Lake Carmi Dam

Hydrologic, Hydraulic, and Alternatives Analyses

Franklin, Vermont

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EXECUTIVE SUMMARY

Lake Carmi Dam

The Lake Carmi Dam, also known as Mill Pond Dam, (hereinafter referred to as the Dam) is owned, operated, and maintained by the Vermont Department of Environmental Conservation (VTDEC); it was reconstructed in 1970. The Dam, which impounds the Mill Pond (hereinafter referred to as the Pond), is an earthen and concrete gravity structure with a principal spillway, dual stoplog channels, and slide gate operated low-level outlet. The Dam is approximately 160 feet long, has a structural height of approximately 9 feet, and a drainage area of approximately 12.3 square miles (mi^2). The principal spillway is 81 feet long and has a crest elevation of 434.6 feet (NAVD88), and the right and left abutments have crest elevations of approximately 436.0 feet and 436.1 feet (NAVD88), respectively. The Dam is located approximately 2,500 feet downstream of the Dewing Road crossing, which is at the outlet for Lake Carmi (hereinafter referred to as the Lake). The Lake has a surface area of approximately 2.1 mi^2, representing approximately 17% of the drainage area at the Dam. The water levels in the Lake are controlled by both channel invert at the Dewing Road crossing and the Dam. The Dam is currently classified by VTDEC as low hazard, indicating that a dam failure would not likely result in loss of life and there would be minimal economic loss.

Hydrologic and Hydraulic Summary

The hydrologic model used to compute flood flows was the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), Version 4.2 computer software. A precipitation hyetograph was developed for each subbasin and each storm event to be analyzed in the hydrologic model. The outflow hydrographs for each subbasin were used as inputs to a hydraulic model to route flows through the Lake and over the Dam. Table ES- 1 summarizes the event type (sunny day and flood flow return intervals), peak water surface elevations (WSEL) at the Dam, and the amount of abutment freeboard. The results suggest that the spillway has the capacity to discharge flows up to the 500-year event without overtopping. During the 500-yr event there is 0.3 feet of freeboard indicating that the Dam could pass more than the 500-year event before beginning to overtop.

Table ES- 1: Summary of Peak WSEL at Dam and Freeboard

Event	Peak Flow at Dam (cfs)	Peak WSEL at Dam (ft)	Abutment Freeboard/ Overtopping (ft)
Sunny Day	24	434.8	-1.2
2-Yr	83	435.0	-1.0
10-Yr	131	435.2	-0.8
25-Yr	165	435.3	-0.7
50-Yr	195	435.4	-0.6
100-Yr	235	435.5	-0.5
500-Yr	348	435.7	-0.3
0.5 PMF	2,201	437.3	1.3
PMF	4,968	438.3	2.3

Note:

Freeboard and Overtopping are computed relative to the right abutment crest elevation of 436.0 feet. A negative value indicates freeboard, while a positive value indicates overtopping.

The hydraulic model used to evaluate velocities and depths from the various flows is the USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS), Version 5.0.4. The model was used to assess flows, WSELs, and velocities downstream of the Dam, as well as WSELs within the Lake and Pond for each storm event. Flows at the Dam and WSELs downstream of the Dam due to a breach of the Dam were of interest. The analysis evaluated various events including dam failure scenarios.

In addition to flow over the Dam, the hydraulic model considered interbasin flow, where flow could potential leave the basin at the southern end of the Lake. The model results showed that no interbasin transfer occurs for floods less than or equal to the 500-year event. However, under the 0.5 probable maximum flood (PMF) a peak interbasin flow transfer of approximately 3,360 cfs occurs (events between the 500-year and 0.5 PMF were not evaluated).

Breach analyses were done for the sunny day flow and a series of high flows between the 100-year flow and the PMF. Federal Energy Regulatory Commission Engineering Guidelines were used to develop the breach parameters. Finally, the failure was conservatively initiated at the peak headwater for the Dam, during which time the largest volume of water is stored behind the Dam.

Based on the hydraulic modeling, the Dam in its current configuration can pass the low hazard SDF (100-yr) event through the existing spillway without overtopping. The analysis found that there would be approximately 0.5 feet of freeboard during the SDF event and 1.2 feet of freeboard at normal pool. VTDEC typically requires at least 3.0 feet of freeboard be maintained at normal pool and 1.5 feet of freeboard during the peak SDF conditions. As such, the Dam does not meet either the SDF or normal pool freeboard requirements. The findings are shown in Table ES- 2.

Table ES- 2: Flood Flows and Approximate Freeboard at Dam

Structure	Event	Top of Dam (ft)	WSEL (ft)	Freeboard (ft)	VTDEC Required Freeboard (ft)
Lake Carmi Dam	Sunny Day Normal Pool	436.0	434.8	1.2	3.0
	100-yr	436.0	435.5	0.5	1.5

Dam Assessment

Based on the hydrologic and hydraulic analyses, it is recommended that the Dam remain a low hazard dam. The description of a low hazard dam is provided in Table ES- 3. Under the 100-year flood plus breach the incremental increases in WSELs downstream of the Dam range from 2.2 feet to 3.1 feet in the studied reach; however, there are no incremental impacts to roads or habitable structures caused by the breach. During the 100-yr event, there are no impacts to the downstream roads or structures under either the breach or no breach conditions.

Table ES- 3: Hazard Classification Summary

Hazard Classification	Description	Typical Spillway Design Flood
Low	Dams where failure is not expected to cause loss of life and only minimal property damage. This is typically interpreted as meaning the no inhabited structures are impacted and only rural, lightly traveled roads might be impacted.	100-year

Inundation Mapping

Inundation mapping was developed for the Sunny Day plus breach and 100-year plus breach scenarios. These scenarios were selected to bracket the potential impacts due to a breach of the Dam from normal conditions to the SDF condition.

Alternatives Analysis

Because the Dam does not meet the VTDEC freeboard requirements, five alternatives were evaluated to bring the Dam into compliance. The alternatives are summarized in Table ES- 4. The alternatives are:

- No action: consists of status quo with no changes made to the Dam.
- Overtopping protection: consists of improving Lake Carmi Dam to reduce the risk of overtopping, but with no hydraulic improvements to the structure.
- Two alternatives looked at lowering the spillway crest elevation to meet the freeboard requirements.
- Removing the Dam: consists of removing the concrete spillway.

Table ES- 4: Alternative Analysis Summary

Alternatives	Sunny Day WSEL (ft)	SDF WSEL (ft)	Meets VTDEC Freeboard Requirement?		Construction Costs	Cons
			Normal Pool	SDF		
Alternative 1: No Action	434.8	435.5	No	No	None	Maintenance would still be required
Alternative 2: Overtopping Protection	434.8	435.5	No	No	Low	Potential impacts to recreational lots
Alternative 3: Lower Spillway Crest (432.75 ft)	432.9	433.5	Yes	Yes	Medium	Potential impacts to Mill Pond and Lake Carmi
Alternative 4: Lower Spillway Crest (433.75 ft)	433.9	434.5	No	Yes	Medium	Potential impacts to Mill Pond and Lake Carmi
Alternative 5: Dam Removal	425.9	427.2	n/a	n/a	High	Eliminates Mill Pond and lowers the Lake Carmi normal pool

Sediment Sampling and Testing

Over time sediment has accumulated behind the Dam and lowering the crest (Alternatives. 3 and 4) or removal of the Dam (Alternative 5) could mobilize this sediment. Thus, the quantity and quality of sediment was evaluated as part of the study. The total sediment volume in Mill Pond (defined as from the Dam to the Dewing Road crossing) is approximately 36,200 cubic yards. The sediment thickness ranged from 0.5 feet to 4.5 feet and water depths ranged from 2 feet to 9.5 feet. A single sediment sample was obtained in the Pond to test for various potential contaminants. Results from the sediment testing were compared to the ecological and human health Sediment Quality Guidelines defined by the VTDEC Recommended Guidelines for Evaluating Contaminant Concentrations in Freshwater Sediments (Oct. 2016). The sediment sample results were used to evaluate if any contaminants were present at elevated levels or if any contaminants posed a threat to freshwater ecological resources. For this single sample, there were no exceedances of the contamination thresholds. Overall, the sediment in this area appears to represent low risk to freshwater biota.

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LIST OF ABBREVIATIONS

%	Percentage
µg/kg	microgram of contaminant concentration per kilogram of sediment
2D	Two dimensional
ACER	Assistant Commissioner – Engineering and Research (US Department of Interior)
ADCP	Acoustic Doppler Current Profiler
AMC	Antecedent Moisture Conditions
cfs	Cubic Feet per Second
CN	Curve Number
Dam	Lake Carmi Dam
DEM	Digital Elevation Model
ft	Foot (Feet)
ft/s	Feet per Second
fps	Foot per Second
GPS	Global Positioning System
GSE	Gomez and Sullivan Engineers, DPC
H:V	Horizontal : Vertical
HEC	Hydrologic Engineering Center
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling Software
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HMR	Hydrometeorological Reports
hr(s)	Hour(s)
Ia	Initial Abstraction
Lake	Lake Carmi
ID	Identification
in.	Inch (Inches)
LiDAR	Light Detection and Ranging
mg/kg	Milligram of contaminant concentration per kilogram of sediment
mi^2	Square Miles
min.	Minute(s)
NAVD88	North American Vertical Datum of 1988
ND	Not detected at reported limit
NED	National Elevation Dataset
NLCD	National Land Cover Dataset
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OPCC	Opinion of Probably Construction Cost
PCB	Polychlorinated Biphenyl
PEC	Probable Effect Concentration
PMF	Probable Maximum Flood
Pond	Mill Pond
Rd	Road
RTE	Rare, Threatened, and Endangered
RTK-GPS	Real-time Kinematic Global Positioning System
SCS	Soil Conservation Services

SDF	Spillway Design Flood
SIR	Scientific Investigations Report
SQGs	Sediment Quality Guidelines
SSURGO	Soil Survey Geographic Database
T1	Transect 1, etc.
TEC	Threshold Effect Concentration
TM	Technical Memorandum
typ.	Typical
USACE	US Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
V_{pred}	Variance of Prediction
VT AOT	Vermont Agency of Transportation
VT	Vermont
VTDEC	Vermont Department of Environmental Conservation
WSEL	Water Surface Elevation
yr	Year(s)

1. Introduction and Purpose

The Lake Carmi Dam (also known as the Mill Pond Dam, hereinafter referred to as the Dam) is located in northern Vermont on an unnamed tributary to the Pike River, which flows into Canada, eventually draining into the northern end of Missisquoi Bay of Lake Champlain (see Figure 1-1).

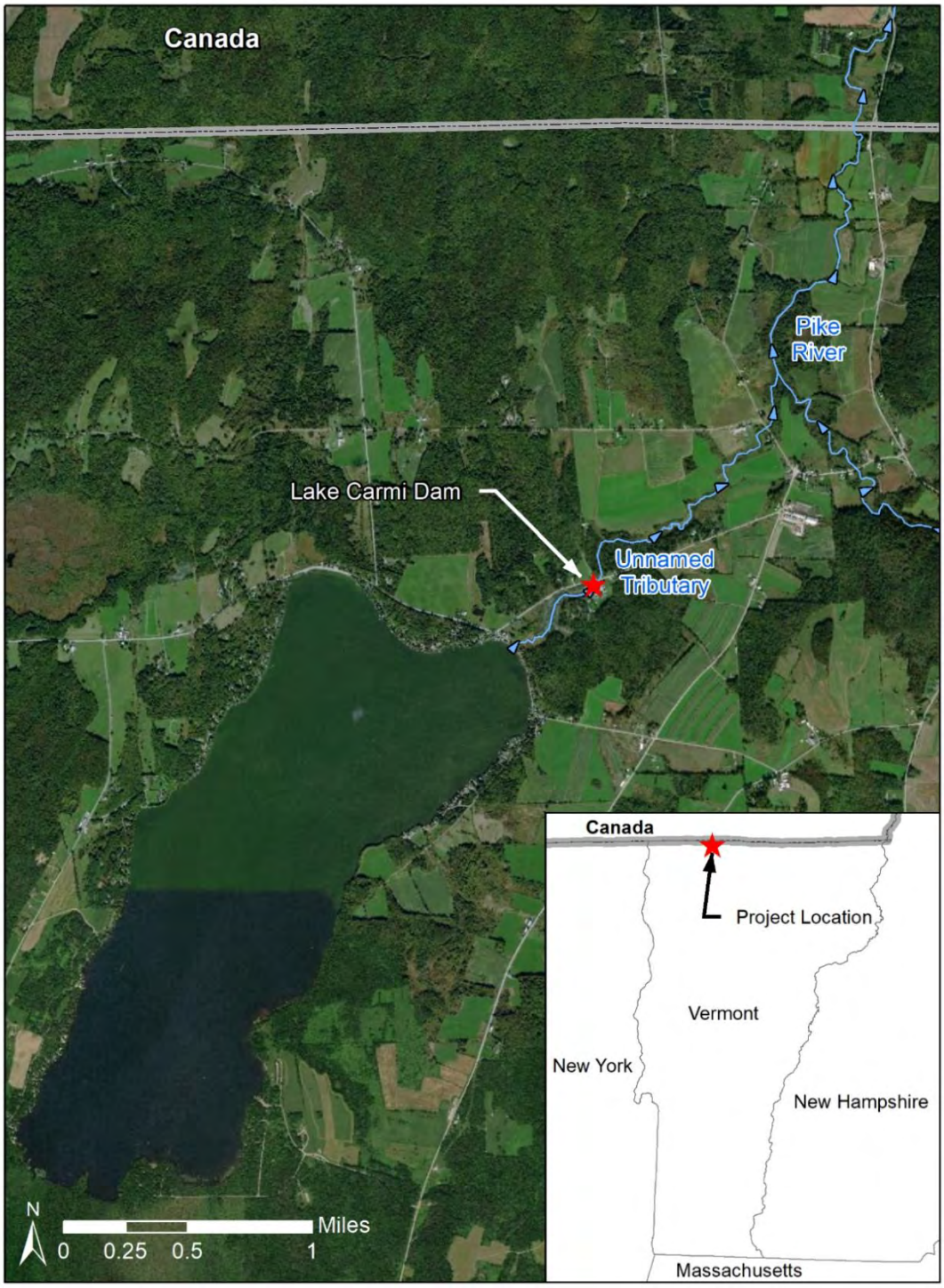

Figure 1-1: Location Map

The Dam is owned, operated, and maintained by the Vermont Department of Environmental Conservation (VTDEC); it was reconstructed in 1970. The Dam, which impounds the Mill Pond (hereinafter referred to as the Pond), is an earthen and concrete gravity structure with a principal spillway, stoplog channels, and low-level outlet. The Dam is approximately 160 feet long, has a structural height of 9 feet, and a drainage area of approximately 12.3 square miles (mi^2). The Dam is located approximately 2,500 feet downstream of the Dewing Road crossing, which is at the outlet for Lake Carmi (hereinafter referred to as the Lake). The Lake has a surface area of approximately 2.1 mi^2, representing approximately 17% of the drainage area at the Dam. The water levels in the Lake are controlled by both channel invert at Dewing Road and the Dam. The Dam is currently classified by VTDEC as low hazard, indicating that a dam failure would not likely result in loss of life and there would be minimal economic loss. Figure 1-2 provides an overview of pertinent features in close proximity of the Dam.

Figure 1-2: Overview of Features near Lake Carmi Dam

VTDEC contracted Gomez and Sullivan Engineers, D.P.C. (GSE) to conduct hydrologic, hydraulic, and an alternative analysis of the Dam. Specific objectives of the hydrologic analysis included identifying peak flows for various recurrence interval events up to the Probable Maximum Flood (PMF). The hydrologic analysis encompassed the entire drainage area upstream of the Dam. Hydraulic analysis included hazard classification and spillway design flood (SDF) determination, as well as inundation mapping under sunny day and SDF conditions. The hydraulic analysis extended along the unnamed tributary from the Lake to its confluence with the Pike River and continued along the Pike River to United States Geological Survey (USGS) Gage No. 04294300: Pike River at East Franklin near Enosburgh, VT (hereinafter referred to as the

gage). Based on the analysis, the Dam does not meet the VTDEC freeboard requirements and thus an alternative analysis was conducted to evaluate five alternatives: no action, overtopping protection, lowering the spillway crest to different elevations and increasing its length, by extending the principal spillway into the stoplog bays, and removing the Dam. The alternatives analysis evaluated costs, impacts to the Pond and Lake levels, and data gaps for each alternative. Figure 1-3 shows an overview of the study area for these analyses. The hydrologic model extents encompass the drainage area for the Dam as shown in red. The hydraulic model extends from the Lake along the unnamed tributary and continues along the Pike River to USGS Gage 04294300. The hydraulic model includes the Lake, the Pond, the Dam and three road crossings (Dewing Road, Route 120/Lake Road, and Middle Road). The hydraulic model considers the potential for interbasin flow transfer out of the south end of the Lake.

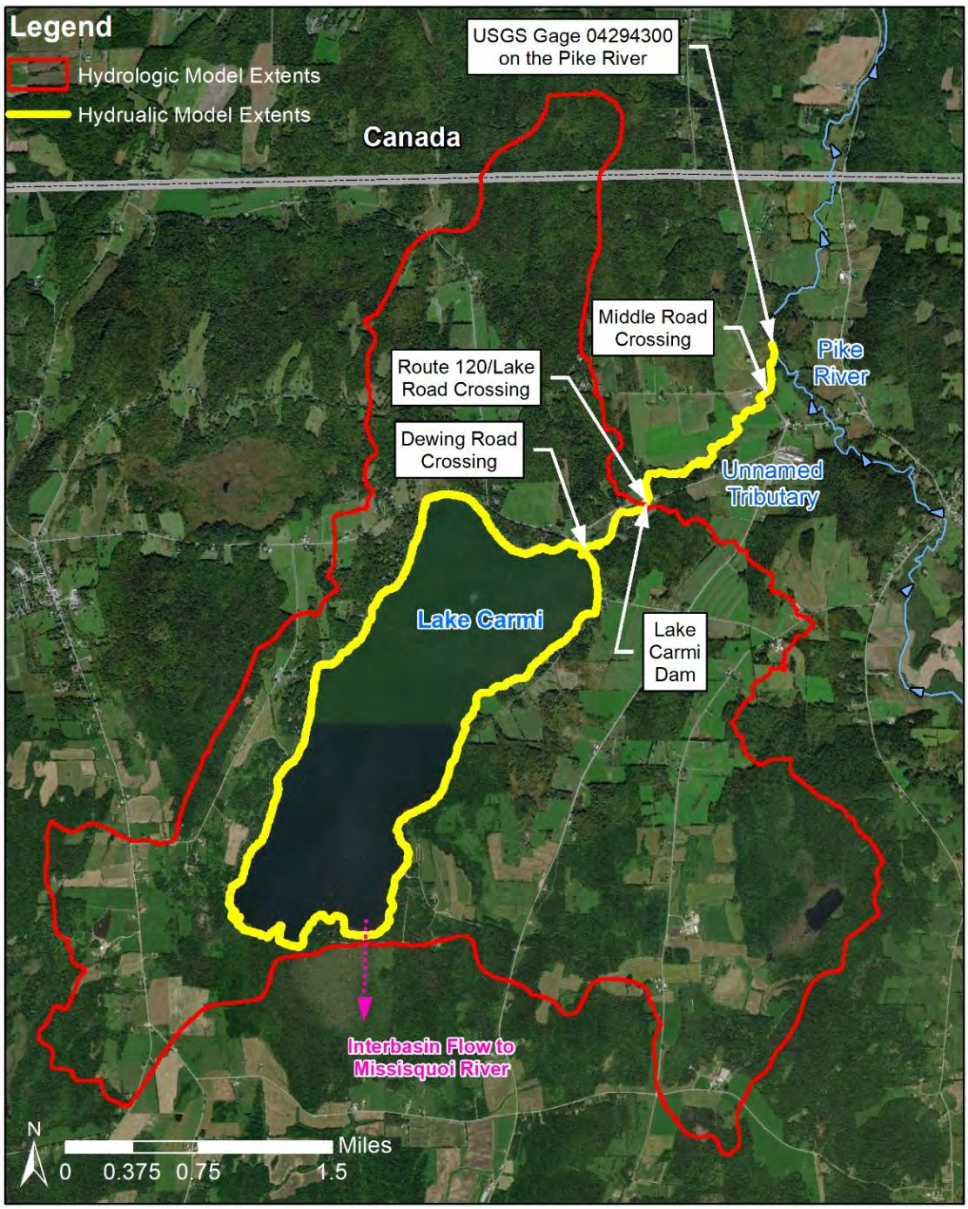

Figure 1-3: Overview of Study Extents

2. Field Survey

Field surveys were performed by GSE staff in May and June of 2018, during which various measurements were collected using a variety of methods as described below. All elevations within this report refer to the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted. Note that elevations reported in NAVD88 are approximately 0.40 feet lower than elevations reported in National Geodetic Vertical Datum of 1929 (NGVD29). All references to left and right side of the Dam, Pond, or river in this report is based on one looking downstream.

2.1 Structures

Positions and elevations were generally collected using Real-Time Kinematic Global Positioning System (RTK-GPS) instruments, while other measurements were also collected using tape measures and other manual methods. Photographs were taken of the structures and their immediate surroundings, including any unusual or notable features and are included in Appendix A.

2.1.1 Lake Carmi Dam

Table 2-1 summarizes the data collected at the Dam and shown in Figure 2-1. The field survey for the Dam focused on collecting information required to complete a hydrologic and hydraulic analysis of the Dam and did not include a formal dam inspection. However, during the field survey observations were made with respect to the condition of the Dam, embankments and outlet works. Specifically, it was observed that portions of the left earthen embankment are lower than the left abutment crest elevation. This could be the result of settlement which should be investigated and corrected if necessary. It was also observed that areas of concrete on the Dam and spillway are showing signs of deterioration. This should also be investigated and monitored or corrected as necessary. Finally, during the field survey, VTDEC staff indicated that the low-level outlet (i.e. sluice gate) is no longer operable and the stoplogs were secured with lag bolts to prevent their removal. While functional stop logs are not necessarily required, an operable low-level outlet is typically required to allow the Pond to be drawn down. As such this should also be investigated and repaired or replaced as appropriate.

Table 2-1: Lake Carmi Dam Dimensions

Feature	Parameter	Value
Left Embankment	Crest Elevation (ft)	435.7 - 436.6
Left Abutment	Length (ft)	23
	Crest Elevation (ft)	436.1
	Number of Stop Log Sluice Openings	2
	Length of each Stop Log Sluice Opening (ft)	4
	Crest Elevation of Stop Logs (ft)	434.5
Spillway	Length (ft)	81
	Crest Elevation (ft)	434.6
Right Abutment	Length (ft)	25
	Crest Elevation (ft)	436.0
	Sluice Gate Height (ft)	2
	Sluice Gate Width (ft)	2
	Low-level Outlet Sill Elevation (ft)	427.4
Right Embankment	Crest Elevation (ft)	436.6

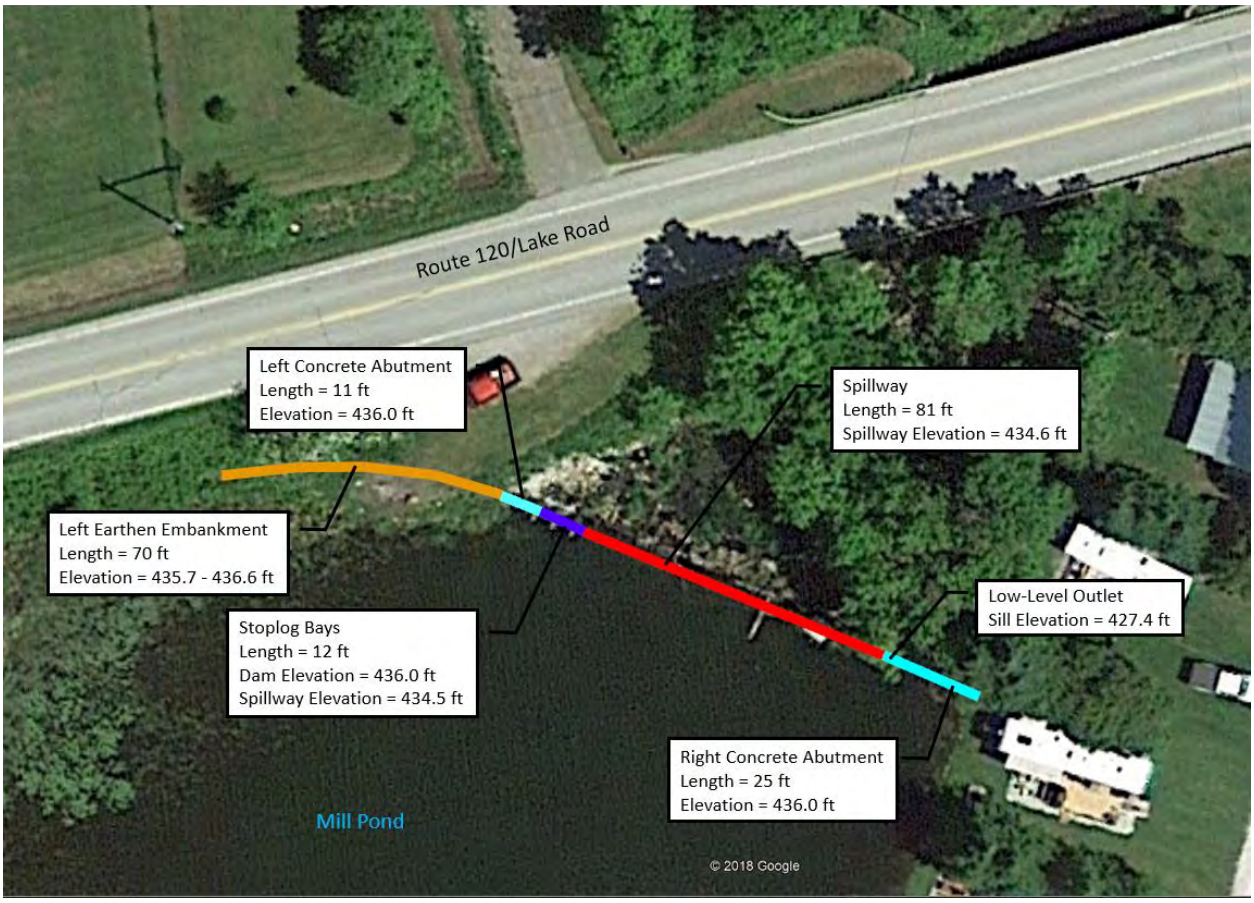

Figure 2-1: Lake Carmi Dam Existing Conditions

2.1.2 Dewing Road Crossing

The Dewing Road crossing located at the exit of the Lake is a precast concrete bridge, which is level from left to right as it crosses the stream. The invert of the channel invert at Dewing Road is approximately 2.5 feet lower than the Dam spillway crest elevation. Survey of the structure generally confirmed the elevations and dimensions provided on available drawings of the crossing. Table 2-2 summarizes the information collected for this crossing.

Table 2-2: Dewing Road Crossing Dimensions

Parameter	Value
Road Centerline Elevation (ft)	439.4
Low Chord Elevation (ft)	437.0
Upstream Invert Elevation (ft)	432.5[1]
Downstream Invert Elevation (ft)	432.0[1]
Opening Width (ft)	21.0
Deck Width (ft)	28.0
Guardrail Height (ft)	1.7

Note: All elevations based on instrument survey (RTK GPS) unless otherwise noted. All dimensions based on field measurements.

1. Elevations based on field measurements

2.1.3 Lake Road Crossing (Route 120)

The Lake Road crossing located immediately downstream of the dam consists of a bridge with a concrete deck and steel girders, which rises in elevation from left to right as it crosses the stream. Table 2-3 summarizes the information collected for this crossing.

Table 2-3: Lake Road Crossing Dimensions

Parameter	Value
Road Centerline Elevation (ft)	434.7 - 435.8
Low Chord Elevation (ft)	429.7 - 430.2
Streambed Elevation (ft)	424.3-424.5[1]
Opening Width (ft)	64.7
Deck Width (ft)	35.4
Guardrail Height (ft)	1.6

Note: All elevations based on instrument survey (RTK-GPS) unless other noted. All dimensions based on field measurements.
1. Elevations based on field measurements

2.1.4 Middle Road Crossing

The Middle Road crossing, located about one mile downstream of the Dam consists of a corrugated metal pipe-arch culvert through an earthen roadway embankment, whose roadway surface falls in elevation from left to right as it crosses the stream. Table 2-4 summarizes the information collected for this crossing.

Table 2-4: Middle Road Crossing Dimensions

Parameter	Value
Road Centerline Elevation (ft)	423.0 - 424.1
Deck Width (ft)	30
Guardrail Height (ft)	1.3 - 1.6
Upstream Culvert Invert Elevation (ft)	410.2
Downstream Culvert Invert Elevation (ft)	410.1
Maximum Culvert Opening Width (ft)	7.0
Maximum Culvert Opening Height (ft)	5.1
Culvert Length (ft)	58

Note: All elevations based on instrument survey (RTK-GPS) unless other noted. All dimensions based on field measurements.

2.2 Sediment

One alternative VTDEC requested GSE to investigate was removal of the Dam. An issue with most dam removals is sediment deposition upstream of the dam. Typically, the quantity and quality of sediment is characterized to inform a sediment management plan should the dam be removed. To quantify the sediment volume impounded by the Dam, sediment depth measurements were obtained on May 29, 2018 along transects between the Dam and Dewing Rd. Positions and elevations were generally collected using RTK-GPS and manual measurement methods. Photographs were taken of the immediate surroundings for each transect (see Appendix A).

2.2.1 Sediment Depth Collections

A total of seven sediment depth transects were collected along the Pond from the upstream dam face to Dewing Rd (see Figure 2-2). For each transect, a tie-off point on the right and left banks and the water's edge was recorded using RTK-GPS. Along each transect, a steel rod marked in 0.5-foot increments was first lowered down to the Pond bed at points spaced approximately 20 feet apart on average, and the depth of water recorded. The steel rod was then driven down with a hammer into the sediment until refusal to determine the sediment thickness at each point. Sediment composition was roughly characterized based on observations, feel, and any vertical changes in composition as the probe was driven into the sediment were also noted. Sediment thicknesses were initially measured relative to the WSEL and were documented. The sediment depths were later converted to elevations based on the surveyed WSEL.

Figure 2-2: Mill Pond Sediment Transect Locations

2.2.2 Sediment Quantity Assessment

The total sediment volume in the Pond was calculated using the cross-sectional sediment area for each of the seven transects based on the thickness of sediment at each point across each transect. The sediment thickness at each point was calculated as the difference of the depth to sediment (water depth) and the depth to refusal. The approximate total sediment volume was calculated using the average end area method across the transects in the Pond area.

The total sediment volume in the Pond is approximately 36,200 cubic yards. The sediment thickness ranged from 0.5 feet to 4.5 feet. Water depths ranged from 2 feet to 9.5 feet as summarized in Figure 2-3. Much of the sediment was found between transects T3 and T4. Refer to Appendix B for cross-sectional plots of each transect showing the WSEL and sediment area.

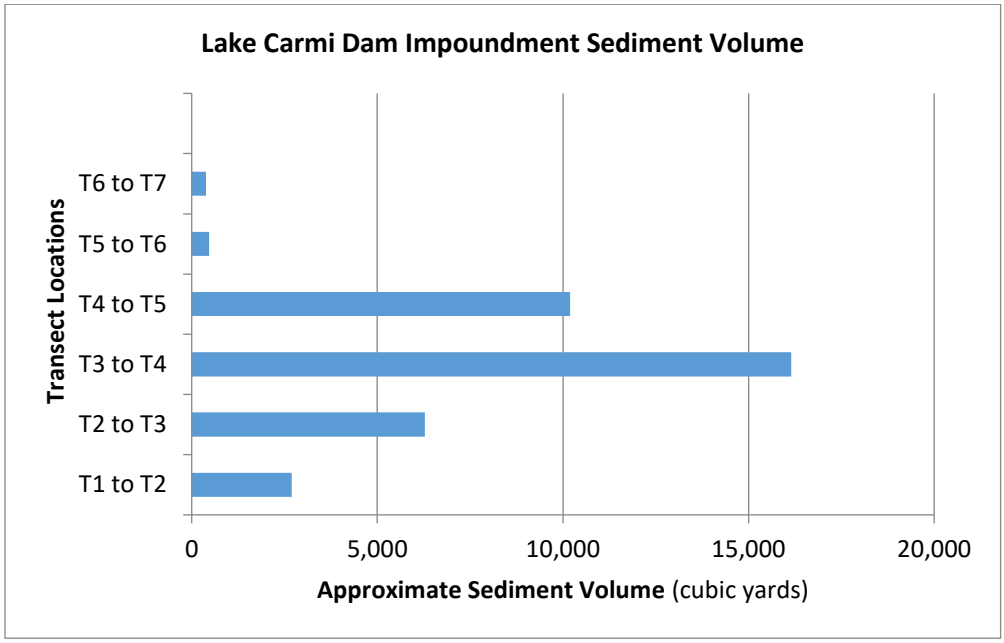

Figure 2-3: Mill Pond Sediment Volumes

The total sediment volume does not represent the potentially mobile sediment volume if the Dam were removed. If the Dam were removed, much of the sediment along the fringes of the Pond would revert to soils and vegetation would ultimately stabilize these sediments in place. It is beyond the scope of this study, but if dam removal were considered, the mobile sediment volume should be estimated to develop a sediment management plan.

2.2.3 Sediment Quality Assessment

To characterize the quality of sediment impounded by the Dam, a single sediment sample was collected on May 29, 2108 by GSE staff. The sample was sent to Test America, a VT-state certified laboratory, and analyzed for possible chemical constituents and physical properties. The sample was collected with a stainless-steel hand corer at the deepest sediment thickness point along Transect T4 as shown in Figure 2-2. The depth of the sample was approximately 4 feet deep. The core was taken back to shore and photographed (see Figure 11 in Appendix A). The excess water on the top of the core was carefully drained. The sediment was emptied in a sterilized stainless-steel bowl and stirred with sterilized stainless steel spatulas. The homogenized sediment sample was emptied into a container provided by Test America. The container was put in ice and hand delivered to the Test America lab in Burlington, VT on the same day it was collected. The Burlington Test America lab overnighted a percentage of the sample to their Pittsburg, PA lab. The chain of custody records are included in the laboratory test results in Appendix B. Test America analyzed the sediment for volatile organic compounds, semi-volatile organic compounds, pesticides, polychlorinated biphenyls (PCBs), and metals in accordance with the "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" standards. The physical properties of the sample

were evaluated in accordance with the standards of ASTM D2216-90 (water moisture content), ASTM D2937 (soil density), ASTM D422 (grain size), and ASTM D854 (specific gravity).

The soil classification is summarized in Table 2-5 and is also included in Appendix B. In accordance with the Burmister classification system, the sediment is classified as a fine to coarse sand, some clayey silt, and trace fine gravel; however, sand comprises most of the sample. It should be noted that some assumptions were made about the silt and clay fines because a plasticity index test was not completed during the analysis. If a plasticity index test were to be completed in the future, the classification may change.

Table 2-5: Soil Sample Classification

Soil Classification	Percent of Sample
Gravel	6.0
Sand	48.0
Composition of Sand	Composition of Sand
Course Sand	6.4
Medium Sand	15.9
Fine Sand	25.7
Silt	39.1
Clay	6.9

If dam removal were considered, it is recommended that, at a minimum, additional sediment samples be obtained at the following locations:

- One sample in a free-flowing section of the river above the Lake; probably the largest inflowing tributary to Lake Carmi.
- Two to three samples in the Pond.
- One sample in a free-flowing section of the river below the Dam.

The additional sediment samples upstream and downstream of the Dam would be collected to understand the concentration levels of contaminants (if any) flowing into and out of the system. If deep sediment cores were present, layers of cores could be tested separately (i.e. top 1-3 feet, middle 4-6 feet, deep 7+ feet). This additional information would be beneficial in the development of the sediment management plan should dam removal be a viable alternative.

Results from the single sample sediment contaminant analysis were compared to the ecological and human health Sediment Quality Guidelines (SQGs) defined in the VTDEC Recommended Guidelines for Evaluating Contaminant Concentrations in Freshwater Sediments (Oct. 2016). The SQGs are predominately based on MacDonald et al., 2000 to evaluate if any contaminants are present at elevated levels or if any contaminants pose a threat to freshwater ecological resources. The SQGs are categorized into two categories, Threshold Effect Concentration (TEC) and the Probable Effect Concentration (PEC) values. Definitions of TEC and PEC are provided below:

- TEC: Threshold Effects Concentration – TEC values are screening thresholds below which adverse effects to freshwater ecosystems are unlikely to occur.
- PEC: Probable Effects Concentration – PEC values are screening thresholds above which adverse effects to freshwater ecosystems are likely to be observed.

In accordance with VTDEC guidelines, any exceedance of a TEC will require a further site assessment in the form of biological community assessments, toxicity testing, or both. The degree of response required would be dictated by a weight-of-evidence evaluation. Sediment testing results compared to the VTDEC SQRs (TEC and PEC) are shown in Table 2-6. The laboratory results are included in Appendix B. For this single sample, there were no exceedances of TECs or PECs. Overall, the sediment in this area presents low risk to freshwater biota.

Table 2-6: Test America Sediment Sample Test Results

Contaminant	TEC[1]	PEC[1]	Sample[2]
Metals (mg/kg)			
Arsenic	9.79	33.0	1.5
Cadmium	0.99	4.98	0.44
Chromium	43.4	111	11
Copper	31.6	149	16
Lead	35.8	128	23
Mercury	0.18	1.06	0.1
Nickel	22.7	48.6	11
Zinc	121	459	52
Polycyclic Aromatic Hydrocarbons (µg/kg)			
Anthracene	57.2	845	*ND*
Fluorene	77.4	536	*ND*
Naphthalene	176	561	*ND*
Phenanthrene	204	1,170	*ND*
Benz(a)anthracene	108	1,050	40
Benzo(a)pyrene	150	1,450	46
Chrysene	166	1,290	54
Dibenz(a,h)anthracene	33		*ND*
Fluoranthene	423	2,230	63
Pyrene	195	1,520	52
Total PAHs	1,610	22,800	255
Polychlorinated Biphenyls (µg/kg)			
Total PCBs	59.8	676	*ND*
Organochlorine Pesticides (µg/kg)			
Chlordane	3.24	17.6	*ND*
Dieldrin	1.90	61.8	*ND*
Sum DDD	4.88	28.0	0.54
Sum DDE	3.16	31.3	0.48
Sum DDT	5.28	572	0.33
Endrin	2.22	207	*ND*
Heptachlor Epoxide	2.47	16.0	*ND*
Lindane (gamma-BHC)	2.37	4.99	*ND*

1. Concentrations reported in VT DEC Recommended Sediment Quality Guidelines
2. ND = Not detected at reporting limit

3. Hydrology

The main objective of the hydrologic analysis was to identify peak flows for a range of recurrence interval events (and non-recurrence interval events) up to the PMF. These events included average baseflow, 2-year, 10-year, 25-year, 50-year, 100-year, 500-year, ½ PMF, and PMF. A review of previous analyses was performed prior to developing a hydrologic and hydraulic model to estimate peak flows at the Dam. This section of the report includes a detailed discussion of the previous analyses and the hydrologic model. While the hydraulic model was also needed to estimate peak flows at the Dam, detailed discussion of the hydraulic model can be found in Section 4 - Hydraulics.

