Huntington District's design for Bluestone Dam.

Although it does not make any mention of the influence of Claytor, Hawk's Nest, or Tygart dams on the design of Bluestone Dam, a digest of design decisions concerning Bluestone Dam from October 1936 reveals interesting information about the design process. For example, this document indicated that a sketch by Dr. Paul Cret (1876-1945) was the basis for the dam's overall design. Cret was a successful French architect who became a United States citizen in 1927. Cret was educated at the École des Beaux Arts in Paris, which was widely recognized as Europe's leading architectural academy at that time. The University of Pennsylvania appointed Cret as an architecture critic in 1903, after which Cret remained closely associated with the United States and the City of Philadelphia. Cret served in the French army during World War I but otherwise spent most of his time in the United States. During the 1930s, Cret designed a significant number of federal facilities, most notably the 1932 Federal Reserve Bank building in Washington D.C. Cret worked as architect for many engineering projects, most notably the Benjamin Franklin Suspension Bridge in Philadelphia.[113] The federal government retained Cret as an advisor and to design aesthetic components of dams and lockkeeper houses in the 1930s. Correspondence links Cret to the Pittsburgh District's Tygart Dam (1934-1938). Lists of Cret's major accomplishments also include involvement in the design of Montgomery Locks and Dam, a navigation structure on the Ohio River, and Bonneville Dam in Oregon for the U.S. Army Corps of Engineers.[114] Cret was largely responsible for the streamlined Art Deco lines of Bluestone Dam as it was constructed. Documentation indicates that Cret personally introduced his elevation sketch of Bluestone Dam at a Board of Consultants meeting in 1936. [115]

Another interesting item mentioned in this report was the use of hydraulic models to guide the design of various parts of the dam, including the overflow section, crest gates, sluice gates, and stilling basins. Use of modeling was mandated by a decision of the Huntington District Engineer on November 6, 1935.[116] The modeling was performed at the Hydraulic Laboratory of the Carnegie Institute of Technology in Pittsburgh under the direction of the Huntington District Engineer. The general design of these features and other parts of the dam were worked out in the design room of the Huntington District, but in many cases, multiple design schemes were produced for a particular detail or feature. Construction of a scale model of the dam allowed the laboratory to test and measure the effects of water on various parts of the dam. Modeling was used to determine the shape

of a number of concrete components, including the spillway section, the spillway gate piers, and training walls. Modeling also helped determine the design of the dam's rectangular sluices, needle valve sluice outlets, and protection methods for counteracting erosion of the toe of the dam, the power house tail race, and the left bank of the New River below the stilling weir.[117]

One important problem addressed in the modeling studies was how to slow the speed of high-velocity jets of water issuing from the dam's sluice gates. This question was first addressed via modeling at Tygart Dam, which could, at full reservoir levels, release up to 500,000 horsepower of destructive energy from its sluice gates. If not slowed, this energy could cause destructive erosion below the dam. After hydraulic model studies, the solution chosen at Tygart was to install a concrete "cushion pool" or stilling basin below the dam by building a small concrete auxiliary dam 250 feet downstream from the base of the main dam. Concrete deflectors were also installed at the sluice openings to further dissipate the jets of water as they made contact with the stilling basin surface. The solution reached at Tygart was used at Bluestone, with only minor modifications.[118] Additional model studies for Bluestone Dam were completed in 1946 at the U.S. Army Corps of Engineers Waterways Experiment Station at Vicksburg, Mississippi.[119]

The Huntington District originally intended to construct a dam that would perform both flood control and hydroelectric functions. During the planning process, a number of design options were considered according to their ability to facilitate hydroelectric power production. In August 1936, three alternatives were considered. The first possibility specified the construction of the dam as a flood control project only. In this option, the crest gates would be omitted, and the design of the hydroelectric powerhouse would be deferred to a later date. Plans being drawn up for the dam in August 1936 were based on the second design option, which called for crest gates but made provisions for building the hydroelectric powerhouse at a later date. The third possibility was to build the dam as a combined flood control and hydroelectric facility by completing the crest gates and powerhouse in the initial construction campaign.[120] As construction began in 1941, option three was favored because of the need for hydroelectric power at that time. When construction resumed in 1946, however, option two seems to have become the preferred plan. The powerhouse structure was not constructed, although the penstocks needed for hydroelectric power were installed. The crest gates were also not installed during the 1946-1949 construction campaign, but instead were added during a separate construction effort in 1952.

Water can flow through Bluestone Dam via sluice gates or crest gates. A series of sixteen tunnels allow water through the dam, and hydraulically operated sluice gates control the flow by opening and closing the tunnels. In a meeting on January 21-22, 1936, the Board of Consultants discussed the types of sluice gates that might be used in the dam. W. H.

McAlpine was the only board member opposed to the use of butterfly gates instead of vertical lift gates. The ensuing discussion led to an official decision that Broome gates would be favored over butterfly gates, although it was recognized that the Broome gates would be expensive because each gate would need an individual operating hoist. Hydraulic cylinder-operated gates were also advocated as a cheaper alternative.[121]

In May 1936, the Board of Consultants decided to install either Broome or fixed roller gates on the dam. The decision between Broome and fixed roller gates was to be determined based on which type could be installed at the lowest cost.[122] In *Design of Dams*, Hanna and Kennedy indicate that Broome gates are a type of roller gate. Hanna and Kennedy also state that these gates use rollers to overcome the problem of friction that is often encountered in the use of slide gates. Hanna and Kennedy list three major types of roller gates: Stoney, Sirnit, and Broome, and give this description of Broome gates:

> In the Broome type, the roller train travels in the same manner as the traction tread of the caterpillar tractor. The rollers bear on a track on the gate and a track on the frame. The frame seat is inclined toward the gate near the bottom, and the gate being thus inclined is forced to seat by gravity and vertical water pressure, and the rollers are relieved of the load. The roller type of gate is usually used for heads under about 70 ft., but they are applicable to wider spans than slide gates on account of their lesser frictional resistance to motion.[123]

In the end, hydraulically powered sluice gates were installed. It is unclear when the initial decision to install Broome gates was overturned, but hydraulically operated sluice gates are referred to in the 1941 specifications for Bluestone Dam. However, the installation diagram drawings for these sluice gates were not delineated until 1946. Hanna and Kennedy refer to sluice gates as “slide gates” and state:

> Slide gates are used for controlling the flow over spillways where the quantity of water to be handled is relatively small and the range of fluctuation is about 10 ft. or less. They are also used for relatively small discharges through outlets under heads up to about 120 ft. These gates are usually made of cast iron or cast steel in one piece or rolled-steel plates and sections. The frames of the cast gates are made of the same materials as the gate leaves, and the leaves are reinforced with horizontal and vertical ribs. The gates are operated with hoists.[124]

The Bluestone sluice gates are operated via hydraulic machinery. Each of the sixteen sluices actually has two gates, a service gate and an emergency gate that can be operated in case there is a problem with the service gate. The gate machinery is located in an

operating gallery located just above the sluices. A hydraulically powered hoist moves the sluice gate up and down to increase or decrease water flow through the sluice.

The dam also contains a set of 21 crest gates for releasing water from the lake during high water conditions. The crest gates are positioned at the top of the dam, where they allow excess water to flow out of the reservoir in extreme high water conditions. The Board of Consultants had to decide if each of the 21 crest gates was to have its own operating system to lift and lower the gate, or if the gantry crane that was to be mounted on top of the dam could be used to raise and lower these gates. A decision was made to have an individual operation system for each gate, rather than using the gantry crane. The cost of installing an individual operating mechanism for each gate was estimated to be about $100,000, and the Board recognized that this machinery would increase maintenance costs for the dam. However, it decided that this cost was justified since the individual operating machinery would allow more uniform raising of the gates. There was also concern that the gantry crane might at some point be needed to lift the crest gates and perform other functions at the same time if the individual crest gates' machinery was not installed.[125]

SECTION 4: HISTORY OF BLUESTONE DAM: CONSTRUCTION

Construction of the Dam 1941-1952

Contract Award, 1941

On November 10, 1941, the United States Supreme Court refused to revisit its decision that the Hinton to Allisonia section of the New River was navigable and therefore under federal jurisdiction. This decision cleared the last obstacles for federal construction of Bluestone Dam, and the Huntington District immediately mobilized its resources to get construction under way as soon as possible. The day after the court decision was announced, the U.S. Army Corps of Engineers announced that it would immediately advertise for bids on the project. The Corps was hoping that bids could be opened on December 15, even though the contractor probably could not begin work until January 1, 1942.[126] Meanwhile, Corps legal representatives filed a new motion for the government to take possession of lands needed for Bluestone Dam and Lake.[127]

The Huntington District soon appointed personnel to oversee construction of the dam. Robert B. Jenkinson of the Huntington District was named resident engineer for the Bluestone project. Jenkinson, a native of Greenville, Ohio, graduated from Wayne Technical College in 1924 and joined the U.S. Army Corps of Engineers in 1931. He was involved in the construction of the Huntington District's Winfield, London, and Marmet Locks and Dams on the Kanawha River, and Gallipolis Locks and Dam (now Robert C.

Byrd Locks and Dam) on the Ohio River in the 1930s. Jenkinson and four other officials paid a visit to Hinton to study the construction site and to select a location for the office building that would house the Corps' engineering staff during construction of the dam. Construction began on this two-story wood-frame building on November 28, 1941.[128]

Representatives of companies bidding on the Bluestone Dam construction contract visited the site on December 2, 1941. Visiting the site were representatives of the Dravo Corporation of Pittsburgh, the United Construction Company and Porter-DeWitt Construction Company of Minnesota, the Seaboard Construction Company of Kiski, New York, and the Morrison Knudsen Company of Boise, Idaho. These representatives visited the construction site and investigated the availability of construction materials in the area.[129]

The U.S. Army Corps of Engineers announced in early December 1941 that bids for construction of Bluestone Dam would be opened on December 16, but the opening was delayed to allow contractors more time to evaluate wage scales set for the project by the U.S. Department of Labor.[130] Bids for the construction of the dam were opened on December 23, 1941. The following contractors submitted offers: Seaboard Construction Company of Mt. Kisco, New York, Dravo Corporation of Pittsburgh, and a joint venture by B. Perini and Sons, Inc. – Rugo Construction Company of Framingham, Massachusetts. The high bidder was Perini and Sons at $11,722,750.00. Dravo was in the middle at $11,376,080.00, and Seaboard Construction was the low bidder at $10,195,575.00. The government estimated project cost was $9,749,826.00.[131] Major F. H. Faulkner, Huntington District engineer, announced that construction on Bluestone Dam would begin in early 1942, once the Corps completed procedures necessary to formally award the construction contract to the low bidder. These procedures included investigation of the company that submitted the low bid, and approval of the contract by the U.S. Engineer's Office in Cincinnati. The overall estimate for all aspects of the project (including both the contractor's portion and direct government expenses) was about $14,000,000, but with the installation of hydroelectric generation facilities, the estimate came to about $22,000,000.[132]

Seaboard was low bidder by slightly over one million dollars but, since that company could not obtain performance bond, the contract went to the Dravo Corporation on January 12, 1942, on a bid of $11,376,000.00. Dravo actually began construction operations on January 19. Contract No. W-516-eng-1818, as awarded to the Dravo Corporation, called for them to do all work in connection with the construction of the actual structure of Bluestone Dam. Certain appurtenant items of work, such as drilling and grouting the deep curtain wall, clearing the reservoir area, removing cemeteries, and furnishing and erecting certain electrical and mechanical items, were exempted from this contract and awarded to specialists in such work under separate prime contracts. The

original contract called for completion of all work in 900 calendar days after reception of the notice to proceed, or by July 4, 1944.[133]

First Construction Phase and Subsequent Termination of Construction, 1942-1945

Work on the dam proceeded during the early years of World War II, in an effort to secure the hydroelectric power of the project and to apply the energy toward relieving the critical shortage of electric power. The work was originally given a priority rating of A-2 by the War Production Board, but as war industries increasingly and urgently needed materials and supplies, this rating soon dropped to A-6, with the A-2 remaining only for emergency items. A few months later, when the need for electric power reached crisis levels, the priority rating was moved up, and the contractor was once more able to obtain needed materials and supplies.[134]

The Corps issued a notice to proceed for construction of Bluestone Dam on January 14, 1942. By January 19, Dravo work crews had begun preliminary excavation, had started building the construction plant, and had undertaken construction of a timber bridge over the Greenbrier River and a railroad spur to the site.[135] Earth was removed from a large portion of the construction site, allowing the drilling of 30-inch core holes to investigate the condition of the foundation rock.[136] The timber bridge under construction over the Greenbrier was supported on wooden pilings and was completed between February 8 and March 6, 1942. The first train crossed over to the construction site on April 14, 1942.[137]

The following months were spent building the construction plant and other facilities necessary for the dam's construction. The construction plant was located on the east side of the Bluestone River on a 400-foot wide section of plain (see fig. 14). The facility was laid out according to a linear plan along small-gauge railroad tracks that led to the dam site. The construction plant consisted of 29 buildings, including personnel-related facilities, a concrete mixing plant, storage buildings, and various shop structures. Highlights of the portion of the plant immediately north of the dam included a multi-story concrete mixing plant immediately adjacent to the dam site, a series of shops and locker rooms north of the concrete plant, and the contractor's office. The northern half of the plant featured U.S. Army Corps of Engineers offices, storage facilities, a sawmill, a large platform for carpentry layout and assembly, a boiler house, and a tractor and truck repair garage.[138] Most of the construction plant buildings were hastily constructed wood-frame structures. Since electrically powered cranes, vibrators, and other equipment were to be used in the dam's construction, an electrical line was run to the site, and four electrical substations were built as part of the construction plant.[139]

Fig. 14. Historic View of the Bluestone Dam Construction Plant. View was probably taken from dam during later phases of construction. (1949 Final Report)

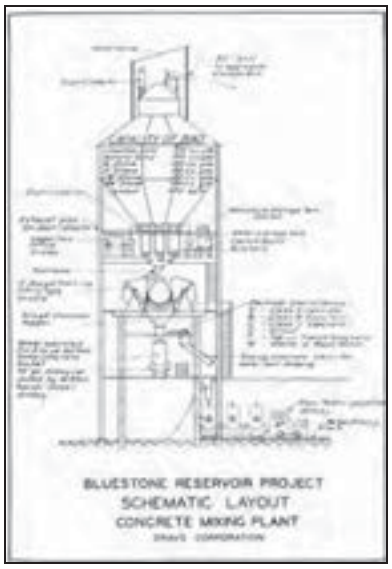

Fig. 15. Schematic Drawing of Bluestone Concrete Mixing Plant (Final Report, 1949).

One of the most important components of the construction plant was the concrete mixing facility (see figs. 15-16). The C. S. Johnson Company of Champaign, Illinois designed the concrete plant. It contained three Koehring tilting mixers turned by 40-horsepower motors. The complex also included six aggregate bins, each bin consisting of 100 cubic yards of aggregate, and one large cement bin with a capacity of 800 barrels of cement. Eight scales for weighing aggregate, cement, and water were also included.[140]

Fig. 16. Historic Photograph of the Concrete Mixing Plant at Bluestone Dam (1949 Final Report)

The plant was also equipped with a "dinkey" small-gauge railroad system for transportation of materials (see fig. 17). The system was characterized as a 42-inch gauge track system on elevated trestles that were supported on steel bents.[141] However, Dravo apparently used one diesel 42-inch gauge locomotive and two gasoline-powered 36-inch dinkey locomotives on the project, indicating that both 42-inch and 36-inch gauge track was in use.[142] Concrete was transferred from the dinkey cars to forms on the dam by whirler cranes mounted on steel trestles (see fig. 18). The trestles were, in many cases, mounted on completed portions of the dam. The locations of the whirler cranes changed as concrete pouring began on higher sections of the dam.[143]

Construction of dams in the 1930s and 1940s became easier and less expensive because of advances in construction equipment. Gasoline- and diesel-powered vehicles could now be used to move earth and rock more efficiently than the steam-powered equipment used in the past. Electric cranes replaced the derrick rigs used to lift building materials at nineteenth-century dam construction sites. Small-gauge railroads transported concrete and other materials quickly and efficiently across the construction site. Dravo Corporation appears to have taken full advantage of the equipment available in the early

1940s, and its construction plant was full of modern power equipment. However, World War II-related delays in obtaining equipment, and the spare parts and replacement components needed to keep them running, slowed the project's progress.

Fig. 17. Historic Photograph of a Dinkey, with Locomotive and Cars, Used at Bluestone Dam (Final Report, 1949).

Fig. 18. Historic Photograph of a Whirler Crane Used at Bluestone Dam (Final Report, 1949).

Fig. 19. A Row of Sheetpile Cells at Bluestone Dam. The bulk of Cofferdams 1 and 2 were made up of these steel cells filled with sand, gravel, and loam, and topped off with broken shale. (1949 Final Report)

In addition to building the construction plant, another early task in the project was the construction of cofferdams, which would divert the flow of the river and provide dry areas in which construction could begin. The river was about 100 feet wide at the dam site, with a 400-foot flood plain. The river was seldom deeper than two or three feet in the summer, but it could rise as much as ten to twelve feet during late fall, winter, and early spring. The river diversion plan for the site included construction of two large cofferdams.[144]

The first cofferdam was located on the eastern section of the dam, and it covered the easternmost 34 of the 55 concrete monoliths that made up the dam. Construction of the second cofferdam was not completed until the second construction phase of the dam in 1946.[145] Much of the first cofferdam was constructed of steel sheetpile cells filled with sand, loam, and coarse gravel, then topped off with broken shale (see fig. 19). The remainder of the cofferdam was constructed using the "Ohio River Box Type," with timber sheeting tied together with steel coffer rods.[146] The three-sided cofferdam produced a dry area on the eastern section of the river, while water was allowed to flow freely on the western half of the river. The south wall of the cofferdam consisted of 19 cells connected by intermediate cell segments, while the west wall contained 20 cells. The south wall of the cofferdam was 770 feet long, 22 feet thick, and was built to an average of 13 feet above the riverbed, using the Ohio River Box technique.[147] Construction of the cofferdam was completed using a large whirler crane mounted on a set of steel rails. This crane positioned materials and drove piling. Once construction of the cofferdam advanced into the river, it was necessary to build rock fill mounds in the river to support the crane (see fig. 20). The construction of cofferdams for river projects was usually a major operation that required large amounts of materials and many hours of labor. Approximately 93,000 linear feet of sheet piling weighing 1,430 tons were used to construct the first cofferdam at Bluestone.[148]

Fig. 20. Construction of the First Cofferdam in May 1942. Note whirler crane mounted on steel rails positioned on a pile of crushed rock. (1949 Final Report)

Fig. 21. First Cofferdam in August 1942. (1949 Final Report)

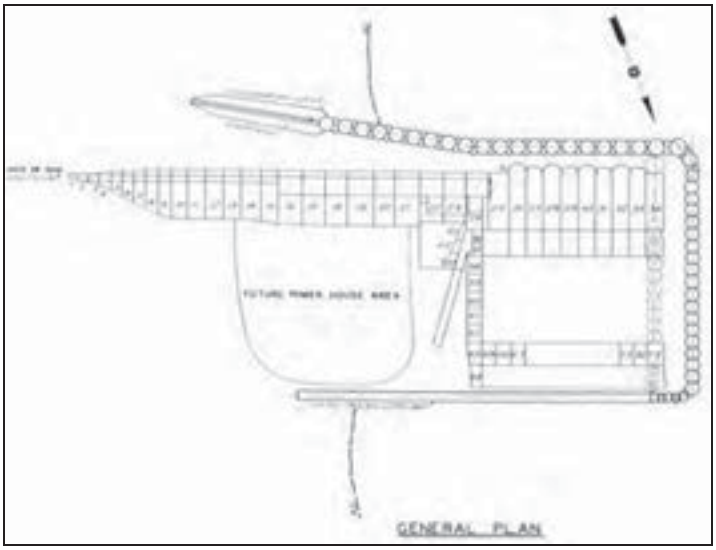

Fig. 22. Plan of First Cofferdam for Bluestone Dam (1949 Final Report). This cofferdam covered the eastern portion of the construction site, while the New River flowed through on the western half of the construction site until the second cofferdam was built.

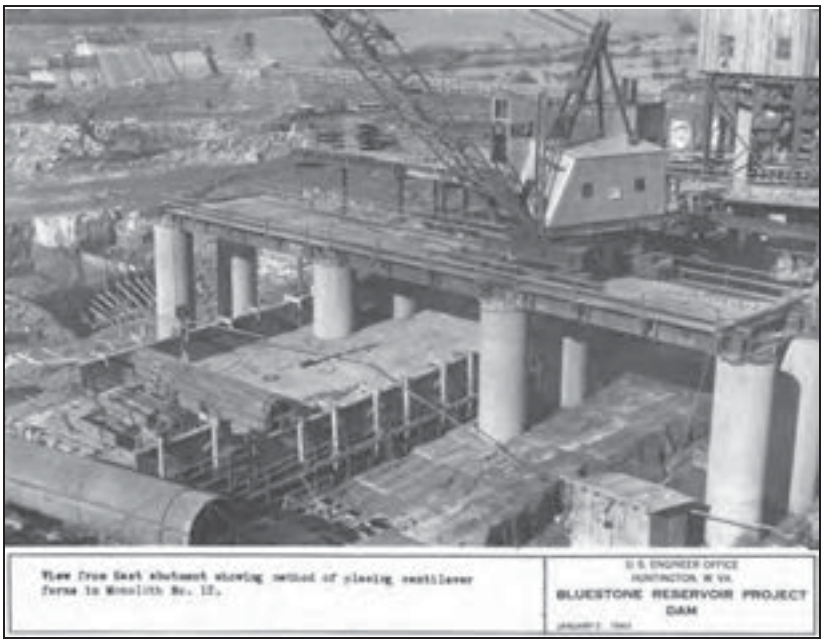

Fig. 23. Scene from the First Bluestone Dam Construction Phase, January 1943. Whirler crane is visible in foreground. (1949 Final Report)

The construction of the plant, transportation facilities, and the first cofferdam proceeded fairly smoothly. However, the project soon fell behind schedule due to unforeseen difficulties with the foundation rock. A series of test holes were drilled into the riverbed to explore the condition of the rock on top of which the dam would be positioned. The first 30" core holes were drilled in the stone on the sites of the dam's concrete monoliths (numbers 13 to 17) on March 30, 1942. This drilling continued until Corps officials ordered a 25' by 32' exploratory shaft excavated at the toe of the dam.[149] A series of problems were discovered as a result of this drilling, including a seam in the foundation rock 34 feet below surface. Concerned that the seam might facilitate water seepage, a large open pit investigation of the seam was undertaken. In the end, this open pit excavation covered an irregular area of approximately 218 feet by 100 feet, and in some places reached 40 feet below surface. A total of 16,023 cubic yards of rock were removed from this area, requiring 25,665 feet of line drilling and pouring 11,737 cubic years of concrete backfill. Aside from the concrete backfill, the total cost of the excavation was $120,626.[150] According to correspondence from Dravo Corporation, it was originally expected that this exploratory work would be completed by the time that the construction site's concrete mixing plant was operational. Instead, nine exploratory areas were investigated, with the process continuing until February 8, 1943. The work revealed large areas of weak foundation stone that had to be removed.[151] In its official record of the construction campaign, the Huntington District stated:

> Although original contract plans did not call for any drilling and grouting, except for a few investigation holes and drain and anchor holes, the information obtained from the extensive foundation investigations in the intake and powerhouse area, supplemented by investigations in other area, indicated that desirability and necessity for some degree of shallow foundation consolidation. Consequently, under a supplemental agreement with the Contractor, the entire area under the dam, with the exception of the narrow abutment monoliths, was consolidated by grouting through 3-inch diamond drilled core holes. This involved the drilling of 879 holes to an average depth of 45.2 feet per hole, and the placing of 89,666 bags of grout.[152]

Dravo Corporation recorded additional project delays due to materials arriving late or being unavailable because of wartime shortages. Items arriving weeks or months late included concrete mixers, conveyors, and locomotives for the "dinkey" railroad system used to haul building materials.[153] Dravo also used Mack trucks for hauling earth and foundation fill (see fig. 24). Although the trucks were fast, rugged and highly reliable, Dravo had to stop using them because it became impossible to obtain replacement tires. Once the trucks were out of commission, hauling was done with slow, cumbersome vehicles known as Athey Wagons towed by tractors (see fig. 25). The performance of the Athey Wagons was unsatisfactory, and in 1946, when World War II tire rationing ended, Dravo stopped using the wagons and returned to using trucks.[154] At the beginning of construction, the company also planned to use three new C-17 model 30-ton electric whirler cranes to lift materials and equipment. However, these cranes could not be procured because of wartime shortages. In the end, the company acquired one C-17 crane from an old derrick boat and converted it for use, and for the other two cranes, made do

with two 15-ton C-14 cranes that were modified to a 17-foot gauge. It was reported that "Although the C-14's were capable of handling this load, the speed and technique required in placing large quantities of concrete tended to tax them beyond their limits and their performance was not equal to that of the C-17s."[155]

Fig. 24. Historic Photograph of Mack Truck Used at Bluestone Dam (Final Report, 1949). These trucks were reliable, but wartime tire shortages forced Dravo to stop using them during the first construction campaign.

Fig. 25. Historic Photograph of an Athey Wagon Used at Bluestone Dam (Final Report, 1949). When tire shortages grounded Dravo's Mack trucks, these wagons were used.

Part of the problem, according to Dravo Vice President J. S. Miller, was the project's rating by the War Production Board. Particularly harmful, according to Dravo, was the demotion of the project from a favorable rating of A-2 (the highest rating was A-1-a) to a much less favorable rating of A-6. Miller stated that the first pour of concrete on the main dam at Bluestone was originally scheduled for July 13, 1942, but because of delays in receiving equipment, the first pour did not occur until September 26, 1942. This first concrete was poured not on the main dam, but on the small stilling weir of the main spillway. The first concrete on the main portion of the dam was poured on November 13, 1942, four months later than the originally scheduled date.[156]

Delays in the first construction phase of Bluestone Dam do not appear to have been attributable to poor performance by Dravo Corporation. The company experienced shipping delays of materials and items because of wartime industrial demands. The company also had no control over the discovery of flawed foundation rock underneath the dam site and associated drilling and grouting that was not included in the original contract. While these delays were not due to incompetence on the part of Dravo Corporation, they had a devastating effect on the company's efforts to complete Bluestone Dam in a timely manner. Because of the delays, on January 8, 1943, the War Production Board directed that all construction work on Bluestone Dam be suspended except for such work necessary to bring the project to a safe point of suspension. The priority rating for the job was again reduced to A-6 and the contractor was directed to construct the portion of the dam inside Cofferdam No. 1 to elevation 1390, a level approximating the top of the cofferdam, and to remove the cofferdam and then suspend construction operations for the duration of the war.

Some of the concrete monoliths were completed to a level below elevation 1390, because of the contractor's system of pouring concrete. As a result, monoliths were left at varying levels, ranging from elevation 1375.0 to 1402.5. Once these monoliths were completed to this level, work was suspended on March 1, 1944 with the dam approximately 35% complete.[157] There was some discussion in April 1944 of whether it would be more favorable for the government to simply suspend the existing contract, or to terminate the contract and offer a new contract for completion of the dam once conditions were favorable for the resumption of work. It was estimated that if the contract were terminated, the government would need to pay Dravo Corporation a total of $4,900,321. In contrast, if the contract were suspended and then resumed, the government would be obligated to pay Dravo $4,090,207, plus a monthly charge of $12,231.[158]

In a letter of March 10, 1944, Dravo officials stated that they did not want the Bluestone contract to be terminated, but wanted to complete the dam at the earliest possible moment. Dravo officials also argued that the government would save money by keeping the existing contractor instead of putting the project out to be re-bid at the end of the war.[159] In the end, a supplemental agreement of January 1, 1945 called for suspension of work under the old contract, but supplied "necessary instruments for repaying the contractor all justified costs and expenses costs and expenses incurred by him because of

the suspension."[160] This agreement made provision for acceptance of all completed work on the dam and payment in full of the contractor, and to reimburse the contractor for demobilizing the construction plant. All ownership of Dravo's construction plant at the dam was to be conveyed to the U.S. Government for $412,000.00, with the understanding that the construction plant would be returned to the contractor upon resumption of construction at the dam. The agreement also called for a lump sum of $66,226.00 to be paid to Dravo for performing additional work related to the suspension of construction activities.[161]

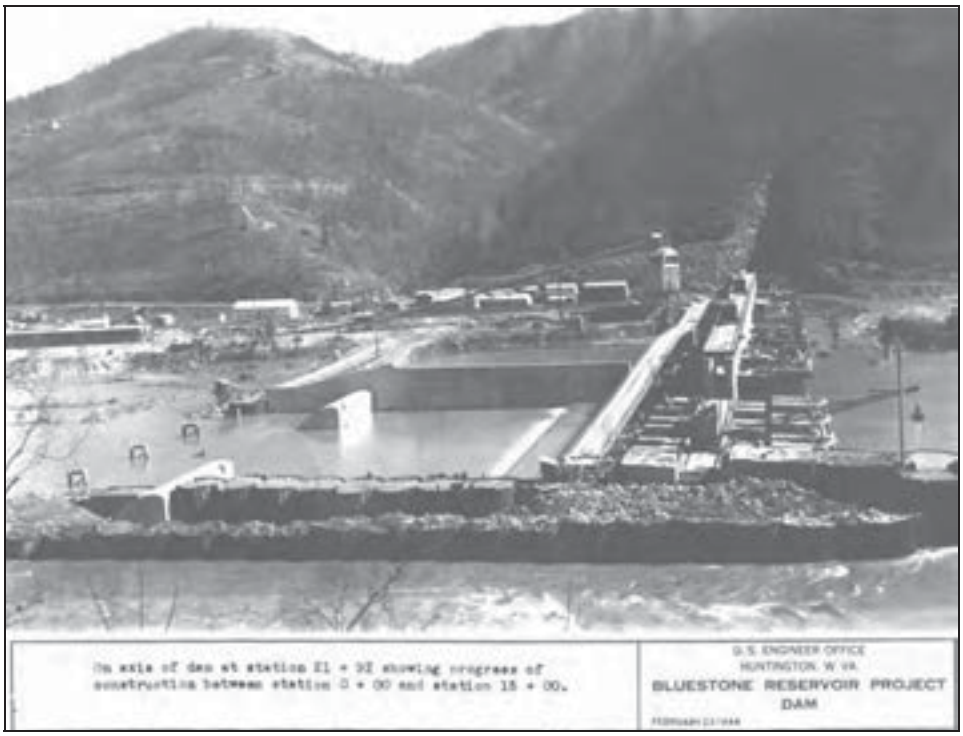

Fig. 26. Bluestone Dam, Construction Photo Showing Construction Progress on Main Dam and Spillway (U.S. Army Corps of Engineers, February 23, 1944). Sheetpile cells can be seen in the foreground.

Aside from the construction plant itself, Dravo left other pieces of equipment at the site, including whirler and crawler cranes, tractors, bulldozers, and trucks. Three Dravo employees, a clerk, mechanic, and mechanic's helper, stayed on-site to maintain and service the equipment. The federal government also provided three men who were in charge of guarding the construction site. The government paid Dravo Corporation for the three men that the company committed to the site. Dravo employees also completed maintenance work and improvements on the railroad access trestle and the aggregate bins of the concrete plant, efforts that included creosote work and the replacement of rotten railroad ties. After significant deterioration was detected on the bridge, Dravo undertook

additional rehabilitation from October to December 1945. Work on rehabilitating the aggregate bins, which involved cleaning and priming over 900 wooden piles, was not completed until two weeks before active construction resumed in January 1946.[162]

Second Construction Campaign and Completion 1946-1949

The first construction phase from 1942-1944 had completed a great deal of important work. The dam site had been cleared, and weak foundation rock had been removed and the resulting spaces filled with concrete. Work had begun on lower sections of some of the large concrete monoliths that would make up much of the dam's concrete mass. However, there was a large amount of work to be done when construction resumed in 1946. There was still a large amount of concrete that needed to be poured for the monoliths, and additional concrete work was needed on other parts of the dam. Other important features of the dam that waited to be installed until the second construction campaign included the sluice gates, crest gates, and the penstocks, which were large water pipes installed in the hydroelectric area of the dam.

On December 29, 1945, President Truman signed a deficiency appropriation bill that included $3,000,000 for the completion of Bluestone Dam. This act paved the way for the resumption of construction. Soon thereafter, Albert C. Hook was appointed interim resident engineer for the U.S. Army Corps of Engineers at Bluestone. Hook was to serve in that position until Robert Jenkinson, who had been resident engineer on the project before construction was halted, could return from service in the U.S. Navy. Robert Thompson, Bluestone project superintendent for Dravo, also soon arrived at the site.[163] Construction of Bluestone Dam resumed on January 2, 1946.

The first four months of the new construction campaign was taken up by the rehabilitation of the construction plant and preparation of the site for the resumption of construction. Dravo was required to perform this work at an actual cost basis, without additional money added for profit. Much of the work required replacing rotten wood. Approximately 50% of the wood in the construction plant, dinkey trestles, and other structures had rotted. The government was able to obtain free surplus war stock lumber to repair the wooden structures, although much of this wood was of inferior quality or cut to the wrong dimensions. The overall cost of rehabilitating the construction plant was $195,688.13.[164]

Permanent construction activities on the site resumed only in July 1946, following a series of delays. A second cofferdam that needed to be constructed could not be built until after June 1, 1946, because of delays in reaching an agreement that a "…highway traversing the west abutment of the dam could be abandoned."[165] Apparently, the West Virginia State Road Commission decided to keep this low-lying road open to accommodate school bus traffic. A second problem occurred when partial filling of the reservoir could not proceed as planned because the government was not yet ready to purchase a number of low-lying farms above the dam that were in the planned reservoir area. The raising of water in the reservoir was further delayed when the State Road

Commission had to raise a highway bridge in the reservoir area to prevent it from being flooded. In reference to these problems, the final report for the dam's construction stated: "the contractor understood the position of the government and cooperated to the fullest extent. In most cases, he subjected himself to greater risk and more trouble than the United States requested or had a right to expect. He did not claim any extra time or payment for the delays."[166]

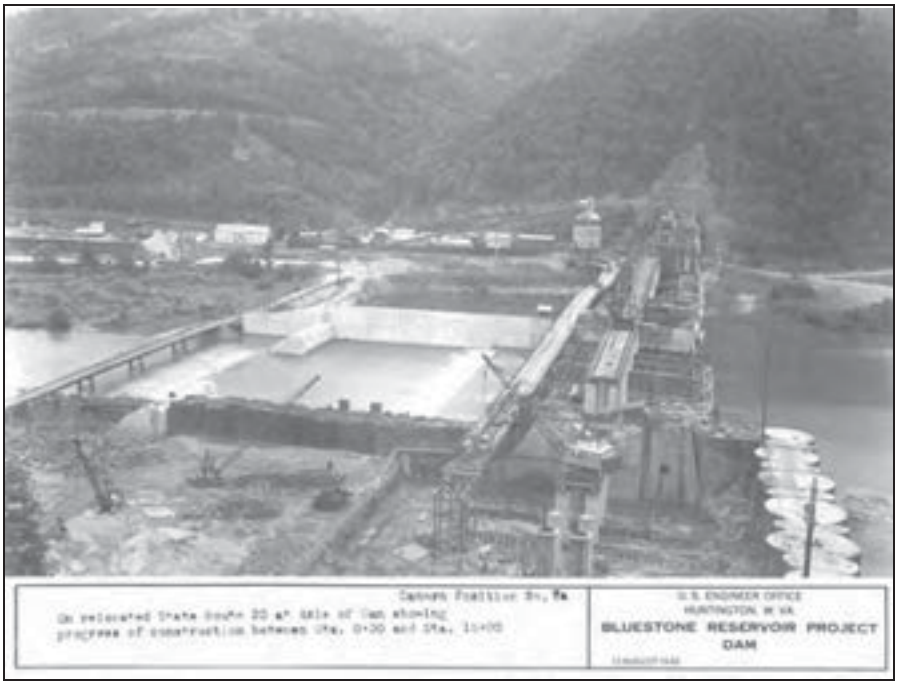

Fig. 27. Construction Underway at Bluestone Dam, August 1946. De-watered area of second cofferdam is visible in foreground, while river is diverted through eastern half of spillway. (1949 Final Report)

While these delays and a number of other problems arose during the second construction campaign, this phase was not plagued by the material, labor and equipment shortages of the World War II era. With the end of wartime tire rationing, Dravo discontinued use of inefficient Athey Wagons and returned to utilizing reliable Mack dump trucks. Unable to obtain new 30-ton whirler cranes during World War II, Dravo was able to commission the construction of a new electric 30-ton C-17 crane in 1946 for Bluestone. By the time concrete pouring was at its height in the second construction campaign, the company was using a total of five whirler cranes on the construction site's main trestle.[167]

The second cofferdam only covered the area of the river occupied by monoliths 34-55 of the dam, and was therefore smaller than the first cofferdam. The upstream arm of the second cofferdam required construction of seven new sheetpile cells, while two cells from the old cofferdam were utilized. The downstream arm of the second cofferdam followed the "Ohio River Box" design. As the second cofferdam was being completed, the river arm of the first cofferdam was removed.[168]

The late summer and fall of 1946 was a productive period that saw the pouring of a large amount of concrete. Concrete at Bluestone Dam was discharged directly from mixers at the concrete plant into a 12 cubic yard wet-batch hopper. From this hopper located underneath the mixer floor, the concrete was drawn into buckets, each with a capacity of 3 cubic yards. Three buckets were placed on each dinkey railroad flat car and hauled to the construction site. Whirler cranes lifted the buckets off of the flat cars and lowered the buckets into position. The bottom of each bucket opened to release the wet concrete (see fig. 28), and empty buckets were returned to the flat cars for removal. The progression of flat cars was arranged so that the whirler cranes constantly removed and poured buckets of concrete. Once poured, the concrete often clumped in a tight mass, so electric vibrators were used to spread the concrete into corners and depressions, and to surround pieces of steel rebar and pipe that were to be embedded in the dam. The vibrators each weighed about 95 pounds and operated on 110 volts of electricity.[169]

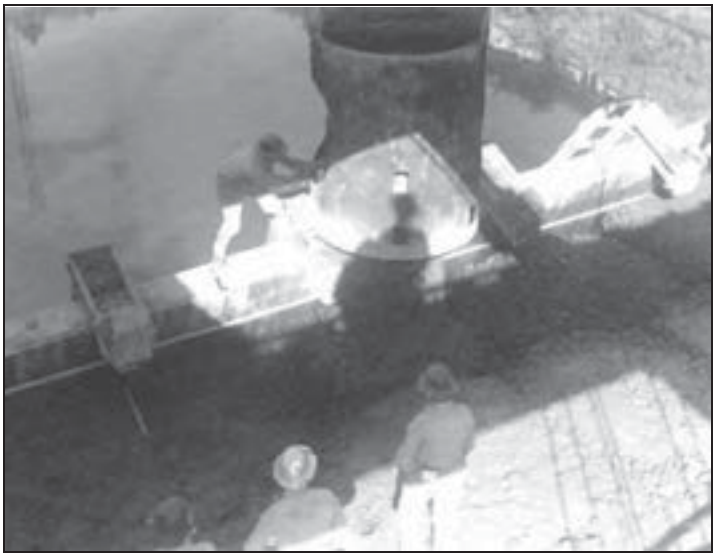

Fig. 28. Historic View of Concrete Being Released from a 3 Cubic Yard Bucket at Bluestone Dam (1949 Final Report)

As concrete pouring progressed, components of the sluice gates also arrived at the construction site in mid-1946. The Hardie-Tynes Manufacturing Company in Birmingham, Alabama, manufactured the sluice gates and machinery. Unlike the penstocks, which were acquired under the Dravo contract for dam construction, the federal government purchased the sluice gates directly. The components of the gate assemblies were lowered into place using the whirler cranes. To avoid misalignment, the positioning of the gate assemblies had to be precise, so eight 30-ton hydraulic jacks were used to carefully position the assemblies. As they moved the assemblies into position, a series of steel wedges fixed the jacks into position. Once the gate frame was adjusted to its correct position, the wedges were arc-welded to the frames and to nearby steel piling caps to prevent further movement of the gate assembly. The hoists and hoist machinery were then installed using the whirler cranes. By June 30, 1947, 24 hoists had been installed, and concrete had been poured around 16 of the 24 hoists.[170]

The sluice gates were installed in stages, not simultaneously. Sluice gates were installed on the western half of the dam during stage two of the river diversion plan, during which the second cofferdam was in place. In stage three, when the upper wall of the second cofferdam was removed, the river was allowed to flow through the western bays of the spillway, while semicircular cofferdams were installed in some of the sluice openings in the eastern half of the dam to allow for the installation of trash racks and the sluice gates. Once the gates were installed in the eastern half of the dam, these gates were opened, and water began flowing through this half of the dam. The gates of the western half of the dam were then closed (stage 4). This allowed the completion of unfinished sections of the stilling weir on the western half of the dam.[171]

Fig. 29. Bluestone Dam, Construction Photograph of Penstock being set into place by a Whirler Crane (1949 Final Report).

