

That Dam Project

Upgrading the Town of Wake Forest's Smith Creek Reservoir Dam

Presented by: Jon Becker, PE (March 18th, 2024)



Who am I?



The Rest of the Team



Michael Chilson ✓ · 2nd
Assistant Vice President, Technical Principal
Alpharetta, Georgia, United States · [Contact info](#)



Everett Gupton, PE, PMP ✓ · 1st
Senior Vice President - Southern States District Water Lead at WSP
USA



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Geotechnical / Civil Engineer
Atlanta, Georgia, United States · [Contact info](#)

The Rest of the Team



Gregory Hebler · 2nd
Geotechnical Engineer at WSP

Atlanta, Georgia, United States · [Contact info](#)



Sullivan Gibbs, PLS · 2nd
Southeastern SUE Director at WSP

Raleigh, North Carolina, United States



Kaitlin Hughes, AICP · 1st
Senior Environmental Planner at WSP USA

Raleigh, North Carolina, United States · [Contact info](#)



Travis Howell, RF · 1st

Geospatial Manager Raleigh, NC at WSP & PhD student at North Carolina State University



Clint Sorrell, PG, CEM ✓ · 1st

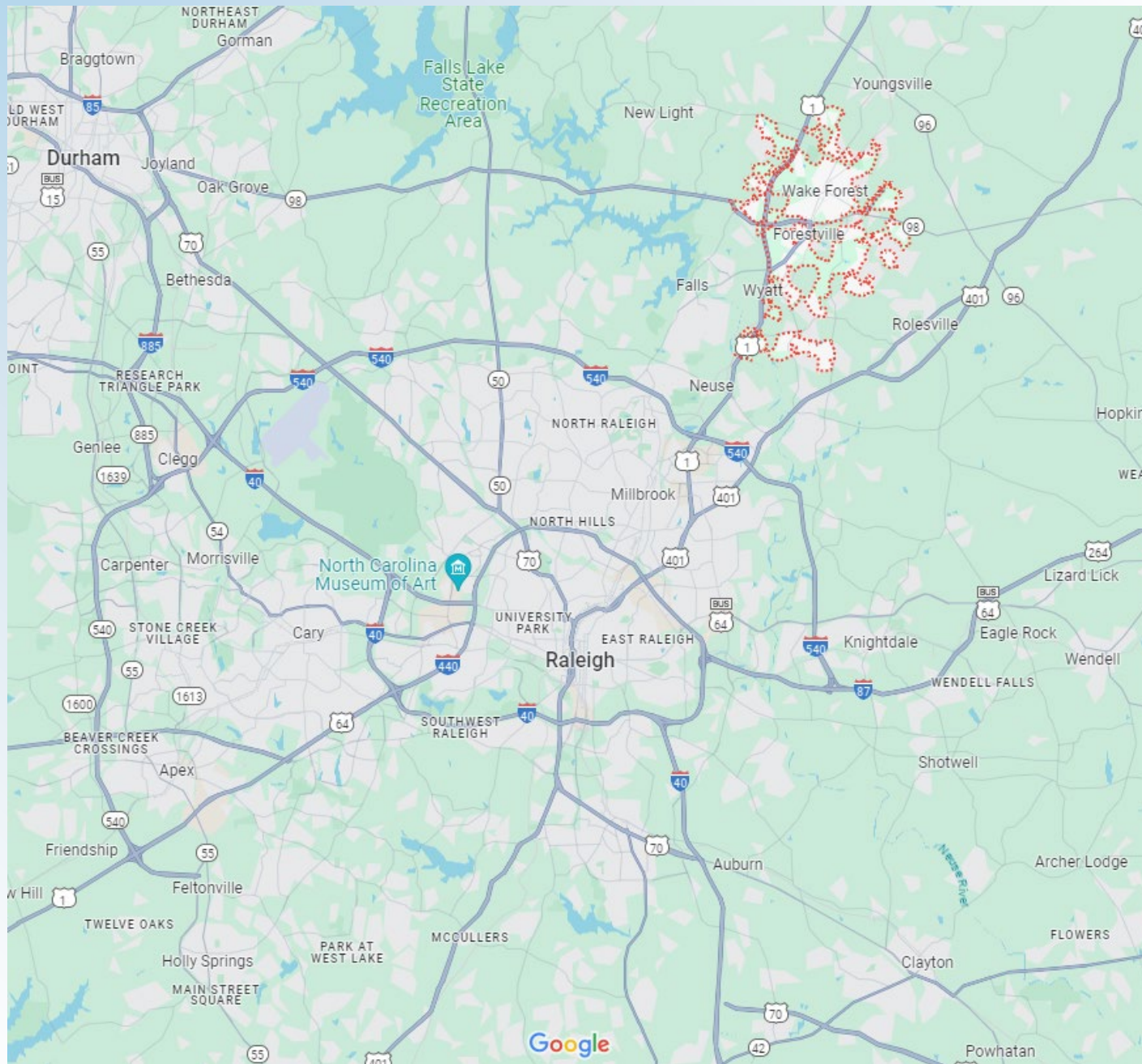
Senior Geologist at WSP

Fuquay-Varina, North Carolina, United States · [Contact info](#)

The Rest of the Team

Disciplines Involved:

- Water Resources (H&H)
- Geotechnical Investigation
- Geotechnical Design
- Survey / SUE
- Structural / Underwater Inspection
- Natural Resources Delineation and Permitting
- National Environmental Policy Act
- Etc.



What are we Talking about Today?



- Population: 49,657
- 19.7 sq mi
- 19 mi NE of Raleigh
- NOT the home of WFU

What are we Talking about Today?

WAKE-176 (NC00995)

- Built: 1960
- Class: C (Medium)
- Height: 36 ft
- Length: 665 ft
- Volume: 536 ac-ft
- Spillway: 57 ft wide
- Watershed: 2,089 acres





What are we Talking about Today? GG Hill Water Treatment

- WF Water and Sewer merged with Raleigh in 2004
- Treatment plant returned to WF in 2009
- 1.2 MGD

This event has passed.

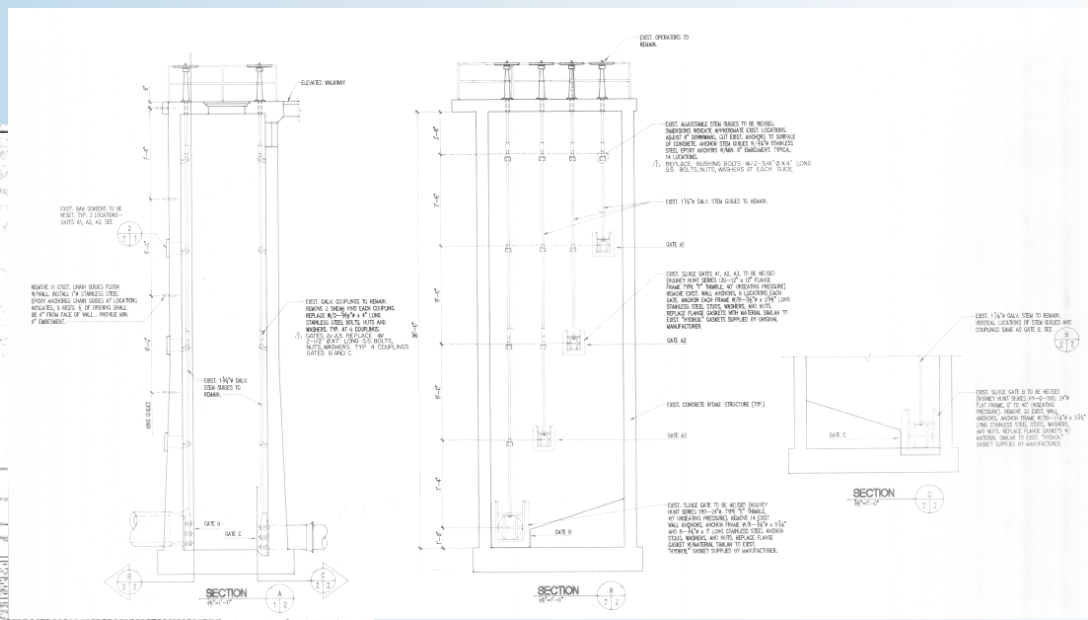
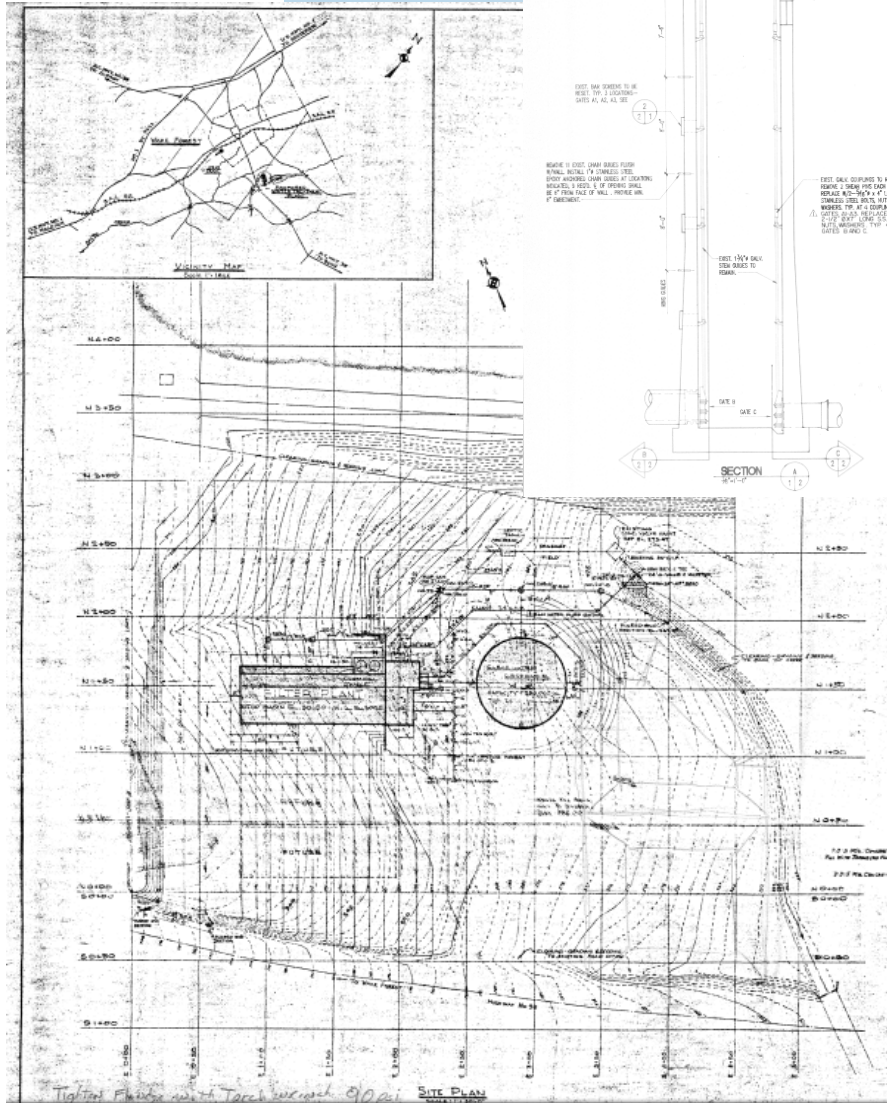
Wake Forest, NC/ Re-Bid – Wake Forest, NC – G. G. Hill WTP Lagoon Closure