3.1 Previous Analyses

The Vermont Agency of Transportation (VT AOT) provided estimated peak flows for events up to the 100-year recurrence interval in a memo dated November 18, 2011 titled *Franklin TH 18 (Dewing Road) Bridge 15 over Lake Carmi outlet stream Site about 500' southeast of VT 120*. Note that the peak discharges were estimated at the Dewing Road crossing as opposed to the Dam. The VT AOT memo states that normal hydrologic methods could not be used to estimate flows at Dewing Road due to the large amount of storage in the Lake. The memo noted that the flow estimates were developed using several hydrologic methods but no backup is provided.

The VTDEC utilized a hydrologic model (HEC-1) to estimate peak flows for events ranging from the 100-year to the PMF. These peaks have been documented in previous inspections of the Dam, such as the VTDEC memo *Inspection of Lake Carmi Dam, Franklin VT* dated August 2, 2006.

Additionally, methods outlined in the 2014 USGS publication *Scientific Investigations Report 2014-5078: Estimation of Flood Discharges at Selected Annual Exceedance Probabilities for Unregulated Rural Streams in Vermont* (hereinafter referred to as the SIR) were used to estimate peak flows at the Dam. Two different approaches were used to evaluate peak flows at the Dam: (a) utilizing regional regression equations at the Dam, and (b) prorating of the weighted flood discharge computed at the gage.

Both methods rely upon the regional regression equations developed in the Scientific Investigations Report (SIR) (Equations 3 through 10). The required input parameters for these equations can be obtained from the USGS webtool Streamstats (https://water.usgs.gov/osw/streamstats/). The SIR specifies the valid range for each parameter based on the information used to develop the equations. Table 3-1 summarizes the valid range for each parameter, and the value obtained from Streamstats for the drainage area at the Dam and at the gage. Note that the percent storage for the Dam's drainage area is outside of the valid range for the regional regression parameters. This indicates that the influence of the Lake's storage may invalidate the results of any regional regression analysis for the Dam. Additionally, the large difference in percent storage between the Dam and the gage suggests that any proration of discharge estimates at the gage to the Dam could also be negatively influenced. The mean annual precipitation value incorporated precipitation data collected from 1981 to 2010 from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) Climate Group and was within the valid range for the regional regression parameters.

Table 3-1: Regional Regression Parameters

Parameter	Valid Range	Value at Dam	Value at Gage
Drainage Area (mi^2)	0.18 - 689	12.3	34.6
Percent Storage from NLCD 2006 (%)	0.0 - 18.5	23.9	9.72
Mean Annual Precipitation from PRISM 1981-2010 (in)	33.5 - 70.4	44.1	46.6

A flood frequency analysis was performed on the 16 annual instantaneous peak flows reported at the gage (i.e. water years 2002 through 2017). The latest USGS guidelines for flood frequency analysis (Bulletin 17C, 2018) suggest that as little as 10 years of systematic streamgage records are sufficient to warrant a statistical analysis (with an informative regional skew and [or] record extension), but that flood estimates may change as more years of record become available. The analysis was performed using the USGS software PeakFQ, Version 7.2. Inputs included the gage's peak flows, a regional skew of 0.44, and standard error of 0.28. The regional skew was obtained from the SIR (b_1 reported in Table 7), while the standard error was computed using Equation 12 of the SIR with the variance of prediction (V_{pred}) being obtained from the SIR (AVP_{new} reported in Table 7). The weighted flood discharge at the gage was then computed using Equation 17 of the SIR. This value was prorated by the drainage area at the Dam over the drainage area at the gage (12.3/34.6) to estimate the prorated peak discharge at the Dam.

Table 3-2 summarizes the peak discharges and provides an overview of those estimates (up to the 500-year event) which are not reported at the gage. Note that the values shown in Figure 3-1 are generally reported at the Dam except for those from VT AOT, which are reported at Dewing Road crossing.

Table 3-2: Summary of Previous Peak Discharge Estimates

Event Magnitude	Peak Discharge Estimate (cfs)						
	VT AOT	VTDEC	Regional Regression at Dam	Regional Regression at Gage	Peak Frequency at Gage	Weighted at Gage	Prorated at Dam
2-Year	-	-	219	762	1,250	1,208	429
2.33-Year	180	-	-	-	1,358	-	-
5-Year	-	-	339	1,170	1,879	1,787	635
10-Year	350	-	429	1,470	2,361	2,203	783
25-Year	450	-	558	1,910	3,049	2,779	988
50-Year	560	-	665	2,280	3,620	3,240	1,152
100-Year	650	280	777	2,670	4,245	3,723	1,323
200-Year	-	-	903	3,100	4,928	4,240	1,507
500-Year	-	-	1,080	3,730	5,934	4,982	1,771
0.25 PMF	-	585	-	-	-	-	-
0.5 PMF	-	2,815	-	-	-	-	-
PMF	-	7,828	-	-	-	-	-

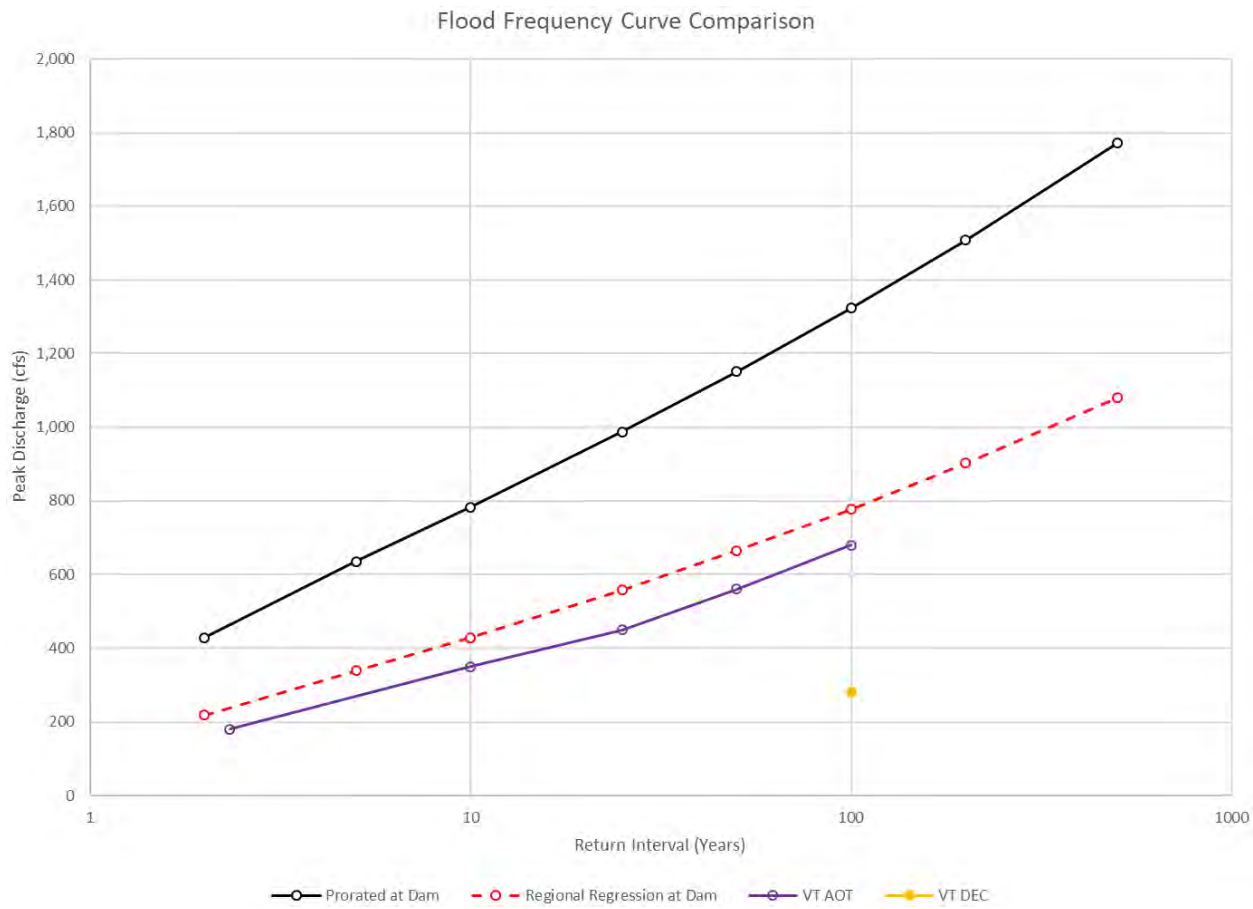

Figure 3-1: Overview of Previous Peak Discharge Estimates

3.2 Hydrologic Model Development

The hydrologic model utilized the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), Version 4.2 computer software. The outflow hydrographs for each subbasin were used as inputs to a hydraulic model to route flows through the Lake and over the Dam.

The hydrologic model utilized two subbasins (see Figure 3-2); the Lake Subbasin encompassing the area upstream of Dewing Road, and the Dam Subbasin encompassing the drainage area between the Dam and Dewing Road. These subbasin areas were developed with the aid of the USGS Streamstats webtool. The Lake Subbasin comprises approximately 11.2 mi^2 of the 12.3 mi^2 at the Dam, while the Dam Subbasin accounts for the remaining 1.1 mi^2. The hydrologic model utilized the Soil Conservation Service (SCS) methodology for subbasin loss and transform, while the recession method was utilized to evaluate baseflow. Precipitation hyetographs were developed using information from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Volume 10: Northeastern Region, and USACE Hydrometeorological Reports 51 and 52 (HMR-51 and HMR-52). Sensitivity analyses were performed on select subbasin parameters prior to finalizing the results.

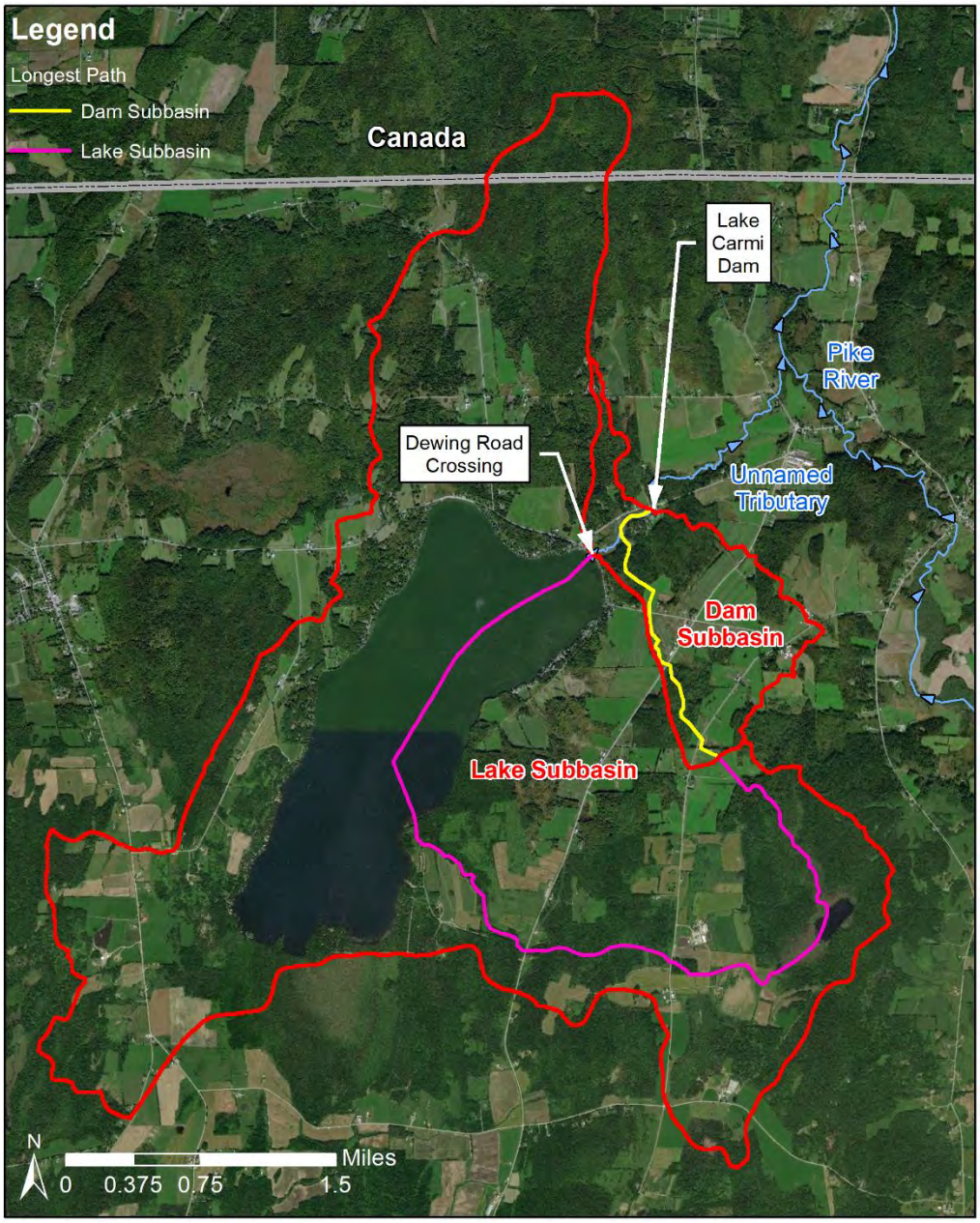

Figure 3-2: Overview of Subbasins

3.2.1 Subbasin Parameters

The parameters associated with the SCS loss method are percent impervious area, curve number (CN), and initial abstraction (Ia). The percent impervious area and average curve number for each subbasin was estimated using the 2011 National Land Cover Dataset (NLCD) and the Soil Survey Geographic Database (SSURGO). Areas within these datasets which were coded as water, swamp, wetlands, or dam were assumed to be impervious. Curve numbers were assigned to a given area based on its combination of land use and hydrologic soil group using values guidance provided in the second edition of the United States Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) document *Technical Release 55: Urban Hydrology for Small Watersheds* from June 1986. An area weighted average curve number was then developed for each subbasin. Note that approximately two percent (2%) of the

Lake Subbasin extends into Canada for which these datasets did not provide information. Therefore, it was assumed that the Canadian portion of the subbasin has the same relative distribution of land use and hydrologic soil groups as the rest of the subbasin. Figures of the breakdown of land use and soils within the subbasin are provided in Appendix C. Note that the soils data shown in the figure corresponds to the "predominant" soil type for a given region. However, the estimation of curve number utilized the percent breakdown of each soil type for a given region. The initial abstraction was estimated using the equation outlined by the SCS method [Ia = 0.2*(1000/CN – 10)], assuming average antecedent moisture conditions (AMC II).

The standard SCS transform method was applied, which only requires a lag time to be defined. The lag time was computed using the methods outlined in the *National Engineering Handbook, Part 630: Hydrology, Chapter 15 – Time of Concentration* (NRCS, 2010), where the total lag was estimated as the sum of the travel time for sheet flow, shallow flow, and channel flow for the path with the longest travel time for each subbasin. The "Longest Path" (in terms of travel time) for each subbasin is provided on Figure 3-2. The headwaters for the longest path for each subbasin happen to coincide. An alternative path was evaluated from the northern end of the Lake Subbasin, which produced a slightly lower lag time. The computations for final lag times are provided in Appendix C. Sensitivity of this parameter was performed as discussed in Section 3.3.

The parameters associated with the recession method for baseflow are discharge per area, recession constant, and ratio to peak. The discharge per area should represent a sunny day flow. The gage has a drainage area of 34.6 mi^2 and provides an annual mean discharge from 2002 to 2017. The average annual discharge during this period of record is 68.4 cfs, which equates to 1.98 cfs/mi^2 (68.4/34.6 = 1.98). As such, a value of 2 cfs/mi^2 was used as the discharge per area in the hydrologic model. The recession constant and ratio to peak are used to define the falling limb of a hydrograph and are often determined through model calibration. The recession constant often falls between 0.6 and 0.9, while the 0.1 to 0.35 is a common range for the ratio to peak. Insufficient information is available for calibration to significant historical events. Therefore, engineering judgement was used to select an appropriate value for each parameter. Sensitivity of these parameters was performed as discussed in Section 3.3.

Table 3-3 provides the final subbasin parameters utilized in the HEC-HMS model.

Table 3-3: Final Subbasin Parameters

Category	Parameter	Lake Subbasin	Dam Subbasin
Geometry	Drainage Area (mi^2)	11.2	1.1
Loss	Curve Number	70.2	72.9
	Impervious Area (%)	29.0	19.2
	Initial Abstraction (in)	0.85	0.74
Transform	Lag Time (min)	80	45
Baseflow	Discharge (cfs/mi^2)	2	2
	Recession Constant	0.8	0.8
	Ratio to Peak	0.2	0.2

3.2.2 Precipitation

A precipitation hyetograph was developed for each subbasin and each storm event to be analyzed in the hydrologic model. NOAA Atlas 14 was used to develop hyetographs up to the 500-year event, while HMR-51 and HMR-52 were utilized to develop hyetographs for the PMF.

The precipitation frequency data server for NOAA Atlas 14 (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html) was utilized to collect the information necessary for development of hyetographs for events other than the PMF. The centroid of each subbasin was entered to obtain the temporal distribution and total rainfall for a 24-hour storm for each event using an analysis of partial duration time series. NOAA Atlas 14 provides five (5) different tables of temporal distribution based on historical storms (first-quartile cases, second-quartile cases, third-quartile cases, fourth-quartile cases, and all cases). The quartiles refer to the period of the day during which most of the precipitation falls (e.g. first -quartile has most of the precipitation falling in the first 6 hours of the 24 hour storm). Each table provides nine (9) different temporal distributions, each denoted by their percent of occurrence. Each temporal distribution provides the cumulative percentage of total precipitation in half hour increments. As such, NOAA Atlas 14 provides 45 different temporal distributions from which to choose (5 tables x 9 distributions = 45). This study utilized the 50% occurrence distribution from the all cases table.

Figure 3-3 provides the temporal distribution for both subbasins, while Table 3-4 provides the total rainfall for each subbasin for events up to the 500-year storm. It should be noted that the total rainfall is for a given point location. This study provides a conservative estimate for subbasin precipitation, as it does not apply an areal reduction factor to these point rainfalls when defining the hyetographs. Appendix C includes the values from Figure 3-4 in tabular format.

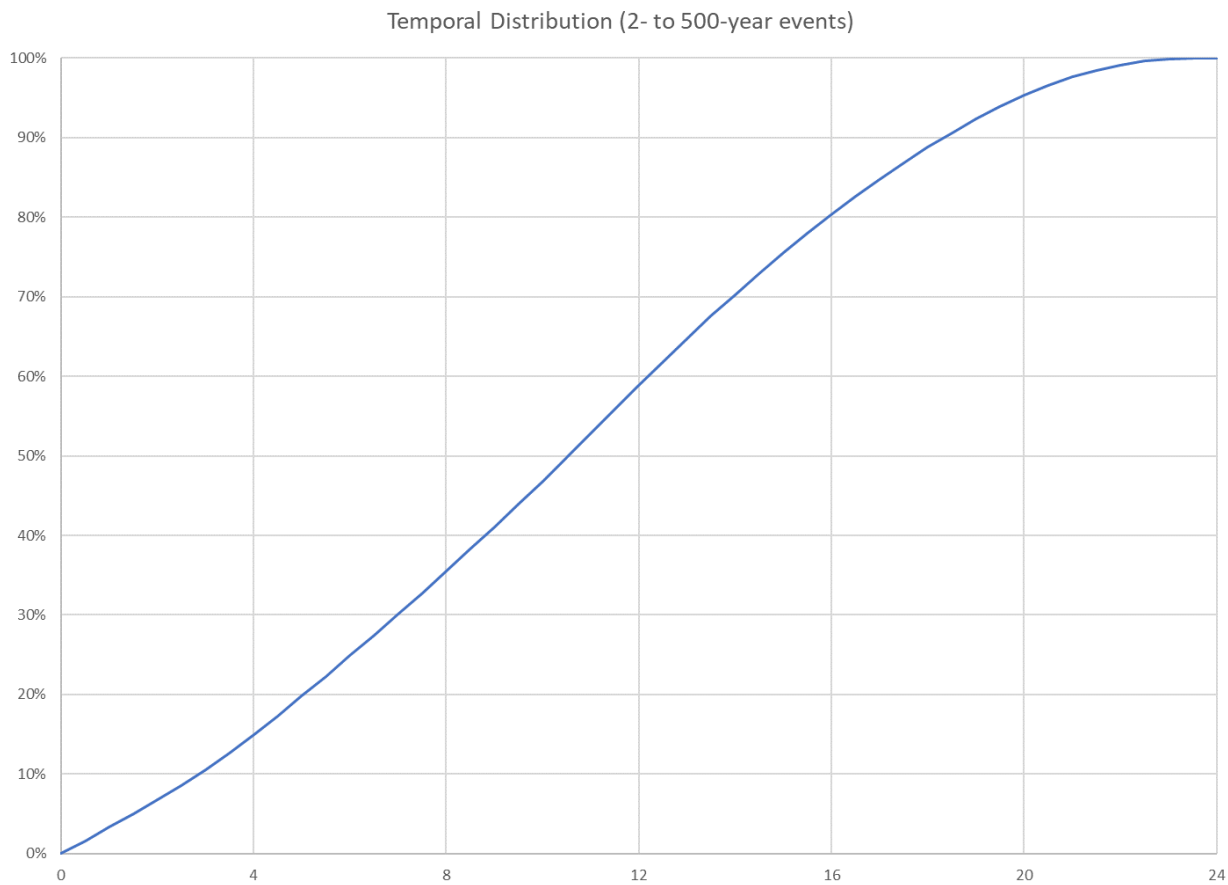

Figure 3-3: Temporal Distribution for Both Subbasins

Table 3-4: Total Precipitation for 24-Hour Duration Storm (2- to 500-year events)

Recurrence Interval	Total Precipitation (in)	
	Lake Subbasin	Dam Subbasin
2-Year	2.30	2.32
10-Year	3.27	3.29
25-Year	3.87	3.90
50-Year	4.33	4.36
100-Year	4.80	4.83
500-Year	6.13	6.17

The centroid of the drainage area for the Dam was used in conjunction with figures in HMR-51 to obtain the depth-area-duration table, 1-hour to 6-hour ratio (0.343256), and preferred orientation (204 degrees) for the PMF. The preferred orientation was estimated, as the centroid falls just outside of the lines provided in the HMR-51 figure. Table 3-5 provides the depth-area-duration table developed from HMR-51. The hyetographs for the PMF were then computed using methods outlined in HMR-52 using the values obtained from HMR-51 along with a shapefile of the subbasins. This was accomplished using the HMR-52 methodology. The software selected a storm orientation of 205 degrees and storm size of 25 mi^2, resulting in a basin average 72-hour precipitation depth of 27.37 inches for the Lake Subbasin and 28.05 inches for the Dam Subbasin. The peak precipitation intensity for a given half hour period was computed as 6.45 inches for the Lake Subbasin and 6.82 inches for the Dam Subbasin.

Table 3-5: Precipitation Depth-Area-Duration Curves for PMF at Lake Carmi Dam

Duration (hrs)	Area (mi^2)					
	10	200	1,000	5,000	10,000	20,000
6	19.92	13.66	9.56	5.97	4.62	3.57
12	23.27	16.47	12.27	8.61	7.32	5.83
24	25.52	18.66	14.56	10.54	9.05	7.60
48	28.10	21.32	16.97	12.72	10.97	9.76
72	29.48	22.06	17.60	13.69	12.31	10.72

3.3 Parameter Sensitivity

None of the previous analyses were considered appropriate for hydrologic model calibration or verification, due to the lack of backup for the VT AOT and VTDEC estimates and the potentially large influence of the Lake on the USGS estimates. Therefore, in lieu of hydrologic model calibration or verification, a sensitivity analysis was performed on some subbasin parameters for the 100-year flow. Table 3-6 provides an overview of the parameters analyzed as well as the resulting peak flow at the Dam. This table shows that the lag time and recession constant have relatively little influence on the peak flow at the Dam. The ratio to peak parameter is shown to have greater influence on peak flow at the Dam. It should be noted that these results are comparable to the previous analysis by VTDEC but are much lower than the other previous analyses.

Table 3-6: Hydrology Sensitivity

Evaluation	Lag Time (min)		Recession Constant	Ratio to Peak	Peak Flow at Dam (cfs)
	Lake Subbasin	Dam Subbasin			
Final	80	45	0.8	0.2	235
Sensitivity A	40	22.5	0.9	0.2	240
Sensitivity B	80	45	0.8	0.2	240
Sensitivity C	80	45	0.8	0.35	310
Sensitivity D	40	22.5	0.9	0.35	362

It should also be noted that the Lake has a large impact on attenuation of flows. The final evaluation provides a peak inflow to the Lake of 1,394 cfs and a peak outflow of 206 cfs for the 100-year event. This attenuation causes a double peak at the Dam (see Figure 3-4), with the first peak being associated with discharge from the Dam subbasin, and the second peak associated with outflow from the Lake. This second peak was generally lower than the first. Sensitivity C evaluation provides an example of when the second peak is larger, however such a high ratio to peak is not considered reasonable due to the total volume discharged from the Lake in relation to precipitation fallen.

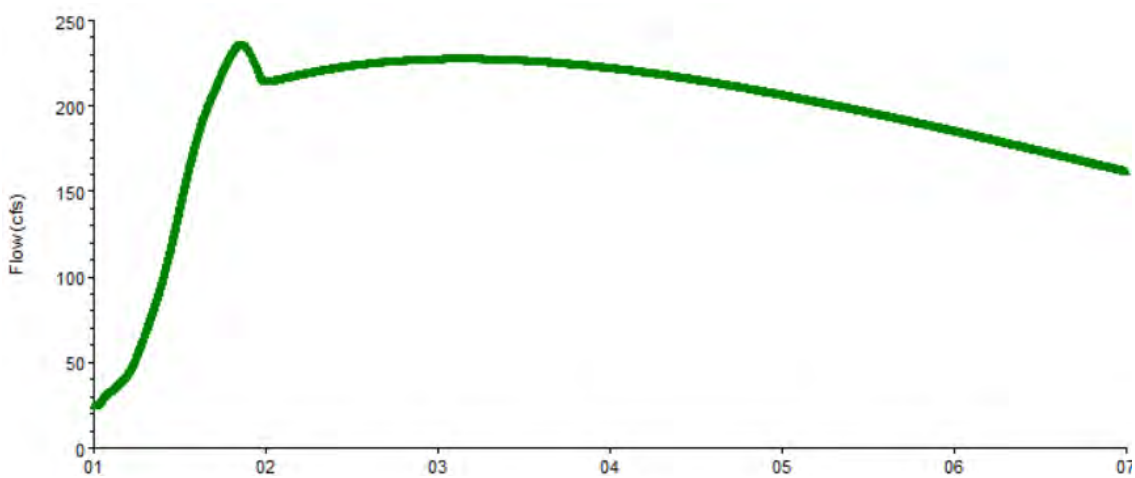

Figure 3-4: Discharge at Dam for Final Evaluation of 100-Year Event (X-Axis is in Days)

An additional sensitivity was performed for estimating 50% of the PMF (0.5 PMF). To approximate the 0.5 PMF, the outflow hydrographs for each subbasin from the hydrologic model were multiplied by 0.5 prior to being entered as inflows to the hydraulic model. This method produced a discharge at the Dam of 2,201 cfs. The second method was to use half of the peak discharge at the Dam during PMF conditions. This resulted in approximately 2,484 cfs (4,968 *0.5 = 2,484), for a difference between peak discharge estimates of approximately 283 cfs. The first method involving manipulation of the PMF hydrographs is used as the final value for methodological consistency during the hazard analysis.

3.4 Hydrologic Results

As previously mentioned, the hydraulic model used to route flows through the Lake and Pond and estimate peak flows at the Dam includes consideration for interbasin flow transfer out of the southern end of the Lake. The results indicate that such interbasin transfer does not occur for event magnitudes less than or equal to the 500-year event. However, under the 0.5 PMF a peak interbasin flow transfer of

approximately 3,360 cfs occurs (events between the 500-year and 0.5 PMF were not evaluated). Table 3-7 summarizes the peak flows and WSELs at the Dam, as well as an assessment of abutment overtopping for each of the events analyzed. The results suggest that the spillway has the capacity to discharge flows up to the 500-year event without overtopping. During the 500-yr event there is 0.3 feet of freeboard indicating that the Dam could pass more than the 500-year event before beginning to overtop.

Table 3-7: Hydrology Results at Dam

Event	Peak Flow at Dam (cfs)	Peak WSEL at Dam (ft)	Abutment Freeboard/ Overtopping (ft)
Sunny Day	24	434.8	-1.2
2-Yr	83	435.0	-1.0
10-Yr	131	435.2	-0.8
25-Yr	165	435.3	-0.7
50-Yr	195	435.4	-0.6
100-Yr	235	435.5	-0.5
500-Yr	348	435.7	-0.3
0.5 PMF	2,201	437.3	1.3
PMF	4,968	438.3	2.3

Note:

Freeboard and Overtopping are computed relative to the right abutment crest elevation of 436.0 feet. A negative value indicates freeboard, while a positive value indicates overtopping.

Table 3-8 summarizes the peak flows and WSELs at the Dewing Road crossing, as well as an assessment of overtopping for each of the events analyzed. The results indicate that the Dewing Road crossing still has approximately 0.8 feet of freeboard under the 0.5 PMF, with a hydraulic drop of approximately 1.2 feet from the upstream side of the crossing to the downstream side. The hydraulic drop is approximately 0.3 feet under the 500-year event, as the water surface has not impacted the low chord of the bridge opening.

Table 3-8: Hydrology Results at Dewing Road

Event	Peak Flow at Crossing (cfs)	Peak Headwater at Crossing (ft)	Peak Tailwater at Crossing (ft)	Crossing Freeboard/Overtopping (ft)
Sunny Day	22	434.8	434.8	-4.6
2-Yr	69	435.2	435.2	-4.2
10-Yr	110	435.5	435.5	-3.9
25-Yr	139	435.7	435.6	-3.7
50-Yr	172	435.9	435.7	-3.5
100-Yr	206	436.0	435.8	-3.4
500-Yr	300	436.4	436.1	-3.0
0.5 PMF	778	438.6	437.4	-0.8
PMF	2,221	440.8	439.2	+1.4

Note:

Freeboard and Overtopping are computed using the headwater elevation relative to the top of deck elevation 439.4 feet. A negative value indicates freeboard, while a positive value indicates overtopping.

4. Hydraulics

A hydraulic model was developed to assess flows, WSELs, and velocities downstream of the Lake, as well as WSELs within the Lake. Flows at the Dam and WSELs downstream of the Dam due to a breach of the Dam were of interest. The analysis utilized the USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS), Version 5.0.4 to evaluate various events including dam failure scenarios.

4.1 Hydraulic Model Development

The hydraulic model extends from the Lake and downstream approximately 1.9 miles to where the unnamed tributary (that originates at the Lake) enters the Pike River and continues approximately 300 feet on the Pike River to the USGS gage. Figure 4-1 is an overview of the cross-section layout. It was noted that under significant events, flow could potentially exit the southern side of the Lake and flow towards the Missisquoi River. As such, the hydraulic model includes a fictitious storage area to receive this interbasin flow transfer.

4.1.1 Geometry

A digital elevation model (DEM) obtained from the USGS National Elevation Dataset (NED) was utilized to develop cross-section geometry. This DEM was developed using LiDAR data, and has a horizontal cell size of one-ninth arc-second (i.e. approximately 10 foot). A channel was cut into each cross-section, as LiDAR data typically does not penetrate the water surface. The cross-sections within the Pond (i.e. between the Dewing Road crossing and the Dam), were based on the transects collected by Acoustic Doppler Current Profiler (ADCP) data collected in the field. The channel geometry for the remaining cross-sections was generally based on channel depths surveyed at each bridge, the channel slopes suggested by the DEM, and engineering judgement.

The Lake was modeled as a storage area for which the storage-elevation relationship was based on multiple sources. A depth chart of the Lake from 1972 was used to develop the storage volume for elevations up to 435 feet, while the DEM was used to develop the storage volume for elevations starting at 435 feet. While the depth chart was obtained from the VTDEC website, it appears a newer version is now available on the website. The newer depth chart appears to generally conform with the 1972 version. Since the differences are not expected to greatly impact the hydraulic model results (even considering a dambreak), a sensitivity analysis was not performed. The stage-storage curve utilized in the model is provided in tabular format within Appendix C. Note that the stage-storage curve goes up to elevation 450.0 feet which is well above the peak water level in the Lake during the most extreme event evaluated (the PMF).

As previously mentioned, portions of the left embankment crest were found to be potentially lower than the left abutment crest. The hydraulic model assumes that the left earthen embankment crest is no lower than the left abutment crest elevation, to provide conservative estimates of downstream impacts due to a breach of the Dam. The composite weir coefficient for the stoplog bays and spillway crest varies from 2.8 under a WSEL of 434.8 feet to 3.3 for WSELs equal to or above 436.2 feet. A composite weir coefficient of 3.2 was utilized in the model, which corresponds to a WSEL of 436.0 feet (crest elevation of the right abutment). As such, the model may slightly underestimate the peak WSEL at the Dam for events less than or equal to the 500-year event and may slightly overestimate the peak WSEL at the Dam for events such as the 0.5 PMF and PMF.

The hydraulic model considered the top of deck at the bridges to be equal to the top of the guardrail within the hydraulic model. This was done to account for debris blockages between the roadway and guardrail, which would greatly reduce the hydraulic capacity of the opening between the top of deck and bottom of guardrail.

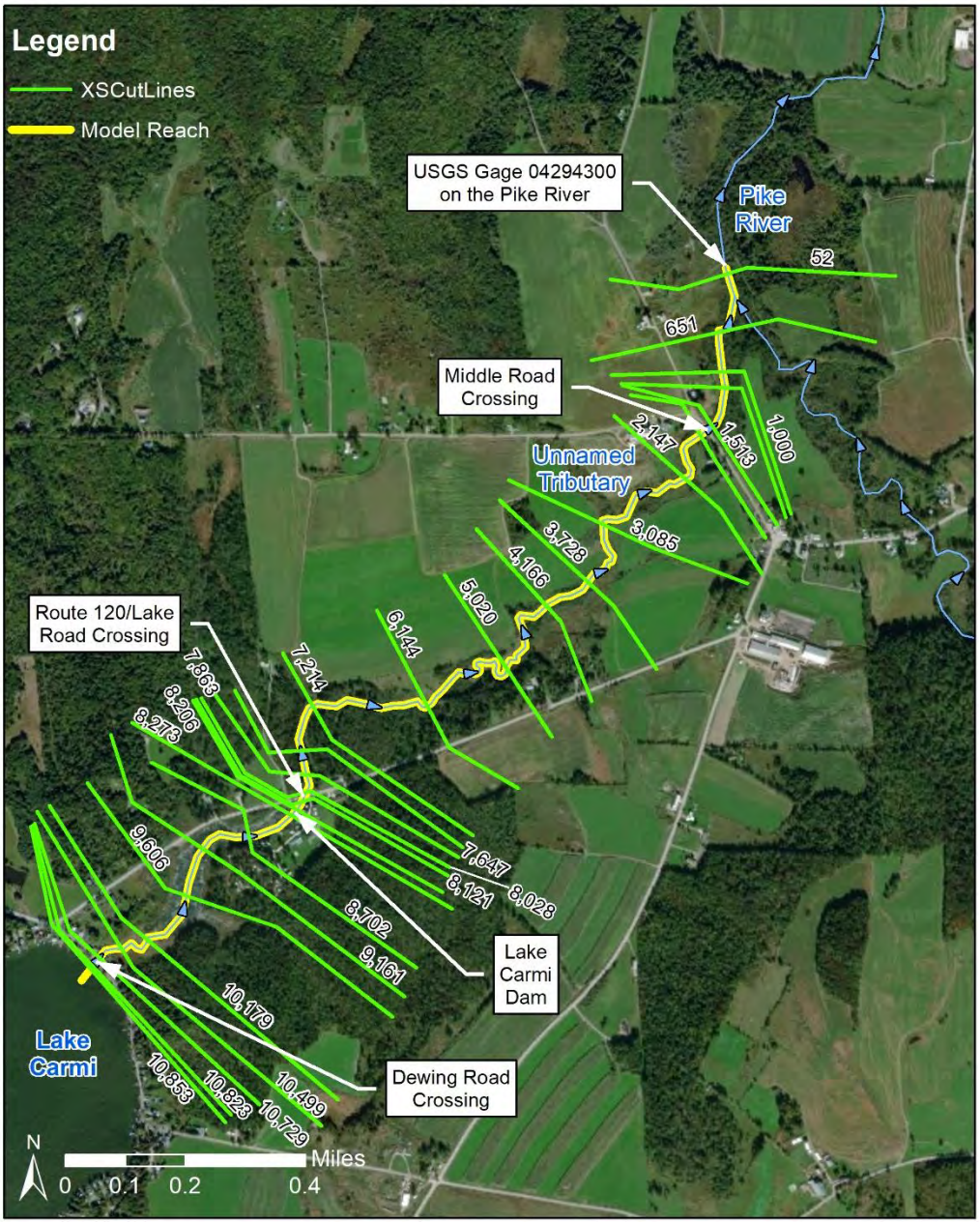

Figure 4-1: Overview of Cross-Section Layout

4.1.2 Boundary Conditions

Inflow hydrographs were entered in the hydraulic model at either the Lake, or approximately 550 feet downstream of Dewing Road, to appropriately evaluate flow results from each of the subbasins utilized in the hydrologic model. It should be noted that the 2 cfs/mi^2, utilized as a baseflow in the hydrologic model, was used as the sunny day flow from each subbasin for hydraulic modeling.

