Lake Carmel Dam (NYS DEC ID No: 231-0867)

(NYS DEC Grant Award Contract No. C01365GG)

Town of Kent Workshop

John M. Watson, PE / Michael P. Taylor, PE

October 11, 2022

INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, P.C.

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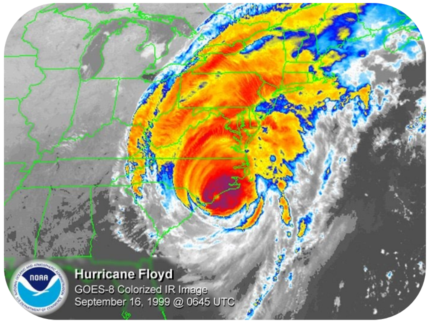

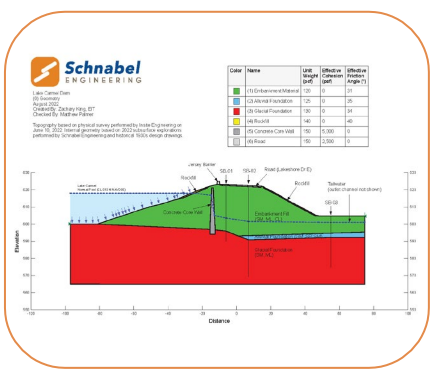

ENGINEERING REPORT (PRE-DESIGN STUDY)

Lake Carmel Dam (NYS DEC ID No: 231-0867)
HHPD Grant Award Contract No. C01365GG
Town of Kent, Putnam County, New York

John M. Watson, PE / Michael P. Taylor, PE

October 11, 2022

INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, P.C.

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Presentation Topics (Lake Carmel Dam):

- Background and Grant Award
- Scope of Pre-Design Engineering Study
- Hydrology and Hydraulics
- Geotechnical Explorations and Testing
- Dam Engineering Evaluations
- Findings / Conclusions
- Repairs and Rehabilitation
- Pre-Design Opinion of Costs

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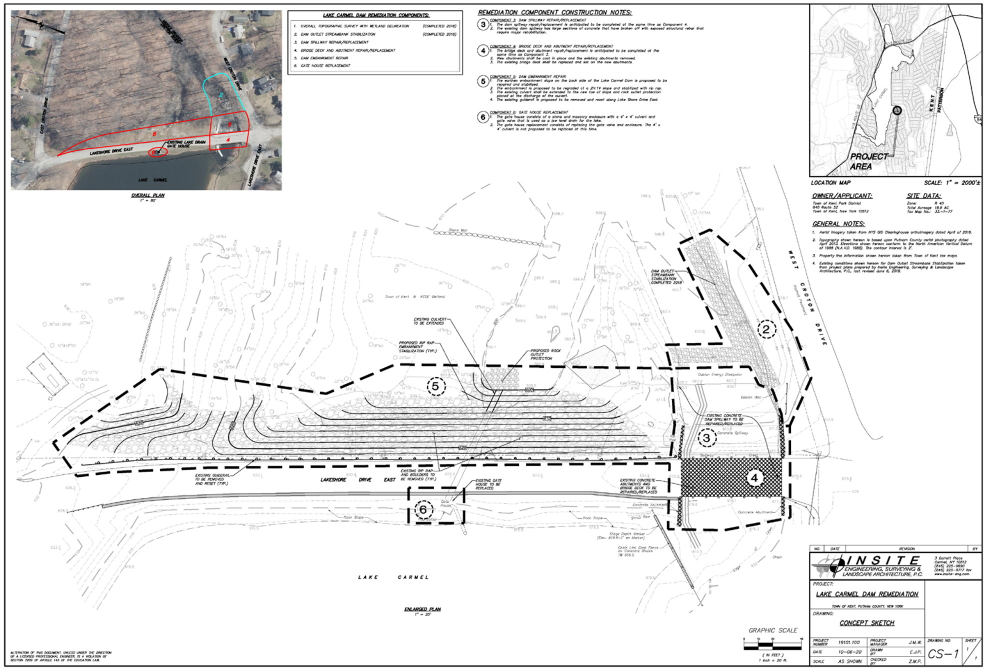
Background and Grant Award

Insite working on the Lake Carmel Dam project since 2011:

- NYSDEC Regulatory Compliance:
  - Annual Certification
  - Emergency Action Plan (EAP)
  - Engineering Assessment (EA)
- Carp Fence
- Streambank Stabilization



- ➢ EA showed the dam in need of major rehabilitation
- ➢ Kent received grant for the 1st phase of Pre-Design work

Presentation Topics:

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NYS DEC Grant – Pre-Design Study

Consolidate results of prior engineering work and obtain new information and data to:

- Evaluate dam safety deficiencies (spillway, embankment, ancillary)
- Summarize existing conditions
- Provide recommendations
- Develop repair alternatives
- Establish basis for scope of Design and Construction
- Provide an Engineering Opinion of Probable Construction Costs (EOPCC)

ENGINEERING REPORT
(PRE-DESIGN STUDY)

Lake Carmel Dam
NYS DEC ID No: 231-0867
Town of Kent
Putnam County, New York

New York State Department of Environmental Conservation (NYS DEC) Grant,
High Hazard Potential Dam (HHPD) Award Contract No. C01365GG
Schnabel Reference 22250008.010

September 15, 2022

Michael P. Taylor, PE
NY Professional Engineer No. 074353

Geotechnical Data Report (GDR)

Industry standard to present the results of subsurface explorations and testing.

A GDR provides physical data and information, but *intentionally excludes* engineering evaluations.