April 21, 2022

Re-Bid – Wake Forest, NC – G. G. Hill WTP Lagoon Closure

The closure of existing alum lagoons and related structures, removal of three above ground storage tanks (ASTs) used for the storage of chemicals at the former Town of Wake Forest, G.G. Hill Water treatment plant.

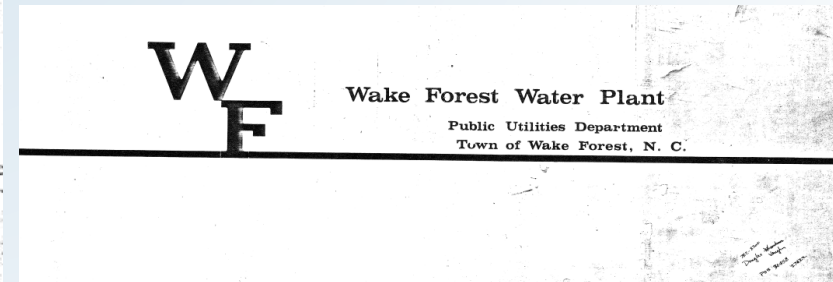
For information regarding this Invitation to Bid, contact as follow:



What are we Talking about Today?

CG Hill Water Treatment

- WF Water and Sewer merged with Raleigh in 2004
- Treatment plant returned to WF in 2009
- 1.2 MGD



Funding Application

Subgrant Project Application

Application Title: Wake Forest's Smith Creek Reservoir Dam Mitigation
Subgrant Applicant: Town of Wake Forest
Application Number:
Application Year: 2022
Grant Type: Project Application
Address: 301 Brooks Street, Wake Forest, NC 27587-2901

Subapplicant Information

Name of Subapplicant

Town of Wake Forest

State

NC

Type of Subapplicant

Local Government

Legal status, function, and facilities owned:

State Tax Number:

Federal Tax Number:

Other type name:

- Community Project Funding
- Department of Public Safety and FEMA Region IV





Benefit-Cost Analysis



SMITH CREEK DAM WAKE FOREST RESERVOIR ASSESSMENT REPORT

Prepared for:

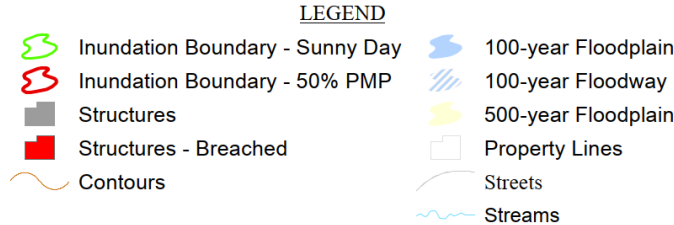
Town of Wake Forest

July 2017

Existing - 50% PMP W/ Breach	
Frequency (yrs)	3572
Total Structures Impacted ($\geq 1'$ above FFE)	43
Total Structural Damage	\$ 10,949,662.00
Proposed - 50% PMP W/O Breach	
Frequency (yrs)	3572
Total Structures Impacted ($\geq 1'$ above FFE)	4
Total Structural Damage	\$ 810,584.00

FIGURE 1 OF 2
TOWN OF WAKE FOREST

SMITH CREEK DAM
PRELIMINARY INUNDATION MAP
50% PROBABLE MAXIMUM PRECIPITATION



TOWN of
WAKE FOREST



Benefit-Cost Analysis



Funding Received



Wake Forest Gazette

Whenever the people are well-informed, they can be trusted with their own government. – T

HOME	NEWS	OBITUARIES	CONTACT
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WF gets \$2.175 M for reservoir, plant

March 30, 2022 Top News

Project will add recreation at the reservoir

Last Wednesday, March 23, U.S. Representative David E. Price announced that the Town of Wake Forest would receive \$2.175 million for its Smith Creek Reservoir repairs as part of the \$17.8 million in Community Project Funding (CPF) for the Fourth Congressional District.

Stakeholders

An official website of the State of North Carolina [How you know](#) ✓



The FEMA logo, featuring the Department of Homeland Security seal and the text "FEMA".

Disasters & Assistance ▾ Grants ▾ Floods & Maps ▾ Emergency Management ▾

About Us

Regions, States & Territories

Region 4

Design Goals – Authority and Regulations

The NC Dam Safety Program operates under the authority of:

- [North Carolina Dam Safety Law of 1967 \(NCGS 143-215.23 through 37\)](#)
 - [Senate Bill 1004 / Session Law 2009-390 \(PDF\)](#)
 - [Senate Bill 14 / Session Law 2015-7 \(PDF\)](#)
 - [Senate Bill 107 / Session Law 2017-145 \(PDF\)](#)
- [North Carolina Administrative Code, Title 15A, Subchapter 2K: Dam Safety](#)
- [Coal Ash Management Act \(CAMA\) \(PDF\)](#)
- [Environmental Protection Agency \(EPA\) Coal Combustion Residuals \(CCR\) Rule \(PDF\)](#)
- [Chapter 56 - Board of Examiners for Engineers and Surveyors: Section .0100 - Organization of Board](#)
- [G.S.132 Public Records Act \(PDF\)](#)

Design Goals – NC Dam Safety Law

MINIMUM SPILLWAY DESIGN STORMS		
Hazard	Size	Spillway Design Flood (SDF)
Low (Class A)	Small	50 year
	Medium	100 year
	Large	1/3 PMP
	Very Large	1/2 PMP
	Medium	1/3 PMP
Intermediate (Class B)	Small	100 year
	Large	1/2 PMP
	Very Large	3/4 PMP
High (Class C)	Small	1/3 PMP
	Medium	1/2 PMP
	Large	3/4 PMP
	Very Large	PMP

PERMISSIBLE VELOCITIES FOR VEGETATED EARTH SPILLWAYS				
	Permissible velocity ¹ feet per second			
	Erosion resistant soils		Easily erodible soils	
	Slope of exit channel Percent		Slope of exit channel Percent	
Vegetation	0 to 5	5 thru 10	0 to 5	5 thru 10
Bermuda Grass	8	7	6	5
Bahia grass				
Tall fescue	7	6	5	4
Kentucky bluegrass				
Reed canary				

Design Goals - PMP

PROBABLE MAXIMUM PRECIPITATION (PMP)

Probable Maximum Precipitation (PMP) is used in the design of high hazard and critical infrastructure that must be able to withstand the largest physically possible flood (often referred to as the Probable Maximum Flood)