The hydraulic model also considers coincident flows from the drainage area downstream of the Dam (including from the Pike River upstream of its confluence with the unnamed tributary). The coincident inflows were entered as steady flow hydrographs at the confluence of the Pike River and unnamed tributary. The coincident flow magnitude was based on the discharges weighted at the gage (see Table 3-2) prorated by the difference in drainage area between the Dam and the gage (22.3/34.6). It should be noted that the coincident flow for a 500-year event was utilized as the coincident flow for events larger than the 500-year flood (e.g. 0.5 PMF, PMF). This was done as it is unlikely that larger storms events would scale in the same fashion as smaller events, considering the storm size selected during PMF computations was only 25 mi^2.

The downstream boundary was developed based on the rating curve at the gage developed by the USGS. This rating curve was retrieved on 2/28/2018 (Rating ID: 6.0), and only provides discharge estimates between 0.5 cfs and 1,180 cfs. As such, the rating curve was extrapolated using engineering judgement to cover the range of flows being analyzed. Figure 4-2 shows the USGS rating curve, along with the extrapolated portion of the rating curve.

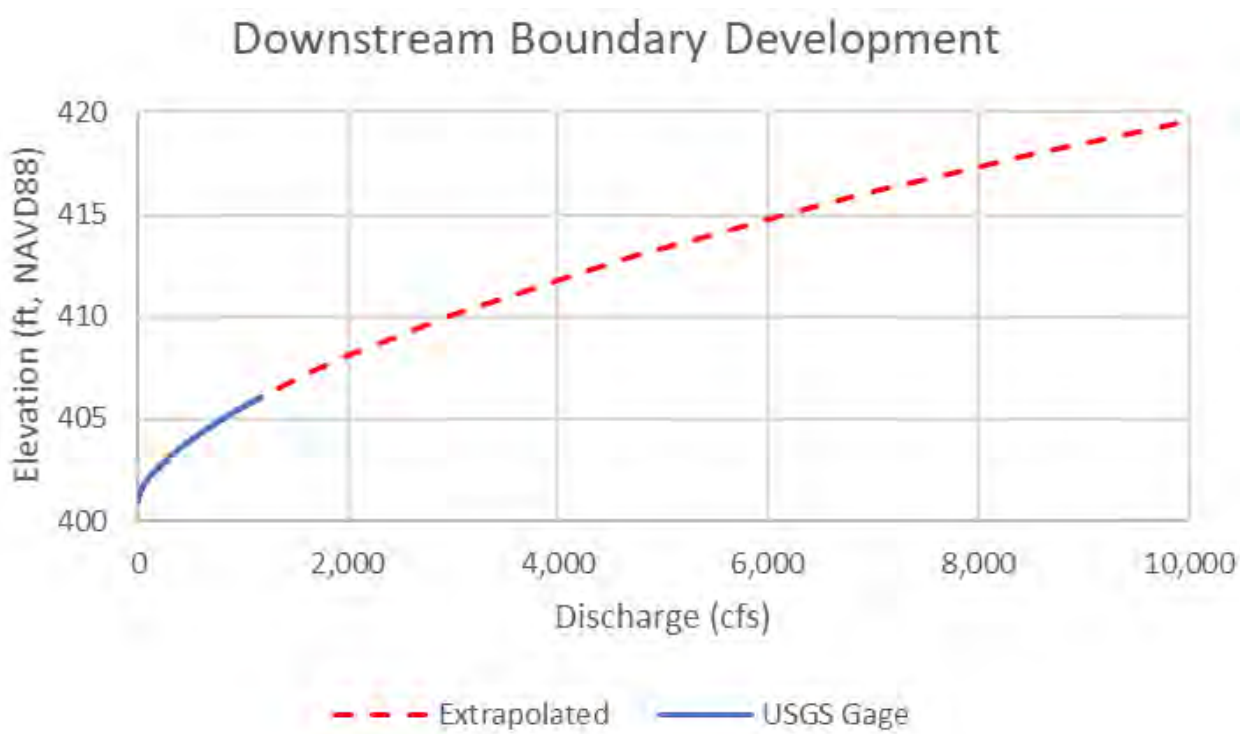

Figure 4-2: Discharge Rating Curve for Downstream Boundary

The model also considers the potential for interbasin flow transfer as water could exit the southern side of the Lake and flow towards the Missisquoi River. A fictitious storage area was developed to receive this flow, and a storage area connection was used to model the interbasin flow transfer. The storage area connection consists of a weir which reflects the elevation of the saddle on the southern side of the Lake where interbasin flow transfer would occur. The low point of the saddle is approximately at elevation 436.55 feet and corresponds with Causway Road in the Lake Carmi State Park. A weir coefficient of 0.35 was utilized in the model, which falls within the suggested range (0.2 – 0.5) for non-elevated overbank areas, as published in the HEC-RAS 2D modeling user's manual (USACE, 2016).

4.1.3 Breach Parameters

Breach analyses were done for the sunny day flow and a series of high flows between the 100-year flow and the PMF. Federal Energy Regulatory Commission Engineering Guidelines were used to develop the breach parameters outlined in Table 4-1. Consistent with these guidelines, for concrete gravity structures, the breach side slopes were assumed to be vertical. The average breach width is suggested to be 1 or more monoliths wide, but usually less than half of the total structure. This study conservatively assumed nearly half of the 81-foot-long spillway failed. The suggested time to failure for a concrete gravity structure is between 0.1 and 0.3 hours, for which this study utilized the median value of 0.2 hours. The bottom elevation of the breach was based on the lowest channel elevation surveyed immediately downstream of the Dam. Finally, the failure was conservatively initiated at the peak headwater for the Dam, during which time the largest volume of water is stored behind the Dam.

Table 4-1: Breach Parameters

Parameter	Value
Side Slopes (H:V)	0H:1V
Average Width (ft)	40
Time to Failure (hrs)	0.2
Bottom Elevation (ft)	426.4
Failure Initiated	Peak Headwater at Dam

4.1.4 Parameter Sensitivity

Due to the presence of a double peak in the flow hydrograph at the Dam, a sensitivity analysis was performed on the timing of the failure for the 100-year event. Breach A analyzed a breach of the Dam at the first peak (i.e. overall highest peak), while Breach B analyzed a breach of the Dam at the second peak. The results show that the peak WSELs were generally the same, with a few cross-sections immediately upstream of the Middle Road Crossing exhibiting a peak WSEL approximately 0.1 feet lower under the Breach B scenario. This supports the conclusion that the overall peak should be used as the condition to initiate the breach.

4.2 Hydraulic Results

Under all dam break scenarios, the incremental rise in WSEL at the downstream end of the hydraulic model (at the gage) was less than 1 foot, confirming the hydraulic model does not need to be extended further downstream. Water is expected to overtop Causway Road, leaving the basin and flowing towards the Missisquoi River for events in excess of the 500-year event, as the peak water surface in the Lake is expected to be 436.4 feet (i.e. approximately 0.15 feet below Causway Road) under the 500-year event.

4.2.1 Potentially Impacted Structures

To evaluate the potential impact at bridges, the lowest road centerline elevation at each bridge was identified from Table 2-2, Table 2-3, and Table 2-4. Similarly, the crest elevation of the right abutment (see Table 2-1) was used to evaluate impacts at the Dam, as it represents the point at which the spillway capacity has been exceeded. In addition to evaluating impacts at the Dam and bridges, the impacts at residences were also considered. To evaluate potential impacts to downstream residential structures under breach and non-breach conditions, the lowest ground elevation in the immediate vicinity of residential structures (the four corners of each building were checked) within the floodplain was used as a surrogate for the lowest livable floor of each structure. While the first floor is usually located above

grade, this estimation of lowest livable floor would not be conservative if the basement provides livable space. If multiple structures were identified near the same cross section, only the most critical structure (i.e. lowest estimated ground elevation) was evaluated. Table 4-2 shows that the only structures for which this elevation was exceeded under PMF conditions considering a breach (PMF plus Breach) were located on the right bank between the Dam and State Route 120 (Lake Road), as identified in Figure 4-3. These structures were assumed to be impacted at an elevation of 434 feet. Table 4-3 provides information pertaining to the peak WSEL at these residences, as well as at the Dam and each bridge for various events. The depth inundated column refers to the lowest overtopping elevation for bridges and the right abutment for the Dam.

Table 4-2: Peak WSEL at Residences under PMF plus Breach

Residence	Distance Downstream of Dam (ft)	Ground Elevation (ft)	Peak WSEL with a Breach (ft)	Depth of Flooding (ft)
A*	35	434.0	437.9	+3.9
B	380	437.0	431.1	-5.9
C	3,220	438.0	428.3	-9.7
D	4,075	443.0	428.1	-14.9
E	6,095	432.0	428.1	-3.9
F	6,595	431.0	428.0	-3.0
G	6,730	441.0	417.5	-23.5

Note: The lowest ground elevation in the immediate vicinity of residential structures is used to evaluate the depth of flooding. (+) values indicate depth of flooding, (-) values indicate how far the water is below the elevation at which flooding is assumed to begin.

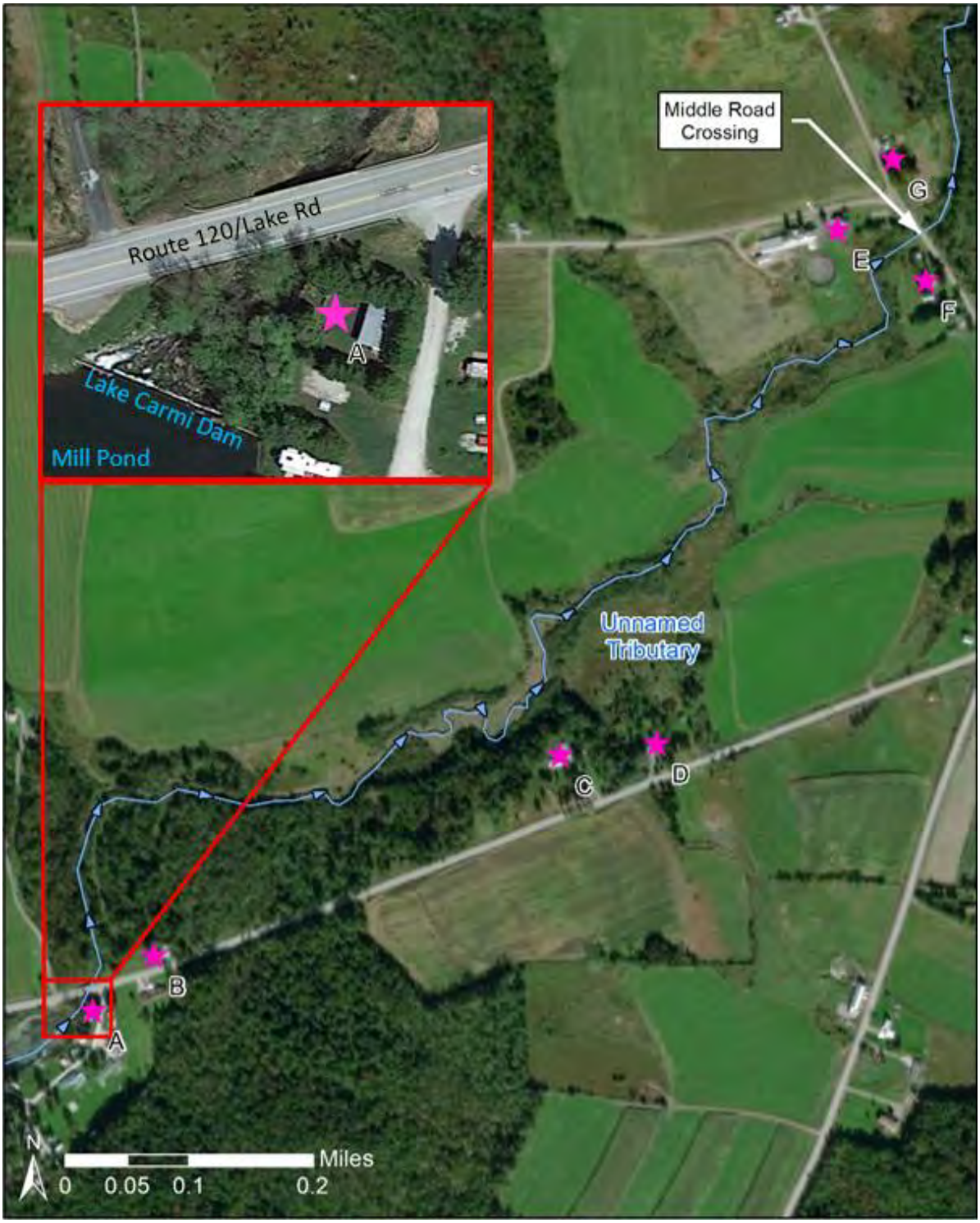

Figure 4-3: Overview of Residences

Table 4-3: Hydraulic Results at Significant Structures for Various Events

Event	Structure	Without a Breach			With a Breach			
		Peak WSEL (ft)	Depth of Flooding (ft)[1]	Structure Velocity[2] (ft/s)	Peak WSEL (ft)	Depth of Flooding (ft)[1]	Structure Velocity[2] (ft/s)	Peak WSEL Diff. (ft)
100-Year	Dewing Rd	436.0	-3.4	0.5	436.0	-3.4	0.5	0.0
	Lake Carmi Dam	435.5	-0.5	0.3	435.5	-0.5	0.3	0.0
	Residence A	427.3	-6.7	-	430.1	-3.9	-	2.8
	Route 120/Lake Rd	426.9	-7.8	2.0	430.0	-4.7	4.3	3.1
	Middle Rd	416.8	-6.2	1.3	419.0	-4.0	1.0	2.2
500-Year	Dewing Rd	436.4	-3.0	0.6	436.4	-3.0	0.7	0.0
	Lake Carmi Dam	435.7	-0.3	0.4	435.7	-0.3	0.4	0.0
	Residence A	427.6	-6.4	-	430.4	-3.6	-	2.8
	Route 120/Lake Rd	427.4	-7.3	2.3	430.3	-4.4	4.4	2.9
	Middle Rd	419.7	-3.3	1.0	420.9	-2.1	0.8	1.2
0.5 PMF	Dewing Rd	438.6	-0.8	1.1	438.6	-0.8	1.1	0.0
	Lake Carmi Dam	437.3	1.3	1.7	437.3	1.3	1.7	0.0
	Residence A	431.2	-2.8	-	433.9	-0.1	-	2.7
	Route 120/Lake Rd	431.2	-3.5	4.6	433.8	-0.9	4.6	2.6
	Middle Rd	425.6	2.6	1.3	426.1	3.1	1.6	0.5
0.70 PMF	Dewing Rd	439.5	0.1	0.4	439.5	0.1	0.4	0.0
	Lake Carmi Dam	437.7	1.7	2.3	437.7	1.7	2.3	0.0
	Residence A	433.6	-0.4	-	435.7	1.7	0.3	2.1
	Route 120/Lake Rd	433.5	-1.2	4.6	435.7	1.0	3.5	2.2
	Middle Rd	426.6	3.6	2.0	427.0	4.0	2.3	0.4
PMF	Dewing Rd	440.8	1.4	0.7	440.8	1.4	0.7	0.0
	Lake Carmi Dam	438.3	2.3	3.2	438.3	2.3	3.2	0.0
	Residence A	437.3	3.3	0.4	437.9	3.9	0.4	0.6
	Route 120/Lake Rd	437.3	2.6	3.3	437.9	3.2	3.2	0.6
	Middle Rd	427.8	4.8	3.0	428.0	5.0	3.1	0.2

Notes:

1. *Depth of flooding is based on the lowest deck elevation at each bridge, the lowest abutment elevation at the Dam, and the ground elevation identified for each residence. A negative value indicates the depth for which the water surface is below the identified structure elevation, while a positive value indicates the depth for which the structure is flooded.*
2. *Velocities at the road crossings and the Dam are recorded as channel velocity. Velocity at Residence A is recorded as right overbank velocity.*

5. Dam Assessment

5.1 Hazard Classification and Spillway Design Flood

Based on recent discussions with VTDEC staff, as shown in Table 5-1, VTDEC has three (3) hazard classifications that they currently use to classify dams and an associated range of Spillway Design Floods (SDF) for each hazard classification. These hazard classifications and the range of SDFs are based on the US Army Corps of Engineer's manual, ER 1110-2-106, dated September 26, 1979. The hazard classifications are not formal VTDEC policies but are the standards that have historically been applied and will be used as a guide for determining the hazard classification and SDF for the Dam, for this study.

Table 5-1: VTDEC Hazard Classification and Inflow Design Flood Requirements

Hazard Classification	Description	Typical Spillway Design Flood
Low	Dams where failure is not expected to cause loss of life and only minimal property damage. This is typically interpreted as meaning the no inhabited structures are impacted and only rural, lightly traveled roads might be impacted.	100-year
Significant	Dams where failure is expected to cause loss of few lives and appreciable damage to homes, industrial or commercial facilities, secondary highways, or railroads. This is generally interpreted as less than 6 lives or 2 or fewer structures impacted.	100-year to 0.5 PMF
High	Dams where failure is expected to cause loss of more than a few lives and excessive damage to homes, industrial or commercial facilities, important public utilities, main highways, or railroads. Failure would likely result in the loss of more than 6 lives, and/or damage more than 3 homes.	0.5 PMF to PMF

In addition to the hazard classification and design storms shown in Table 5-1, VTDEC typically requires at least 3.0 feet of freeboard be maintained at normal pool and 1.5 feet of freeboard during the peak SDF conditions. It should be noted, that under normal pool conditions the Dam has about 1.2 feet of freeboard and does not meet the normal pool freeboard requirement.

As part of the dam break analysis an incremental damage assessment (IDA) was completed that assessed the failure of the Dam under a range of floods from the 100-year flood to the PMF, as shown in Table 4-3. Based on the results of the dam break analysis and IDA presented in Section 4.2, when compared to VTDEC's guidelines outlined in Table 5-1, the results suggest that differing hazard classifications could be assigned based on the interpretation and application of engineering judgement for the Dam.

On one hand, under the 0.7 PMF scenario, the breach of the Dam causes Residence A (See Figure 4-3) to go from not being impacted to potentially being impacted by approximately 1.7 feet of water and causes the bridge at Route 120, classified as a Major Collector by VT AOT, to also go from not being overtopped

to being overtopped by approximately 1.0 feet of water. With one residence and one Major Collector potentially impacted, one could conclude that the Dam is Significant Hazard.

On the other hand, based on US Department of the Interior Bureau of Reclamation Assistant Commissioner – Engineering and Research Technical Memo 11 (ACER TM-11) the depth (1.7 feet) and velocity (0.3 fps) at Residence A during the 0.7 PMF plus breach would suggest that the potential for loss of life at the residence is low. A depth of 1.7 feet and a velocity of 0.3 fps puts Residence A in the "low danger zone" for houses built on foundations, mobile homes, and adults, and in the "judgement zone" for children. Also, Route 120 adjacent to the impoundment (regardless of breach) would be flooded by approximately 1.7 feet of water meaning that the road would likely be closed due flooding before a breach occurs. Also, the storm under which impacts are seen (0.7 PMF) is above the range of SDFs for a Significant Hazard dam in VT. Considering this, an argument could be made to classify the Dam as a low hazard structure.

If the Dam were considered Low Hazard, the SDF would be the 100-yr event. Under the 100-yr flood plus breach the incremental increases downstream of the Dam range from 2.2 feet to 3.1 feet in the studied reach, however, there are no incremental impacts to roads or habitable structures caused by the breach. During the 100-yr event, there were no overtopping impacts under either breach or no breach conditions at downstream roads and structures.

Based on discussions with VTDEC staff, it was decided that considering the low velocities under the 0.7 PMF plus breach and the fact that Route 120 will be flooded under the 0.7 PMF plus breach regardless of the Dam breaching or not, and the lack of incremental impacts under the 100-year plus breach event, classifying the Dam as Low Hazard and assigning it an SDF equal to the 100-year event is appropriate.

The HEC-RAS hydraulic modeling results for the sunny day and 100-year SDF are summarized in Table 5-2. As shown, currently the Dam has 0.5 feet of freeboard under the 100-year SDF and 1.2 feet of freeboard at normal pool. As such, the Dam does not currently meet either of the VTDEC freeboard requirements which require 1.5 feet of freeboard under the SDF and 3.0 feet of freeboard at normal pool.

Table 5-2: Existing Condition Hydraulic Summary

Structure	Event	Top of Dam (ft)	WSEL (ft)	Freeboard (ft)	VTDEC Required Freeboard (ft)	Difference (ft)
Lake Carmi Dam	Sunny Day Normal Pool	436.0	434.8	1.2	3.0	-1.8
	SDF (100-yr)	436.0	435.5	0.5	1.5	-1.0

5.2 Inundation Mapping

Inundation mapping was developed for the Sunny Day plus breach and 100-year plus breach scenarios. These scenarios were selected to bracket the potential impacts due to a breach of the Dam from normal conditions to the SDF condition. The inundation extents were not extended upstream on the Pike River, as this area was not included within the model and the incremental impacts in this area are expected to be minimal. In addition to the inundation extents, the map also provides information for select locations regarding the peak flow and stage, incremental rise due to a breach, and time to wave arrival and peak

stage. Times are referenced from the initiation of the breach. The time to wave arrival was determined as the time when the incremental rise reached one (1) foot, or 25% of the maximum incremental rise (i.e. if the maximum incremental rise was less than one (1) foot). Flows were rounded to the nearest 10 cfs, while depths/elevations were rounded to the nearest 0.1 foot, and times to the nearest five (5) minutes. The inundation map can be found in Appendix C.

6. Alternatives Analyses

Based on the HEC-RAS hydraulic modeling, the Dam can pass the low hazard SDF (100-yr) event through the existing spillway without overtopping. The analysis found that there would be approximately 0.5 feet of freeboard during the SDF event and 1.2 feet of freeboard at normal pool. VTDEC typically requires at least 3.0 feet of freeboard be maintained at normal pool and 1.5 feet of freeboard under the SDF. As such, the Dam does not meet either the SDF or normal pool freeboard requirements. The following five (5) conceptual design alternatives were evaluated for the Dam to address the lack of freeboard:

- **Alternative 1:** Evaluated taking no action and leaving the Dam in its existing condition. If nothing is done to improve the Dam it will not meet VTDEC's dam safety requirements.
- **Alternative 2:** Evaluated installing overtopping protection with no hydraulic improvements to the spillway. Under this alternative overtopping protection would be used in-lieu of meeting the freeboard requirements to reduce risk of overtopping failure.
- **Alternative 3**: Evaluated lowering the spillway crest from 434.6 feet to 432.75 feet. Alternative 3 meets both the SDF freeboard requirement and the normal pool freeboard requirement.
- **Alternative 4:** Evaluated lowering the spillway crest from 434.6 feet to 433.75 feet. Alternative 4 meets the SDF freeboard requirement but not the normal pool freeboard requirement.
- **Alternative 5:** Evaluated removal of the Dam.

Herein, the normal pool is defined as the water level under normal flow conditions and not the spillway crest elevation. Based on the hydrologic and hydraulic analyses described in Sections 3 and 4 above, under the normal flow (or sunny day) condition there is a baseflow of approximately 25 cfs at the Dam which results in a normal pool elevation of approximately 434.8 feet. This is 0.2 feet above the Dam's spillway crest elevation.

6.1 Alternative 1 – No Action

Alternative 1 consists of leaving the Dam and spillway in their current configuration. Hydraulically, the existing spillway can pass the SDF event without overtopping the Dam but does not meet either of the VTDEC freeboard requirements.

The VTDEC freeboard requirements are established to provide a factor of safety against the Dam overtopping that could lead to dam failure. The existing spillway has approximately 0.5 feet of freeboard during the SDF event and approximately 1.2 feet of freeboard at normal pool, which does not meet the 1.5 feet SDF and 3.0 feet normal pool freeboard requirements, respectively.

Leaving the Dam in its existing configuration does not change either the Lake's or the Pond's normal pool elevations or impact water surface elevations at Dewing Road, Route 120/Lake Road, or Middle Road. While there would be no construction costs associated with Alternative 1, the Dam would still not meet VTDEC dam safety requirements. Although this alternative does not include hydraulic improvements to the Dam or spillway, maintenance of the Dam would still be required. Specifically, observed concrete

deterioration would need to be monitored or repaired and the cause of apparent settlement along the earthen embankment investigated. Also, based on discussions with VTDEC staff, the low-level outlet is inoperable. An investigation of the low-level outlet structure would be required to evaluate if the structure should be repaired or replaced. The pros and cons for Alternative 1 are summarized in Table 6-1.

Table 6-1: Alternative 1 Pros and Cons

Pros	Cons
• No construction costs. • The water surface elevations at Dewing Road, Route 120/Lake Road, and Middle Road would not change during the SDF event.	• Would not meet VTDEC SDF or normal pool freeboard requirements and risk of overtopping failure would remain. • Maintenance would still be required to address deteriorated concrete, embankment settlement and overgrown vegetation

6.2 Alternative 2 – Overtopping Protection (No Hydraulic Improvements)

Alternative 2 consists of leaving the spillway in its current configuration with no hydraulic improvements and providing overtopping protection in lieu of meeting the freeboard requirements. Hydraulically, the existing spillway can pass the SDF without overtopping but does not meet the VTDEC freeboard requirements, therefore, for this alternative the concrete spillway will be left "as-is" and overtopping protection installed along the left earthen embankment and right and left groin areas to reduce the risk of dam failure due to overtopping. Observed concrete deterioration would need to be monitored or repaired. Based on discussions with VTDEC staff, the low-level is inoperable. An investigation of the low-level outlet structure would be required to evaluate if the structure should be repaired or replaced, and VTDEC would need to evaluate whether they want to permanently "plug" the stoplog bays under this alternative (Note: we did not include "plugging" the stop log bays in the OPCC for this alternative).

Overtopping protection of the earthen embankments and groin areas could be provided with rip-rap, articulated concrete blocks, or synthetic turf to protect them from erosion during an overtopping event. As shown in Figure 6-1, the overtopping protection would be installed along the left earthen embankment and the groins on the right and left sides of the Dam. On the right side, the concrete abutment appears to intersect with natural grade and therefore there is no embankment on the right side that would require overtopping protection. This would need to be verified with a detailed topographic survey of the Dam and surrounding areas. On the downstream side of the Dam, overtopping protection would be required along the groin to help protect against head cutting as water re-enters the channel. On the left side of the Dam, the groin protection will extend down to the water's edge. On the right side of the Dam, there is an existing stone wall approximately half-way down the slope. Assuming the existing stone wall is structurally sound, overtopping protection could terminate at the stone wall. The structural integrity of the stone wall would need to be verified to make this determination. The extent of the overtopping protection on the left embankment is limited by Route 120/Lake Road and would protect the 1 to 2-foot-high embankment that extends from the left concrete abutment. See Figure 6-1 for the approximate extents of the overtopping protection for the Dam.

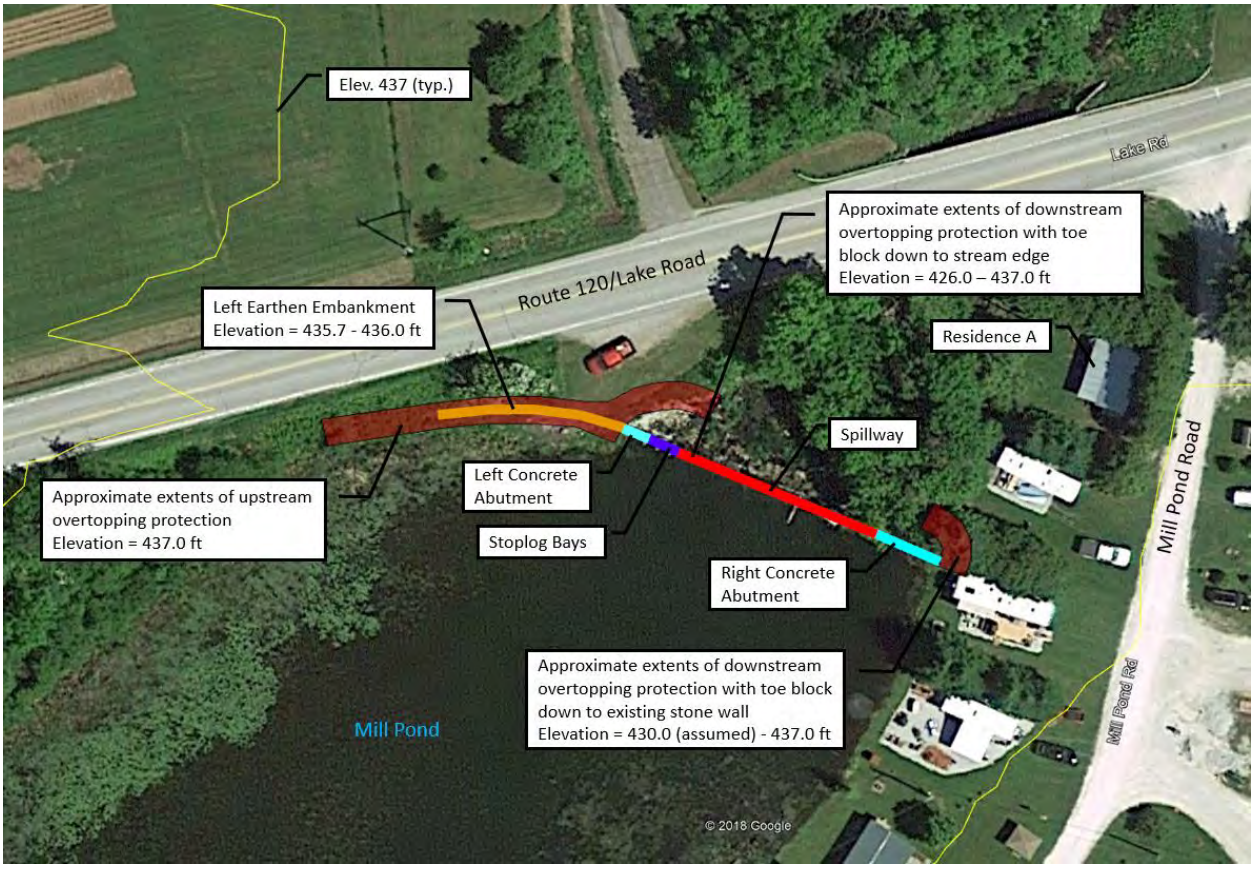

Figure 6-1: Alternative 2 Plan View Extents

Leaving the Dam in its existing hydraulic configuration does not affect either the Lake's or the Pond's SDF or normal pool elevations, or the peak flood elevations at Dewing Road, Route 120/Lake Road, or Middle Road during the SDF event. The overtopping protection described is conceptual and would require that a complete engineering design be completed. The design of overtopping protection would require additional investigations, including a detailed topographic survey of the Dam and surrounding areas, a seepage and stability analysis of the embankment and a stability analysis of the concrete gravity section. If the structure is determined to be unstable, providing overtopping protection may not be appropriate. Observed concrete deterioration would need to be monitored or repaired. Based on discussions with VTDEC staff, the low-level outlet is inoperable. An investigation of the low-level outlet structure would be required to evaluate if the structure should be repaired or replaced. The overtopping protection may need to extend beyond property owned by VTDEC and coordination may be required with VT AOT and private property owners to obtain the appropriate easements. Public outreach would likely be required due to the potential impacts to recreational lots along the Pond's edge, near the right abutment.

The conceptual Opinion of Probable Construction Cost (OPCC) for Alternative 2 is approximately $51,000 to $58,000, depending on the overtopping protection material selected. These costs are based on 2018 construction rates and would need to be adjusted if the timeframe were to change. The cost includes mobilization/demobilization, material, concrete repair, and erosion and sediment controls. The cost does not include rebuilding the left embankment and the associated cofferdam and dewater that would go along with such work. This cost includes a 40% contingency due to the level of detail during the conceptual design. See Appendix D for the detailed OPCC estimate for Alternative 2. It should be noted that additional

site investigations (i.e. structural, geotechnical, field survey), engineering design, permitting, environmental studies, and construction management costs are not included as part of this OPCC.

A summary of the potential environmental considerations for the Pond are in Table 6-9 and for the Lake are in Table 6-10. A summary of pros and cons for Alternative 2 is provided in Table 6-2.

Table 6-2: Alternative 2 Pros and Cons

Pros	Cons
• Lowest construction cost option. • The overtopping protection is not expected to affect the normal pool of Lake Carmi or Mill Pond. • The peak flood elevations at Dewing Road, Route 120/Lake Road, and Middle Road would not change during the SDF event.	• The overtopping protection may impact/displace some of the recreational lots on Mill Pond adjacent to the right abutment. • Not as robust an option as increasing the spillway capacity to meet the freeboard requirements. • Easements may be required if overtopping protection extends beyond VTDEC property.

6.3 Alternative 3 – Lower Spillway Crest Elevation to 432.75 feet

Alternative 3 consists of lowering the existing spillway crest elevation by 1.85 feet from 434.6 feet to 432.75 feet and removing the existing stoplog bays, which would increase the crest length from 81 feet to a length of 92 feet. With the increased spillway capacity and lower spillway crest elevation provided under this alternative, the Dam would meet both the VTDEC normal pool and SDF freeboard requirements.

The VTDEC normal pool freeboard requirement specifies that the normal pool water surface elevation be a minimum of 3.0 feet below the top of the Dam. The existing normal pool at the Dam is at elevation 434.8 feet. This is 1.2 feet below the top of the Dam and as such the Dam does not meet the 3.0 feet normal pool freeboard requirement. The VTDEC SDF freeboard requirement specifies that the SDF water surface elevation be a minimum of 1.5 feet below the top of the Dam. The SDF water surface elevation at the Dam is 435.5 feet. This is 0.5 feet below the top of the Dam and as such the Dam does not meet the 1.5 feet SDF freeboard requirement. Based on hydraulic modeling of the Dam, it was determined that the VTDEC normal pool freeboard requirement was the controlling factor with respect to design of the spillway for this alternative.

In addition to modifying the spillway crest to meet the normal pool freeboard requirements, VTDEC has expressed interest in removing the stoplogs bays at the Dam as they have been removed by unauthorized people to lower the pool level in the past. To address this, Alternative 3 would demolish the stoplog bays and lower that section to the new proposed spillway crest elevation of 432.75 feet. The area of the current stoplog bays would become an extension of the spillway crest, increasing the effective length of the spillway from 81 feet to 92 feet. The spillway modifications at the Dam would be limited to the existing concrete spillway and the stoplog bays, leaving the concrete abutments and earthen embankment in place. See Figure 6-2 for the extents of the spillway modifications in Alternative 3.

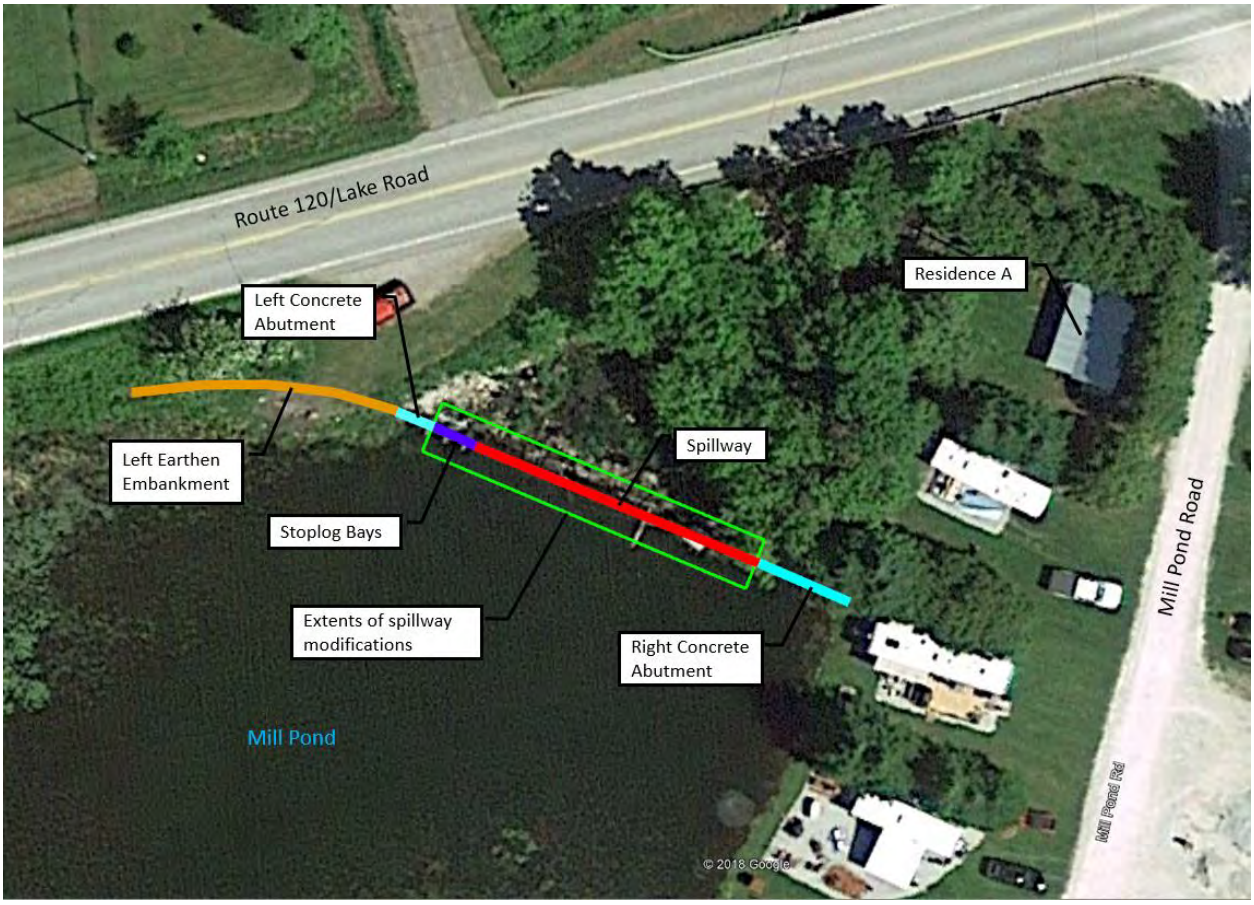

Figure 6-2: Alternative 3 Plan View Extents

As described above, to meet the normal pool freeboard requirement, the spillway crest elevation would need to be lowered to an elevation of 432.75 feet, which is a reduction of 1.85 feet. An elevation view of the Dam is shown in Figure 6-3 with these spillway modifications highlighted (sections to be removed in red). The concrete spillway and stoplog bays would be partially demolished and a new concrete cap poured on the crest at the proposed crest elevation. With the spillway crest modifications, the hydraulic results indicate that the normal pool at the Dam would be lowered 1.9 feet to an elevation of 432.9 feet. This is 3.1 feet below the top of the Dam and as such the Dam would meet the VTDEC 3.0 feet normal pool freeboard requirement. The SDF water surface elevation at the Dam would be reduced to 433.5 feet. This is 2.5 feet below the top of the Dam and as such the Dam would meet the VTDEC 1.5 feet SDF freeboard requirement. The hydraulic results for Alternative 3 are summarized in Table 6-3.

