30% Design Report: Hands Mill Dam Removal

PROJECT NO.

20-007

REVIEWED BY:

MRA

PREPARED FOR:

Gianna Petito / *District Manager*
Winooski Natural Resources Conservation District (WNRCD)
617 Comstock Road, Suite 1
Berlin / VT 05602
gianna@winooskinrcd.org
802.828.4493 x3178

SUBMITTED BY:

Gabe Bolin, PE / *Senior Water Resources Engineer*
Stone Environmental, Inc.
535 Stone Cutters Way
Montpelier / VT 05602
gbolin@stone-env.com
603.809.6101

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Cover Photo: View of Hands Mill Dam looking upstream.

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30% Design Report

1.1. Introduction

In July 2020, Stone Environmental, Inc. (Stone) was retained by the Winooski Natural Resource Conservation District (Winooski NRCD) to provide a 30% conceptual engineering design for the removal of Hands Mill Dam and restoration of Jail Branch within the vicinity of the dam. The dam is currently owned by the Town of Washington, and in 2016 the Vermont Department of Environmental Conservation (VTDEC) classified the dam as a Class 2 "significant hazard dam" following a dam safety inspection that found the dam to be in poor condition. Removal of the dam has the potential to increase aquatic organism passage (AOP) along the Jail Branch and connect 14.7 miles of fish habitat. The goals of this project include developing 30% designs for the removal of the Hands Mill Dam for risk mitigation, and restoration of the upstream channel to return to dynamic stream equilibrium, improve water quality, decrease flooding risk, connect native Eastern Brook Trout to high-quality refuge habitat, and grow riparian corridor integrity.

The following text provides a summary of the work completed to evaluate existing conditions at the site and describes the development of conceptual designs for the removal of the Hands Mill Dam, improvement of aquatic organism passage (AOP), and restoration of stream equilibrium.

1.2. Site Description

The Hands Mill Dam is a partially breached stone and concrete structure located along the Jail Branch in the Town of Washington, Orange County, Vermont (The Town). The Town is located near the geographical center of Vermont and is part of the Vermont Piedmont physiographic region. The Vermont Piedmont is hilly with low mountains, with slopes that are moderately steep. The Town's soils are predominately glacial till, with often steep, occasionally wet glaciated soils.

The dam is situated on Jail Branch near the intersection of Woodchuck Hollow Road (formerly called Brown Road) and West Corinth Road (formerly known just as the 'Corinth Road') on a 3.5-acre property owned by the Town (Town Parcel #7105.000). The town property abuts five other private residential properties. The dam impounds a pond with a surface area of about 2 acres at normal pool elevation that is substantially filled with sediment. The dam is currently partially breached and in poor condition. As part of this project, a dam breach analysis was completed by the Vermont Department of Environmental Conservation Dam Safety Division. The dam breach analysis indicated that dam failure could potentially impact several road crossings, homes and business, and a school located downstream. Water depths, velocities, and time of arrival of flooding at immediately downstream properties pose a potential loss of life risk. The 2020 DSS Wise Lite Dam Flood Mapping Report from the Vermont Department of Environmental Conservation Dam Safety Division is provided as Attachment 1 to this report.

The Hands Mill Dam obstructs flow and AOP along the Jail Branch, also known as Jail Brook, a tributary to the Winooski River. Downstream of the dam, Jail Branch runs over 8 miles north and northwest into Barre, where it converges with the Stevens Branch. The Stevens Branch then flows a similar distance northwest to its confluence with the Winooski River in the southeast portion of Montpelier. The watershed area draining to the Hands Mill Dam location (at 44.10569, -72.43000) is 6.65 mi^2 (StreamStats, 2020). The watershed is 84% forested, 8% agricultural, 4% developed, 2% shrubs and grasses, and 2% wetlands. (NLCD 2011 classes 21-24; StreamStats, 2020).

1.3. Existing Conditions

1.3.1. Review of Existing Data

Stone completed a review of existing data for the dam and surrounding property. The review was limited to data and files collected and provided by the Winooski NRCD as part of the RFP and 30% design development. These documents include historical property information (Attachment 2), VTDEC Dam Safety Inspection reports from 1953 through 2020 (Attachment 3), septic system information for the house at 16 Woodchuck Hollow Road directly adjacent to the dam on river left, and the Town's Hazard Mitigation Plan. The VTDEC is expected to have a new Dam Safety Inspection Report available in Spring or Summer 2021. Despite efforts to find additional documents online via internet searches, no additional data was found.

A review of the Dam Safety Inspection Reports indicated continued deterioration of the dam over recent decades, specifically the downstream wall, crest of the dam and the concrete training wall. The following provides a summary:

- Downstream Wall – The wall is made up of concrete and large stones. Multiple reports indicated the loss of stones from the wall. Reports of scour to the left of the spillway were also mentioned frequently. In the 2013 inspection report, it was reported that this area has 'deteriorated rapidly, probably as a result of Tropical Storm Irene and recent high water'.
- Dam Crest – The crest was consistently reported to be in poor condition. Reports stated it was covered with vegetation and signs of overtopping, erosion, and evidence of a partial breach near the mid-section with fallen concrete at the dam bottom, in line with this location.
- Concrete Training Wall – The training wall to the right of the dam was reported as being consistently covered with vegetation with cracking visible at exposed sections.
- Reports of the dam in 'poor' or 'weakened' condition date back to inspections from 1953. The 1953 report states that 'the north wing wall has fallen down and water has started to erode the earth embankment behind it', with additional reports of seepage through the south abutment.
- Suggestions by the state for repairs date back to the 1953 report, and suggestions for retaining a professional engineer to develop plans to either reconstruct or remove the dam date back to 2001.
- A hydrologic study in a 1975 report indicated that the 'East Orange Brook' watershed was used as a reference to develop peak flood estimates for recurrence interval storm events at the dam. Similarly, Stone selected the East Orange Branch USGS gage for our hydrologic analysis; see Task 3.

1.3.2. Infrastructure Stability Analysis

Stone conducted a preliminary infrastructure inventory and analysis using knowledge of the project site, publicly available information, and state culvert and bridge inventories. Stormwater, drinking water, wastewater, and overhead utilities (i.e., electric and telecom) were investigated. Infrastructure investigated included bridges, roadways, rights-of-ways, and the dam itself. Following our review of this data, a total of four infrastructure items were thought to require additional review with respect to dam removal and potential stability and/or conflict issues. A summary of these items is provided in Table 1 below. The bridge dimension data provided in the table was obtained from the state inventories.