The large steel plates used to build the penstocks also arrived in multiple shipments between September 18 and December 21, 1946. Each penstock was made up of 14 steel rings, with each ring consisting of two semicircular steel plates of varying widths. The thickness of the rings varies from 15/16” to ¾” thick, depending on the position of the ring within the penstock. Each penstock also featured twenty steel stiffener rings. All parts of the penstocks were held together by welding, except for a few bolts that were used to secure the temporary bulkheads that stopped water from flowing through the penstocks. Each penstock assembly weighed approximately 90 tons. The steel for the penstocks was provided by the Bethlehem Steel Company. During installation, circular wooden centerings called “spiders” were placed inside the penstocks.[172] Remains of a “spider” were identified and photographed when the intake section lagoon was de-watered in March 2001 (see fig. 32). The “spiders” structurally reinforced the penstocks and helped maintain their circular form as they were moved around during construction.

Fig. 30. Elevation Drawing of a “Spider” Penstock Centering (1949 Final Report).

Fig. 31. Penstock in Place with “Spider” Visible (1949 Final Report)

Fig. 32. Remains of a Wooden "Spider" Penstock Centering. Photographed at the bottom of the Bluestone Dam lagoon during April 2001 de-watering. This centering was apparently discarded into the lagoon during the 1946-1949 construction phase and has been preserved by continual immersion in water.

During the winter of 1947, work slowed on the dam's large monoliths. Smaller areas of concrete such as the small west training wall monoliths were then poured, in order to use the wintertime steam concrete curing techniques on portions of the dam that had smaller surface areas of concrete.[173] By spring 1947, the penstocks had been completely embedded in concrete, and work concentrated on the west training wall and stilling weir, and on construction of concrete monoliths in the area of the dam covered by the second cofferdam. By late summer 1947, almost all monoliths had been brought up to grade, and work began on dismantling the second cofferdam. It was also reported for the first time that the contractor had the job in a "balanced state" and could freely move construction activity from one portion of the site to another, instead of concentrating on a specific area of the job to help it "catch up" with more thoroughly constructed areas.[174]

In a March 1948 report, Dravo Corporation announced its intention to complete a number of tasks in the following months that would require the closing of some of the dam's sluice gates. These operations included closing eight of the 16 sluice gates of the dam so that work on one half of the stilling weir could be completed. The company also planned to remove some or all of the "dinkey" trestle across the spillway. Apparently, the past policy of the Huntington District was to have Dravo Corporation keep all sluice gates

open at all times. This policy was established to keep Bluestone Lake from overtopping the "Old True Bridge." However, Dravo Corporation claimed that the continuation of this policy would seriously delay work on the dam.[175] The Huntington District replied in April 1948 that the Route 20 bridge would be raised by the West Virginia Highway Department as soon as water levels were low enough. Until then, the district was not comfortable with closing any of the sluice gates.[176]

Fig. 33. View of a Section of Bluestone Dam's Service Bridge Under Construction. This photo was taken relatively late in the second 1946-1948 construction phase. (1949 Final Report)

Concrete work on the upper sections of the monoliths continued through late 1948. Construction on upper sections of the dam was finished in December 1948, concluding all permanent work. The completion date for the dam had been established as September 1, 1948, but the completion date was delayed until December 11, 1948. The government officially accepted the dam on December 10, 1948. The remainder of the construction campaign consisted of removing the whirler cranes and the contractor's construction plant from the site. Dravo Corporation finished this demobilization in January 1949.

Fig. 34. Construction of Crest Gate Piers Underway in June 1948. Western half of spillway is in full operation, with sluice gates opened. Construction work continues on eastern portion of spillway. (1949 Final Report)

Fig. 35. Dismantling the Concrete Plant at Bluestone Dam at the End of the Second Construction Phase (1949 Final Report)

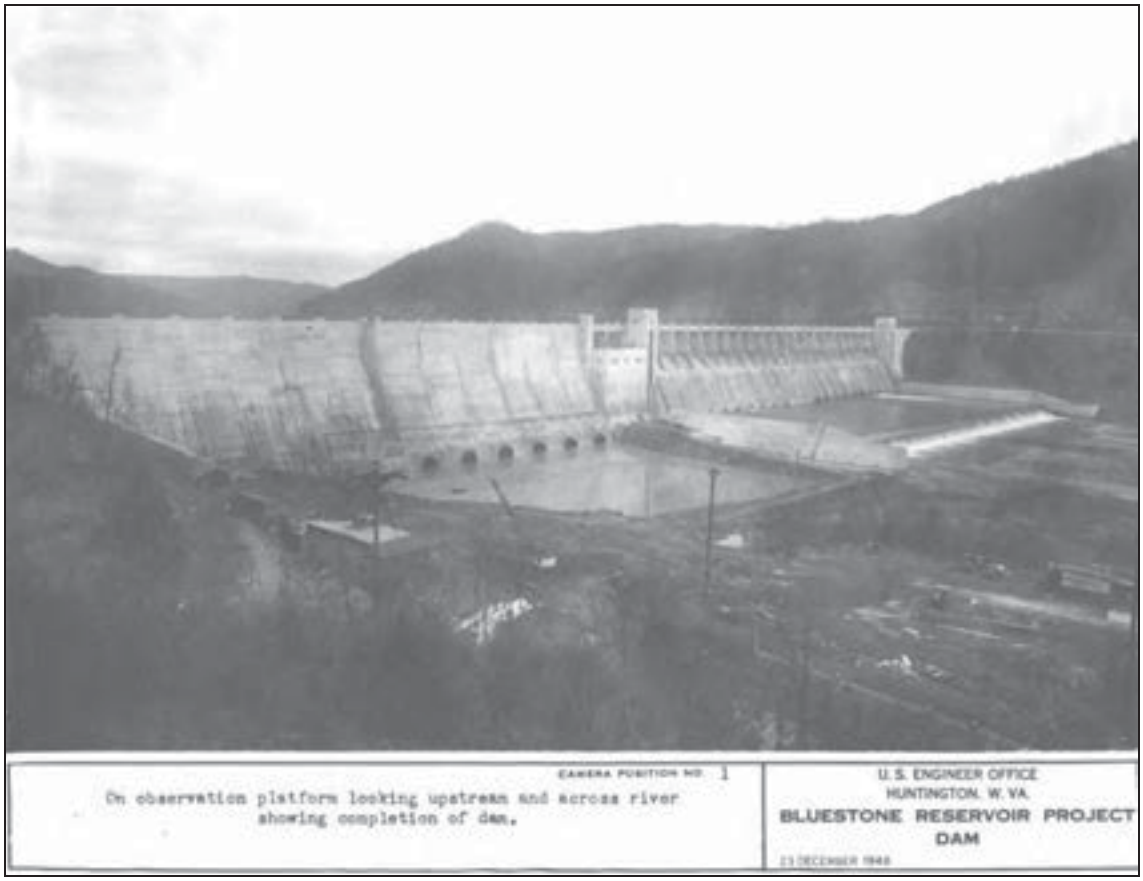

Fig. 36. North Elevation of Bluestone Dam at the End of the Second Construction Phase. Note that crest gates and gate machinery have not been installed in the spillway section (1949 Final Report).

With the alleviation of the World War II-era power shortage, construction of the dam's hydroelectric powerhouse was cancelled. The dam was thus completed as a flood control structure with provisions that would allow for the future addition of a powerhouse. The powerhouse was never constructed, and while Bluestone Dam continues to function as a flood control facility, it currently has no hydroelectric power facilities.

The total amount of money paid to Dravo Corporation under the Bluestone Dam construction contract was $13,419,935.08. This amount included an adjustment of $991,662.17 under the contract's escalator clause, fees of $477,356.80 paid to Dravo because of the suspension of construction, and other fees and charges for items such as government purchase of the contractor's access railroad and bridge, refunds for federal transportation taxes and emergency freight charges, and payments for increases in freight rates.[177] In comparison, Dravo's original January 1942 bid to complete the job was $11,376,000.00, and the original government estimate of the cost of the contract was

$9,749,826.00. In the end, the government paid Dravo Corporation $2,043,935.08 more than Dravo's original bid for the project. Much of this cost can be attributed to expenses associated with shutting down and resuming construction of the dam at the end of World War II, and to higher material and labor costs that were encountered when construction was resumed in 1946.

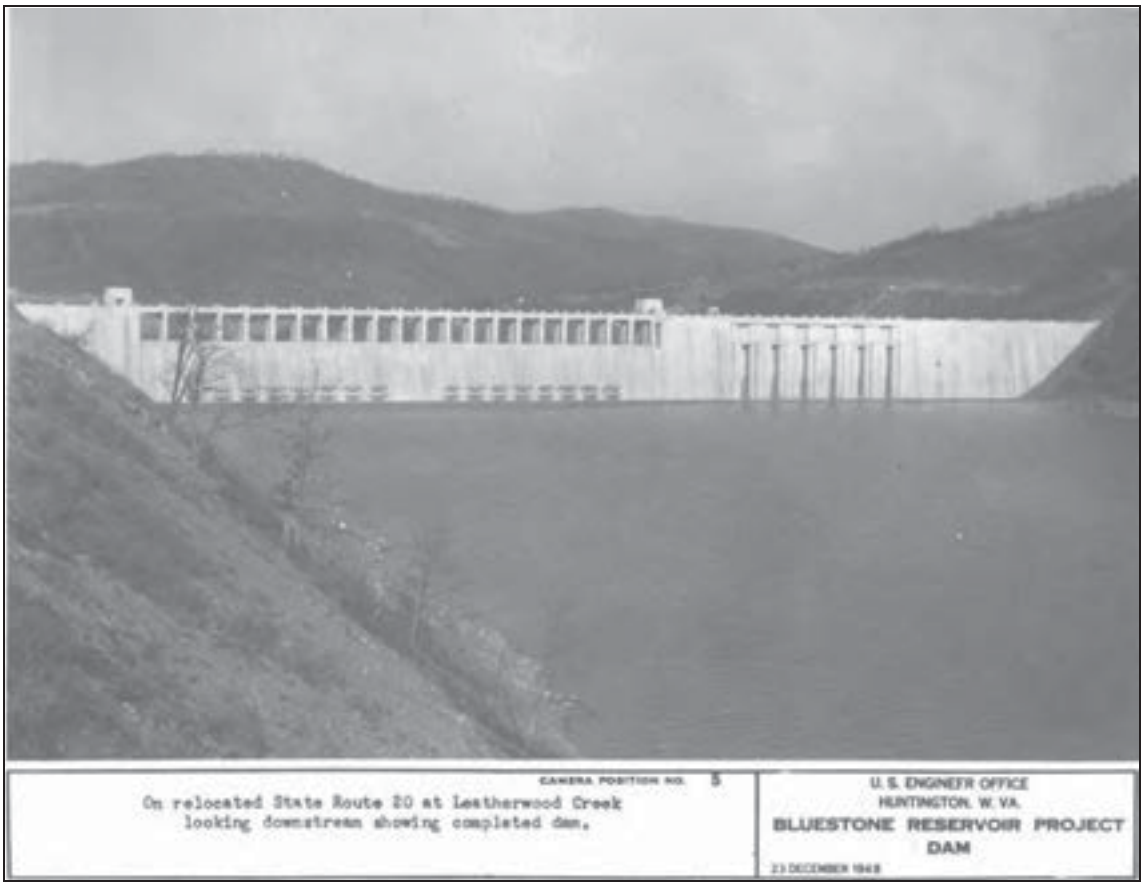

Fig. 37. South Elevation of Bluestone Dam at End of Second Construction Phase, December 1948 (1949 Final Report)

The amount paid to Dravo did not represent the full cost of Bluestone Dam to the government. The government paid directly for some items used in the construction of the dam, such as all cement used and the dam's 32 sluice gates and gate liners. Separate contracts covered a few other construction items. The full cost to the federal government for the dam and associated structures and improvements was $18,743,463.19.[178]

Installation of Crest Gates and Initial Operation of Dam, 1949-1952

Dravo Corporation finished removal of its construction plant and completed site cleanup in January 1949. The original contract called for the installation of the dam's crest gates as part of the main construction campaign, although the gates were not actually designed until after construction had started. Like the sluice gates, the crest gates were purchased directly by the United States and installed by Dravo Corporation. However, it was argued late in the second construction campaign that since the hydroelectric powerhouse was not to be built, the gates were not essential for operating the dam as a flood control structure. It was also argued that if the Huntington District took additional time to re-design the gates to have a higher allowable unit stress, it would permit significant financial savings. The installation of the crest gates was finally removed from the main construction contract under Contract Modification No. 20.

Fig. 38. View Across the Service Bridge on the Crest of Bluestone Dam, 1949. Crest gate openings have been completed but gates have not been installed. The gates were not actually installed until 1952 (1949 Final Report).

The government planned to complete design modifications on the gates and purchase them in 1949. Installation of the gates was to take place in 1950 under a separate construction contract.[179] In the end, installation of the crest gates was not completed until 1952. With the expense of crest gate installation, the total construction cost for Bluestone Dam was nearly $30 million.[180]

Even before the crest gates were fully installed, Bluestone Dam was fulfilling its flood control mandate. During a severe flood in December 1950, the dam stored 121,400 acre-feet of water, lowering the flood's crest levels at Hinton by four feet and at Charleston by ten feet. Without the intervention of Bluestone Dam, the 1950 flood would have caused severe property damage in Charleston, Hinton and other communities. Within twelve years of its completion, Bluestone Dam probably prevented flood damage that would have amounted to twice the cost of the dam's construction.[181]

Division of Labor and Working Conditions During Construction, 1942-1949

Supervision and Management

Dravo Corporation built Bluestone Dam under the direction of the Huntington District U.S. Army Corps of Engineers. The Contracting Division of Dravo's General Construction Department administered the project. The Dravo construction superintendent was Orval Auhl during the first construction phase, with R. A. Thompson as Assistant Construction Superintendent. For the second construction phase, R. A. Thompson took over as construction superintendent while Auhl took over administration of Dravo's General Construction Department. The assistant construction superintendent, also known as the "walking boss," was responsible for daily operation at the construction site, assigning tasks to work groups, making sure that all groups of workers stayed busy, and resolving any problems or difficulties that might arise.[182]

In contrast, the construction superintendent defined a broad strategy for completing the work, but left the daily operation of the construction site to the assistant superintendent. The Construction Superintendent met periodically with the assistant superintendent and head foremen to discuss important issues. The construction superintendent also closely assessed the costs of the project and recommended changes in future construction procedures. The superintendent also monitored the arrival of construction materials to determine if material availability would affect the long project's long-range progress. The construction superintendent was also in charge of addressing any safety hazards or violations reported by the U.S. Army Corps of Engineers safety inspector and safety engineer assigned to the site. In general, the construction superintendent coordinated with the resident engineer and his own subordinates to assure that the project was progressing as planned.[183]

The project also included a Materials Clerk and clerical staff responsible for ordering and accounting for all supplies and materials, and an Office Engineer and accounting staff in charge of tracking financial expenditures. The superintendent also had an Office Manager who served as the Construction Superintendent's administrative aide, overseeing hiring and firing, timekeeping, payroll, and salary check preparation. The office manager was also responsible for writing correspondence and for any public relations activities.[184]

Workers and Foremen

Foremen and workers under the control of the Assistant Superintendent completed the actual construction work. The two largest groups of employees were the laborers, who were under the control of the General Labor Foreman, and the carpenters, who were supervised by a General Carpenter Foreman. The laborers handled many aspects of construction, including excavation, drilling, loading, shooting, and hauling. The laborers were also in charge of concrete operations such as unloading aggregate, cleaning cars, cleaning forms, and pouring concrete. The laborers completed other miscellaneous tasks, including painting and general cleanup.

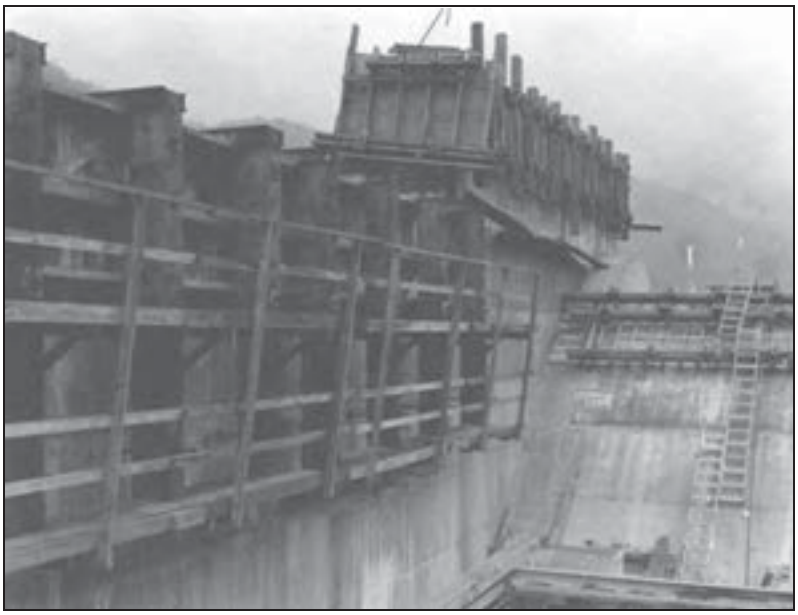

Fig. 39. Cantilever-Type Concrete Forms at Bluestone Dam. (1949 Final Report) Much of the work of constructing a concrete gravity dam in the 1940s consisted of building thousands of wood forms to pour the concrete into. For this reason, a large force of carpenters were employed during the construction of Bluestone Dam.

The carpenters were divided into three major groups. One crew of about 70 carpenters installed most of the concrete forms, built the railroad trestles and cofferdams, and placed any concrete rebar that was needed. A smaller group of carpenters constructed specialized forms needed for certain parts of the dam. These carpenters worked on the large carpenter's assembly platform or in the carpenter's shop. The assembly platform was located in the northern half of the Bluestone Dam construction plant, north of the dam site, and appears to have remained at this site during the entire construction of the

dam. A small sawmill was positioned south of the assembly platform. Workers assigned to the assembly platform included many of the most experienced carpenters, whose higher skill levels were useful in constructing the more complex forms for complicated sections of the dam, such as the sluice intakes. The third group of carpenters worked on specific assignments related to particular parts of the dam. The final report for the project stated that Dravo was short of carpenters for most of the job. Based on this statement it appears very likely that Dravo recruited local men to fill its need for additional carpenters.[185]

Fig. 40. Workers on the Carpenter's Platform at the Bluestone Dam Construction Plant. Many of the wooden forms used to pour concrete were constructed here. (1949 Final Report).

The Master Mechanic supervised a third division of workers. The Master Mechanic and his crew were responsible for operating all electrical and mechanical equipment and for constructing all of the dam's mechanical and electrical features. There were three divisions of mechanics, each overseen by an assistant master mechanic. One division was in charge of electrical work and equipment, another for mechanical work and equipment, and a third division was in charge of work completed on the job's second shift.[186]

On construction jobs, there is often friction among the different crafts or building trades. The friction sometimes results from a general suspicion and dislike between the trades, or from disputes over which trade is assigned which tasks. Resentment can result if, for

example, carpenters believe that laborers are being assigned work that should rightfully go to the carpenters, or vice versa. The 1949 final report for the construction of Bluestone Dam made this statement about relations between the various building trades: "There was good-natured rivalry between the various groups and crafts, but all of the supervisors and most of the key employees had worked together and for the contractor for a long time. Consequently, there was no serious labor trouble and a well organized happy job was the result."[187]

Work Schedule and Shifts

The daily work schedule included a day shift, a second shift, and a third shift. The day shift put forms in place and prepared those forms for concrete pouring. The second and third shifts poured and cured the concrete, unloaded aggregate, and made machinery repairs. It was reported that about 25-30 employees were used on the second shift, and that approximately 15-20 employees worked on the third shift. Scheduling the concrete pours for the second shift left the cranes available during the day shift for moving and placing forms. Likewise, on second shift, the workers did not need the cranes for lifting forms and could concentrate wholly on lifting and placing buckets of wet concrete. In this way, the work proceeded smoothly, with relatively little interference between form construction and concrete pouring.[188]

Labor Relations

The time span of the construction of Bluestone Dam was a turbulent one in terms of the availability of labor in the United States. By the time construction began, World War II had begun. The war effort quickly made it difficult to find able-bodied male workers. By the time construction resumed in 1946, the supply of common laborers became more plentiful, but skilled tradesmen were hard to come by, possibly because of the post-World War II construction boom. However, aside from problems with worker availability, the labor situation at Bluestone Dam appears to have been fairly placid.

The 1949 completion report for Bluestone Dam paints a fairly pleasant picture of labor relations. The report states that a strike or work stoppage was never considered during the dam's construction. The project was operated as a unionized closed shop, in which employees were required to join the union before working on the job. The closed shop agreement was signed with the Heavy Construction Department of the American Federation of Labor (AFL).[189] The AFL established a hiring hall at Hinton and all requests for labor were initially channeled through the hiring hall. However, it was reported that after the start of work, the hiring hall was no longer able to supply an adequate workforce. Dravo Corporation then initiated a recruiting effort that included advertising, the use of an employment agency, and contacting potential employees within a 150-mile radius of Hinton, West Virginia. Dravo's agreement with the AFL permitted the hiring of non-union employees in cases where the AFL hiring hall could not supply

sufficient labor for the project. However, men who were not hired through the AFL hiring hall were asked to sign union agreements before they started work. Because of federal wartime policies, potential employees were also cleared through the United States Employment Service.[190]

As the war progressed, labor scarcity became an issue. In 1942, Dravo Corporation provided a physical examination for all job applicants, and 20% of the candidates were rejected because of physical disabilities. However, labor became scarcer during 1943, and the rejection rate due to physical disabilities dropped to 9%. It was reported that during the 1943 labor shortage,

> …only men, who in the company doctor's opinion would have been definite liabilities to the work and were reasonably certain to be injured were rejected. The hiring qualifications of the company were reduced so as to make use of illiterates, men with fingers missing, men with medium deafness, and, in some cases, one eye. However, under no circumstances would men be hired with one arm or leg missing. It was not the policy of the examining physician to relate to the applicant the cause of his rejection, unless the applicant requested him to do so. Although the armed forces continued to take more of his physically fit men, and made it necessary for him to employ less physically able workers, the Contractor would not submit to waiving the physical examination entirely, in spite of adverse criticism from both the AFL and the United States Employment Service. He managed to maintain crews on all three shifts by working a selected number of employees overtime shifts each week. The maximum number of men employed at one time during this period of work was 306.[191]

Clearly the departure of servicemen at this time forced Dravo to relax its hiring standards and accept workers it would have rejected in times of a more plentiful labor supply.

After the end of World War II, construction resumed at Bluestone Dam. The account of labor conditions in the 1949 Final Report for the dam construction has some interesting perspectives on labor in the post-World War era. The report first states that the strict physical examination standards maintained by Dravo Corporation at the beginning of World War II were re-instated. The account also states that "The returning war veterans did not show too great an inclination for work during the first part of 1946, apparently preferring to take advantage of their unemployment insurance, and difficulty was experienced in securing a force of physically able men. However, during the latter part of the year, the situation eased and an ample supply of physically fit, unskilled labor was available and waiting for work."[192] Thus, the supply of common laborers became more plentiful after the first months of 1946. However, the report paints a different picture of the availability of skilled workers. The 1949 Annual Report stated:

> The skilled occupations offered more of a problem, and the Contractor was short on carpenters for the major portion of the work. In order to secure and hold the skilled craftsmen, it was necessary to upgrade men beyond their experience. Carpenter helpers were signed on as carpenters. Laborers and handymen were noted as carpenter helpers, etc. The more experienced men, distressed and disgusted at being paid the same rate as the upgraded men, openly loafed and slowed down to match the slower rate of progress set by these employees. Three rounds of wage increases were granted during the time of the contract, matching the increases secured by labor throughout industry. These were an average of $0.15 per hour increase effective 1 February 1946, and average $0.15 per hour increase effective 16 December 1946, and an average $0.125 per hour increase effective 10 November 1947. There was some agitation for a fourth round of increases in the summer of 1948, but seeing the end of the job close ahead, the union did not press the issue to any extent. All wage increase discussions were conducted peaceably with both parties recognizing the needs of the other and seeking a just solution. The net result of the combined slowdown and lowered productivity on the part of the workers, with the higher wages paid, was to make the unit cost of all work performed considerably higher than it had been.[193]

With the post-World War II construction boom in America, it is not surprising that Dravo had difficulty attracting skilled construction workers to Bluestone.

Wages

The original 1941-1942 minimum worker wages for the project ranged from $0.55 to $1.50 per hour. Unskilled laborers, apprentices, and helpers were paid minimum wage levels below $1.00 an hour, while most skilled trades had wages in the $1.00 to $1.25 per hour range. A few skilled trades, especially the structural steel workers and the equipment operators, received minimum wage levels of over $1.25 per hour. The operators of derricks, two-drum hoists, and pile drivers earned $1.50 per hour.[194]

These wages increased as the project progressed, especially during the 1946-1948 construction phase. An authorized wage rate chart in the 1949 final construction report tracked the increase in wages over the course of the project. For example, machinists at Bluestone had an authorized wage rate of $1.25 per hour from the beginning of the project in 1942 through the beginning of 1946. Machinist wages were raised to $1.40 in February 1946, went up again to $1.55 in December 1946, and topped at $1.675 in November 1947. The two 1946 wage increases amounted to a $0.15 per hour for all classes of labor, while the 1947 increase amounted to $0.125 for all grades of labor.[195]

Workforce Size

The number of workers at the site fluctuated somewhat during the original 1942-1944 construction phase. The work crew went from approximately ten men on January 14, 1942, when the notice to proceed with construction was issued, and rose to about 100 men by the middle of February 1942. The highest number of workers on the site during 1942 was approximately 250 men, who were present at the site in the first half of May. In the middle of May 1942, however, Dravo laid off 43 workers, citing the scarcity of construction materials. Through the middle of July 1942, Dravo further reduced the workforce by laying off an additional 19 men, again citing the lack of construction materials. The workforce slowly increased to nearly 200 men in autumn 1942, with the first concrete pouring at the main dam on November 15. The workforce stayed at or around 200 men throughout the winter of 1942-1943, jumping to a high of about 260 men in late May and early June 1943.[196]

Beginning in August 1943, the number of men employed on the project steadily declined. In contrast to the situation in 1942, when labor was available but men were laid off during material shortages, the declining workforce in later 1943 was attributed to a scarcity of workers. This labor shortage was blamed on a number of factors. The most obvious reason was that young, able-bodied men were leaving to fight in World War II. Information was also circulating that the Bluestone Dam construction project would be shut down in the near future, making employment there less appealing for potential workers. On October 10, 1943, Dravo records even stated that "hunting season (is) interfering with work."[197] In late fall 1943 and winter 1944, the workforce continued to decline steadily, from approximately 150 workers in early November 1943 to about 125 workers in the last half of December 1943, and down to about 40 workers by February 1944.[198] Construction at Bluestone Dam was suspended on March 1, 1944. Detailed information on workforce size could not be located for the second construction phase of 1946-1948.

Safety and Accidents

The occupational safety measures provided by Dravo Corporation for the workers at Bluestone Dam included on-site medical staff. The company originally retained a physician during the entire duration of active construction. The physician lived at the jobsite and was on-call at all times at the field hospital, which handled all injuries and first-aid cases, except in severe cases requiring the injured party's transfer to a Hinton facility. The field hospital included an office, a first-aid room, an examination room, and an X-ray room. The first-aid room was equipped to treat superficial wounds, eye injuries, sprains, contusions, asphyxiation, and fractures.[199]

Dravo also employed safety experts at the construction site to maintain a safe working environment. The company hired a full-time safety engineer at the beginning of the project, but wartime labor shortages made it difficult for Dravo to retain him full-time,

and the superintendent or other engineers later took over the safety engineer's duties. With resumption of construction in 1946, Dravo Corporation reported that it was unable to find an affordable full-time physician or a safety engineer. As a result, a first-aid man was hired to administer basic medical services and to be responsible for some safety duties. Other safety tasks were assigned to various supervisors. The Construction Superintendent also assumed a large degree of responsibility for the safety program and relied on the various project foremen to enforce safety measures, to educate workers regarding safe work methods and to instruct them in avoiding work-related hazards. Foremen were also required to attend a safety meeting every two to three weeks, and to have a weekly five- to ten-minute safety meeting with their work crews.[200] Dravo provided all workers with a hard hat and required employees to wear the hats at all times when on the construction job. The company made available other safety equipment, including goggles, welding shields, safety belts, life jackets, and respirators.[201]

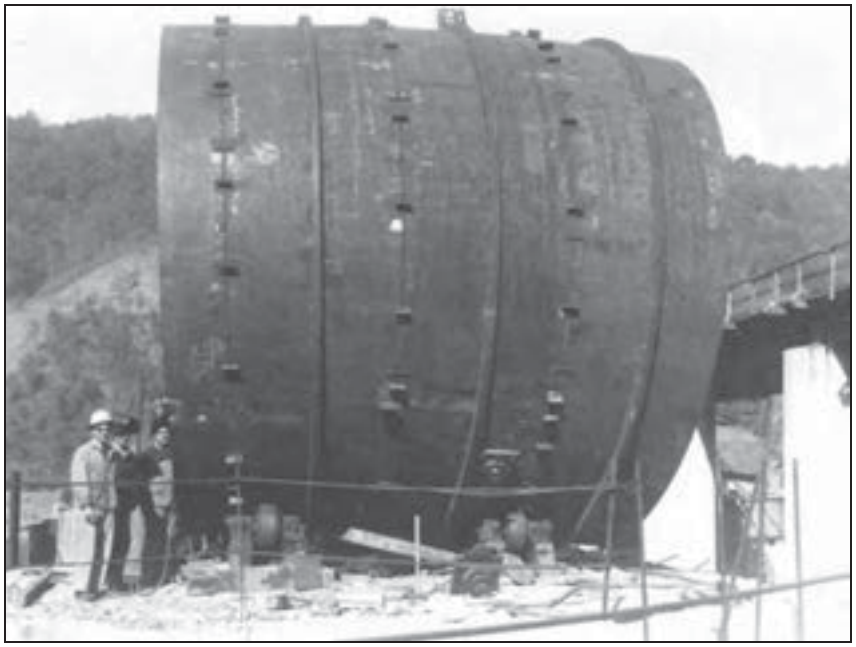

Fig. 41. Workers Posed Next to a Section of Steel Penstock During 1946-1948 Construction Phase. (1949 Final Report)

Injuries on the Bluestone job do not seem to have been excessive. There was some concern among Dravo and Huntington District staff that many of the men employed on this job were rural farm workers who lacked experience completing potentially dangerous construction tasks. Dravo tried to address this issue by having frequent safety meetings and presentations and by encouraging foremen and other supervisors to enforce safety regulations. Despite these efforts, "…because of the nature of the work being scattered all about the project, making it impossible to constantly check for safety

violations, some men persisted in being negligent where the use of protective equipment was concerned and many avoidable injuries occurred, particularly eye injuries. Fortunately, most of them were minor and required little, if any, treatment."[202] Nail punctures were another common injury on the job, and men with these wounds were required to report to the infirmary for tetanus shots and other medical treatment. While workers were required to wear hard hats at Bluestone Dam, they were not required to wear safety boots, and the large number of nail punctures and other foot injuries on the job were probably related to this policy.[203]

Out of 3,008,835 man-hours worked at Bluestone by Dravo employees, there were 3,042 first-aid dressings, 143 non-lost-time injuries, and 26 lost-time injuries. Out of the 427,846 man-hours worked by governmental employees at Bluestone, there were seven first-aid dressings, one non-lost-time injury, and four lost-time injuries. A safety record sheet in the Final Report indicated that there were two fatalities and four instances in which injuries resulted in permanent disabilities, but no further details were given.[204]

Records for one of the fatal accidents were located in surviving construction correspondence. On June 10, 1948 at 4:20 p.m., Dravo laborer Coin B. Owens was unloading a car of concrete aggregate and sustained an injury that required the surgical amputation his left arm. Owens died from complications related to the surgery on July 1, 1948. Although it did not describe the accident in great detail, correspondence related to the event stated that the cause of the accident "appears to be deliberate chance taking on the part of the foreman, and the subcauses are given as defective brake on railroad car and inoperative derail device."[205] Documentation indicates that the foreman was responsible for "dropping" the aggregate out of the car at the time of the accident, and there was extensive discussion of a defective brake and the fact that the car was located on an uneven grade. As the aggregate descended, the car may have shifted and derailed, injuring Owens. The recommended course of action in the aftermath of the accident was to fire the foreman of the unloading crew, to test the derail device before additional cars were unloaded in the area in question, and to repair the brake if it was found defective. The final statement was that "no car of aggregate should be dropped downgrade when men are in the car if the derail is out of order." The foreman in charge at the time of the accident, R. G. Wooten, was fired and the replacement foreman and other foremen were briefed on the accident and resulting safety measures.[206]

Summary

Labor relations for the Bluestone project seem to have been fairly placid. There was apparently a relatively low level of tension between the union, the contractor, and the U.S. Army Corps of Engineers concerning labor questions. There appear to have been no strikes or threats of strikes during either of the project's two construction phases. Major labor-related problems for the project seem to have been caused by fluctuating personnel

availability, which was the result of nationwide trends and world events. Military enlistment and the draft drained the labor pool of able-bodied construction workers, a shortage that plagued the first construction phase of 1943-1944. During the second phase of construction from 1946-1948, skilled workers became scarce, probably because of the post-World War II construction boom that accompanied the return of men and women from overseas service. This situation caused the promotion of less skilled men to highly skilled positions. The 1949 Final Report cited an unfortunate result of this situation, which was an intentional slowdown by the more skilled employees, an action that increased the project costs. The contractor and the U.S. Army Corps of Engineers seem to have tolerated this slowdown, since there are no existing records that document any retaliation against this action.

Had this dam been constructed during the high unemployment of the 1930s, as originally planned, the workers probably would have had less bargaining leverage. If a worker lost his or her job during times of high unemployment, there was a high likelihood that an unemployed replacement could be found to take his or her place. However, the first Bluestone Dam construction campaign occurred during wartime conditions in which labor was scarce. The remainder of the dam was completed during the post-World War II building boom of the late 1940s, when skilled construction workers were in high demand. These tight labor markets gave the union and workers at Bluestone more leverage in dealing with the general contractor.

Construction Technology and Engineering Significance

Introduction

Bluestone Dam is a late example in the series of concrete gravity dams built by federal agencies during the ambitious public works program that began in the early 1930s. In its design and technology, Bluestone Dam was fairly typical for its time. Articles in engineering journals do not cite many innovations or “firsts” associated with Bluestone. In a number of ways, the design of the dam is similar to that of the Pittsburgh District’s Tygart Dam (1935-1937) built in northern West Virginia on the Tygart River. In most cases, each concrete gravity dam built in this period is a unique structure. Each dam had to be tailored, both in scale and design, to its site. Each dam therefore had different dimensions, and elements such as crest gates, sluice gates, stilling basins and spillway chases were individually designed and engineered to suit the specific site. Design variations were also related to the function of the dam, since hydroelectric dams required features that were unnecessary for dams intended only for water storage.