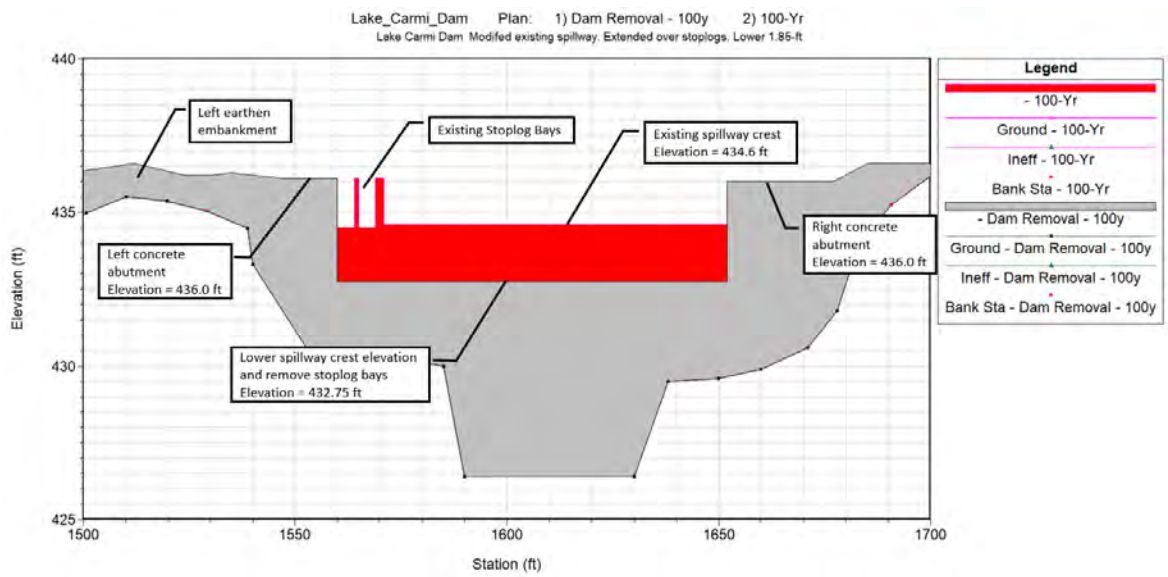

Figure 6-3: Alternative 3 Dam Elevation View with Spillway Modifications

With the Alternative 3 spillway modifications, the Pond's normal pool would be lowered by approximately 1.9 feet to an elevation of 432.9 feet, and the Lake's normal pool would be lowered by approximately 0.9 feet to an elevation of 433.9 feet. During periods of dry weather, the water level in the Lake and the Pond could drop below the calculated normal pool (which is based on the average mean annual flow) to the spillway crest elevation of 432.75 feet. The lower normal pools may negatively impact aesthetics and/or recreation on and around the Pond and the Lake. With changes to the normal pool, environmental studies and permitting may be required to evaluate the effects to wetlands and rare, threatened, and endangered species. A summary of the potential environmental considerations for the Pond and the Lake are included in Table 6-9 and Table 6-10. Under this alternative the peak flood elevations downstream (i.e. near Route 120/Lake Road and Middle Road) during the SDF event are reduced because there is more storage available in the Pond to attenuate flood flows.

Table 6-3: Alternative 3 Hydraulic Summary

Event	Lake Carmi Outlet (Dewing Road)		Lake Carmi Dam		Upstream Route 120/Lake Road		Upstream Middle Road	
	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)
Existing Sunny Day	22	434.8	25	434.8	25	425.3	25	411.8
Proposed Sunny Day	22	433.9	25	432.9	25	425.3	26	411.8
Difference	0	-0.9	0	-1.9	0	0.0	+1	0.0
Existing SDF	206	436.0	235	435.5	235	426.9	230	416.8
Proposed SDF	126	435.4	195	433.5	195	426.7	194	416.0
Difference	-80	-0.6	-40	-2.0	-40	-0.2	-36	-0.8

Under this alternative the existing earthen embankment and concrete abutments would not be modified, however, any observed concrete deterioration would need to be monitored or repaired and the cause of apparent settlement along the earthen embankment would need to be investigated and corrected. Also, based on discussions with VTDEC staff, the low-level outlet is inoperable. An investigation of the low-level outlet structure would be required to evaluate if the structure should be repaired or replaced.

The design of the spillway modifications would require additional investigations including a detailed topographic survey of the Dam and surrounding areas, a seepage and stability analysis of the embankment and a stability analysis of the concrete gravity section. Coordination may be required with VT AOT and private property owners to obtain temporary easements for construction access. A significant amount of public outreach would likely be required due to the changes in the normal pools.

The conceptual OPCC for lowering the spillway crest elevation to 432.75 feet and widening it to 92 feet is approximately $172,000. This cost is based on 2018 construction rates and would need to be adjusted if the timeframe were to change. The cost includes mobilization/demobilization, demolition of stoplog bays, modification of the concrete spillway, concrete resurfacing, cofferdam, water control, and erosion and sediment controls. This cost includes a 40% contingency due to the level of detail during the conceptual design. See Appendix D for the detailed OPCC estimate for Alternative 3. It should be noted that additional site investigations (i.e. structural, geotechnical, field survey), engineering design, permitting, environmental studies, and construction management costs are not included as part of this OPCC.

The pros and cons for Alternative 3 are summarized in Table 6-4.

Table 6-4: Alternative 3 Pros and Cons

Pros	Cons
• Would meet the VTDEC 3.0 feet normal pool freeboard requirement. • Would meet the VTDEC 1.5 feet SDF freeboard requirement. • Would remove the stoplog bays from the Dam. • The peak flood elevations at Dewing Road, Route 120/Lake Road, and Middle Road would be lower during the SDF event.	• Not the lowest construction cost option. • Would lower the normal pool in Mill Pond by approximately 1.9 feet to elevation 432.9 feet which could negatively impact aesthetics, recreation, or wetlands. • Would lower the normal pool in Lake Carmi by approximately 0.9 feet to 433.9 feet which could negatively impact aesthetics, recreation, and wetlands. • During periods of dry weather, the water level in the Lake and the Pond could drop to the spillway crest elevation of 432.75 feet.

6.4 Alternative 4 – Lower Spillway Crest Elevation to 433.75 feet

Alternative 4 consists of lowering the existing spillway crest elevation by 0.85 feet from 434.6 feet to 433.75 feet and removing the existing stoplog bays, which would increase the crest length from 81 feet to a length of 92 feet. This alternative is very similar to Alternative 3 but does not lower the spillway crest as much as that alternative and as a result does not lower the normal pool as much either. By lowering

the spillway crest to 433.75 feet, the Dam meets the VTDEC SDF freeboard requirement but does not meet the normal pool freeboard requirement.

As described in Alternative 3, the Dam does not currently meet either of the VTDEC freeboard requirements. Because it was established that the VTDEC normal pool freeboard requirement was the controlling factor with respect to design of the spillway modifications in Alternative 3, Alternative 4 was evaluated to only focus on the SDF freeboard requirement. Meeting only the SDF freeboard requirement would still provide a factor of safety against overtopping failure but with the added benefit of not lowering the normal pools in the Pond or the Lake as much as in Alternative 3.

As with Alternative 3, VTDEC has expressed interest in removing the stoplogs bays at the Dam as they have been removed by unauthorized people to lower the pool level in the past. To address this, Alternative 4 would demolish the stoplog bays and lower that section to the new proposed spillway crest elevation of 433.75 feet. The area of the stoplog bays will become an extension of the spillway crest, increasing the effective length of the spillway from 81 feet to 92 feet. The spillway modifications at the Dam would be limited to the existing concrete spillway and the stoplog bays, leaving the concrete abutments and earthen embankments in place. See Figure 6-4 for the extents of the spillway modification in Alternative 4.

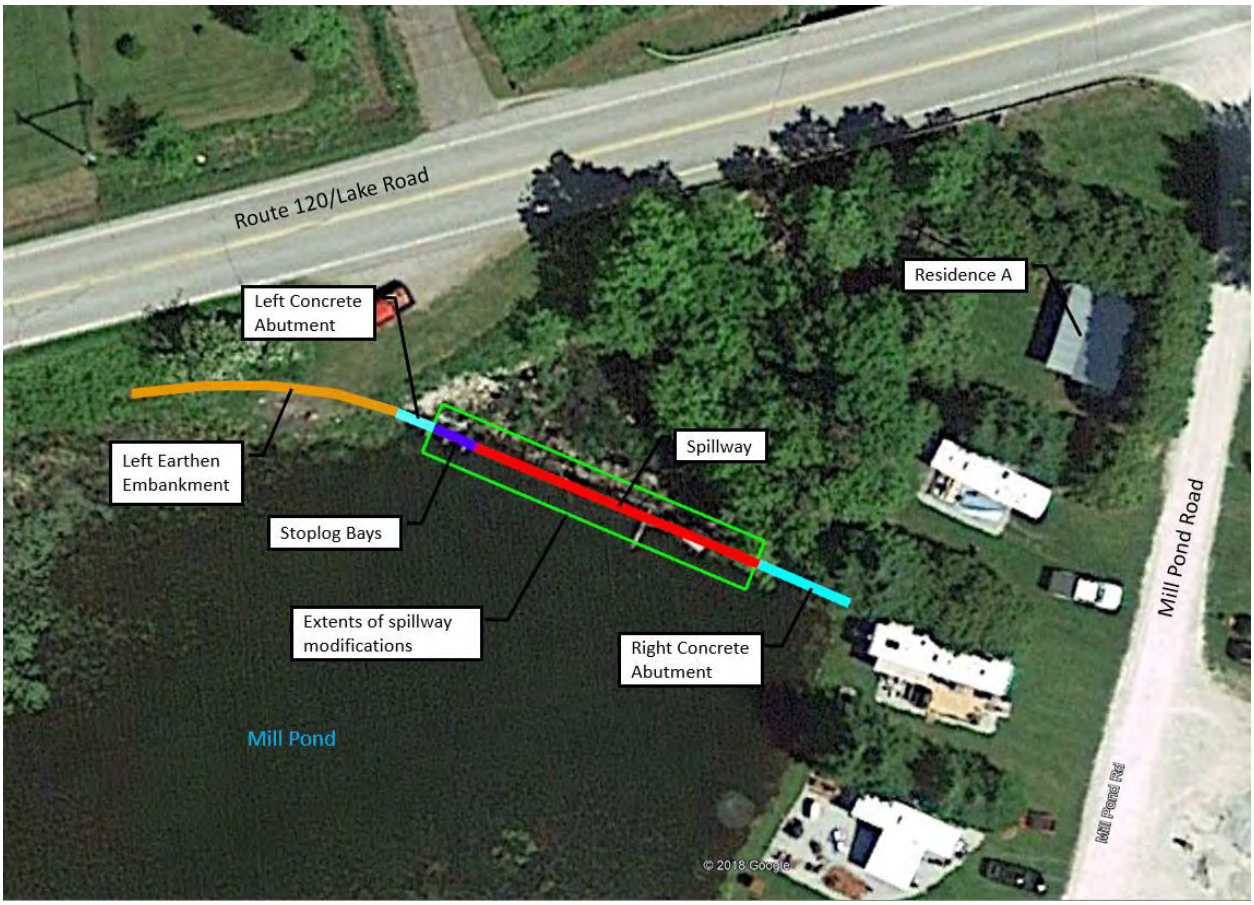

Figure 6-4: Alternative 4 Plan View Extents

As described above, to meet the SDF freeboard requirement, the spillway crest elevation will be lowered to an elevation of 433.75 feet, which is a reduction of 0.85 feet. An elevation view of the Dam is shown in

Figure 6-5 with the spillway modifications highlighted (sections to be removed in red). The concrete spillway and stoplog bays would be partially demolished and a new concrete cap poured on the crest at the proposed crest elevation. With the spillway crest modifications, the hydraulic results indicate that the SDF water surface elevation at the Dam would be lowered 1.0 foot to an elevation of 434.5 feet. This is 1.5 feet below the top of the Dam and as such the Dam would meet the VTDEC 1.5 feet SDF freeboard requirement. The hydraulic results indicate that the normal pool at the Dam would be lowered 0.9 feet to an elevation of 433.9 feet. This is 2.1 feet below the top of the Dam and as such the Dam would not meet the VTDEC normal pool freeboard requirement if this alternative is implemented. The hydraulic results for Alternative 4 are summarized in Table 6-5.

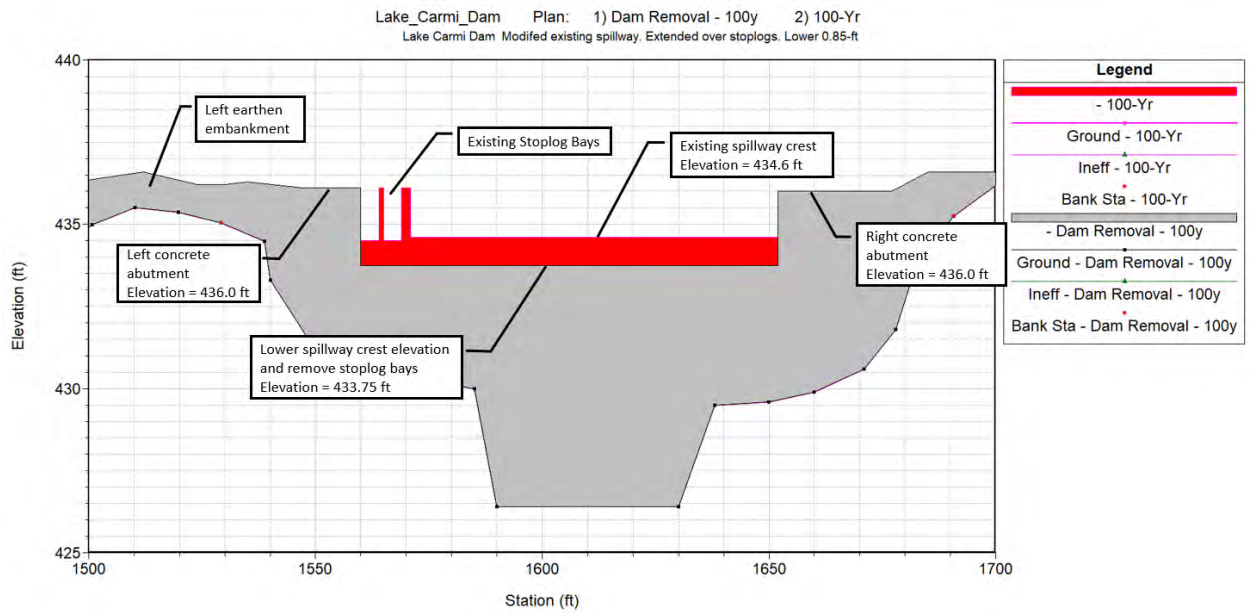

Figure 6-5: Alternative 4 Dam Elevation with Spillway Modifications

With the Alternative 4 spillway modifications, the Pond's normal pool would be lowered by approximately 0.9 feet to an elevation of 433.9 feet, and the Lake's normal pool elevation would be lowered by approximately 0.7 feet to an elevation of 434.1 feet. During periods of dry weather, the water level in the Lake and the Pond could drop below the calculated normal pool (which is based on the average mean annual flow) to the Dam's spillway crest elevation of 433.75 feet. The lower normal pools may negatively impact aesthetics and/or recreation on or around the Pond and the Lake. With the changes in the normal pool, environmental studies and permitting may be required to evaluate the effects to wetlands and rare, threatened, and endangered species. A summary of the potential environmental considerations for the Pond and the Lake are included in Table 6 9 and Table 6 10. When compared to Alternative 3, under this alternative the Pond's normal pool would only be lowered by 0.9 feet compared to 1.9 feet under Alternative 3, which is 1 feet less. Similarly, at the Lake, the normal pool would be lowered by 0.7 feet under this alternative compared to 0.9 feet under Alternative 3, which is 0.2 feet less. Under this alternative the ecological and recreational impacts would be less than those for Alternative 3, but they are still a consideration. Like Alternative 3, under this alternative the peak flood elevations downstream (i.e. near Route 120/Lake Road, or Middle Road) during the SDF event are reduced because there is more storage available in the Pond to attenuate flood flows.

Table 6-5: Alternative 4 Hydraulic Summary

Event	Lake Carmi Outlet (Dewing Road)		Lake Carmi Dam		Upstream Route 120/Lake Road		Upstream Middle Road	
	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)
Existing Sunny Day	22	434.8	25	434.8	25	425.3	25	411.8
Proposed Sunny Day	22	434.1	25	433.9	25	425.3	25	411.8
Difference	0	-0.7	0	-0.9	0	0.0	0	0.0
Existing SDF	206	436.0	235	435.5	235	426.9	230	416.8
Proposed SDF	145	435.6	195	434.5	195	426.7	193	416.0
Difference	-61	-0.4	-40	-1.0	-40	-0.2	-37	-0.8

Under this alternative the existing earthen embankment and concrete abutments would not be modified, however, any observed concrete deterioration would need to be monitored or repaired and the cause of apparent settlement along the earthen embankment would need to be investigated and corrected. Also, based on discussions with VTDEC staff, the low-level is inoperable. An investigation of the outlet structure would be required to evaluate if the structure should be repaired or replaced.

The design of the spillway modifications would require additional investigations including a detailed topographic survey of the Dam and surrounding areas, a seepage and stability analysis of the embankment and a stability analysis of the concrete gravity section. Coordination may be required with VT AOT and private property owners to obtain temporary easements for construction access. A significant amount of public outreach would likely be required due to the changes in the normal pools.

The conceptual OPCC for lowering the spillway crest elevation to 433.75 feet and widening the spillway crest to 92 feet is approximately $152,000. This cost is based on 2018 construction rates and would need to be adjusted if the timeframe were to change. The cost includes mobilization/demobilization, demolition of stoplog bays, modifications of the concrete spillway, concrete resurfacing, cofferdam, water control, and erosion and sediment controls. This cost includes a 40% contingency due to the level of detail during the conceptual design. See Appendix D for the detailed OPCC estimate for Alternative 4. It should be noted that additional site investigations (i.e. structural, geotechnical, field survey), engineering design, permitting, environmental studies, and construction management costs are not included as part of this OPCC.

The pros and cons for Alternative 4 are summarized in Table 6-6.

Table 6-6: Alternative 4 Pros and Cons

Pros	Cons
• Would meet the VTDEC 1.5 feet SDF freeboard requirement. • Would remove the stoplog bays from the Dam. • The peak flood elevations near Dewing Road, Route 120/Lake Road, and Middle Road would lower during the SDF event. • When compared to Alternative 3, the normal pool in Mill Pond and Lake Carmi would not be as low and would have fewer ecological and recreational impacts.	• Alternative 4 is not the lowest construction cost option. • Would not meet the VTDEC 3.0 feet normal pool freeboard requirement with only 2.1 feet of freeboard. • Would lower the normal pool in Mill Pond by approximately 0.9 feet to elevation 433.9 feet which could negatively impact aesthetics, recreation, or wetlands. • Would lower the normal pool in Lake Carmi by approximately 0.7 feet to 434.1 feet which could negatively impact aesthetics, recreation, and wetlands. • During periods of dry weather, the water level in the Lake and the Pond could drop to the spillway crest elevation of 433.75 feet.

6.5 Alternative 5 – Dam Removal

Alternative 5 consists of the removing the Dam. Under this alternative enough of the Dam would be removed such that it is no longer considered jurisdictional by the VTDEC. Dam removal was evaluated as a potential alternative because the Dam does not meet VTDEC freeboard requirements, and the cost to bring the Dam into compliance could be prohibitively high. In addition, there is a movement to remove dams to restore natural flow and sediment transport regimes and improve aquatic organism passage in streams and rivers.

Under this alternative the concrete spillway structure would be demolished down to the bottom of the foundation. The lateral extent of the demolition would be limited to the existing concrete spillway and the stoplog bay area, leaving the concrete abutments and earthen embankments in place. The approximate dam removal extents are shown in Figure 6-6.

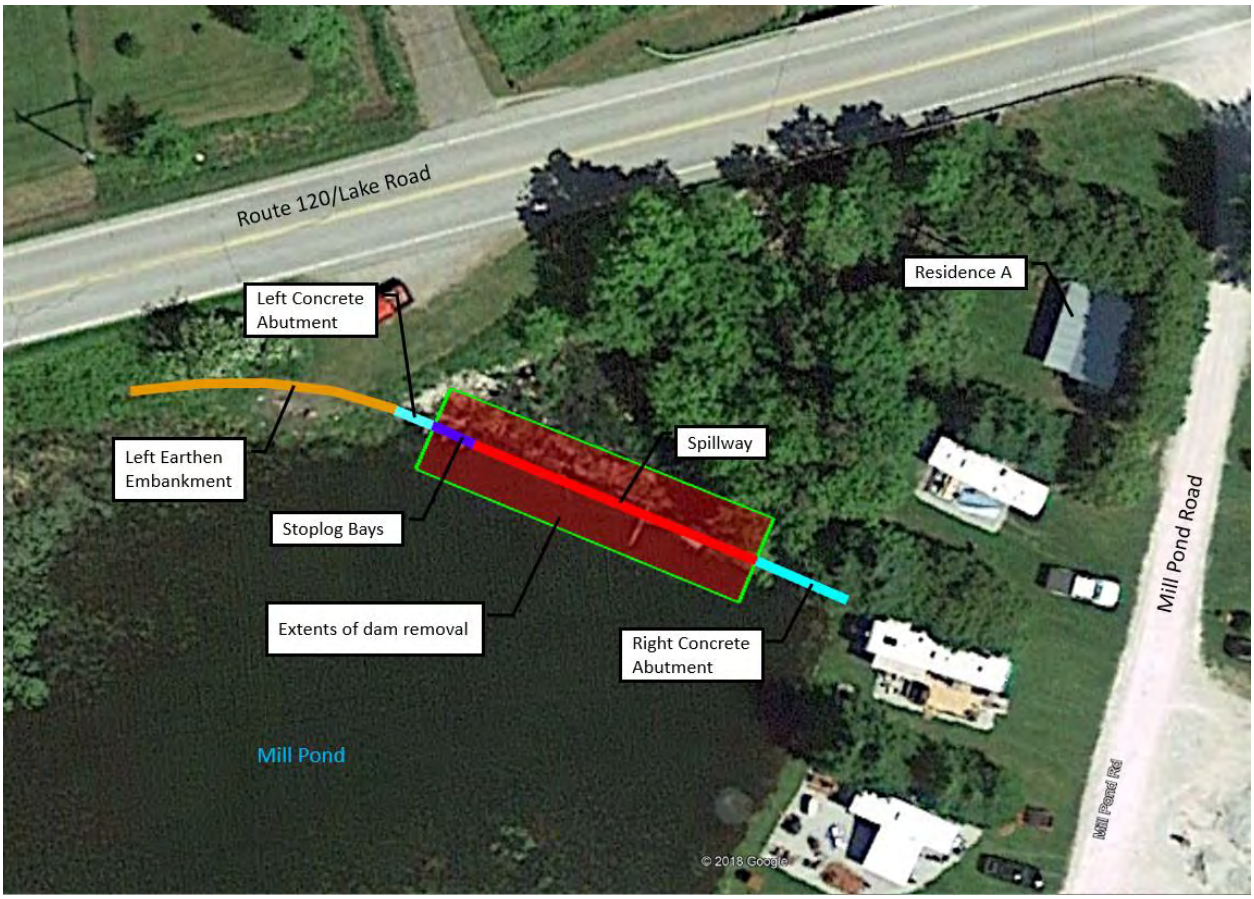

Figure 6-6: Alternative 5 Plan View Extents

The bottom of the Dam foundation elevation, based on the refusal elevation measured during the sediment mapping, is at approximately 425.0 feet. Soil borings and a geotechnical analysis would be required to verify the foundation elevation. The sediment accumulated upstream of the Dam would need to be graded for construction access. During sediment mapping, it was observed that Transect 1 (the closest transect to the Dam) has a depth of approximately 2.5 feet of sediment. An elevation view of the Dam is shown in Figure 6-7.

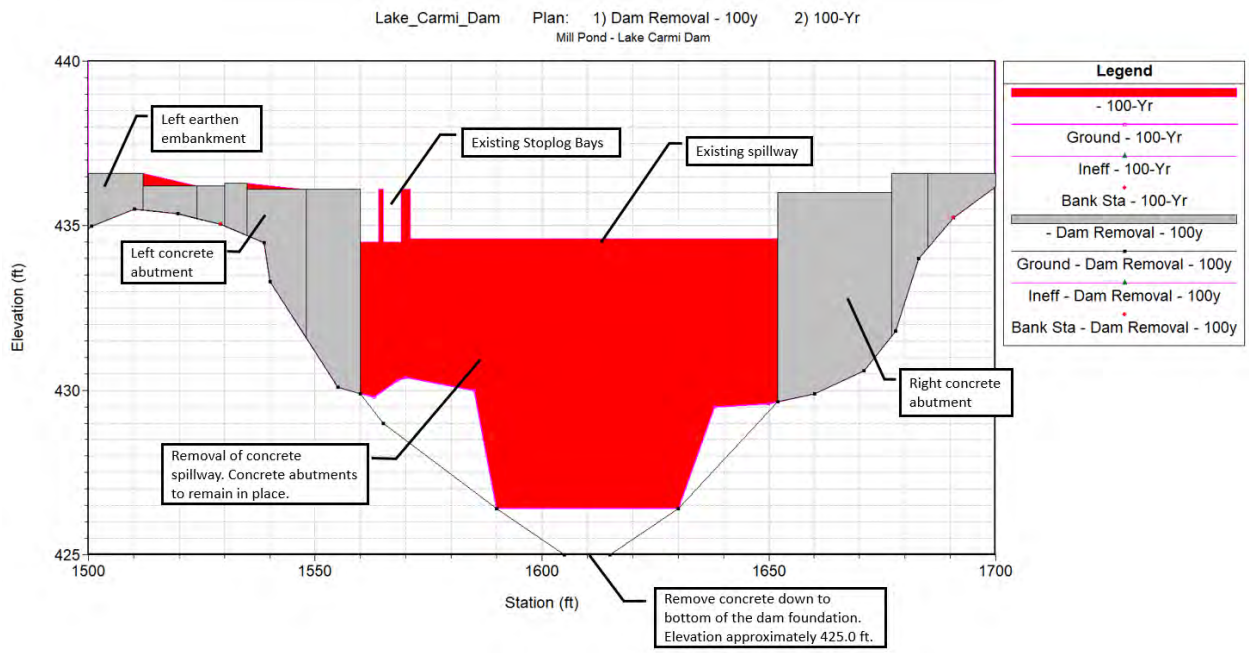

Figure 6-7: Alternative 5 Dam Elevation View with Dam Removal

With the Dam removed, the accumulated sediment has the potential to be mobilized. A new channel is recommended to be graded throughout the Pond from Dewing Road to Lake Road to limit the amount of potential mobile sediment that can flow downstream. The shape of the channel should be hydraulically similar to a natural channel cross section downstream of Lake Road to maintain continuity in the stream. The depth of the channel is limited by the depth to refusal throughout the impoundment and ranges from 1 to 5 feet deep. The depths to refusal (bottom of sediment) compared to the existing depths (top of sediment) are shown in Figure 6-8. As mentioned in Section 2.2, the sediment sample results showed no exceedances of TECs or PECs and the sediment in the Pond presents low ecological risk to freshwater biota. Also, as noted earlier, GSE recommends more sediment samples and testing to have a better sense of the overall sediment quality throughout the Pond. Assuming additional sediment samples yielded similar results as the single sample, and assuming the stream reach downstream of the Dam has the energy to transport the sediment, GSE would recommend allowing the sediments to naturally mobilize following dam removal. However, in our previous experience with dams located in Vermont that also had accumulated sediment with low ecological risk, the owners were still required to dredge a large percentage of the sediment before removing the Dam.

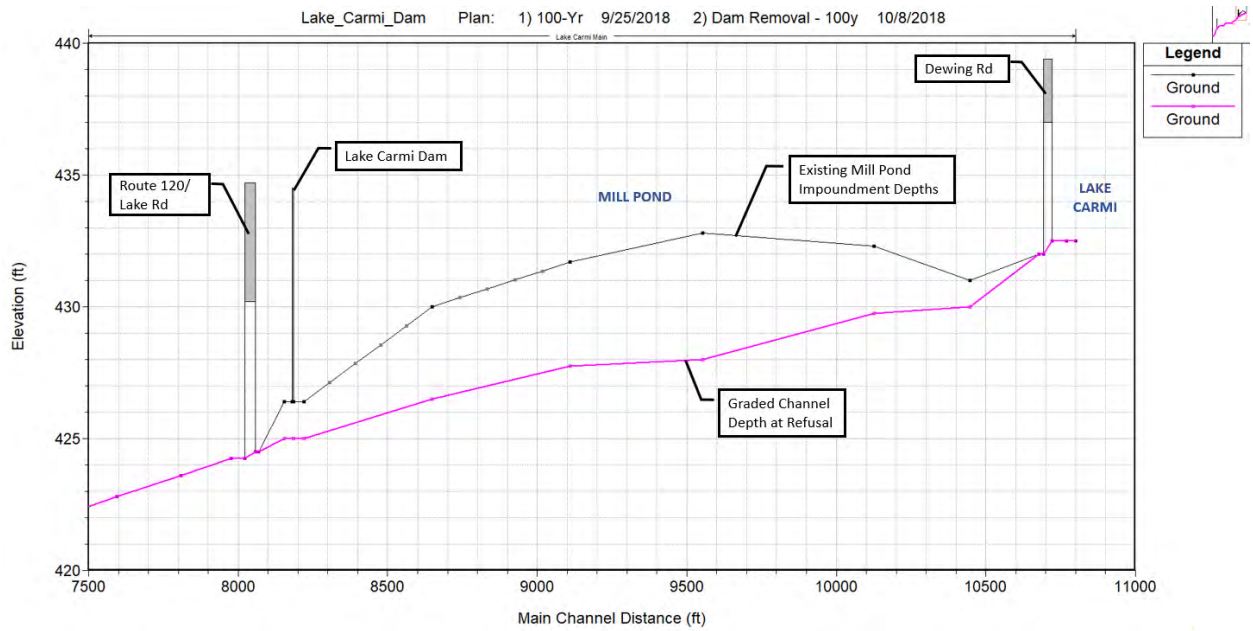

Figure 6-8: Mill Pond Impoundment Bedrock Depths

The hydraulic modeling indicates that with the Dam removed, the SDF WSEL in the Pond would be lowered 8.3 feet to an elevation of 427.2 feet, and the peak flood elevations would be reduced near Dewing Road, Route 120/Lake Road, or Middle Road during the SDF event. With the Dam removed, the Lake's normal pool elevation would be controlled by the channel invert at Dewing Road which is approximately 2.5 feet lower than the existing dam crest elevation. Accordingly, with the Dam removed, the Lake's normal pool would be lowered by approximately 1.7 feet to an elevation of 433.1 feet. During periods of dry weather, the water level in the Lake could drop below the calculated normal pool, which is based on the average mean annual flow, to the channel invert elevation of 432.5 feet at Dewing Road.

The hydraulic modeling shows that the concrete abutments that would remain in place after the Dam is removed do not create any backwater condition during the 100-year storm event and would not impound water under normal low flow periods to create a permanent pool. The Pond would transition from a permanent pool into a channelized stream as it becomes a part of the unnamed tributary downstream of the Lake. With changes in the normal pool WSEL, environmental studies and permitting would be required to evaluate the potential impacts to water quality, wetlands, wildlife, and rare, threatened, and endangered species. The summaries of the potential environmental considerations are included in Table 6-9 and Table 6-10. In addition, with the Lake Carmi normal pool elevation being lowered, other potential impacts would need to be assessed including recreation, and recreation access (boat docks, boat launches), and aesthetics.

In addition to the above, GSE would highly recommend a scour analysis be conducted at the Dewing Rd crossing as the hydraulic control of Lake Carmi WSELs would shift from the Dam to the Dewing Rd crossing with the Dam removed. The potential scouring at the Dewing Road crossing could further impact Lake Carmi WSELs. The hydraulic results for Alternative 5 are summarized in Table 6-7.

Table 6-7: Alternative 5 Hydraulic Summary

Event	Lake Carmi Outlet (Dewing Road)		Lake Carmi Dam		Upstream Route 120/Lake Road		Upstream Middle Road	
	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)	Flow (CFS)	WSE (FT)
Existing Sunny Day	22	434.8	25	434.8	25	425.3	25	411.8
Proposed Sunny Day	22	433.1	25	425.9	25	425.3	45	412.4
Difference	0	-1.7	0	-8.9	0	0.0	+20	+0.6
Existing SDF	206	436.0	235	435.5	235	426.9	230	416.8
Proposed SDF	165	434.6	217	427.2	217	426.8	215	416.5
Difference	-41	-1.4	-18	-8.3	-18	-0.1	-15	-0.3

Further feasibility analyses are needed before dam removal is considered a viable alternative. Additional feasibility steps and steps needed for dam removal are summarized below.

Feasibility Steps (in no particular order):

- Infrastructure Impacts. It is unclear at this juncture if there are any utilities (water, sewer, electrical) located beneath the river or Pond, or near the Dam location. Further consultation with federal, state and local agencies are needed to determine if any utilities could be impacted due to dam removal. As noted above, the hydraulic control would shift to the Dewing Rd crossing. Whereas with the Dam in place velocities are likely very low or negligible at the Dewing Rd crossing, with the Dam removed, velocities will increase. GSE would highly recommend conducting a scour analysis at the Dewing Rd crossing to determine if channel bed scouring could occur and potentially lower the Lake levels further.

- Existing Conditions Plans. An existing condition plan of the Dam and overall impact area is needed. Further survey is needed of the Dam, utilities, roads, access area, etc. and property lines

- Wetlands Delineation. A wetlands delineation of the Pond, and Lake would be needed as removal of the Dam would impact not only the Pond, but also the Lake and tributaries.

- Environmental Assessment. It is possible the agencies would require the following:

    - Water Quality. The Lake has already been closed in the past to cyanobacteria issues. It is unclear if lowering the Lake water levels could potentially further contribute to cyanobacteria.
    - Fisheries evaluation (impact to the littoral zone due to lowering of the Lake water levels, access to Lake tributaries for spawning, etc.).
    - Wetlands and wildlife evaluation.

- Rare, Threatened and Endangered Species (at this juncture it is unclear if RTE species would be located in work areas needed to remove the Dam, or in impacted areas associated with the lowering of water levels).

- Sediment – Quality and Management Plan. As noted above further sediment testing and analysis is needed to further evaluate the sediment quality through the Pond. Consultation with federal and state agencies would be required to determine potential sediment management options which could range from allowing the sediment to naturally migrate downstream upon dam removal to full dredging and disposal.

- Cultural Resources Assessment. A historic structures assessment of the Dam and an archaeological assessment would be required by the Vermont Division of Historic Preservation. Relative to archaeology, the geographic extent of the assessment would include access areas to remove the Dam and potentially the Pond and the Lake shorelines (since water levels will drop). Pending the findings of a Phase 1A archaeological investigation there is potential for having to conduct Phase IB and Phase II studies.

- Recreation and Recreation Access. As noted above, lowering of the Lake WSEL could have a major impact to the numerous private and public docks and boat launching areas. Further feasibility investigation would be needed.

- Public Outreach. GSE cannot underscore enough that should dam removal be the preferred alternative, considerable public outreach would be needed. It is likely there would be considerable opposition to removing the Dam if it resulted in lowering the Lake water levels.

The estimated cost for completing the feasibility steps is approximately $50,000; however, note that the findings of the feasibility steps could require further evaluation thus increasing the costs. Additional engineering tasks for the dam removal would include engineering drawings, project manual and bid documents, an erosion control plan, updating hydraulic models, an OPCC, bidding services, and construction services.

It is difficult to estimate the costs associated with removing the Dam absent further feasibility steps. However, GSE has led several dam removal projects and has contractor pricing on similar projects. Assuming no concerns for contaminated sediment, and assuming the sediment is permitted to naturally transport downstream, the conceptual OPCC for removing the Dam is approximately $318,000. This cost is based on 2018 construction rates and would need to be adjusted if the timeframe were to change. The cost includes mobilization/demobilization, demolition of stoplog bays, full demolition of the concrete spillway, cofferdam, water control, grading, seeding and mulching of the new channel, and erosion and sediment controls. This cost includes a 40% contingency due to the level of detail during the conceptual design. See Appendix D for the detailed OPCC estimate for Alternative 5. It should be noted that additional site investigations (i.e. structural, geotechnical, field survey), engineering design, permitting, environmental studies, sediment management plan, and construction management costs are not included as part of this OPCC.

The pros and cons for Alternative 5 are summarized in Table 6-8.

Table 6-8: Alternative 5 Pros and Cons

Pros	Cons
• VTDEC dam safety requirements no longer apply; the Dam would be no longer jurisdictional. • The peak flood elevations near Dewing Road, Route 120/Lake Road, and Middle Road would lower during the SDF event. • Would eliminate potential breach or overtopping failure risks for downstream. • Would eliminate future dam maintenance.	• Alternative 5 is the highest construction cost option. • Would eliminate the normal pool in Mill Pond which could negatively impact aesthetics, recreation, or wetlands. • Would lower the normal pool in Lake Carmi by approximately 1.7 feet to 433.1 feet which could negatively impact aesthetics, recreation, and wetlands. There would likely be major public resistance to this alternative as it would lower Lake Carmi water levels.

6.6 Environmental Considerations

Four of the five alternatives will have some degree of impact on the environment of the Pond and of the Lake. Table 6-9 and Table 6-10 provide information on the five alternatives in relation to Rare, Threatened, or Endangered (RTE) species, wetlands, the area downstream of Mill Pond, and sediment where applicable. Preliminary data needs and the studies that might be required are also provided. Continued dialogue and consultation with Resource Agencies is required. Based on the results of the preliminary environmental investigations, further field studies may be required.