- Summary of subsurface exploration program
- Geologic, Seismologic, and Subsurface Conditions
- Boring logs
- Instrumentation (piezometers)
- Soils laboratory testing data

GEOTECHNICAL DATA REPORT

Lake Carmel Dam
NYS DEC ID No. 231-0867
Town of Kent
Putnam County, New York

New York State Department of Environmental Conservation (NYS DEC) Grant
High Hazard Potential Dam (HHPD) Award Contract C01365GG
Schnabel Reference 22250008.010
September 15, 2022

Michael P. Taylor, PE
NY Professional Engineer No. 074353

Presentation Topics:

- Background and Grant Award
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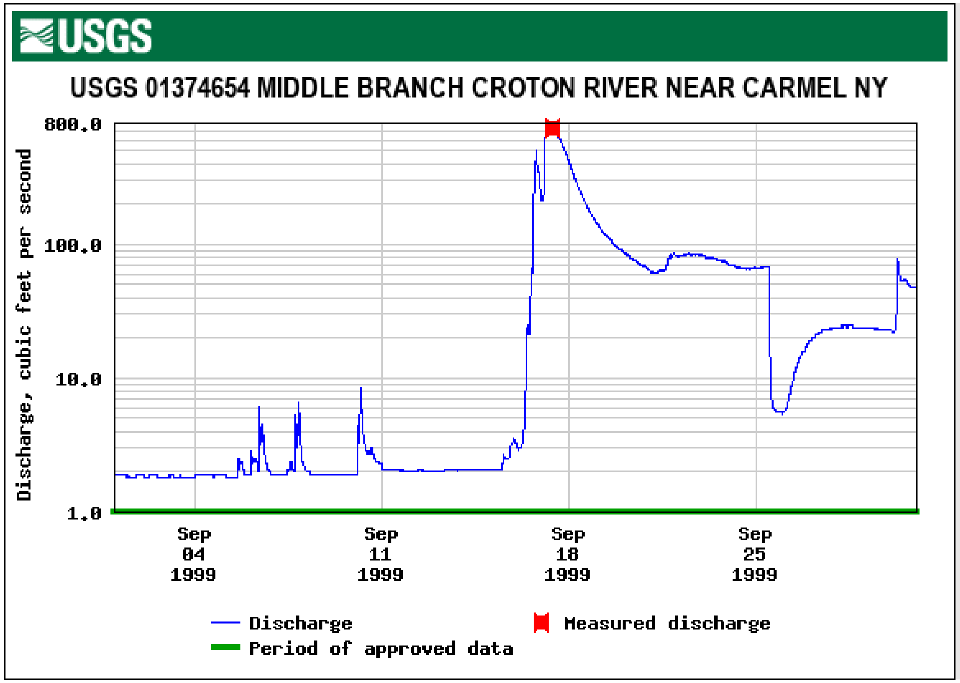
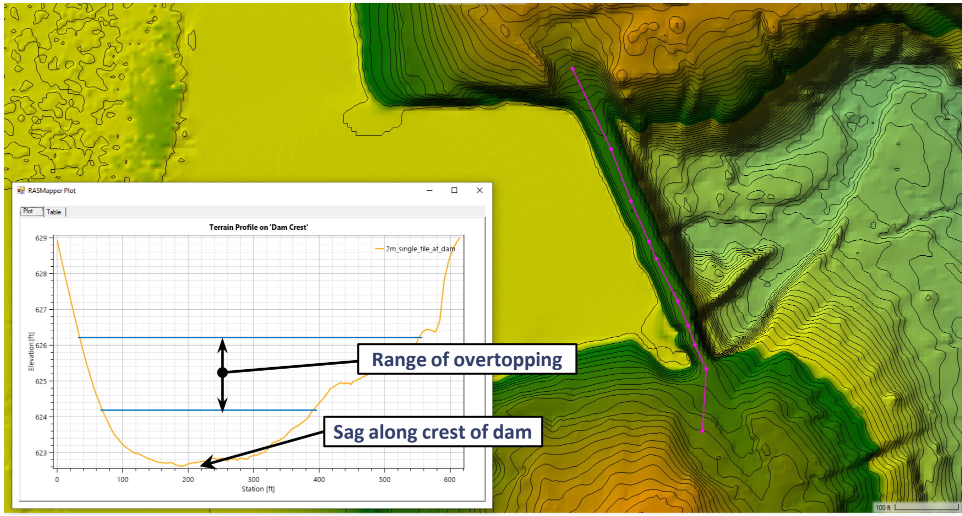
Hydrologic and Hydraulic (H&H) Parameters

Existing spillway has insufficient capacity to safely pass the required Spillway Design Flood (SDF)

- Stormwater inflow is greater than spillway capacity
- Insufficient capacity to safely convey the 50% PMF SDF (req'd)
- Water rises into bridge structure and overtops embankment dam by several feet
- Spillway is significantly deteriorated and at risk of erosional breach





Presentation Topics:

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- Scope of Pre-Design Engineering Study
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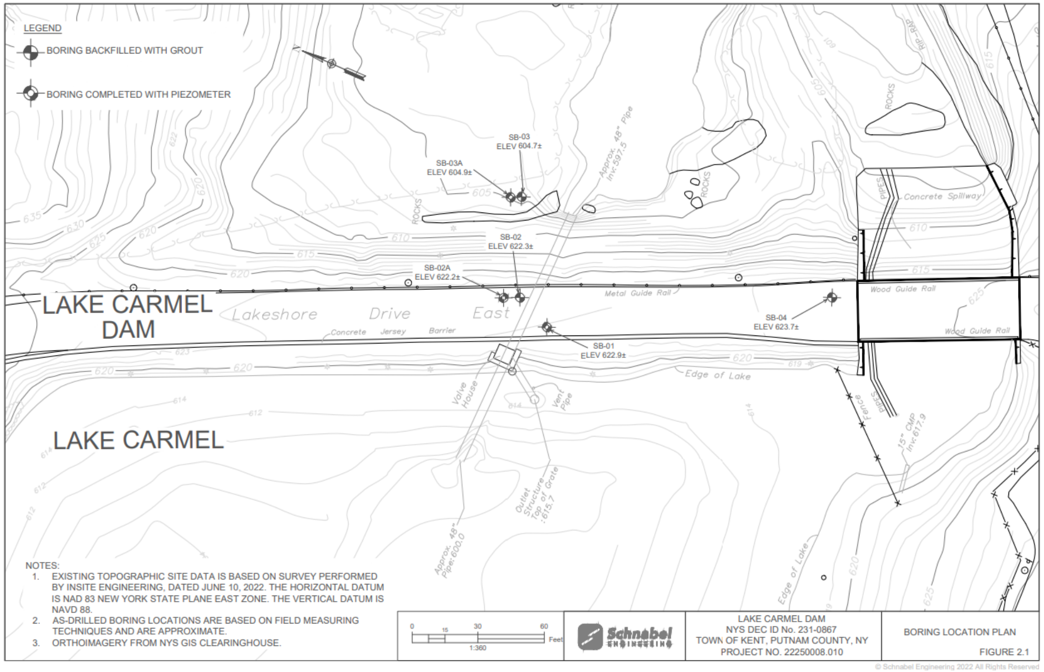
Subsurface Explorations (Soil Borings)

Conducted geotechnical subsurface explorations at embankment dam and spillway bridge abutment.

- Completed four borings
- Obtained soil samples for geotechnical laboratory testing
- Identified bottom of embankment and explored the foundation
- Installed instrumentation (piezometers)
- Measured seepage line (piezometric surface) through embankment dam



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Evaluation of Embankment Dam Stability

Evaluated embankment stability for NYS DEC (and US Army Corps) dam safety requirements for High Hazard Potential dams.

- Embankment geometry (cross-section) obtained from recent Insite topographic survey
- Evaluated standard loading cases:
  - Normal Pool (Steady-State Seepage)
  - Max. Surcharge Pool (Steady-State Seepage)
  - Rapid Drawdown (Normal Pool)
  - Rapid Drawdown (Maximum Pool)
  - Seismic Yield Acceleration

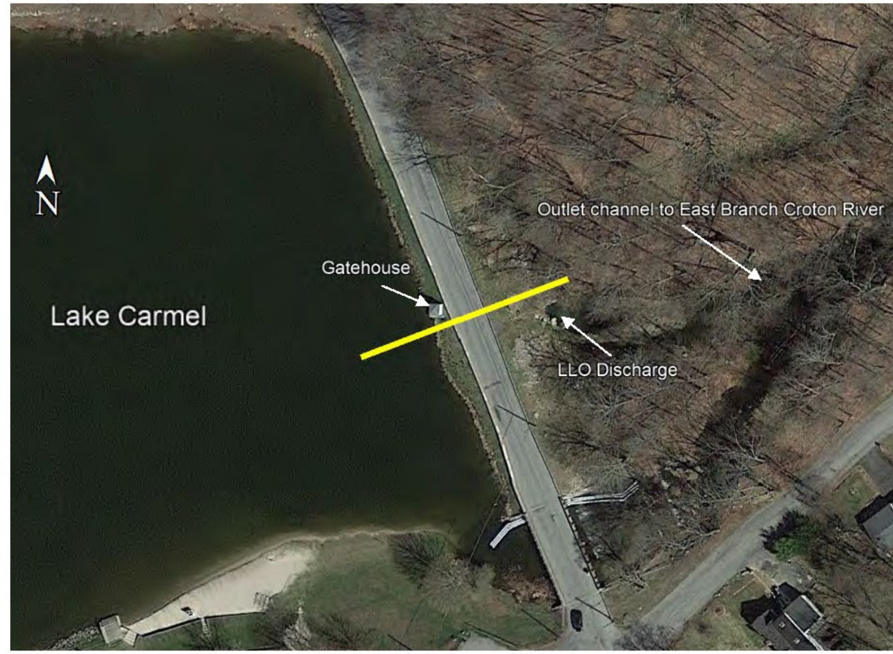

Figure 3.1: Approximate Location of Selected Embankment Cross-Section

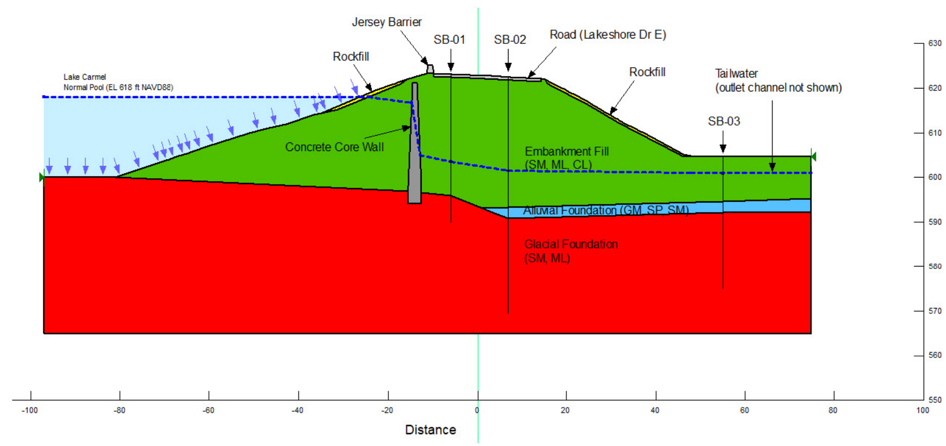

Figure 3.2: Analyzed Geometry of Selected Cross-Section (looking north)