Despite the lack of “firsts” reported in engineering journal articles on the dam, there are several interesting aspects of the dam’s design and engineering. The dam was built in an

era when scientific research and new discoveries led to advancements in concrete technology. In the 1940s, for example, construction specialists were beginning to understand the value of air entrainment, a technique in which the strength and durability of concrete was enhanced by trapping air bubbles in the mix. This technique was not used in the first construction phase of Bluestone Dam, but it was adopted soon after the second construction phase began in 1946. Along with Tygart Dam, Bluestone Dam was also a fairly early example of the use of hydraulic model testing to assist in the design of the spillways and other parts of the dam related to water flow. Since it was planned and designed in the mid-1930s and built from 1942-1948, Bluestone Dam's construction technologies reflect the changes that occurred in American construction from the Great Depression era of the 1930s, through World War II, and into the postwar era of the late 1940s.

Concrete

The vast majority of Bluestone Dam's mass consists of concrete, some of it reinforced with steel rods, or rebar. Concrete that is not reinforced with steel performs well under compression, when forces place pressure directly on the concrete. Plain concrete does not have very high tensile strength, meaning that it is not very strong when subjected to pulling, stretching, or bending. By embedding steel rebar in concrete, the concrete's tensile strength increases greatly. Most structural concrete construction today uses steel-reinforced concrete.

The transportation and pouring of the Bluestone Dam concrete appears to have been fairly typical for the time. The concrete was transported in bottom-dump concrete buckets, each with a capacity of two to three cubic yards. Flat cars on the dinkey railroad then moved the buckets around as needed. Whirler cranes picked up the concrete dump buckets, positioned them above the spot where the concrete needed to be poured, and then the buckets were emptied. A vibrator was then inserted into the liquid concrete to settle and consolidate the material, and to remove air and water pockets that formed during pouring. The surface of the concrete was then tamped and leveled. Finishing was accomplished in most areas with wooden floats, although some areas of the dam were finished with a steel trowel. Mixing and placing inspectors were on duty during all shifts to ensure that good results were obtained in the concrete work.[207]

Many of the concrete techniques used at Bluestone Dam reflected the forefront of concrete construction technology in the 1940s. Some of the processes utilized at Bluestone, such as air entrainment, were among the earliest applications of new innovations in dam construction. The engineers and construction managers in charge of the Bluestone project during both major phases of the dam's construction were apparently aware of the latest developments in concrete building techniques.

Fig. 42. Dinkey Railroad Trestle at Bluestone Dam. This wooden trestle built next to the dam allowed the dinkey railroad to transport buckets of concrete to sections of the dam where they were needed. (1949 Final Report).

The original construction specifications for Bluestone Dam were issued in 1941. These specifications state that the concrete was to be "…composed of cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce a plastic, workable mixture in accordance with all requirements under this section and suitable to the specific conditions of placement."[208] The specifications also outlined three grades of concrete to be used. Class A concrete was to be used for highly reinforced areas of the dam such as slabs, beams, hoist support piers, and service bridge girders. Class B concrete was to be used for training walls, spillway aprons, stilling weirs, and in some sections of the reinforced spillway piers of the dam. Class C concrete was intended for all other sections of the dam. Every cubic yard of Class C concrete was to contain 329 pounds of cement. The total for Class B went up to 423 pounds, and the highest cement content was reserved for Class A concrete, at 517 pounds per cubic yard.[209] The specifications indicated that most of the large sections of the dam would be poured in horizontal concrete courses measuring three to five feet in height. All concrete was then to be spread and settled through the use of mechanical vibrating equipment, which removed air bubbles and pushed the concrete into crevices and depressions after pouring.[210]

The 1949 Final Report for Bluestone Dam indicates that all concrete poured on the dam was cured with either water or steam, depending on the weather conditions. The curing, or hardening, process is actually a chemical change that takes place within the concrete, and is not a matter of the concrete simply "drying out." The exposed portions of the concrete at Bluestone had to be kept wet during the curing process, and during warm

months a hose and sprinkler system sprayed water on the exposed concrete surfaces and wooden forms. In colder months when freezing presented problems, the concrete prepared for Bluestone Dam was cured using steam. In this process, steam was pumped onto the curing concrete's exposed surface. The steam had the dual purpose of heating the concrete while also keeping the surface of the concrete wet. In extremely cold temperatures, tarps were placed over the concrete's surface to hold the steam close to the concrete. Steam curing generally took about five days, but could take longer during very cold conditions.[211] A more complex problem was the maintenance of an acceptable internal temperature inside the curing concrete.

In building a series of large concrete dams in the 1930s and 1940s, the U.S. Army Corps of Engineers soon realized the need to avoid temperature extremes inside large masses of uncured concrete. One way to avoid excessively high temperatures was to chill the water used in mixing the concrete. Refrigerated mixing water may have been used as early as 1939 at Hiwassee Dam to lower the temperature of concrete as it cured.[212] The Corps further developed water-chilling techniques for the Norfolk Flood Control Dam in Arkansas (1941-1945). At Norfolk Dam, crushed ice was dumped into the concrete mixing water during warm months, which was successful in reducing the temperature of the freshly mixed concrete by about 10 degrees Fahrenheit.[213] The use of chilled water and low-heat cement in the initial construction campaign at Bluestone was roughly contemporary with the Norfolk project, but the 1941 construction specifications for Bluestone Dam do not seem to have required that a water-cooling plant be built at the site.[214] A water-cooling unit was nevertheless installed in the original concrete plant that was built on the site in 1942. The cooling unit was a York ice machine with two ammonia compressors powered by a pair of 100-horsepower motors. The cooling plant was designed to cool 100 gallons of river water per minute, from its original temperature of 85 degrees down to 35 degrees. If the water temperature before cooling was as low as 60 degrees, the plant could process 200 gallons per minute.[215]

In general, it was reported that the concrete curing efforts at Bluestone Dam were satisfactory, although contemporary observers made some amusing comments about this process. Authors of the 1949 Final Construction Report wrote:

> On the whole, the curing operations were satisfactory, but it was a continual battle to keep them so. Contractor's employees, working near a lift being cured, understandably didn't like to be sprayed with water, especially on cold days. Consequently, they turned the water off, plugged the pipes, cut the hoses, and performed other similar acts in an effort to keep the water off of themselves. It was necessary to keep an inspector roving over the job constantly on the day shift in order to keep the water turned on and the concrete under continuous curing.[216]

Another interesting technological aspect of the Bluestone Dam's construction is the modification of the concrete mixture as the construction progressed. The concrete mixture appears to have remained consistent throughout the 1942-1944 construction campaign, but in late 1946, detected problems encouraged changes. Corps officials observed that the dam's sloping concrete surfaces contained too many irregularities. A change order stated that the "sloping surfaces of the concrete being placed on the dam contain air and water pockets."[217] These air and water pockets were detrimental to the durability of the concrete and needed to be eliminated.[218]

After some discussion of the probable cause of these defects, the problem was determined to be an insufficient amount of natural and stone sand in the concrete's fine aggregate. The Corps decided that the solution was to increase the amounts of natural and stone sand in the aggregate, so that the sand would occupy between eight and ten percent of the aggregate's volume. This change resulted in an increase of $84,640 to the construction contract.[219] A significant increase in the amount of fine sand did improve the concrete's quality by reducing air and water pockets and other unsightly pockmarks on the surface of the concrete. This technique mainly improved the appearance of the concrete, and not its strength or durability.[220]

Shortly after the alterations to the fine aggregate's compositional proportions, a second major change was made to the composition of Bluestone Dam's concrete. Beginning in the mid-twentieth century, a technique known as air entrainment was developed to provide more durable, workable concrete. Air-entrained concrete often possesses a more consistent appearance than regular concrete, and it is highly resistant to harsh climate conditions. In the 1940s, the air entrainment technique generally involved adding a mixture that trapped small air bubbles in the concrete. Air entrainment eventually became standard practice in concrete construction, but it was still an innovation in the early 1940s. The original 1941 construction specifications for Bluestone Dam do not mention air entrainment, and the technique was not used during the 1942-1944 construction phase. A change order of March 20, 1947 explained, "When the original plans/specs were prepared, the advantage of the use of air entraining agents in the concrete had not yet been adequately determined. Higher authority has subsequently recommended the use of air entraining admixtures in concrete structures of this type."[221]

A series of experimental concrete pours at Bluestone Dam were undertaken in 1946, and a variety of materials were added to the concrete to improve its workability, durability, consistency, and appearance. For some experimental pours, materials like pozzolith and natural cement were added to the mixture. Two air-entraining agents, Darex AEA and Vinsol Resin, were also used in some experimental pours. In early 1948, the American Society for Testing Materials (ASTM) officially recognized only these two air-entraining admixtures for concrete. The ASTM characterized Darex AEA as a triethanolamine salt of a sulfonated hydrocarbon, and described Vinsol Resin as a petroleum-hydrocarbon

insoluble fraction of a coal-tar hydrocarbon extract of pine wood.[222] Additional experiments and research on concrete additives were performed at the U.S. Army Corps of Engineers Ohio River Division Laboratory at Mariemount, Ohio. In the end, it was felt that Darex AEA improved the consistency, workability, and durability of the concrete, and it was also relatively easy to add. These factors made Darex AEA the best choice.[223]

A letter dated January 7, 1947 and sent by a Corps official to J. S. Miller of Dravo Corporation stated that recent tests on the concrete of Bluestone Dam showed that the addition of an air-entraining agent to the concrete would "produce a concrete that is more plastic and workable than ordinary concrete."[224] On March 20, 1947, a change order was issued to add Darex AEA to all concrete being poured at Bluestone Dam. The additional cost to add Darex to all future concrete poured at Bluestone was reported as $24,566.00.[225] The change order stated that:

> Recent developments in the use and design of concrete mixes have indicated that the addition of an air entraining admixture to the concrete is necessary in order to produce a more workable mix and a more durable concrete. Tests of various admixtures conducted by the Ohio River Division Laboratories and this district determined that Darex AEA, as manufactured by the Dewey and Almy Chemical Company of Cambridge, Mass. is the air entraining agent best suited for use in connection with the remaining concrete to be placed at the Bluestone Dam.[226]

The concrete of the lower sections of the dam built in 1942-1944 still retains a darker, ochre-colored hue, and there are many areas of moss growth and discoloration. The concrete of the upper portions of the dam is of a slightly different color and is cleaner and smoother, with relatively few moss growths, pockmarks, or other surface irregularities. This may be evidence of the greater durability of the post-1946 concrete poured at the dam, a concrete produced with a higher percentage of fine sand and using the process of air entrainment.

Schnitter states that air-entraining agents were first used in connection with concrete dam construction at Angostura Dam in South Dakota. The U.S. Bureau of Reclamation completed this dam in 1949, around the time that Bluestone Dam was finished.[227] Experiments using Vinsol Resin as an air-entraining agent were published in connection with Angostura Dam in 1949.[228] Davis states that around 1945, air entrainment became standard practice for pouring concrete that was to be exposed to severe weather conditions.[229] However, Davis does not clearly state when this technique was first applied to concrete dam construction. Depending on when air entrainment was first used in the construction of a concrete dam, Bluestone may have been one of the first concrete gravity dams built in the United States with air-entrained concrete.

Primary Contractor

Dravo Corporation was the primary construction contractor for Bluestone Dam. By the 1940s, the company was a well-established business. Francis R. Dravo, a mechanical engineer, founded Dravo Construction in 1891. By the turn of the century, the Pittsburgh company was experienced in heavy marine construction. Dravo Construction received its first federal government contract to build a river navigation structure in 1902, and is today best known as a builder of federal locks and dams on the Ohio, Allegheny and Monongahela Rivers.[230]

In addition to lock and dam construction, Dravo was also heavily involved in the building of concrete piers and abutments for bridges. While many of these bridges were located on the Ohio, Allegheny and Monongahela Rivers, the company also built bridge piers for spans in Maryland, Delaware, Michigan, Massachusetts and the District of Columbia. However, most of the company's bridge related work was clustered in the states of Ohio, Pennsylvania, West Virginia and Kentucky. Major clients for Dravo's bridge-related operations included the municipal governments of Pittsburgh and Philadelphia, the Pennsylvania Railroad, and the Pittsburgh and Lake Erie Railroad. Dravo Corporation was involved in 47 major bridge construction projects between 1903 and 1947.[231]

With regard to dam construction, Dravo was highly active in Ohio, West Virginia, and western Pennsylvania. Dravo held the American patent for a type of roller dam gate developed by the Krupp Corporation in Germany. As a result, Dravo was contracted by the Huntington District U.S. Army Corps of Engineers to build navigation dams on the Kanawha River at Marmet and London, West Virginia, during the early 1930s. Dravo was also responsible for the construction of Gallipolis Dam (now Robert C. Byrd Dam) on the Ohio River, which was the largest roller gate dam in the world upon its completion in 1938.[232]

SECTION 5: OPERATION AND ENVIRONMENTAL IMPACT OF BLUESTONE DAM

Bluestone Dam's Role in Flood Control, Tourism and Recreation, 1952-2001

Since the completion of the facility, the U.S. Army Corps of Engineers, Huntington District, has operated Bluestone Dam as a flood control reservoir facility. In 1938, Congress had plans for five flood control reservoirs for the Kanawha River basin, including Bluestone Dam. In 1941, planning began on Sutton Dam and Lake, located on the Elk River 85 miles above Charleston. Construction of this concrete gravity dam, which is 40 feet higher than Bluestone Dam, was completed between 1956 and 1961. Construction of Summersville Dam on the Gauley River took place between 1960 and 1966, providing additional flood control for the area. Bluestone Dam, Sutton Dam, and

Summersville Dam today provide flood protection to West Virginia's Kanawha Valley, which includes the city of Charleston, an important industrial center and the state capital. These three reservoirs control 57% of the total water drainage in the Charleston area, and Bluestone Lake controls about 44% of this total. Bluestone Dam has prevented approximately $1.6 billion in flood damages since it began operation at the beginning of 1949. [233] Bluestone Lake currently extends 10 ½ miles up the New River, and has the largest drainage area and flood storage of any dam in West Virginia.

Bluestone Lake is also the third largest lake in West Virginia, and in addition to providing important flood control benefits to the Kanawha Valley, the reservoir is an important recreational facility for Summers County. As such, the lake provides significant economic benefits to Hinton and Summers County. During the summer, the lake's total surface area covers more than 2,040 acres and provides opportunities for recreational activities such as boating, fishing and water skiing. The area surrounding the lake is a popular destination for picnics, hunting, biking, and camping.

Federal lands around Bluestone Lake are designated as the Bluestone Wildlife Management Area. This includes 17,632 acres of land, much of which has been leased to the State of West Virginia for forest, fish and wildlife conservation. The Bluestone Lake Wildlife Management Area is one of the most popular public hunting and fishing areas in the state, and features wild turkey, whitetail deer, and a variety of small game. Many also believe that the New River is West Virginia's best warm-water fishery. Bluestone Dam and Bluestone Lake attract over 1.3 million visitors annually, which brings significant economic benefit to the local economy.[234] The area includes recreational facilities such as seven campgrounds and a rustic cabin and barn area. A large public hunting area has also been reserved at the upper end of the lake, and the Presbyterian Churches of West Virginia operates a day and overnight camp within the area.

Bluestone State Park is also located on the shores of Bluestone Lake, about 16 miles south of Interstate 64. While the Huntington District U.S. Army Corps of Engineers manages the operation of the dam and its immediate site, including the parking areas, scenic overlook, and picnic area, the State of West Virginia, under a licensing agreement with the federal government, provides fish, wildlife, and forest management of the lands around the lake in West Virginia. The State of West Virginia has developed a portion of the reservoir lands and adjacent state-owned lands as Bluestone State Park and Pipestem State Park. The state park contains 25 cabins, 87 tent/trailer campsites, and provides boat rentals, hiking trails, and an accessible fishing pier. The portion of the lake and associated lands located in Virginia are operated by the U.S. Army Corps of Engineers in cooperation with law enforcement and conservation officials of Virginia.[235]

In 1997, Bluestone Dam was evaluated to determine whether or not the structure was eligible for the National Register of Historic Places. It was found that Bluestone Dam

was historically significant under National Register Criterion A, which recognizes resources that are associated with important events in American history, or with important patterns and trends in American history. Resources eligible for the National Register under Criterion A can be historically significant at the local, state, or national level. It was found that Bluestone Dam is historically significant for its associations with the landmark Supreme Court case that strengthened the federal government's ability to develop water resources. The dam was also cited as significant for its associations with the federal flood control program of the early to mid-twentieth century, which resulted in the establishment of large reservoirs in many parts of the United States. These reservoirs have prevented billions of dollars in flood damage to cities and towns of all sizes. Use of Works Progress Administration (WPA) funds for the project and the positive local economic impact of Bluestone Lake and the Bluestone Wildlife Management area were also mentioned as themes that contribute to the dam's historic significance.[236]

The U.S. Army Corps of Engineers funded the 1997 National Register eligibility assessment, because of long-range plans to alter Bluestone Dam. One severe problem in the dam's operation is the severe buildup of driftwood and other trash in Bluestone Lake during and after times of high water. At times, up to a twenty-acre area of flood debris can back up behind Bluestone Dam. These materials range from driftwood to old tires, bottles, cans, and abandoned refrigerators and other appliances. Removal of these items is time-consuming, and if these materials pass through the dam during low water conditions, they can become snagged in scenic areas below Bluestone Dam in the New River Gorge Scenic River Area, which is administered by the National Parks Service.[237]

The U.S. Army Corps of Engineers has been concerned about this problem and its effect on the natural and scenic resources below Bluestone Dam. Plans are currently in place to construct a drift release tower at Bluestone Dam. This facility would consist of a large opening in the dam that could be manipulated to pass driftwood and other debris through the dam during high water, so that the material will wash down the New River and out of the area. Some larger pieces of debris such as tires and appliances may be removed before they pass through the drift release tower. The estimated cost of the drift release tower is currently $9.2 million, and completion is expected in the summer of 2003. Construction of the tower is part of a comprehensive effort to remove trash from the New River, which is one of the top whitewater rafting destinations in the eastern United States.[238]

The Impact of Bluestone Dam and Bluestone Lake in Summers County and the New River Valley

Bluestone Dam has had an undeniable impact on the New River Valley, on Hinton, and on Summers County and the surrounding counties of Virginia and West Virginia that border the shores of Bluestone Lake. In many cases, the construction of a flood control

reservoir dam has sparked protest and opposition due to the displacement of residents and communities in the area flooded by the reservoir. In the case of Bluestone Dam, the New River Valley above the mouth of the Bluestone River was geologically suitable for a reservoir. The area to be flooded by the lake was also sparsely populated and contained no large towns, cities, or major railroad or power production facilities, hence the human displacement caused by Bluestone Dam was less severe than that caused by other flood control dams. The displacement of those who established farms, homes, businesses and communities in a given area is nevertheless always a traumatic experience, especially if the residents have a long history in the region. While a relatively modest number of residents had to relocate out of the Bluestone Lake impoundment area, many of the families had long-standing ties to the locale and had been living in the New River Valley since the early to mid-nineteenth century.[239]

Bluestone Lake did exact a price on the area residents. Perry reported in his 1949 report on the dam's construction that "many landmarks of this region have been either removed or inundated, and it has had a vast effect upon the people of this area."[240] Perry stated that many "cherished homes" were destroyed by the lake, along with two churches, the Greenbrier Baptist/Four Mile Church and the Buffalo Church. Perry also recalled that the lake inundated the sites of three historic mills at Indian Mills, Upper Bluestone Mills, and Lower Bluestone Mills. Perry also stated that the reservoir flooded the sites of four ferries that crossed the New River, at Pack's Ferry, Haynes Ferry, Warford Ferry, and Shanklin's Ferry.[241] Perry mourned the loss of many scenic sites in the Bluestone Lake area, including Landcraft's Shoals and Bull Falls, which had been studied as a potential site for Bluestone Dam. Historic sites that Perry stated would be flooded by the lake included Thurmond Camp Ground, a battle site at Salt Well, and a tannery site and swimming hole known as "Round Rock" near Landcraft's Eddy.[242]

Cemetery removal was one of the more grim tasks necessary to make way for Bluestone Lake. By 1949, twenty-five cemeteries were removed, resulting in the relocation of 681 graves from the reservoir area. The Wearly Monument Company of Muncie, Indiana, performed the cemetery removal services under a separate contract for the Bluestone project.[243] Many of those interred in the lake area were early settlers of the region who were born before 1850, and included members of the Meador, Pack, Bradberry, and Landcraft families. These names are still common in this area.[244] Since the National Historic Preservation Act did not exist in the 1940s, it is likely that the filling of Bluestone Lake submerged other undiscovered historic and prehistoric sites. The cemeteries were usually private or family burial grounds and ranged in size from a single grave to 149 burials. Despite efforts to identify the dead, only about half of the deceased could be identified. The remains were re-interred in four nearby cemeteries. Next of kin were consulted if they could be identified, otherwise, re-interment occurred in the nearest of the four cemeteries, or in a nearby cemetery that contained burials from the same family as the deceased. The cemetery removal campaign also uncovered evidence of pre-

Civil War slavery in the area. The 1949 Final Report stated that "Two cemeteries contained only the remains of Negro slaves, and it is possible that many of the unknown graves were those of Negroes"[245]

The most serious public issue surrounding items that were to be submerged by the impoundment of water in Bluestone Lake was the relocation of a state road, West Virginia Route 20, which ran through the proposed reservoir site. Two plans were proposed to relocate Route 20. In one scenario, the new road would follow the New River past the dam site and then rejoin the old course of Route 20 above a settlement known as "True." The alternative called for the road's relocation up Beech Run Mountain and then across the Bluestone River. The second proposal would have increased the distance to Athens, West Virginia, by seven miles. On August 10, 1942, following popular sentiment in the area, the West Virginia State Road Commission announced that it favored the relocation of Highway 20 along the New River. While this plan was approved, the actual relocation of the road did not occur until 1946.[246]

The delay in relocating Route 20 caused old Route 20 to become flooded a number of times during the winter of 1947-1948, cutting off transportation between Hinton and the town of Pipestem. After the beginning of January 1948, it became necessary to transport children from Pipestem to school in Hinton by a barge supplied by the U.S. government. The bridge that carried Route 20 over the Bluestone River was also submerged for most of that winter. During the following spring, this bridge was elevated fifteen feet to prevent further flooding. Meanwhile, grading of the new section of Route 20 was completed in September 1948.[247]

Some families and cemeteries had to be relocated out of the Bluestone Lake impoundment area, but the area was very sparsely populated, and a relatively modest amount of disruption resulted from the dam's construction. In contrast, the dam has provided significant flood prevention benefits to communities such as Hinton, located near the New River and directly below Bluestone Lake. The dam also lowers floodwater along the Kanawha River, which has saved Charleston, the West Virginia state capital and a major center of industry, from severe flooding that was once commonplace before the construction of Bluestone and its sister flood control dams in the area.

Bluestone Lake is also a major tourist attraction, especially for those interested in fishing and boating. Other attractions such as the New River Gorge National Scenic River, and Pipestem State Park provide further opportunities for recreational activity. The presence of Bluestone Lake as a water recreation area thereby enhances the tourism potential of Summers County and benefits the local economy.

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236. Heritage Resources, Inc. "Determination of Eligibility Assessment of Bluestone Dam and County Route 23." Sec. 2 p. 7.

237. "Officials Discuss Cleanup of Bluestone Dam, New River." *Morgantown Dominion-Post*, June 5, 2001.

238. *Ibid*.

239. Perry, p. 25.

240. Ibid. p. 24.

241. Ibid.

242. Perry, p. 25.

243. Huntington District. *Final Report*. p. 228.

244. Perry, p. 25.

245. See note 243.

246. Perry, 21-22.

247. *Ibid*.

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APPENDIX A:

COMMENTS FROM WEST VIRGINIA STATE HISTORIC PRESERVATION OFFICE

WEST VIRGINIA DIVISION OF
CULTURE AND HISTORY

September 27, 2001

Mr. S. Michael Worley
Department of the Army
Corps of Engineers
502 Eighth Street
Huntington, WV 25701

RE: Bluestone Dam - Historic Documentation Report
FR#: 01-1427-SU

Dear Mr. Worley:

We have received the above referenced project for review as required by Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties."

The Preliminary Draft of the *Historic Documentation Report for Bluestone Dam* has been reviewed by our office. Staff found the report to be quite extensive in the past history of the construction of the dam by the US Army Corps of Engineers, and inclusive of the significance of the construction technology and impact on the region. The drawings cover a wide scope of sections of the construction and the photographs appear to be complete. Please send us the final copy of the report and other items as covered in the Memorandum Of Agreement.

We appreciate the opportunity to be of service. If you have any questions, please contact our office (304) 558-0220.

Sincerely,

Susan M. Pierce

Susan M. Pierce
Deputy State Historic Preservation Officer

SMP:kmj

THE CULTURAL CENTER • 1900 KANAWHA BOULEVARD, EAST • CHARLESTON, WEST VIRGINIA 25305-0300
TELEPHONE 304-558-0220 • FAX 304-558-2779 • TDD 304-558-3562
EEO/AA EMPLOYER

APPENDIX B:

LARGE FORMAT PHOTOGRAPHS

BLUESTONE DAM

INDEX TO LARGE FORMAT PHOTOGRAPHS

BLUESTONE DAM
New River
Hinton Vicinity
Summers County
West Virginia

Jeff Bates, Hardlines Design Company Photographer, March 1 and May 3, 2001

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3	AERIAL VIEW OF SOUTH ELEVATION OF DAM, LOOKING NORTHEAST
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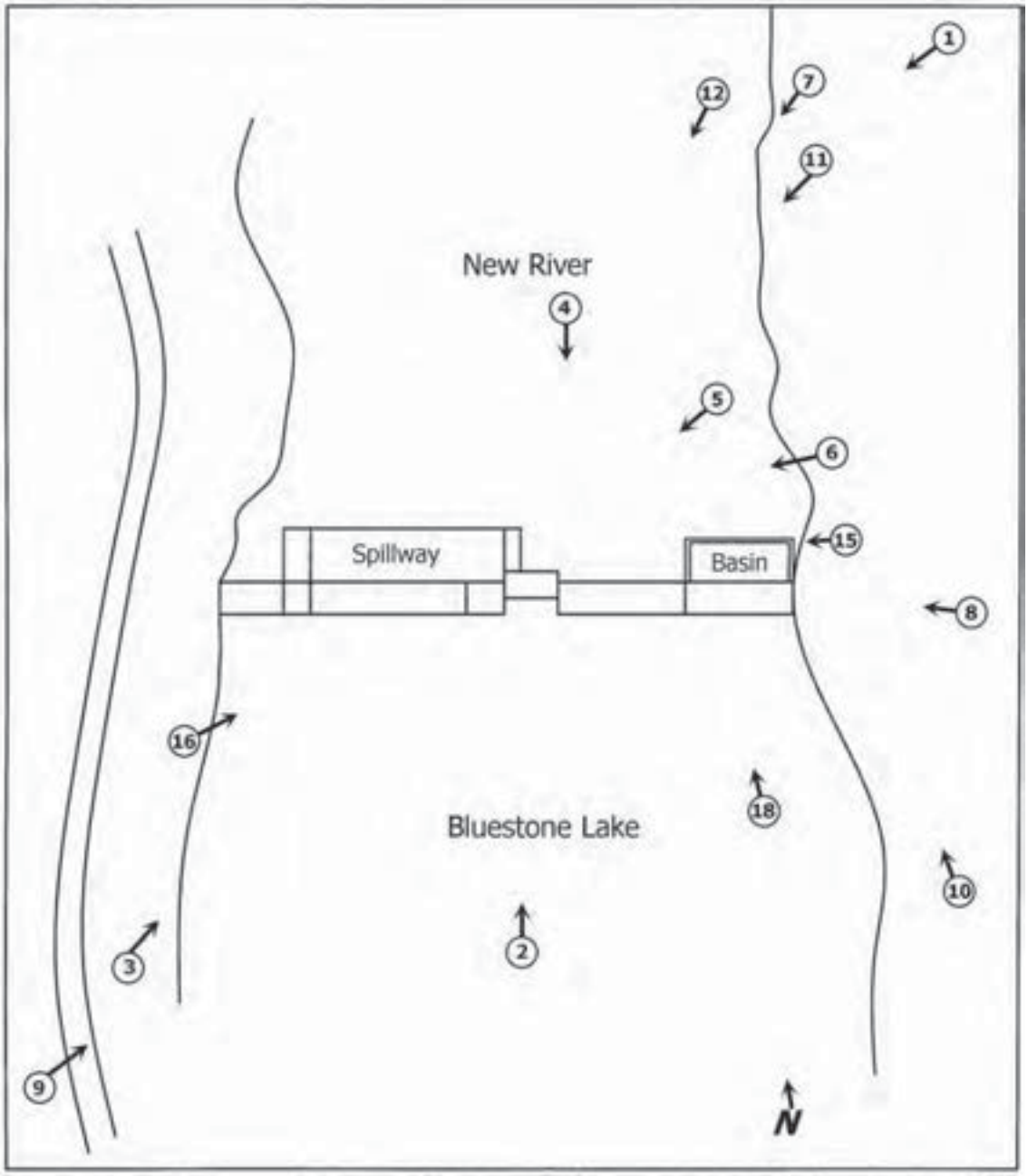

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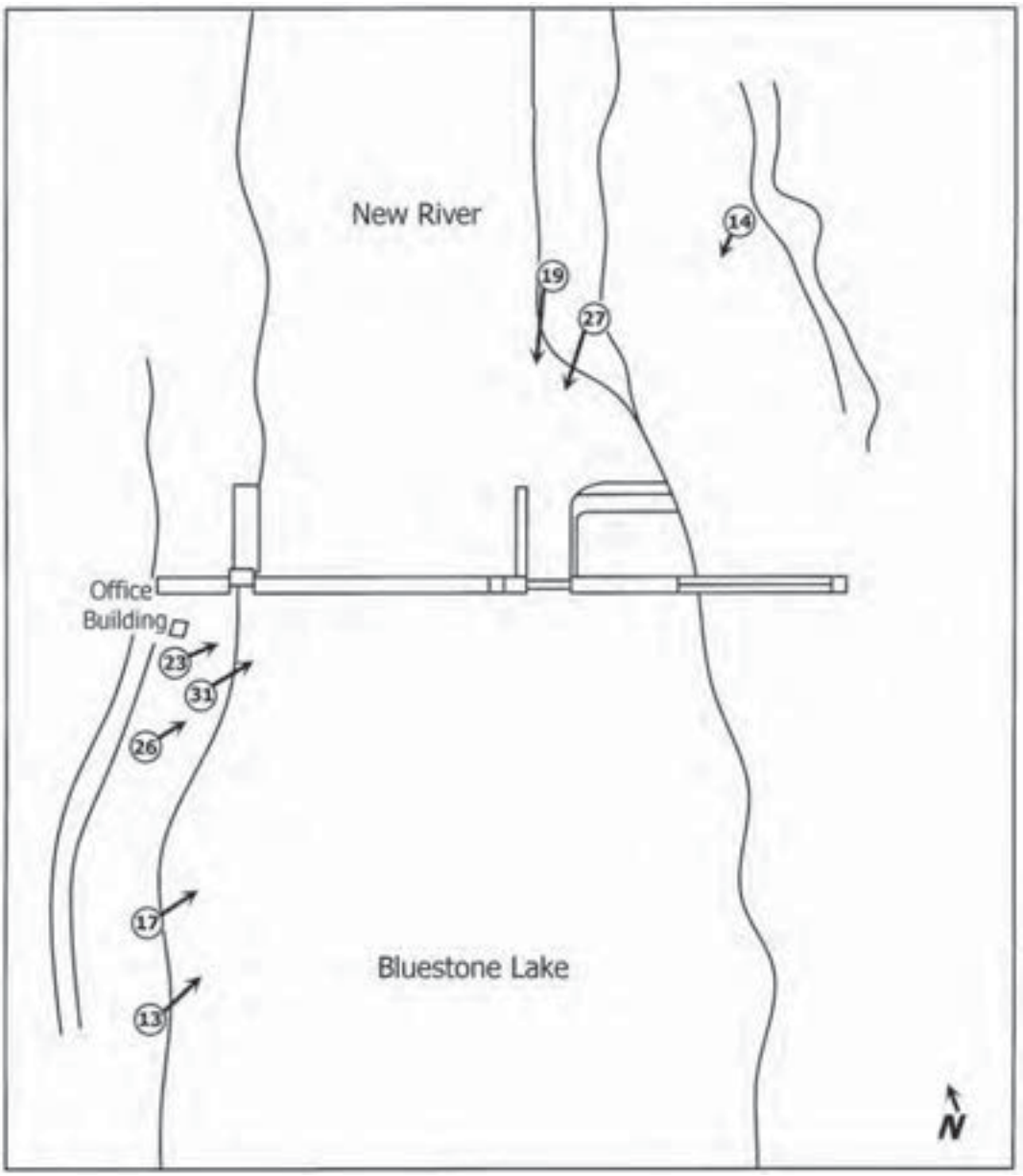

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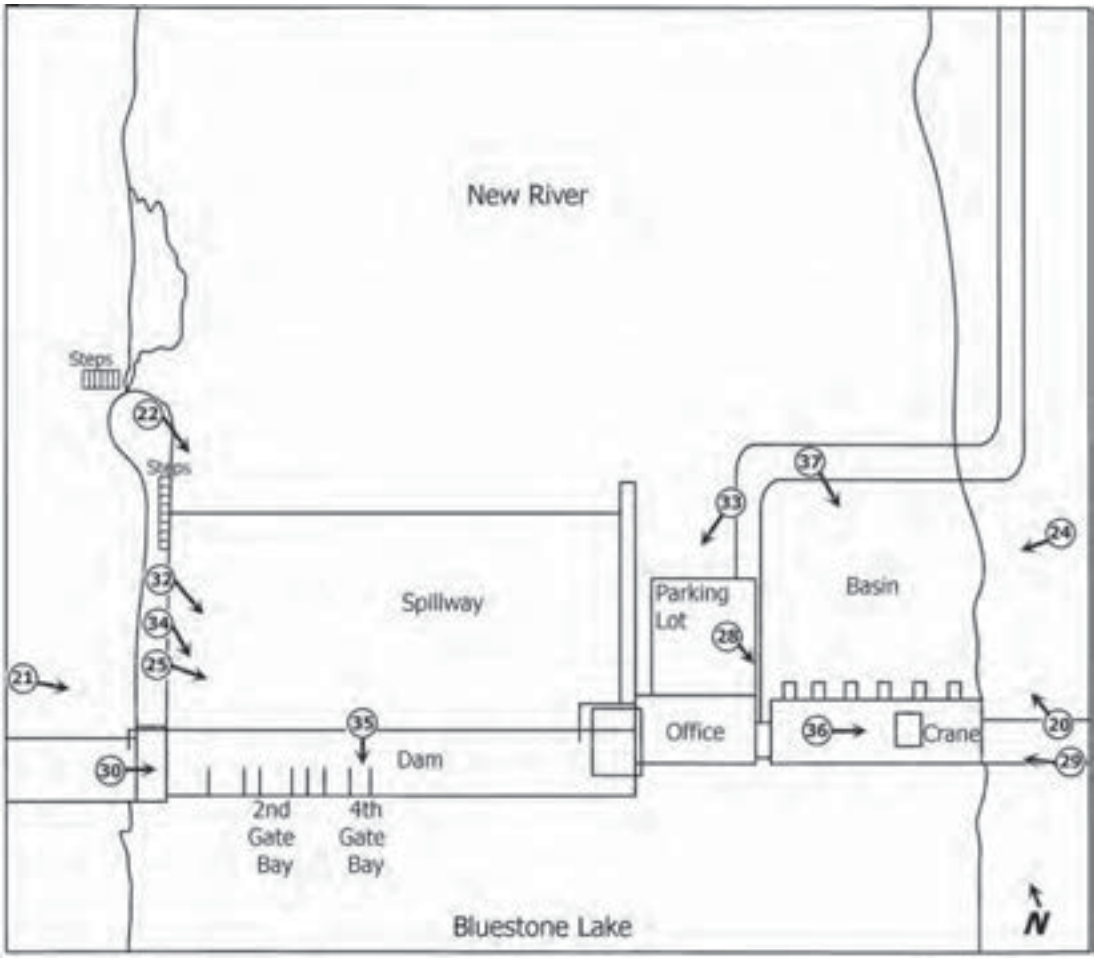

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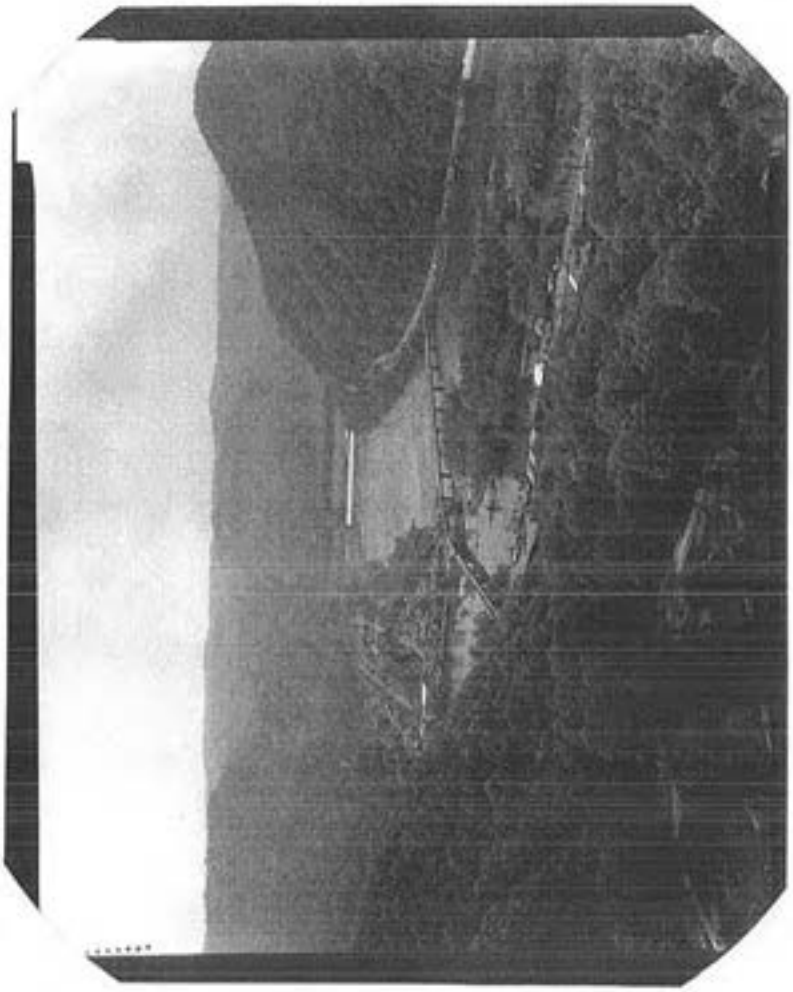