Table 1: Infrastructure of Interest Within the Project Vicinity

Item	Location	Location Relative to Dam	Ownership	Notes	Vulnerability
West Corinth Road Bridge	Jail Branch at West Corinth Road	Upstream	Town	Span 15', width 28' (in direction of flow)	Low
Woodchuck Hollow Road Bridge	Jail Branch at Woodchuck Hollow Road	Downstream	Town	Span 18', width 26' (in direction of flow)	Low
Roadways	West Corinth Road and Woodchuck Hollow Road	Those directly adjacent to project area	Town	West Corinth Rd. newly paved; Woodchuck Hollow Rd. gravel	Low
Water Hydrant	Corner of West Corinth Road and Vermette Lane	Upstream, outside of project vicinity	Unknown	No record of potable water system in state GIS databases	NA

Source: Stone site visits, VTrans Online Bridge and Culvert Inventory
Date and Author: 09-23-20 / GMB

1.3.3. Topographic Survey

Stone staff completed a topographic survey of the project site on August 11 and 12, 2020 using a GPS base and rover. The GPS base and rover were used 1) to set control points throughout the project establishing horizontal and vertical control, 2) to collect longitudinal profile and cross-section data upstream and downstream of the dam, and 3) to collect details of structures such as the dam, bridges, infrastructure, and utilities.

Stone established four control points in the vicinity of the dam and downstream of the Woodchuck Hollow Road bridge. Control points were set in road pavement, at utility poles, and at the downstream bridge headwall. Locations and descriptions of control points are provided on Sheet 2 of the design plans in Attachment 4. As a quality control measure, Stone regularly checked back to control points to assess equipment precision and data accuracy. Any discrepancies found to be over 0.1 feet resulted in resurveying of relevant data.

The extent of the survey data is shown on Sheet 2 of the design plans (Attachment 4). Approximately 2,200 feet of longitudinal profile were collected along Jail Branch, extending form upstream references reaches to a few hundred feet downstream of the Woodchuck Hollow Road bridge. Additionally, several unnamed tributaries to Jail Branch were surveyed. Typical features collected as part of the longitudinal profiles along Jail Branch and the unnamed tributaries included top and bottom of steps, pool head and tail crest, maximum pool depth, riffle head and tail, etc. While these features are useful in developing a stream profile and assessing reach slopes, they are also useful in assessing fish habitat and will be used during the final design of the channel bed. Longitudinal profile data was used to define reach slopes for the preliminary design of the pilot channel. A longitudinal profile along the thalweg of the stream channel is provided on Sheet 7 of the design plans (Attachment 4).

Cross section data was collected along the main channel within the project area and reference reach, including top of bank, bottom of bank, thalweg, bars, and other bed features. The dam was surveyed and detailed, and roads and utilities were also located during the survey. Where Stone was unable to access land to survey, we combined the survey data with LiDAR data made available by the State.

Stone staff developed the project basemap in AutoCAD using both the survey and LiDAR data to develop a 3-dimensional surface (i.e., triangular irregular network, or TIN) of the project site. The TIN was used to develop 1-foot contours through the project extent. Contours for existing conditions are shown on Sheet 3 of the 30% design plans (Attachment 4).

1.3.4. Initial Geomorphic Survey

On September 4, 2020, Stone completed a limited geomorphic assessment of Jail Branch upstream and downstream of the dam, along the primary unnamed tributary entering Jail branch river right at station 14+30, and along a reference reach on Jail Branch approximately 1,430 feet upstream of the dam.

Initial Survey of Project Area

The first portion of the assessment consisted of collecting bankfull width and depth measurements upstream and downstream of the dam to determine entrenchment ratios of Jail Branch, to get a general sense of geomorphic conditions throughout the project area. Observations and measurements were obtained at six locations, three upstream and three downstream of the dam. The results of this initial geomorphic assessment are presented in Table 2. Station data is provided on Sheet 3 of the design plans (Attachment 4).

Table 2: Initial Geomorphic Assessment Results

Location	Distance Upstream from Dam (ft)	Bankfull Width (ft)	Bankfull Depth (ft)	Flood-Prone Width (ft)	Entrenchment Ratio	Channel Description
US3	13+35	43.5	3.4	337.5	7.8	pool head
US2	10+12	28.6	4.0	494.0	17.3	riffle
US1	9+27	32.7	4.1	280.2	8.6	riffle
DS1	4+32	30.4	5.3	145.2	4.8	step
DS2	2+28	28.6	6.1	78.3	2.7	riffle
DS3	1+78	35.0	3.3	47.0	1.3	riffle
Avg.		*33.1*	*4.4*			

Source: Stone site visits

Date and Author: 09-23-20 / GMB

Flood-prone widths were measured at an elevation equal to twice the bankfull depth at each location, using LiDAR and knowledge of the site. Entrenchment ratios were calculated by dividing the flood-prone width by the bankfull width. Per the Rosgen Stream Classification Technique (USDA, 2007), entrenchment ratios of greater than 2.2 are considered 'Slightly Entrenched', indicating the stream is generally well connected to adjacent floodplains. Entrenchment ratios at the site ranged from 1.3 (DS3) to 17.3 (US2), with floodplain connection upstream of the dam generally greater than floodplain connection downstream of the dam. The lowest entrenchment ratio was recorded at the furthest downstream location (DS3), where the channel is deep and channelized for a few hundred feet downstream of the Woodchuck Hollow Road Bridge. Moving upstream from DS3, channel entrenchment is gradually reduced and floodplain connectivity increased.

The average of bankfull width and depth measurements through the project area are 33.1 feet and 4.4 feet, respectively (

Table 3). The largest bankfull width value of 43.5 feet measured at the most upstream location (US3) could be considered exaggerated since it is just downstream of the junction between Jail Branch and the largest unnamed tributary to Jail Branch. This junction is suspected to be a dynamic area during high flow events, with flow and sediment transport highly influencing bank full geometry in the immediate area. The average bankfull width of 33.1 feet matches well with the calculated bankfull width based on the Vermont Regional Hydraulic Geometry Curves, where a width of 30 feet, depth of 1.8 feet and a cross sectional area of 51 ft^2 were calculated (VTANR 2006). However, the average bankfull depth measured in the field (4.4 feet) does not align with the regional curve estimate (1.8 feet). One potentially reason for the difference, is that during large storm events the dam causes backwater conditions, slowing down floodplain waters in the impoundment area. The reduction in floodplain water velocity may lead to excessive settling of sediments on floodplain surfaces overtime. The 'building up' of those floodplain surfaces has potentially increased floodplain surface elevations relative to the streambed, resulting in deeper bankfull depths.