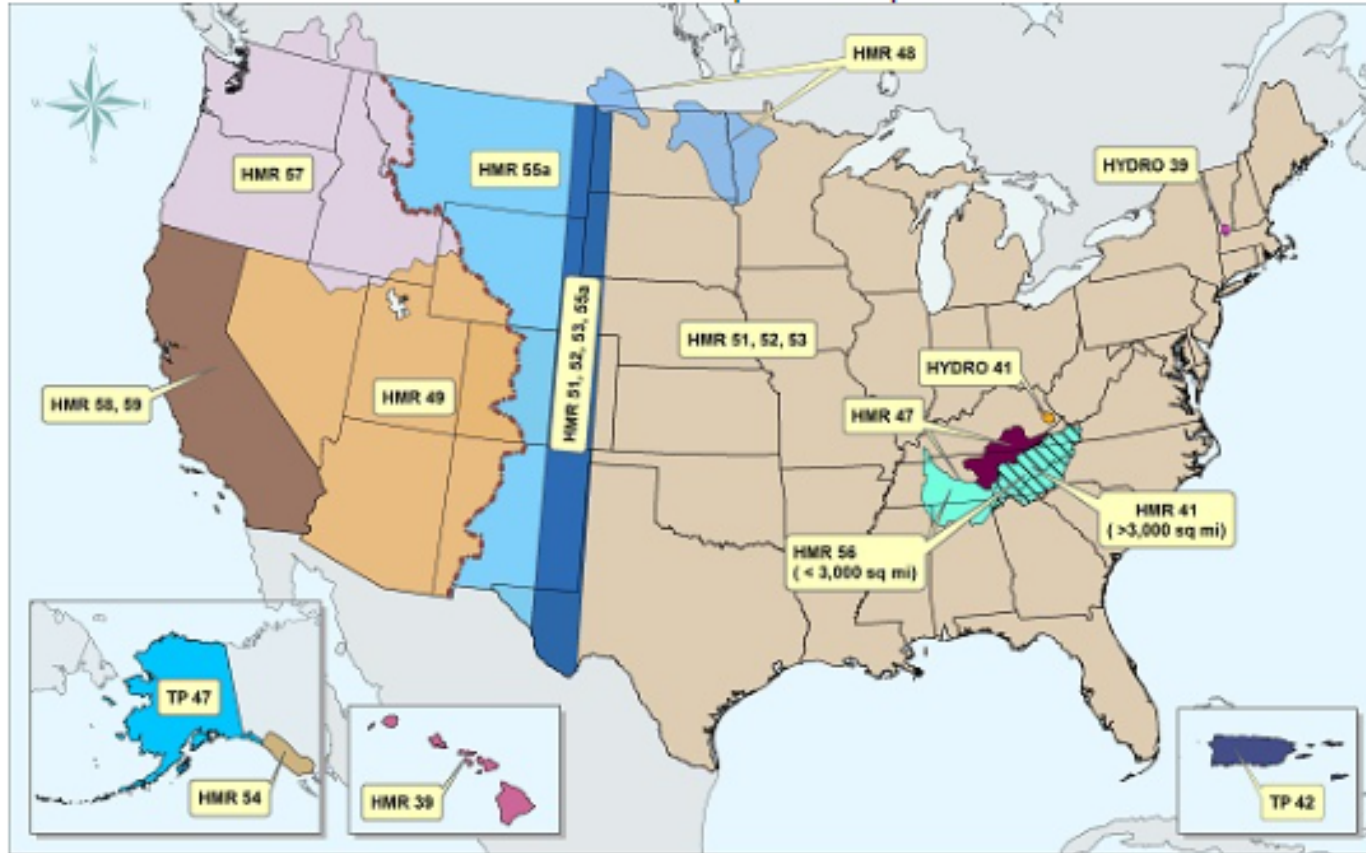
Probable Maximum Precipitation (PMP) is used in the design of high hazard and critical infrastructure that must be able to withstand the largest physically possible flood (often referred to as the Probable Maximum Flood). PMP is most often estimated with a storm-based approach to calculate a deterministic (single maximum) value. However, in recent years, AWA has also developed a process to calculate Annual Exceedance Probabilities (AEPs) that extend to the PMP event and probability estimate of the PMP depths. This information is extremely valuable when evaluating critical infrastructure from a risk perspective and in combination with deterministically derived PMP depths.



Design Goals - PMP

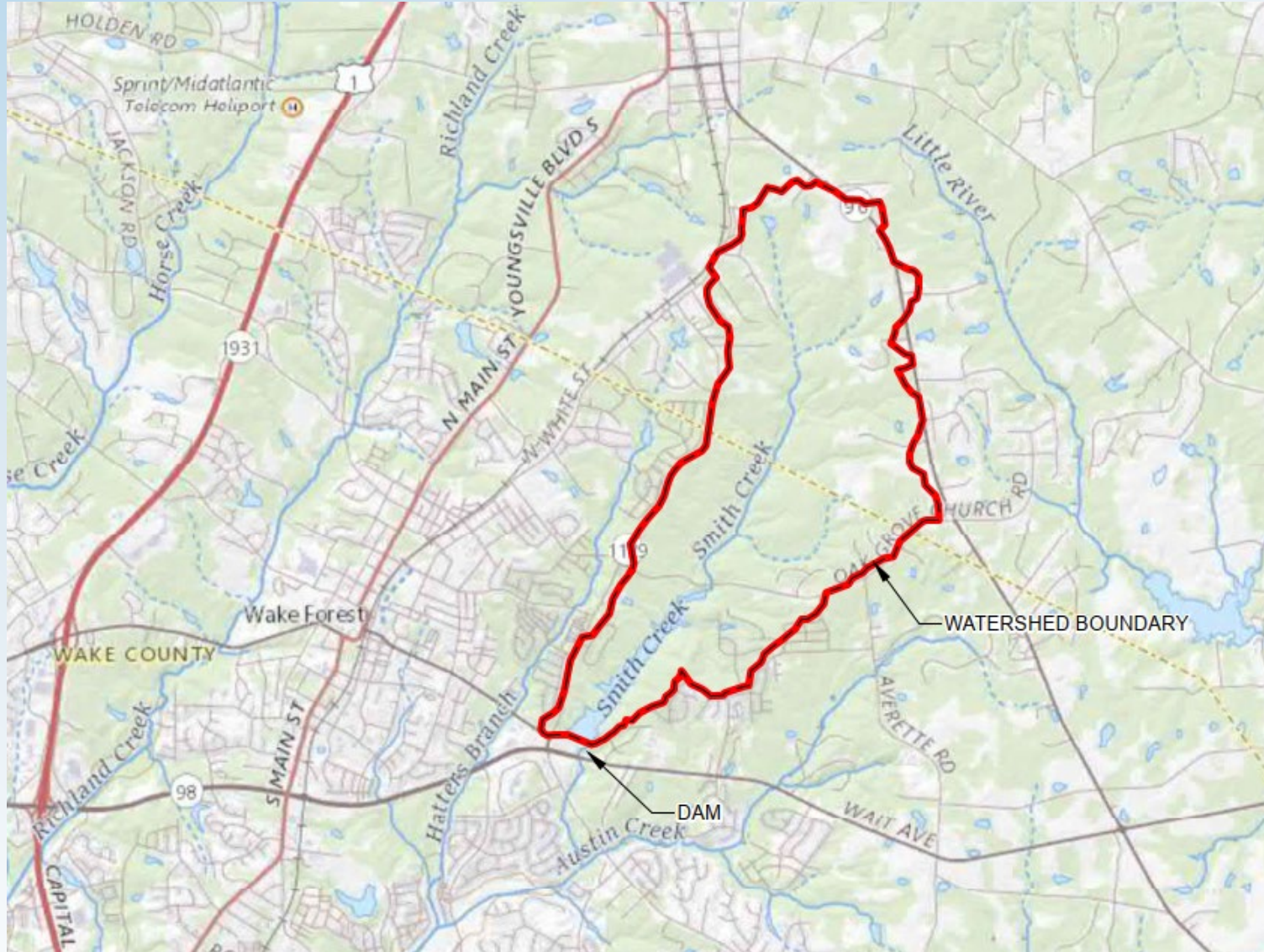
NWS Legacy Probable Maximum Precipitation (PMP) Documents

NOAA's National Weather Service continues to provide copies of PMP studies on this site.



Regions covered by different NWS PMP documents (as of 2015).