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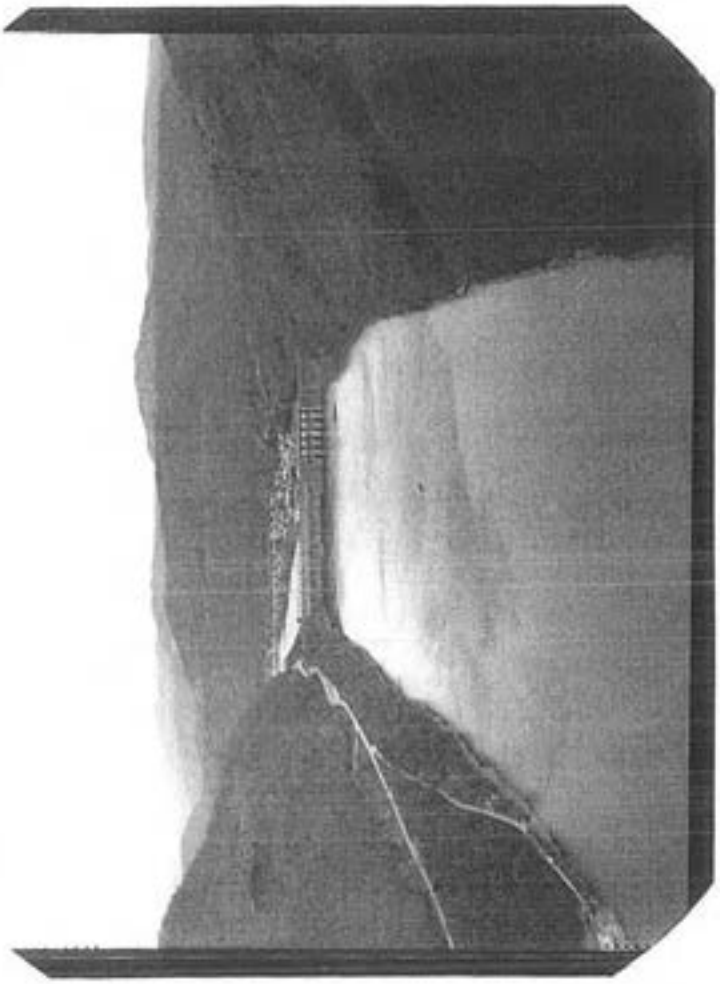

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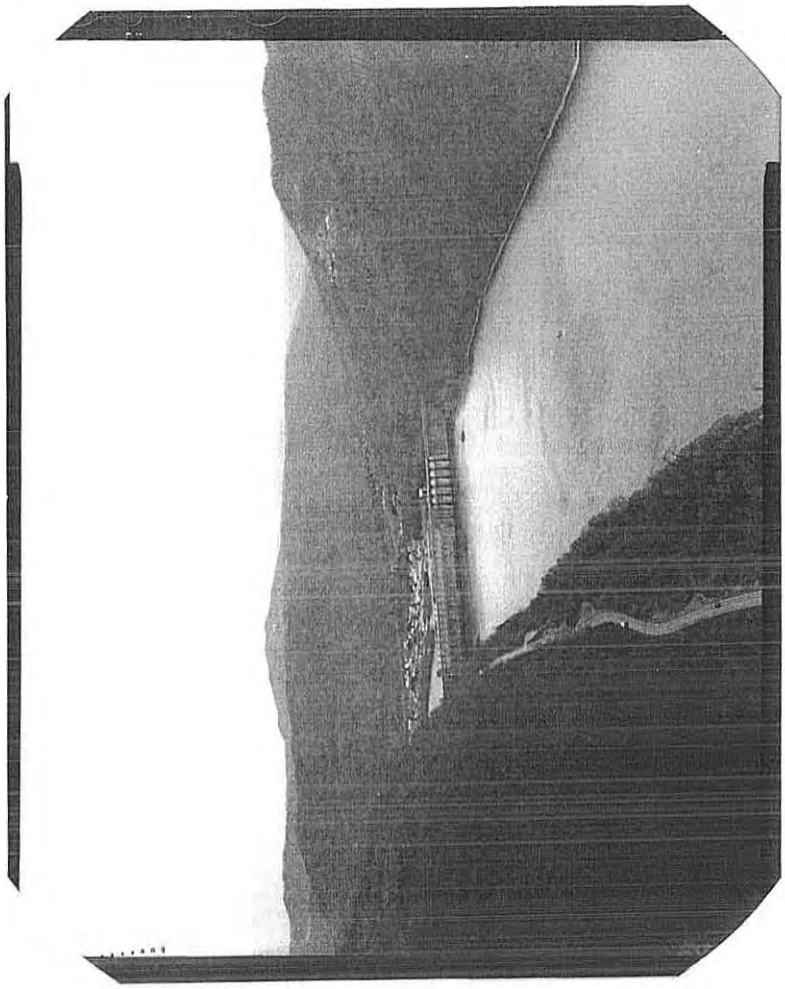

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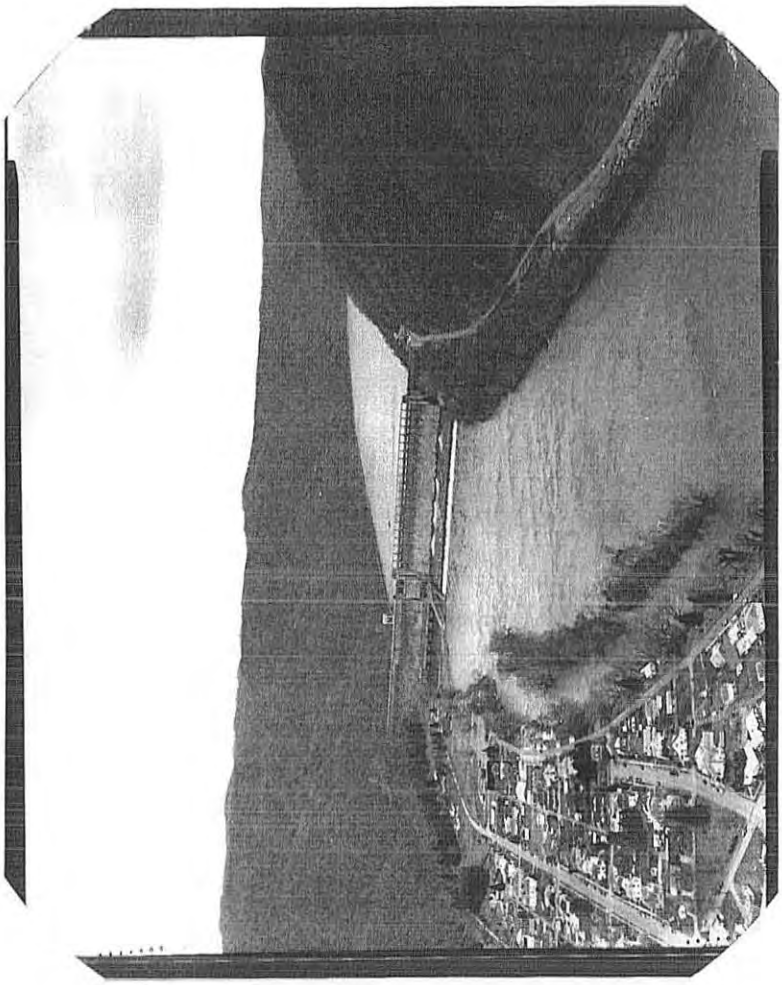

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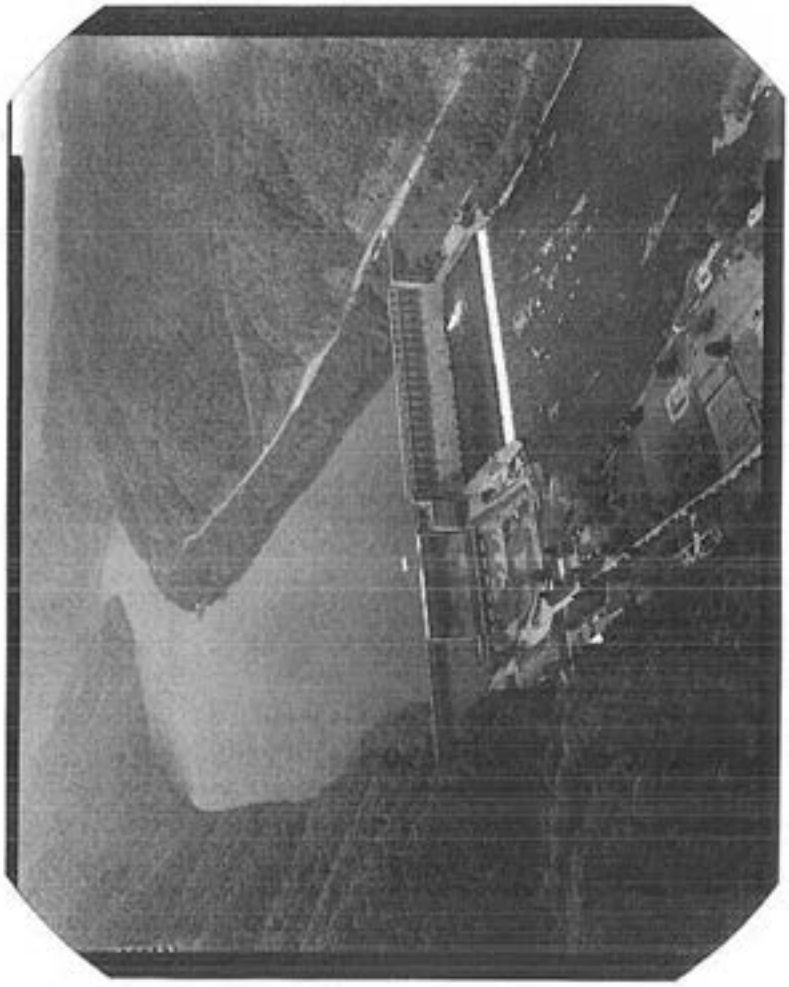

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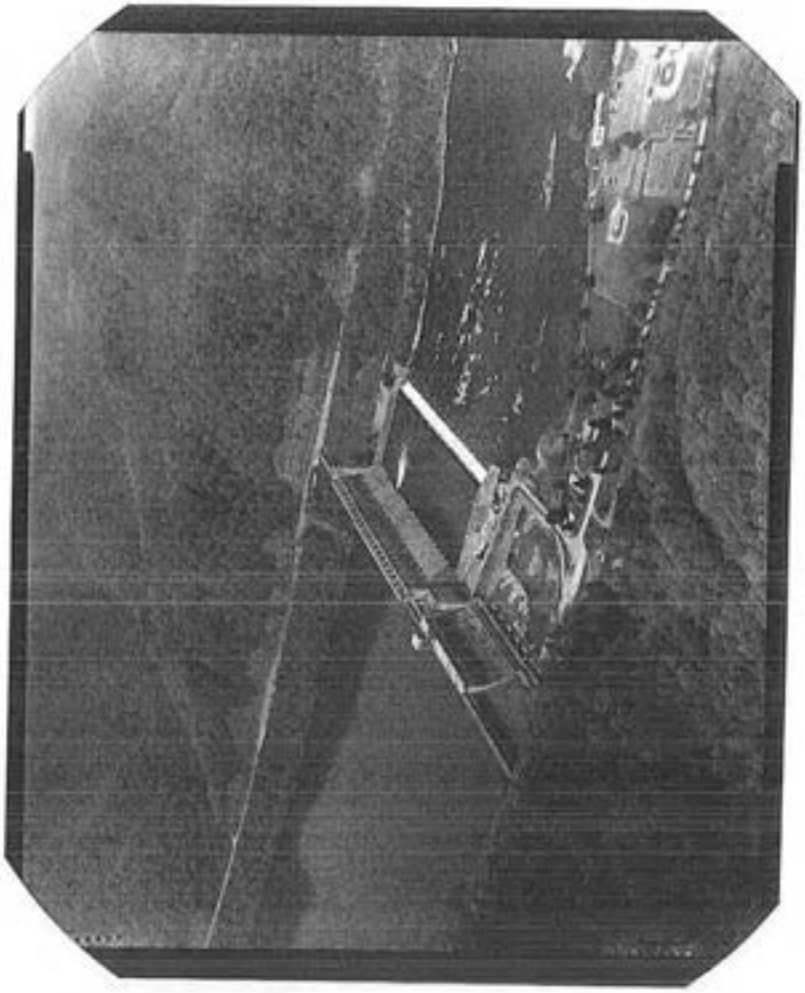

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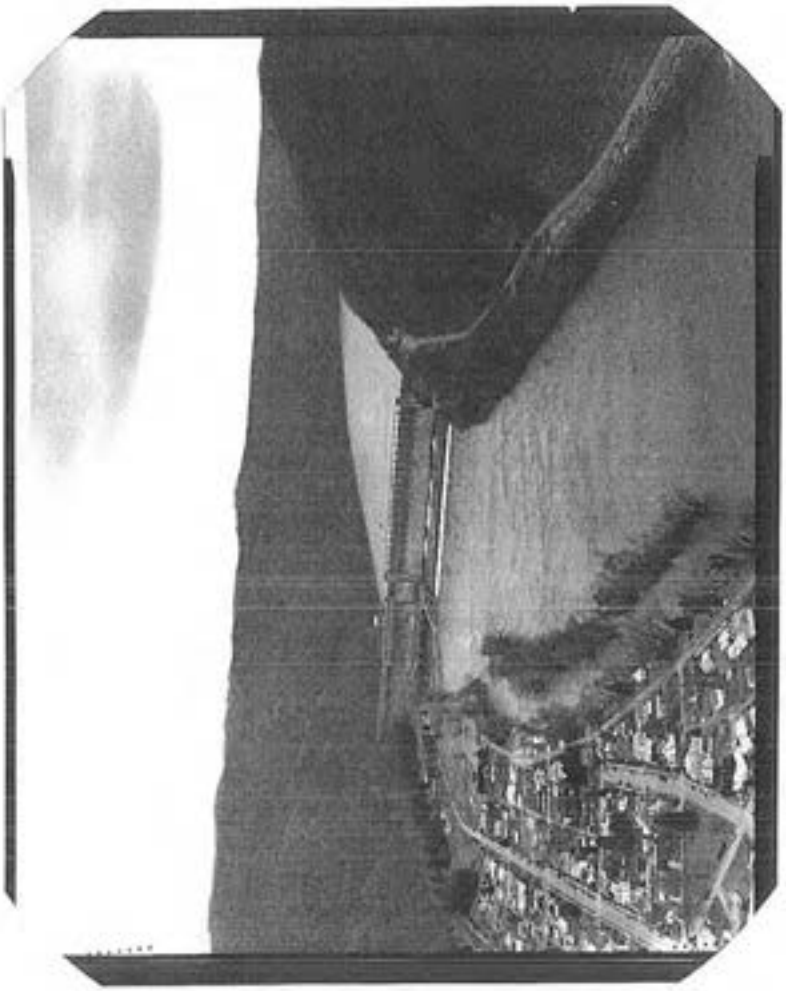

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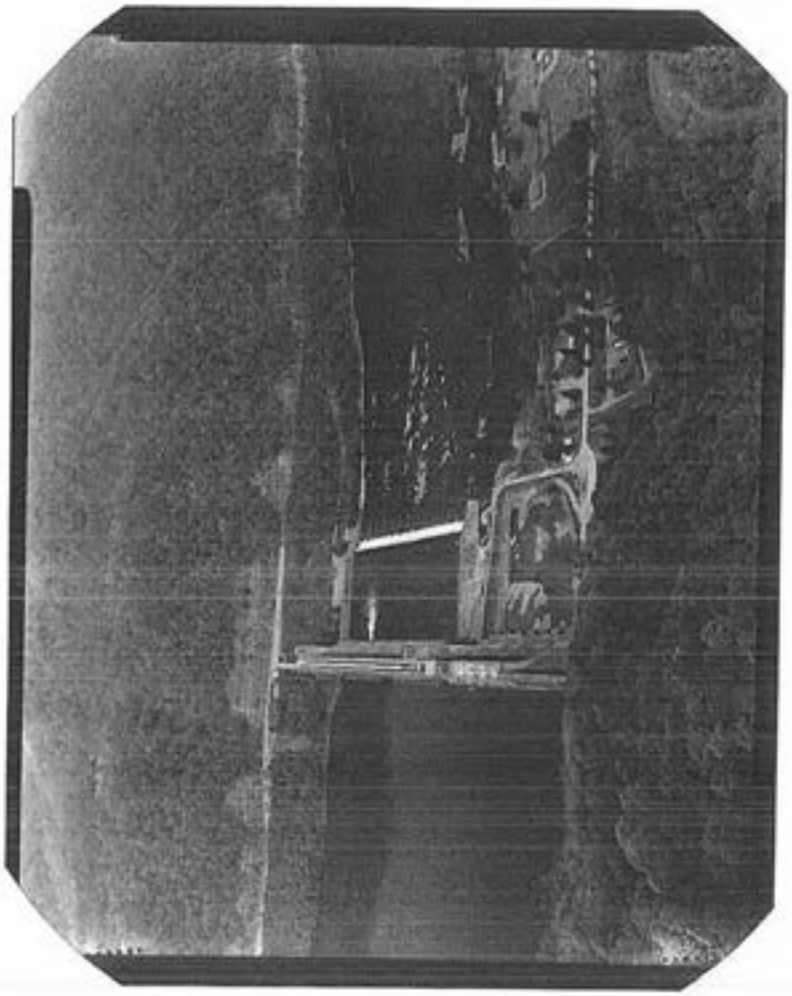

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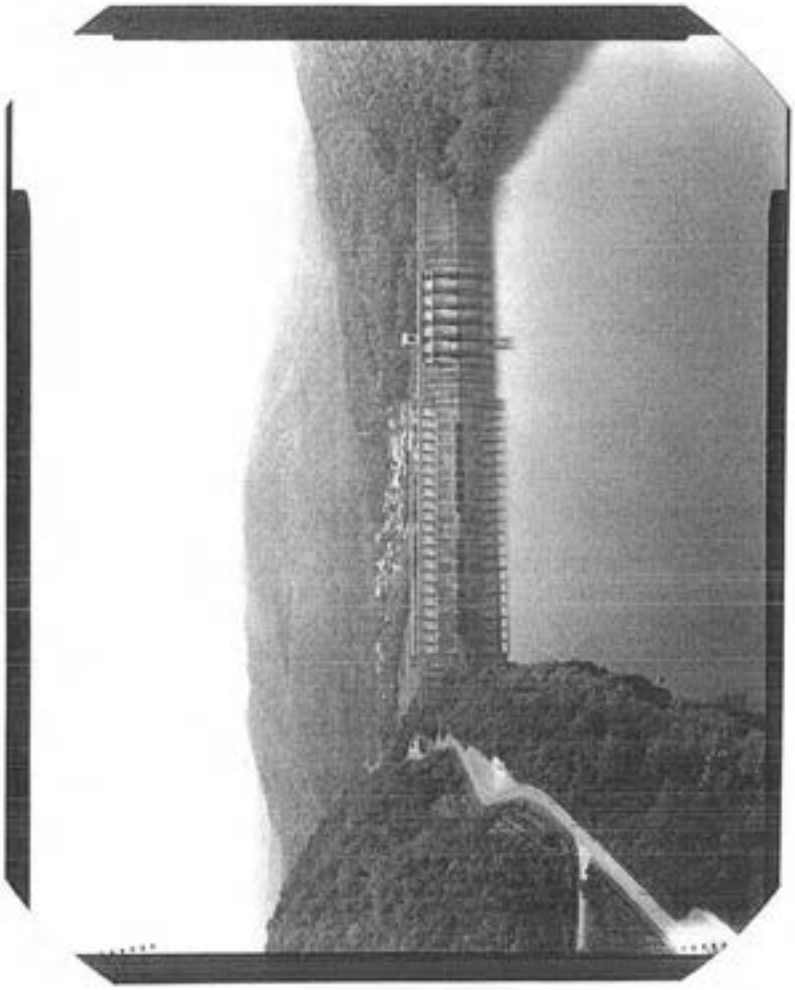

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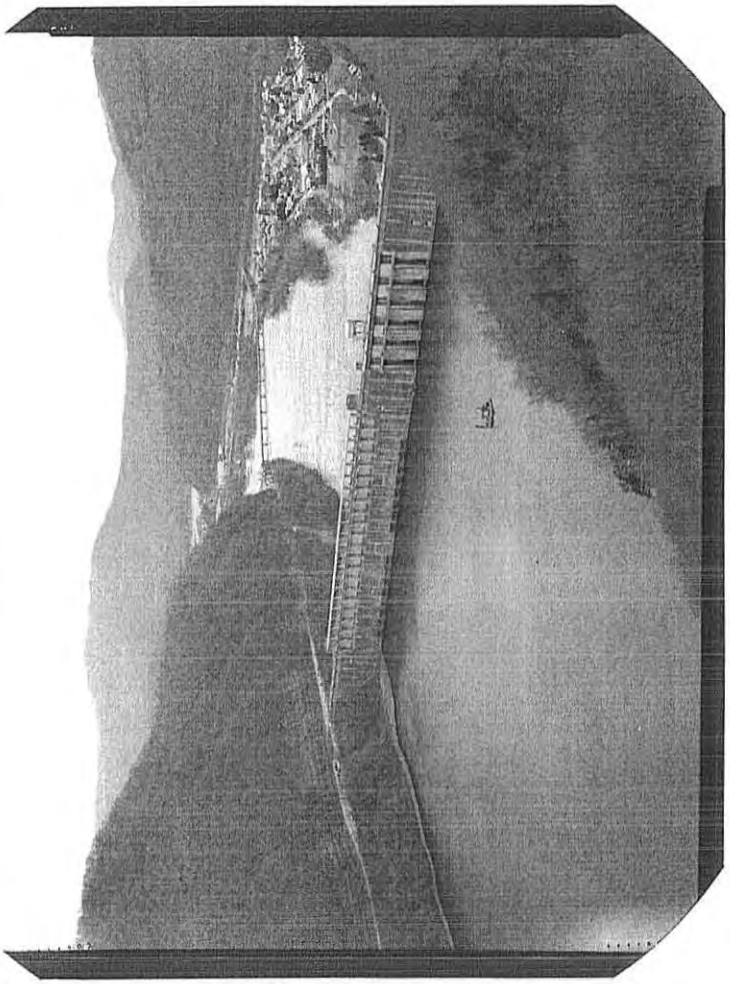

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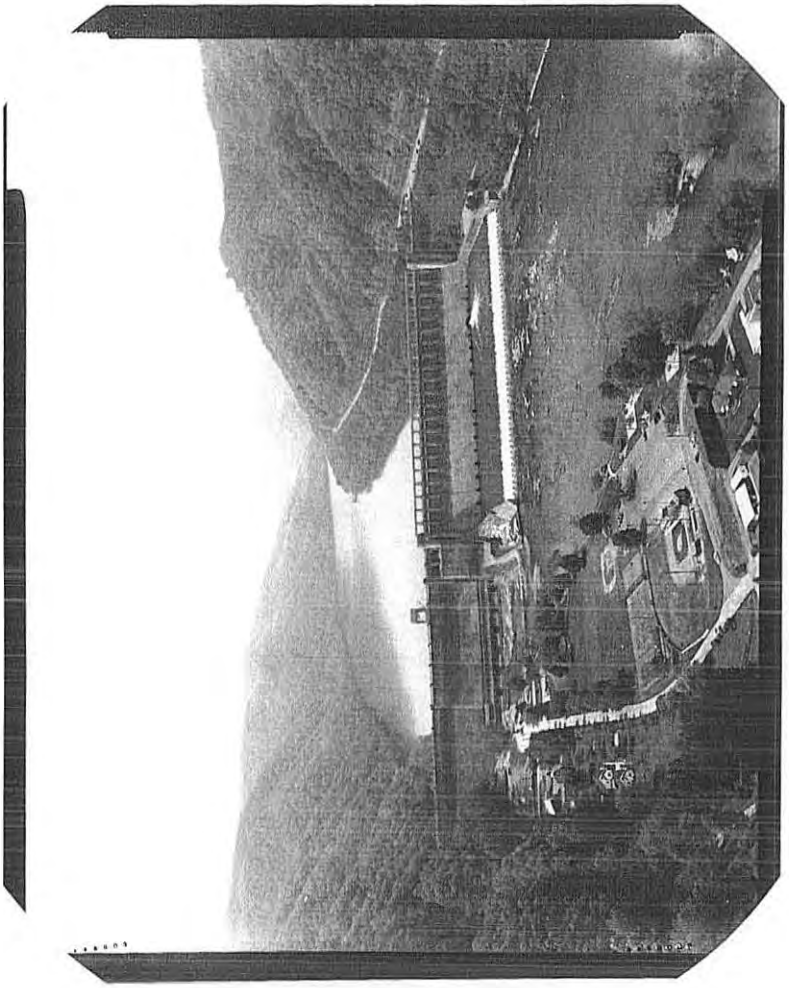

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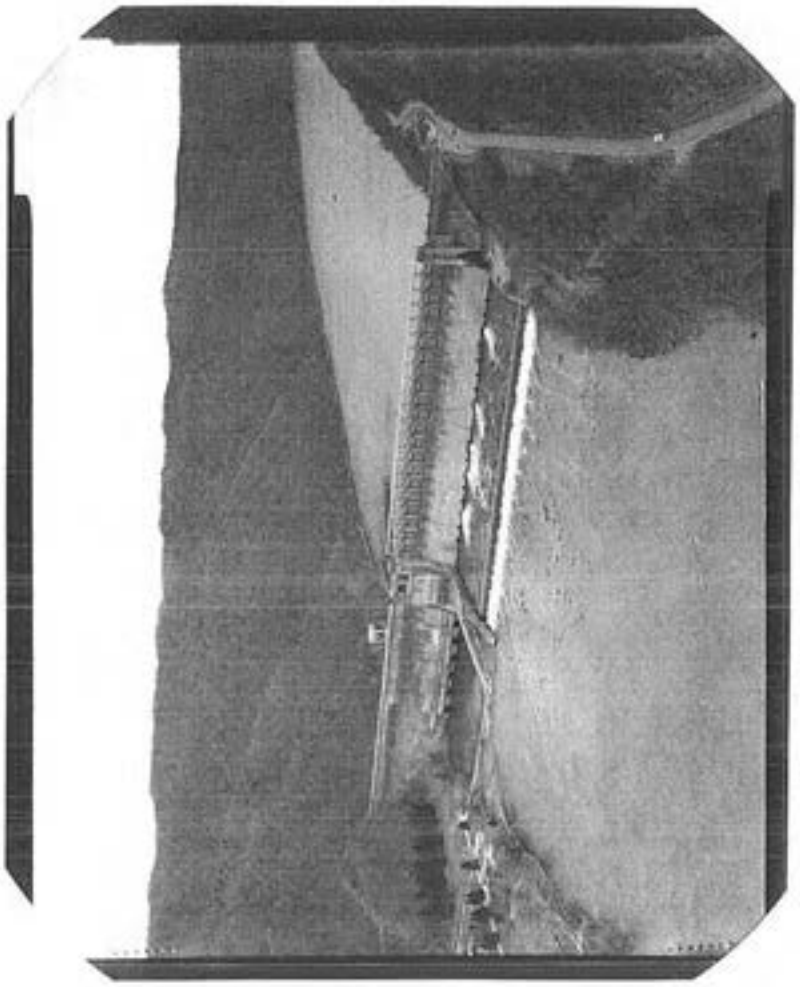

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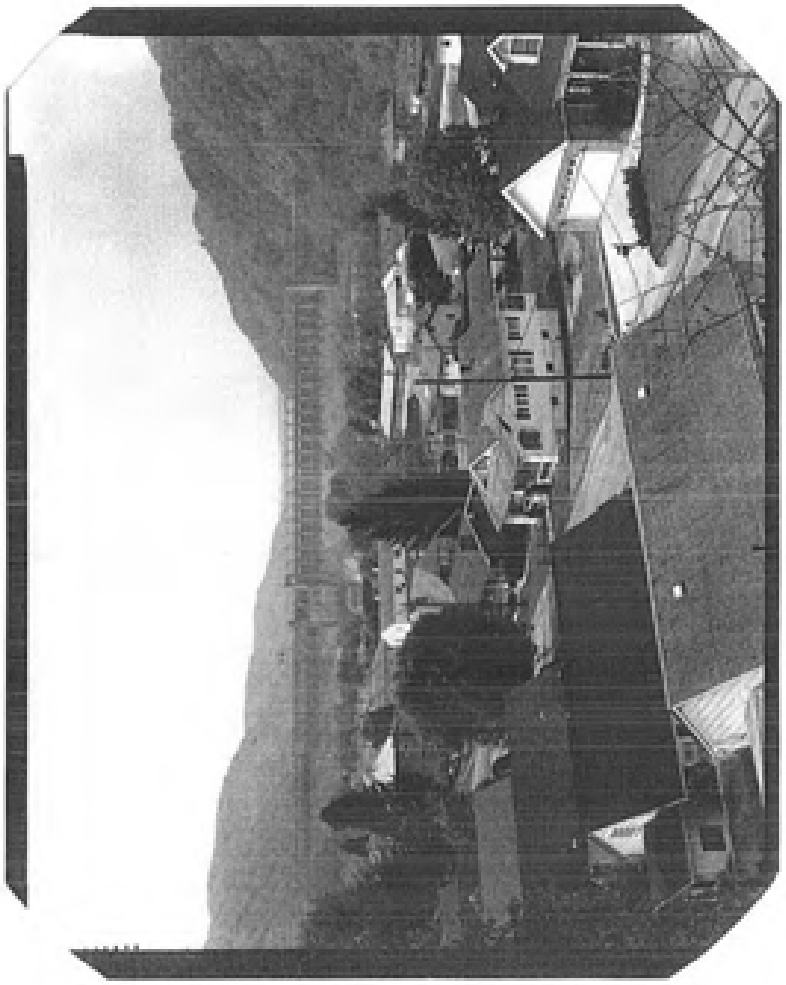

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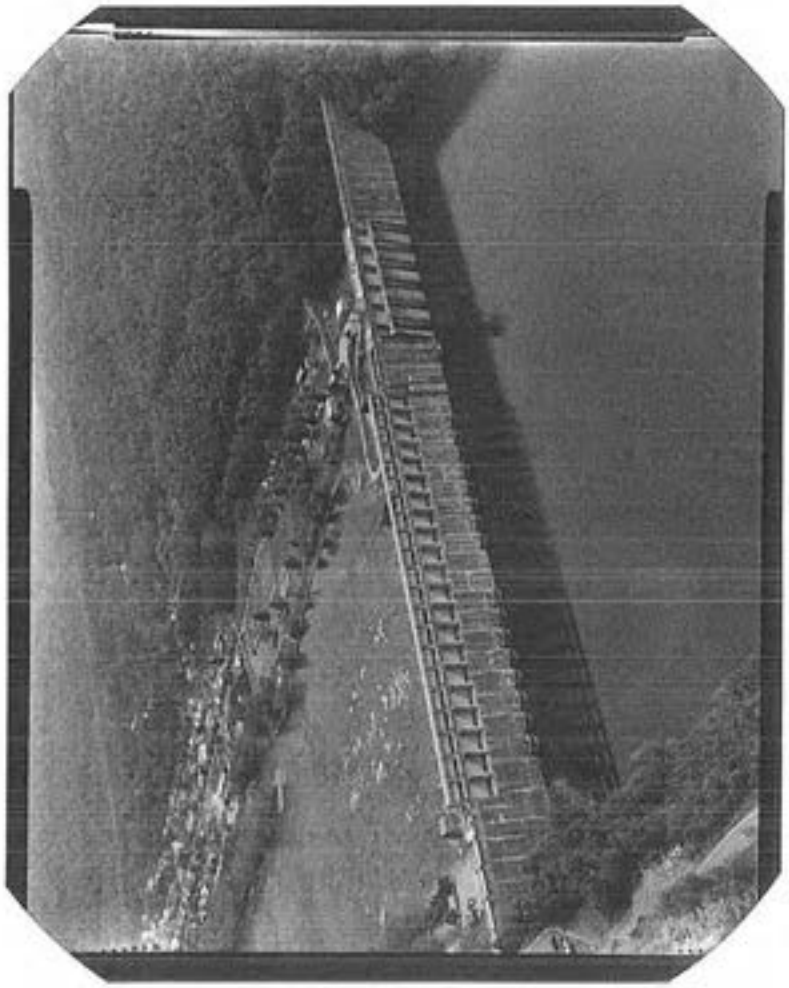

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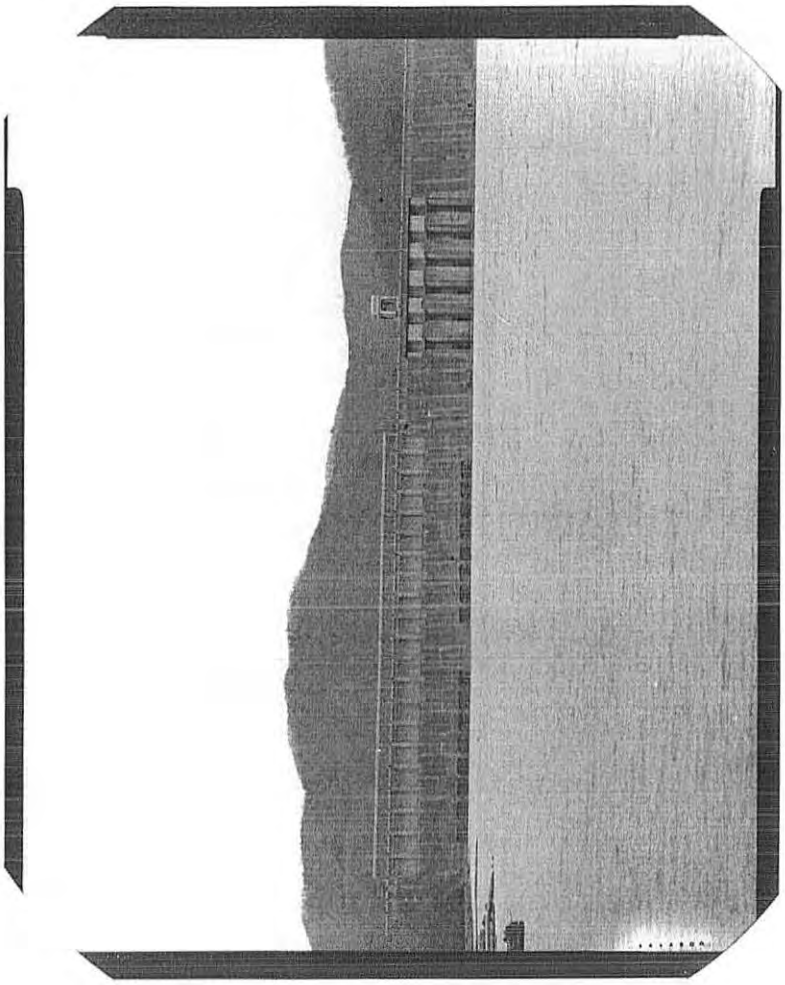

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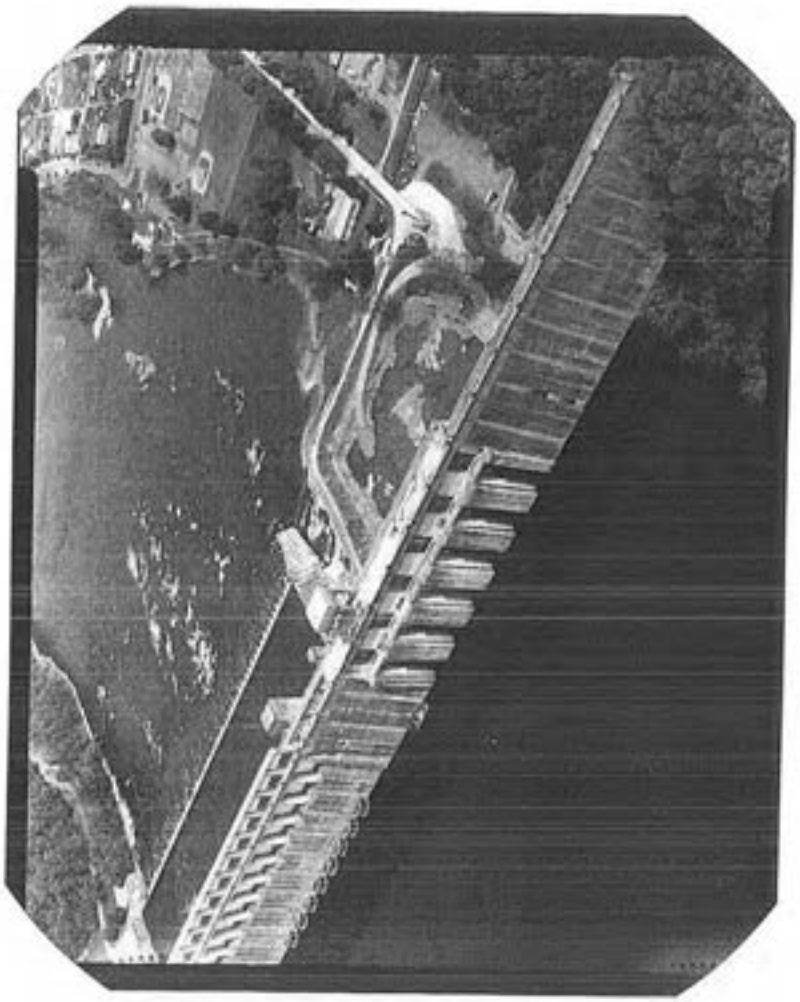