Reference Reach Assessment

Stone staff completed a geomorphic assessment in a reference reach to inform design and restoration plans. Stone staff identified reference reach conditions approximately 100 feet south of the culvert at Jail Branch and West Corinth Road during the topographic survey. From that point, the reach extends another 200 feet upstream along Jail Branch. Upon review of all reaches of Jail Branch and tributaries, this section of stream was selected as a reference because it was clearly out of the impounded area, it was not overly influenced by anthropogenic impacts, it visually appeared to be in equilibrium, and it contains a fair amount of habitat features in the bed (pools, backwatered areas, favorable bed substrate, etc.). On Sheet 2 of the plans, the reference reach extends upstream from about station 20+00 to 22+00 (south of West Corinth Road, and potentially extending past this station).

Stone staff characterized the stream bed, collected bankfull measurements, and collected cross section data in the reference reach. Stream bed data included the delineation of bed habitat features (i.e., step, riffle, pool, run, etc.), bed feature length, width, elevation features, and frequency. For instance, three pools were found within the reference reach, with an average length of 23', average width of 10.7', and average max pool depth of 1.3'. The bed material within the pools consisted of 50% cobble with small boulders, and occasional large boulders providing cover and refuge for aquatic organisms. Key pieces, or small to large boulders that made up individual stone steps found in the reach, had an average intermediate measurement of 21 inches, among the 20 pieces that were measured. The roundedness of these stones ranged from rounded to angular, with the majority of pieces being rounded, while the embeddedness of the pieces in the stream bed ranged from 0 to 50% embedded. Roughness boulders were also observed in the reach. Roughness boulders are stones that are not included in a bed structure but exist in a random nature throughout the stream bed and tend to add roughness to the channel. The measured roughness boulders had an average intermediate measurement of 24.6 inches, a roundedness that ranged from rounded to sub-angular, and were 5 to 50% embedded in the channel. Two pebble counts were performed in the reference reach as well. The purpose of these counts is to characterize the gradation of the bed material, or distribution of different sized stones within the bed matrix. A plot of the count date as a grain size distribution is provided in Attachment 5.

Bankfull measurements were collected in the reference reach. Similar measurements were also obtained in the primary unnamed tributary to Jail Branch, conveying flow from the northeast. Table 3 below provides a summary of bankfull measurements from each reach, along with averages. Note that while the unnamed tributary was not used as a reference reach, this tributary did exhibit reference reach characteristics and could be further investigated as a reference reach if needed, during Phase 2 design.

Table 3: Bankfull Measurements in Reference Reach and Unnamed Tributary

Reach	Location	Bankfull Width (ft)	Bankfull Depth (ft)
Jail Branch Reference Reach	BF1	25.2	2.33
	BF2	25.8	1.8
	BF3	19.3	1.68
	Avg.	*23.4*	*1.9*
Unnamed Tributary	TRIB-BF1	18.2	2.22
	TRIB-BF2	17.9	1.84
	TRIB-BF3	20.2	1.68
	Avg.	*18.8*	*1.9*

Source: Stone site visits
Date and Author: 09-23-2020 / GMB

1.3.5. Vegetation Survey

During the topographic survey and a second site visit in October 2020, Stone developed an inventory of trees over 3" diameter at breast height (dbh) within the limits of disturbance that may require removal during construction of the project. Table 4 provides a summary of those trees. Note that at this time the project design is at the conceptual level (i.e., 30% design level) and certain trees along the boundary of the limits of disturbance may or may not need to be removed, depending on the details of final design. Because of this current uncertainty, the column 'Likelihood of Removal' has been included to capture the possibility of removal relative to final design.

Table 4: Vegetation Survey Summary

#	Species	Size (dbh, inches)	Location	Likelihood of Removal
1	Black Willow	32	River left, near parking area	High
2	White Birch	6, double	On top of dam	High
3	Pine	24	River left, on 16 Woodchuck Hollow Road property	Medium
4	Sugar Maple	18	River right, ~station 9+00	Medium
5	Pine	24	River left, ~station 10+00	High
6	Pine	20	River right, ~station 10+50	Low
7	Oak	20	River right, ~station 11+50	Low
8	Pine	18	River right, ~station 13+50	Low
9	Sugar Maple	18	River right, ~station 13+75	Low
10	Sugar Maple	16	River right, ~station 14+00	Low
11	Green Ash	10	River right, ~station 6+00	Low
12	Green ash	4	River right, ~station 6+00	Low
13	Green Ash	4	River right, ~station 5+50	Low
14	Sugar Maple	8	River right, ~station 5+50	Low
15	Green ash	12	River left, ~station 12+00	Very low

#	Species	Size (dbh, inches)	Location	Likelihood of Removal
16	Green ash	6	River left, ~station 12+50	Very low
17	Black willow	6	River left, ~station 13+50	Very low
18	Black willow	4	River left, ~station 13+50	Very low
19	Sugar Maple	11	River right, ~station 14+00	Low

Source: Stone site visits
Date and Author: 03-10-2021 / GMB and MRA

1.3.6. Impounded Sediment Analysis

1.3.6.1. Sediment Probing

Probing Methods

On August 26, 2020, Stone performed sediment probing within the impoundment, from directly behind the dam to approximately 130 feet upstream using an extendible steel tile rod. Probing was completed at 15 locations as shown on Sheet 3 (Attachment 4). At each location, the steel tile rod was advanced into the streambed by hand or driven into the streambed using a hammer, depending on the difficulty advancing the probe into the bed sediment. When the steel rod was unable to be driven further into the streambed, the nature of refusal, including resistance, vibrations, and audible cues, were noted.

To compare the probing depths to the bottom of the dam elevation and to ultimately assess the potential for AOP following dam removal, a temporary datum of 0.0’ was set at the impoundment water surface. The bottom of the dam relative to this datum measured approximately 11-13’ down, along the face of the dam. Therefore, at any probing location where we were able to drive 12’ or more of rod under the water surface, we considered the tip of the rod to be approximately even with, or below, the bottom of the dam.

At each probing location, in addition to refusal data, the total rod depth from the water surface to refusal, water depths, and location data were recorded.

Probing Results

Overall, exploratory probing provided insight into refusal elevations and the nature of refusal immediately upstream of the dam. The results at each location are summarized in Table 5. Locations where the tip of the rod was approximately even with, or below, the bottom of the dam are indicated in bold.

Where vibrations and audible cues indicated refusal via bedrock at a few locations, a lack of refusal at other locations suggests either 1) the absence of bedrock and/or an AOP barrier, or 2) a different type of material at depth that would require additional driving of the probing rod. At many of these locations, substantial hammering and effort would typically only result in a half inch or inch advancement. And at a few locations that followed the thalweg, suction force (in the presence of muck) or resistance force (in the presence of sand/gravel) posed major challenges in retrieving the probing equipment, and therefore some explorations were abandoned for fear of losing equipment. When a probing location was abandoned, a new probing location was attempted close by to eliminate any spatial data gaps.