Embankment Dam Stability: Existing Conditions (Static)

Factor of Safety (FS) for Standard static slope stability Cases 1b and 2:

- Case 1b - Normal pool, FS = 1.3
- Case 2 - Maximum pool, FS = 1.1
- Required FS = 1.5

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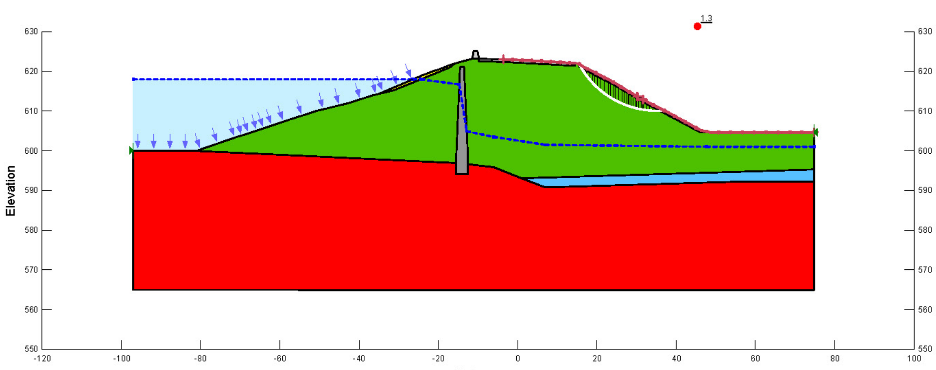
Lake Carmel Dam
(1b) D/S Slope - Normal Pool (EL 618)
August 2022
Created By: Zachary King, EIT
Checked By: Matthew Palmer

Topography based on physical survey performed by Insite Engineering on June 10, 2022. Internal geometry based on 2022 subsurface explorations performed by Schnabel Engineering and historical 1930s design drawings.

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	(1) Embankment Material	120	0	31
	(2) Alluvial Foundation	125	0	35
	(3) Glacial Foundation	130	0	34
	(4) Rockfill	140	0	40
	(5) Concrete Core Wall	150	5,000	0
	(6) Road	150	2,500	0



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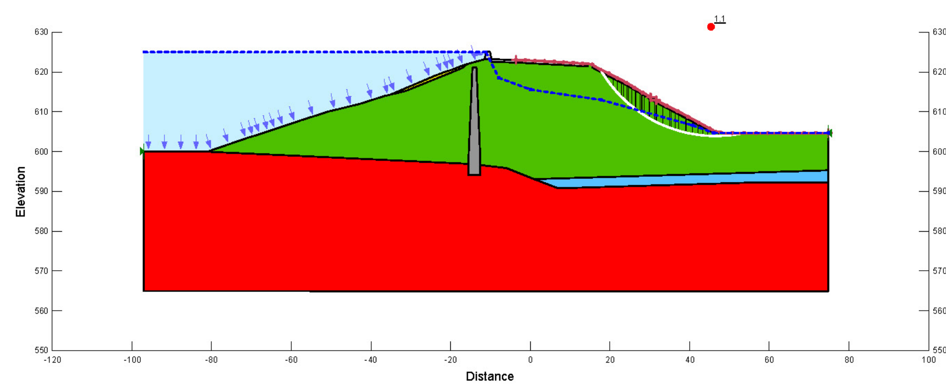
Lake Carmel Dam
(2) D/S Slope - Max Pool (EL 625)
August 2022
Created By: Zachary King, EIT
Checked By: Matthew Palmer

Topography based on physical survey performed by Insite Engineering on June 10, 2022. Internal geometry based on 2022 subsurface explorations performed by Schnabel Engineering and historical 1930s design drawings.

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	(1) Embankment Material	120	0	31
	(2) Alluvial Foundation	125	0	35
	(3) Glacial Foundation	130	0	34
	(4) Rockfill	140	0	40
	(5) Concrete Core Wall	150	5,000	0
	(6) Road	150	2,500	0



Results of Stability Evaluations (Existing Conditions)

Standard Loading Cases (FS of existing conditions vs. required FS):

- FS presented for potential range in soil strengths
- FS < Required for several loading cases
- FS for existing steep d/s slope geometry is very sensitive to soil strength

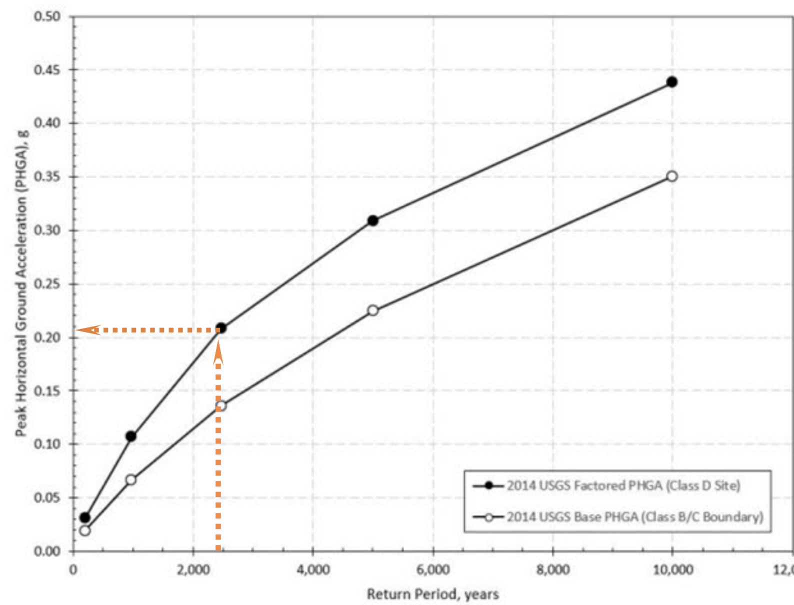
Table 3.3: Static Slope Stability Analysis Results with Decreased Embankment Strength