Table 6-9: Potential Environmental Considerations for Mill Pond

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Potential Data Needs
Water Level Changes	No change	No change to water levels; downstream impacts	Reduces normal pool by 1.6 feet	Reduces normal pool by 0.7 feet	Reduces normal pool by 8.92 feet.	
RTE species	No change	Screening level analysis and Agency consultation needed	Screening level analysis and Agency consultation needed	Screening level analysis and Agency consultation needed	Screening level analysis and Agency consultation needed	If screening analysis indicates presence of an RTE species, a field presence/absence survey is needed. Agency consultation required.
Wetlands	No change	Temporary flow changes in the downstream wetlands due to construction, limited to no impacts expected to upstream wetlands	Permanent changes to seasonal flooding and draining patterns	Permanent change to seasonal flooding and draining patterns	Permanent changes/loss of wetlands. Natural reclamation may occur.	Formal wetlands delineation of wetlands in or connected to Mill Pond both upstream and downstream of the Dam will be needed for alternatives 3, 4, and 5. Agency consultation required.
Downstream	No change	Permanent changes to streambanks, habitat changes due to vegetation removal and construction	Some impacts to downstream wetlands, seasonal flooding and draining patterns will change.	Some impacts to downstream wetlands, seasonal flooding and draining patterns will change.	Multiple impacts. Downstream wetlands may be cut off from water source or drain differently. Sediment scouring and settling.	Alternative 2 may require a botanical/wildlife resources inventory survey or a habitat assessment in the downstream region that will be altered by the overtopping protection.
Sediment	No change	No change	Deposition pattern may change	Deposition pattern may change	Mobilization of sediment. Multiple impacts	Additional sediment core testing and full sediment transport model needed

Table 6-10: Potential Environmental Considerations for Lake Carmi

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Notes
Water Level Changes	No change	No change to water levels; downstream impacts	Reduces normal pool by 1.0 feet	Reduces normal pool by 0.7 feet	Reduces normal pool by 1.71 feet.	
RTE species	No change	Screening level analysis and Agency consultation needed	Screening level analysis and Agency consultation needed	Screening level analysis and Agency consultation needed	Screening level analysis and Agency consultation needed	If screening analysis indicates presence of an RTE species, a field presence/absence survey is needed. Agency consultation required.
Wetlands	No change	No expected impact	Permanent changes to seasonal flooding and draining patterns. May cut water supply to some wetlands	Permanent changes to seasonal flooding and draining patterns. May cut water supply to some wetlands	Permanent changes to seasonal flooding and draining patterns. May cut water supply to some wetlands	Formal wetlands delineation will be needed for alternatives 3, 4, and 5. Agency consultation required.
Littoral Zone	No change	No expected impact	Reduce available littoral habitat	Reduce available littoral habitat	Reduce available littoral habitat	A littoral zone habitat study will need to be conducted in the proposed drawdown areas to help assess the impacts of the permanent normal pool reductions.

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Appendix A - Photo Logs

Figure 1: Upstream side of Dewing Bridge

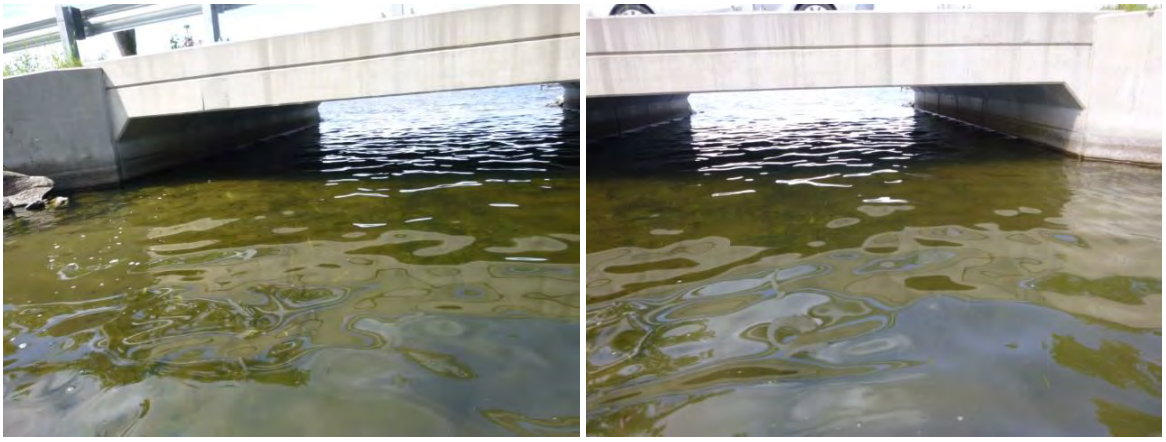


Figure 2: Downstream side of Dewing Bridge

Figure 3: Upstream side of dam

Figure 4: Downstream side of dam

Figure 5: Upstream view of the VT-120 Bridge.

Figure 6: Downstream view of the VT-120 Bridge.

Figure 7: Upstream view from Middle Road

Figure 8: Downstream view from Middle Road

Figure 9: Transect 1

Figure 10: Transect 2

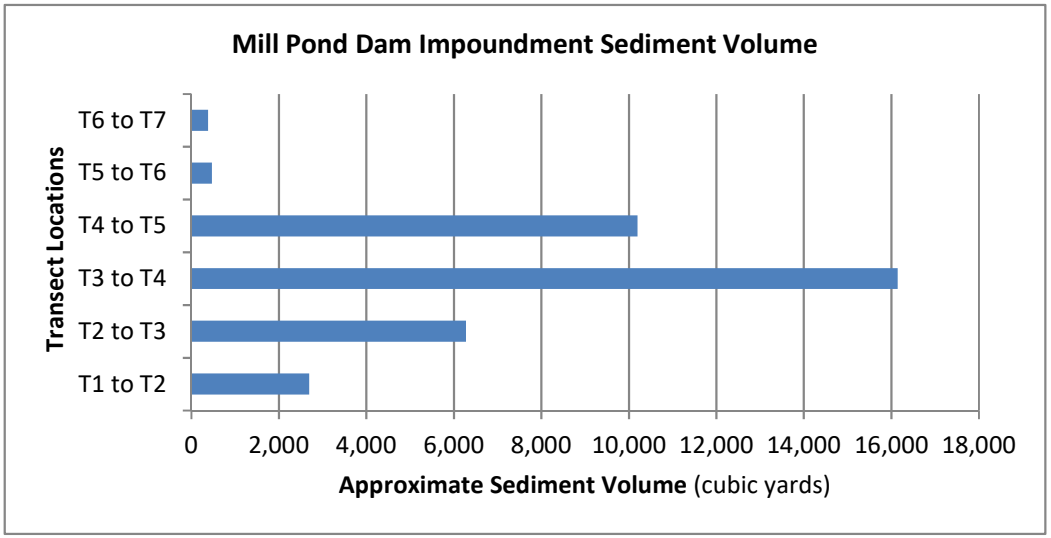
Figure 11: Core Sample

Figure 12: Core Sample

Appendix B - Sediment Analysis

Mill Pond Dam Sediment Volume Summary

Transect ID	Sediment Cross-Sectional Area (sq ft)				Distance between Transescts (ft)	Sediment Volume (CY)	
	TOTAL						
	Transect	*Average (between transects)*				TOTAL	Potentially Mobile
T1	168						
T1 to T2		234.0			311	2,695	2,695
T2	300						
T2 to T3		361.5			469	6,279	6,279
T3	423						
T3 to T4		744.0			586	16,148	16,148
T4	1065						
T4 to T5		566.5			486	10,197	10,197
T5	68						
T5 to T6		49.0			261	474	474
T6	30						
T6 to T7		27.5			374	381	381
T7	25						
						TOTAL	36,174
						ROUNDED	**36,200**



Mill Pond Dam Sediment Depth Survey

Transect No.:	**1**
Survey Date:	5/30/2018
Crew:	Elisabeth Bleistine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

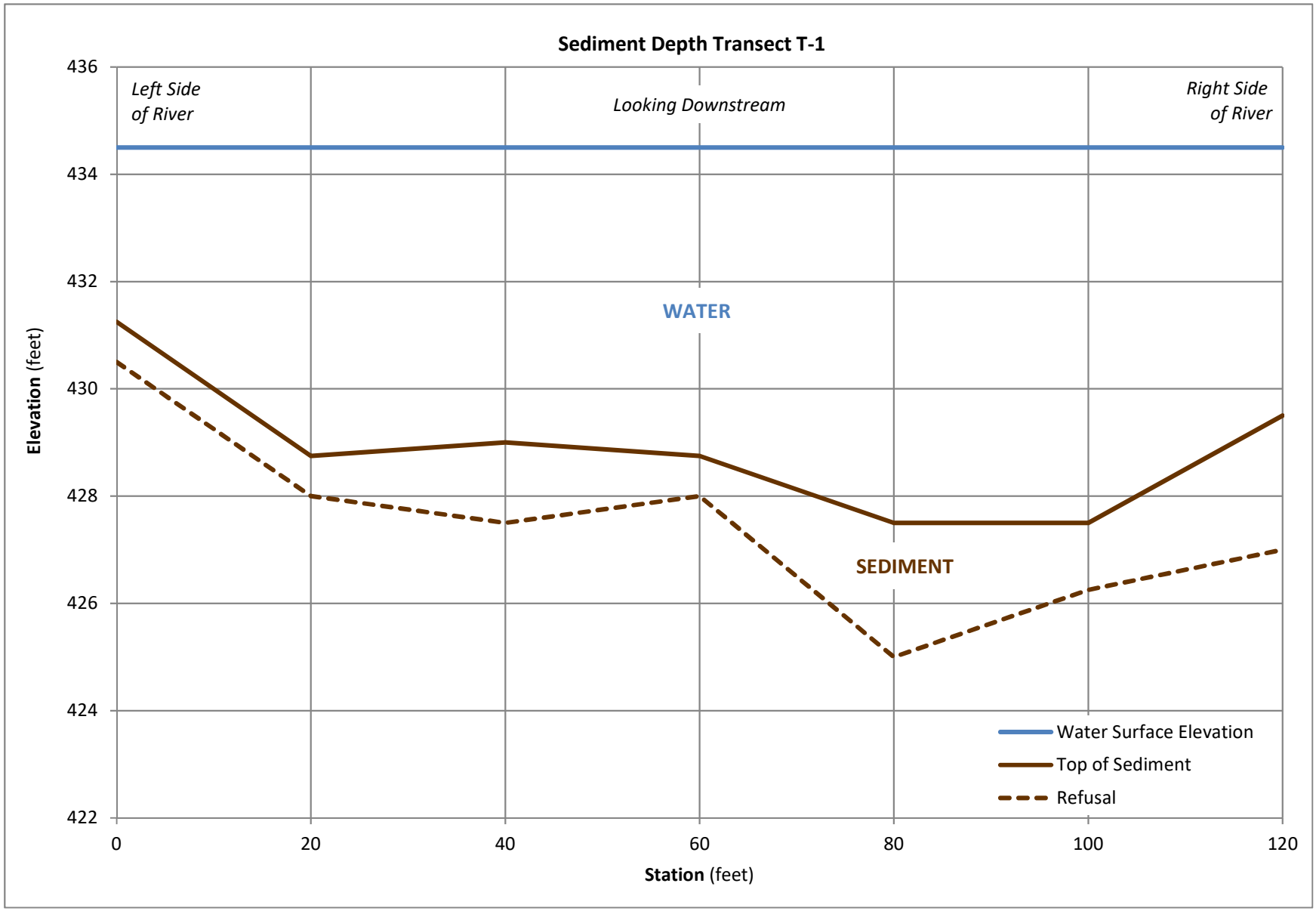
Comments:	Just upstream of dam, closest transect to dam.

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
LEOW	0		3.25	4	0.75	0	0	0	434.5	431.25	430.5	Rocky with pockets
CH	20	20	5.75	6.5	0.75	90	105	15	434.5	428.75	428	
CH	40	20	5.5	7	1.5	112.5	135	22.5	434.5	429	427.5	
CH	60	20	5.75	6.5	0.75	112.5	135	22.5	434.5	428.75	428	
CH	80	20	7	9.5	2.5	127.5	160	32.5	434.5	427.5	425	
CH	100	20	7	8.25	1.25	140	177.5	37.5	434.5	427.5	426.25	Start of RS concrete wall
REOW	120	20	5	7.5	2.5	120	157.5	37.5	434.5	429.5	427	

Total Estimated Sediment Area (sq ft)**: 168**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-1
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Elevation (feet)
436
434
432
430
428
426
424
422
0
20
40
60
80
100
120
Station (feet)
Water Surface Elevation
Top of Sediment
Refusal

Mill Pond Dam Sediment Depth Survey

Transect No.:	**2**
Survey Date:	5/30/2018
Crew:	Elisabeth Bliestine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

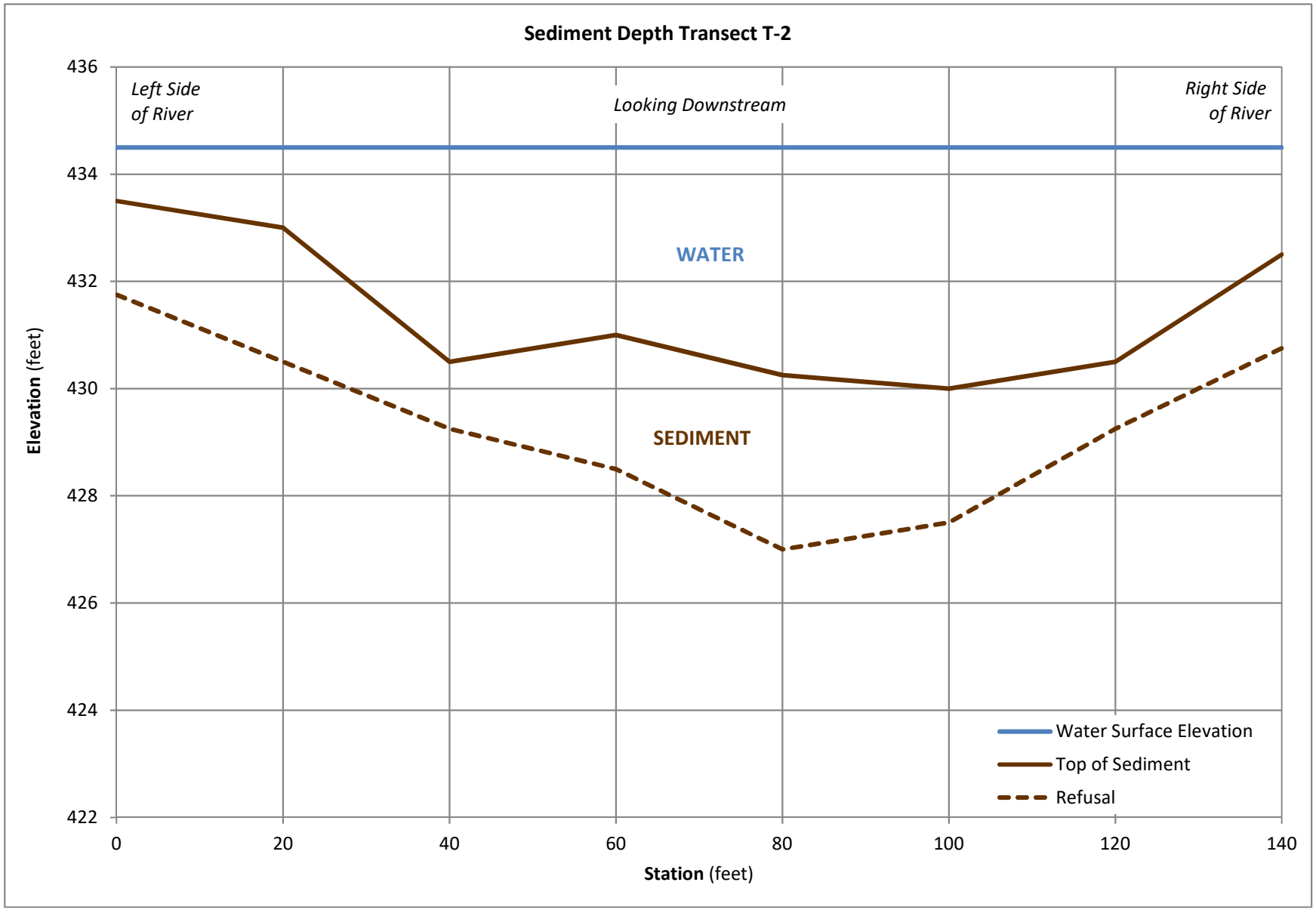
Comments:	Next transect upstream

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
LEOW	0		1	2.75	1.75	0	0	0	434.5	433.5	431.75	mucky with lots of lily pads
CH	20	20	1.5	4	2.5	25	67.5	42.5	434.5	433	430.5	
CH	40	20	4	5.25	1.25	55	92.5	37.5	434.5	430.5	429.25	
CH	60	20	3.5	6	2.5	75	112.5	37.5	434.5	431	428.5	
CH	80	20	4.25	7.5	3.25	77.5	135	57.5	434.5	430.25	427	approx. middle of transect
CH	100	20	4.5	7	2.5	87.5	145	57.5	434.5	430	427.5	
CH	120	20	4	5.25	1.25	85	122.5	37.5	434.5	430.5	429.25	
REOW	140	20	2	3.75	1.75	60	90	30	434.5	432.5	430.75	

Total Estimated Sediment Area (sq ft)**: 300**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-2
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Elevation (feet)
436
434
432
430
428
426
424
422
0
20
40
60
80
100
120
140
Station (feet)
Water Surface Elevation
Top of Sediment
Refusal

Mill Pond Dam Sediment Depth Survey

Transect No.:	**3**
Survey Date:	5/30/2018
Crew:	Elisabeth Bleistine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

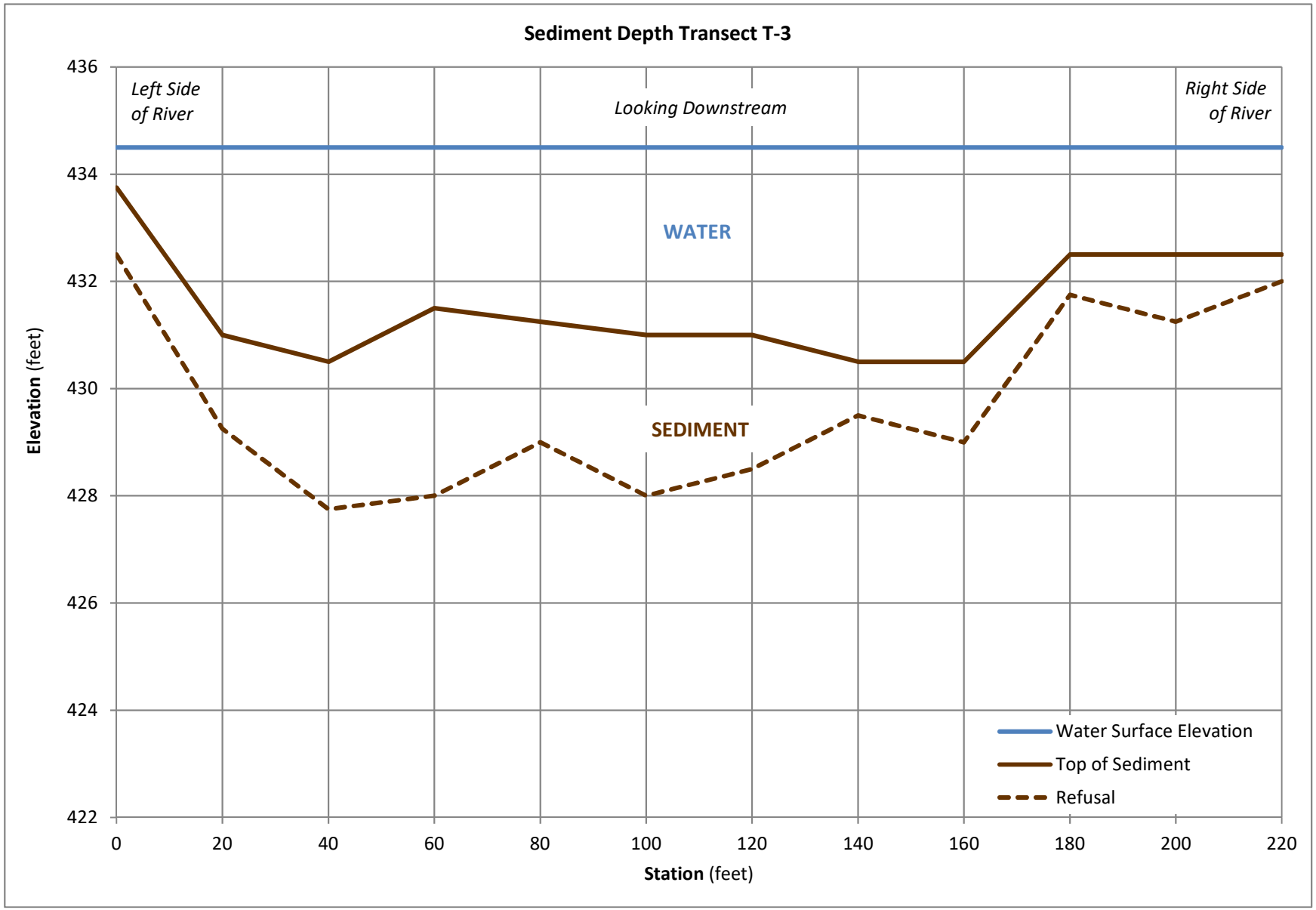
Comments:	

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
LEOW	0		0.75	2	1.25	0	0	0	434.5	433.75	432.5	
CH	20	20	3.5	5.25	1.75	42.5	72.5	30	434.5	431	429.25	
CH	40	20	4	6.75	2.75	75	120	45	434.5	430.5	427.75	
CH	60	20	3	6.5	3.5	70	132.5	62.5	434.5	431.5	428	
CH	80	20	3.25	5.5	2.25	62.5	120	57.5	434.5	431.25	429	
CH	100	20	3.5	6.5	3	67.5	120	52.5	434.5	431	428	
CH	120	20	3.5	6	2.5	70	125	55	434.5	431	428.5	
CH	140	20	4	5	1	75	110	35	434.5	430.5	429.5	
CH	160	20	4	5.5	1.5	80	105	25	434.5	430.5	429	
CH	180	20	2	2.75	0.75	60	82.5	22.5	434.5	432.5	431.75	less mucky, very rocky and uneven
CH	200	20	2	3.25	1.25	40	60	20	434.5	432.5	431.25	
REOW	220	20	2	2.5	0.5	40	57.5	17.5	434.5	432.5	432	

Total Estimated Sediment Area (sq ft)**: 423**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-3
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Elevation (feet)
436
434
432
430
428
426
424
422
0
20
40
60
80
100
120
140
160
180
200
220
Station (feet)
Water Surface Elevation
Top of Sediment
Refusal

Mill Pond Dam Sediment Depth Survey

Transect No.:	**4**
Survey Date:	5/30/2018
Crew:	Elisabeth Bleistine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

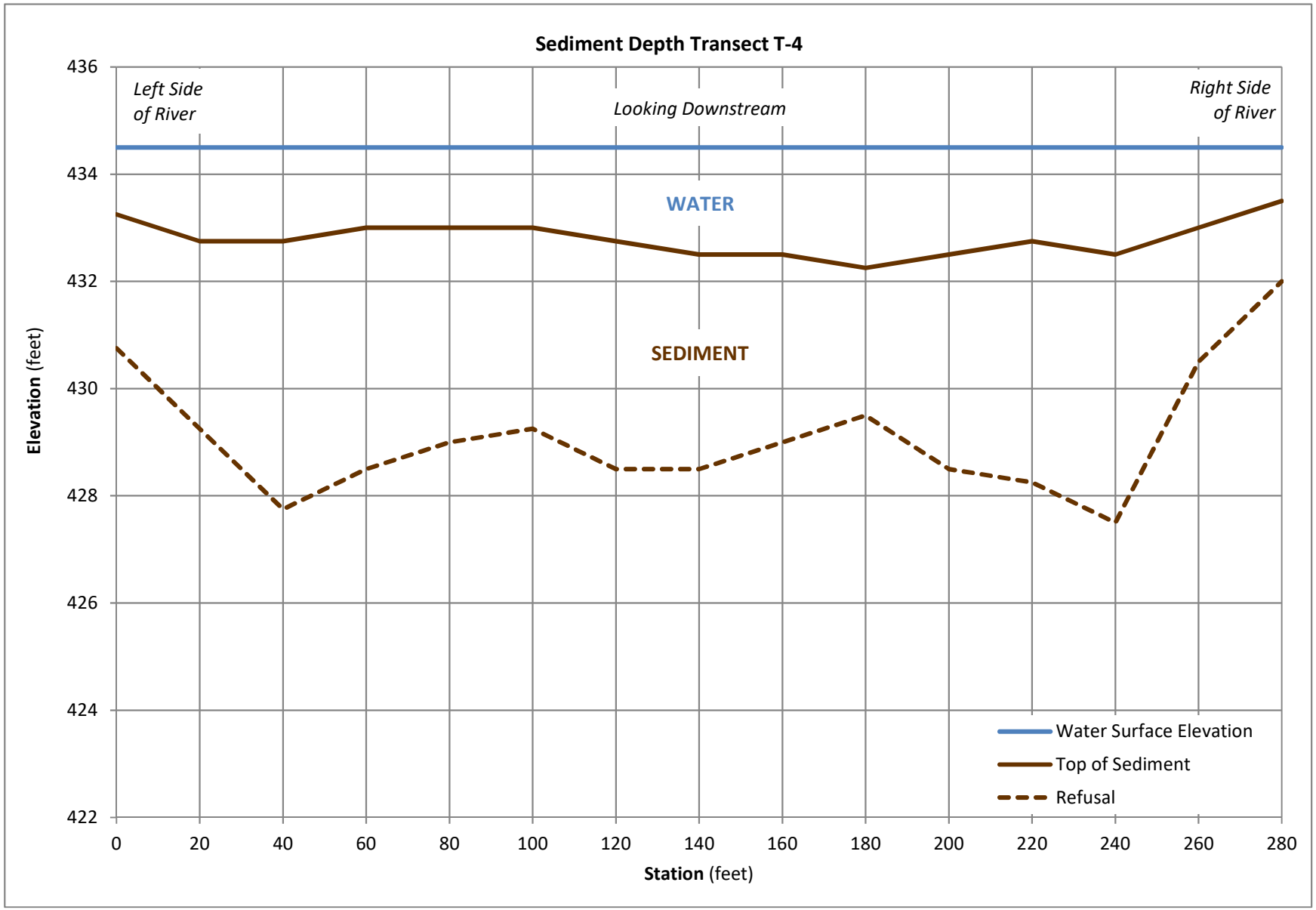
Comments:	

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
LEOW	0		1.25	3.75	2.5	0	0	0	434.5	433.25	430.75	
CH	20	20	1.75	5.25	3.5	30	90	60	434.5	432.75	429.25	
CH	40	20	1.75	6.75	5	35	120	85	434.5	432.75	427.75	
CH	60	20	1.5	6	4.5	32.5	127.5	95	434.5	433	428.5	
CH	80	20	1.5	5.5	4	30	115	85	434.5	433	429	
CH	100	20	1.5	5.25	3.75	30	107.5	77.5	434.5	433	429.25	
CH	120	20	1.75	6	4.25	32.5	112.5	80	434.5	432.75	428.5	
CH	140	20	2	6	4	37.5	120	82.5	434.5	432.5	428.5	measuring rod stuck and bent
CH	160	20	2	5.5	3.5	40	115	75	434.5	432.5	429	
CH	180	20	2.25	5	2.75	42.5	105	62.5	434.5	432.25	429.5	
CH	200	20	2	6	4	42.5	110	67.5	434.5	432.5	428.5	
CH	220	20	1.75	6.25	4.5	37.5	122.5	85	434.5	432.75	428.25	
CH	240	20	2	7	5	37.5	132.5	95	434.5	432.5	427.5	rod stuck in sediment underwater
CH	260	20	1.5	4	2.5	35	110	75	434.5	433	430.5	
REOW	280	20	1	2.5	1.5	25	65	40	434.5	433.5	432	

Total Estimated Sediment Area (sq ft)**: 1065**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-4
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Elevation (feet)
436
434
432
430
428
426
424
422
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Station (feet)
Water Surface Elevation
Top of Sediment
Refusal

Mill Pond Dam Sediment Depth Survey

Transect No.:	**5**
Survey Date:	5/30/2018
Crew:	Elisabeth Bleistine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

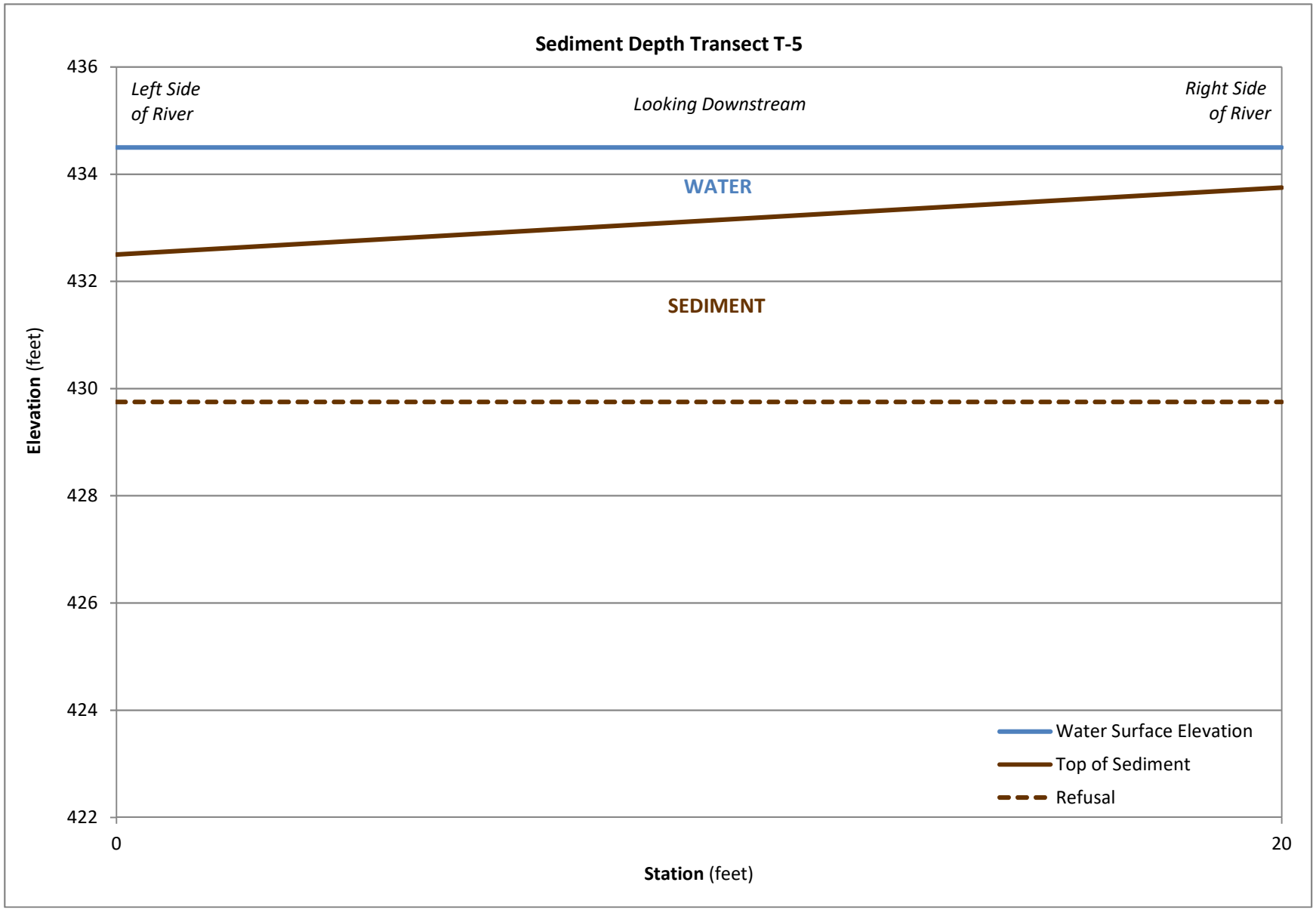
Comments:	

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
LS	0		2	4.75	2.75	0	0	0	434.5	432.5	429.75	LB
RS	20	20	0.75	4.75	4	27.5	95	67.5	434.5	433.75	429.75	RB

Total Estimated Sediment Area (sq ft)**: 68**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-5
436
434
432
430
428
426
424
422
Elevation (feet)
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Water Surface Elevation
Top of Sediment
Refusal
0
20
Station (feet)

Mill Pond Dam Sediment Depth Survey

Transect No.:	**6**
Survey Date:	5/30/2018
Crew:	Elisabeth Beleistine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

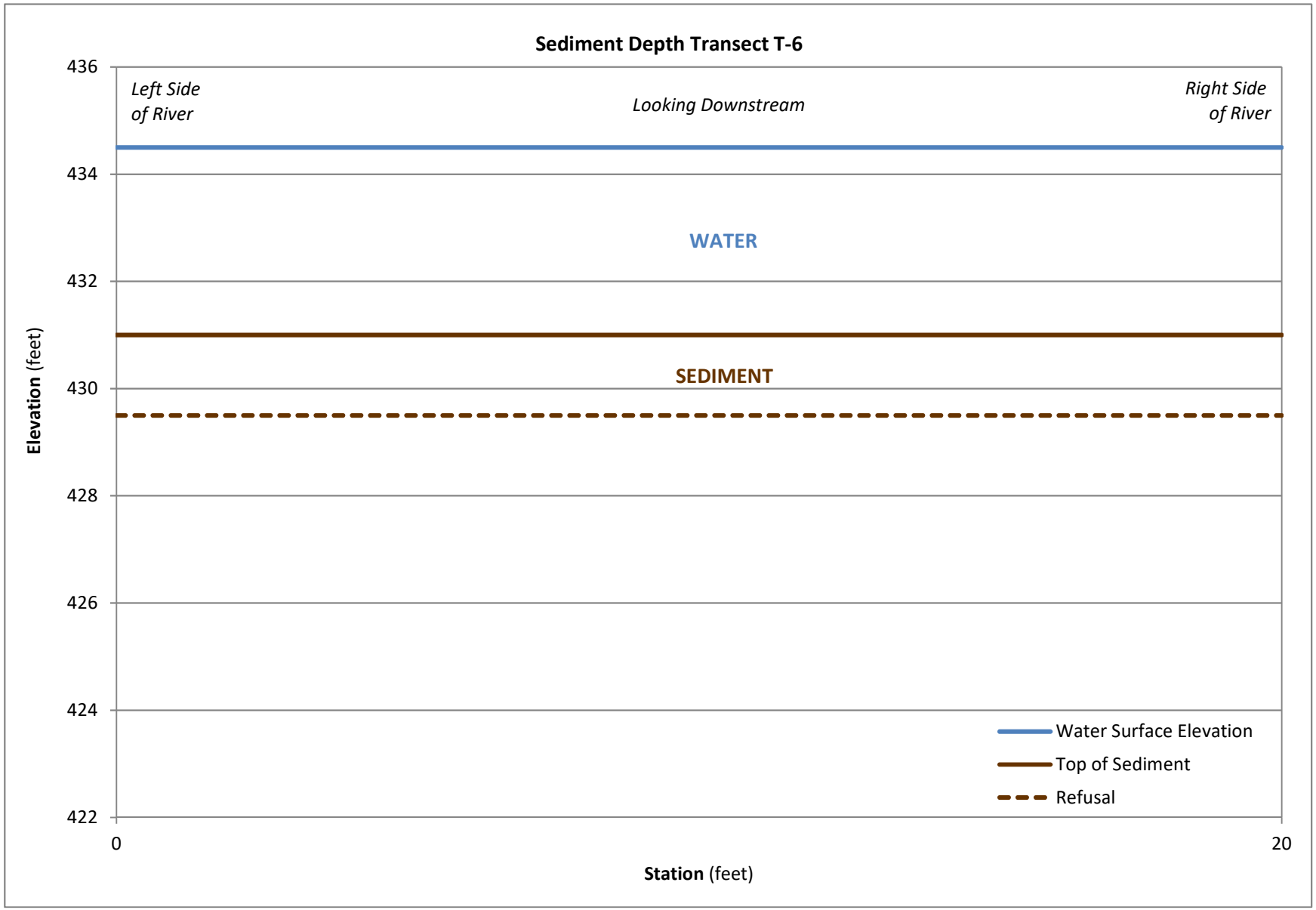
Comments:	Only one measurement taken

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
Center	0		3.5	5	1.5	0	0	0	434.5	431	429.5	center of channel only
	20	20	3.5	5	1.5	70	100	30	434.5	431	429.5	

Total Estimated Sediment Area (sq ft)**: 30**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-6
436
434
432
430
428
426
424
422
Elevation (feet)
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Water Surface Elevation
Top of Sediment
Refusal
0
20
Station (feet)

Mill Pond Dam Sediment Depth Survey

Transect No.:	**7**
Survey Date:	5/30/2018
Crew:	Elisabeth Bleistine and Ben Sawyer
Weather:	Sunny, hot
WSE on Survey Date:	434.5 (ft, NAVD88)

KEY

WSE	Water Surface Elevation
LB	Left Bank (looking downstream)
RB	Right Bank (looking downstream)
CH	Channel
EOW	Edge of Water

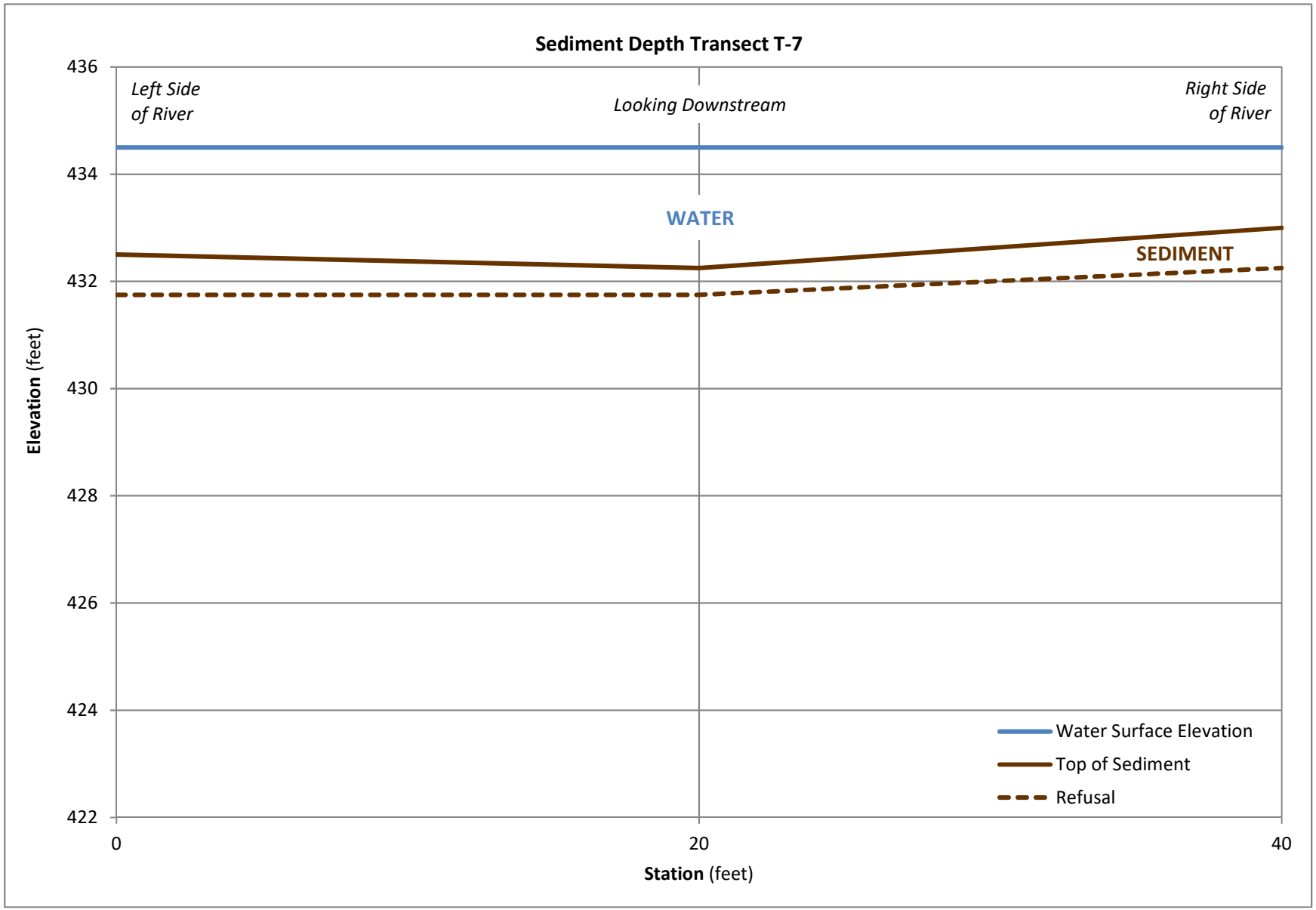
Comments:	Originally measured from RB to LB

Location	**Station** (ft)[1]	**Distance between Stations** (ft)	**Depth** (ft)			**Cross-Sectional Area** (sq ft)[2]			**Elevation** (ft, NAVD88)			**Sediment Type/Notes**
			Water	Water + Sediment	Sediment	Water	Water + Sediment	Sediment	Water Surface	Top of Sediment	Bottom of Sediment	
LEOW	0		2	2.75	0.75	0	0	0	434.5	432.5	431.75	all rock
CH	20	20	2.25	2.75	0.5	42.5	55	12.5	434.5	432.25	431.75	mix of rock and sand
REOW	40	20	1.5	2.25	0.75	37.5	50	12.5	434.5	433	432.25	sand instead of soft much

Total Estimated Sediment Area (sq ft)**:** **25**

[1] *Stationing is from left bank (STA 0) to right bank, looking downstream.*

[2] *Cross-sectional area formula (Area=0.5*(ΔE1+ΔE2)*(Distance)) works for impoundment situations where all sediment is below the WSE. If not, the shoelace algorithm will be used and noted.*


Sediment Depth Transect T-7
Left Side of River
Looking Downstream
Right Side of River
WATER
SEDIMENT
Elevation (feet)
436
434
432
430
428
426
424
422
0
20
40
Station (feet)
Water Surface Elevation
Top of Sediment
Refusal

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Burlington
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Suite 11
South Burlington, VT 05403
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TestAmerica Job ID: 200-43658-1
Client Project/Site: Vermont Sediment Project REVISED

For:
Gomez and Sullivan Engineers, D.P.C.
PO BOX 2179
Liberty Hill Road, Building 1
Henniker, New Hampshire 03242

Attn: Elisabeth Bleistine

Authorized for release by:
7/2/2018 10:30:20 AM

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LINKS

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The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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Definitions/Glossary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
B	Compound was found in the blank and sample.