Overall, Stone staff attempted to drive the probe to 12’ below water surface to confirm a lack of bedrock and/or barrier at the estimated bottom of dam elevation. While the results in the table indicate that there seems to be a path upstream of the dam where bedrock and/or barriers are not present down to the bottom of dam elevation, it is important to understand that the probe diameter used for the explorations is approximately ½" in diameter and the accuracy of this data should be considered coarse, with limitations based on the equipment used and density of explorations.

Table 5: Probing Results Upstream of Dam

Probe ID	Water Depth (ft)	Description	Height Above Dam Bottom (ft)
P-1		No data – equipment malfunction	
P-2		No data – equipment malfunction	
P-3	3.15	No refusal, hard sand layer (?), abandon	5.85
P-3-2	3.18	Refusal, boulder/bedrock	4.8
P-4	3.16	Refusal, boulder/bedrock	4.5
P-5	2.15	No refusal, muck, abandon	3.3
P-6	2.56	No refusal	**-0.31**
P-7	2.45	Refusal, no boulder/bedrock, but hard layer	8.45
P-8	0.92	No refusal	**0.00**
P-9	2.34	Refusal, sand/debris	3.98
P-10	1.75	Refusal, sand/debris	8.89
P-11	1.75	No refusal	3.08
P-12	0.37	Refusal, boulder/bedrock	1.94
P-13	2.32	No refusal, muck, abandon	3.14
P-14	1.4	No refusal	**0.55**
P-15	1.94	No refusal	**0.27**
P-16	2.05	No refusal	**0.43**

Source: Stone site visits
Date and Author: 09-23-2020 / GMB

Recommendations for Potential AOP

Further inspection of the data suggests that a path for aquatic organism passage exists from P-6 and P-8 at the dam extending upstream to P-15, P-16, and P-14. No obstructions at the bottom of dam elevation were encountered at these probing locations. However, it should be noted that explorations just upstream of the dam (i.e., 5-10 feet upstream) at locations P-7, P-9 and P-10 indicated refusal due to hard layers and/or debris. While probing results like this are expected along the perimeter of a dam due to potentially variability in dam construction and dimensions, our probing efforts cannot confirm what the dam is directly built on. Therefore, bedrock or an AOP barrier may still exist just under the dam structure or within a few feet of its perimeter. Confirmation of what the dam was built on can potentially be confirmed via ground penetration radar (GPR) surveys, or via dam removal during the construction phase. For the purposes of this conceptual design, Stone has confirmed that there seems to be a path with no obstructions at the bottom of dam elevation, from about 15 feet behind the dam to approximately 125 feet upstream, adjacent to the visible portion of the training wall along river right.

1.3.6.2. Impounded Sediment Characterization

Impounded Sediment Volume Estimate

Stone estimated the volume of impounded sediment wedge behind the dam based on 1) the topographic survey data, 2) the probing data, and 3) the use of the proposed pilot channel slope and section, as a proxy for the historical channel. The topographic survey data was used as the existing, or current surface, while the probing depths and proposed pilot channel section were used to mimic the channel that existed prior to dam construction. Using the pilot channel as a proxy to the relic channel was feasible since the pilot channel is set to slopes and bankfull dimensions similar to adjacent reaches. This methodology provided a good initial estimate of the impounded sediment wedge volume behind the dam, in the channel, and in the immediate bank areas.

Additionally, Stone estimated the amount of impounded sediment that may have settled on relic floodplains. The existing conditions surface within the project area (see Sheet 2) show a relatively wide and flat floodplain along river left that extends almost to West Corinth Road, while the contours on river right slope gently from uplands towards the river right bank of the Jail Branch and show a narrower floodplain. While pre-dam floodplain elevations along either bank are unavailable, one can assume that prior to dam construction, much of the natural floodplain area for this system within the project area existed along river left. Due to the impounding nature of the dam, it is likely that this natural floodplain filled in with sediment, similar to the channel, over the approximately 160 years since dam construction. To account for settling of sediments not only in the channel but in the floodplains as well, for this conceptual calculation Stone revised the pilot channel cross section to include an 80-foot-wide floodplain bench. Note, the pilot channel floodplain bench designed for these impounded sediment calculations does not have the same dimensions as the floodplain bench in the final 30% designs (See the 'Typical Channel Cross Section' detail on Sheet 7 (Attachment 4)). Using the pilot channel slope and this altered section as a proxy for the historical channel and floodplain area, for the purposes of this calculation only, we estimate that a total of 14,300 CY of impounded sediment exists behind the dam, above the relic channel and within the historic floodplain along river left. The limit of impounded sediment, based on our interpretation of the bed sediment, topographic data, and sediment wedge is at approximate Station 13+25, and is indicated by a note on Sheets 3 and 4 (Attachment 4).

Volume Potentially Released During an Uncontrolled Failure

Stone developed a conceptual level estimate of the potential volume of sediment mobilized during an uncontrolled dam failure. Due to the conceptual level of this study and lack of a project sediment transport model, it is difficult to accurately estimate this. However, if we assume the sediment transported will be limited to the impounded area, and that the stream will want to migrate to a stable slope soon after a hypothetical large storm event, we can assume that the channel will headcut back to approximate station 14+00 based on our assessment of stable slopes within the project area and reaches adjacent to the project.

Assumptions regarding the amount of dam failure were also made in the sediment volume calculations. Considering the dam removal alternatives presented in Section 1.6 below, we assumed that the extent of dam failure is equal to the median value of proposed dam removal, or 94 linear feet of dam failure.

While the extent of potential headcut matches the upstream limit of our pilot channel construction, and since the extent of dam failure matches Alternative A3, for the purposes of this exercise we make the conservative assumption that the amount of material that may be mobilized during an uncontrolled failure is equal to the amount of material we proposed to remove as part of Alternative A3, or 11,100 CY. The details of proposed sediment removal for this alternative are discussed further under Task 4-1.

Note that the assumptions made to support this calculation are arbitrary and were only made to develop a rough conceptual idea and estimate of potential material that could move beyond the dam given a dam failure. In the event of a failure, many different variables would be at play and several different factors could lead to a wide range of release scenarios.