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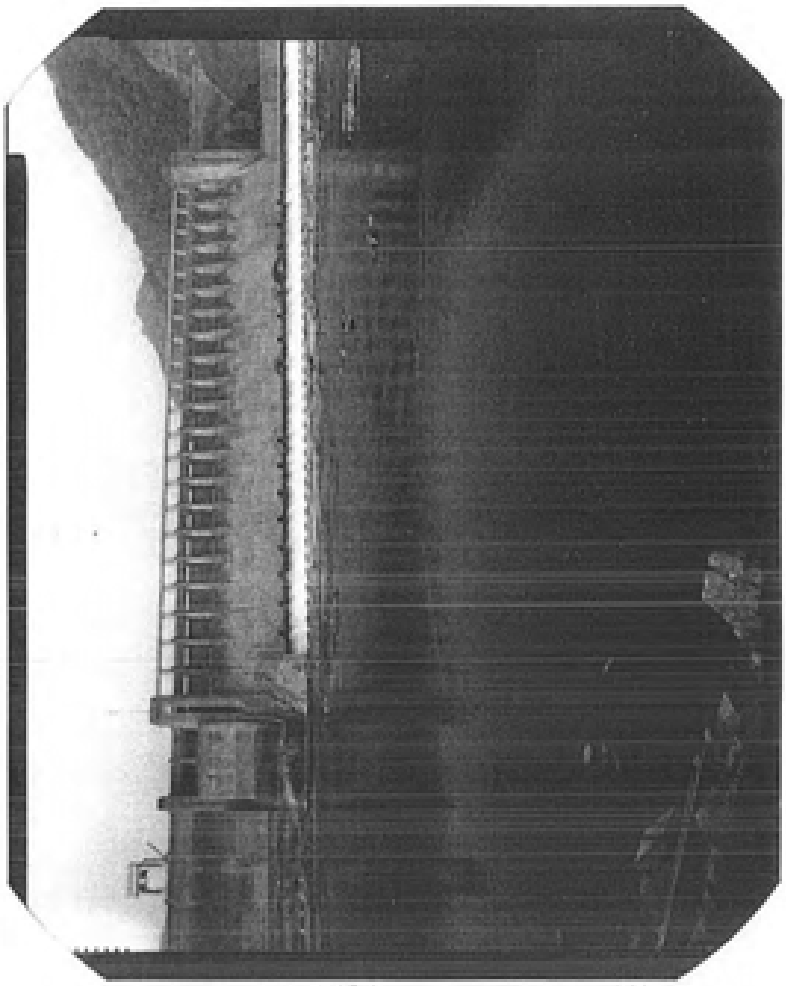

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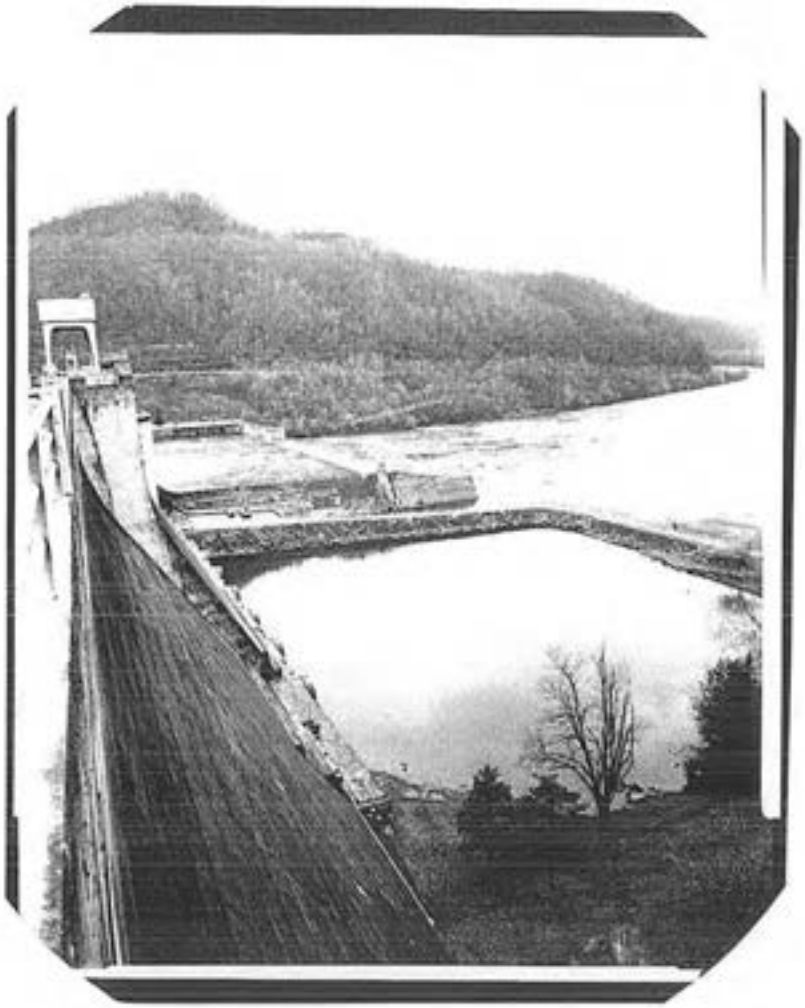

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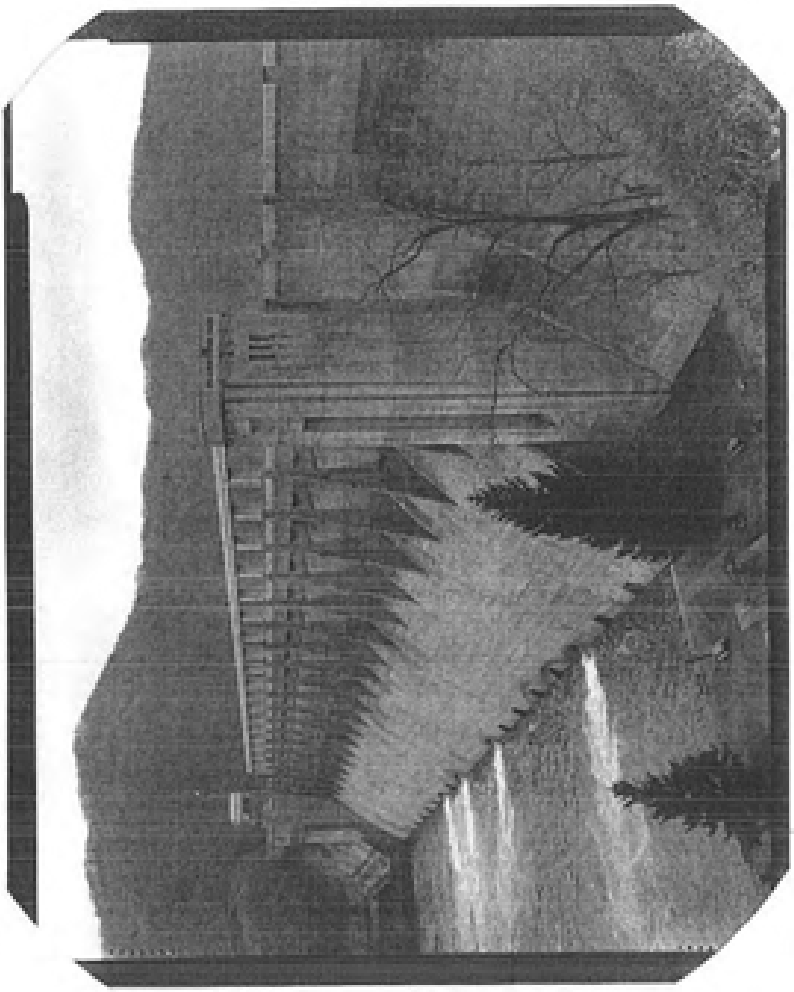

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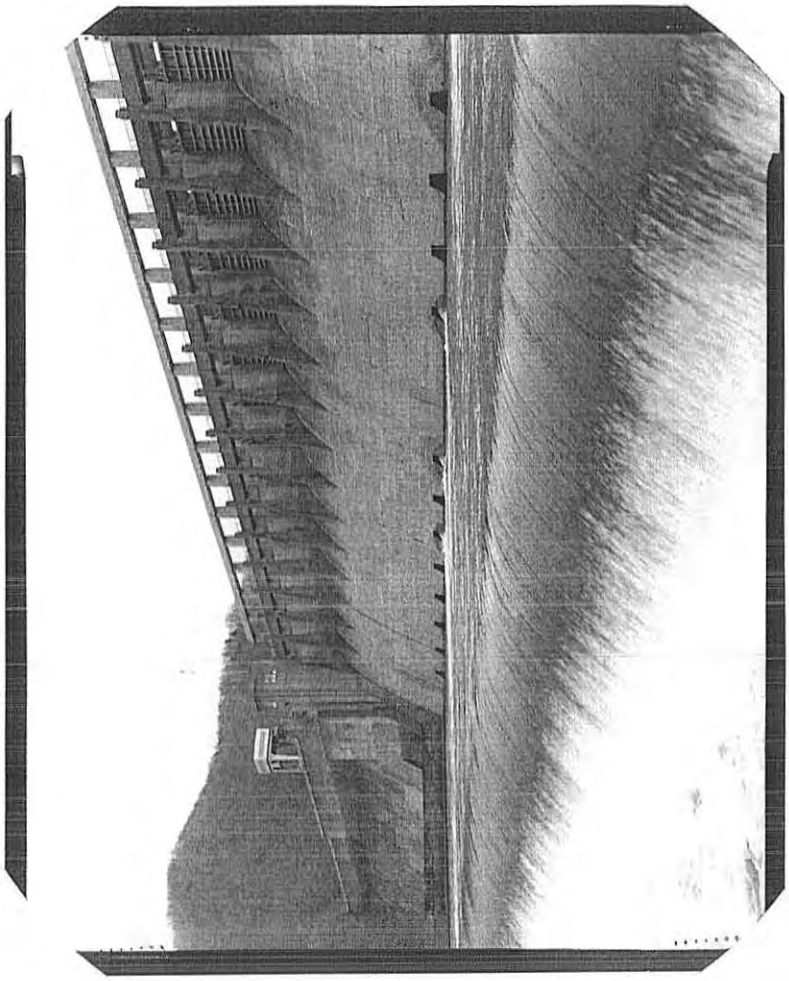

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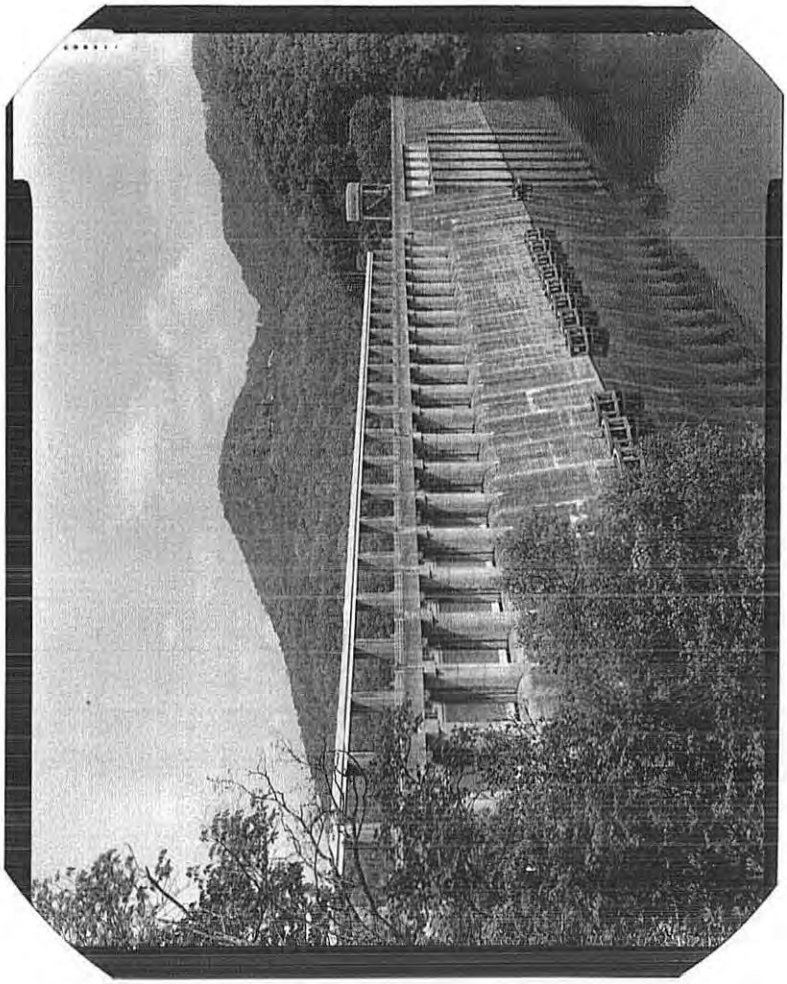

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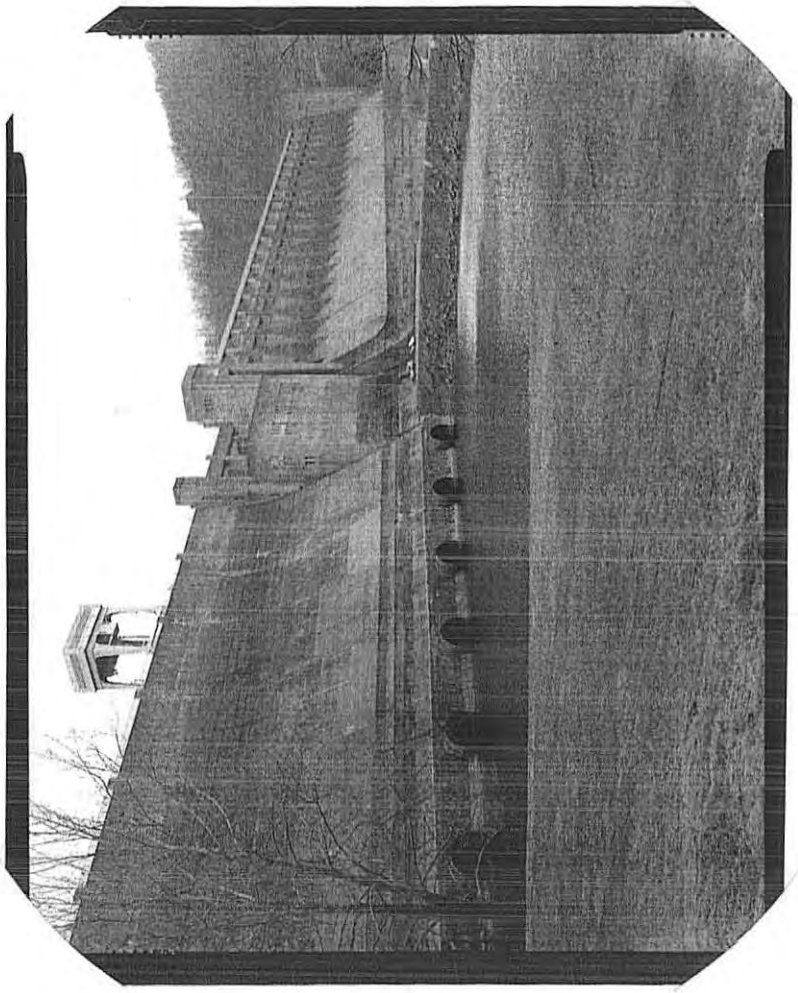

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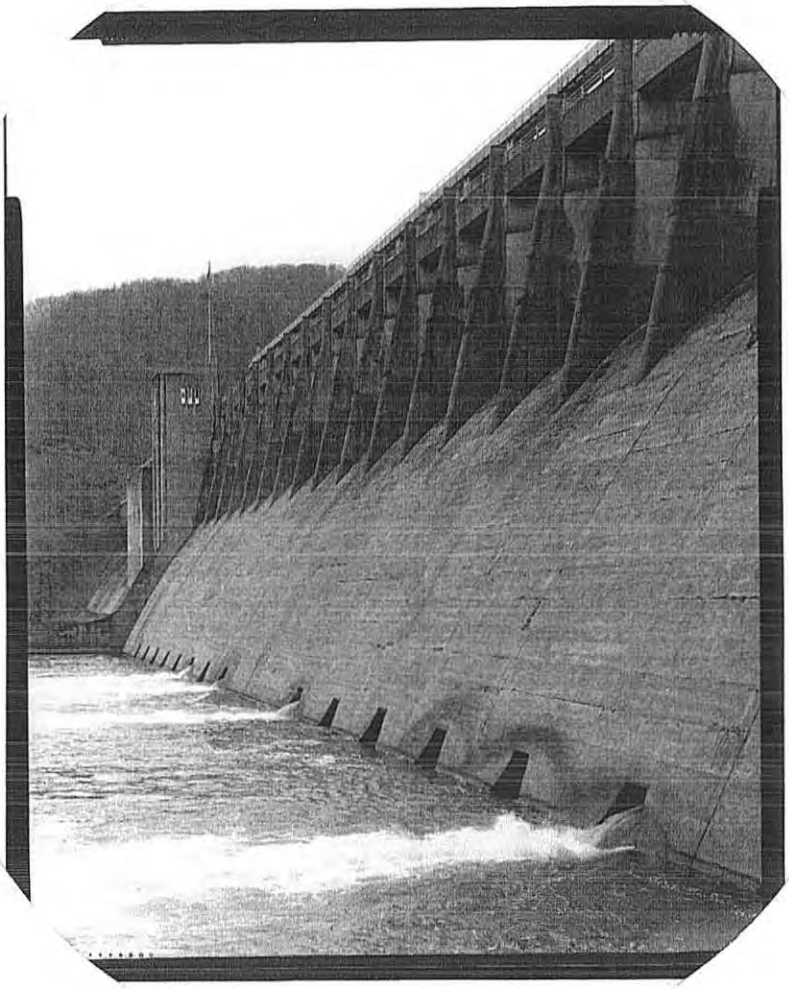

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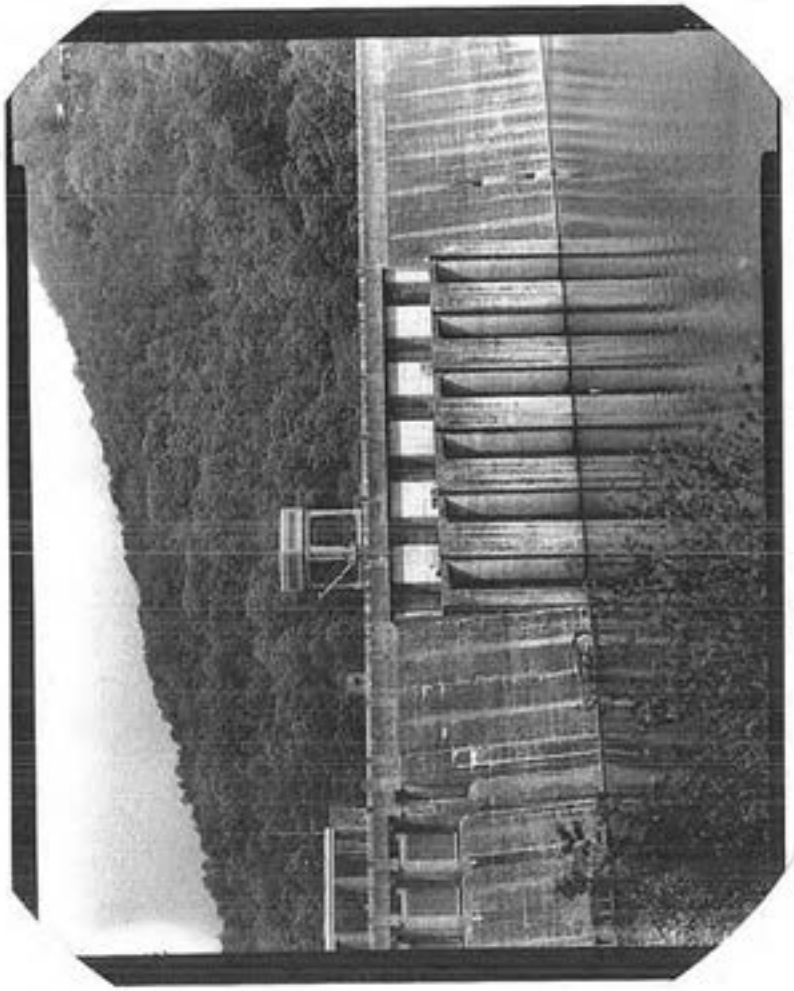

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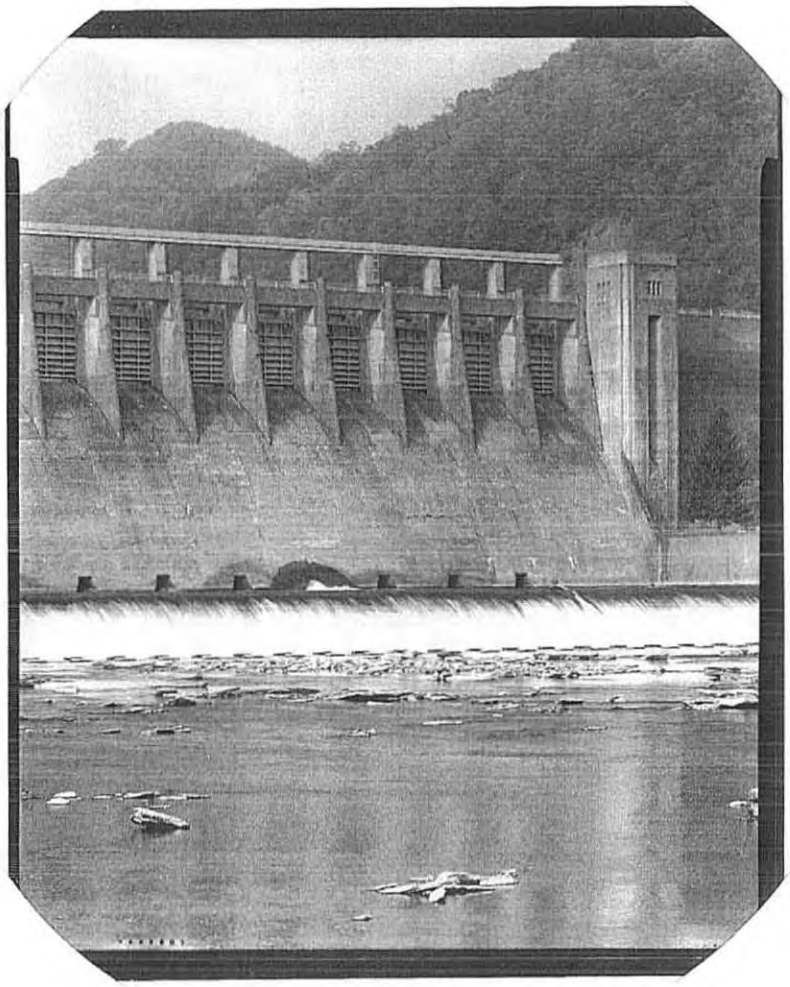

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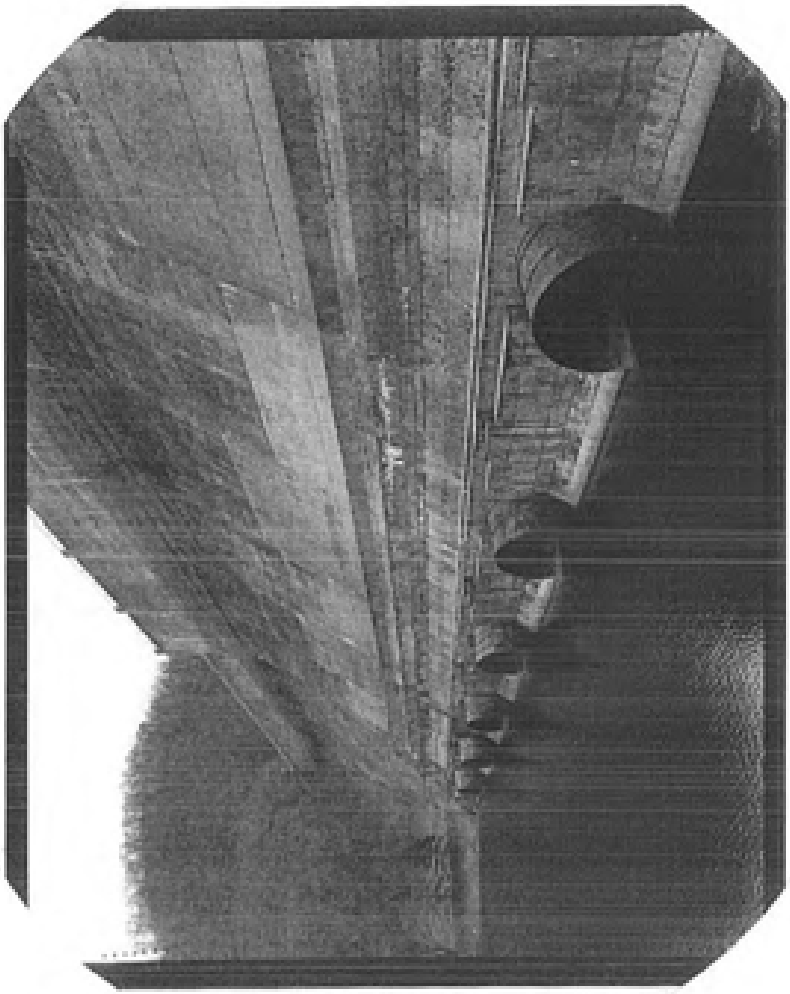

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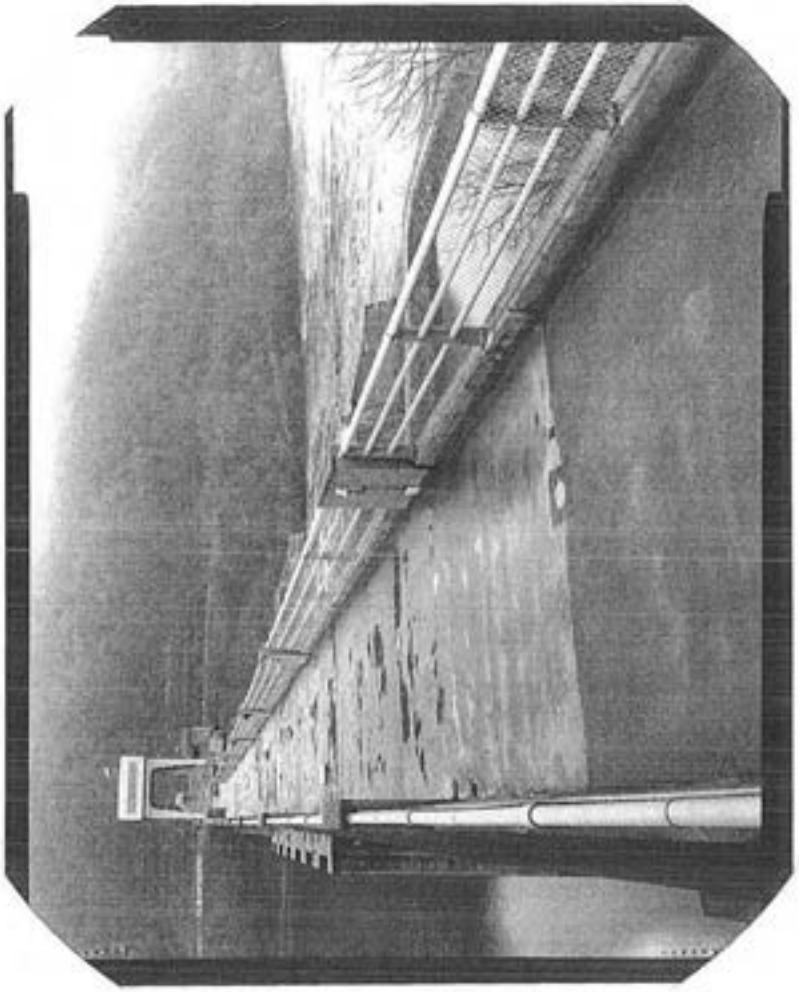

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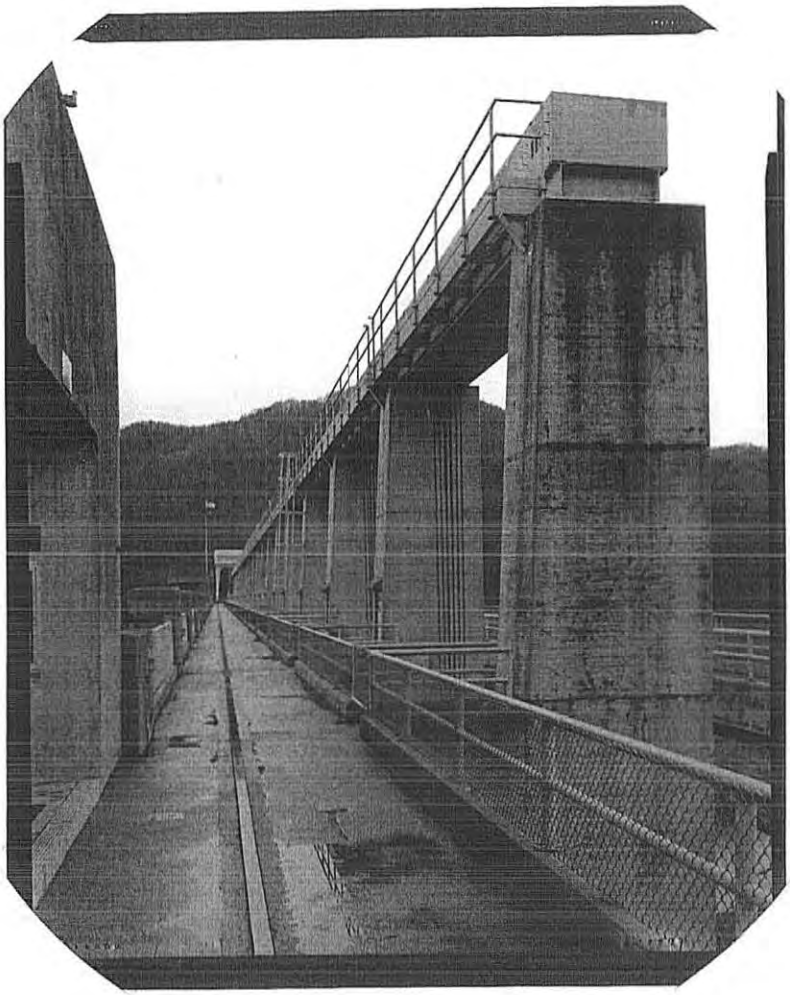

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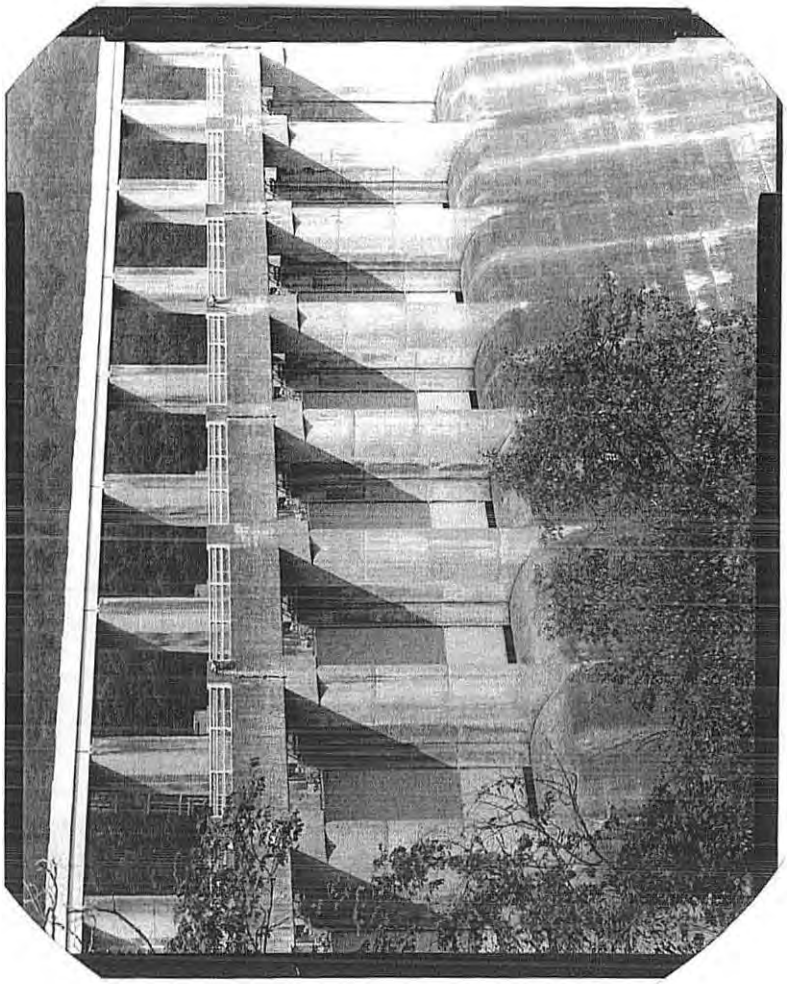

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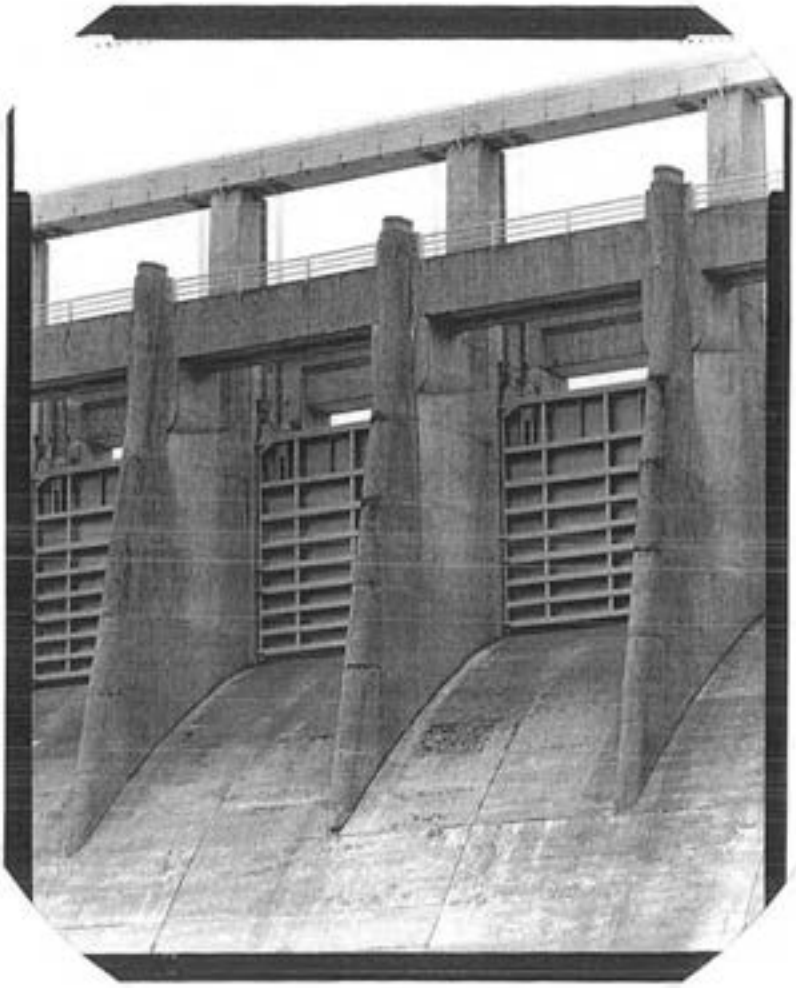

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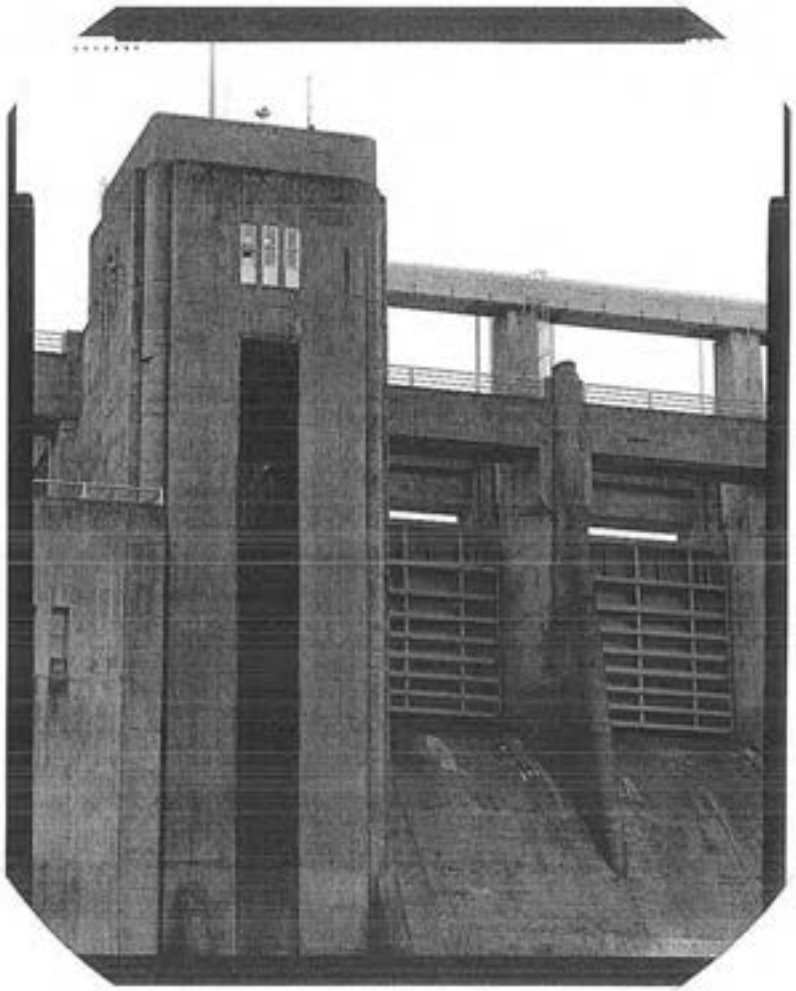