Load Case	Load Case Description	Embankment Slope	Factor of Safety (FS) (ϕ'=31°)	Factor of Safety (FS) (ϕ'=29°)	USACE Required Minimum Factor of Safety
1A	Normal Pool Steady-State Seepage	Upstream	1.5	1.4	*1.5*
1B		Downstream	1.3	1.2	*1.5*
2	Max. Surcharge Pool Steady-State Seepage	Downstream	1.1	1.0	*1.4*
3A	Rapid Drawdown Normal Pool	Upstream	1.4	1.1	*1.3*
3B	Rapid Drawdown Max. Surcharge Pool	Upstream	1.4	1.1	*1.1*

Seismic Considerations (Stability is Specific to Site)

Dams must be stable against seismic motion (horizontal yield acceleration).

- Design Earthquake is 2,475 yr. event
- Subsurface explorations help define Site Class based on soil type(s)
- Lake Carmel Dam is founded on Site Class D foundation soils
- Horizontal Yield Acceleration = .21g for Site Class D



RETURN PERIOD (YR)	BASE PHGA (g)	AMPLIFICATION FACTOR	FACTORED PHGA
200	0.019	1.6	0.031
975	0.067	1.6	0.107
2,475	0.136	1.53	0.208
5,000	0.224	1.38	0.309
10,000	0.351	1.25	0.438

LATITUDE: 41.456 N LONGITUDE: 73.662 W

Sources:
ASCE (2016). "SEISMIC DESIGN CRITERIA" ASCE 7-16 CHAPTER 11. AMERICAN SOCIETY OF CIVIL ENGINEERS, RESTON, VA.
ASCE (2016). "SITE CLASSIFICATION PROCEDURE FOR SEISMIC DESIGN," ASCE 7-16 CHAPTER 20. AMERICAN SOCIETY OF COVIL ENGINEERS, RESTON, VA.
USGS UNIFORM HAZARD TOOL, DYNAMIC: CONTERMINOUS U.S. 2014 (V4.2.0). https://earthquake.usgs.gov/hazards/interactive/

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LAKE CARMEL DAM
NYS DEC ID No. 231-0867
TOWN OF KENT, PUTNAM COUNTY, NEW YORK
PROJECT NO. 22250008.010

PHGA CURVES

FIGURE 3.3

Embankment Dam Stability: Existing Conditions (Seismic)

Horizontal Yield (Y_H) for Standard static slope stability Cases 1b and 2:

- Case 4A - Upstream $Y_H = 0.15g$
- Case 4B – Downstream $Y_H = 0.16g$
- Less than required $Y_H =$ **0.21g**

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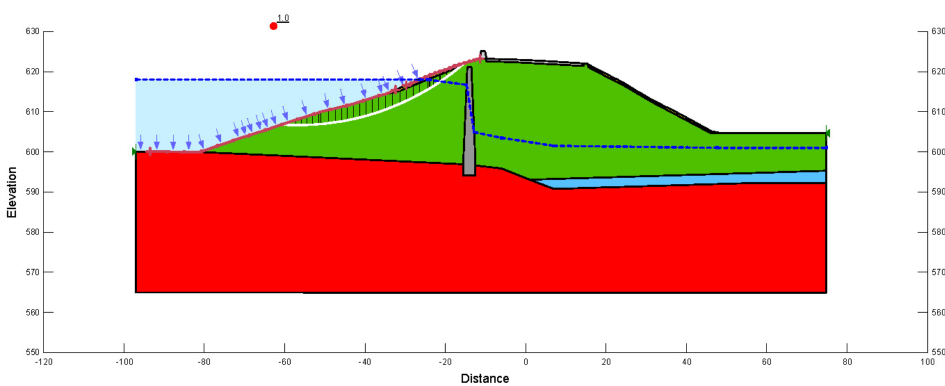
Lake Carmel Dam
(4a) U/S Slope - Seismic Yield (EL 618)
August 2022
Created By: Zachary King, EIT
Checked By: Matthew Palmer

Topography based on physical survey performed by Insite Engineering on June 10, 2022. Internal geometry based on 2022 subsurface explorations performed by Schnabel Engineering and historical 1930s design drawings.

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Cohesion R (psf)	Phi R (°)
Green	(1) Embankment Material	120	0	31	200	17
Light blue	(2) Alluvial Foundation	125	0	35	0	0
Red	(3) Glacial Foundation	130	0	34	200	18
Yellow	(4) Rockfill	140	0	40	0	0
Dark grey	(5) Concrete Core Wall	150	5,000	0	0	0
Light grey	(6) Road	150	2,500	0	0	0