Volume Released During and After Dam Removal

Similar to other dam removal projects in Vermont, this project will require a state Stream Alteration Permit, a US Army Corps of Engineers Vermont Category 2 General Permit, and other similar permits, where the prevention of sediment transport to downstream reaches is of primary concern. These permits will require the contractor to have erosion protection and sediment controls in place prior to any work; will require that a plan be in place for bypassing flows around the work area; and may require staged land disturbance to ensure limitations of concurrent soil disturbances. However, even with these controls in place, a small amount of sediment may bypass these controls and be transported downstream. Based on our experience with dam removals, the transported amount can usually be considered negligible, or, as a temporary negative impact (i.e., lasting hours to days) that is outweighed by the long-term gain (lasting years to decades) realized by the completion of a large dam removal and/or restoration project, where benefits include restoration of geomorphic functions, floodplain connectivity, aquatic organism passage, etc.

Based on the text and calculations presented in this section, the theoretical maximum quantity of sediment that could be released after dam removal is the total impounded sediment volume of 14,300 CY minus the quantity of sediment proposed for removal as part of the conceptual design (13,940 CY for A4), or 360 CY. However, the proposed final 30% design pilot channel 'Typical Channel Cross Section' as shown on Sheet 7 will incorporate the establishment of vegetation and erosion controls to stabilize remaining impounded sediment. The vegetation selected should be native and relatively quick growing, with rooting systems that will ensure soil stability over the life of the project. Stone staff observed robust stands of willow within the floodplains and along the stream banks during field work. The revegetation plan should include planting of these existing onsite willows, in addition to other native species on disturbed surfaces to ensure quick establishment of deep rooting vegetation. Erosion control fabric made of natural fibers (i.e., coir or coconut fiber matting) can also be used along new surfaces to promote stability while vegetation takes time to root and establish.

It is possible that the sediment volume released following dam removal will be below the amount calculated in the paragraph above (360 CY). The successful implementation of the design and establishment of vegetation will minimize erosion and most likely reduce the total sediment volume released over time. Additionally, the potential quantity mobilized will depend on channel adjustments the system might develop as a result of dam removal and pilot channel construction. For example, if following dam removal, the Jail Branch attempts to find equilibrium by moving significantly further into a meander bend that is part of the final design, then erosion along the meander bank may result in sediment conveyed downstream. The released quantity can be estimated from the amount of soil loss at the meander and quantified by field measurements. Given the tendency of natural systems to adjust and considering typical design and construction tolerances, post-project adjustments are common and almost inevitable. Predicting their quantity in terms of sediment volume, however, is difficult in any design stage.

Overall, if the pilot channel is designed at a slope that reasonably matches adjacent channel slopes (i.e., within +/- 25% of adjacent slopes), and stabilization of disturbed surfaces is successful, the majority of sediment conveyed after dam removal should equal the bed load of the fluvial system. Additions to that quantity are possible if there are post-project channel adjustments that result in bed, bank or floodplain surface erosion, as discussed in the preceding paragraph.

1.4. Geotechnical Analysis and Report

Stone completed desktop, field, and laboratory geotechnical investigations at the Hands Mill Dam as part of the overall 30% design effort. The following sections provide a summary of these investigations including field and laboratory methods, data logs, and the implications of the data for site design and construction processes. Additional detail is provided in the Geotechnical Memo in Attachment 5.

Desktop Evaluation

A preliminary desktop evaluation was performed to determine the potential extents of sampling. Aerial imagery of the Hands Mill Dam location (44.10569, -72.43000) from Google Earth shows aggradation of sediment, likely coarse grained, for approximately 750 linear feet upstream of the Hands Mill Dam. Visible changes in bed slope and material indicated that the direct impact of the dam on the sediment impoundment was likely limited to approximately 600 linear feet upstream. (See Figure 1 in Attachment 5). This area was further investigated in the field to confirm sampling locations. The number of channel samples to be collected (six in total) was predetermined and included a combination of pebble counts and laboratory grain size analyses (methodologies defined below). The number of floodplain samples to be collected (three in total) was also predetermined to represent the spatial extent of the left-bank floodplain.

Field and Laboratory Investigations

Channel sediment sampling was focused within the 600-foot impoundment extent identified in the desktop evaluation. Exact sampling locations were selected to maximize the range of outcomes of the grain size analyses in order to assess the variability of grain size distribution throughout the channel. One sample, HM-S6, was excluded from further analysis and was sent to archive due to extensive similarity to sample HM-S4. Floodplain samples were spaced at equidistant intervals (approximately 150 - 200 feet apart) throughout the left bank floodplain.

Grain size analyses were performed using one (or more) of three methods at each channel sampling location: modified Wolman pebble count, laboratory sieve analysis, and/or laboratory hydrometer analysis. The modified Wolman pebble counts were performed using the methodology of Leopold (1970) where individual grains are selected using heel-to-toe spacing along cross-sectional transects. For laboratory testing, bulk sediment samples were collected to a depth of approximately 6-10 inches below the surface using a hand shovel. The samples were sent to the University of Vermont (UVM) Agricultural & Environmental Testing Laboratory (Lab) given the Lab's ability to perform a specific phosphorus content test. Laboratory sieve analyses were performed on the coarse fraction of bulk sediment samples, and laboratory hydrometer analyses were performed on the fine fraction of bulk sediment samples. Bulk sediment samples were also sent to the UVM laboratory for phosphorus content analysis via microwave digestion and inductively coupled plasma (ICP) analysis. Results of the laboratory analysis are included in Attachment 5.

Floodplain soil/sediment samples were collected to a depth of approximately three (3) feet using a hand auger. Soil characteristics, including color, moisture, consistency, and field assessed USCS classifications were recorded on a soil boring log for each of the three samples (see Attachment 5). Field-assessed USCS classifications were determined in accordance with ASTM standards D-2487 and D-2488.

Geotechnical Analysis Results

The results of the channel and floodplain investigations are shown in Table 6 through Table 8. Pebble count data were aligned with the size classes tested via hydrometer and sieve analyses at the UVM Lab for direct comparison. Figure 2 in Attachment 5 shows the cumulative grain size distribution at each of the channel sampling sites (note that the curves for HM-S4 and HM-S5 were generated from pebble count data).