Reservoir Hydrology



Reservoir Hydrology

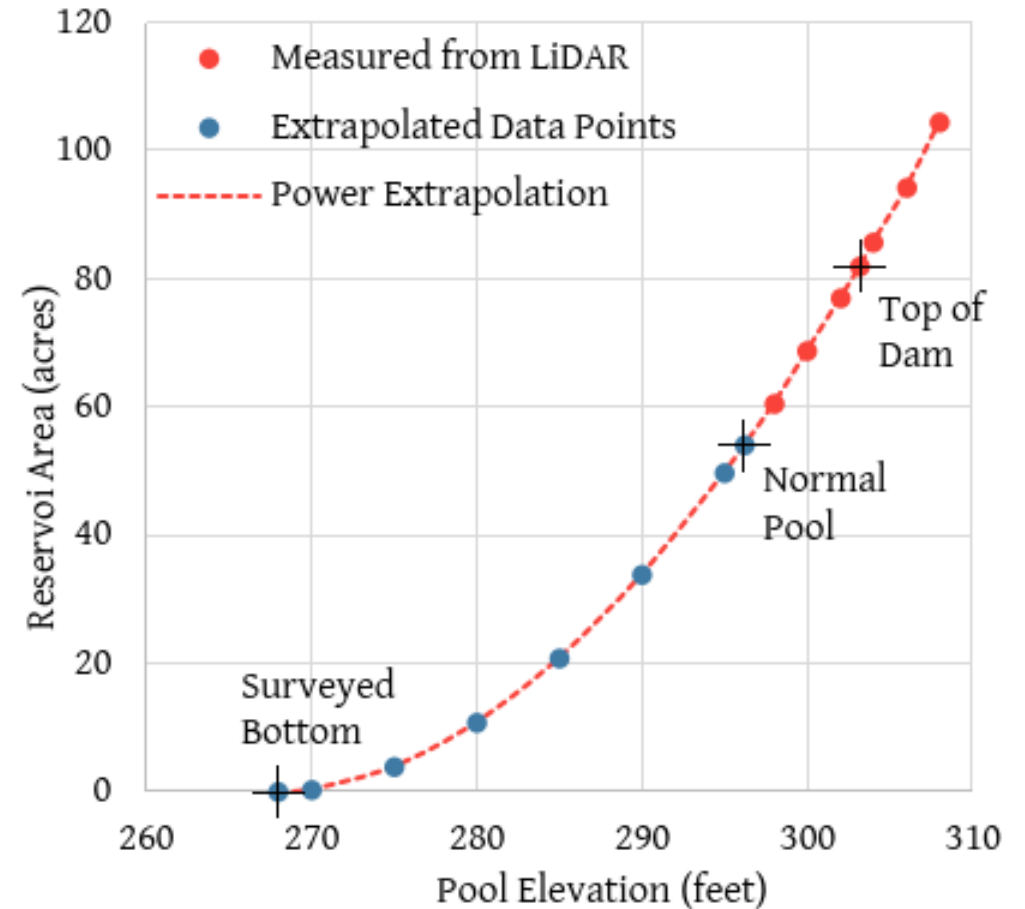
MODEL PARAMETER	FOR EXISTING LAND USE	FOR FUTURE LAND USE
Watershed Area (square miles)	3.26	3.26
Curve Number	58	65
Lag Time (hours)	1.6	1.4
Reservoir Surge Volume (acre-feet) *	474	474
Maximum Spillway Capacity (cfs) **	3,462	3,462

* Surge volume is the reservoir storage volume between normal pool and the top of dam.

** Maximum Spillway capacity is the discharge with a driving reservoir head at the top of dam.

Hydraulics – Existing Condition

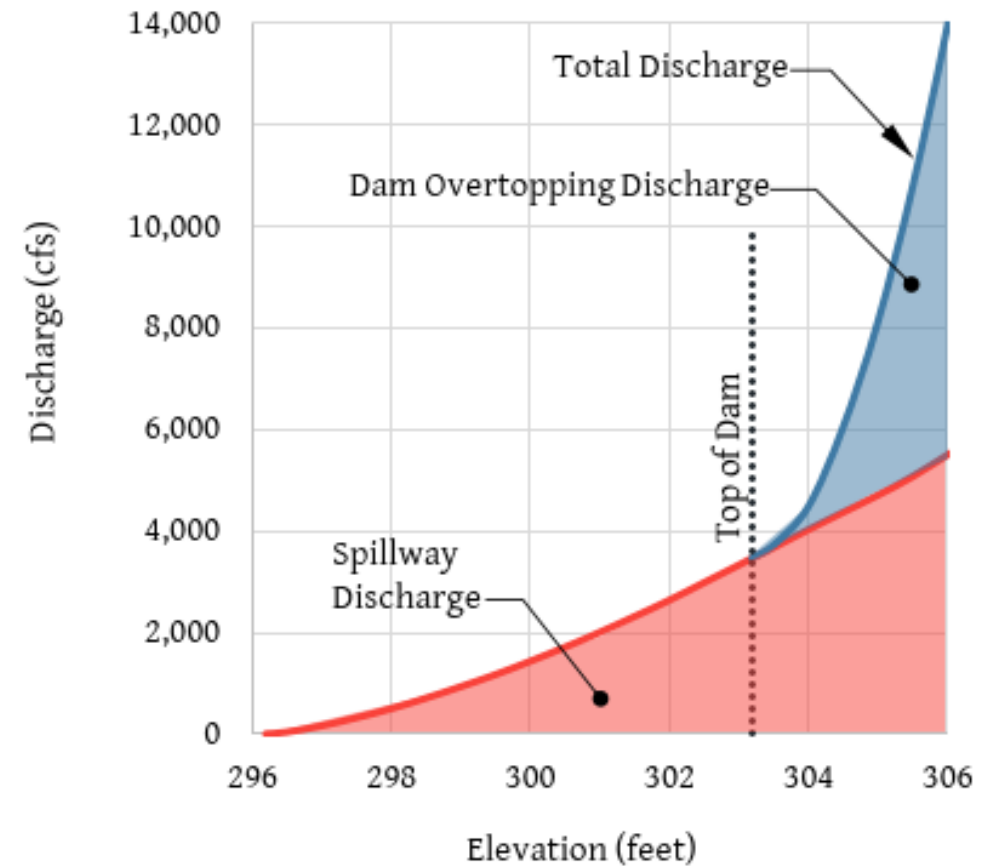
ELEVATION (feet)	AREA (acres)	VOLUME (acre-feet)	METHOD
268	0	0	Surveyed Bottom
270	0.4	0.4	Power Extrapolation
275	4	11	
280	11	48	
285	21	128	
290	34	265	
295	50	474	
296.2	54	536	Normal Pool
298	61	640	Measured from LiDAR
300	69	769	
302	77	915	
303.2	82	1,010	Top of Dam
304	86	1,077	
306	94	1,257	
308	105	1,456	



Hydraulics – Existing Condition

RESERVOIR ELEVATION (feet)	SPILLWAY (cfs)	TOP OF DAM (cfs)	TOTAL (cfs)	TAILWATER ELEVATION * (feet)
296.2	0		0	
297.0	158		158	261.3
298.0	494		494	264.1
299.0	927		927	266.9
300.0	1,427		1,427	269.6
301.0	1,997		1,997	273.5
302.0	2,629		2,629	279.6
303.0	3,321		3,321	285.4
303.2	3,462	0	3,462	286.3
304.0	4,018	444	4,462	291.6
305.0	4,696	3,385	8,081	298.8
306.0	5,487	8,403	13,891	299.7

* Backwater from Wait Avenue Culverts



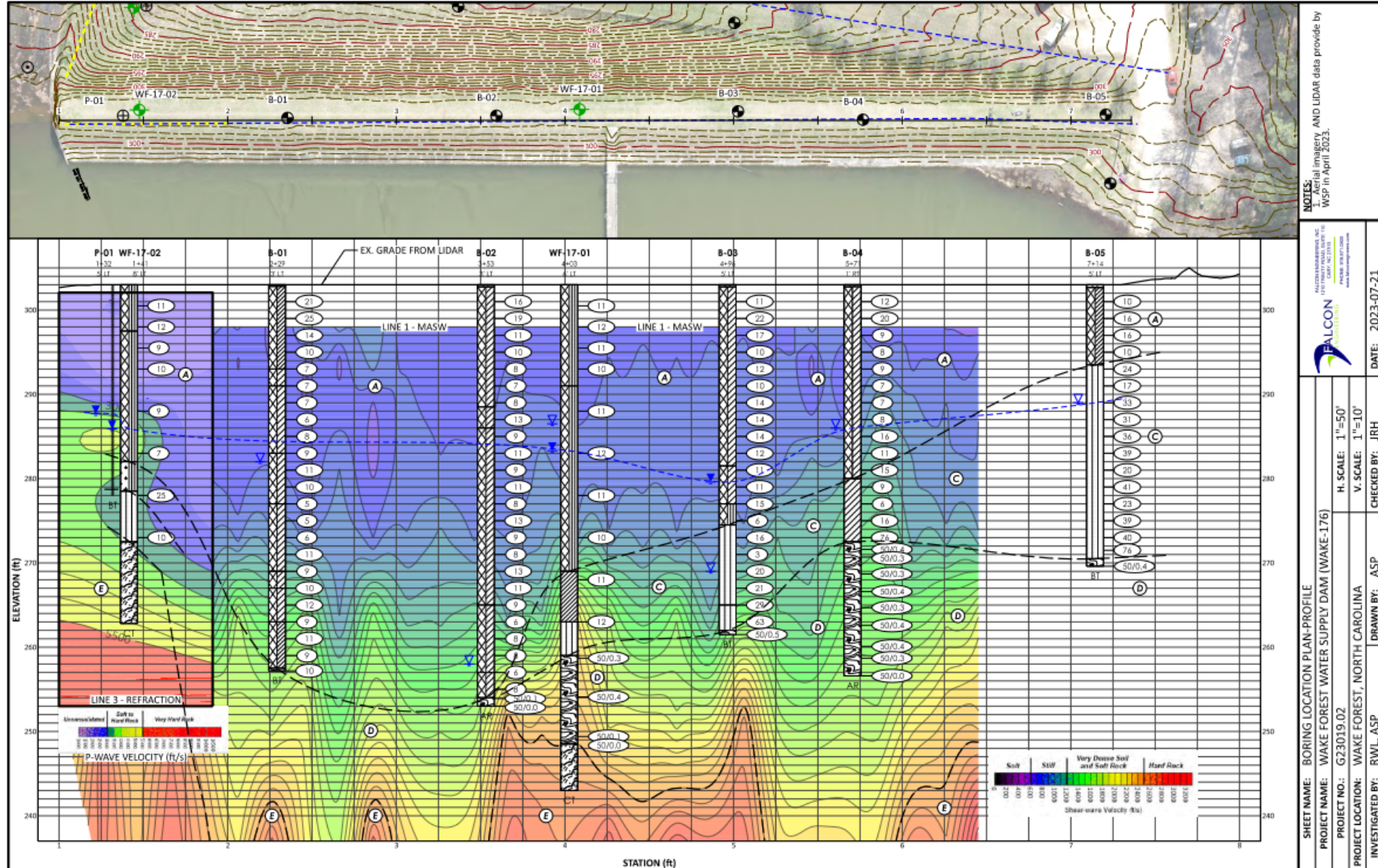
Storm Routing and PMP – Existing Conditions