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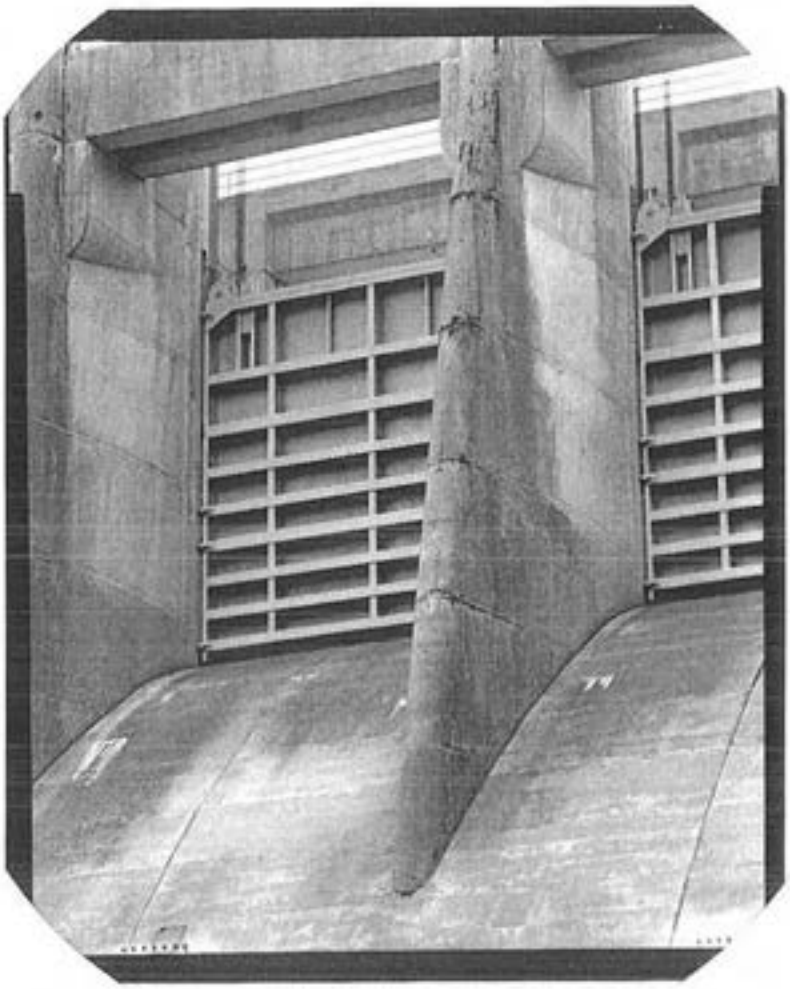

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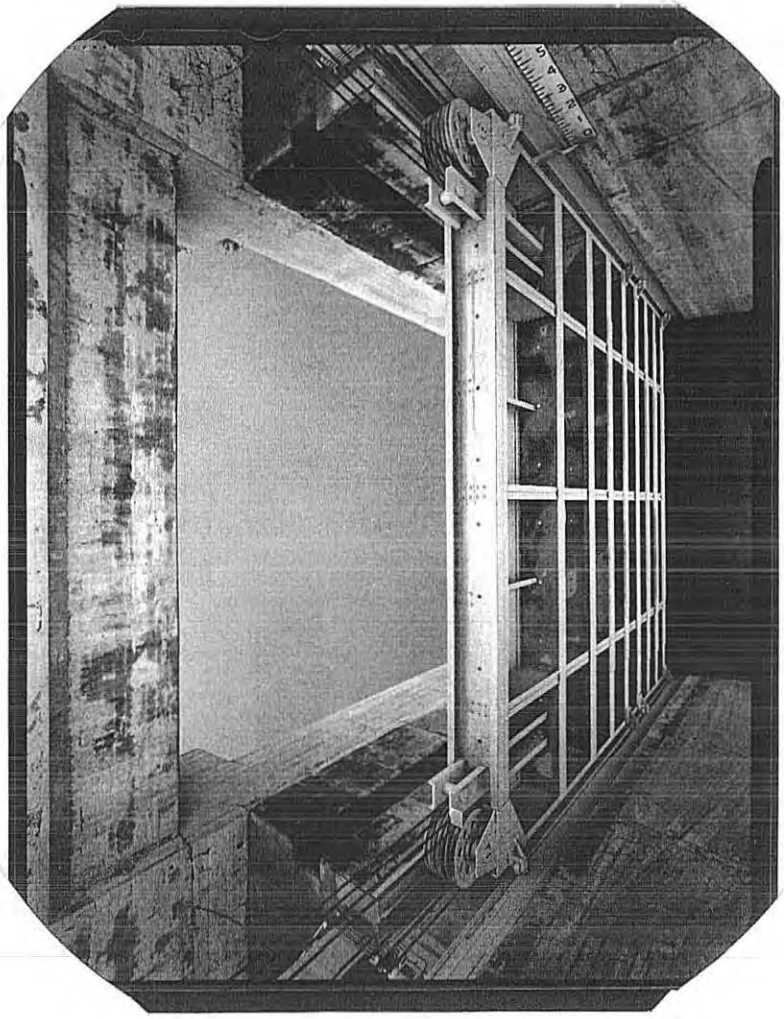

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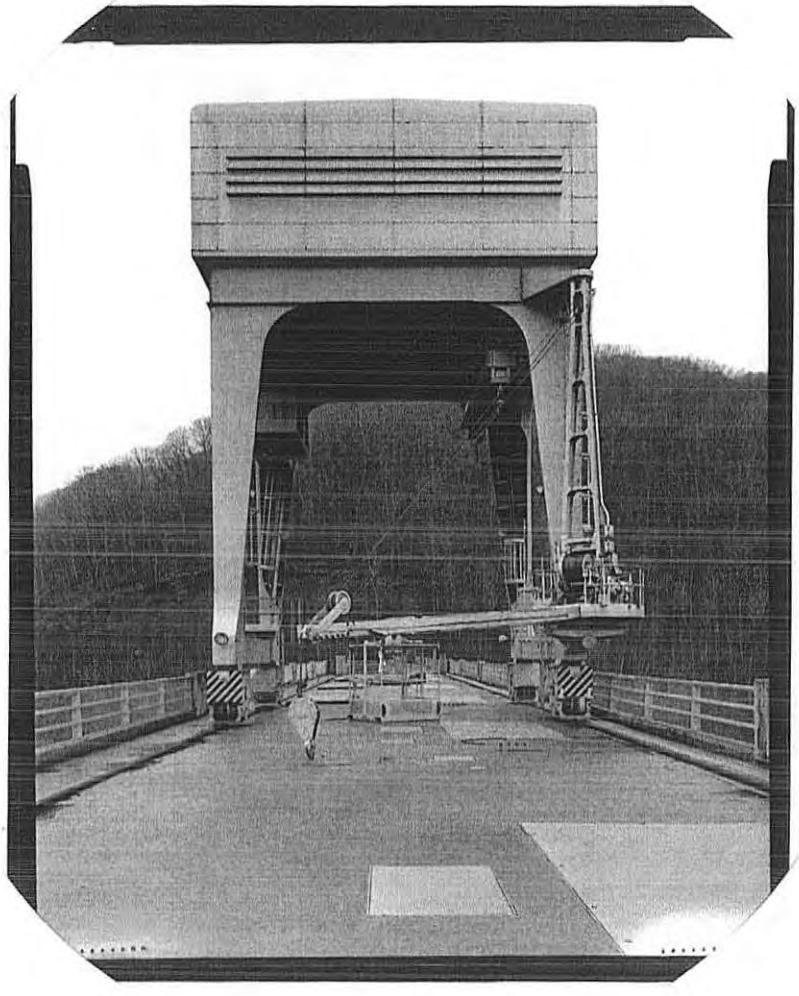

Contract Publication WV05-72

UPDATE TO THE HISTORIC PROPERTIES MANAGEMENT PLAN FOR BLUESTONE LAKE IN WEST VIRGINIA

By
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Cultural Resource Analysts, Inc.

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January 30, 2006

Lead Agency: U.S. Army Corp of Engineers, Huntington District
Contract No.DACW69-03-D-0005, Task Order No. 0017

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Chapter 1. Project Description and Background

Introduction

The U.S. Army Corps of Engineers, Huntington District (Huntington District), has fee-owned property and easements at Bluestone Lake, located on the New River in Summers, Mercer, and Monroe counties in West Virginia, and Giles County, Virginia (Figure 1-1). This report represents an update of the 1998 modification of the Historic Properties Management Plan (HPMP) for Bluestone Lake (USACE 1998).

The modified 1998 HPMP served as the framework for this report, and was in turn modified further to accommodate the Scope of Services for this update pursuant to the requirements set forth in Chapters 6-8 f of EP 1130-2-540 (Appendix A). New information was obtained from the Huntington District, the West Virginia State Historic Preservation Office (WVSHPO), and other primary and secondary sources.

Topics to be addressed by this HPMP update include:

1) project description and background;

2) the environmental setting of the reservoir;

3) relevant culture history;

4) the history of cultural resource investigations at the reservoir;

5) descriptions of the known cultural resources;

6) curation of known collections and associated radiocarbon dates;

7) impact zones, upland and reservoir processes, and the physical integrity of the cultural resources;

8) site evaluations and the identification of archaeologically sensitive landforms; and

9) management priorities, recommendations, and general policies.

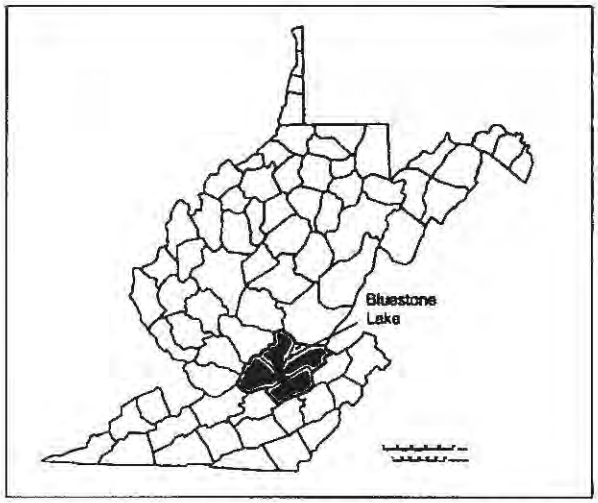

Figure 1-1. Location of Bluestone Lake in Mercer, Monroe, and Summers Counties, West Virginia, and Giles County, Virginia.

Bluestone Lake

The Bluestone Lake Project was authorized for construction by Executive Order No. 7183 dated September 12, 1935, the Flood Control Acts of June 22, 1935 and June 28, 1938, for flood control, hydroelectric power, recreation and fish and wildlife recreation purposes. The dam for Bluestone Lake is located three miles upriver from Hinton, West Virginia, and 65 miles upriver from where the New and Gauley rivers converge to form the Kanawha River. The Kanawha River continues north to join the Ohio River 162 miles downriver from the Bluestone Lake dam.

The project is located in the Appalachian Plateau physiographic province and the Southern Appalachian Ridges and Valleys land resource area (USDA 1981), with elevations ranging from 1370 ft amsl at the dam to 3000 ft amsl above the Bertha camping area (USACE 1975). Normal pool elevation is 1410 ft amsl, and the elevation during winter drawdown is 1406 ft amsl. The area considered under this management plan contains a total of 21,931 acres, of which

19,658 acres are leased to the West Virginia Department of Natural Resources (DNR) for park, recreation, fish, and wildlife purposes. At normal elevation, the lake itself contains 2,040 acres.

Bluestone Lake has a shoreline of approximately 29 miles. Most of the shoreline is steep, rocky, and forested along the seasonal pool elevation. The main portion of the lake is 10.8 miles long. The valley is narrow, causing the lake to have a ribbon like appearance. The lake has a mean width of 1,558 ft and a maximum depth at the dam of 42 ft at normal pool elevation (USACE 1975).

Organization and Content of Report

This report is organized into eight chapters. The environmental setting of the project area is described in Chapter 2, including a discussion of physiography, geology, geomorphology, soils, hydrology, climate, and flora and fauna. Chapter 3 presents a culture history for southeastern West Virginia, while a review of relevant archaeological investigations previously conducted within associated counties is provided in Chapter 4. Chapter 5 presents a discussion of identified sites, with descriptions, locations, and other characteristics provided on a site by site basis. Chapter 5 also provides information for existing collections, including curation location and associated accession numbers, as well as an inventory and brief discussion of radiocarbon assays. Processes of site disturbance, impact zones, and site integrity are discussed in Chapter 6. Discussion centers on National Register of Historic Places (NRHP) evaluations and the identification of archaeologically sensitive landforms in Chapter 7. Management recommendations and summary statements are provided in Chapter 8.

Chapter 2. Environmental Setting

Introduction

Bluestone Lake is located on the New River in Summers, Mercer, and Monroe counties in West Virginia, and in Giles County, Virginia. The lake begins north of The Narrows in Giles County, Virginia, flowing northward into Mercer and Monroe counties, West Virginia briefly before running through the heart of Summers County, West Virginia (Figure 2-1). The boundaries presented in Figure 2-1 are based on the USACE Monumentation and Boundary Line (MBL) Map of Bluestone Lake. This map was originally completed in 1973, and updated in 1980. The Huntington District Bluestone Lake Real Estate Map, originally dated 1953 and updated in 1989, was also employed as part of the GIS boundary mapping for this project. Horizontal control is based on the 1927 North American Datum.

Physiography, Geology, and Soils

Bluestone Lake is located in the Appalachian Plateau physiographic province, just west of the Allegheny Front, and is within the Southern Appalachian Ridges and Valleys land resource area (USDA 1981, 1984). The Southern Appalachian Ridges and Valleys land resource area is a broad band of northeast-southwest trending ridges and valleys extending from Pendleton County southwest through Summers County and into Mercer County (USDA 1981). Most of the area has steep or very steep hillsides and ridges that are separated by the less sloping valleys.

The Bluestone Lake area is underlain by gently- to strongly-folded rocks of the Mauch Chunk Group. The Mauch Chunk Group is a Mississippian system comprised of (in descending order of extent) the Bluestone, Princeton, Hinton, and Bluefield formations (USDA 1984). These formations consist of red, green, and gray shale and sandstone, with a few thin limestone beds present in the Hinton and Bluestone formations.

The upper portion of Bluestone Lake, from the dam at Hinton south to Toms Run, consists of soils from the Calvin and Berks-Gilpin soil associations (USDA 1984). These associations represent moderately deep, strongly-sloping to very steep, well-drained upland soils. South of Toms Run and Bull Falls to the Virginia border the lake narrows back to the original New River width as it becomes surrounded by soils of the Monongahela-Kanawha-Chagrin soil association in Crump's Bottom. These soils are deep, nearly level to strongly-sloping, well-drained, and moderately well-drained soils on stream terraces and floodplains. The Calvin and Berks-Gilpin soil associations found adjacent to the northern portion of the lake are found in the uplands above the stream terraces and floodplains in this southern area.

Climate

The climate in this area of West Virginia is continental in character and temperature and precipitation levels can fluctuate widely. The prevailing winds are westerly and most of the storms cross the state in a west to east pattern. Low-pressure storms that originate in the Gulf of Mexico and move in a northeasterly direction across West Virginia contribute the greater proportion of precipitation received by the state. Warm, moist, tropical air masses from the Gulf predominate during the summer months when humidity levels also remain quite high. As storms move through the state, occasional hot and cold periods of short duration may be experienced. During the spring and fall, storm systems tend to be less severe and have a lesser frequency, thus resulting in less radical extremes in temperature and rainfall.

Summers County winters are typically cold and snowy at higher elevations. In the valleys intermittent thaws preclude a long-lasting snow cover. Summers are relatively

warm on mountain slopes and very warm with occasional very hot days in the valleys. Rainfall is evenly distributed throughout the year, but heavier amounts occur on the windward, west-facing slopes than in valleys.

At Bluestone Lake the average winter temperature is 34 degrees F. The average daily minimum temperature is 24 degrees F. In summer, the average temperature is 72 degrees F at Bluestone Lake, with the average daily maximum temperature being 79 degrees F. In the general project area the average annual temperature is 52 degrees F. At Bluestone Lake the total annual precipitation is 35 inches. Of this amount, approximately 60 percent usually falls in the period from April to September. Thunderstorms occur on about 45 days per year. Average seasonal snowfall totals about 21 inches at Bluestone Lake.

As discussed by Niquette and Donham (1985), climatic conditions during the Holocene age represented a series of transitions in temperature, rainfall, and seasonal patterns. These transitions created a seemingly infinite range of ecological variation across time and space, both limiting and expanding survival strategies of human populations.

The beginning of the Holocene Age, between 11,300 and 12,700 BP, was associated with major and fairly rapid warming temperatures, decreases in cloud cover, and generalized landscape instability (Delcourt 1979; Webb and Bryson 1972). Estimated temperature increases during this period were three times greater than later Holocene fluctuations (Webb and Bryson 1972). During the early Holocene, rapid increases in boreal plant species occurred on the Allegheny Plateau in response to the retreat of the Laurentide ice sheet from the continental United States (Maxwell and Davis 1972; Whitehead 1973). At lower elevations, deciduous species returned after having migrated to southern Mississippi Valley refugia during the Wisconsin advances (Delcourt and Delcourt 1981).

The climate during the early Holocene was considerably cooler than modern climate and extant species in upper altitude zones of the Allegheny Plateau reflected conditions most similar to the Canadian boreal forest region (Maxwell and Davis 1973). Conditions at lower elevations were less severe and favored the transition from boreal to mixed mesophytic species. Paleoindian sites in the eastern United States are generally associated with the Early Holocene or Pleistocene-Holocene interface, but Late Pleistocene sites are also known. Middle Holocene (8000 - 4000 BP) climate conditions appear to have been consistently dryer and warmer than twentieth-century conditions (Delcourt 1979; Wright 1968). The influx of westerly winds during this Hypsithermal climatic episode contributed to periods of severe moisture stress in the Prairie Peninsula and to an eastward advance of prairie vegetation (Wright 1968). Delcourt has identified Middle Holocene moisture stress along the Cumberland Plateau in Tennessee, but indicates that upland barrens did not expand appreciably as did the midwestern prairies (Delcourt 1979). Changes in Archaic settlement patterns in both central and northern Missouri have been associated with possible decreases in upland resource availability during the episode (Joyer and Roper 1980; Warren 1982).

The earliest distinguishable Late Holocene climatic episode began around 4000 - 5000 BP and ended around 2800 BP. This episode is associated with the establishment of essentially modern deciduous forest communities in the southern highlands and increased precipitation across most of the mid-continental United States (Delcourt 1979; Maxwell and Davis 1972; Warren and O'Brien 1982). Beginning around 2800 BP, generally warm conditions, probably similar to the twentieth century, prevailed until the onset of the Neo-Boreal episode around 700 BP. Fluctuations in this Late Holocene Pacific episode appear to have varied locally, with either increased or decreased temperatures and precipitation (Baerris, Bryson and Kutzbach 1976; Warren and O'Brien 1982).

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6-3
6-4
6-5
6-6
6-8
6-9
6-10
Legend
Bluestone Lake USACE Boundaries 1980
Transferred to NPS 1989
6-x Figure Reference
Site Type
Prehistoric
Historic
Prehistoric and Historic
Unknown
Not From GPS Data

Certain of these fluctuations have been associated with adaptive shifts in midwestern prehistoric subsistence and settlement systems. An example is Struever and Vickery's (1973) suggestion of a possible correlation between the onset of a cooler, moister period around 1600 BP and increased use of *polygonum* (knotweed) by Late Woodland groups in the Midwest (Struever and Vickery 1973:1215-1216). During this same period (1600-1300 BP) warmer temperatures have been inferred for the Great Plains and dryer conditions for the Upper Great Lakes (Baerreis et al. 1976; Warren and O'Brien 1982). Other fluctuations during the Pacific episode are similarly non-uniform across the midcontinental United States; however, the interfaces of all fluctuations are generally consistent. Local paleoecological evidence is required in order to determine the kinds of climatic fluctuations Woodland populations experienced during the Pacific episode. Given evidence of fluctuations elsewhere, it is most likely that changes occured around 1700 BP, 1300 BP, and 900 BP, with a possible fourth change around 2300 BP.

Recent studies of historic weather patterns and tree ring data by Fritts, Lofgren, and Gordon (1979) have indicated that climatological averages were "unusually mild" when compared with seventeenth - nineteenth century trends (Fritts et al. 1979:18). Their study suggests that winters were generally colder, weather anomalies were more common, and unusually severe winters were more frequent between 1602 and 1899 than after 1900. These cooler, moister conditions were associated with the Neo-Boreal episode, or Little Ice Age, which began around 700 BP and coincided with minor glacial advances in the northwest and Europe (Denton and Karlan 1973; Warren and O'Brien 1982). This episode is viewed by Warren and O'Brien (1982) as a causal factor in vegetation pattern shifts in northeast Missouri.

The effects of the Neo-Boreal episode, which ended during the mid- to late-nineteenth century, have not been studied in detail for this region. Despite this, it appears that the area experienced less radical temperature decreases during the late Neo-Boreal than did the upper Midwest and northern Plains (Fritts et al. 1979). Related changes in extant vegetation should therefore be more difficult to detect. It is probably safe to assume, however, that average temperatures were at least a few degrees cooler during the late Prehistoric and early Historic periods. The frequency of severe winters and average winter precipitation were probably greater as well.

Floral Resources

Bluestone Lake is included in the Mixed Mesophytic Forest Region. The forest associations found in this region are the oldest and most complex of the deciduous forests. Mesophytic refers to a climax community where dominance is shared by several species.

Approximately 15,490 acres of project land located above seasonal pool are forested with approximately 4,400 acres of cleared land located on the bottomlands and ridgetops. Canopy tree species include white oak, red oak, black oak, scarlet oak, chestnut oak, pitch pine, Virginia pine, American beech, tulip tree, basswood, sugar maple, white pine, black maple, hemlock, red maple, black walnut, American elm, black locust, shagbark hickory, butternut hickory, and American planetree. Understory species include black tupelo, sassafras, flowering dogwood, sourwood, redbud, striped maple, magnolia, serviceberry, hop hornbeam, American holly, and witch hazel. Common shrubs and herbs include mountain laurel, azalea, smilax, hydrangea, paw paw, viburnums, spicebush, gooseberry, elderberry, rattlesnake plantain, alumroot, wood tickseed, Christmas fern, maidenhair fern, lady fern, Jack-in-the-pulpit, Solomon's seal, trillium, goldenseal, hepatica, mayapple, bloodroot, violets, wild phlox, bluebells, foam flower, stonecrop, and Dutchman's breeches (USACE 1975:13).

Faunal Resources

The types of faunal species inhabiting southern West Virginia and Summers County have changed in response to broader environmental changes and climatic

fluctuations over the last 12,000 years. Extinct late Pleistocene species might have included giant beaver, stag moose, mammoth, mastodon, horse, giant ground sloth, and dire wolf (Funkhouser 1925; Jillson 1968). With the retreat of the Wisconsin ice sheets and the onset of more moderate climatic conditions, these species were replaced by modern types such as turkey, passenger pigeon, caribou, wolves, and buffalo. Today, the area is inhabited by a wide range of animals including beaver, bobcat, eastern cottontail, white-tailed deer, groundhog, gray and red fox, muskrat, raccoon, fox and gray squirrel, grouse, quail, wild turkey, and woodcock. Local rivers support such fish species as largemouth bass, spotted bass, black crappie, channel catfish, flathead catfish, sunfish carp, and sucker.

Chapter 3. Culture History

Introduction

Discussion of culture history is restricted primarily to the Bluestone Lake area whenever possible, although references to West Virginia in general and other external areas are made when local information is lacking. The culture history is described using broad temporal divisions that are generally accepted by scholars, beginning with the earliest appearance of human groups in the New World.

Prehistoric Culture History

Pre-Clovis Period

In the eastern United States, support for "Early Entry" is provided by a small number of professionally excavated sites. Evidence for pre-Clovis occupation at these sites is based on information obtained from relative and/or absolute dating. Although very little is known about this early period of occupation, archaeologists are becoming more aware of both the contexts in which such sites occur and the types and styles of diagnostic artifacts as more sites are identified and excavated.

Over the last decade a growing body of data has accumulated supporting a pre-Clovis occupation in North America, including areas in the upper Ohio Valley and Southeast where technologically distinct lithic assemblages have been recovered from contexts located stratigraphically below Early Paleoindian contexts (Adovasio et al. 1999; Goodyear 1999; McAvoy and McAvoy 1997). The few available uncorrected radiocarbon dates place this occupation at approximately 15,000 to 13,000 B.C.

Two of the most important sites reported to contain pre-Clovis components are located in relatively close proximity to West Virginia. The first site is Meadowcroft Rockshelter (36Wh297) located in extreme western Pennsylvania (Adovasio et al. 1999). At Meadowcroft, a sequence of deeply-stratified archaeological deposits has been unearthed, with interpretation of chronology in large part based on 52 radiocarbon dates, 13 of which are older than 10,850 ± 870 B.C. (Adovasio et al. 1999). All but four of the dates are internally consistent. The earliest cultural deposits at the site, both stratigraphically and temporally, are classified as belonging to the Miller complex, which, according to Adovasio et al. (1999), appears to represent the pioneer population in the upper Ohio Valley and perhaps the Northeast. Using existing radiocarbon dates, this manifestation appears to pre-date 13,000 B.C.

The Cactus Hill site (44Sx202) in Sussex County, Virginia, is a stratified open-air site located on an eolian sand dune. The site was found to contain a long record of occupation that included late Pleistocene and early Holocene components. McAvoy and McAvoy (1997) documented the presence of an occupation located stratigraphically below a Clovis stratum. White pine charcoal recovered from a feature-like deposit was dated to 13,120 ± 70 B.C. A second radiocarbon assay of 14,720 ± 730 B.C. for this occupation was obtained from a feature-like deposit in association with a cluster of prismatic blades. The presence of an overlying occupation with western-style Clovis points dating to 8970 ± 250 B.C. is highly significant because it supports the integrity of the site's stratigraphic record (Goodyear 1999). Together, information from these sites strongly suggests that parts of the eastern U.S., including the general area of West Virginia, was inhabited several thousand radiocarbon years before the first Clovis hunters entered the region. Existing data, although incomplete, fails to provide observable culture-historic linkage between pre-Clovis and Clovis, at least as viewed from Meadowcroft and Cactus Hill, where the occupations are characterized by disparate technologies separated by thousands of radiocarbon years.

Little information for examining the functional variability of Pre-Clovis sites is available, although it is evident that both rockshelter and open-air settings were utilized. At Meadowcroft Rockshelter the pre-Clovis inhabitants reduced chert cores and thinned and refurbished bifaces made from a variety of local and regional raw materials, including Kanawha Black Flint from West Virginia. On this basis, Adovasio et al. (1999) interpret the organization of the lithic system as curated rather than expedient. The presence of fire hearths and ash lenses indicated fires were important and possibly served as an anchor to which many other activities were tethered. The site may have been occupied repeatedly during this period by small, kin-based groups.

The pre-Clovis occupation at Cactus Hill is represented by a small assemblage of materials recovered from secure contexts, in large part mirroring the types of materials documented at Meadowcroft Rockshelter. The presence of hearths and possible shallow features, in combination with the type and quantity of materials recovered, suggest the site was used as some type of short-term camp. More specific information is not available.

The flaked stone assemblage from the pre-Clovis levels at Meadowcroft Rockshelter contains small prismatic blades, prepared polyhedral cores, and unfluted lanceolate points. The core and blade industry has been described as having an Eurasiatic, Upper Paleolithic flavor (Adovasio et al. 1999). The pre-Clovis assemblage is viewed as distinct and lacking apparent connections with Clovis. Adovasio et al. (1999) indicate that the chipped stone lithic assemblage includes raw materials derived from a number of local and non-local source areas. Included is Flint Ridge from Ohio, Kanawha Black Flint from West Virginia, Pennsylvania jasper from quarries well east of the site, and local Monongahela chert. The diversity of raw materials suggests a relatively high degree of residential mobility and a curated lithic technology.

Lithic artifacts from the pre-Clovis occupation at Cactus Hill include flake debris and prismatic blades, as well as basally thinned trianguloid to lanceolate bifaces. The technology and pattern of raw material usage is described as distinct from the overlying Clovis occupation (McAvoy and McAvoy 1997). Raw materials used in the manufacture of chipped stone tools include higher quality local cherts, quartzite, and good grades of metavolcanic materials.

The assemblages are not morphologically or technologically diverse, although both core and blade and biface technologies are represented. Lacking from the reported assemblages are drills, formal unifaces, and groundstone implements. To date, items fashioned from ivory, bone, wood, and other non-lithic materials have not been reported. The tool kit is highly portable and not unlike those associated with other late Pleistocene and early Holocene hunter-gatherer cultures in the region.

The extant record is not sufficient to interpret the settlement and subsistence strategies used by pre-Clovis peoples in the Bluestone Lake region. Information obtained from the analysis of lithic assemblages elsewhere indicates small groups of highly mobile hunter-gatherers probably occupied the region, likely using a foraging rather than a collector strategy. Forager strategies are based on a high degree of residential mobility, and the associated artifact assemblages typically reflect generalized rather than specialized activities. Pre-Clovis artifacts have not been discovered in association with extinct Pleistocene species. Adovasio et al. (1999) view these early populations as generalized hunter-foragers, rather than specialized hunters.

No sites with pre-Clovis components have been identified in the Bluestone Lake area.

Paleoindian Period

In its current form, the archaeological record for the eastern U.S. suggests the first wide-spread occupation took place during the early Paleoindian period at approximately

9500 to 9000 B.C., when small, mobile groups using Clovis technology adapted to rapidly changing environmental conditions during the late Pleistocene or Pleistocene/Holocene transition (Tankersley 1994). Available evidence indicates that the Paleoindian lifestyle and technologies survived until about 8000 B.C., when side notched points, typically associated with the beginning of the Early Archaic period, replace lanceolate varieties.

Paleoindian sites are most often recognized by the presence of morphologically and technologically distinct fluted and unfluted lanceolate bifaces, often made of high-quality tool stone. Sites are typically small and characterized by low-density scatters of lithic artifacts, typically confined to disturbed and/or temporally and culturally mixed contexts. Most studies have focused on issues of artifact typology, lithic technology, and technological organization, mobility, and settlement dynamics. Subsistence remains are rarely encountered and few sites in the region have been dated by either relative or absolute methods. Nevertheless, archaeologists in the eastern U.S. have proposed a number of chronologies for the period.

Frameworks for culture-historic development in the eastern U.S. typically divide the Paleoindian period into two or three subperiods (Table 3-1). However, inference and cross-dating have been at least as important to the development of these chronologies as stratigraphy and radiocarbon dating. In other words, many of the "diagnostic" point types used to define various subperiods are not securely dated (Anderson 1996; Bonnichsen and Will 1999; Curran 2000; Peterson 1995). Anderson (1996:14) indicates his use of Early, Middle, and Late subperiods is based on the fact that the "…best current evidence indicates these subdivisions encompass major episodes of technological or organizational change within the Southeast." For the purpose of this study, the three subperiod framework proposed by Tankersley (1996) for Kentucky is followed, with Early Paleoindian dating from 9500 to 9000 B.C., Middle Paleoindian from 9000 to 8500 B.C., and Late Paleoindian from 8500 to 8000 B.C.

There have been 79 Paleoindian points found in West Virginia, generally recovered from surface contexts (Broyles1967; Campbell and Cooper 1985; Carr and Gardner 1978; Dunnel 1967, 1979; Fuerst 1981; Gardner 1987:23; McMichael 1962; Mayer-Oakes 1955; O'Malley 1988; Olafson 1959; Wilkins 1978). To date, no Paleoindian period sites have been excavated in the state. A review of the Kentucky-Ohio-West Virginia radiocarbon database indicates that none of the 301 dates reported for West Virginia as of 1996 are associated with Paleoindian sites or deposits (Maslowski et al. 1995). Recently, Anslinger (1998) reported a date of 10,960 B.C. for the St. Albans site in Kanawha County. The dated material consisted of wood charcoal recovered from a thermal feature located 4.8 m below surface. However, because diagnostic artifacts were not in direct association, the reliability of this assay is problematic. Because West Virginia lacks radiocarbon dates for the Paleoindian period, any temporal designations used in chronologies (e.g., Table 3-1) or to date specific point types are inferential.

In addition to the lack of radiocarbon dates, the current record for the state appears to lack information for any stratified sites containing a clear record of Paleoindian occupation. Although some rockshelter sites reported by McMichael (1965) and Bays and Bays (1977) appear to contain possible Late Paleoindian points, the level of documentation is not sufficient to make conclusive interpretations. Given the quality of photographs and/or line drawings available in these reports, it is possible some of these specimens actually represent Late Archaic Guilford points.

In general, Paleoindian artifacts are typically described as belonging to a small, portable tool kit of Upper Paleolithic derivation (Adovasio et al. 1999). The tool kit was highly specialized toward hunting and processing large game, which, at least in some regions of the country, included extinct species of late Pleistocene megafauna. Although some differences in morphology and technology are present in artifact assemblages obtained from geographically dispersed sites,

there is a considerable amount of similarity, whether the sites are located in the Northeast, Southeast, Midwest, or Great Plains (Tankersley 1996). Artifacts of known Paleoindian origin reported for West Virginia sites are limited to diagnostic fluted and unfluted point types. Given that most of the reported artifacts have been recovered from surface contexts, this is not unexpected. Review of the literature indicates that most reported specimens date to the Middle to Late Paleoindian periods, with little evidence exists for Early Paleoindian Clovis points.

Artifacts made from bone, ivory, antler, and wood have been recovered from Early Paleoindian sites, although the most diagnostic artifact is the fluted Clovis point. Clovis points were possibly mounted to bone and ivory foreshafts, which in turn were inserted into primary shafts of wood (Tankersley 1996). Artifacts documented for Early Paleoindian assemblages include Clovis points, unifacial end and side scrapers, spurred end scrapers, polyhedral cores and percussion blades, bifacial knives, hammerstones, antler billets, bone and ivory foreshafts, awls, and eyed bone needles.

In some areas, the Middle Paleoindian tool kit witnessed some losses and several new additions. Items no longer used include prismatic blades detached from prepared polyhedral cores. According to Tankersley (1996), the core and blade technology was replaced by a bipolar technology, and was presumable developed in response to the use of poorer quality raw materials for tool manufacture. In the Middle and Upper Ohio Valley, the hallmark artifacts for the period are fluted Cumberland and Gainey points. Scrapers, and especially spurred end and slug-shaped varieties are quite common during this period.

The Late Paleoindian tool kit includes large, bipointed, alternately beveled bifaces, backed bifaces, proximal end and side scrapers, hafted perforators, and backed and snapped unifaces. Fluted points are, for the most part, replaced with unfluted lanceolate varieties belonging to the Plano and Dalton clusters (Justice 1987; Tankersley 1990, 1996).

Because the composition of Paleoindian assemblages in the eastern U.S. is heavily biased toward chipped stone artifacts and waste debris, the primary method for identifying functional variation in the settlement record has been lithic analysis. Through technological, typological, raw material, and assemblage composition and diversity studies, researchers have been able to develop persuasive interpretations for site activities and the functional orientation of sites. Collectively, this information is valuable for settlement system reconstruction that can be useful in areas like West Virginia and Bluestone Lake, where Paleoindian settlement system data is lacking. This is especially true where such data can be interpreted in combination with environmental and subsistence data. For example, Gardner (1977, 1987) identified five functionally distinct types of sites for the Flint Run Complex of Paleoindian sites in northern Virginia. These site types include quarries, lithic reduction stations, tool-manufacturing base camps, base camp maintenance stations, and hunting sites, and their definitions were based on assemblage composition and setting. The range of site types identified for the Flint Run Complex might not be present in all other areas, as natural setting is viewed as an important, if not causal, factor in the spatial segregation of activities within the larger settlement system (Gardner 1987). Similar site types have been reported for other areas of the eastern United States. For Kentucky, Tankersley (1990) discusses open habitations, caves and rockshelters, quarries and workshops, kill sites, and isolated finds. This is the kind of general information that is recorded on the typical state archaeological site recording form. Unlike the types defined for the Flint Run Complex, these "types" are defined by setting and/or assemblage composition. For example, the type open habitation refers to sites located at strategic positions on the landscape, regardless of the

Table 3-1. Select Paleoindian Chronologies for the Eastern United States.

Subperiod	Temporal Range (B.P.)	Diagnostic Points	Reference
Southeast			
Early Paleoindian	10,500 - 8900	Clovis	Goodyear 1999
Middle Paleoindian	8900 - 8500	Cumberland, Beaver Lake, Redstone, Quad, Suwannee, Simpson	
Late Paleoindian	8500 – 7950	Dalton	
Virginia			
Paleoindian I	≤9450 to ≥7950	Clovis	Gardner 1989
Paleoindian II	Operative by 8550		
Paleoindian III	Ended by 7950		
West Virginia			
Early Paleoindian	9,500 to 8900	Clovis	Pollack and Crothers 2005
Middle Paleoindian	8900 to 8500	Gainey, Cumberland	
Late Paleoindian	8500 to 8000	Lanceolate Plano (Plainview & Agate Basin) and Dalton (Dalton, Beaver Lake, Quad) Clusters	
West Virginia			
Clovis	12,950+ to 7950	Clovis	McMichael 1968
Cumberland		Cumberland	
Dalton		Dalton	
West Virginia			
Early Paleoindian	12,950 to 9950	Clovis, Cumberland	Fuerst 1981
Late Paleoindian	9950 to 8950	Hardaway fluted notched, Plano, Dalton	

range of site-specific activities conducted.

Little can be said about the functional variation of Paleoindian sites anywhere in West Virginia at this time. As previously indicated, the overwhelming majority of identified sites consist of isolated points recovered from plowzone and other disturbed surface contexts. In the West Virginia State Plan, Gardner (1987) discusses the site types he had identified for the Flint Run Complex in northern Virginia, as mentioned previously. Whether a similar range of sites is reflected in West Virginia and archaeological record of the Bluestone Lake area is not known, although it seems reasonable to assume that the types of activities with such sites would have been conducted.