Table 6: Grain Size Distribution of Channel Samples

Sampling Site	Sample Type	Cumulative Percent Retained (%)								
		Larger than 3/4 Sieve[2]	3/4 Sieve	1/2 Sieve	1/4 Sieve	#5 Sieve	#10 Sieve	Sand	Silt	Clay
HM-S1	B/L	-	100.0	100.0	100.0	99.9	99.7	5.9	2.0	0.1
HM-S2	B/L	-	100.0	85.0	73.3	60.8	55.2	46.6	4.7	1.2
HM-S3	B/L	-	100.0	99.9	99.9	99.3	98.6	95.8	3.4	1.6
HM-S4	B/L	-	100.0	99.4	90.2	77.3	69.8	52.4	3.4	1.0
Sampling Site	**Sample Type**	**Cumulative Percent by Size Class (%)**								
		Larger than 3/4	**3/4 Sieve**	**1/2 Sieve**	**1/4 Sieve**	**#5 Sieve**	**#10 Sieve**	**Sand**	**Silt**	**Clay[1]**
HM-S4	PC	100.0	88.0	70.0	48.0	38.0	36.0	4.0	0.1	-
HM-S5	PC	100.0	66.7	56.6	49.5	42.4		9.1	0.1	-

Abbreviations: B/L = bulk samples sent to UVM lab for analysis; PC = pebble count sample

[1]Results not recorded for this combination of methodology and size class

Date and Author: 11-16-2020 / MS

Table 7: Phosphorus Content of Channel Samples

Sampling Site	Test Description	P-Content (mg/kg)
HM-S1	Phosphorus (P) from ICP	267.9
HM-S2	Phosphorus (P) from ICP	343.3
HM-S3	Phosphorus (P) from ICP	206.1
HM-S4	Phosphorus (P) from ICP	426.5

Date and Author: 11-16-2020 / MS

Table 8: Soil Characteristics of Floodplain Samples[3]

Sampling Site	Composite Relative Soil Moisture	Composite Soil Color	Predominant USCS Classification
HM-FP1	Moist to Wet	Dark Brown	SM (Silty Sand)
HM-FP2	Moist to Wet	Brown	SM (Silty Sand)
HM-FP3	Moist to Wet	Brown/Grey Brown	SM/ML (Silt with Fine Sand)

Date and Author: 11-16-2020 / MS

Discussion of Geotechnical Analysis Results

As is common with pebble counts, the sampling data show that the pebble count samples tended towards the coarser fraction of the impounded bed sediment material than the Lab tested bulk samples. However, both the Lab samples and pebble counts indicate that the median grain size (d50) of the channel material is less than 10 mm (1 cm) in diameter. Particles of this size are highly mobile via both rolling and entrainment during common storm events. Both sample types also indicate that approximately 75% or more of the impounded bed sediment is finer than 25 mm (approximately 1 inch) in diameter. Coarse gravel in this size class is still likely to mobilize during storm flow events based on a simple incipient motion approximation using the critical Shields Number.

The average phosphorus (P) content of the impounded channel sediment is approximately 311 mg P/kg sediment. The total amount of phosphorus removed can be estimated based on 1) the extent of the impoundment, 2) an assumption that much of the phosphorus is contained within the active sediment layer (top 10 cm), and 3) an assumption that approximately 30% of the phosphorus is biologically available (value provided by the VANR workgroup). Review of publicly available LiDAR and aerial photography, and confirmation with field-run survey yields a total area of approximately 15,000 ft2 of sediment impoundment. Based on the above assumptions and an average P loading of 311 mg/kg, the total bioavailable phosphorus to be removed associated with the proposed dam removal is 21 kg (or 46 lbs.). This estimate is limited to the sediment impounded within the confines of the channel. Floodplain sediments were not tested for P content, however utilizing the same assumptions as above, the same loading rate of 311 mg/kg, and the surface area of the proposed floodplain bench excavation (approximately 18,000 ft^2) an additional 25 kg (55 lbs.) of phosphorus would be removed. If the entire impounded depth were assumed to contain phosphorus-laden sediments, the total P removals from channel and floodplain sediments would increase to 317 kg (699 lbs.) and 381 kg (840 lbs.), respectively. See Attachment 5 for supporting calculations.

Field evaluation of floodplain soils revealed that the floodplain soils are predominantly silty sands, or USCS classification SM. Based on this characterization, the soils are likely limited to a maximum grade of 2H:1V outside of the channel limits. The internal friction angle of SM soils is approximately 30 to 35 degrees, depending upon the fractions of silt and sand, therefore precluding the ability to permanently grade these soils to a slope exceeding 2H:1V. Sandy soils do not generally achieve high levels of compaction in comparison to silty or clayey soils, and silty soils are subject to the highest relative amounts of post-construction settlement, particularly in regions with highly active freeze-thaw. Caution should therefore be taken to limit steep grading to the maximum extent practicable.

1.5. Wetlands Delineation

Wetland boundaries were delineated by Karina Dailey of the Vermont Natural Resources Council (VNRC) on October 8, 2020. The wetland delineation was performed in accordance with the U.S. Army Corps of Engineers Wetland Delineation Manual, Technical Report Y-87-1, January 1987, Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), January 2012, and Section 3.2 of the Vermont Wetland Rules. Wetland boundaries are shown on Sheet 3 of the design plans (Attachment 4). Additional wetland boundary investigations will be performed at the potential sediment disposal sites during the final design phase of the project.

1.6. Alternatives Considered

An alternatives analysis was completed as part of this project. Stone developed and assessed a total of four options for dam removal, including a ‘no action” alternative of leaving the dam in place. A phased dam removal was also discussed with stakeholders; however due to the poor conditions of the dam, phased removal was not further examined as part of this project. Stone presented the alternative to the District and stakeholders at the stakeholder check-in meeting on September 28, 2020. The four presented alternatives are as follows:

- A1 - No Action – The dam and impounded sediment remain in place. Given the trajectory of historical inspections and current state of the dam, the potential for dam failure would be expected to increase over time.
- A2 - Removal of 44 linear feet – Includes the embankment section and principal concrete spillway only. While this alternative would not allow the continuance of a floodplain bench through the dam area, this alternative is included for comparison purposes.
- A3 - Removal of 94 linear feet – Including the embankment section and principal concrete spillway, and 50 linear feet of the concrete/stone wall. This would remove all the concrete/stone wall and only leave the concrete training wall in place.
- A4 - Removal of entire dam - 165 linear feet plus any dam portions that are buried (~30 linear feet). This alternative may be required if cuts in the dam area are deep enough (i.e., ~12-14 feet) such that the concrete training wall is undermined and would not be stable over the long term.

Costs were developed for each alternative based on estimated construction quantities. Table 9 below provides a summary of the typical engineering opinion of probable costs (OPCs) for each alternative, in addition to life cycle costs calculated per Attachment B of the RFP.