LAND USE	STORM EVENT	PEAK RUNOFF (cfs)	PEAK DISCHARGE (cfs)	PEAK ELEVATION (feet)	PEAK + FREEBOARD *
Existing	100-Year, 24-Hour	1,498	845	298.82	NA
	½-PMP, 6-Hour	5,167	3,558	303.32	305.42
	½-PMP, 24-Hour	4,175	3,717	303.49	305.59
Future	100-Year, 24-Hour	2,131	1,189	299.55	NA
	½-PMP, 6-Hour	6,425	4,570	304.03	306.13
	½-PMP, 24-Hour	4,533	4,288	303.87	305.97

* A wave-action freeboard of 2.1 feet was added to the modeled peak reservoir stage, based on a wave-action height calculation included in Appendix B.

Top of Dam: 303.2 ft

WS | D



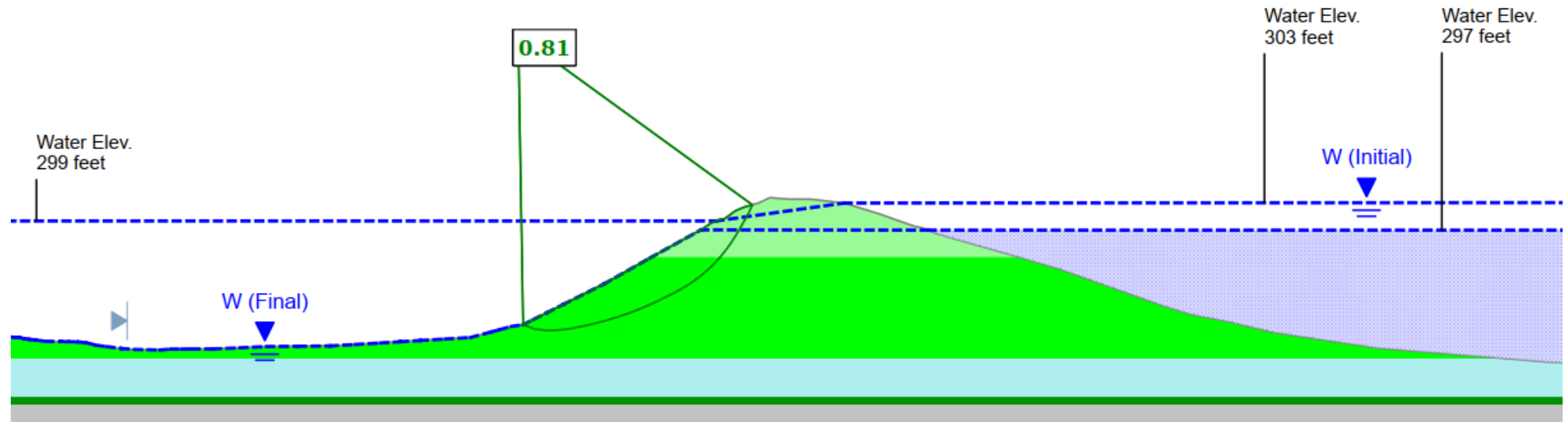
Design Goals – Slope Stability

15A NCAC 02K .0208 Structural Stability and Slope Protection (b)

“A minimum factor of safety of 1.5 for slope stability for normal loading conditions, and 1.25 for quick drawdown conditions and for construction conditions, shall be required unless the design engineer provides a thoroughly documented basis for using other safety factors.”

The computed factors of safety for the upstream slope meet or exceed the minimum requirements. The computed factors of safety for the downstream slope for the three loading conditions evaluated are less than the minimum required.

X The existing dam is not in compliance.



Slope Stability – Existing Condition

LOCATION	LOADING CONDITIONS	WATER ELEVATIONS (FEET)		FACTOR OF SAFETY (FS)	
		UPSTREAM	DOWNSTREAM	COMPUTED *	REQUIRED
Downstream Slope	Short-term	297	269	1.2	1.3
	Long-term, steady-state seepage	297	269	1.3	1.5
	Rapid Drawdown of Tailwater	Initial; 303 Final; 297	Initial; 299 Final; Ground	0.8	1.25
Upstream Slope	Short-term	297	269	1.9	1.3
	Long-term, steady-state seepage	297	269	2.1	1.5
	Rapid Drawdown of tailwater	Initial; 303 Final; 297	Initial; 299 Final; Ground	2.0	1.25
	Rapid Drawdown of reservoir	Initial; 297 Final; 272.5	Initial; 269 Final; 269	1.25	1.25

* **Bold Red** – Computed safety factor is below the minimum required threshold

Summary of Design Goals

— H&H

- *Increase storage and conveyance capacity*
- *Update infrastructure to ensure long-term protection*

— Geotechnical

- *Improve slope stability*
- *Manage seepage*
- *Update infrastructure to ensure long-term protection*

Summary of Design Goals

- Raise the Dam
- Spillway Configuration
- Sand Blanket
- Improve Slope Stability
- Ease Maintenance
- Facilitate future park

Alternatives



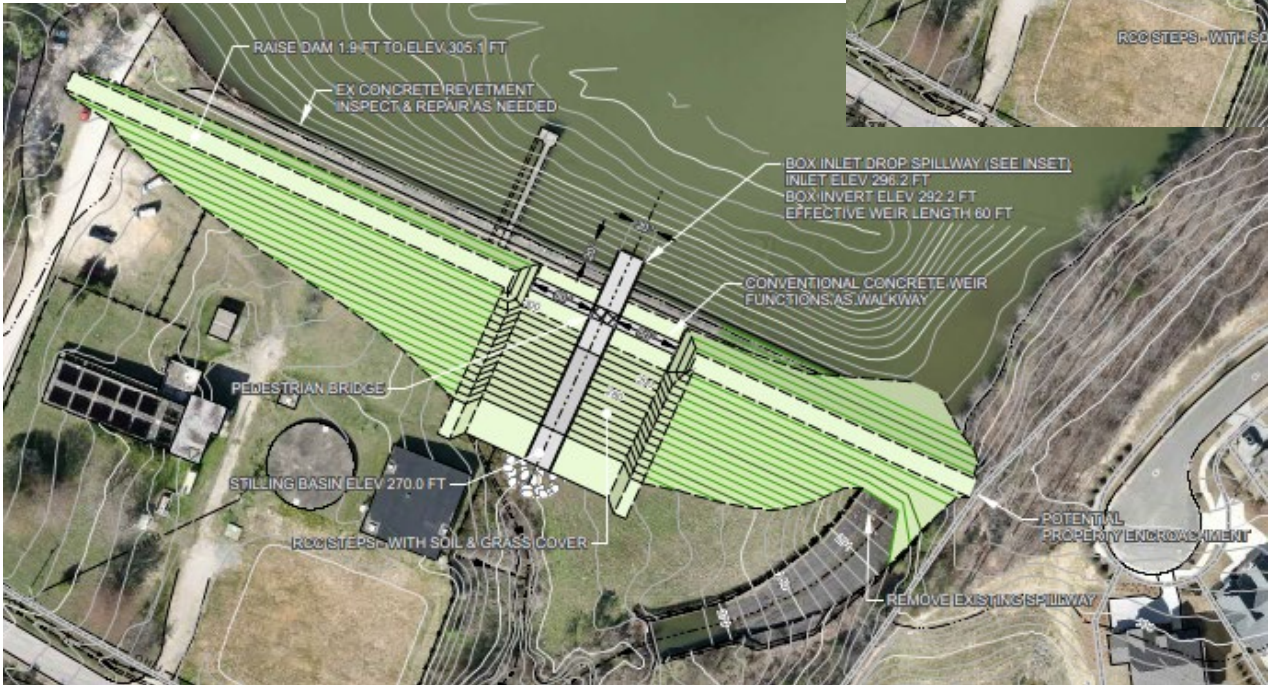
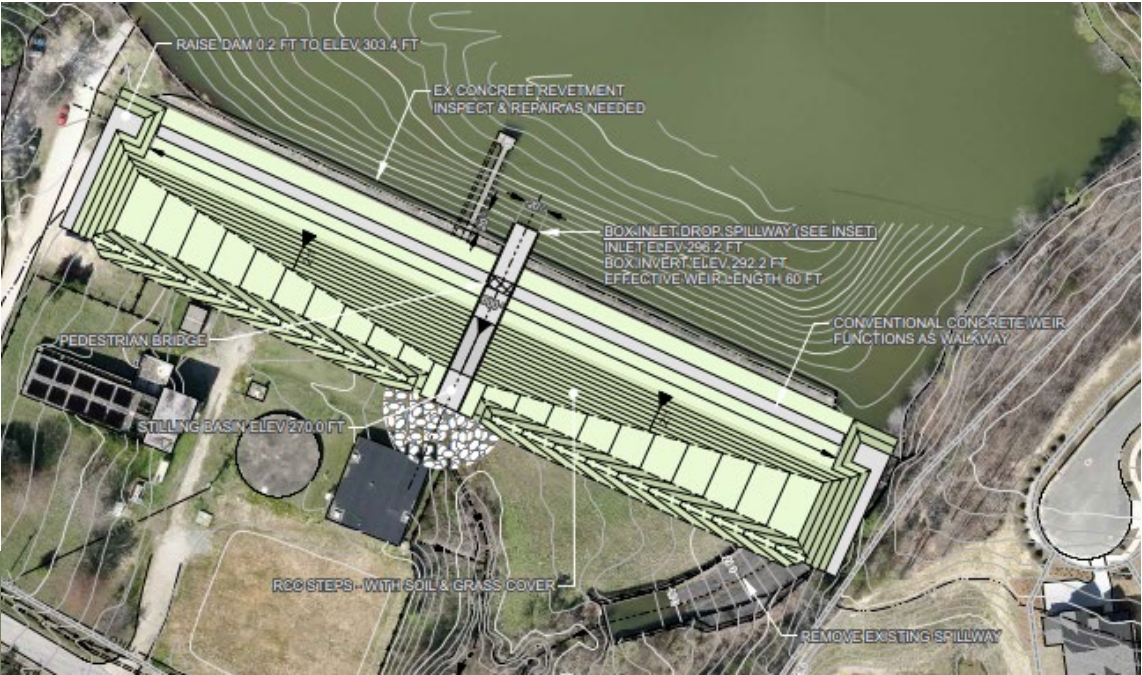
Alternatives