GC/MS Semi VOA

Qualifier	Qualifier Description
*	LCS or LCSD is outside acceptance limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
p	The %RPD between the primary and confirmation column/detector is >40%. The lower value has been reported.

General Chemistry

Qualifier	Qualifier Description
H	Sample was prepped or analyzed beyond the specified holding time

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 200-43658-1

Laboratory: TestAmerica Burlington

Narrative

CASE NARRATIVE

Client: Gomez and Sullivan Engineers, D.P.C.

Project: Vermont Sediment Project REVISED

Report Number: 200-43658-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

RECEIPT
The samples were received on 05/31/2018; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 5.9 C.

VOLATILES
Methylene Chloride was detected in method blank MB 180-246394/5 at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged.

The continuing calibration verification (CCV) analyzed in batch 180-246394 was outside the method criteria for the following analyte: Carbon Disulfide. A CCV standard at or below the reporting limit (RL) was analyzed with the affected samples and found to be acceptable. As indicated in the reference method, sample analysis may proceed; however, any detection for the affected analyte is considered estimated.

The continuing calibration verification (CCV) analyzed in 180-246394 was outside the method criteria for the following analytes: Chloroethane, Dichlorodifluoro-methane, and Trichlorofluoromethane. As indicated in the reference method, sample analysis may proceed; however, any detection for the affected analytes is considered estimated.

SEMIVOLATILES
The following sample was diluted due to the nature of the sample matrix: TRANSECT 4 (200-43658-1). Elevated reporting limits (RLs) are provided.

The laboratory control sample(LCS) for preparation batch 180-247249 and analytical batch 180-247601 recovered outside control limits for the following analyte: Benzaldehyde. Benzaldehyde has been identified as a poor performing analyte when analyzed using this method; therefore, re-extraction/re-analysis was not performed.

The continuing calibration verification (CCV) analyzed in batch 180-247601 was outside the method criteria for the following analytes: 2,2'-oxybis[1-chloropropane], Bis(2-ethylhexyl) phthalate, and Butyl benzyl phthalate were greater than 20% high; 4-Nitrophenol, 2,4,5-Trichlorophenol, Hexachlorobutadiene, Hexachlorocyclopentadiene, and Pentachlorophenol were greater than 20% low. Therefore, a CCV standard at or below the reporting limit (RL) was analyzed with the affected samples and found to be acceptable. As indicated in the reference method, sample analysis may proceed; however, any detection for the affected analytes is considered estimated.

PESTICIDES
2,4'-DDD was detected in method blank MB 180-247381/2-B at a level that was above the method detection limit but below the reporting

Job ID: 200-43658-1 (Continued)

Laboratory: TestAmerica Burlington (Continued)

limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged.

The continuing calibration verification (CCV) associated with batch 249177 recovered above the upper control limit for Toxaphene, Chlordane (technical), oxy-Chlordane and Heptachlor. The samples associated with this CCV were non-detect for the affected analytes; therefore, the data have been reported. The following samples were impacted: TRANSECT 4 (200-43658-1), (CCV 180-249177/2), (CCV 180-249177/3), (CCV 180-249177/4) and (CCVIS 180-249177/6).

PCBs
No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

METALS
No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GENERAL CHEMISTRY
The following sample was prepared outside of preparation holding time due to instrument issues that prevented this sample from being run within HT: TRANSECT 4 (200-43658-1). The sample was analyzed within 2 times the holding time.

The reporting limit for Lloyd Kahn TOC analysis is a nominal value and does not reflect adjustments in sample mass processed on an individual basis.

GEOTECHNICAL
The density results for the following sample do not represent the in-place density of the soil: TRANSECT 4 (200-43658-1). The soils were received in a disturbed state and were subsequently molded in the laboratory to an approximation of the field environment.

Detection Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4 — Lab Sample ID: 200-43658-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Acetone	26	J	97	15	ug/Kg	1	☼	EPA 8260C	Total/NA
Methylene Chloride	36	B	24	11	ug/Kg	1	☼	EPA 8260C	Total/NA
Benzo[a]anthracene	40	J	170	32	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Benzo[a]pyrene	46	J	170	37	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Benzo[b]fluoranthene	69	J	170	42	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Benzo[g,h,i]perylene	66	J	170	36	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Chrysene	54	J	170	33	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Fluoranthene	63	J	170	45	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Indeno[1,2,3-cd]pyrene	46	J	170	34	ug/Kg	10	☼	EPA 8270D LL	Total/NA
Pyrene	52	J	170	40	ug/Kg	10	☼	EPA 8270D LL	Total/NA
cis-Chlordane	0.084	J p	0.21	0.053	ug/Kg	1	☼	EPA 8081B LL	Total/NA
4,4'-DDD	0.54		0.21	0.057	ug/Kg	1	☼	EPA 8081B LL	Total/NA
4,4'-DDE	0.48		0.21	0.043	ug/Kg	1	☼	EPA 8081B LL	Total/NA
4,4'-DDT	0.33		0.21	0.080	ug/Kg	1	☼	EPA 8081B LL	Total/NA
Arsenic	1.5		0.26	0.067	mg/Kg	1	☼	EPA 6020A	Total/NA
Cadmium	0.44		0.26	0.044	mg/Kg	1	☼	EPA 6020A	Total/NA
Chromium	11		0.51	0.17	mg/Kg	1	☼	EPA 6020A	Total/NA
Copper	16		0.51	0.29	mg/Kg	1	☼	EPA 6020A	Total/NA
Lead	23		0.26	0.092	mg/Kg	1	☼	EPA 6020A	Total/NA
Nickel	11		0.26	0.16	mg/Kg	1	☼	EPA 6020A	Total/NA
Zinc	52		1.3	0.86	mg/Kg	1	☼	EPA 6020A	Total/NA
Mercury	0.10		0.070	0.016	mg/Kg	1	☼	EPA 7471B	Total/NA
Total Organic Carbon - Duplicates	86000	H	5100	3800	mg/Kg	1	☼	EPA-Lloyd Kahn	Total/NA
Moisture Content	235.9				%	1		D2216-90	Total/NA
In Place Density	0.357				g/cc	1		D2937	Total/NA
Gravel	6.0				%	1		D422	Total/NA
Sieve Size 3 inch - Percent Finer	100.0				% Passing	1		D422	Total/NA
Sand	48.0				%	1		D422	Total/NA
Sieve Size 2 inch - Percent Finer	100.0				% Passing	1		D422	Total/NA
Coarse Sand	6.4				%	1		D422	Total/NA
Sieve Size 1.5 inch - Percent Finer	100.0				% Passing	1		D422	Total/NA
Medium Sand	15.9				%	1		D422	Total/NA
Sieve Size 1 inch - Percent Finer	100.0				% Passing	1		D422	Total/NA
Fine Sand	25.7				%	1		D422	Total/NA
Sieve Size 0.75 inch - Percent Finer	100.0				% Passing	1		D422	Total/NA
Sieve Size 0.375 inch - Percent Finer	100.0				% Passing	1		D422	Total/NA
Silt	39.1				%	1		D422	Total/NA
Clay	6.9				%	1		D422	Total/NA
Sieve Size #4 - Percent Finer	94.0				% Passing	1		D422	Total/NA
Sieve Size #10 - Percent Finer	87.6				% Passing	1		D422	Total/NA
Sieve Size #20 - Percent Finer	79.4				% Passing	1		D422	Total/NA
Sieve Size #40 - Percent Finer	71.7				% Passing	1		D422	Total/NA
Sieve Size #60 - Percent Finer	64.2				% Passing	1		D422	Total/NA
Sieve Size #80 - Percent Finer	58.5				% Passing	1		D422	Total/NA
Sieve Size #100 - Percent Finer	55.4				% Passing	1		D422	Total/NA
Sieve Size #200 - Percent Finer	46.0				% Passing	1		D422	Total/NA
Hydrometer Reading 1 - Percent Finer	9.8				% Passing	1		D422	Total/NA
Hydrometer Reading 2 - Percent Finer	9.8				% Passing	1		D422	Total/NA
Hydrometer Reading 3 - Percent Finer	7.1				% Passing	1		D422	Total/NA
Hydrometer Reading 4 - Percent Finer	7.1				% Passing	1		D422	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4 (Continued)

Lab Sample ID: 200-43658-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Hydrometer Reading 5 - Percent Finer	6.9				% Passing	1		D422	Total/NA
Hydrometer Reading 6 - Percent Finer	2.7				% Passing	1		D422	Total/NA
Hydrometer Reading 7 - Percent Finer	-0.7				% Passing	1		D422	Total/NA
Specific Gravity at 20 deg Celsius	2.40				NONE	1		D854	Total/NA
Porosity	85.1				%	1		LAB-BUR	Total/NA
Void Ratio	5.7				NONE	1		LAB-BUR	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4

Date Collected: 05/31/18 13:50
Date Received: 05/31/18 16:07

Lab Sample ID: 200-43658-1

Matrix: Sediment
Percent Solids: 19.6

Method: EPA 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		24	12	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,1,2,2-Tetrachloroethane	ND		24	14	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		24	9.3	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,1,2-Trichloroethane	ND		24	12	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,1-Dichloroethane	ND		24	8.8	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,1-Dichloroethene	ND		24	14	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,2-Dibromo-3-Chloropropane	ND		24	15	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,2-Dichlorobenzene	ND		24	20	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,2-Dichloroethane	ND		24	7.0	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,2-Dichloropropane	ND		24	12	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,2,4-Trichlorobenzene	ND		24	7.8	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,3-Dichlorobenzene	ND		24	7.7	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,4-Dichlorobenzene	ND		24	4.9	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
2-Butanone (MEK)	ND		24	14	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
2-Hexanone	ND		24	20	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
4-Methyl-2-pentanone (MIBK)	ND		24	9.0	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Acetone	**26**	**J**	97	15	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Benzene	ND		24	9.5	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Bromoform	ND		24	13	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Bromomethane	ND		24	22	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Carbon disulfide	ND		24	15	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Carbon tetrachloride	ND		24	16	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Chlorobenzene	ND		24	7.6	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Chlorodibromomethane	ND		24	12	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Chloroform	ND		24	10	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Chloromethane	ND		24	19	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Chloroethane	ND		24	13	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
cis-1,2-Dichloroethene	ND		24	7.6	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
cis-1,3-Dichloropropene	ND		24	7.8	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Dichlorobromomethane	ND		24	11	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Dichlorodifluoromethane	ND		24	14	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Ethylbenzene	ND		24	10	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
1,2-Dibromoethane	ND		24	13	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Cyclohexane	ND		24	5.9	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Isopropylbenzene	ND		24	11	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Methyl acetate	ND		120	29	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Methyl tert-butyl ether	ND		24	18	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Methylcyclohexane	ND		24	10	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Methylene Chloride	**36**	**B**	24	11	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Styrene	ND		24	6.5	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Tetrachloroethene	ND		24	9.7	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Toluene	ND		24	8.2	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
trans-1,2-Dichloroethene	ND		24	12	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
trans-1,3-Dichloropropene	ND		24	8.4	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Trichloroethene	ND		24	7.3	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Trichlorofluoromethane	ND		24	7.1	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Vinyl chloride	ND		24	18	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1
Xylenes, Total	ND		49	21	ug/Kg	☼	06/01/18 12:12	06/01/18 14:18	1

Client Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4

Date Collected: 05/31/18 13:50
Date Received: 05/31/18 16:07

Lab Sample ID: 200-43658-1

Matrix: Sediment
Percent Solids: 19.6

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*104*		*62 - 118*	*06/01/18 12:12*	*06/01/18 14:18*	*1*
4-Bromofluorobenzene (Surr)	*91*		*76 - 111*	*06/01/18 12:12*	*06/01/18 14:18*	*1*
Dibromofluoromethane (Surr)	*100*		*72 - 116*	*06/01/18 12:12*	*06/01/18 14:18*	*1*
Toluene-d8 (Surr)	*105*		*80 - 129*	*06/01/18 12:12*	*06/01/18 14:18*	*1*

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		170	49	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Acenaphthylene	ND		170	37	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Anthracene	ND		170	44	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Benzo[a]anthracene	**40**	**J**	170	32	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Benzo[a]pyrene	**46**	**J**	170	37	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Benzo[b]fluoranthene	**69**	**J**	170	42	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Benzo[g,h,i]perylene	**66**	**J**	170	36	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Benzo[k]fluoranthene	ND		170	51	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Bis(2-chloroethyl)ether	ND		170	31	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Bis(2-chloroethoxy)methane	ND		840	40	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,2'-oxybis[1-chloropropane]	ND		170	63	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Bis(2-ethylhexyl) phthalate	ND		8400	900	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4-Bromophenyl phenyl ether	ND		840	59	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Butyl benzyl phthalate	ND		840	580	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4-Chloroaniline	ND		840	28	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2-Chloronaphthalene	ND		170	39	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4-Chlorophenyl phenyl ether	ND		840	51	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Chrysene	**54**	**J**	170	33	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Dibenz(a,h)anthracene	ND		170	38	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Dibenzofuran	ND		840	37	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Di-n-butyl phthalate	ND		840	370	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
3,3'-Dichlorobenzidine	ND		840	790	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Diethyl phthalate	ND		840	250	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Dimethyl phthalate	ND		840	31	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,4-Dinitrotoluene	ND		840	42	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,6-Dinitrotoluene	ND		840	52	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Di-n-octyl phthalate	ND		840	490	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Fluoranthene	**63**	**J**	170	45	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Fluorene	ND		170	33	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Hexachlorobenzene	ND		170	61	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Hexachlorobutadiene	ND		170	49	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Hexachlorocyclopentadiene	ND		840	43	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Hexachloroethane	ND		840	44	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Indeno[1,2,3-cd]pyrene	**46**	**J**	170	34	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Isophorone	ND		840	43	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2-Methylnaphthalene	ND		170	41	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Naphthalene	ND		170	33	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2-Nitroaniline	ND		4300	390	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
3-Nitroaniline	ND		4300	210	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4-Nitroaniline	ND		4300	41	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Nitrobenzene	ND		1700	310	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
N-Nitrosodi-n-propylamine	ND		170	57	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
N-Nitrosodiphenylamine	ND		840	280	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10

Client Sample ID: TRANSECT 4

Date Collected: 05/31/18 13:50
Date Received: 05/31/18 16:07

Lab Sample ID: 200-43658-1

Matrix: Sediment
Percent Solids: 19.6

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phenanthrene	ND		170	45	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Pyrene	**52**	**J**	170	40	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Carbazole	ND		170	40	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Acetophenone	ND		1700	46	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Atrazine	ND		1700	370	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Benzaldehyde	ND	*	1700	100	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
1,1'-Biphenyl	ND		840	35	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Caprolactam	ND		4300	550	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4-Chloro-3-methylphenol	ND		840	40	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2-Chlorophenol	ND		840	39	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2-Methylphenol	ND		840	240	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Methylphenol, 3 & 4	ND		840	250	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,4-Dichlorophenol	ND		170	65	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,4-Dimethylphenol	ND		840	53	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,4-Dinitrophenol	ND		8400	2300	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4,6-Dinitro-2-methylphenol	ND		4300	1500	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2-Nitrophenol	ND		840	48	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
4-Nitrophenol	ND		4300	590	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Pentachlorophenol	ND		4300	1400	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
Phenol	ND		840	260	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,4,5-Trichlorophenol	ND		840	60	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10
2,4,6-Trichlorophenol	ND		840	46	ug/Kg	☼	06/11/18 18:25	06/14/18 18:55	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*47*		*40 - 105*	*06/11/18 18:25*	*06/14/18 18:55*	*10*
2-Fluorophenol (Surr)	*51*		*38 - 105*	*06/11/18 18:25*	*06/14/18 18:55*	*10*
2,4,6-Tribromophenol (Surr)	*44*		*20 - 129*	*06/11/18 18:25*	*06/14/18 18:55*	*10*
Nitrobenzene-d5 (Surr)	*52*		*38 - 105*	*06/11/18 18:25*	*06/14/18 18:55*	*10*
Phenol-d5 (Surr)	*53*		*40 - 106*	*06/11/18 18:25*	*06/14/18 18:55*	*10*
Terphenyl-d14 (Surr)	*54*		*20 - 124*	*06/11/18 18:25*	*06/14/18 18:55*	*10*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.21	0.065	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
alpha-BHC	ND		0.21	0.052	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
beta-BHC	ND		0.21	0.054	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
delta-BHC	ND		0.21	0.067	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
gamma-BHC (Lindane)	ND		0.21	0.072	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
cis-Chlordane	**0.084**	**J p**	0.21	0.053	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
trans-Chlordane	ND		0.21	0.049	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
oxy-Chlordane	ND		0.21	0.047	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
4,4'-DDD	**0.54**		0.21	0.057	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Chlordane (technical)	ND		2.1	0.90	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
4,4'-DDE	**0.48**		0.21	0.043	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
4,4'-DDT	**0.33**		0.21	0.080	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Dieldrin	ND		0.21	0.053	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Endosulfan I	ND		0.21	0.057	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
2,4'-DDD	ND		0.21	0.037	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Endosulfan II	ND		0.21	0.046	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Endosulfan sulfate	ND		0.21	0.055	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1

Client Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4

Date Collected: 05/31/18 13:50
Date Received: 05/31/18 16:07

Lab Sample ID: 200-43658-1

Matrix: Sediment
Percent Solids: 19.6

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2,4'-DDE	ND		0.21	0.055	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Endrin	ND		0.21	0.082	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Endrin aldehyde	ND		0.21	0.075	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
2,4'-DDT	ND		0.21	0.081	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Endrin ketone	ND		0.21	0.075	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Heptachlor	ND		0.21	0.066	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Heptachlor epoxide	ND		0.21	0.054	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Methoxychlor	ND		0.21	0.082	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1
Toxaphene	ND		8.4	5.7	ug/Kg	☼	06/12/18 16:03	06/30/18 14:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene	*61*		*26 - 120*	*06/12/18 16:03*	*06/30/18 14:11*	*1*
Tetrachloro-m-xylene	*91*		*26 - 120*	*06/12/18 16:03*	*06/30/18 14:11*	*1*
DCB Decachlorobiphenyl (Surr)	*80*		*33 - 137*	*06/12/18 16:03*	*06/30/18 14:11*	*1*
DCB Decachlorobiphenyl (Surr)	*79*		*33 - 137*	*06/12/18 16:03*	*06/30/18 14:11*	*1*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		2.1	0.68	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1221	ND		2.1	1.4	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1232	ND		2.1	1.3	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1242	ND		2.1	1.3	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1248	ND		2.1	1.7	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1254	ND		2.1	1.4	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1260	ND		2.1	0.60	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1262	ND		2.1	1.5	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1
PCB-1268	ND		2.1	1.0	ug/Kg	☼	06/11/18 18:22	06/14/18 10:24	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*110*		*20 - 145*	*06/11/18 18:22*	*06/14/18 10:24*	*1*
DCB Decachlorobiphenyl (Surr)	*96*		*20 - 145*	*06/11/18 18:22*	*06/14/18 10:24*	*1*
Tetrachloro-m-xylene (Surr)	*93*		*20 - 131*	*06/11/18 18:22*	*06/14/18 10:24*	*1*
Tetrachloro-m-xylene (Surr)	*87*		*20 - 131*	*06/11/18 18:22*	*06/14/18 10:24*	*1*

Method: PCB - Total PCB Calculation

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Polychlorinated biphenyls, Total	ND		2.1	1.7	ug/Kg			06/26/18 05:29	1

Method: EPA 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.5**		0.26	0.067	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1
Cadmium	**0.44**		0.26	0.044	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1
Chromium	**11**		0.51	0.17	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1
Copper	**16**		0.51	0.29	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1
Lead	**23**		0.26	0.092	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1
Nickel	**11**		0.26	0.16	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1
Zinc	**52**		1.3	0.86	mg/Kg	☼	06/05/18 16:24	06/07/18 06:25	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.10**		0.070	0.016	mg/Kg	☼	06/12/18 10:04	06/12/18 15:27	1

Client Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	80.4		0.1	0.1	%			06/05/18 12:25	1
Total Organic Carbon - Duplicates	86000	H	5100	3800	mg/Kg	☼		06/16/18 14:31	1

Method: D2216-90 - Water (Moisture) Content

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Moisture Content	235.9				%			06/01/18 19:52	1

Method: D2937 - Density of Soil in Place by the Drive-Cylinder Method

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
In Place Density	0.357				g/cc			06/01/18 19:51	1

Method: D422 - Grain Size

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gravel	6.0				%			06/01/18 19:37	1
Sieve Size 3 inch - Percent Finer	100.0				% Passing			06/01/18 19:37	1
Sand	48.0				%			06/01/18 19:37	1
Sieve Size 2 inch - Percent Finer	100.0				% Passing			06/01/18 19:37	1
Coarse Sand	6.4				%			06/01/18 19:37	1
Sieve Size 1.5 inch - Percent Finer	100.0				% Passing			06/01/18 19:37	1
Medium Sand	15.9				%			06/01/18 19:37	1
Sieve Size 1 inch - Percent Finer	100.0				% Passing			06/01/18 19:37	1
Fine Sand	25.7				%			06/01/18 19:37	1
Sieve Size 0.75 inch - Percent Finer	100.0				% Passing			06/01/18 19:37	1
Sieve Size 0.375 inch - Percent Finer	100.0				% Passing			06/01/18 19:37	1
Silt	39.1				%			06/01/18 19:37	1
Clay	6.9				%			06/01/18 19:37	1
Sieve Size #4 - Percent Finer	94.0				% Passing			06/01/18 19:37	1
Sieve Size #10 - Percent Finer	87.6				% Passing			06/01/18 19:37	1
Sieve Size #20 - Percent Finer	79.4				% Passing			06/01/18 19:37	1
Sieve Size #40 - Percent Finer	71.7				% Passing			06/01/18 19:37	1
Sieve Size #60 - Percent Finer	64.2				% Passing			06/01/18 19:37	1
Sieve Size #80 - Percent Finer	58.5				% Passing			06/01/18 19:37	1
Sieve Size #100 - Percent Finer	55.4				% Passing			06/01/18 19:37	1
Sieve Size #200 - Percent Finer	46.0				% Passing			06/01/18 19:37	1
Hydrometer Reading 1 - Percent Finer	9.8				% Passing			06/01/18 19:37	1
Hydrometer Reading 2 - Percent Finer	9.8				% Passing			06/01/18 19:37	1
Hydrometer Reading 3 - Percent Finer	7.1				% Passing			06/01/18 19:37	1
Hydrometer Reading 4 - Percent Finer	7.1				% Passing			06/01/18 19:37	1
Hydrometer Reading 5 - Percent Finer	6.9				% Passing			06/01/18 19:37	1
Hydrometer Reading 6 - Percent Finer	2.7				% Passing			06/01/18 19:37	1
Hydrometer Reading 7 - Percent Finer	-0.7				% Passing			06/01/18 19:37	1

Method: D854 - Specific Gravity

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Specific Gravity at 20 deg Celsius	2.40				NONE			06/01/18 19:53	1

Client Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4

Date Collected: 05/31/18 13:50
Date Received: 05/31/18 16:07

Lab Sample ID: 200-43658-1

Matrix: Sediment
Percent Solids: 19.6

Method: LAB-BUR - Porosity

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Porosity	85.1				%			06/01/18 19:54	1
Void Ratio	5.7				NONE			06/01/18 19:54	1

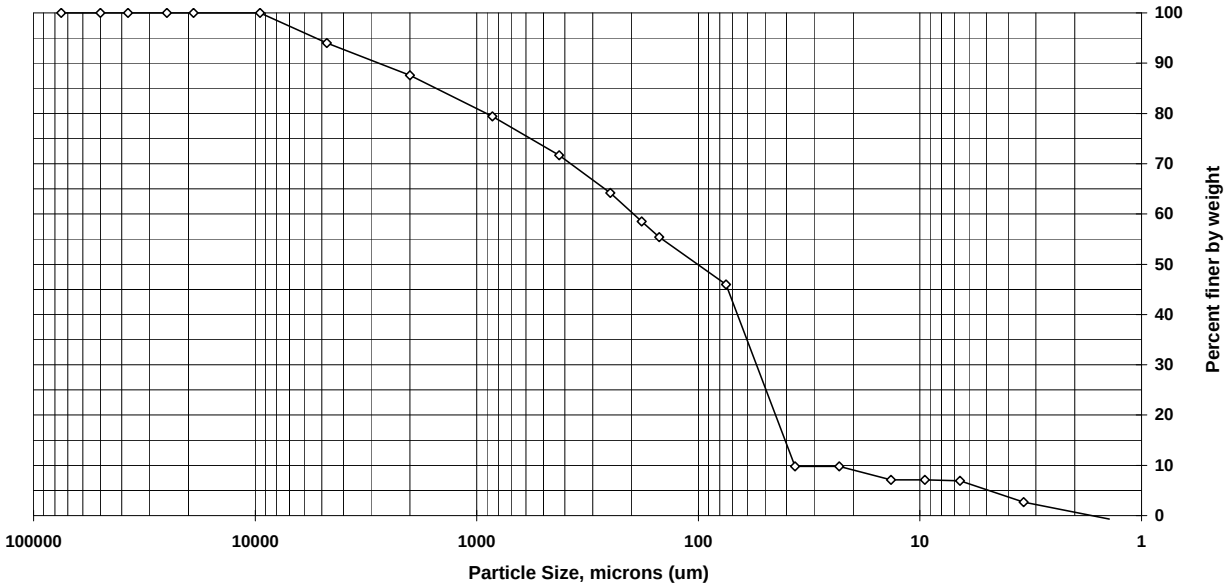
Particle Size of Soils by ASTM D422

				Date Received:	5/31/2018
Sample ID:	TRANSECT 4	**Percent Solids:**	29.1%	**Start Date:**	6/1/2018
Lab ID:	200-43658-G-1	**Specific Gravity:**	2.650	**End Date:**	6/7/2018

Shape (> #10): subrounded

Non-soil material: plant

Hardness (> #10): hard



Sieve size	Particle size, um	Percent finer	Incremental percent
3 inch	75000	100.0	0.0
2 inch	50000	100.0	0.0
1.5 inch	37500	100.0	0.0
1 inch	25000	100.0	0.0
3/4 inch	19000	100.0	0.0
3/8 inch	9500	100.0	0.0
#4	4750	94.0	6.0
#10	2000	87.6	6.4
#20	850	79.4	8.2
#40	425	71.7	7.7
#60	250	64.2	7.5
#80	180	58.5	5.7
#100	150	55.4	3.1
#200	75	46.0	9.4
Hyd1	36.6	9.8	36.2
Hyd2	23.1	9.8	0.0
Hyd3	13.5	7.1	2.7
Hyd4	9.5	7.1	0.0
Hyd5	6.6	6.9	0.2
Hyd6	3.4	2.7	4.2
Hyd7	1.4	-0.7	3.3

Soil Classification	Percent of sample
Gravel	6.0
Sand	48.0
Coarse Sand	6.4
Medium Sand	15.9
Fine Sand	25.7
Silt	39.1
Clay	6.9

TestAmerica Burlington

Sediment Grain Size - D422

Client	
Client Sample ID	TRANSECT 4
Lab Sample ID	200-43658-G-1

Date Received	5/31/2018
Start Date	06/01/2018 19:37
End Date	06/07/2018 23:28

Dry Weight Determination

Tin Weight	0.93	g
Wet Sample + Tin	25.04	g
Dry Sample + Tin	7.95	g
% Moisture	70.88	%

Non-soil material:	plant
Shape (> #10):	subrounded
Hardness (> #10):	hard

Date/Time in oven	06/01/2018 19:40
Date/Time out of oven	06/04/2018 17:14

Sample Weights	Tare (g)	Pan+Samp (g)	Samp (g)
Sample Weight (Wet)	47.69	254.27	206.58
Sample Weight (Oven Dried)			60.1

Sample Split (oven dried)	Tare (g)	Pan+Samp (g)	Samp (g)
Sample >=#10			7.42
Sample <#10			52.7
% Passing #10			25.5

Hydrometer Data

Serial Number	542325
Calib. Date (mm/dd/yyyy)	01/03/2018
Low Temp (C)	17.0
Reading at Low Temp	1.0030
High Temp (C)	23.0
Reading at High Temp	1.0020
Hydrometer Cal Slope	-0.000166667
Hydrometer Cal Intercept	1.005833333
Default Soil Gravity	2.6500

Gravel/Sand Fraction (Sieves)

Sample Fraction	Size (um)	Pan Tare (g)	Pan+Sample (g)	Sample		% Finer	Classification	Sub Class
3 inch	75000			0.00	g	100.0	Gravel	
2 inch	50000			0.00	g	100.0	Gravel	
1.5 inch	37500			0.00	g	100.0	Gravel	
1 inch	25000			0.00	g	100.0	Gravel	
3/4 inch	19000			0.00	g	100.0	Gravel	
3/8 inch	9500			0.00	g	100.0	Gravel	
#4	4750	488.08	491.67	3.59	g	94.0	Gravel	
#10	2000	462.71	466.54	3.83	g	87.6	Sand	Coarse
#20	850	378.97	383.89	4.92	g	79.4	Sand	Medium
#40	425	353.13	357.75	4.62	g	71.7	Sand	Medium
#60	250	348.15	352.65	4.50	g	64.2	Sand	Fine
#80	180	337.80	341.25	3.45	g	58.5	Sand	Fine
#100	150	328.39	330.26	1.87	g	55.4	Sand	Fine
#200	75	325.13	330.76	5.63	g	46.0	Sand	Fine
				0.00	g	46.0		

Adjusted Hydrometer Sample Mass

Hydrometer Sample Mass (g)	60.1

Silt/Clay Fraction (Hydrometer Test)

Hydrometer Test Time (min)	Actual	Spec. Gravity	Temp C	Particle Size (Micron)	% Finer	Classification	Sub Class
2	2	1.0060	21.0	36.6	9.8	Silt	
5	5	1.0060	21.0	23.1	9.8	Silt	
15	15	1.0050	21.0	13.5	7.13	Silt	
30	30	1.0050	21.0	9.5	7.13	Silt	
60	63	1.0050	20.5	6.6	6.9	Silt	
250	241	1.0035	20.0	3.4	2.67	Clay	
1440	1388	1.0020	21.5	1.4	-0.668	Clay	

Surrogate Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Method: EPA 8260C - Volatile Organic Compounds by GC/MS

Matrix: Sediment **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		DCA	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(62-118)	(76-111)	(72-116)	(80-129)
200-43658-1	TRANSECT 4	104	91	100	105
LCS 180-246394/3	Lab Control Sample	97	93	95	98
MB 180-246394/5	Method Blank	96	91	95	100

Surrogate Legend

DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level

Matrix: Sediment **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)					
		FBP	2FP	TBP	NBZ	PHL	TPHL
Lab Sample ID	Client Sample ID	(40-105)	(38-105)	(20-129)	(38-105)	(40-106)	(20-124)
200-43658-1	TRANSECT 4	47	51	44	52	53	54
LCS 180-247249/1-A	Lab Control Sample	64	65	66	63	69	74
MB 180-247249/2-A	Method Blank	57	56	50	55	62	71

Surrogate Legend

FBP = 2-Fluorobiphenyl
2FP = 2-Fluorophenol (Surr)
TBP = 2,4,6-Tribromophenol (Surr)
NBZ = Nitrobenzene-d5 (Surr)
PHL = Phenol-d5 (Surr)
TPHL = Terphenyl-d14 (Surr)

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Matrix: Sediment **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		TCX1	TCX2	DCB1	DCB2
Lab Sample ID	Client Sample ID	(26-120)	(26-120)	(33-137)	(33-137)
200-43658-1	TRANSECT 4	61	91	80	79
LCS 180-247381/1-B	Lab Control Sample	85	91	81	97
MB 180-247381/2-B	Method Blank	75	100	84	104

Surrogate Legend

TCX = Tetrachloro-m-xylene
DCB = DCB Decachlorobiphenyl (Surr)

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Matrix: Sediment **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		DCB1	DCB2	TCX1	TCX2
Lab Sample ID	Client Sample ID	(20-145)	(20-145)	(20-131)	(20-131)
200-43658-1	TRANSECT 4	110	96	93	87
LCS 180-247248/1-C	Lab Control Sample	102	122	89	84

Surrogate Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC) (Continued)

Matrix: Sediment **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)							
		DCB1	DCB2	TCX1	TCX2				
Lab Sample ID	**Client Sample ID**	**(20-145)**	**(20-145)**	**(20-131)**	**(20-131)**				
MB 180-247248/2-C	Method Blank	98	101	100	92				

Surrogate Legend

DCB = DCB Decachlorobiphenyl (Surr)
TCX = Tetrachloro-m-xylene (Surr)