Table 9: Summary of Costs for Alternatives

Alternative	Typical Engineering OPC ($)	Life Cycle Costs ($)
A1	$0	$0
A2	$340,100	$181,843
A3	$372,000	$193,442
A4 (30%)	$476,600	$285,960

Date and Author: 09-21-2020 / GMB

The OPCs were developed to the 15% design level for alternatives A1, A2, and A3. Costs include volumes for concrete and sediment removal, and other quantities estimated from the drawings and knowledge of the site. Unit costs based on 2-year average unit cost data maintained by VTrans (http://vtrans.vermont.gov/cost-estimating), and unit costs from recent construction projects for similar bid items were used to develop the OPCs. The OPC for the selected alternative, A4, was developed to the 30% design level. The 30% design OPC includes volumes for concrete and sediment removal, and other quantities estimated from the drawings and knowledge of the site, such as conceptual costs for survey layout, construction access, erosion prevention and sediment control measures, flow bypass measures, channel realignment, installation of grade controls, bank stabilization features and soil stabilization. Per standard cost estimating methodologies developed by the US Army Corps of Engineers, each OPC includes a 20% contingency to account for unforeseen construction costs related to site conditions, variability in pricing, etc. Also, per Corps standards, as the project advances through subsequent design refinements and estimates of costs become more certain, the contingency for the selected alternative will be reduced down to 10% for the 100% design submittal. The costs also include mobilization/demobilization costs, estimated at 10% of the construction costs. The costs developed to the 15% design level do not include final design engineering fees, permitting, or bid phase services; however, those costs are provided in the final 30% design OPC for the chosen alternative, A4 (see Attachment 6).

Life cycle costs were based on Attachment B to the RFP, and the United States Department of Agriculture Rural Utilities Service Bulletin 1780-2, Preliminary Engineering Reports for the Water and Waste Disposal

Program, as provided on the state's State Revolving Fund website (https://dec.vermont.gov/water-investment/water-financing/srf/srfstep1/PER). Life cycle cost analysis (LCCA) consists of adding all initial and ongoing costs of the project over the life of the project, subtracting the salvage value of the project at the end of that time, and adjusting for inflation. With regards to annual costs, Stone assumed an annual cost of $2,000 to account for vegetation establishment and/or management, over an assumed 20-year project life. We also assumed $5,000 of 'repairs' every five years of the course of the project, accounting for any repairs or stabilization that may be required due to channel adjustments or any other unforeseen issues. Life cycle costs for each alternative are provided in detail in Table 11 below.

Table 10: Life Cycle Costs for Each Alternative

Alternative	Total Project Cost [1]	PW Annual O&M Cost [2]	PW Bank Repair Cost[3] (20 yrs, 5 yr interval)	PW Salvage Value[4] (20 yrs, 0.25%)	Present Value	PW (Cost + Present Value)
A1	-	-	-	-	-	-
A2	$287,696	$38,969	$19, 387	($164,209)	($105,853)	$181,843
A3	$314,719	$38,969	$19,387	($179,633)	($121,277)	$193,442
A4	$476,600	$38,969	$19,387	($195,748)	($137,392)	$285,960

[1]Capital Total Project Costs based on estimated construction cost in report
[2]Present Worth (PW) O&M costs based on estimated O&M cost in report
[3]PW Bank Repair Costs (5 yr interval)
[4]Estimated PW Salvage Value based on OMB Circular No. A-94 rate
[5]Present Worth of Salvage Value
Date and Author: 03-11-2021 / MRA

1.7. Selected Alternative

Alternative 4 (A4) was selected as the final alternative, which includes removal of the entire visible portion of the dam (165 linear feet) plus a portion of the dam that is buried along river right. The removal extents include the embankment section and principal concrete spillway, 67 linear feet of the concrete/stone wall, 70 linear feet of the visible portion of the concrete training wall and 30 linear feet of the buried portion of the concrete training wall.

Alternative A4 was selected over other alternatives due to the depth of sediment removal directly behind the dam (approximately 14' deep) and the need to remove most of the concrete training wall due to long-term stability concerns. Besides the length and extent of dam removal, all other project components were the same across each alternative. Additionally, alternative A4 allows for channel and floodplain restoration within the vicinity of the dam. The ecological and hazard mitigation benefits associated with channel and floodplain restoration are not captured in the life cycle cost analysis.

A1 was discarded because it failed to address the existing hazards and the potential for flooding and dam failure was expected to increase over time with this alternative. A2 removed only the principal concrete spillway but blocked full restoration of a floodplain bench, so it was discarded in favor of either A3 or A4, which would both remove the dam and allow for floodplain restoration to alleviate both the flooding and dam failure hazards. A3 and A4 were discussed in depth by the stakeholder group at the September 28, 2020 stakeholder meeting and it was determined that A4 was the most logical removal alternative due to the required excavation depths behind the dam. Staged removal was also discussed during the meeting, and it was decided that given the age and condition of the dam, it was uncertain whether partial removal under the A4 scenario would be technically feasible or whether partial removal would undermine the remaining structure and increase risk of infrastructure failure. Ultimately the stakeholders concurred that A4 via conventional removal methods was the best alternative to address all hazards of concern.

1.8. Hydrologic Analysis

Peak Flow Analysis

Stone staff delineated the geographical region contributing flow to the site and determined the watershed size to be 6.65 mi^2. Streamflow data from nearby USGS gages were used to determine peak flow rates using a gage transfer technique. Stone located 3 gages within 50 miles of the site and chose 2 of those 3 gages for further analysis based on watershed size relative to the Jail Branch watershed, geology and surficial soils, length of period of record, and presence of obstructions to flow (ex. dam or withdrawal). At each gage, a Log-Pearson Type III distribution was used to determine the 2-, 5-, 10-, 25-, 50- and 100-yr recurrence interval design flows. For each gage, an additional hydrologic analysis was performed that compared records to data collected after 1970, to identify if the hydrology at each site was impacted by a recent shift in hydrologic regimes as a result of climate change. The resulting distributions were plotted and compared to the StreamStats distribution.

The East Orange Branch, near East Orange, Vermont gage (#01139800) was selected to determine peak flows at the site due to its long period of record (61 years), its comparable watershed size (8.8 mi^2), proximity to the site, location along an unregulated stream and current status as an active gage. Because the post-1970 flows were higher than those corresponding to the entire record at this particular gage, the post-1970 flows were used for our analyses.

The USGS gage transfer technique was used to relate the calculated peak flows at the East Orange Branch gage to the site using the following equation:

$$Q_u = \left(\frac{A_u}{A_g}\right)^b Q_g$$

where Qu is the estimated flow statistic for the ungaged site, Au is the drainage area for the ungaged site, Ag is the drainage area for the stream gauging station, Qg is the flow statistic for the stream gauging station, and b, depending on the state, may be the exponent of drainage area from the appropriate regression equation, a value determined by the author of the state report, or 1 where not defined in the state report (for this project a value of 1 was used).

The resulting peak storm flows for Jail Branch are provided in Table 11.