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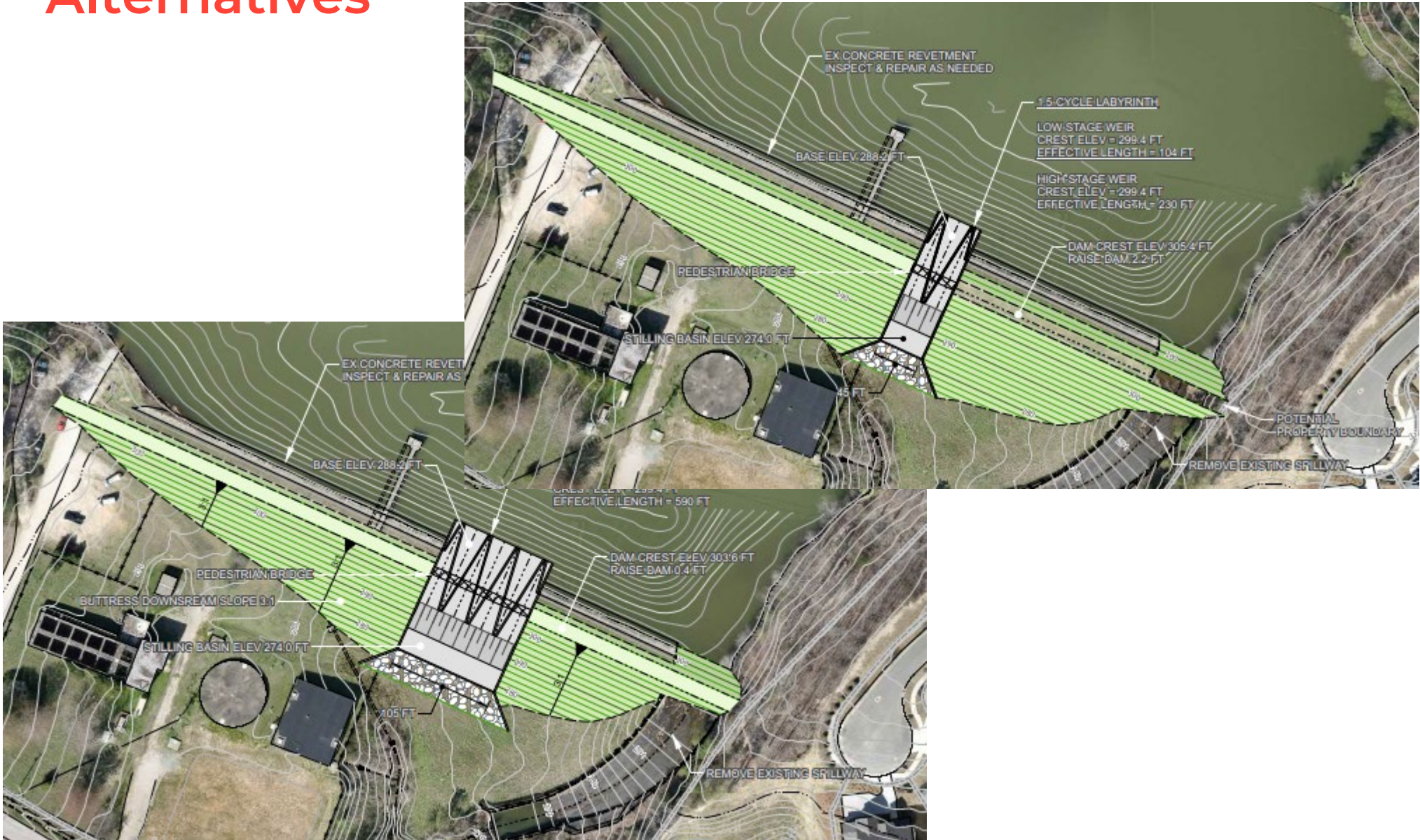
Alternatives

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Alternatives

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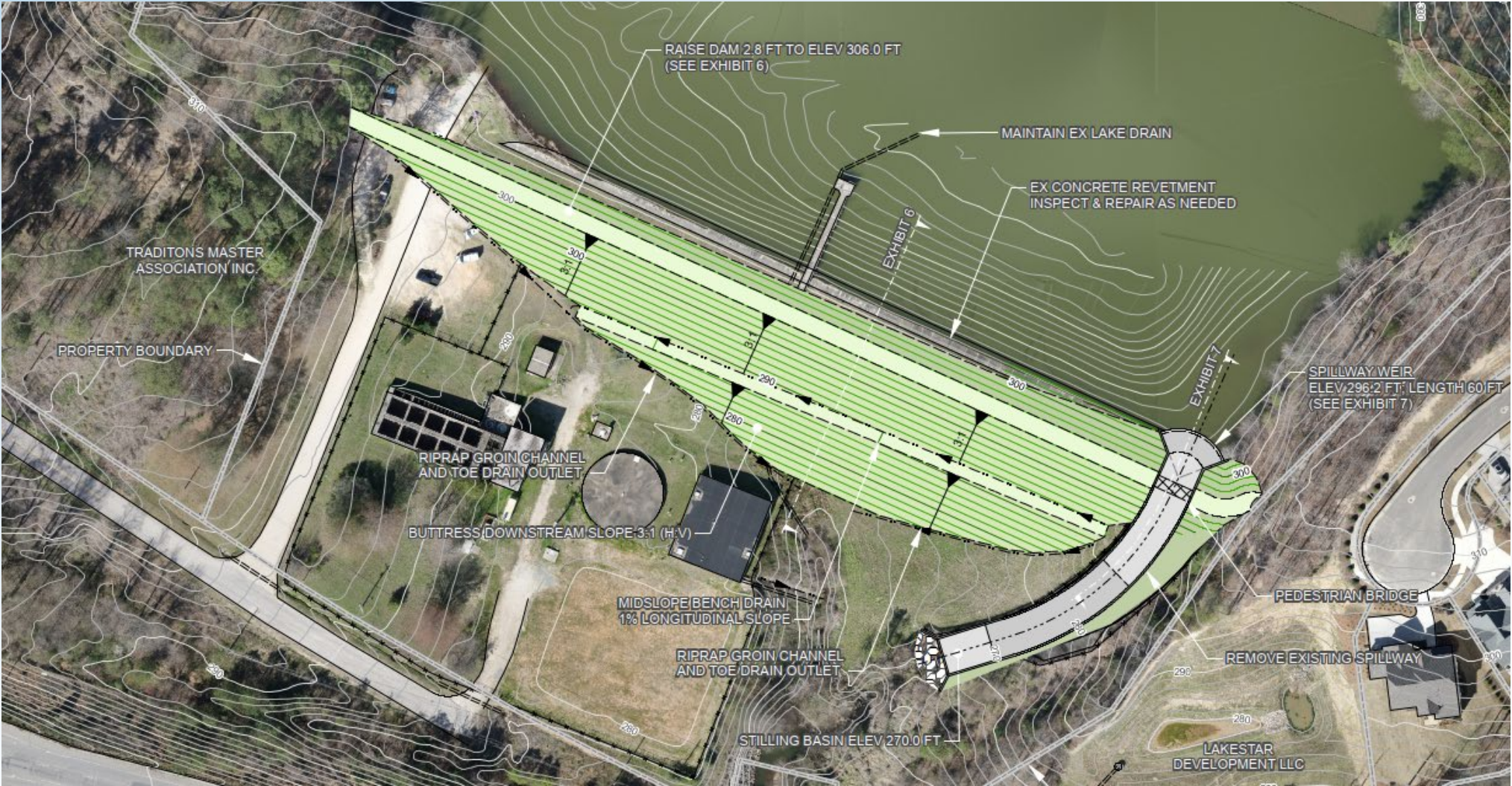
Alternatives