Method: EPA 8260C - Volatile Organic Compounds by GC/MS

Lab Sample ID: MB 180-246394/5
Matrix: Sediment
Analysis Batch: 246394

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		5.0	2.5	ug/Kg			06/01/18 08:28	1
1,1,2,2-Tetrachloroethane	ND		5.0	3.0	ug/Kg			06/01/18 08:28	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		5.0	1.9	ug/Kg			06/01/18 08:28	1
1,1,2-Trichloroethane	ND		5.0	2.4	ug/Kg			06/01/18 08:28	1
1,1-Dichloroethane	ND		5.0	1.8	ug/Kg			06/01/18 08:28	1
1,1-Dichloroethene	ND		5.0	2.9	ug/Kg			06/01/18 08:28	1
1,2-Dibromo-3-Chloropropane	ND		5.0	3.1	ug/Kg			06/01/18 08:28	1
1,2-Dichlorobenzene	ND		5.0	4.0	ug/Kg			06/01/18 08:28	1
1,2-Dichloroethane	ND		5.0	1.5	ug/Kg			06/01/18 08:28	1
1,2-Dichloropropane	ND		5.0	2.5	ug/Kg			06/01/18 08:28	1
1,2,4-Trichlorobenzene	ND		5.0	1.6	ug/Kg			06/01/18 08:28	1
1,3-Dichlorobenzene	ND		5.0	1.6	ug/Kg			06/01/18 08:28	1
1,4-Dichlorobenzene	ND		5.0	1.0	ug/Kg			06/01/18 08:28	1
2-Butanone (MEK)	ND		5.0	2.9	ug/Kg			06/01/18 08:28	1
2-Hexanone	ND		5.0	4.2	ug/Kg			06/01/18 08:28	1
4-Methyl-2-pentanone (MIBK)	ND		5.0	1.9	ug/Kg			06/01/18 08:28	1
Acetone	ND		20	3.2	ug/Kg			06/01/18 08:28	1
Benzene	ND		5.0	2.0	ug/Kg			06/01/18 08:28	1
Bromoform	ND		5.0	2.6	ug/Kg			06/01/18 08:28	1
Bromomethane	ND		5.0	4.5	ug/Kg			06/01/18 08:28	1
Carbon disulfide	ND		5.0	3.0	ug/Kg			06/01/18 08:28	1
Carbon tetrachloride	ND		5.0	3.3	ug/Kg			06/01/18 08:28	1
Chlorobenzene	ND		5.0	1.6	ug/Kg			06/01/18 08:28	1
Chlorodibromomethane	ND		5.0	2.4	ug/Kg			06/01/18 08:28	1
Chloroform	ND		5.0	2.1	ug/Kg			06/01/18 08:28	1
Chloromethane	ND		5.0	3.9	ug/Kg			06/01/18 08:28	1
Chloroethane	ND		5.0	2.6	ug/Kg			06/01/18 08:28	1
cis-1,2-Dichloroethene	ND		5.0	1.6	ug/Kg			06/01/18 08:28	1
cis-1,3-Dichloropropene	ND		5.0	1.6	ug/Kg			06/01/18 08:28	1
Dichlorobromomethane	ND		5.0	2.4	ug/Kg			06/01/18 08:28	1
Dichlorodifluoromethane	ND		5.0	2.9	ug/Kg			06/01/18 08:28	1
Ethylbenzene	ND		5.0	2.2	ug/Kg			06/01/18 08:28	1
1,2-Dibromoethane	ND		5.0	2.7	ug/Kg			06/01/18 08:28	1
Cyclohexane	ND		5.0	1.2	ug/Kg			06/01/18 08:28	1
Isopropylbenzene	ND		5.0	2.3	ug/Kg			06/01/18 08:28	1
Methyl acetate	ND		25	5.9	ug/Kg			06/01/18 08:28	1
Methyl tert-butyl ether	ND		5.0	3.7	ug/Kg			06/01/18 08:28	1
Methylcyclohexane	ND		5.0	2.1	ug/Kg			06/01/18 08:28	1
Methylene Chloride	3.77	J	5.0	2.4	ug/Kg			06/01/18 08:28	1
Styrene	ND		5.0	1.3	ug/Kg			06/01/18 08:28	1
Tetrachloroethene	ND		5.0	2.0	ug/Kg			06/01/18 08:28	1
Toluene	ND		5.0	1.7	ug/Kg			06/01/18 08:28	1
trans-1,2-Dichloroethene	ND		5.0	2.5	ug/Kg			06/01/18 08:28	1
trans-1,3-Dichloropropene	ND		5.0	1.7	ug/Kg			06/01/18 08:28	1
Trichloroethene	ND		5.0	1.5	ug/Kg			06/01/18 08:28	1
Trichlorofluoromethane	ND		5.0	1.5	ug/Kg			06/01/18 08:28	1
Vinyl chloride	ND		5.0	3.7	ug/Kg			06/01/18 08:28	1
Xylenes, Total	ND		10	4.3	ug/Kg			06/01/18 08:28	1

QC Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Surrogate	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
1,2-Dichloroethane-d4 (Surr)	96		62 - 118		06/01/18 08:28	1
4-Bromofluorobenzene (Surr)	91		76 - 111		06/01/18 08:28	1
Dibromofluoromethane (Surr)	95		72 - 116		06/01/18 08:28	1
Toluene-d8 (Surr)	100		80 - 129		06/01/18 08:28	1

Lab Sample ID: LCS 180-246394/3
Matrix: Sediment
Analysis Batch: 246394

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1-Trichloroethane	40.0	40.1		ug/Kg		100	69 - 135
1,1,2,2-Tetrachloroethane	40.0	34.2		ug/Kg		85	71 - 125
1,1,2-Trichloro-1,2,2-trifluoroethane	40.0	35.6		ug/Kg		89	61 - 137
1,1,2-Trichloroethane	40.0	38.0		ug/Kg		95	78 - 118
1,1-Dichloroethane	40.0	39.8		ug/Kg		99	67 - 129
1,1-Dichloroethene	40.0	33.2		ug/Kg		83	59 - 128
1,2-Dibromo-3-Chloropropane	40.0	30.2		ug/Kg		75	54 - 129
1,2-Dichlorobenzene	40.0	39.1		ug/Kg		98	78 - 118
1,2-Dichloroethane	40.0	38.6		ug/Kg		97	67 - 123
1,2-Dichloropropane	40.0	40.3		ug/Kg		101	80 - 121
1,2,4-Trichlorobenzene	40.0	39.4		ug/Kg		99	65 - 135
1,3-Dichlorobenzene	40.0	39.8		ug/Kg		99	78 - 118
1,4-Dichlorobenzene	40.0	39.9		ug/Kg		100	78 - 118
2-Butanone (MEK)	40.0	36.7		ug/Kg		92	30 - 150
2-Hexanone	40.0	37.9		ug/Kg		95	36 - 150
4-Methyl-2-pentanone (MIBK)	40.0	37.1		ug/Kg		93	62 - 145
Acetone	40.0	41.4		ug/Kg		104	36 - 150
Benzene	40.0	39.4		ug/Kg		99	78 - 118
Bromoform	40.0	33.5		ug/Kg		84	56 - 150
Bromomethane	40.0	43.5		ug/Kg		109	34 - 150
Carbon disulfide	40.0	28.9		ug/Kg		72	66 - 128
Carbon tetrachloride	40.0	40.5		ug/Kg		101	60 - 137
Chlorobenzene	40.0	41.0		ug/Kg		103	78 - 118
Chlorodibromomethane	40.0	38.1		ug/Kg		95	58 - 140
Chloroform	40.0	39.8		ug/Kg		99	68 - 124
Chloromethane	40.0	48.2		ug/Kg		121	46 - 150
Chloroethane	40.0	48.0		ug/Kg		120	37 - 150
cis-1,2-Dichloroethene	40.0	38.6		ug/Kg		96	71 - 120
cis-1,3-Dichloropropene	40.0	42.7		ug/Kg		107	70 - 131
Dichlorobromomethane	40.0	38.5		ug/Kg		96	66 - 136
Dichlorodifluoromethane	40.0	47.7		ug/Kg		119	16 - 150
Ethylbenzene	40.0	40.5		ug/Kg		101	78 - 118
1,2-Dibromoethane	40.0	38.3		ug/Kg		96	78 - 118
Cyclohexane	40.0	37.8		ug/Kg		95	70 - 133
Isopropylbenzene	40.0	40.8		ug/Kg		102	76 - 123
Methyl acetate	80.0	64.8		ug/Kg		81	64 - 140
Methyl tert-butyl ether	40.0	37.6		ug/Kg		94	73 - 121
Methylcyclohexane	40.0	37.3		ug/Kg		93	75 - 124
Methylene Chloride	40.0	38.7		ug/Kg		97	68 - 120
m-Xylene & p-Xylene	40.0	40.8		ug/Kg		102	78 - 118
o-Xylene	40.0	40.8		ug/Kg		102	78 - 118
Styrene	40.0	41.3		ug/Kg		103	79 - 119
Tetrachloroethene	40.0	41.2		ug/Kg		103	78 - 118

Method: EPA 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCS 180-246394/3
Matrix: Sediment
Analysis Batch: 246394

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Toluene	40.0	41.1		ug/Kg		103	79 - 121
trans-1,2-Dichloroethene	40.0	38.1		ug/Kg		95	71 - 123
trans-1,3-Dichloropropene	40.0	39.8		ug/Kg		99	62 - 133
Trichloroethene	40.0	39.1		ug/Kg		98	76 - 120
Trichlorofluoromethane	40.0	50.2		ug/Kg		125	25 - 150
Vinyl chloride	40.0	48.1		ug/Kg		120	53 - 148
Xylenes, Total	80.0	81.6		ug/Kg		102	78 - 118

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*97*		*62 - 118*
4-Bromofluorobenzene (Surr)	*93*		*76 - 111*
Dibromofluoromethane (Surr)	*95*		*72 - 116*
Toluene-d8 (Surr)	*98*		*80 - 129*

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level

Lab Sample ID: MB 180-247249/2-A
Matrix: Sediment
Analysis Batch: 247601

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 247249

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		3.4	0.96	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Acenaphthylene	ND		3.4	0.73	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Anthracene	ND		3.4	0.87	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Benzo[a]anthracene	ND		3.4	0.63	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Benzo[a]pyrene	ND		3.4	0.73	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Benzo[b]fluoranthene	ND		3.4	0.82	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Benzo[g,h,i]perylene	ND		3.4	0.72	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Benzo[k]fluoranthene	ND		3.4	1.0	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Bis(2-chloroethyl)ether	ND		3.4	0.61	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Bis(2-chloroethoxy)methane	ND		17	0.80	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,2'-oxybis[1-chloropropane]	ND		3.4	1.2	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Bis(2-ethylhexyl) phthalate	ND		170	18	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4-Bromophenyl phenyl ether	ND		17	1.2	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Butyl benzyl phthalate	ND		17	12	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4-Chloroaniline	ND		17	0.56	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2-Chloronaphthalene	ND		3.4	0.77	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4-Chlorophenyl phenyl ether	ND		17	1.0	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Chrysene	ND		3.4	0.66	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Dibenz(a,h)anthracene	ND		3.4	0.75	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Dibenzofuran	ND		17	0.73	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Di-n-butyl phthalate	ND		17	7.3	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
3,3'-Dichlorobenzidine	ND		17	16	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Diethyl phthalate	ND		17	5.0	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Dimethyl phthalate	ND		17	0.61	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,4-Dinitrotoluene	ND		17	0.83	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,6-Dinitrotoluene	ND		17	1.0	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Di-n-octyl phthalate	ND		17	9.7	ug/Kg		06/11/18 18:25	06/14/18 14:21	1

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level (Continued)

Lab Sample ID: MB 180-247249/2-A
Matrix: Sediment
Analysis Batch: 247601

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 247249

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoranthene	ND		3.4	0.88	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Fluorene	ND		3.4	0.66	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Hexachlorobenzene	ND		3.4	1.2	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Hexachlorobutadiene	ND		3.4	0.98	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Hexachlorocyclopentadiene	ND		17	0.85	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Hexachloroethane	ND		17	0.86	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Indeno[1,2,3-cd]pyrene	ND		3.4	0.68	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Isophorone	ND		17	0.85	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2-Methylnaphthalene	ND		3.4	0.80	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Naphthalene	ND		3.4	0.65	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2-Nitroaniline	ND		85	7.6	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
3-Nitroaniline	ND		85	4.2	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4-Nitroaniline	ND		85	0.81	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Nitrobenzene	ND		33	6.1	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
N-Nitrosodi-n-propylamine	ND		3.4	1.1	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
N-Nitrosodiphenylamine	ND		17	5.6	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Phenanthrene	ND		3.4	0.90	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Pyrene	ND		3.4	0.79	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Carbazole	ND		3.4	0.78	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Acetophenone	ND		34	0.91	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Atrazine	ND		34	7.3	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Benzaldehyde	ND		34	2.1	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
1,1'-Biphenyl	ND		17	0.70	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Caprolactam	ND		85	11	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4-Chloro-3-methylphenol	ND		17	0.79	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2-Chlorophenol	ND		17	0.78	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2-Methylphenol	ND		17	4.8	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Methylphenol, 3 & 4	ND		17	4.9	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,4-Dichlorophenol	ND		3.4	1.3	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,4-Dimethylphenol	ND		17	1.0	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,4-Dinitrophenol	ND		170	45	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4,6-Dinitro-2-methylphenol	ND		85	29	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2-Nitrophenol	ND		17	0.96	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
4-Nitrophenol	ND		85	12	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Pentachlorophenol	ND		85	27	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
Phenol	ND		17	5.1	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,4,5-Trichlorophenol	ND		17	1.2	ug/Kg		06/11/18 18:25	06/14/18 14:21	1
2,4,6-Trichlorophenol	ND		17	0.92	ug/Kg		06/11/18 18:25	06/14/18 14:21	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*57*		*40 - 105*	*06/11/18 18:25*	*06/14/18 14:21*	*1*
2-Fluorophenol (Surr)	*56*		*38 - 105*	*06/11/18 18:25*	*06/14/18 14:21*	*1*
2,4,6-Tribromophenol (Surr)	*50*		*20 - 129*	*06/11/18 18:25*	*06/14/18 14:21*	*1*
Nitrobenzene-d5 (Surr)	*55*		*38 - 105*	*06/11/18 18:25*	*06/14/18 14:21*	*1*
Phenol-d5 (Surr)	*62*		*40 - 106*	*06/11/18 18:25*	*06/14/18 14:21*	*1*
Terphenyl-d14 (Surr)	*71*		*20 - 124*	*06/11/18 18:25*	*06/14/18 14:21*	*1*

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level (Continued)

Lab Sample ID: LCS 180-247249/1-A
Matrix: Sediment
Analysis Batch: 247601

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 247249

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	333	245		ug/Kg		74	43 - 100
Acenaphthylene	333	245		ug/Kg		74	43 - 100
Anthracene	333	250		ug/Kg		75	48 - 100
Benzo[a]anthracene	333	235		ug/Kg		70	46 - 100
Benzo[a]pyrene	333	243		ug/Kg		73	46 - 100
Benzo[b]fluoranthene	333	214		ug/Kg		64	42 - 100
Benzo[g,h,i]perylene	333	250		ug/Kg		75	45 - 100
Benzo[k]fluoranthene	333	241		ug/Kg		72	45 - 100
Bis(2-chloroethyl)ether	333	205		ug/Kg		61	42 - 100
Bis(2-chloroethoxy)methane	333	192		ug/Kg		58	43 - 100
2,2'-oxybis[1-chloropropane]	333	280		ug/Kg		84	27 - 108
Bis(2-ethylhexyl) phthalate	333	292		ug/Kg		88	41 - 121
4-Bromophenyl phenyl ether	333	200		ug/Kg		60	46 - 105
Butyl benzyl phthalate	333	300		ug/Kg		90	42 - 117
4-Chloroaniline	333	220		ug/Kg		66	48 - 100
2-Chloronaphthalene	333	216		ug/Kg		65	44 - 100
4-Chlorophenyl phenyl ether	333	197		ug/Kg		59	44 - 100
Chrysene	333	234		ug/Kg		70	47 - 100
Dibenz(a,h)anthracene	333	241		ug/Kg		72	47 - 100
Dibenzofuran	333	245		ug/Kg		74	48 - 100
Di-n-butyl phthalate	333	274		ug/Kg		82	48 - 105
3,3'-Dichlorobenzidine	333	204		ug/Kg		61	34 - 104
Diethyl phthalate	333	230		ug/Kg		69	41 - 105
Dimethyl phthalate	333	213		ug/Kg		64	45 - 100
2,4-Dinitrotoluene	333	252		ug/Kg		76	45 - 106
2,6-Dinitrotoluene	333	248		ug/Kg		74	45 - 105
Di-n-octyl phthalate	333	270		ug/Kg		81	38 - 122
Fluoranthene	333	230		ug/Kg		69	47 - 100
Fluorene	333	226		ug/Kg		68	45 - 100
Hexachlorobenzene	333	205		ug/Kg		62	45 - 104
Hexachlorobutadiene	333	139		ug/Kg		42	41 - 101
Hexachlorocyclopentadiene	333	160		ug/Kg		48	24 - 108
Hexachloroethane	333	197		ug/Kg		59	46 - 100
Indeno[1,2,3-cd]pyrene	333	241		ug/Kg		72	46 - 100
Isophorone	333	192		ug/Kg		57	45 - 100
2-Methylnaphthalene	333	229		ug/Kg		69	48 - 100
Naphthalene	333	206		ug/Kg		62	46 - 100
2-Nitroaniline	333	231		ug/Kg		69	40 - 115
3-Nitroaniline	333	277		ug/Kg		83	40 - 104
4-Nitroaniline	333	273		ug/Kg		82	37 - 107
Nitrobenzene	333	188		ug/Kg		56	43 - 100
N-Nitrosodi-n-propylamine	333	230		ug/Kg		69	46 - 100
N-Nitrosodiphenylamine	333	262		ug/Kg		79	45 - 102
Phenanthrene	333	238		ug/Kg		71	46 - 100
Pyrene	333	246		ug/Kg		74	41 - 100
Carbazole	333	281		ug/Kg		84	47 - 100
Acetophenone	333	197		ug/Kg		59	41 - 100
Atrazine	333	157		ug/Kg		47	19 - 100

Method: EPA 8270D LL - Semivolatile Organic Compounds by GC/MS - Low Level (Continued)

Lab Sample ID: LCS 180-247249/1-A
Matrix: Sediment
Analysis Batch: 247601

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 247249

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzaldehyde	333	22.2	J *	ug/Kg		7	10 - 150
1,1'-Biphenyl	333	235		ug/Kg		71	44 - 100
Caprolactam	333	242		ug/Kg		73	41 - 112
4-Chloro-3-methylphenol	333	206		ug/Kg		62	47 - 101
2-Chlorophenol	333	224		ug/Kg		67	47 - 100
2-Methylphenol	333	221		ug/Kg		66	46 - 100
Methylphenol, 3 & 4	333	235		ug/Kg		70	46 - 100
2,4-Dichlorophenol	333	184		ug/Kg		55	48 - 100
2,4-Dimethylphenol	333	193		ug/Kg		58	49 - 100
2,4-Dinitrophenol	667	383		ug/Kg		58	31 - 110
4,6-Dinitro-2-methylphenol	667	459		ug/Kg		69	40 - 114
2-Nitrophenol	333	249		ug/Kg		75	48 - 101
4-Nitrophenol	667	293		ug/Kg		44	23 - 136
Pentachlorophenol	667	386		ug/Kg		58	25 - 114
Phenol	333	212		ug/Kg		64	46 - 100
2,4,5-Trichlorophenol	333	183		ug/Kg		55	43 - 103
2,4,6-Trichlorophenol	333	188		ug/Kg		56	45 - 104

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl	*64*		*40 - 105*
2-Fluorophenol (Surr)	*65*		*38 - 105*
2,4,6-Tribromophenol (Surr)	*66*		*20 - 129*
Nitrobenzene-d5 (Surr)	*63*		*38 - 105*
Phenol-d5 (Surr)	*69*		*40 - 106*
Terphenyl-d14 (Surr)	*74*		*20 - 124*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Lab Sample ID: MB 180-247381/2-B
Matrix: Sediment
Analysis Batch: 249177

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 247381

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.042	0.013	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
alpha-BHC	ND		0.042	0.010	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
beta-BHC	ND		0.042	0.011	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
delta-BHC	ND		0.042	0.013	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
gamma-BHC (Lindane)	ND		0.042	0.014	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
cis-Chlordane	ND		0.042	0.010	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
trans-Chlordane	ND		0.042	0.0097	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
oxy-Chlordane	ND		0.042	0.0093	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
4,4'-DDD	ND		0.042	0.011	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Chlordane (technical)	ND		0.42	0.18	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
4,4'-DDE	ND		0.042	0.0085	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
4,4'-DDT	ND		0.042	0.016	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Dieldrin	ND		0.042	0.010	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Endosulfan I	ND		0.042	0.011	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
2,4'-DDD	0.0229	J p	0.042	0.0074	ug/Kg		06/12/18 16:03	06/30/18 14:59	1

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Lab Sample ID: MB 180-247381/2-B
Matrix: Sediment
Analysis Batch: 249177

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 247381

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Endosulfan II	ND		0.042	0.0092	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Endosulfan sulfate	ND		0.042	0.011	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
2,4'-DDE	ND		0.042	0.011	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Endrin	ND		0.042	0.016	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Endrin aldehyde	ND		0.042	0.015	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
2,4'-DDT	ND		0.042	0.016	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Endrin ketone	ND		0.042	0.015	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Heptachlor	ND		0.042	0.013	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Heptachlor epoxide	ND		0.042	0.011	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Methoxychlor	ND		0.042	0.016	ug/Kg		06/12/18 16:03	06/30/18 14:59	1
Toxaphene	ND		1.7	1.1	ug/Kg		06/12/18 16:03	06/30/18 14:59	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene	*75*		*26 - 120*	*06/12/18 16:03*	*06/30/18 14:59*	*1*
Tetrachloro-m-xylene	*100*		*26 - 120*	*06/12/18 16:03*	*06/30/18 14:59*	*1*
DCB Decachlorobiphenyl (Surr)	*84*		*33 - 137*	*06/12/18 16:03*	*06/30/18 14:59*	*1*
DCB Decachlorobiphenyl (Surr)	*104*		*33 - 137*	*06/12/18 16:03*	*06/30/18 14:59*	*1*

Lab Sample ID: LCS 180-247381/1-B
Matrix: Sediment
Analysis Batch: 249177

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 247381

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aldrin	1.67	1.30		ug/Kg		78	37 - 121
alpha-BHC	1.67	1.27		ug/Kg		76	39 - 114
beta-BHC	1.67	1.30		ug/Kg		78	37 - 113
delta-BHC	1.67	0.999		ug/Kg		60	12 - 100
gamma-BHC (Lindane)	1.67	1.30		ug/Kg		78	38 - 115
cis-Chlordane	1.67	1.27		ug/Kg		76	35 - 121
trans-Chlordane	1.67	1.28		ug/Kg		77	36 - 121
4,4'-DDD	1.67	1.34		ug/Kg		81	48 - 119
4,4'-DDE	1.67	1.28		ug/Kg		77	47 - 118
4,4'-DDT	1.67	1.28		ug/Kg		77	29 - 123
Dieldrin	1.67	1.33		ug/Kg		80	46 - 119
Endosulfan I	1.67	1.33		ug/Kg		80	36 - 120
Endosulfan II	1.67	1.39		ug/Kg		83	46 - 114
Endosulfan sulfate	1.67	1.19		ug/Kg		72	40 - 104
Endrin	1.67	1.32		ug/Kg		79	45 - 118
Endrin aldehyde	1.67	1.40		ug/Kg		84	39 - 109
Endrin ketone	1.67	1.35		ug/Kg		81	44 - 114
Heptachlor	1.67	1.38		ug/Kg		83	38 - 122
Heptachlor epoxide	1.67	1.33		ug/Kg		80	36 - 123
Methoxychlor	1.67	1.44		ug/Kg		87	34 - 126

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Tetrachloro-m-xylene	*85*		*26 - 120*
Tetrachloro-m-xylene	*91*		*26 - 120*

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Lab Sample ID: LCS 180-247381/1-B
Matrix: Sediment
Analysis Batch: 249177

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 247381

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
DCB Decachlorobiphenyl (Surr)	*81*		*33 - 137*
DCB Decachlorobiphenyl (Surr)	*97*		*33 - 137*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Lab Sample ID: MB 180-247248/2-C
Matrix: Sediment
Analysis Batch: 247550

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 247248

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.42	0.14	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1221	ND		0.42	0.27	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1232	ND		0.42	0.25	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1242	ND		0.42	0.25	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1248	ND		0.42	0.33	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1254	ND		0.42	0.28	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1260	ND		0.42	0.12	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1262	ND		0.42	0.29	ug/Kg		06/11/18 18:22	06/14/18 08:38	1
PCB-1268	ND		0.42	0.20	ug/Kg		06/11/18 18:22	06/14/18 08:38	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*98*		*20 - 145*	*06/11/18 18:22*	*06/14/18 08:38*	*1*
DCB Decachlorobiphenyl (Surr)	*101*		*20 - 145*	*06/11/18 18:22*	*06/14/18 08:38*	*1*
Tetrachloro-m-xylene (Surr)	*100*		*20 - 131*	*06/11/18 18:22*	*06/14/18 08:38*	*1*
Tetrachloro-m-xylene (Surr)	*92*		*20 - 131*	*06/11/18 18:22*	*06/14/18 08:38*	*1*

Lab Sample ID: LCS 180-247248/1-C
Matrix: Sediment
Analysis Batch: 247550

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 247248

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
PCB-1016	33.3	26.8		ug/Kg		81	32 - 120
PCB-1260	33.3	25.6		ug/Kg		77	35 - 117

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
DCB Decachlorobiphenyl (Surr)	*102*		*20 - 145*
DCB Decachlorobiphenyl (Surr)	*122*		*20 - 145*
Tetrachloro-m-xylene (Surr)	*89*		*20 - 131*
Tetrachloro-m-xylene (Surr)	*84*		*20 - 131*

QC Sample Results

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Method: EPA 6020A - Metals (ICP/MS)

Lab Sample ID: MB 180-246765/1-A
Matrix: Sediment
Analysis Batch: 246996

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 246765

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.050	0.013	mg/Kg		06/05/18 16:24	06/07/18 04:12	1
Cadmium	ND		0.050	0.0085	mg/Kg		06/05/18 16:24	06/07/18 04:12	1
Chromium	ND		0.10	0.033	mg/Kg		06/05/18 16:24	06/07/18 04:12	1
Copper	ND		0.10	0.057	mg/Kg		06/05/18 16:24	06/07/18 04:12	1
Lead	ND		0.050	0.018	mg/Kg		06/05/18 16:24	06/07/18 04:12	1
Nickel	ND		0.050	0.031	mg/Kg		06/05/18 16:24	06/07/18 04:12	1
Zinc	ND		0.25	0.17	mg/Kg		06/05/18 16:24	06/07/18 04:12	1

Lab Sample ID: LCS 180-246765/2-A
Matrix: Sediment
Analysis Batch: 246996

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 246765

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	2.00	1.74		mg/Kg		87	80 - 120
Cadmium	2.50	2.50		mg/Kg		100	80 - 120
Chromium	10.0	9.67		mg/Kg		97	80 - 120
Copper	12.5	12.2		mg/Kg		97	80 - 120
Lead	1.00	1.02		mg/Kg		102	80 - 120
Nickel	25.0	24.3		mg/Kg		97	80 - 120
Zinc	25.0	22.8		mg/Kg		91	80 - 120

Method: EPA 7471B - Mercury (CVAA)

Lab Sample ID: MB 180-247296/1-A
Matrix: Sediment
Analysis Batch: 247408

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 247296

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.016	0.0037	mg/Kg		06/12/18 10:04	06/12/18 15:20	1

Lab Sample ID: LCS 180-247296/2-A
Matrix: Sediment
Analysis Batch: 247408

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 247296

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.205	0.198		mg/Kg		97	80 - 120

Method: EPA-Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: MB 180-247873/3
Matrix: Sediment
Analysis Batch: 247873

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1000	750	mg/Kg			06/16/18 10:47	1

Method: EPA-Lloyd Kahn - Organic Carbon, Total (TOC) (Continued)

Lab Sample ID: LCS 180-247873/4
Matrix: Sediment
Analysis Batch: 247873

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Total Organic Carbon - Duplicates			37800	30700		mg/Kg		81	75 - 125		

Lab Sample ID: MB 180-247984/3
Matrix: Sediment
Analysis Batch: 247984

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1000	750	mg/Kg			06/18/18 19:05	1

Lab Sample ID: LCS 180-247984/4
Matrix: Sediment
Analysis Batch: 247984

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Total Organic Carbon - Duplicates			37800	29800		mg/Kg		79	75 - 125		

QC Association Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

GC/MS VOA

Analysis Batch: 246394

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA 8260C	246398
MB 180-246394/5	Method Blank	Total/NA	Sediment	EPA 8260C	
LCS 180-246394/3	Lab Control Sample	Total/NA	Sediment	EPA 8260C	

Prep Batch: 246398

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	5035	

GC/MS Semi VOA

Prep Batch: 247249

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3541	
MB 180-247249/2-A	Method Blank	Total/NA	Sediment	3541	
LCS 180-247249/1-A	Lab Control Sample	Total/NA	Sediment	3541	

Analysis Batch: 247601

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA 8270D LL	247249
MB 180-247249/2-A	Method Blank	Total/NA	Sediment	EPA 8270D LL	247249
LCS 180-247249/1-A	Lab Control Sample	Total/NA	Sediment	EPA 8270D LL	247249

GC Semi VOA

Prep Batch: 247248

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3541	
MB 180-247248/2-C	Method Blank	Total/NA	Sediment	3541	
LCS 180-247248/1-C	Lab Control Sample	Total/NA	Sediment	3541	

Cleanup Batch: 247287

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3665A	247248
MB 180-247248/2-C	Method Blank	Total/NA	Sediment	3665A	247248
LCS 180-247248/1-C	Lab Control Sample	Total/NA	Sediment	3665A	247248

Cleanup Batch: 247288

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3660B	247287
MB 180-247248/2-C	Method Blank	Total/NA	Sediment	3660B	247287
LCS 180-247248/1-C	Lab Control Sample	Total/NA	Sediment	3660B	247287

Prep Batch: 247381

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3541	
MB 180-247381/2-B	Method Blank	Total/NA	Sediment	3541	
LCS 180-247381/1-B	Lab Control Sample	Total/NA	Sediment	3541	

GC Semi VOA (Continued)

Analysis Batch: 247550

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA 8082A	247288
MB 180-247248/2-C	Method Blank	Total/NA	Sediment	EPA 8082A	247288
LCS 180-247248/1-C	Lab Control Sample	Total/NA	Sediment	EPA 8082A	247288

Cleanup Batch: 248468

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3640A	247381
MB 180-247381/2-B	Method Blank	Total/NA	Sediment	3640A	247381
LCS 180-247381/1-B	Lab Control Sample	Total/NA	Sediment	3640A	247381

Analysis Batch: 248608

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	PCB	

Analysis Batch: 249177

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA 8081B LL	248468
MB 180-247381/2-B	Method Blank	Total/NA	Sediment	EPA 8081B LL	248468
LCS 180-247381/1-B	Lab Control Sample	Total/NA	Sediment	EPA 8081B LL	248468

Metals

Prep Batch: 246765

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	3050B	
MB 180-246765/1-A	Method Blank	Total/NA	Sediment	3050B	
LCS 180-246765/2-A	Lab Control Sample	Total/NA	Sediment	3050B	

Analysis Batch: 246996

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA 6020A	246765
MB 180-246765/1-A	Method Blank	Total/NA	Sediment	EPA 6020A	246765
LCS 180-246765/2-A	Lab Control Sample	Total/NA	Sediment	EPA 6020A	246765

Prep Batch: 247296

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	7471B	
MB 180-247296/1-A	Method Blank	Total/NA	Sediment	7471B	
LCS 180-247296/2-A	Lab Control Sample	Total/NA	Sediment	7471B	

Analysis Batch: 247408

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA 7471B	247296
MB 180-247296/1-A	Method Blank	Total/NA	Sediment	EPA 7471B	247296
LCS 180-247296/2-A	Lab Control Sample	Total/NA	Sediment	EPA 7471B	247296

QC Association Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

General Chemistry

Analysis Batch: 246719

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	2540G	

Analysis Batch: 247873

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	EPA-Lloyd Kahn	
MB 180-247873/3	Method Blank	Total/NA	Sediment	EPA-Lloyd Kahn	
LCS 180-247873/4	Lab Control Sample	Total/NA	Sediment	EPA-Lloyd Kahn	

Analysis Batch: 247984

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 180-247984/3	Method Blank	Total/NA	Sediment	EPA-Lloyd Kahn	
LCS 180-247984/4	Lab Control Sample	Total/NA	Sediment	EPA-Lloyd Kahn	

Geotechnical

Analysis Batch: 130197

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	D2937	

Analysis Batch: 130198

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	D2216-90	

Analysis Batch: 130199

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	D854	

Analysis Batch: 130200

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	LAB-BUR	

Analysis Batch: 130382

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
200-43658-1	TRANSECT 4	Total/NA	Sediment	D422	

Lab Chronicle

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Client Sample ID: TRANSECT 4

Lab Sample ID: 200-43658-1
Date Collected: 05/31/18 13:50
Matrix: Sediment
Date Received: 05/31/18 16:07

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	PCB		1	248608	06/26/18 05:29	JMO	TAL PIT
Total/NA	Analysis	2540G		1	246719	06/05/18 12:25	RSR	TAL PIT
Total/NA	Analysis	D2216-90		1	130198	06/01/18 19:52	MAP	TAL BUR
Total/NA	Analysis	D2937		1	130197	06/01/18 19:51	MAP	TAL BUR
Total/NA	Analysis	D422		1	130382	06/01/18 19:37	MAP	TAL BUR
Total/NA	Analysis	D854		1	130199	06/01/18 19:53	MAP	TAL BUR
Total/NA	Analysis	LAB-BUR		1	130200	06/01/18 19:54	MAP	TAL BUR

Client Sample ID: TRANSECT 4

Lab Sample ID: 200-43658-1
Date Collected: 05/31/18 13:50
Matrix: Sediment
Date Received: 05/31/18 16:07
Percent Solids: 19.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			246398	06/01/18 12:12	KLG	TAL PIT
Total/NA	Analysis	EPA 8260C		1	246394	06/01/18 14:18	KLG	TAL PIT
Total/NA	Prep	3541			247249	06/11/18 18:25	DLL	TAL PIT
Total/NA	Analysis	EPA 8270D LL		10	247601	06/14/18 18:55	DLF	TAL PIT
Total/NA	Prep	3541			247381	06/12/18 16:03	DLL	TAL PIT
Total/NA	Cleanup	3640A			248468	06/24/18 15:08	MAL	TAL PIT
Total/NA	Analysis	EPA 8081B LL		1	249177	06/30/18 14:11	DFE	TAL PIT
Total/NA	Prep	3541			247248	06/11/18 18:22	DLL	TAL PIT
Total/NA	Cleanup	3665A			247287	06/12/18 09:14	JMO	TAL PIT
Total/NA	Cleanup	3660B			247288	06/12/18 09:16	JMO	TAL PIT
Total/NA	Analysis	EPA 8082A		1	247550	06/14/18 10:24	JMO	TAL PIT
Total/NA	Prep	3050B			246765	06/05/18 16:24	KA	TAL PIT
Total/NA	Analysis	EPA 6020A		1	246996	06/07/18 06:25	WTR	TAL PIT
Total/NA	Prep	7471B			247296	06/12/18 10:04	RJR	TAL PIT
Total/NA	Analysis	EPA 7471B		1	247408	06/12/18 15:27	RJR	TAL PIT
Total/NA	Analysis	EPA-Lloyd Kahn		1	247873	06/16/18 14:31	JBF	TAL PIT

Laboratory References:

TAL BUR = TestAmerica Burlington, 30 Community Drive, Suite 11, South Burlington, VT 05403, TEL (802)660-1990

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Accreditation/Certification Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Laboratory: TestAmerica Burlington

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
ANAB	DoD ELAP		L2336	02-25-20
Connecticut	State Program	1	PH-0751	09-30-19
DE Haz. Subst. Cleanup Act (HSCA)	State Program	3	NA	02-01-19
Florida	NELAP	4	E87467	06-30-18 *
Maine	State Program	1	VT00008	04-17-19
Minnesota	NELAP	5	050-999-436	12-31-18
New Jersey	NELAP	2	VT972	06-30-18 *
New York	NELAP	2	10391	04-01-19
Pennsylvania	NELAP	3	68-00489	04-30-19
Rhode Island	State Program	1	LAO00298	12-30-18
US Fish & Wildlife	Federal		LE-058448-0	07-31-18
USDA	Federal		P330-11-00093	07-24-20
Vermont	State Program	1	VT-4000	12-31-18
Virginia	NELAP	3	460209	12-14-18

Laboratory: TestAmerica Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Arkansas DEQ	State Program	6	88-0690	06-27-18 *
California	State Program	9	2891	04-30-19
Connecticut	State Program	1	PH-0688	09-30-18
Florida	NELAP	4	E871008	06-30-19
Illinois	NELAP	5	200005	06-30-19
Kansas	NELAP	7	E-10350	01-31-19
Louisiana	NELAP	6	04041	06-30-18 *
Nevada	State Program	9	PA00164	07-31-18
New Hampshire	NELAP	1	2030	04-04-19
New Jersey	NELAP	2	PA005	06-30-19
New York	NELAP	2	11182	03-31-19
North Carolina (WW/SW)	State Program	4	434	12-31-18
Oregon	NELAP	10	PA-2151	01-28-19
Pennsylvania	NELAP	3	02-00416	04-30-19
South Carolina	State Program	4	89014	04-30-18 *
Texas	NELAP	6	T104704528-15-2	03-31-19
US Fish & Wildlife	Federal		LE94312A-1	07-31-18
USDA	Federal		P330-16-00211	06-26-19
Utah	NELAP	8	PA001462015-4	05-31-18 *
Virginia	NELAP	3	460189	09-14-18
West Virginia DEP	State Program	3	142	01-31-19
Wisconsin	State Program	5	998027800	08-31-18

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Method	Method Description	Protocol	Laboratory
EPA 8260C	Volatile Organic Compounds by GC/MS	SW846	TAL PIT
EPA 8270D LL	Semivolatile Organic Compounds by GC/MS - Low Level	SW846	TAL PIT
EPA 8081B LL	Organochlorine Pesticides (GC)	SW846	TAL PIT
EPA 8082A	Polychlorinated Biphenyls (PCBs) (GC)	SW846	TAL PIT
PCB	Total PCB Calculation	TAL SOP	TAL PIT
EPA 6020A	Metals (ICP/MS)	SW846	TAL PIT
EPA 7471B	Mercury (CVAA)	SW846	TAL PIT
2540G	SM 2540G	SM22	TAL PIT
EPA-Lloyd Kahn	Organic Carbon, Total (TOC)	EPA	TAL PIT
D2216-90	Water (Moisture) Content	ASTM	TAL BUR
D2937	Density of Soil in Place by the Drive-Cylinder Method	ASTM	TAL BUR
D422	Grain Size	ASTM	TAL BUR
D854	Specific Gravity	ASTM	TAL BUR
LAB-BUR	Porosity	ASTM	TAL BUR
3050B	Preparation, Metals	SW846	TAL PIT
3541	Automated Soxhlet Extraction (Low Level)	SW846	TAL PIT
3640A	Gel-Permeation Cleanup	SW846	TAL PIT
3660B	Sulfur Cleanup	SW846	TAL PIT
3665A	Sulfuric Acid/Permanganate Cleanup	SW846	TAL PIT
5035	Closed System Purge and Trap	SW846	TAL PIT
7471B	Preparation, Mercury	SW846	TAL PIT

Protocol References:

ASTM = ASTM International
EPA = US Environmental Protection Agency
SM22 = Standard Methods For The Examination Of Water And Wastewater, 22nd Edition
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.
TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

TAL BUR = TestAmerica Burlington, 30 Community Drive, Suite 11, South Burlington, VT 05403, TEL (802)660-1990
TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Sample Summary

Client: Gomez and Sullivan Engineers, D.P.C.
Project/Site: Vermont Sediment Project REVISED

TestAmerica Job ID: 200-43658-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
200-43658-1	TRANSECT 4	Sediment	05/31/18 13:50	05/31/18 16:07

TestAmerica Burlington
30 Community Drive
Suite 11
South Burlington, VT 05403-6809
phone 802.660.1990 fax 802.660.1919

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	
Your Company Name here	Gomez and Sullivan
Address	41 Liberty Hill Road PO Box 2179
City/State/Zip	Henniker NH 03242
(xxx) xxx-xxxx	603-428-4960 Phone
(xxx) xxx-xxxx	FAX
Project Name:	Mill Pond
Site:	
P O #	

Project Manager: Elisabeth Bleistine
Tel/Fax: 603-428-4960
Site Contact:
Lab Contact: Carrie Gambler
Date: 5/31/18
Carrier: Client Drop off

Analysis Turnaround Time
☐ CALENDAR DAYS ☐ WORKING DAYS
TAT if different from Below _____
☐ 2 weeks
☐ 1 week
☐ 2 days
☐ 1 day

COC No: 1 of 1 COCs
Sampler:
For Lab Use Only:
Walk-in Client:
Lab Sampling:
Job / SDG No.:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y/N)	Perform MS / MSD (Y/N)	8260	SVOC	Pest	PCB	Metals	TOC	Moisture	D422 to therapeo	Sample Specific Notes:
Transect 4	5/31/18	1350	Core	S	7	N		X	X	X	X	X	X	X	X	

200-43658 Chain of Custody

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☑ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☑ Disposal by Lab ☐ Archive for Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No
Custody Seal No.:
Cooler Temp. (°C): Obs'd:_____ Corr'd:_____ Therm ID No.:_____

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Elisabeth A Bleistine	Gomez and Sullivan	5/31/18 4:07			
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:
				TABL	5/31/18 1607

Form No. CA-C-WI-002, Rev. 4.14, dated 9/22/2017

TestAmerica Burlington
30 Community Drive Suite 11
South Burlington, VT 05403
Phone (802) 660-1990 Fax (802) 660-1919

96 F2

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Gamber, Carrie L	Carrier Tracking No(s):	COC No: 200-35314.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: carrie.gamber@testamericainc.com	State of Origin: Vermont	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 200-43658-1
Address: 301 Alpha Drive, RIDC Park,	Due Date Requested: 6/1/2018			
City: Pittsburgh	TAT Requested (days):			
State, Zip: PA, 15238				
Phone: 412-963-7058(Tel) 412-963-2468(Fax)	PO #:			
Email:	WO #:			
Project Name: Vermont Sediment Project REVISED	Project #: 18019003			
Site:	SSOW#:			

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Other:

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	Moisture/ (MOD) Percent Moisture	8260C/5035FP_Calc TCL 4.2 GC/MS Volatiles	8260C/5035FM_Calc TCL 4.2 GC/MS Volatiles	8270D_LL/3541_LL TCL 4.2 Semivolatiles	8081B_LL/3541_LL (MOD) TCL Pesticides 8081B Low Level	8082A_LL/3541_LL (MOD) TCL PCBs LL	Total_PCB/ (MOD) Local Method	6020A/3050B (MOD) Sb,As,Ba,Be,Cd,Cr,Cu,Pb,Ni,Se,Ag,T	7471B/7471B_Prep Mercury (CVAA)	Lloyd_Kahn_Mod				Total Number of containers	Spe
			Preservation Code:																		
TRANSECT 4 (200-43658-1)	5/31/18	13:50 Eastern		Sediment			X	X	X	X	X	X	X	X	X	X				6	

200-43658 Chain of Custody

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to TestAmerica Laboratories, Inc.