Horz Seismic Coef.: 0.148



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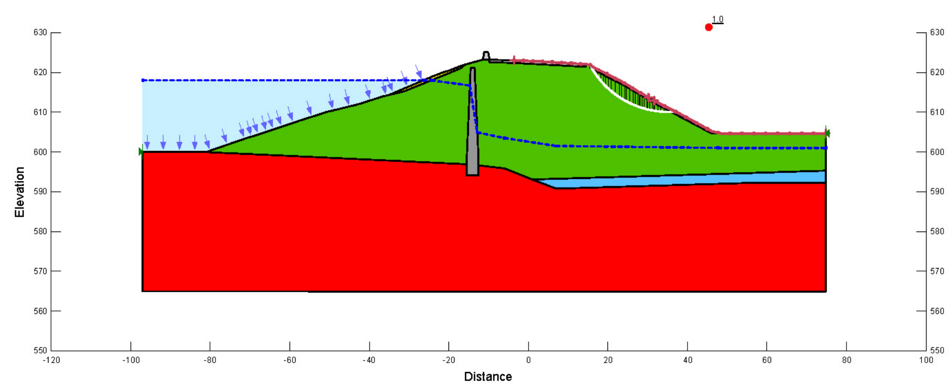
Lake Carmel Dam
(4b) D/S Slope - Seismic Yield (EL 618)
August 2022
Created By: Zachary King, EIT
Checked By: Matthew Palmer

Topography based on physical survey performed by Insite Engineering on June 10, 2022. Internal geometry based on 2022 subsurface explorations performed by Schnabel Engineering and historical 1930s design drawings.

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Cohesion R (psf)	Phi R (°)
Green	(1) Embankment Material	120	0	31	200	17
Light blue	(2) Alluvial Foundation	125	0	35	0	0
Red	(3) Glacial Foundation	130	0	34	200	18
Yellow	(4) Rockfill	140	0	40	0	0
Dark grey	(5) Concrete Core Wall	150	5,000	0	0	0
Light grey	(6) Road	150	2,500	0	0	0

Horz Seismic Coef.: 0.162



Embankment Dam Stability: Modified Geometry

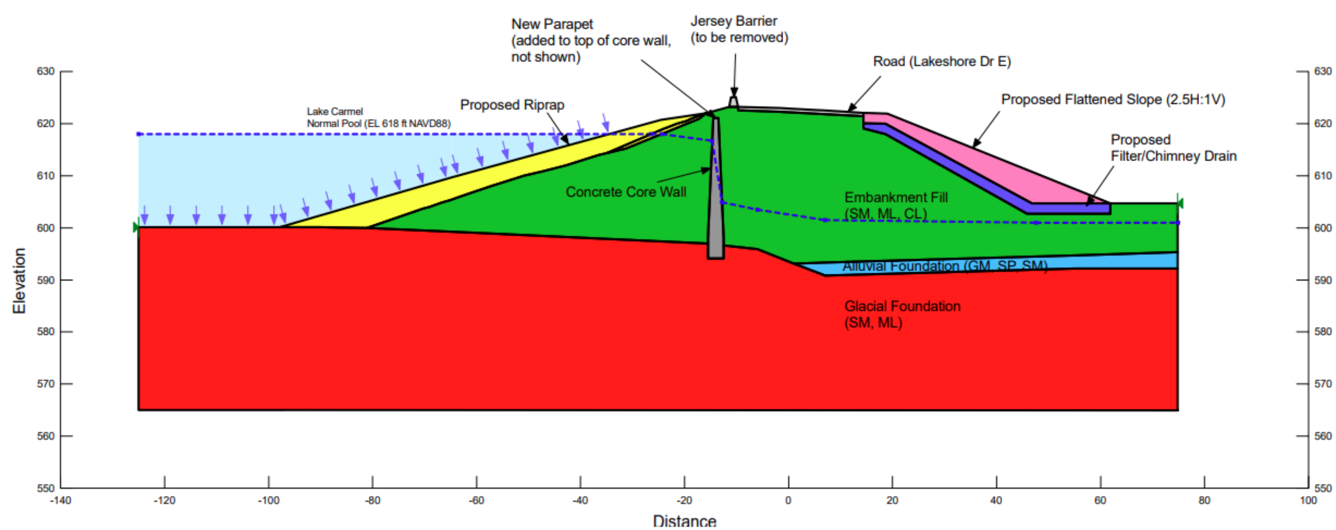
Evaluation of modified embankment dam geometry:

- Flattened d/s slope with added internal filter
- Increased height for core wall
- Flattened u/s slope

Lake Carmel Dam
(0) Conceptual Geometry
August 2022
Created By: Zachary King, EIT
Checked By: Luke Scillieri

Topography based on physical survey performed by Insite Engineering on June 10, 2022. Internal geometry based on 2022 subsurface explorations performed by Schnabel Engineering and historical 1930s design drawings.

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	(1) Drainage Material	120	0	33
	(1) Embankment Material	120	0	31
	(1) Select Embankment Material	120	0	33
	(2) Alluvial Foundation	125	0	35
	(3) Glacial Foundation	130	0	34
	(4) Rockfill	140	0	40
	(5) Concrete Core Wall	150	5,000	0
	(6) Road	150	2,500	0



Results of Stability Evaluations (Existing vs Modified Geometry)

Modified geometry and internal filter provide necessary increase in FS for all loading cases.

Table 3.8: Static Slope Stability Analysis Results for Proposed Repairs

Load Case	Load Case Description	Embankment Slope	Factor of Safety (Existing)	Factor of Safety (Proposed)	USACE Required Minimum Factor of Safety
1A	Normal Pool Steady-State Seepage	Upstream	1.5	2.3	*1.5*
1B		Downstream	1.3	1.7	*1.5*
2	Max. Surcharge Pool Steady-State Seepage	Downstream	1.1	1.7	*1.4*
3A	Rapid Drawdown Normal Pool	Upstream	1.4	1.6	*1.3*
3B	Rapid Drawdown Max. Surcharge Pool	Upstream	1.4	1.6	*1.1*

Modified geometry improves seismic performance (increase horizontal yield acceleration, H_Y)

Table 3.9: Pseudo-Static Slope Stability Yield Acceleration Analysis Results for Proposed Repairs

Load Case	Load Case Description	Embankment Slope	Existing Yield Acceleration (FS = 1.0)	Proposed Yield Acceleration (FS = 1.0)
4A	Seismic Yield Acceleration	Upstream	0.15g	0.21g
4B		Downstream	0.16g	0.28g

Presentation Topics:

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Key Conclusions (Excerpts from Section 6 of Report)

- Lake Carmel Dam is in unsatisfactory condition, primarily from deficiencies with the spillway and embankment.