	CONCEPT	DAM RAISE (feet)	DAM CREST ELEVATION (feet)	CONSTRUCTION COST (2023\$)
A	Box inlet drop spillway or equivalent to existing No new auxiliary spillway	3.2	306.4	\$ 2,896,000
B	Box inlet drop spillway or equivalent to existing 66-foot-wide vegetated spillway at right abutment	2.4	305.6	\$ 2,970,000
C	Box inlet drop spillway or equivalent to existing 200-foot-wide vegetated spillway at right abutment	1.7	304.9	\$ 3,315,000
D	Box inlet drop spillway or equivalent to existing 100-foot-wide ACB overtopping spillway	1.9	305.1	\$ 3,426,000
E	Box inlet drop spillway or equivalent to existing 100-foot-wide RCC overtopping spillway	1.9	305.1	\$ 3,850,000
F	Box inlet drop spillway or equivalent to existing 600-foot-wide RCC overtopping spillway	0.2	303.4	\$ 7,226,000
G	2-Stage Labyrinth Weir 45 feet wide, 1.5 cycles	2.2	305.4	\$ 3,994,000
H	2-Stage Labyrinth Weir 105 feet wide, 3.5 cycles	0.4	303.6	\$ 5,453,000

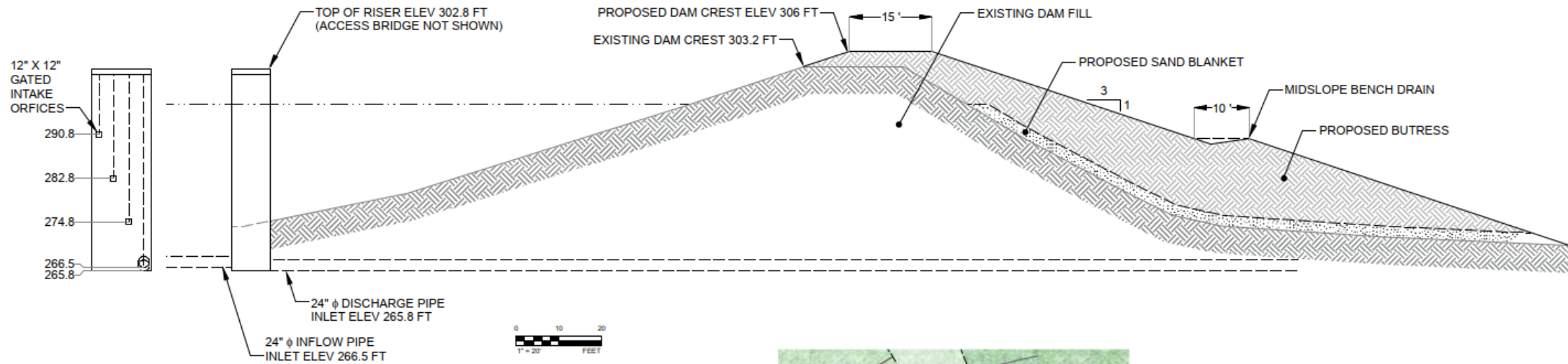
Selected Alternative: "A" (Most Straightforward)

Proposed Design

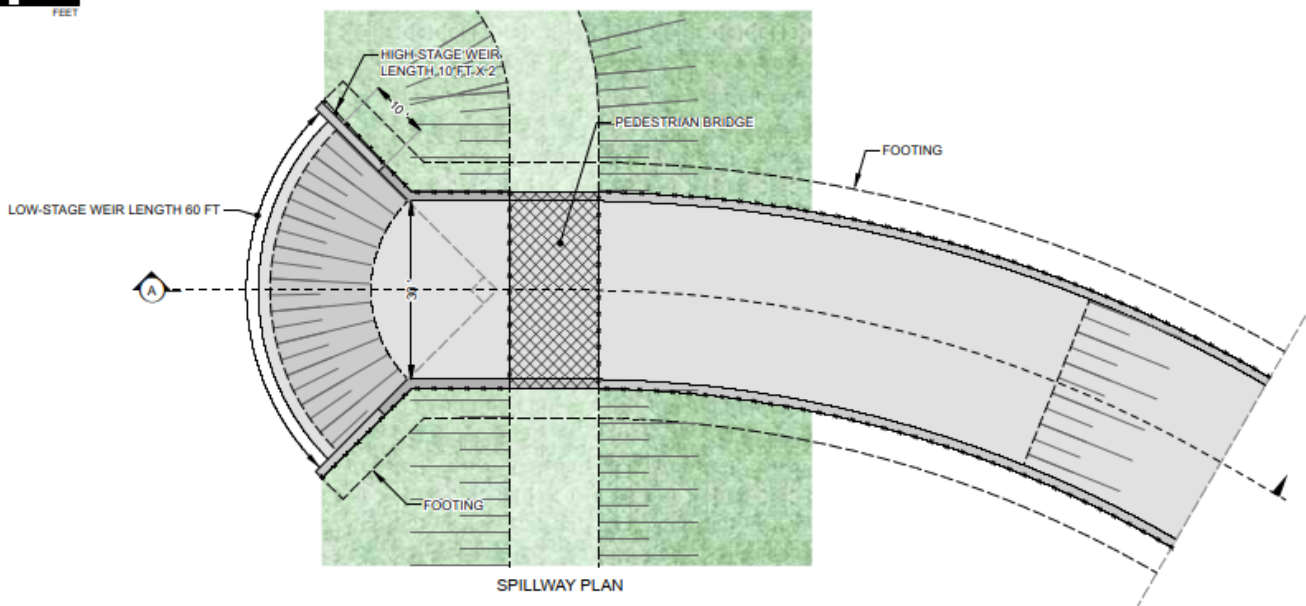
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Proposed Design

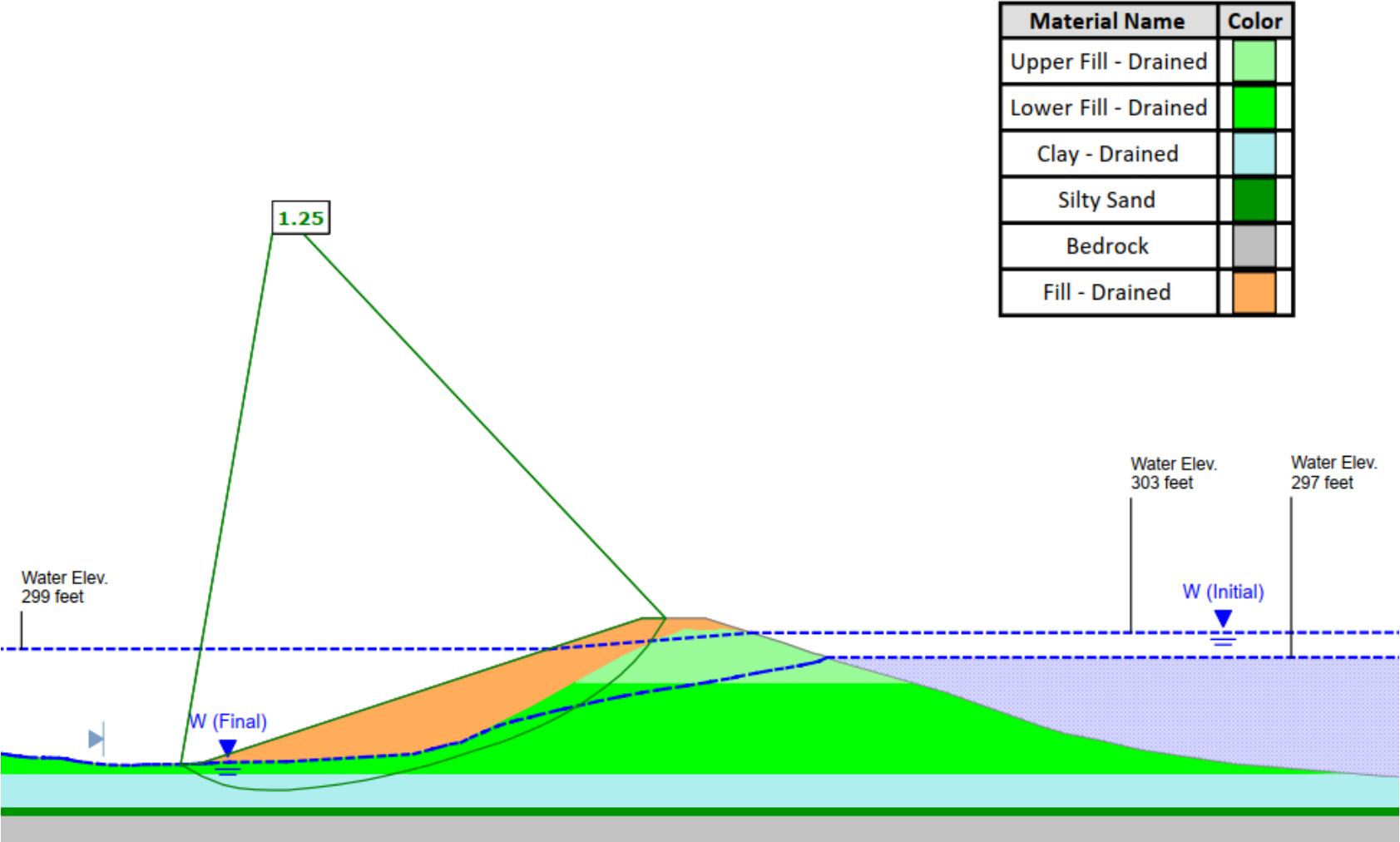


RISER LAKE SIDE VIEW
(RISER NOT IN SECTION)