Based on the evidence at hand, it appears that the Paleoindian subsistence strategy was that of foragers rather than collectors. Foragers gather food on a daily basis and typically do not obtain surpluses that require storage. Furthermore, foragers acquire subsistence resources on an encounter basis, and are characterized by high residential mobility, low-bulk subsistence inputs, and regular daily food procurement strategies (Binford 1980). Resource exploitation is organized through residential moves and changes in group size. Evidence that local Paleoindian populations consisted of small, highly-mobile groups is supported by the density and structural characteristic of sites.

Review of the literature indicates that most information relevant to Paleoindian subsistence and settlement in West Virginia is descriptive and artifact specific. Because of the small number of sites identified and the lack of large and functionally diverse artifacts assemblages, subsistence remains and seasonal indicators, the data base is not conducive to the development of models of settlement and subsistence. However, based on the location of individual finds, it is evident that Paleoindian peoples exploited a wide variety of natural settings within the dissected uplands and terrace settings of major drainages (Broyles 1969; Gardner 1987; Wilkins 1978).

Five sites with Paleoindian components have been identified within the Huntington District boundaries at Bluestone Lake. Identification of these components is based on the recovery of diagnostic artifacts from

surface contexts at 46Su28, 46Su39, 46Su41, 46Su42, and 46Su45. Four of these sites (46Su39, 46Su41, 46Su42, and 46Su45) are located within close proximity of one another along a floodplain terrace of the New River near Bertha, below the Bluestone Conference Center. The floodplain terrace on the outer (eastern) bend of the river exhibits a near-continuous distribution of artifacts. Site 46Su28 is located further upstream, on a floodplain terrace near Harvey Falls in upper Crump's Bottom.

Archaic Period

The concept of the Archaic, whether as a Stage or Period, has been used to define a roughly 7000-year span of time during the Holocene Epoch that witnessed gradual developments and changes in the technological, adaptive, and socio-cultural dimensions of indigenous hunter-gatherer cultures as they adapted to increasingly modern environmental conditions. Over the years, and especially following the development of modern recovery techniques in archaeology, the definition of the Archaic for parts of the Eastern Woodlands has been modified to include many of the variables (e.g., agriculture, pottery, mound construction) traditionally used to define the Woodland Period beginning about 1000 B.C. .

The Archaic Period is usually divided into Early (8000 to 6000 B.C.), Middle (6000 to 3000 B.C.) and Late (3000 to 1000 B.C.) subperiods. The temporal limits and variables used to define each subperiod seldom receive unanimous support from archaeologists working within a given region, with researchers proposing a number of culture-historic frameworks (e.g., Gardner 1987; Jefferies 1996; McMichael 1968; Muller 1986; Fuerst 1981). The chronologies presented in Table 3-2 are generally similar, and reflect general concepts of cultural change with regard to the three subperiods. Gardner's chronology breaks the three Archaic subperiods down into several phases, each of which strictly reflects the chronological positions of diagnostic hafted bifaces and do not necessarily coincide with cultural changes.

Most researchers describe a similar suite of site types that were employed during the Archaic period. While the internal structure, duration, use, size, and organization of these site types sometimes differed based on changing patterns of settlement and subsistence during the Early, Middle, and Late Archaic subperiods, the site types themselves are similar throughout the Archaic period (Fuerst 1981, Gardner 1987). These site types were used and organized differently and with varying frequency as resource acquisition strategies changed from foraging during the Early Archaic to logistical forays initiated from base-camps during the Middle Archaic to collector strategies that developed by Middle and/or Late Archaic times.

Site types typically identified during the Archaic period include transient camps or stations with a limited array of identifiable activities, and multi-activity base camps (Gardner 1987). Transient camps or stations typically reflect a short duration and a reduced set of artifacts and activities. For example, lithic procurement and food procurement sites are typically transient camps. Base camps are larger, and exhibit a variety of features and artifacts that reflect a wide range of daily activities. The consistent nature of site types throughout the Archaic period is not attributable to a lack of dynamic change, but reflects the nature of residential patterns typical of pre-agricultural eras (Gardner 1987).

Thirty-seven separate sites with Archaic components have been identified within the Huntington District boundaries at Bluestone Lake (Table 3-3). These include 11 with Early Archaic components, four with Middle Archaic components, 26 with Late Archaic components, and seven with non-specific Archaic components. Ten sites have multiple Archaic components.

Table 3-2. Selected Archaic Chronologies for West Virginia.

Subperiod	Temporal Range	Diagnostic Points	Reference
West Virginia			
Early Archaic	8000-6000 B.C.	Charleston, Amos, Kirk, McCorkle, St. Albans, LeCroy, Kanawha	Wilkins 1978
Middle Archaic	6000-4000 B.C.	Stanly, Morrow Mountain, Guilford, Amos	
Late Archaic	4000-2000 B.C.	Big Sandy II, Brewerton, Hansford, various stemmed and side-notched	
Transitional	2500-800 B.C.	Piedmont, Perkiomen-Susquehannock, Orient, Snook Kill	
West Virginia			
Early Archaic I	8000-7500 B.C.	Corner-notched (Palmer, Kirk)	Gardner 1987
Early Archaic II	7500-7200 B.C.	Side-notched (Warren, Big Sandy 1, Kessell)	
Early Archaic III	7200-6700 B.C.	Kirk Stemmed	
Middle Archaic I	6700-6000 B.C.	McCorkle, St. Albans, LeCroy	
Middle Archaic II	6000-5000 B.C.	Stanly	
Middle Archaic III	5000-4000 B.C.	Morrow Mountain,	
Middle Archaic IV	4000-3500 B.C.	Guilford	
Middle Archaic V	3500-2500 B.C.	Brewerton/Halifax	
Late Archaic I	2500-1800 B.C.	Savannah River Stemmed	
Late Archaic II	1800-1200 B.C.	Holmes/Savannah River, Susquehanna	
West Virginia			
Early Archaic	9000-6000 B.C.	Kessell, Charleston, Kirk, McCorkle, St. Albans, LeCroy, Kanawha, Palmer, Big Sandy	Pollack and Crothers 2005
Middle Archaic	6000-3000 B.C.	Stanly, Morrow Mountain, Guilford, Big Sandy II	
Late Archaic	3000-1000 B.C.	Savannah River, Brewerton, Perkiomen, Ashtabula, Susquehanna, Normanskill, Dry Brook, Lamoka, Orient, Meadowood, Ledbetter, Lackawaxen, Buffalo, Merom	

Table 3-3. Archaeological Sites with Archaic Components at Bluestone Lake.

Early Archaic	Middle Archaic	Late Archaic	Archaic
-	-	-	44Gs15
-	-	44Gs17	-
-	-	-	44Gs22
-	-	46Su3	-
-	-	46Su5	-
46Su6	-	46Su6	-
46Su9	-	46Su9	-
-	-	46Su10	-
46Su20	-	46Su20	-
46Su21	-	-	-

Table 3-3. Archaeological Sites with Archaic Components at Bluestone Lake.

Early Archaic	Middle Archaic	Late Archaic	Archaic
-	-	46Su22	-
-	-	46Su28	-
46Su39	46Su39	46Su39	-
46Su41	-	46Su41	-
-	-	46Su42	-
-	46Su43	46Su43	-
46Su44	-	46Su44	-
-	-	46Su45	-
-	46Su48	-	-
-	-	46Su52	-
-	-	46Su53	-
46Su54	-	-	-
-	-	-	46Su58
-	-	-	46Su60
-	-	46Su165	-
-	-	-	46Su191
-	-	46Su194	-
-	-	46Su196	-
-	-	-	46Su199
-	-	-	46Su200
-	-	46Su208	-
-	46Su212	46Su212	-
-	-	46Su325	-
46Su326	-	46Su326	-
46Su330	-	46Su330	-
-	-	46Su405	-
46Su441	-	-	-

Early Archaic

Analysis of available radiocarbon assays indicates the emergence of Early Archaic cultures took place during the early Holocene at approximately 8000 B.C. Based primarily on transitional lithic forms and technologies and the similarity of adaptive systems, it is evident that regional Early Archaic expressions developed in situ from late Paleoindian manifestations (Funk 1978). The Early Archaic tool kit is strikingly similar to that used during the late or terminal Paleoindian period, with the primary differences being the replacement of lanceolate hafted bifaces with notched varieties, and the introduction of drills and chipped stone axes (Pollack and Crothers 2005). Morphological and technological changes in hafted bifaces have been documented at a number of deeply stratified open-air and rock shelter sites, including St. Albans in West Virginia (Broyles 1966, 1971) and Longworth-Gick in Kentucky (Collins 1979). Early Archaic artifact assemblages typically contain a limited range of tool functional types, including cores, flake debris, bifaces and hafted bifaces, unifacial scrapers and adzes. Piercing, cutting, and scraping tools associated with the procurement and processing of meat and hides are most common, while implements designed for the collection and preparation of plant foods are generally lacking. During the first half of the Early Archaic subperiod, tools were generally made from high quality raw materials, following the pattern established during the preceding Paleoindian period, and were highly to moderately curated relative to later Middle and Late Archaic technological systems. Early Archaic hafted bifaces include types belonging to the Large Side Notched, Thebes, Kirk, Rice Lobed, and LeCroy clusters (Justice 1987). At the St. Albans site (46Ka27), Broyles (1966, 1971) identified a deeply stratified sequence of Early Archaic deposits that included Kirk Corner Notched, MacCorkle, St. Albans Side-Notched, LeCroy Bifurcate Base, and Kanawha Stemmed components. The information from this site played an important role in the development of the Early Archaic culture-historic sequence for much of the Eastern Woodlands.

Although the Early Archaic sequence for the much of the Eastern Woodlands was developed using data from the St. Albans site, the data from St. Albans and other Early Archaic sites in the region generally fails to provide information for the first five centuries of the period, from approximately 8000-7500 B.C. This elusive segment of the early Holocene sequence is recognized archaeologically by hafted bifaces of the Thebes and Large Side Notched clusters (Justice 1987). For West Virginia, the only hafted biface belonging to either of these clusters recovered from a seemingly primary context is the Kessell Side Notched specimen from Zone 36 at the St. Albans site dated at 7900 B.C. (Broyles 1971). Thebes Cluster hafted bifaces (e.g., Thebes, St. Charles, Lost Lake), although not common in the Kanawha Valley have been reported or illustrated for several sites (McMichael 1965; McMichael and Mairs 1963, 1969; Youse 1969). None of the specimens appear to have been recovered from primary depositional contexts.

In West Virginia, there is a general lack of data for the first 500 years of the Archaic Period. An examination of the published and unpublished literature including Anslinger (1998); Brashler et al. (1994); Broyles (1971); Hemmings (1985); Maslowski et al. (1995); Niquette et al. (1991); Updike et al. (2000); and Youse (n.d.) identified 25 radiocarbon assays for West Virginia sites dating prior to 6000 B.C.. Twenty-four of the dates are within the two millennia period assigned to the early Holocene, most of which are reported for the St. Albans site.

The latter part of the Early Archaic Period is recognized by hafted bifaces belonging to the Rice Lobed and LeCroy clusters (Justice 1987). The former cluster includes the types Rice Lobed, MacCorkle Stemmed, and St. Albans Side Notched. Types in this cluster are characterized by a basal notch or bifurcated stem. The only radiocarbon assay for an archaeological context in West Virginia dating to the late Pleistocene is an assay of 10,960 ±

60 B.C. obtained from charcoal recovered from a thermal feature located 4.8 m (15.7 ft) below surface at the St. Albans site (Anslinger 1998). Diagnostic artifacts were not in association, and based on stratigraphic considerations the date is considered problematic (Anslinger 1998).

The LeCroy Cluster consists of the LeCroy Bifurcated Stem, Lake Erie Bifurcated Base, Kanawha Stemmed, and Fox Valley Truncated Barb point types (Justice 1987). Of these types, LeCroy and Kanawha are common to the Kanawha Basin and are dated at the St. Albans site to 6300 B.C. and 6210 B.C., respectively (Broyles 1971). Given the paucity of available stratigraphic and radiometric data for the Early Archaic period in West Virginia beyond the St. Albans site, it is reasonable to conclude that a certain amount of temporal overlap exists for some of the Early Archaic point types discussed above. Nevertheless, the temporal sequence for early side notched, Kirk Corner Notched, and bifurcated forms is well documented regionally, and is supported by recent data from Dust Cave (Sherwood et al. 2004).

Until a higher quality data set is obtained and more thorough re-analyses of existing data sets (i.e. St. Albans) are conducted, it will be difficult to effectively examine Early Archaic settlement and subsistence on a local or even regional basis. In general, the Early Archaic period witnessed the establishment of the oak-hickory forests that were present at the time of early Euro-American settlement and exploration of the area. However, these forest communities were still immature with different proportions of particular plant species (Ford 1977). Consequently, the proportions of animal species dependent on the forest resources also may have been different. Adding a temperate climate to this environmental setting, it would appear localized fluctuations in available resources would have prohibited human groups from establishing permanent territories (Ford 1977).

Archaeological evidence tends to support this model of limited natural resources promoting the continuation of small, mobile hunting bands. The primary distinction between Early Archaic groups and Paleoindian groups is the initial development of technologies to hunt smaller game and process plant foods. Plant processing and fishing tools rarely appeared, however, indicating such resources provided a minor dietary component (Dragoo 1976). Artifact assemblages and site locations indicate hunting was the primary subsistence practice, with some sites suggesting periodic seasonal reuse (Dragoo 1976). Although seasonal scheduling appears to be developing, the limited natural resources would require frequent changes in groups' territories to offset localized fluctuations. This is evidenced by the wide distribution of diagnostic projectile point styles during this period (Dragoo 1976).

By the beginning of the Early Archaic subperiod many of the harsh conditions associated with the terminal Pleistocene had improved, and the large megafauna species exploited by earlier Paleoindian populations had become extinct. Deciduous forests rich in nut-producing taxa migrated northward and rivers that previously served as sluiceways for glacial meltwaters dwindled in size, exposing broad alluvial valleys conducive to travel, exploitation, and settlement. As interpreted by Muller (1986:56), "many of the features of the Early Archaic, though poorly understood, reflect the beginning of the long period of specialization to Eastern Woodland local environments." Archaeological data collected from surface surveys and excavations indicate that the formation of most Early Archaic sites resulted from short-term occupations by small, mobile bands. Evidence for midden, pit features, structures, and human and dog burials is also generally lacking. When features are present they tend to consist of thermal facilities, including possible smudge pits. Investigations by Ballweber and Michael (1990) document the common occurrence of Early Archaic materials in association with mountain top sites in Boone, Kanawha, Logan, and Wyoming counties in southwestern West Virginia, and Wilkins (1977) documented similar evidence for Early Archaic occupation in Boone County. The largest Early Archaic

sites, however, are often located along terrace margins and natural levees adjacent to large rivers. Both stratigraphic and spatial analyses indicate that these sites were occupied repeatedly for long periods of time. Using data from ridgetop and valley bottom sites, Wilkins (1978) postulated that Early Archaic populations in the Kanawha Basin consisted of semi-sedentary bands exploiting seasonally available resources. However, Wilkins' Early Archaic analytical unit did not differentiate between the various recognized cultures or point traditions, and as such probably masks temporal and cultural variability for the period.

Eleven archaeological sites with Early Archaic components have been identified (Table 3-3). Three of these sites (46Su39, 46Su41, and 46Su44) are located within close proximity of one another along a floodplain terrace of the New River near Bertha, below the Bluestone Conference Center. Two other sites, 46Su20 and 46Su54, are located in the lower portion of Crump's Bottom in the Bull Falls area. The remaining six sites (46Su326, 46Su6, 46Su330, 46Su21, 46Su9, and 46Su441), are widely spaced along New River floodplain terraces, continuing upstream south to The Narrows.

Middle Archaic

The Middle Archaic subperiod spans the period from approximately 6000 to 3000 B.C. Based on trends in the geographic distribution of hafted biface styles, this period marks the first significant development of regionally distinct archaeological cultures in the eastern U.S. (Jefferies 1996). This development is generally viewed as a socio-cultural and technological response to the adaptation of hunter-gatherers to local environments as warmer, drier conditions began to prevail (Fuerst 1981).

A review of the local and regional literature identified 16 radiocarbon dates for 12 West Virginia sites that fall within the period 6000 to 3000 B.C. (Hemmings 1985; Broyles 1971; Wilkins 1985; Youse 1985, 1992; Niquette et al. 1991; Maslowski et al. 1995; Anslinger et al. 1996; McMichael 1968). Based on the regional record, most of the dates appear to provide realistic data for the period of occupation, and provide the best available framework for development of a preliminary chronology. However, most of these dates and their associated sites are located in the Kanawha Valley, and reflect the general lack of data available for southern West Virginia and the Bluestone Lake area. Middle Archaic tool assemblages include a broader range of functional types and styles that reflect concomitant changes in settlement and subsistence. Regional hafted biface types include Stanly, Amos, Morrow Mountain, and Guilford. In West Virginia the distribution of the latter two types is generally in the southern part of state in the New River drainage basin. Toward the end of the subperiod, and probably extending into the early Late Archaic, side-notched varieties including Big Sandy II and Brewerton are common. Also present are newly-introduced groundstone implements including grooved axes, pitted anvils, and mortars and pestles. At midden sites where preservation is generally enhanced, tools of bone and antler usually comprise a significant part of the total assemblage.

Middle Archaic cultures in West Virginia are generally recognized by the presence of diagnostic hafted bifaces, many of which have regional distributions. However, little study of the period has been completed by professional archaeologists, and only a few sites have been tested and dated, with studies by amateurs being most common. In general, data from sites located in alluvial settings along the Kanawha River have provided the most important information; upland sites have more extensively mixed cultural deposits and have not been reliably dated. Collectively, the stratigraphic sequences reported for the St. Albans and Hansford Ballfield sites document nearly ten millennia of occupation, with the record for the Early, Middle, and Late Archaic especially well represented (Brashler et al. 1994; Broyles 1971; Turner 1998; Wilkins 1985; and Youse 1992). Other evidence for Middle Archaic occupation comes from the Amos Power Plant site (46Pu60). Salvage excavations conducted by the West Virginia

Archeological Society from 1968-1970 identified a previously unrecognized type of hafted biface defined by Broyles (1971) as Amos Corner Notched. Broyles assigned this new type to the early part of the Early Archaic; however, subsequent radiocarbon assays obtained for the Amos and Charleston Town Center (46Ka165) sites indicate a Middle Archaic association (Youse n.d., 1992). The contexts for the samples from which these determinations were derived are not well documented, and at least one sample at the Amos site consisted of charcoal collected from two discrete contexts separated by about 0.9 m of elevation (Youse n.d.). Regardless of potential problems, these determinations suggest the Amos occupation in the lower Kanawha Valley post-dates Stanly and pre-dates the appearance of side-notched hafted bifaces typically identified as Big Sandy II and Brewerton.

Overall, however, our current state of knowledge for the Middle Archaic subperiod in southern West Virginia is generally limited to the hafted biface sequence, a small number of radiometric determinations, a paucity of information regarding site types, and some information for raw material use patterns. Meaningful information for subsistence and settlement patterns, site structure, and any details of the adaptive system(s) is generally lacking. Middle Archaic subsistence was based on the exploitation of a wide range of plants and animals (Jefferies 1996; Jefferies and Lynch 1983; Styles et al. 1983). Pollack and Crothers (2005) use data from such sites as Eva (Lewis and Lewis 1961) and Modoc Rock Shelter (Styles et al. 1983) to infer Middle Archaic subsistence patterns along the New River. White-tailed deer and wild turkey were the most important animals consumed, while hickory nuts were the most important plant foods of the Middle Archaic diet (Jefferies 1996). Riverine resources, such as fish and shellfish, also became important, especially towards the end of the Middle Archaic (Brown and Vierra 1983; Jefferies and Lynch 1983).

Based on diagnostic point types, it appears that Middle Archaic peoples had settlement patterns similar to their Early Archaic predecessors. Differences in the intensity of exploitation of upland resource zones between Early and Middle Archaic times is difficult to determine given gaps in the current database, and possible differences in technological systems. Regional studies of subsistence patterns indicate that the overall diversity of the subsistence base increased and mobility decreased during the Middle Archaic. These changes appear to mark a shift in Archaic foraging to a largely logistic collector strategy (Brown and Vierra 1983; Stafford 1994; Stafford et al. 2000). Unlike Early Archaic foragers that moved camp from resource to resource, Middle Archaic groups increasingly acquired resources, at least in part, through logistical forays initiated from base-camps. Residential sites associated with foragers generally have low densities of artifacts, simple hearths, and associated general activity areas (Stafford et al. 2000). Sites of logistically organized groups, on the other hand, show evidence of greater residential stability. In the archaeological record this stability is recognized by the presence of rock-filled midden, large and functionally diverse pit features, and in some instances structures and human and dog burials (Brown and Vierra 1983; Jefferies 1996; Stafford 1994; Stafford et al. 2000). This fundamental shift is perhaps best documented in the deeply-stratified records reported in the Midwest for the Koster (Brown and Vierra 1983) and Modoc Rock Shelter (Styles et al. 1983) sites in southern Illinois. However, in southern West Virginia and the Bluestone Lake area, few Middle Archaic sites have been examined, and it is not clear when the shift from foraging to logistically-organized collecting took place.

Only four sites with Middle Archaic components have been identified within the Huntington District boundaries at Bluestone Lake (Table 3-3). Two of these sites (46Su39 and 46Su43) are located within close proximity of one another along a floodplain terrace of the New River near Bertha, below the Bluestone Conference Center. This area contains a dense concentration of multicomponent sites. Site 46Su212 is part of

the dense concentration of sites at the mouth of Indian Creek, and 46Su48 is located across from Wylie Island farther to the south.

Late Archaic

The Late Archaic period is usually characterized as a time of change that includes the rise of inter-regional trade systems, mortuary ceremonialism, differentiation of status and wealth, focal economies and sedentism, population growth, and horticulture. As Gardner (1987:39) notes, however, these traits do not necessarily coincide with changes in the projectile point types used to chronologically define the Late Archaic, but occur at different times in different places, only partly in other places, and even not at all in some areas. For example, as more Late Archaic and Terminal Archaic sites are investigated, the clear division between pre-ceramic and ceramic lifestyles and cultures becomes increasingly blurred. Storage facilities, structures, the accumulation of exotic materials and ritualistic burial practices, pottery, and horticulture are increasingly associated with Archaic point styles and radiocarbon assays. Some sites, such as Cogswell phase sites in eastern Kentucky, consistently exhibit a combination of Archaic and Woodland attributes (Ison 1988; Ledbetter and O'Steen 1991; Sheldon and Hughes 1990).

Archaeological evidence for the earliest Late Archaic cultures often consists of stemmed points with prominent, squared shoulders. However, the boundary between Middle and Late Archaic is not well defined in many areas; for example, notched points such as Brewerton Eared-Notched and Brewerton Eared-Triangle (Justice 1987) are often considered diagnostic of the late Middle and/or early Late Archaic periods (note differences in Gardner's chronology in Table 3-2). Truncer (2004) reports the appearance of steatite bowl fragments at several Late Archaic sites in the Kanawha Basin and Northern Panhandle, and "copies" of these bowls manufactured from local sandstone are not uncommon on habitation sites within the Kanawha Valley. The development of stone bowl technology is attributed in part to changes in the processing of foodstuffs, and is often associated with the intensification of the use of small starchy and oily seeds as a food source. Stone bowls were later replaced by thinner and more expedient ceramic vessels, the traditional hallmark of the Woodland period. Studies now suggest that pottery may have been introduced gradually over a period of 500 or more years (Seeman 1986), reflecting diffusion of the technology from external areas (possibly the Northeast) as opposed to local invention. Research has demonstrated that ceramics did not occur suddenly or widely over the Eastern Woodlands, and the use of ceramics as a mark for the beginning of the Woodland period is falling out of favor.

As with the Early and Middle Archaic periods, evidence for Late Archaic occupation in West Virginia comes from sites located in a variety of valley and upland settings, though to date the highest quality information for evaluating various aspects of Late Archaic life comes from floodplain sites. For example, the Buffalo site (46Pu31), which is best known for its Late Prehistoric villages, contains a sealed Late Archaic occupation tested by Broyles (1976). On the basis of a single radiocarbon assay dating to 1920 B.C., this component is considered contemporary with Panhandle Archaic to the north, but with a different cultural expression. Hafted bifaces from the site were defined by Broyles (1976) as Buffalo Expanding Stem and Buffalo Straight Stem. Broyles indicated that the smaller Buffalo points are morphologically similar to Savannah River points, but that the two are not related. Eleven Late Archaic features are documented at the Buffalo site as shallow basin fire pits and deeper pits, which probably functioned as cooking facilities. The latter contained large quantities of thermally-altered rock and charcoal. Post molds were associated with thermal features suggesting the construction of wind breaks.

Prufer (2001) has outlined some recent developments in Late Archaic settlement models. This revised model of Archaic settlement is based on new information and

new interpretations of old data. According to Prufer, in light of new data, the larger sites, once called base camps, can now be partitioned into multiple areas that were similar to the smaller sites. Under this model, the larger size of the "base camps" is now considered to be the results of repeated reoccupation throughout the Archaic period, not to a different site function. The large, intensively re-occupied sites often have rich middens, functionally diverse artifact assemblages that include both utilitarian and non-utilitarian items, large numbers of functionally diverse features (e.g., hearths, earth ovens, refuse pits), and human and dog burials. At shell midden sites, where organic artifacts are more likely to survive, assemblages generally include a wide assortment of items made from bone, antler, shell, and teeth. Because stone boiling technology was prevalent, thermally-altered rock is a common component of many sites dating to the period (Dragoo 1958; Winters 1969). Members of "regional macrobands" normally coalesced in these camps along major rivers between winter and late spring to exploit emerging post-winter resources (Wilkins 1978; Fuerst 1981). During the late spring or summer, as resources became more plentiful, a number of extended families would gather at a centralized base camp located along a major river or stream. With the arrival of fall, the family-based groups would depart the base camp and occupy short-term hunting and gathering camps in the uplands. The collection and possible processing of nuts would be important at this time. During the winter, groups would either re-occupy the summer base camp or disperse into the hinterlands.

Overall, the Late Archaic subperiod is considered a time of significant population growth and increasing regionalism (Jefferies 1996). Changes in adaptive strategies resulted in larger and more intensively occupied sites in some areas than witnessed during the preceding periods. In many areas of the midcontinent, the data suggest collector strategies were developed by Middle and/or Late Archaic times. Collectors are logistically organized, and subsistence resources are acquired and supplied to a great extent by specialized, task-oriented groups. Because of the complexity of the system, a wider range of site functions are created relative to those of the more highly mobile foragers. Semi-sedentary residential bases (i.e. base camps) occur, with many of the procurement and processing tasks being conducted at more ephemeral and/or specialized transient camps and stations.

A total of 26 sites with Late Archaic components have been identified within the Huntington District boundaries of Bluestone Lake (Table 3-3). Seven of these sites (46Su3, 46Su39, 46Su41, 46Su42, 46Su43, 46Su44, and 46Su45) are, like the Early Archaic sites, located within close proximity of one another along the floodplain terraces of the New River near Bertha, below the Bluestone Conference Center. Fifteen sites with Late Archaic components (roughly north to south, 46Su20, 46Su53, 46Su165, 46Su325, 46Su326, 46Su6, 46Su10, 46Su22, 46Su52, 46Su194, 46Su196, 46Su208, 46Su212, 46Su28, and 46Su330) have been identified throughout lower, middle, and upper Crump's Bottom and the Indian Creek vicinity. The remaining four sites (46Su5, 46Su405, 46Su9, and 44Gs7) are widely spaced south of Crump's Bottom to The Narrows.

Woodland Period

Like the Archaic period which preceded it, the Woodland period encompassed a long period of time, during which important changes occured in social organization and subsistence and settlement patterns. This time span also is broken into three subdivisions: the Early Woodland (ca. 1000 B.C. to A.D.1), the Middle Woodland (ca. A.D.1 to 500), and the Late Woodland (ca. A.D. 500 to 1000) (Table 3-4). These periods are based on several very broad and traditionally held generalizations

Table 3-4. The Woodland Period in South-Central/Lower New River Region of West Virginia (Pollack and Crothers 2005, Fenton and Andrews 1999, Johnson 1996, Fuerst 1988, Ison et al. 1985, Wilkins 1979).

Tradition	Period	Phase	Temporal Range	Attributes of Note
Kanawha Tradition	Early Woodland	Transitional	1000 to 800 B.C.	No mound building; introduction of thick-walled pottery
		Early Adena	800 to 500 B.C.	Small burial mounds, cremations, minimal grave goods, thick-walled Fayette Thick-like ceramics
		Leslie Mound	500 to 200 B.C.	Accretional mounds, cremations in small log and bark tombs, usually no grave goods, Armstrong ceramics
	Middle Woodland	Murad Climax	200 B.C. to A.D. 1	Large mounds, elaborate log tombs, exotic grave goods, Armstrong ceramics
		Armstrong	A.D. 1 to 500	Mound building declines and moves to secondary drainages, hunting/ gathering/gardening, diffuse small villages, Lick Creek ceramics
	Late Woodland	Schoolyard	A.D. 500 to 800	Hunting/gathering/gardening, diffuse small villages/ hamlets, Lick Creek ceramics
		Buck Garden	A.D. 500 to 1000	Hunting/gathering/gardening, diffuse small villages, Buck Garden ceramics

concerning some of the more significant cultural changes that took place during the Woodland period. For example, the Early Woodland period in West Virginia has been characterized in a general sense as marking the introduction of ceramic vessels in the region, and late in the period, early developments in mound ceremonialism and elaboration of burial practices (Burdin 2004, DuVall 1999, Botwick 1995, Fuerst 1988, Ison et al. 1985). The Middle Woodland period is generally associated with a fluorescence of mound building and Hopewellian-influenced cultural traits (Fuerst 1988). The Late Woodland period has been characterized by the rise in mortuary facilities at habitation sites, a decline in mound construction and burial ceremonialism, and reduced exchange of exotic goods (Burdin 2004, Railey and Henderson 1986, Botwick 1995).

A total of 35 separate sites with Woodland components have been identified within the Huntington District boundaries at Bluestone Lake (Table 3-5). These include four sites with Early Woodland components, eight with Middle Woodland components, ten with Late Woodland components, and 17 with non-specific Woodland components. Four additional sites have been identified from which ceramic vessel fragments have been recovered, but the type of pottery is unknown. Hence, these sites are classified as Woodland/Late Prehistoric. Overall, five sites have multiple Woodland components, and all five are located within close proximity of one another along a floodplain terrace of the New River near Bertha, below the Bluestone Conference Center.

Table 3-5. Archaeological Sites with Woodland and Late Prehistoric Components at Bluestone Lake.

Early Woodland	Middle Woodland	Late Woodland	Woodland	Woodland/Late Prehistoric	Late Prehistoric
-	-	-	-	-	44Gs10
-	-	-	-	44Gs11	-
-	-	-	44Gs15	-	44Gs15
-	-	-	44Gs17	-	-
-	-	-	44Gs20	-	-
-	-	44Gs48	-	-	-
-	-	-	46Me19	-	-
-	-	46Su1	-	-	-
-	-	-	-	-	46Su3
-	46Su6	-	-	-	46Su6
-	-	-	-	-	46Su7
-	-	-	-	-	46Su8
-	46Su9	-	-	-	46Su9
-	-	-	46Su10	-	46Su10
-	-	-	-	-	46Su19
-	-	46Su20	-	-	46Su20
-	46Su22	-	-	-	46Su22
-	-	-	-	-	46Su24
-	-	-	46Su28	-	46Su28
-	-	-	-	-	46Su29
46Su39	46Su39	46Su39	-	-	46Su39
46Su41	46Su41	46Su41	-	-	-
-	46Su42	46Su42	-	-	46Su42
46Su44	-	46Su44	-	-	46Su44
46Su45	46Su45	46Su45	-	-	46Su45
-	-	-	46Su47	-	46Su47
-	-	-	46Su48	-	46Su48
-	-	46Su49	-	-	46Su49
-	-	-	-	-	46Su50
-	-	-	-	46Su52	-
-	-	-	46Su55	-	-
-	-	-	-	-	46Su56
-	-	46Su58	-	-	46Su58
-	46Su60	-	-	-	46Su60
-	-	-	-	-	46Su61
-	-	-	46Su62	-	-
-	-	-	46Su165	-	-
-	-	-	46Su191	-	-
-	-	-	-	46Su193	-
-	-	-	46Su194	-	-
-	-	-	-	46Su195	-
-	-	-	46Su196	-	-
-	-	-	46Su199	-	46Su199
-	-	-	46Su200	-	-
-	-	-	-	-	46Su208
-	-	-	46Su212	-	-
-	-	-	-	-	46Su279
-	-	-	-	-	46Su326

Early Woodland

The Early Woodland period is generally thought to begin with the appearance of thick-walled pottery around 1000 B.C., with a roughly 200-year transition from the Late Archaic period to the first definable Early Woodland mound-building phase around 800 B.C. that will be referred to as the Early Woodland Transitional period in this text. Numerous dates have been proposed for the end of the Early Woodland period, reflecting both geographic differences and the varying extent to which Middle Woodland Hopewell-like traits were adopted in some areas. Some researchers place the transition from Early to Middle Woodland around 200-400 B.C. (Burdin 2004, Fenton and Andrews 1999, Botwick 1995, Fuerst 1988,), while others contend that the Early Woodland period in southern West Virginia essentially continued until around A.D. 1, with the advent of the Hopewellian-influenced Armstrong phase (Ison et al. 1985,). Excavation results from Early Woodland mounds in southern West Virginia tend to favor the former chronology (Table 3-4).

The Early Woodland is divided into three phases, including an Early Woodland Transitional phase (1000-800 B.C.), the Early Adena phase (800-500 B.C.), and the Leslie Mound phase (500-200 B.C.) (Table 3-4) (Fuerst 1988, Ison et al. 1985). The Early Woodland Transitional phase includes the Hansford Ballfield site (46Ka104), for which a radiocarbon date of 1170±70 B.C. was recorded (Wilkins 1977). The Leslie Mound phase includes such sites as the Leslie Mound (46Pu3, radiocarbon dated to 300 B.C.) and the Jarvis Farm mound (46Ka105, radiocarbon dated to 305 B.C) (Maslowski et al. 1995). These three phases are generally defined based on changes in mortuary practices and mound construction, rather than any identifiable changes in settlement or subsistence patterns.

Summaries of Early Woodland settlement have generally focused on either the burial mounds or the habitation sites. Fenton and Andrews (1999) use descriptions of habitation sites from several excavations of Early Woodland sites in eastern Kentucky as a baseline for expectations, since little information is available for southern West Virginia. Habitation sites are characterized as fairly small, short-term sites with one or two circular structures and little evidence of repeated occupation (McBride 1994; Niquette 1989; Boedy 1989). Interior pits and hearths have been identified, but few storage features have been recorded (Fenton and Andrews 1999). Rockshelters were utilized as well, with evidence of Early Adena phase occupations identified in rockshelters in Nicholas County (Maslowski 1985).

Mound building began during the Early Adena phase in West Virginia, post-800 B.C. Typical of Early Adena mound building is the Turkey Creek Mound, where "the Early Adena component is evidenced by a low earthen mound with a cremation in a shallow elliptical pit and grave goods that include Meadowood-like points and a 'ritually killed' blocked end tubular stone pipe" (Fuerst 1988:37, referencing McMichael and Mairs 1969). During the Leslie Mound phase (500-200 B.C.), mound building began to take on more of the characteristics of incipient formal ceremonialism with construction of larger accretional mounds, pre-mound structures with paired posts, and the placement of crematory basins within small log and bark tombs (Fuerst 1988, Ison et al. 1985).

Geometric earthworks have been associated with the Early Woodland period elsewhere in West Virginia, including in the Kanawha River valley below Charleston.

Diagnostic ceramics and hafted bifaces associated with the Early Woodland Transition (1000 to 800 B.C.) include thick, grit- or steatite-tempered pottery, Orient Cluster hafted bifaces, and Potts hafted bifaces (Burdin 2004; Fuerst 1988, Ison et al. 1985). Both Potts and Orient hafted bifaces have been recovered from Early Woodland contexts in Summers County (Ison et al. 1985; O'Malley 1985). The Early Adena phase (800 to 500 B.C.) is characterized by leaf-shaped Adena blades, ovate-stemmed Adena hafted bifaces (Botwick 1995, Ison et al. 1985) and

continued use of thick-walled ceramics bearing resemblance to Vinette I and Fayette Thick types (Ison et al. 1985). Diagnostic ceramics from the Leslie Mound phase (500 to 200 B.C.), as defined by Wilkins (1979), include Adena stemmed points and thinner, shale- or siltstone-tempered Armstrong pottery that is similar to Adena Plain ceramics elsewhere (Ison et al. 1985).

Early Woodland subsistence practices are based on hunting, gathering, and gardening strategies (Burdin 004; Railey 1996). Most groups appear to have pursued a generalized pattern of food-gathering, possibly supplemented by cultivation of native domesticates (Fenton and Andrews 1999, Cutler and Blake 1984). Horticultural activities were conducted primarily within stream bottoms, although some cultivation along ridges was also considered possible (Gremillion 1994; Ison 1988). Hunting strategies focused on white-tailed deer and wild turkey, supplemented by fish, waterfowl, and mollusks in some areas.

The large "base camps" commonly identified during the Late Archaic disappeared and were replaced by multiple smaller hamlets scattered in lowland settings that may be related to an increased reliance on indigenous domesticates (Fenton and Andrews 1999, Smith 1992). The use of rockshelters in upland settings appears to have been limited. Better-studied areas in southwestern West Virginia and eastern Kentucky have demonstrated a clear separation of ceremonial and habitation sites, with small camps scattered in upland tributary valleys and mortuary sites located along high river terraces along main-stem and secondary valleys (Fenton and Andrews 1999, Niquette 1992, Fuerst 1981). Preferred settlement locations in eastern Kentucky include second-order streams, narrow valley bottoms, and hillside ridges in highly dissected country (Fenton and Andrews 1999, Kerr and Creasman 1995).

Four sites with Early Woodland components have been identified within the Huntington District boundaries of Bluestone Lake (Table 3-5). All four of these sites (46Su39, 46Su41, 46Su44, and 46Su45) are located within close proximity of one another along the floodplain terraces of the New River near Bertha, below the Bluestone Conference Center.