- The concrete spillway is undersized and is not capable of safely passing the spillway Design flood (SDF); established by the NYS DEC as 50% of the probable maximum flood (PMF).

- The spillway is significantly deteriorated and at risk of erosional failure/breach from discharges less than the SDF.

Key Conclusions (Excerpts from Section 6 of Report)

- The insufficient spillway capacity results in overtopping of the embankment dam during the SDF.
- The Embankment dam exhibits low factors of safety (FS) for slope stability under required static and seismic loading conditions.
- There are no existing filters or drains within the embankment or a diaphragm filter constructed around the low-level outlet conduit.
- Appurtenant structures (ex. the gatehouse and spillway bridge) are also in need of repairs and/or modifications.

Presentation Topics:

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Key Recommendations
(Excerpts from Section 7 of Report)

- Refine the hydrologic model and calibrate to historic storm events at the nearby USGS Stream Gage and conduct related regression analyses to northeast terrain and storm data.
- Conduct subsurface explorations and engineering analyses along remainder of dam to characterize the conditions and verify the material properties and piezometric levels within the embankment and natural foundation.
- Raise the embankment to provide a uniform crest elevation and a new wider roadway. The modified geometry can also accommodate a pedestrian and bicycle path, separate from the roadway.
- Stabilize the downstream and upstream embankment slopes to meet the minimum required factors of safety for both static and seismic loading conditions (including events at least up to the 2,745-year return period earthquake.
- Develop a new/larger spillway configuration in relation to the embankment dam rehabilitation design, the embankment dam core wall, crest elevation, and other deficiencies.

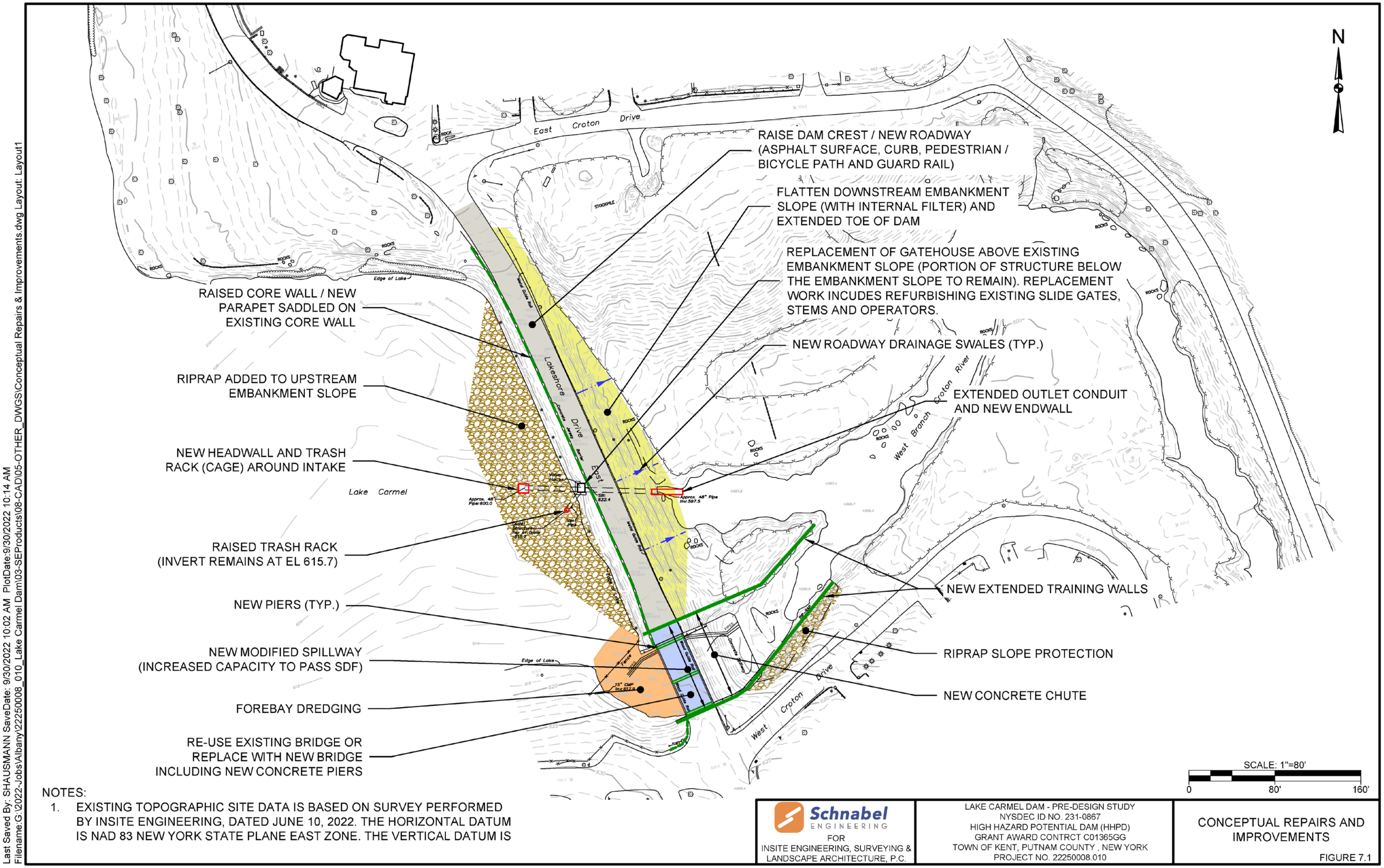
Key Recommendations [Continued] (Excerpts from Section 7 of Report)