Slope Stability

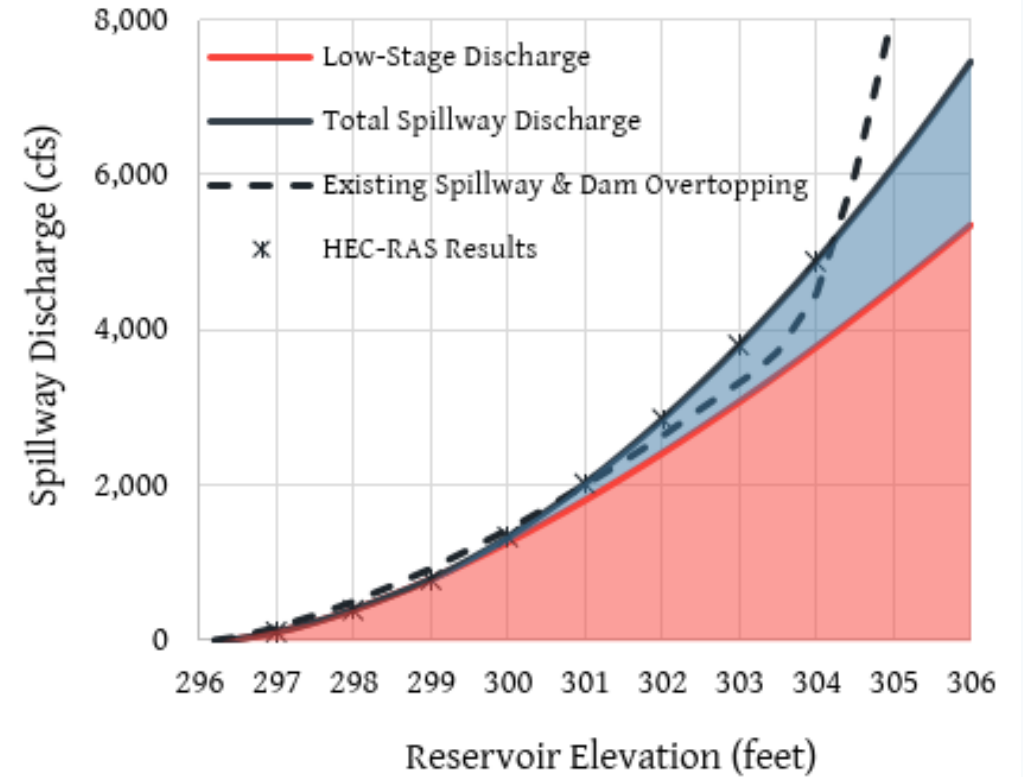
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Hydrology and Hydraulics

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RESERVOIR ELEVATION (feet)	LOW-STAGE WEIR (cfs)	HIGH-STAGE WEIR (cfs)	SPILLWAY TOTAL (cfs)
296.2	0		0
297.0	104		104
298.0	392		392
299.0	785	0	785
300.0	1,260	69	1,329
301.0	1,804	217	2,020
302.0	2,409	437	2,845
303.0	3,070	732	3,801
304.0	3,782	1,106	4,887
305.0	4,542	1,562	6,104
306.0	5,347	2,106	7,453



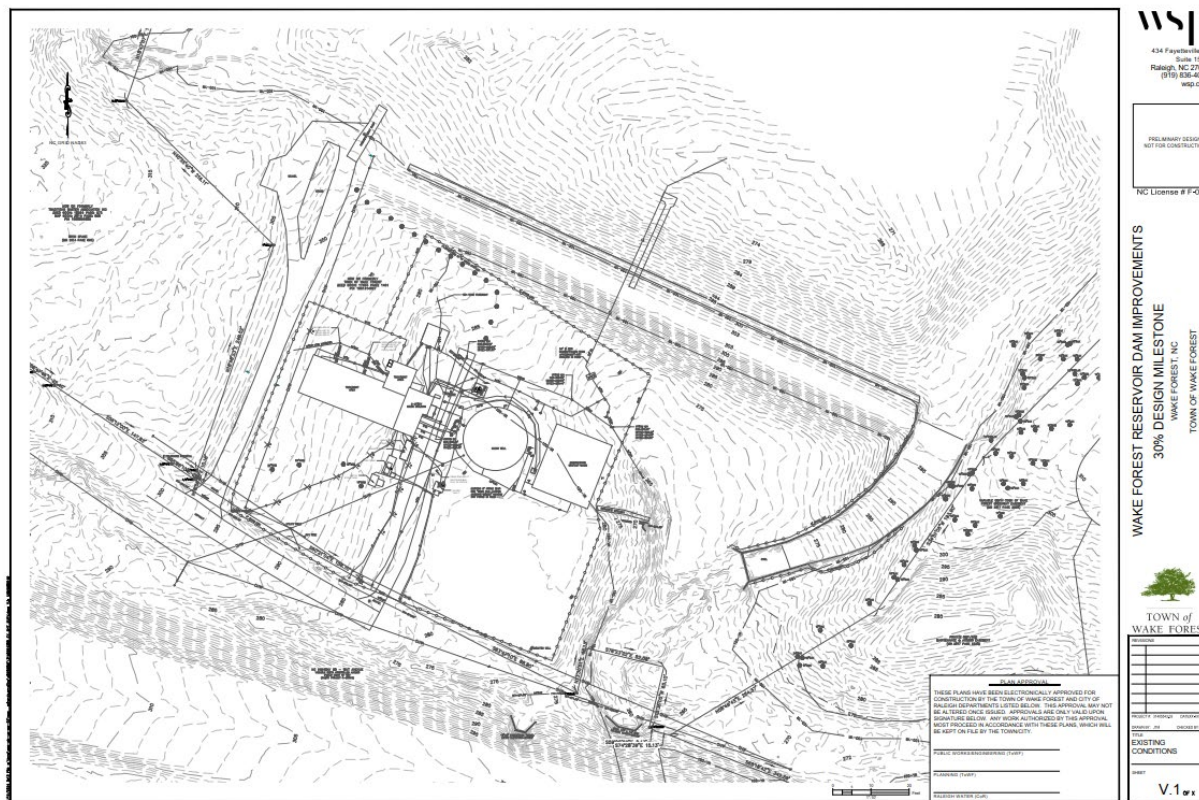
Hydrology and Hydraulics

LAND USE	STORM EVENT	PEAK RUNOFF (cfs)	PEAK DISCHARGE (cfs)	PEAK ELEVATION (feet)	PEAK + FREEBOARD * (feet)
Existing	100-Year, 24-Hour	1,498	815	299.06	NA
	½-PMP, 6-Hour	5,167	3,818	303.02	305.12
	½-PMP, 24-Hour	4,175	3,867	303.06	305.16
Future	100-Year, 24-Hour	2,131	1,182	299.75	NA
	½-PMP, 6-Hour	6,425	4,637	303.78	305.88
	½-PMP, 24-Hour	4,533	4,277	303.45	305.55

* Wave-action freeboard is 2.1 feet; proposed top of dam is elevation 306 feet to contain the peak stage + Freeboard.

Next Steps

- Drafting some Dam Plans
- Moving some Dam soil
- Updating a Dam permit (and EAP)



Dam Name

Emergency Action Plan (EAP)

State ID (First 5 Letters of County): COUNT-XXX

National Inventory of Dams ID (NID): NCXXXXXX

County Name, North Carolina

Revision Number: 01
Month, Year

Dam Owner/Operator:

Name, Email,
Physical Address,
Phone Number (24-Hour Emergency)

EAP Coordinator:
Name, Email,
Phone Number (Office),
Phone Number (24-Hour Emergency)

Dam Owner's Engineer (Select as Appropriate):
Name, Email,
Phone Number (Office),
Phone Number (24-Hour Emergency)

Questions?

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Thank You!



Question today
imagine tomorrow
create for the future

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