Middle Woodland

The transition to the Middle Woodland period generally coincides with the fluorescence of mound building and the influence of Hopewellian peoples to the north and west. The period begins with a flurry of mound building during the Murad Climax phase (200 B.C. to A.D. 1) (Fuerst 1988), though Ison et al. (1985) place the same Murad Climax phase in the Early Woodland period. Radiocarbon dates of 100 B.C. (Murad Mound, 46Ka30) and 175 B.C. (Young Mound, 46Ka65) have been recorded for Murad Climax phase sites (Fuerst 1988). The Armstrong phase (A.D. 1 to 500) is characterized by a sharp decline in mound building activities. A radiocarbon date of A.D. 120 has been obtained from a pit with Armstrong ceramics at the Mount Carbon site (46Fa7) in Fayette County; closer to Raleigh County, a radiocarbon date of A.D. 310 has been returned from the Armstrong phase Spring site (46Su67) (Ison et al. 1985).

During the Middle Woodland period, the Murad Climax phase (200 B.C. to A.D. 1) represents the high point of Hopewell-like mound building in the region. The number, size, and complexity of earthen burial mounds increased, and was accompanied at some point by the construction of graded ways and earthen/stone enclosures (Fuerst 1988). Examples of such constructions are common in Fayette and especially Kanawha County to the north. Examples of Murad Climax phase sites include Murad Mound (46Ka30), Young Mound (45Ka65), the South Charleston Mound, Bell Creek Mound (46Fa5), Gore Mound (46Bo26), and possibly the Mound Carbon Stone Walls (46Fa1) (Fuerst 1988). Other site types from the Murad Climax phase are not well known.

By the late Middle Woodland Armstrong phase, mound building was on the decline. Since some mound sites originally identified

as part of McMichael's (1962) Armstrong phase have been reassigned to the Leslie Mound phase of the Early Woodland period (Wilkins 1979), few Armstrong phase sites (A.D. 1 to 500) remain. A small Middle Woodland occupation with Lick Creek ceramics recovered from pits has been identified at the Spring Site (46Su67) in Summers County. Several rock shelters in Nicholas County are described as having Armstrong ceramics; since little description is available for these assemblages, it is possible that the 20 or fewer sherds recovered from these sites may actually represent Lick Creek ceramics and date to the Armstrong phase (Ison et al. 1985), rather than the late Early Woodland Leslie Mound phase or the early Middle Woodland Murad Climax phase.

The Middle Woodland period includes elaborate mortuary practices and exotic artifacts. Most researchers offer few specifics regarding the ceramics and hafted bifaces of this phase, preferring to focus on non-local trade artifacts and burial goods. Fuerst (1988:39) notes that Murad Climax phase ceramics and hafted bifaces include lobed and zoned incised Armstrong pottery, Robbins hafted bifaces, and Cresap hafted bifaces. Armstrong ceramics have been typically considered a Middle Woodland ware type, and were first described by McMichael (1962). Henderson (1986) and Ison et al. (1985) have since refined McMichael's Armstrong series into an Early Woodland to Middle Woodland type (Armstrong) and Middle to Late Woodland type (Lick Creek) based on excavations in Summers County. The newer definition of the Early to Middle Woodland Armstrong ware describes the ceramic type as a thin, plain, shale/siltstone/claystone-tempered ware with occasional zoned incising that Wilkins (1979) suggests first came into use during the Leslie Mound phase, prior to the Hopewellian-influenced mound building of the Murad Climax phase. Exotic materials such as mica, copper, or marine shell are commonly reported in burial mounds, but are not generally encountered at habitations sites (Fenton and Andrews 1999). Other artifacts typically associated with mound and mortuary contexts during the Murad Climax phase include rolled copper beads, stone and clay pipes, slate gorgets, hematite celts, copper bracelets and headdresses, cached blades, mica sheets, and zoomorphic platform pipes, all of which point toward contact with the Ohio Hopewell (Fuerst 1988, Ison et al. 1985).

Armstrong ceramics were followed by the thicker, cordmarked, shale/siltstone/claystone-tempered Lick Creek ceramics in the late Middle Woodland (Armstrong phase) and into the early Late Woodland (Schoolyard phase).

Middle Woodland hafted bifaces during the Armstrong phase include Snyders, Affinis Snyders, Connestee Triangular, and Manker (Burdin 2004, Justice 1987, Ison 1985). As discussed briefly above, McMichael's (1962) Armstrong series ceramics were revised and refined by Henderson (1986) and Ison et al. (1985) based on excavations at three sites within the Green Sulphur Springs complex in Summers County. Henderson also formally defined a new pottery series, referred to as Lick Creek, that is loosely based on a "second type" of Armstrong Cordmarked ceramics documented by McMichaels (1962). Lick Creek ceramics date from the late Middle Woodland and into the early Late Woodland, and represent cordmarked ware tempered with soft, subangular siltstone. Decoration, when present, occurs only as notched lips. Calibrated radiocarbon dates of A.D. 580±60 (late Middle Woodland Armstrong phase) and A.D. 780-840±70 (early Late Woodland Schoolyard phase) were obtained for carbonized materials associated with Lick Creek ceramics at the Schoolyard site (46Su72) in Summers County (Henderson 1986).

The Middle Woodland Murad Climax phase (200 B.C. to A.D.1) is known primarily from its mound and ceremonial contexts. Associated sites include the Murad Mound (46Ka30), Young Mound/Mound 30, Criel/South Charleston Mound, Bell Creek/Hale Mound (46Fa5), Gore Mound (46Bo26), and possibly the Mount Carbon Stone Walls (46Fa1). The Murad Mound has been radiocarbon dated to 100 B.C.

(McMichael and Mairs 1969), and the Young Mound/Mound 30 has been radiocarbon dated to 175 B.C. (Youse 1969).

Middle Woodland subsistence and settlement, from the Murad Climax through the Armstrong phase, appears to be a continuation of Early Woodland patterns (Fenton and Andrews 1999). Settlements appear to continue as dispersed camps and hamlets along river bottoms and on upland benches and ridgetops (Maslowski 1985, Niquette 1992). The Armstrong phase marks the decline of Hopewell mound building in the region (Fuerst 1988). Mounds tended to be smaller and located in the stem valleys off of major tributaries, rather than prominently placed on floodplains of large rivers (Fenton and Andrews 1999, Frankenberg and Henning 1993).

Eight sites with Middle Woodland components have been identified within the Huntington District boundaries of Bluestone Lake (Table 3-5). Five of these sites (46Su39, 46Su41, 46Su42, 46Su45, and 46Su60) are, like the Early Woodland sites, located within close proximity of one another along the floodplain terraces of the New River near Bertha, below the Bluestone Conference Center. Two sites, 46Su6 and 46Su22, are located near the confluence of Indian Creek with the New River. 46Su6 is located on an upper terrace above the river, and 46Su22 is located on a floodplain terrace just north of the confluence.

Late Woodland

Some of the most recent chronological work appropriate for the Bluestone Lake region divides the Late Woodland period into the Schoolyard phase (A.D. 500 to 800) and the Buck Garden phase (A.D. 800 to 1000) (Fuerst 1988, Railey and Henderson 1986, Ison et al. 1985). The Schoolyard phase is based on excavations at the Schoolyard site (46Su72), where radiocarbon dates of A.D. 470 and A.D. 760 have been recorded in association with Lick Creek ceramics (Ison et al. 1985). The term "Buck Garden phase," first developed by McMichael (1965) in association with rock-tempered Buck Garden ceramics, had been used interchangeably with the Late Woodland period in southern West Virginia until the recent establishment of the Schoolyard phase (Fuerst 1988). Contexts containing grit-tempered version of Buck Garden pottery has been radiocarbon dated to A.D. 820 at the Mount Carbon site in nearby Fayette County.

Wilkins (1979), Fuerst (1988) and others have noted that "Buck Garden" is really a "catch-all" term for the Late Woodland period, likely encompasses multiple cultural developments (as demonstrated by Ison et al. 1985), and should probably be abandoned as a phase designation. Until such time as the associated Buck Garden ceramics are better understood, however, the phase designation should probably continue to be used for the latter portion of the Late Woodland period in the southern West Virginia.

There is a general lack of large Woodland villages in southern West Virginia during the Late Woodland period, with most long-term habitation occurring in hamlets (Ison et al. 1985). While the Late Woodland component of the Mount Carbon site in Fayette County may represent a seasonal coalescence of smaller hamlet sites, settlement during both the Late Woodland period and the preceding Middle Woodland period appears to have occurred primarily in the form of smaller settlements, rockshelters, or as minor components within the more substantial Late Prehistoric villages that were to follow.

Late Woodland ceramics are generally tempered with various kinds of crushed rock, including chert, sandstone, siltstone, limestone, and others (Fenton and Andrews 1999). More specifically, Buck Garden and Lick Creek ceramic series are most commonly cited for the region (Burdin 2004). Lick Creek ceramics are a thick, cordmarked, chalky-paste, siltstone-tempered type identified at the Green Sulphur Springs complex in Summer County and associated with the late Middle Woodland and earliest portions of the Late Woodland, as noted during the discussion of Middle Woodland material culture earlier in this chapter (Henderson 1986). Buck Garden

ceramics are generally characterized by a wide range of rock temper types (McMichael 1962). Wilkins (1979) has noted that Buck Garden ceramics represent an undifferentiated collection of several ceramic types, and other authors have commented on the wide range of decorative and technological variability encompassed by the rock-tempered, collared, S-twist-dominated Buck Garden assemblage (O'Malley 1990:738, Kerr et al. 1991:157). As Kerr et al. note, the Buck Garden assemblage likely includes a range of early and late Late Woodland types, and, as it stands, is of questionable usefulness for comparative purposes.

Diagnostic Late Woodland hafted bifaces in the Kanawha River basin include hafted bifaces from the Lowe and Chesser clusters during the early Late Woodland period. Chesser Notched and Lowe Flared Base hafted bifaces were recovered in association with Lick Creek ceramics at the early Late Woodland Schoolyard Site, part of the Green Sulphur Springs Complex in Summers County (Ison et al. 1985). Jack's Reef Cluster hafted bifaces (Justice 1987:217-219, Seeman 1992) were more common in the later stages of the Late Woodland period (Burdin 2004). A variety of small triangular hafted bifaces, including Levanna and Hamilton types, are also associated with Late Woodland components.

While many of the cultural manifestations thought to represent the hallmarks of the transition from the Middle Woodland to the Late Woodland period are present in some parts of West Virginia, some of these traits are poorly expressed in southern West Virginia. In portions of West Virginia nearer the Ohio Valley, changes in Late Woodland settlement patterns include the nucleation of dispersed hamlets into larger villages; however, in southern West Virginia, settlement tended to remain relatively dispersed as people continued to occupy upland rockshelters and establish open-air campsites on ridgetops, upland benches, and stream heads (Fenton and Andrews 1999:41). The reliance on local sources of rock temper noted in the earlier summary of Late Woodland ceramics is consistent with the idea of reduced mobility and exchange during the Late Woodland period.

Results from excavations at the Schoolyard Site in Summers County generally support a diffuse subsistence economy based on hunting and gathering and supplemented by gardening (Ison et al. 1985). Agricultural practices did intensify in some areas, with corn added to the diet to varying degrees (Burdin 2004, Fenton and Andrews 1999). More specifically, McMichael and Mairs (1969) characterize the Buck Garden phase (late Late Woodland period) as marking the appearance of small, diffuse hamlets or villages based on horticulture.

Ten sites with Late Woodland components have been identified within the Huntington District boundaries of Bluestone Lake (Table 3-5). Five of these sites (46Su39, 46Su41, 46Su42, 46Su44, and 46Su45) are, like the Early and Middle Woodland sites, located within close proximity of one another along the floodplain terraces of the New River near Bertha, below the Bluestone Conference Center. Sites 46Su49 and 46Su58 are located further upstream on New River floodplain terraces on either side of the river at Wylie Island. Downstream from Bertha, 46Su20 is located on a river floodplain in lower Crump's Bottom near Bull Falls, and 46Su1 is a rockshelter located opposite the confluence of the Bluestone River with the New River. Site 46Gs48 is located on the west bank floodplain of the New River across from Glen Lyn, Virginia, and north of The Narrows.

Late Prehistoric Period

Significant cultural developments took place during the Late Prehistoric period, the sources of which were both indigenous and foreign. By A.D. 1000, many native peoples had come to depend on the cultivation of corn, beans, and squash for their livelihood, a change in subsistence that had its roots in the preceding late Late Woodland period. Changes took place during the Late Prehistoric period in technology, settlement size and plan, settlement patterns, exchange, and burial practices. In some regions of the Eastern

Woodlands, socio-political organization became more complex and chiefdoms developed (Chapman 1985; Dent 1995; Gallivan 2003; Milner 1998; Potter 1993). In other areas, including the Bluestone Lake area, socio-political organization apparently remained small-scale and tribal (Pollack and Crothers 2005, Fuerst 2004, 2005; Henderson 1998; Snow 1994). While predominantly indigenous Late Prehistoric cultural expressions are usually considered to have ended by A.D. 1700, Henderson (2005) ends the Late Prehistoric period with the advent of European trade goods after A.D. 1500 – in other words, commencing with indirect rather than direct contact.

Several factors have hampered efforts to understand the Late Prehistoric period in the Lower New River Region. The region is on a distinct cultural boundary zone between the Ohio Valley's Fort Ancient culture and the Ridge and Valley Province's Intermontane Culture (Evans 1955; Johnson 1984; Maslowski and King 1983); few major excavations have been conducted at Late Prehistoric sites in this region; and few radiocarbon dates are available. As noted by Henderson (2005) in Pollack and Crothers' recent study of the New River Gorge National River, the Bluestone Lake study area provides a rich research opportunity for investigating how groups influenced each other and interacted across cultural boundaries; in this case, the Fort Ancient-inspired groups of the lower New River valley and those of the "Intermontane" (Radford) Culture located further upstream on the New River, past Narrows and into Virginia. Several Late Prehistoric villages have been identified along the New River in this area, making Bluestone Lake an important region both for the study of Late Prehistoric culture history and for the study of what may represent different ethnic groups on either side of a "cultural fracture zone" (Evans 1955; Johnson 1984; Maslowski and King 1983).

Late Prehistoric settlements exhibit several important differences from the preceding Woodland societies, including 1) an increased reliance on agriculture; 2) increased sedentism; and 3) a rise in sociopolitical complexity. However, unlike contemporaneous Mississippian groups in the Midwest and Southeast, no large ceremonial centers or earthworks have been found at Late Prehistoric sites in the Bluestone Lake area that would indicate a similar settlement hierarchy.

To date, the only site types identified for the Late Prehistoric period in the Bluestone Lake area (and in West Virginia generally) are villages and small extractive camps. However, the majority of recorded Late Prehistoric sites are circular villages located on a trail network situated on the floodplains and terraces of major rivers. Nucleated villages contained concentric activity areas with an outer domestic/residential areas and inner plazas, with burials occurring within the villages rather than in association with mounds as the use of mounds and earthworks became uncommon. These sites tend to become consolidated over the course of the Late Prehistoric period, moving from higher to lower terraces possibly to more effectively exploit floodplain environments (Fuerst 1981). Little is known about the small extractive camps, which are usually identified by the presence of a small amount of shell-tempered pottery or an isolated biface in upland settings.

The Late Prehistoric period in the Bluestone Lake area generally begins around A.D. 1000 and continues until at least A.D. 1500. Numerous regional chronologies within this general framework have sprung up over time, including various phases, traditions, and complexes (Ison et al. 1985; Graybill 1981, 1986, 1988; McMichael 1968). These categories represent attempts to reflect the complex multicultural interactions of the region. One of the Late Prehistoric study areas defined by Henderson (2005) is the "Fort Ancient – Mountain Interior," which encompasses a variety of complexes that have been variously referred to as Mount Carbon, Woodside, and Bluestone. These Fort Ancient-related complexes include the area in the Upper Kanawha River Valley, the Big Sandy/Guyandotte River, and the Lower New River regions. The Bluestone Lake area is

encompassed by Henderson's Lower New River region, and the Late Prehistoric sites in the Bluestone Lake area constitute the sites used to define the Bluestone Complex of the lower New River region (Henderson 2005).

There is little or no data in the Bluestone Lake area for what is often called the early Late Prehistorie period (A.D. 1000-1200) elsewhere in West Virginia. The poorly defined (and possibly defunct) late Late Woodland Buck Garden phase is thought to have continued until around A.D. 1200, but little supporting evidence has been identified (Railey and Henderson 1986). Little is known about the culture history of the Bluestone Lake area until after the beginning of the Bluestone Complex around A.D 1200.

The Late Prehistoric period begins around A.D. 1200 in the Bluestone Lake region with the advent of the Bluestone Complex. A detailed summary of the Bluestone Complex was assembled by Henderson (2005), and much of the discussion below is derived from her discussion of Late Prehistoric cultures for the University of Kentucky's study of the New River Gorge National River (Pollack and Crothers 2005).

Limited excavations and surface collections at five large village sites in the Bluestone Reservation provide the data upon which Graybill defined the Bluestone Complex (A.D. 1150-1550) (Johnson 1984:369). These sites are Barkers Bottom (46Su3), French Farm (46Su9), Harmon Farm (46Su22), Farley Farm (46Su20), and Warford (46Su24) (Applegarth et. al. 1978; Graybill 1988:57-60; Johnson 1984, 1996:112-116; Johnson et. al. 1980; Solecki 1949). Based on the relative frequency of shell-tempered ceramics, the relative proportions of exterior surface treatments, and a series of nine acceptable radiocarbon dates, the earliest Bluestone villages are Barkers Bottom and French Farm. Calibrated dates show that French Farm was occupied in the late A.D. 1200s and late A.D. 1300s, while Barkers Bottom was occupied repeatedly: during the early A.D. 100s, late A.D. 1200s, the early A.D. 1300s, the late A.D. 1300s-early 1400s, and the early A.D. 1500s (Johnson 1984, 1996; Jones 1987). Harmon Farm was occupied sometime between A.D. 1400 and 1500 (calibrated to the early A.D. 1400s) (Johnson 1984, 1996; Jones 1987). Ceramic assemblage characteristics for the undated Warford and Farley Farm sites suggest the former was occupied sometime before A.D. 1400 and that the latter was occupied as late as the early A.D. 1500s.

Although information is limited, investigations at Barkers Bottom, Harmon Farm, and French Farm suggest that Bluestone Complex sites represent planned, circular villages with central plazas (Applegarth et al. 1978; Graybill 1988; Johnson 1984). These semi-permanent settlements were lived in year-round. The domestic activity area that encircles the plaza includes houses, hearths, and storage/refuse pits, including bell-shaped pits (Johnson 1984, 1996). Smaller, extractive camps also may have been part of the settlement pattern, but none have been documented to date (Graybill 1988). It is not known whether palisades surrounded these villages (Johnson 1984). Burial mounds were not present, but burials did occur, although information on burial patterns and practices is limited due to the small number of graves investigated. At French Farm, one individual, covered with eight sandstone slabs, was buried partially flexed with shell beads, while another was a bundle burial (Johnson 1984).

Bluestone Complex ceramic assemblages are predominantly shell-tempered and plain surfaced, but these plain surfaced examples share only the most basic characteristics (temper and exterior surface treatment) with specimens from southwestern Virginia assigned to New River Plain defined by Evans (1955) and Holland (1970). Instead, they are identical, in terms of decoration, castellations, handles, and vessel form, to middle Fort Ancient Feurt phase ceramics from sites such as Roseberry Farm, located far to the north on the Ohio River (Johnson 1996). Johnson (1978) considers that these ceramics represent a diffused, nonlocal ceramic tradition.

Bluestone Complex sites also include variable mixtures of shell-tempered, knot-roughened/net-impressed or Z-twist cordmarked New River series ceramics and limestone-tempered, knot-roughened/net-impressed or cordmarked Radford series ceramics (Graybill 1988; Johnson 1978, 1984). Vessel forms include constricted neck jars. Other ceramic artifacts include pipes, discs, and scrapers (Applegarth et al. 1978; Johnson 1984). Lithic artifacts include triangular projectile points, bifaces, drills, and vasiform stone pipes. The points are isosceles with straight or flared bases. French Farm also produced Yadkins and Clarksville Small triangular hafted bifaces (Johnson 1984). Antler tine projectile points and flakers are present, and bone artifacts include shuttles, beamers, and awls as well as ornaments, such as beads, drilled animal teeth, and turkey digits (Johnson 1984). Shell artifacts include freshwater mussel shell hoes, and ornaments, such as circular and ovoid beads and marginella shell beads (Johnson 1984). Macrobotanical data from these sites was scarce, but includes small samples of carbonized Northern Flint corn cobs from Barkers Bottom feature fill (Johnson 1984). C13/C14 analyses on human bone suggest that corn represented a significant portion of the diet (Graybill 1988). Nuts and wild plant foods were collected. Like their contemporaries, the Bluestone Complex inhabitants hunted a variety of mammals, birds, and fish, with deer, bear, elk, and turkey representing the species of major importance but also consuming occasional small mammals, box turtle, fish, and freshwater mussels (Applegarth et al. 1978; Johnson 1984).

Johnson (1984, 1996) has suggested that the earlier, downriver Bluestone Complex sites of Barkers Bottom, Warford, and Harmon Farm represent the movements of a single intrusive Fort Ancient population or a local population heavily influenced by Fort Ancient cultural traditions. He provides several scenarios for the contemporary occupation at the upstream French Farm. It was either occupied by a local terminal Late Woodland population with a Radford ceramic tradition that was assimilating foreign Feurt phase ceramic traits, a mixed Fort Ancient-Intermontane Culture population, or, like the rest of the other Bluestone Complex sites, its inhabitants were an intrusive population that, due to their proximity to groups producing Radford Series ceramics, were absorbing significant amounts of southwestern Virginia ceramic tradition traits or potters.

On the other hand, Graybill (1988:58; see also Johnson 1996:115) considered the Bluestone Complex a local cultural development due to the high percentages of limestone-tempered Radford ceramics; cordmarked and knot-roughened/net-impressed exteriors; and other traits such as smoking pipes and triangular points. Determining the identity of the Bluestone Complex inhabitants hinges on the origin of the population, and the direction of the vectors of change, which can only be resolved with more research in the area.

A total of 30 sites with Late Prehistoric components have been identified within the Huntington District boundaries of Bluestone Lake (Table 3-5). Seven of these sites (46Su3, 46Su39, 46Su42, 46Su44, 46Su45, 46Su60, and 46Su61) are located within close proximity of one another along the floodplain terraces of the New River near Bertha, below the Bluestone Conference Center. Eleven sites with Late Prehistoric components (roughly north to south, 46Su19, 46Su20, 46Su24, 46Su326, 46Su6, 46Su10, 46Su22, 46Su208, 46Su28, 46Su29, and 46Su279) have been identified throughout lower, middle, and upper Crump's Bottom and at the confluence of Indian Creek with the New River. Site 46Su199 was identified on a stream terrace further upstream on Indian Creek, and 46Su56 was identified on a New River floodplain across from Saltwell Ridge near Lick Creek.

Continuing upstream and to the south along the New River, eight prehistoric archaeological sites have been recorded on the New River floodplain on either side of Wylie Island. Late Prehistoric components have been recorded for seven of these sites, including

46Su8, 46Su9, 46Su47, 46Su48, 46Su49, 46Su50, and 46Su58. Site 46Su7 is located at the confluence of Roundbottom Creek and the New River, and the remaining three sites (44Gs10, 44Gs15, and 44Gs48) all situated on New River floodplain terraces near Glen Lynn in Virginia, downstream (north) of The Narrows.

Protohistoric Period

The Protohistoric period is typically defined as beginning at the first evidence of European contact around A.D. 1550 and continuing to around A.D. 1700. Archaeological evidence for occupation of the Bluestone Lake area during the Protohistoric period is limited. A blue glass bead was reportedly recovered from Barkers Bottom (46Su3) (Solecki 1949:378). Outside of the project area but within Summers County on a terrace overlooking the confluence of the Little Bluestone and Bluestone River, recent research at 46Su672 documented a possible protohistoric component (Stathakis 2001; Trader 2003). The site produced two glass beads: a green one that may date to between A.D. 1600 and 1625, and a dark blue or black glass bead that could not be dated (Trader 2003:74-75).

Historic Period Culture History

The first documented settlement marked the beginning of the Colonial and Revolutionary War Period (A.D. 1753 - 1795). This settlement was located on Crump's Bottom at the mouth of Joshua's Run and was settled by Andrew Culbertson in 1753. This settlement was subsequently abandoned at the outbreak of the French and Indian War (Miller 1908; USACE 1979, 1983).

At the outbreak of Dunmore's War in 1774 Colonel William Preston ordered Major James Robertson to build a small fort on Culbertson's Bottom. This fort was referred to as Culbertson's Fort. Major Robertson commanded a small detachment of scouts at the fort to watch the Indian trails on the Bluestone River and Paint Creek (USACE 1979, 1983)

In October 1774, Captain Joseph Martin took command of Culbertson's Fort (Thwaites and Kellogg 1905) and a month later the detachment of scouts was disbanded. In 1777 Captain John Lucus was in command of the fort at Culbertson's Bottom which was now referred to as Fort Field (Johnston 1906; USACE 1979, 1983).

After much litigation Culbertson's Bottom came into the ownership of Thomas Farley of Albermarle County, Virginia, who built a stockaded fort at the downstream end of the bottom in 1775. James Caldwell stated that Farley's Fort on Culbertson's Bottom was burned by the Indians in the spring of 1778. At this time Caldwell stated that he served under the command of Captain Archibald Woods and they spent 15 days pursuing the party of hostile Indians who burned the fort (USACE 1979, 1983).

Peace was established with the Indians during the Early Settlement Period (A.D. 1795-1848) in 1795 after the Battle of Fallen Timbers. This assured the peaceful settlement of the Ohio and Big Sandy valleys and increased the influx of settlers into the New River Valley. The project area was probably occupied by several families who engaged in subsistence farming with heavy reliance on hunting and fishing as sources of protein. Surplus produce was sold locally but gradually farms grew large enough to ship grain and livestock to eastern markets (USACE 1979, 1983).

The Giles, Fayette and Kanawha Turnpike was completed in 1848 during the Agricultural and Commercial Period (A.D. 1848 - Present). The Turnpike, proceeding from Peterstown, Virginia, crossed the Bluestone River near its mouth on the New River and extended up the Little Bluestone River to Jumping Branch and then to Beckley (Richardson 1949; USACE 1979, 1983).

At this time, part of Crump's Bottom was owned by T.S. Campbell. His estate consisted of 800 acres which included 550 acres of flat

bottomland and 200 acres of virgin timber. Campbell raised 200 head of hogs and 100 head of cattle a year. Each year the stock was driven overland to markets in Philadelphia, Baltimore, and Richmond (Donnelly 1960; USACE 1979, 1983).

L.P. Campbell, the son of T.S. Campbell, indicated that in his boyhood (the 1850s) the New River was full of fish and there was plenty of deer, raccoon, squirrels, wild turkeys, wild ducks, and other waterfowl. At this time there were "millions of pigeons" and flocks of wild geese passing over Crump's Bottom each year. Crump's Bottom was too rich for raising wheat, which would grow up quickly and then fall over, making it difficult to harvest. In 1857 the Campbells sold their estate for $37,000 and bought Red Sulphur Springs where the family ran Red Sulphur Spa (Donnelly 1960; USACE 1979, 1983).

In 1855, Major William G. Crump purchased a large portion of the area that became known as Crump's Bottom. He built a 22-room mansion on a hill overlooking the bottomland. The structure was built by slaves from brick made on the site. The timber in the house was mostly walnut and cherry and the four 40-foot front porch columns were solid poplar. The mansion had a full basement with a dirt floor and a plastered attic on the fourth floor. The kitchen was in a wing in the back of the house and the four main rooms on the first and second floors each had a fireplace (Browning 1953; USACE 1979, 1983).

Upon Crump's death, Colonel John G. Crockett acquired the land and in 1902 he sold the 1,744 acre estate to George W. Harman of Tazewell, Virginia. The federal government acquired the property in 1948 (Browning 1953; USACE 1979, 1983).

Construction of a dam for hydropower purposes in the Bluestone area has been considered since 1910 when a rough set of specifications and drawings for a power project were prepared by several Hinton area residents in order to interest power companies. The site chosen by the residents was near the mouth of the Bluestone River, approximately two miles upstream from its present-day site. These plans were presented to the Appalachian Power Company in 1911, who immediately expressed an interest. Plans were developed for a chain of dams that would make the New River the source of power for supplying coal mines, trolley lines, factories, and farms with electric power at an extremely low price (Perry n.d.)

Appalachian Power Company sent engineers to Bull Falls near Hinton, in 1912 to make surveys for the proposed dam. Negotiations were started for land acquisition. Virginia Power Company, a subsidiary of Appalachian Power Company, made the first land purchases and test excavations on the site at the mouth of the Bluestone River in 1913. Test excavations revealed that suitable foundation rock was at an excessive depth below the surface. Another location was chosen near Bull Falls, about nine miles above the present site. Appalachian Power Company's plans were soon halted by the passage of the West Virginia legislature's Water Power Act of 1913. The Water Power Act was passed to grant, define, and regulate the rights, duties, powers, and privileges of hydropower and other companies producing other energy or power. It also provided that all streams within the state capable of developing energy or power should be under the control of the state. This Act, however, did not interfere with the jurisdiction of the U.S. Government over navigable streams (Perry n.d.).

Appalachian Power Company allowed their plans to lag while efforts were being made to pass legislation that would permit the dam's construction without the interference of the state. Legislation was not passed until 1929 that allowed developers to proceed and protected the interests of the state. In the meantime, Appalachian Power continued testing sites, and in 1924 Virginia Power Company investigated the geology of the New River Valley from Hinton, West Virginia, to Narrows, Virginia. At this time, the current site of the dam was investigated and chosen as the best location. In September 1924, West Virginia Power Company, another subsidiary of Appalachian Power, was formed to con-

struct a single development at the present site. A construction permit application was filed with the West Virginia Public Service Commission. The Huntington District favored the development of the project and recommended that the permit be granted. The Public Service Commission failed to act on the application and it was placed on their retired docket (Perry n.d.; Johnson 1977).

After the 1929 legislation was passed, Appalachian Power resumed plans for the Bluestone Project. The plans were amended to include a joint development at Hinton and Bull Falls, known as the Bluestone Project. Appalachian Power began acquiring lands and in 1930, the West Virginia Power Company petitioned for reinstatement of the 1924 application. The application was amended to include the double/joint development (Perry n.d.).

Appalachian Power never began construction of the Bluestone Dam. The coal industry was fearful of the competition from hydropower and fought the project. Civic organizations in the coal regions of both Beckley and Bluefield, West Virginia, also were opposed to the dam. During the early 1930s, Congressman John Kee of Bluefield led the fight for federal construction of Bluestone Dam. He argued that it should be built for flood control and hydropower. Appalachian Power and citizens of the area believed the Bluestone Dam might turn the New River Valley into a "despicable mudhole" and fought this (Johnson 1977; Perry n.d.)

In June 1908, the U.S. Government Survey began a study of possibilities for flood control in the Ohio Valley. Stations were established at various points along the Ohio River and its tributaries. Records regarding stream flow were maintained for a period of five years. From this data it was determined that 100 reservoirs were needed for flood control in the Ohio Valley. It was not until the 1930s, however, that serious consideration was given to flood control in the Bluestone area when Congress became concerned with establishing a nationwide flood control policy (Perry n.d.)

In 1927, Congress authorized planning studies of water resources problems and all possible measures that could benefit navigation, hydropower development, or flood control in all the major river basins in the nation. The results of these studies became popularly known as the "308" reports. In 1932, the Huntington District submitted their 308 report to Congress. The Bluestone Dam and Reservoir was one of the four large storage reservoirs recommended as necessary for flood control in the Kanawha Valley. It was recommended that the project be constructed as a federal project under provisions of the National Recovery Act at an estimated cost of $12,942,000 (Lady 1983).

President Franklin Roosevelt authorized construction of the Bluestone Dam and Reservoir in Executive Order 7183-A on September 12, 1935. Appropriations were included by Congress in the Flood Control Acts of June 22, 1936, and June 28, 1938 (Perry n.d.)

Appalachian Power owned much of the land in the proposed reservoir, and attempted, through litigation, to clear the way for construction of their project. Appalachian Power maintained that the New River was not navigable and therefore not under the jurisdiction of the Federal Power Commission. The Federal Power Commission and the Huntington District believed the stream to be navigable and fought Appalachian Power in the courts. The confrontation between the federal government and the power company ended in the Supreme Court in the fall of 1940. At stake was not just the construction of the Bluestone Reservoir, but also the government's control of our nation's waterways, including their navigation, flood control and hydropower development (Johnson 1977; Perry n.d.).

The legal question for the courts revolved around the navigability of the New River. Proof of navigability involved a 111-mile section of the New River from Allisonia, Virginia, to Hinton, West Virginia. Determination rested on whether or not the stream had "capability of use by the public for

the purposes of transportation and commerce." Federal proof of navigability involved several steps, ranging from documentation of historical navigation to an actual boat trip on the New River in 1936 (Johnson 1977; Perry n.d.). In addition to the use of interviews and the documented history of navigation on the New River, the Huntington District demonstrated the possibility of navigation on the river in 1936. Patrick A. Gragnon and four other men ascended the New River from Hinton, West Virginia, to Allisonia, Virginia, in a government survey boat with an outboard motor. The trip was made in July 1936. The trip took several rough days, but the men reached Allisonia, Virginia, with no carries or portages. It was not necessary to pull or push the boat more than 1-1/4 mile going upstream and more than a few hundred feet downstream. Thus, in 1936, the New River was designated a navigable stream (Johnson 1977; U.S. v. Appalachian Power; Lady 1983:189-190).

On October 14 & 15, 1940, the United States v. Appalachian Power Company was argued before the Supreme Court. On December 16, 1940, the Court stated that the issue involved "the scope of the federal commerce power in relation to conditions in licenses, required by the Federal Power Commission for the construction of hydroelectric dams on navigable rivers of the United States" (U.S. v. Appalachian Power). The Court found that the New River was a navigable stream, thus ending Appalachian Power's plans of the past 40 years. With this conclusion, the federal government was given control of our nation's navigable waterways, commerce including not only navigation, but all aspects of water resources development (U.S. v. Appalachian Power Company; Lady 1983:190).

While the Bluestone case was in the courts, the Huntington District established a suboffice at Hinton and undertook detailed surveys and extensive foundation investigations to obtain necessary data for dam design. Land acquisition for the project occurred over several years and could not be completed until after the Supreme Court decision in 1940 (Perry n.d.; Johnson 1977).

While actual dam construction could not begin until the legal obstructions were cleared, two Civilian Conservation Corps (CCC) camps were established near the proposed dam site. These camps provided employment to approximately 200 men who worked to clear the reservoir site. They also built an access road to an observation tower overlooking the dam site and installed a sewer and culvert in the area (Perry n.d.; Johnson 1977).

On November 10, 1941, the Supreme Court denied Appalachian Power's application for a rehearing of the Bluestone Dam case, which brought to a conclusion all legal obstacles which had delayed the project's construction for five years. A few days later, the resident engineer and a staff of 20 men were sent to Hinton and on November 28, 1941, ground was broken for the Huntington District's two-story office building. On December 23, 1941, bids for the construction were opened in Huntington, West Virginia. The contract was awarded to Dravo Corporation on January 14, 1942, on a bid of $11,376,000. Under the contract, Dravo was to construct the dam, exclusive of sluice gates and hydroelectric equipment. The work was to be accomplished in 900 calendar days or by July 4, 1944. Dravo Corporation began work on the construction of Bluestone Dam on January 19, 1942 (Perry n.d.).

The first step necessary for construction of the dam was the building of a railroad bridge across the Greenbrier River at Bellepoint so materials could be transported to the construction site. The bridge was begun on February 10, 1942, and was completed eight days later (Perry n.d.). Actual work on the dam proper began in March 1942 with the construction of cofferdams (Perry n.d.; Johnson 1977).

The War Production Board now obstructed the project's completion. The contract for Bluestone had been awarded during the time the country was mobilizing for war. Dravo Corporation was assured that materials and equipment for Bluestone Dam

would receive sufficient priority to insure its uninterrupted construction (Lady 1983). However, foundation difficulties hampered the construction and caused the work to fall so far behind schedule that the project lost its priority status. On January 8, 1943, the War Production Board directed that all construction work be suspended except for such work necessary to bring the project to a safe point of suspension. Operations continued on a limited basis until December 31, 1943. On December 29, 1945, President Truman signed a project resumption deficiency appropriation bill which included $3,000,000 for Bluestone Dam. After a lapse of two years, construction work was resumed on January 2, 1946 (Perry n.d.; Lady 1983:195).

State Highway No. 20 was the principal highway from Hinton to the south, and three miles of it lay in the reservoir area. A new route outside the New River valley was out of the question--the road had to be relocated in the reservoir above the projected pool level. A high-level bridge across the arm of the reservoir extending up the Bluestone River also had to be constructed. The government paid the West Virginia State Highway Commission $2,395,910 to complete the work. Permanent construction activities were finally resumed in July 1946. Work progressed smoothly and all work was accepted by the U.S. Government on December 10, 1948 (Lady 1983:195-196).

Bluestone Dam and Reservoir was completed as a flood control project with provisions for the future addition as a powerhouse. The war years had caused delays in construction of other authorized flood control projects and the government felt it necessary to utilize the entire capacity of Bluestone Reservoir for flood control to protect the industrialized Kanawha Valley. Additionally, the critical power shortage of the war years had been alleviated, making the cost of the power installation less economic (Lady 1983).

A minimum pool elevation was initially established at 1391.6 ft amsl. As recreation demands increased, the pool level was raised. During the 1950s, the reservoir was affected by the Korean War. Army engineers at Fort Belvoir, Virginia, chose Prince, West Virginia, as a suitable site for conducting service tests of pontoon bridges and other floating equipment and for training troops in the installation of this material because the stream flow of the New River at Prince could be controlled by Bluestone Dam. Between 1950 and 1953, the pool of Bluestone Lake was raised and lowered intermittently for bridge testing purposes. In 1970, a normal pool elevation of 1410 ft amsl was established and is maintained today (Lady 1983).