- Install a new filter and drain system (e.g., a chimney and toe drain) between the existing downstream embankment slope and new earthwork (flattening of the slope).
- Extend the existing concrete outlet conduit beyond the toe of the modified embankment slope and include a formal headwall and apron.
- Install a granular filter diaphragm around the low-level outlet conduit.
- Raise the embankment to provide a uniform crest elevation and a new wider roadway. The modified geometry can also accommodate a pedestrian and bicycle path, separate from the roadway.
- Stabilize the downstream and upstream embankment slopes to meet the minimum required factors of safety for both static and seismic loading conditions (including events at least up to the 2,745-year return period earthquake.
- Develop the new spillway configuration in relation to the embankment dam rehabilitation design, including the embankment dam core wall, crest elevation, and other deficiencies.

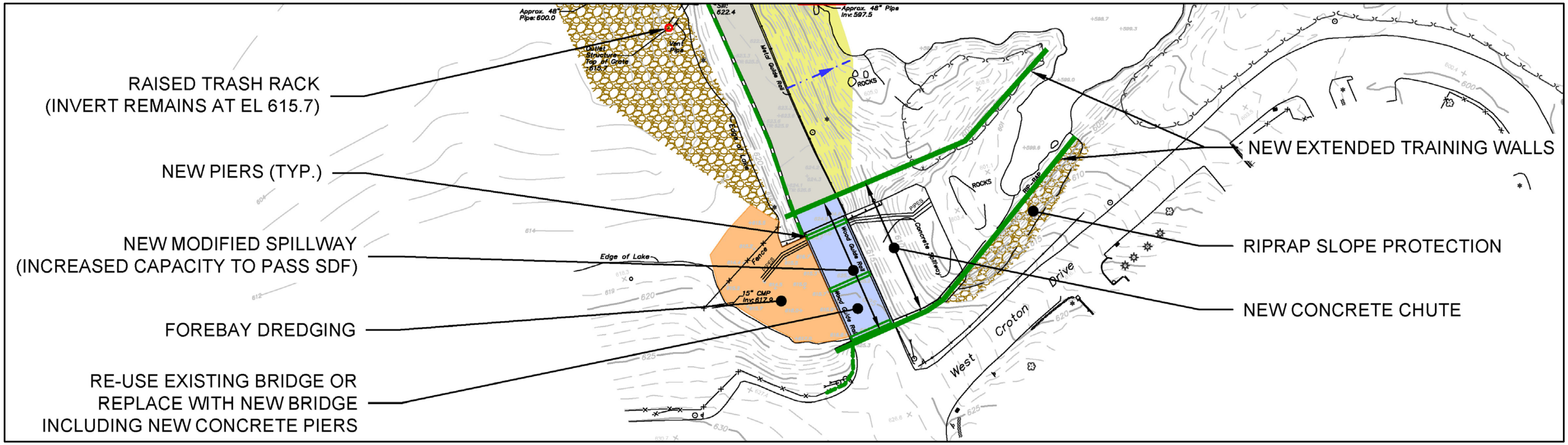
Key Recommendations [Continued] (Excerpts from Section 7 of Report)

- Coincident with the larger/modified spillway, provide a larger spillway chute and side training walls with increased capacity to pass the spillway design flood (SDF).
- Install a new trash rack around the intake of the existing main low-level outlet pipe.
- Reconstruct the gatehouse (ex. above the existing embankment slope) and refurbish the existing slide gates, stems, and actuators.
- The existing roadway bridge should be re-purposed and/or replaced and a new or refurbished bridge. It can be provided with the construction of the new (greater hydraulic capacity) spillway. It is recommended that the Town continue conversations with Putnam County to clarify the ownership of the bridge and necessary coordination for the replacement of the bridge coincident with the spillway reconstruction.
- Conduct regular monitoring and maintenance, including periodic monitoring of the water level (piezometric surface) through the embankment dam; using the recently installed piezometers.

Overview of Recommendations (Figure 7.1 from Report)



Overview of Recommendations (Figure 7.1 from Report)



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Opinion of Probable Construction Costs (Table 8.1)

Conducted a “Class 5” estimate, defined by the Association for the Advancement of Cost Engineering (AACE) International.

Class 5 estimates are appropriate for concept screening-level effort at the 0% to 2% level of project definition. For this project, and current information and added contingencies, an accuracy range of -30% to +50% is used.

Table 8.1: Engineer’s Opinion of Probable Construction Costs (EOPCC)

Recommendations (grouped)	Opinion of Probable Construction Costs
1. Preliminaries (mobilization, environmental controls, demolition, etc.)	$825,000
2. Embankment Earthworks (crest and downstream slope, etc.)	$630,000
3. Embankment Earthworks (upstream slope) and	$560,000
4. Gatehouse and Low-Level Outlet works	$265,000
5. Larger primary spillway, chute, training walls, core wall extension, etc.	$840,000
6. Final work (bridge, roadway pavement, cleanup, demobilization, etc.)	$750,000
7. Contingency for unidentified items (~15%)	$580,000
8. Construction contingency (`15%) for unanticipated conditions, etc.)	$670,000
9. Escalation to Construction Midpoint - 2024 (~3% for 2 years)	$310,000
Total	**$5,430,000**

The expected accuracy range (-30% to +50%) of this Class 5 estimate is about $3,800,000 to $8,145,000.

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