Possible Hazard Identification *Unconfirmed*	***Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)*** ☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:		Method of Shipment:		
Relinquished by:	Date/Time: 5/31/18 1700	Company: TASUR	Received by:	Date/Time: 6-1-18 950	Company: TAPitt	
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company	
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company	
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks:			

Ver: 09/20/2016

Login Sample Receipt Checklist

Client: Gomez and Sullivan Engineers, D.P.C.

Job Number: 200-43658-1

Login Number: 43658
List Number: 1
Creator: Lavigne, Scott M

List Source: TestAmerica Burlington

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	Lab does not accept radioactive samples.
The cooler's custody seal, if present, is intact.	True	Not present
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	5.9ºC
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	N/A	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Gomez and Sullivan Engineers, D.P.C.

Job Number: 200-43658-1

Login Number: 43658
List Number: 2
Creator: Watson, Debbie

List Source: TestAmerica Pittsburgh
List Creation: 06/01/18 12:09 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Appendix C - Hydrology and Hydraulics

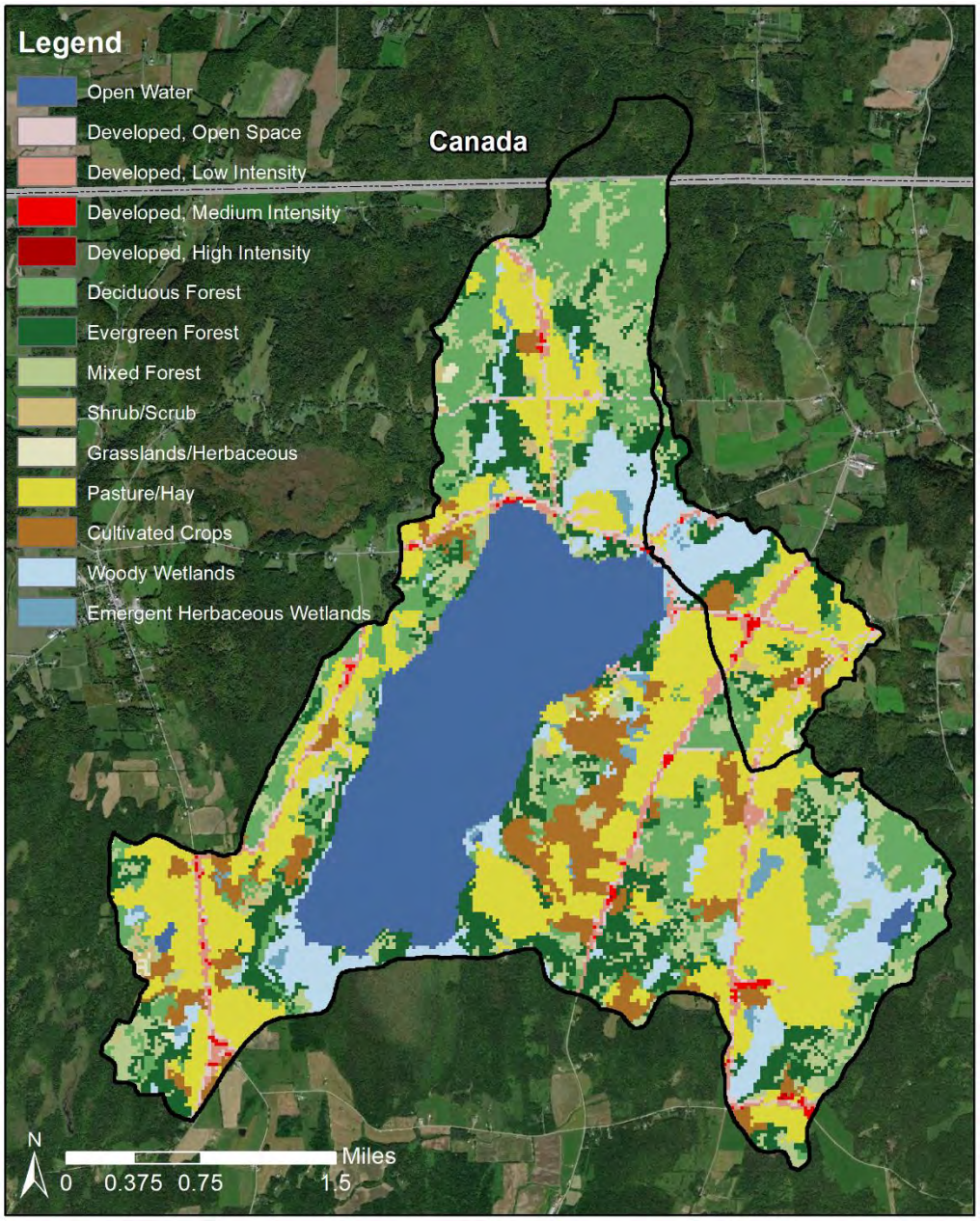


Figure C-1: Land Use Information

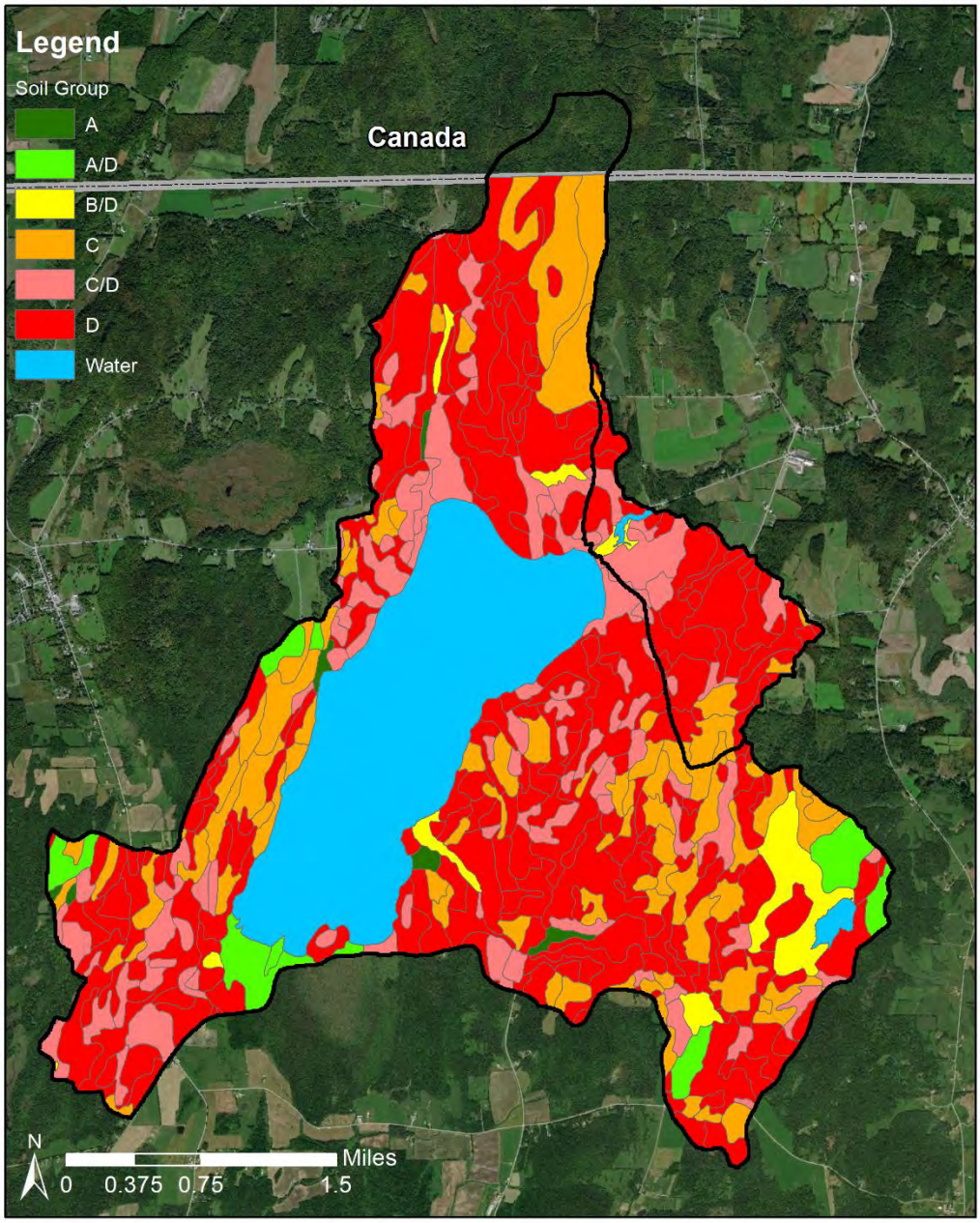


Figure C-2: Soils Information

Computation of Lag Time

$$Lag = 0.6(T_{Sheet} + T_{Shallow} + T_{Channel})$$ Equation C-1

Where,

Lag = Lag Time (hrs)
T_{Sheet} = Travel time for sheet flow (hrs)
$T_{Shallow}$ = Travel time for shallow flow (hrs)
$T_{Channel}$ = Travel time for channel flow (hrs)

$$T_{Sheet} = \frac{0.007(n_{Overland}L_{Sheet})^{0.8}}{P_2^{0.5}S_{Sheet}^{0.4}}$$ Equation C-2

Where,

$n_{Overland}$ = Manning's roughness coefficient for overland flow
L_{Sheet} = Length of sheet flow (ft)
P_2 = 2-year, 24-hour rainfall depth (in)
S_{Sheet} = Slope of hydraulic grade line during sheet flow, usually approximated by land slope (ft/ft)

The length of sheet flow is typically less than 100 feet, and the following equation has been proposed for estimating the maximum sheet flow length:

$$L_{Sheet} = \frac{100\sqrt{S_{Sheet}}}{n_{Overland}}$$ Equation C-3

$$T_{Shallow} = \frac{L_{Shallow}}{3600*V_{Shallow}}$$ Equation C-4

Where,

$V_{Shallow}$ = Velocity of shallow flow (ft/s)
$L_{Shallow}$ = Length of shallow flow (ft)

$$T_{Channel} = \frac{L_{Channel}}{3600*V_{Channel}}$$ Equation C-5

Where,

$V_{Channel}$ = Velocity of Channel flow (ft/s)
$L_{Shallow}$ = Length of Channel flow (ft)

$$V_{Channel} = \frac{C}{n_{Channel}}R^{2/3}S_{Channel}^{1/2}$$ Equation C-6

Where,

C = 1.49 for U.S. Customary Units
R = Hydraulic radius of channel (ft)
$S_{Channel}$ = Slope of hydraulic grade line during channel flow, usually approximated by channel slope (ft/ft)
$n_{Channel}$ = Manning's roughness coefficient for channel flow

Table C-1: Lag Time Computations

Parameter	Units	Lake Subbasin	Dam Subbasin	Notes
$n_{Overland}$	-	0.24	0.24	Appropriate for dense grasses
S_{Sheet}	ft/ft	0.02	0.02	Estimated from elevation data
L_{Sheet}	ft	65	65	Computed using Equation C-3
P_2	in	2.30	2.32	Obtained from StreamStats
T_{Sheet}	hr	0.19	0.19	Computed using Equation C-2
$S_{Shallow}$	ft/ft	0.035	0.035	Estimated from elevation data
$V_{Shallow}$	ft/s	0.45	0.45	Estimated from Figure 15-4 (NRCS, 2010) based on land use of hay meadows
$L_{Shallow}$	ft	1,240	1,415	Estimated from elevation data
$T_{Shallow}$	hr	0.77	0.87	Computed using C-4
$n_{Channel}$	-	0.035	0.035	Appropriate for minor streams with some stones and weeds
R	ft	2	2	Assumed depth of flow
$S_{Channel}$	ft/ft	0.01	0.04	Estimated from elevation data
$V_{Channel}$	ft/s	6.74	13.1	Computed using Equation C-6
$L_{Channel}$	ft	31,955	7,945	Estimated from Streamstats
$T_{Channel}$	hr	1.32	0.17	Computed using Equation C-5
Lag	hr	1.36	0.74	Computed using Equation C-1
	min	80	45	Converted to minutes

Table C-2: Temporal Distribution (2- to 500-year events)

Time (hrs)	Cumulative Percentage of Total Precipitation (%)		Time (hrs)	Cumulative Percentage of Total Precipitation (%)
0	0.00		12.5	61.78
0.5	1.63		13	64.69
1	3.31		13.5	67.53
1.5	5.00		14	70.28
2	6.73		14.5	72.94
2.5	8.57		15	75.5
3	10.55		15.5	77.96
3.5	12.67		16	80.32
4	14.93		16.5	82.58
4.5	17.31		17	84.75
5	19.78		17.5	86.82
5.5	22.31		18	88.78
6	24.89		18.5	90.63
6.5	27.49		19	92.35
7	30.12		19.5	93.93
7.5	32.79		20	95.34
8	35.49		20.5	96.58
8.5	38.24		21	97.63
9	41.05		21.5	98.48
9.5	43.92		22	99.13
10	46.84		22.5	99.59
10.5	49.81		23	99.86
11	52.81		23.5	99.98
11.5	55.82		24	100.00
12	58.81			

Table C-3: Lake Carmi Stage-Storage Curve

Elevation (ft)	Volume (ac-ft)
402	0
405	305
415	4,717
425	13,245
435	25,560
436	27,002
437	28,493
438	30,027
439	31,594
440	33,192
441	34,823
442	36,487
443	38,184
444	39,916
445	41,685
446	43,495
447	45,347
448	47,241
449	49,176
450	51,148

Hydrology Model File Log

Within the HEC-HMS folder is a folder titled Lake_Carmi_Dam which contains all of the model files associated with the hydrologic model for this project. Please note that the model was developed using HEC-HMS Version 4.2. There are six (6) folders, which should be empty (basinStates, datavar, forecast, maps, montecarlo, and optimizer). The results folder should contain 11 files with a .results extension. The names of these files should correspond with the runs listed in Table C-4.

The Lake_Carmi_Dam folder should also contain 67 other files whose naming convention associate them with either the model (Lake_Carmi_Dam) or an individual run (e.g. 2_YR). The following list provides the number of files associated with various file extensions:

- .access: 1 model file
- .basin: 5 run files (see Table C-4)
- .control: 7 run files (see Table C-4)
- .dsc: 11 run files
- .dss: 11 run files
- .gage: 1 model file
- .hms: 1 model file
- .log: 1 model file and 11 run files
- .met: 1 run file (see Table C-4)
- .out: 1 model file and 11 run files
- .pdata: 1 model file
- .run: 1 model file

Table C-4: Hydrologic Model Runs

Run	Associated Files		
	.basin	.met	.control
2-yr	Existing	Precip	2-yr
10-yr	Existing	Precip	10-yr
25-yr	Existing	Precip	25-yr
50-yr	Existing	Precip	50-yr
100-yr	Existing	Precip	100-yr
100-yr_Sensitivity A	Sensitivity A	Precip	100-yr
100-yr_Sensitivity B	Sensitivity B	Precip	100-yr
100-yr_Sensitivity C	Sensitivity C	Precip	100-yr
100-yr_Sensitivity D	Sensitivity D	Precip	100-yr
500-yr	Existing	Precip	500-yr
PMF	Existing	Precip	PMF

Hydraulic Model File Log

The HEC-RAS folder contains all of the model files associated with the hydraulic model for this project. Please note that the model was developed using HEC-RAS Version 5.0.4. The terrain folder should include three files (.hdf, .tif, and .vrt). The other 224 files are provided within the HEC-RAS folder. The model is associated with four (4) files (.dsc, .dss, .prj, .rasmap), while each plan is associated with eight (8) files (e.g. .b01, .bco01, .IC01, .O01, ,p01, .p01.blf, .p01.hdf, .r01), each geometry is associated with four (4) files (e.g. .c01, .g01, .g01.hdf, .x01), and each flow is associated with one (1) file (e.g .u01). A description is provided in Table C-5 for the geometry files. A description is provided in Table C-6 for all the unsteady flow files. A description is provided for each plan in Table C-7 with its associated geometry and flow files.

It should be noted that the model runs used during the alternative analyses (Plan ID 26-33) were created using updated flow files (Flow ID 17-24) rather than the existing hydrology flow files for each storm event. The updated flow files used the same respective boundary conditions (such as inflow hydrographs and rating curves) but reset the initial conditions initial elevation to reflect how the proposed geometry would affected the sunny day WSEL in Lake Carmi.

Table C-5: Hydraulic Geometry Files

Geometry ID	Description
01	Existing
02	Alt 4 – Modify Spillway – 433.75
03	Alt 3 – Modify Spillway – 432.75
04	Labyrinth Weir [Not Discussed in Report]
05	[Not Used]
06	[Not Used]
07	Typical Cross Section for Mill Pond Impoundment
08	Alt 5 – Dam Removal

Table C-6: Hydraulic Unsteady Flow Files

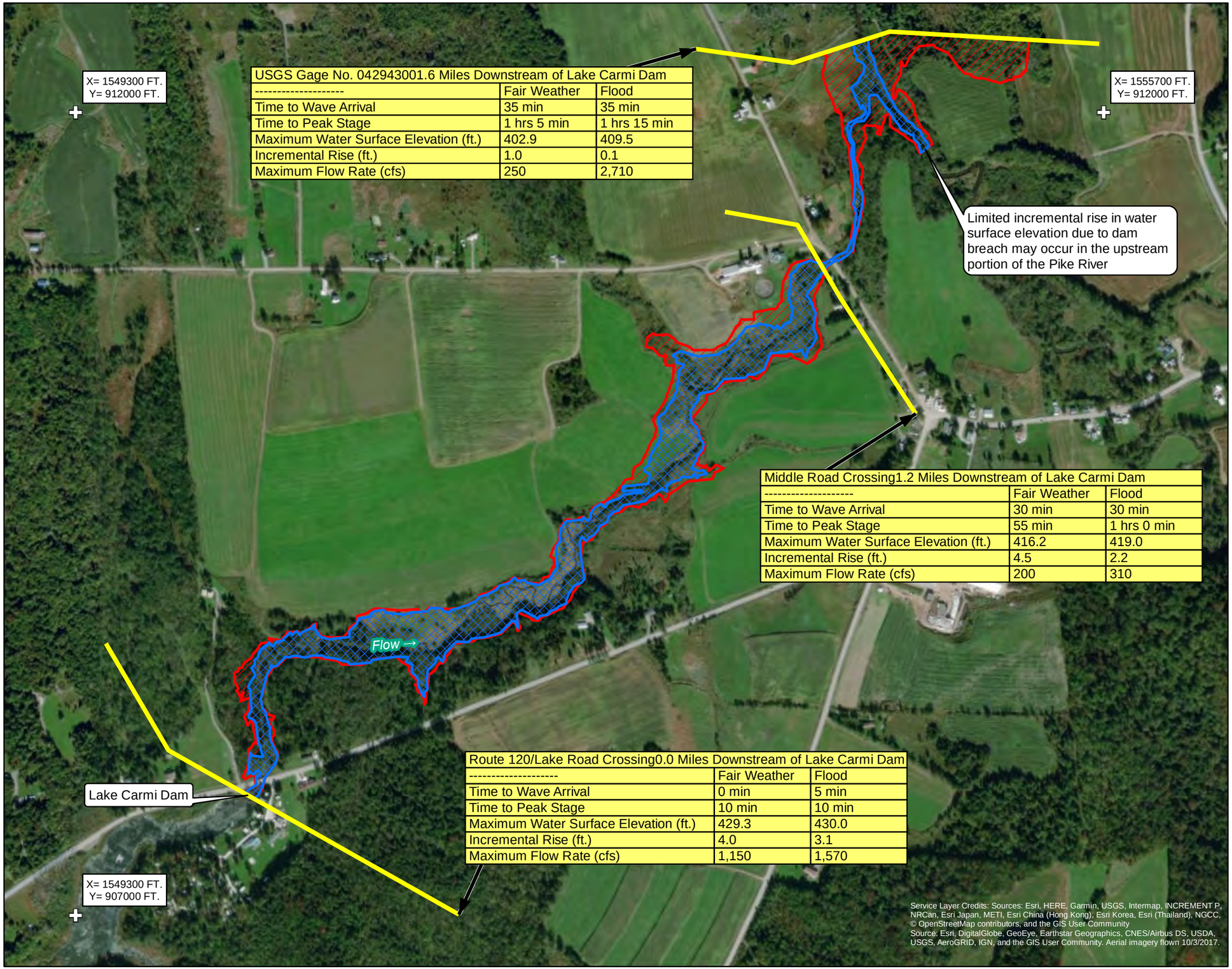
Flow ID	Description
01	2-Yr
02	10-Yr
03	25-Yr
04	50-Yr
05	100-Yr
06	500-Yr
07	0.5 PMF
08	PMF
09	100-Yr Sensitivity A
10	100-Yr Sensitivity B
11	100-Yr Sensitivity C
12	100-Yr Sensitivity D
13	Sunny Day
14	0.75 PMF [Not Discussed in Report]
15	0.80 PMF [Not Discussed in Report]
16	0.70 PMF
17	Alt 5 - Dam Removal – Sunny Day
18	Alt 5 – Dam Removal – 100-Yr
19	Alt 3 – Modify Spillway – 432.75 – Sunny Day
20	Alt 3 – Modify Spillway – 432.75 – 100-Yr
21	Labyrinth Weir – Sunny Day [Not Discussed in Report]
22	Labyrinth Weir – 100-Yr [Not Discussed in Report]
23	Alt 4 – Modify Spillway – 433.75 – Sunny Day
24	Alt 4 – Modify Spillway – 433.75 – 100-Yr

Table C-7: Hydraulic Model Runs

Run ID	Associated Files		Description
	Geometry	Flow	
01	01	01	2-Yr
02	01	02	10-Yr
03	01	03	25-Yr
04	01	04	50-Yr
05	01	05	100-Yr
06	01	06	500-Yr
07	01	07	0.5 PMF
08	01	08	PMF
09	01	09	100-Yr Sensitivity A
10	01	10	100-Yr Sensitivity B
11	01	11	100-Yr Sensitivity C
12	01	12	100-Yr Sensitivity D
13	01	05	100-Yr Breach A
14	01	05	100-Yr Breach B
15	01	13	Sunny Day
16	01	13	Sunny Day Breach
17	01	06	500-Yr Breach
18	01	07	0.5 PMF Breach
19	01	08	PMF Breach
20	01	14	0.75 PMF [Not Discussed in Report]
21	01	14	0.75 PMF Breach [Not Discussed in Report]
22	01	15	0.8 PMF [Not Discussed in Report]
23	01	15	0.8 PMF Breach [Not Discussed in Report]
24	01	16	0.7 PMF
25	01	16	0.7 PMF Breach
26	08	18	Alt 5 – Dam Removal – 100-yr
27	03	20	Alt 3 – Modify Spillway – 432.75 – 100-yr
28	04	21	Labyrinth Weir – Sunny Day [Not Discussed in Report]
29	04	22	Labyrinth Weir – 100-yr [Not Discussed in Report]
30	02	24	Alt 4 – Modify Spillway – 433.75 – 100-yr
31	02	23	Alt 4 – Modify Spillway – 433.75 – Sunny Day
32	08	17	Alt 5 – Dam Removal – Sunny Day
33	03	19	Alt 3 – Modify Spillway – 432.75 – Sunny Day

Vermont Department of Environmental Conservation Lake Carmi Dam Breach Inundation Map

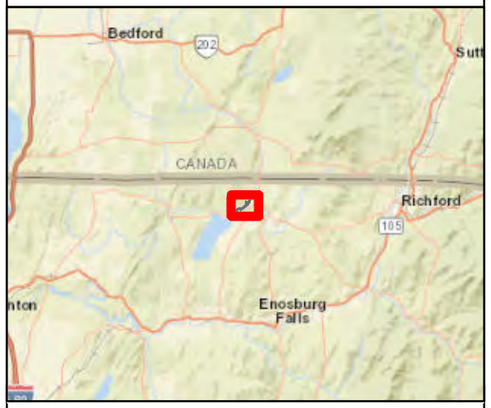
Map 1 of 1



USGS Gage No. 042943001.6 Miles Downstream of Lake Carmi Dam		
----------	Fair Weather	Flood
Time to Wave Arrival	35 min	35 min
Time to Peak Stage	1 hrs 5 min	1 hrs 15 min
Maximum Water Surface Elevation (ft.)	402.9	409.5
Incremental Rise (ft.)	1.0	0.1
Maximum Flow Rate (cfs)	250	2,710

Middle Road Crossing1.2 Miles Downstream of Lake Carmi Dam		
----------	Fair Weather	Flood
Time to Wave Arrival	30 min	30 min
Time to Peak Stage	55 min	1 hrs 0 min
Maximum Water Surface Elevation (ft.)	416.2	419.0
Incremental Rise (ft.)	4.5	2.2
Maximum Flow Rate (cfs)	200	310

Route 120/Lake Road Crossing0.0 Miles Downstream of Lake Carmi Dam		
----------	Fair Weather	Flood
Time to Wave Arrival	0 min	5 min
Time to Peak Stage	10 min	10 min
Maximum Water Surface Elevation (ft.)	429.3	430.0
Incremental Rise (ft.)	4.0	3.1
Maximum Flow Rate (cfs)	1,150	1,570



Legend

- Cross Section
- Fair Weather Inundation Area
- SDF Inundation Area

NOTES:

1. Because of the methods, procedures, and assumptions used to develop the inundation areas, the limits of flooding and travel times shown are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual flood failure conditions and may differ from areas shown on this map.
2. Inundation limits shown on this map are for dam breach conditions considering Sunny Day and Spillway Design Flood scenarios.
3. The inundated areas shown on this map reflect events of an extremely remote nature. These results are not in any way intended to reflect upon the integrity of any project.
4. Times mentioned are from the start of Lake Carmi Dam breach.
5. Stated mileage is measured from Lake Carmi Dam
6. Basis of elevation: North American Vertical Datum of 1988 (NAVD88).
7. Reference Points are given in NAD83 State Plane Vermont (US feet) Coordinates
8. Times are rounded to the nearest five minutes. Time to wave arrival is determined by one foot of incremental rise, or 25% of the total incremental rise if total incremental rise is less than one foot. Water surface elevations and incremental rise are rounded to the nearest tenth of a foot. Flows are rounded to the nearest 10 cfs.

0 150 300 600 900 1,200 Feet

Document Path: P:\1995\Inundation Mapping\eap_map.mxd

Appendix D - Opinion of Probable Construction Costs (OPCCs)

Table D-1

Prepared by: RGF Checked: KC

Gomez and Sullivan Engineers, D.P.C. Project No: J01995

Prepared for:

Vermont Department of Enivornmental Conservation

OPINION OF PROBABLE CONSTRUCTION COST 10/9/2018

Project: **Lake Carmi Dam**

Estimate for: **Alternative 2 - Overtopping Protection**

Item	Description	Quantity	Unit	Unit Price	Cost
Contractor Gen. Requirements[1]		10%		$34,529.17	$3,453
Material[4]	Concrete Repair	200	SF	$33	$6,600
Access	Clearing and Grubbing	0.1	ACRE	$25,000	$2,500
Access	Rock Ramp for equipment loading/unloading (AASHTO #1)	1	LS	$7,500	$7,500
Material[4]	Miscellaneous E/S Controls	1	LS	$5,000	$5,000
Alternative - Material[4]	Rip-rap, D50 = 12"	160	CY	$75	$12,000
Alternative - Material[4]	Geo-textile, non-woven under stone	75	SY	$4	$300
Alternative - Material[4]	Articulated concrete block (4.5")	650	SF	$24	$15,600
Alternative - Material[4]	Synthethic turf	650	SF	$17	$10,888

Subtotal Direct Cost (w/ Rip-rap and geo-textile fabric)	**$37,353**
Contingency Allowance (40%)[2]	$15,000
Total Direct Cost[3] (w/ Rip-rap and geo-textile fabric)	**$53,000**
Subtotal Direct Cost (w/ Articulated concrete block)	**$40,653**
Contingency Allowance (40%)[2]	$17,000
Total Direct Cost[3] (w/ Articulated concrete block)	**$58,000**
Subtotal Direct Cost (w/ Synthethic turf)	**$35,940**
Contingency Allowance (40%)[2]	$15,000
Total Direct Cost[3] (w/ Synthethic turf)	**$51,000**

Notes:

1. Contractor General Requirements (mobilization, demobilization, trailer, adminstration, etc.) taken as 10% of the remaining itemized costs totaled.
2. Contingency Allowance taken as 40% and rounded up to the nearest $1,000.
3. Rounded up to the nearest $1,000.
4. Labor and equipment costs are built into the material unit price.
5. OPCC is based on generally available databases (e.g. RSMeans) and in-house pricing information for the local market. Competitive bidding environments, unknown field conditions, and other local market factors may contribute to variances in costs.
6. OPCC includes probable costs for construction only. The total cost does not reflect costs for potential permitting, environmental studies, or engineering design.

Table D-2

Prepared by: RGF Checked: KC

Gomez and Sullivan Engineers, D.P.C. Project No: J01995

Prepared for:

Vermont Department of Enivornmental Conservation

OPINION OF PROBABLE CONSTRUCTION COST 10/9/2018

Project: **Lake Carmi Dam**

Estimate for: **Alternative 3 - Modify Spillway Crest Elevation - 432.75 ft**

Item	Description	Quantity	Unit	Unit Price	Cost
Contractor Gen. Requirements[1]		10%		$111,340.00	$11,134
Material[4]	Concrete, Demolition and Disposal	50	CY	$250	$12,500
Material[4]	Concrete, Full depth patching 6 inches deep	870	SF	$32	$27,840
Access	Clearing and Grubbing	0.1	ACRE	$25,000	$2,500
Access	Rock Ramp for equipment loading/unloading (AASHTO #1)	1	LS	$7,500	$7,500
Access	Port-a-dam cofferdam/Water Control (dewatering)	1	LS	$56,000	$56,000
Material[4]	Miscellaneous E/S Controls	1	LS	$5,000	$5,000

Subtotal Direct Cost	**$122,474**
Contingency Allowance (40%)[2]	$49,000
Total Direct Cost[3]	**$172,000**

Notes:

1. Contractor General Requirements (mobilization, demobilization, trailer, adminstration, etc.) taken as 10% of the remaining itemized costs totaled.
2. Contingency Allowance taken as 40% and rounded up to the nearest $1,000.
3. Rounded up to the nearest $1,000.

4. Labor and equipment costs are built into the material unit price.
5. OPCC is based on generally available databases (e.g. RSMeans) and in-house pricing information for the local market. Competitive bidding environments, unknown field conditions,
6. OPCC includes probable costs for construction only. The total cost does not reflect costs for potential permitting, environmental studies, or engineering design.

Table D-3

Prepared by: RGF Checked: KC

Gomez and Sullivan Engineers, D.P.C. Project No: J01995

Prepared for:

Vermont Department of Enivornmental Conservation

OPINION OF PROBABLE CONSTRUCTION COST 10/9/2018

Project: **Lake Carmi Dam**

Estimate for: **Alternative 4 - Modify Spillway Crest Elevation - 433.75 ft**

Item	Description	Quantity	Unit	Unit Price	Cost
Contractor Gen. Requirements[1]		10%		$97,920.00	$9,792
Material[4]	Concrete, Demolition and Disposal	20	CY	$250	$5,000
Material[4]	Concrete, Full depth patching 6 inches deep	685	SF	$32	$21,920
Access	Clearing and Grubbing	0.1	ACRE	$25,000	$2,500
Access	Rock Ramp for equipment loading/unloading (AASHTO #1)	1	LS	$7,500	$7,500
Access	Port-a-dam cofferdam/Water Control (dewatering)	1	LS	$56,000	$56,000
Material[4]	Miscellaneous E/S Controls	1	LS	$5,000	$5,000

Subtotal Direct Cost	**$107,712**
Contingency Allowance (40%)[2]	$44,000
Total Direct Cost[3]	**$152,000**

Notes:

1. Contractor General Requirements (mobilization, demobilization, trailer, adminstration, etc.) taken as 10% of the remaining itemized costs totaled.
2. Contingency Allowance taken as 40% and rounded up to the nearest $1,000.
3. Rounded up to the nearest $1,000.

4. Labor and equipment costs are built into the material unit price.
5. OPCC is based on generally available databases (e.g. RSMeans) and in-house pricing information for the local market. Competitive bidding environments, unknown field conditions,
6. OPCC includes probable costs for construction only. The total cost does not reflect costs for potential permitting, environmental studies, or engineering design.

Table D-4

Prepared by: RGF Checked: KC

Gomez and Sullivan Engineers, D.P.C. Project No: J01995

Prepared for:

Vermont Department of Enivornmental Conservation

OPINION OF PROBABLE CONSTRUCTION COST 10/9/2018

Project: **Lake Carmi Dam**

Estimate for: **Alternative 5 - Dam Removal**

Item	Description	Quantity	Unit	Unit Price	Cost
Contractor Gen. Requirements[1]		10%		$206,250.00	$20,625
Material[4]	Concrete, Demolition and Disposal	505	CY	$250	$126,250
Access	Clearing and Grubbing	0.1	ACRE	$25,000	$2,500
Material[4]	Earthwork - Rough Grading	2500	CY	$10	$25,000
Access	Rock Ramp for equipment loading/unloading (AASHTO #1)	1	LS	$7,500	$7,500
Access	Port-a-dam cofferdam/Water Control (dewatering)	1	LS	$35,000	$35,000
Material[4]	Miscellaneous E/S Controls	1	LS	$10,000	$10,000

Subtotal Direct Cost	**$226,875**
Contingency Allowance (40%)[2]	$91,000
Total Direct Cost[3]	**$318,000**

Notes:

1. Contractor General Requirements (mobilization, demobilization, trailer, adminstration, etc.) taken as 10% of the remaining itemized costs totaled.
2. Contingency Allowance taken as 40% and rounded up to the nearest $1,000.
3. Rounded up to the nearest $1,000.

4. Labor and equipment costs are built into the material unit price.
5. OPCC is based on generally available databases (e.g. RSMeans) and in-house pricing information for the local market. Competitive bidding environments, unknown field conditions,
6. OPCC includes probable costs for construction only. The total cost does not reflect costs for potential permitting, environmental studies, or engineering design.
7. A sediment management plan is recommended to accompy a dam removal and is not included in the OPCC.