Table 11: Summary of Peak Flows at Jail Branch

Recurrence Interval (years)	Flow (ft^3/s)
2	215

Recurrence Interval (years)	Flow (ft^3/s)
5	336
10	433
25	576
50	701
100	839

Abbreviations: ft = feet; s = second

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Fish Passage Flows Analysis

High and low fish passage flows were estimated to assess potential fish passage conditions at the site following dam removal. Daily streamflow data was downloaded from the East Orange Branch gage and used to calculate the 5% and 95% exceedance flows (seasonal high and low flow) during September to November, when brook trout migration is likely. The 5% and 95% exceedance flows were also calculated using daily streamflow data from the entire year. The fish passage flows calculated for both time intervals are provided in Table 12.

Table 12: Fish Passage Flows at Jail Branch

Flow	Sept – Nov Fish Passage Flow (ft^3/s)	All Months Fish Passage Flow (ft^3/s)
High	15.6	31.7
Base	4.0	6.7
Low	1.2	1.3

Abbreviations: ft = feet; s = second

Date and Author: 09-14-2020 / MRA

The design flow and fish passage flow scenarios above were simulated using a one-dimensional hydraulic model described below.

1.9. Hydraulic Modeling

Model Development

Stone used the US Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System model (HEC-RAS; http://www.hec.usace.army.mil/software/hec-ras/) to develop a one-dimensional, steady flow hydraulic model of Jail Branch, the dam and its floodplains. This model was used to simulate the peak flows and fish passage flows for existing and proposed conditions.

The basemap developed as part of Stone's assessment of the existing conditions at the site was the source of the topography and bathymetry for the existing conditions hydraulic model. The basemap was developed in a relative datum and will be tied to NAVD88 datum during 100% design. Stone staff exported the TIN surface as a digital elevation model (DEM) and then imported the DEM into HEC-RASMapper to create a terrain model, which supported the development of the geometry file in HEC-RAS.

Once the geometry file was created, the dam structure and features such as natural levees, ineffective flow areas, stream bank stations, distances between cross-sections, and Manning's roughness coefficient at each cross-section were more fully defined. Survey data collected by Stone staff were used to specify the dam locations and dimensions in the existing conditions model. Manning's n values were selected based on channel surface roughness, vegetation, and channel features such as pools.

HES-RAS requires boundary conditions to set the starting water surface elevation at the upstream and/or downstream ends of the river system being modeled. Additionally, a flow regime (subcritical, supercritical, or mixed) must be selected for each analysis. For this 30% design, each steady flow analysis was completed using a subcritical flow regime, which is well suited for preliminary dam removal evaluations. Since the subcritical flow regime was used, only a downstream boundary condition was specified. The downstream boundary condition was set to normal depth with an energy slope of 0.0055, for all flow profiles. The energy slope was estimated based on the channel slope in the vicinity of the downstream cross sections. The boundary condition was set at cross-sections sufficiently far away from the area of interest as to minimize errors due to estimating the starting water surface elevation.

The peak flow and fish passage flow values calculated using gage transfer and statistical techniques were entered into the HEC-RAS flow file that was used for both the existing conditions and the proposed conditions model. For this final 30% design deliverable, the model included the tributary junction at Jail Branch and the Unnamed Tributary and incoming flows were apportioned to each tributary based on tributary watershed size. Table 13 lists the peak flow conditions simulated and Table 14 lists the fish passage flow simulated.

Existing Conditions Hydraulic Analysis

The hydraulic analysis completed for the existing conditions provides insight into the expected water surface elevations, water velocities, flood inundation limits, and barriers to fish passage for the flow scenarios analyzed. A longitudinal profile and water surface elevation results for selected cross sections under existing conditions, is provided in Attachment 7.

Proposed Conditions Hydraulic Analysis

Stone developed a one-dimensional hydraulic model to simulate flow conditions for the selected alternative (Alternative A4). The model for Alternative A4 was developed based on approximately 195 total linear feet of dam removal, the extents of which are shown on Sheets 5 and 6 of the plans. The model also incorporates the removal of approximately 13,940 CY of impounded sediment behind the dam, which is simulated in the model via a revised pilot channel slope as shown on Sheet 7 (see dashed blue line in the profile at top of sheet) and the dimensions of the Typical Channel Cross Section also provided on Sheet 7, which includes bank stabilization measures and incorporation of a 30' wide floodplain bench along river left (green shaded area on Sheet 6).

The proposed alternative lowers the modeled water surface elevation in the vicinity of the Hand Mill Dam for the modeled recurrence interval floods. Under existing conditions, the 100- and 500-year WSEs at the dam are 1,279.79 and 1,280.01' respectively (Table 13). Based on hydraulic modeling completed using USACE's HEC-RAS model, the WSEs for the 100- and 500-year at the dam location are 1,265.15' and 1,266.21' respectively, and lower than existing conditions (Table 13). Longitudinal profile and selected cross section results are provided in Attachment 7.

Table 13: Water Surface Elevation Comparison at Dam for the 100-Year Recurrence Interval Flow

Scenario	100-yr WSE[1] (ft)	Linear Feet of Dam Removed
Existing	1279.79	0
Alternative A4	1265.15	195

Abbreviations: ft = feet; WSE = water surface elevation

[1]WSE presented references a relative datum and will be tied to NAVD88 during 100% design development

Date and Author: 1-5-2021 / MRA/GMB

It is evident that Alternative A4 provides significant reduction in water surface elevations compared to those of the existing conditions, with a peak water surface reduction of 14.64 feet for the 100-year recurrence interval storm event. Similar reductions apply for other significant recurrence intervals (i.e., 10-, 25- and 50-year intervals). In addition to these peak water surface elevation reductions and mitigation of flooding, the dam removal also improves public safety by removing a high hazard dam that has been deteriorating over the past few decades.

Fish passage modeling results indicate that the channel velocities and main channel water depth support adult brook trout passage and generally support juvenile brook trout passage under low, base, and high fish passage flows (Table 14). While stream velocities exceed the maximum velocity for brook trout passage at some cross sections during peak flows, it is anticipated that brook trout will find refuge in slowly moving pools and eddies during these conditions.

Table 14: Channel Velocity Model Results for Fish Passage Flows (Proposed Conditions)

Flow	Sept – Nov Channel Velocity[1] (ft/s)	All Months Channel Velocity[1] (ft/s)
High	2.11	2.65
Base	1.58	1.68
Low	1.19	1.22

[1]Average channel velocity at dam location after dam removal under Alternative A4

Date and Author: 03-11-2021 / MRA

1.10. Proposed Project

1.10.1. 30% Design

Conceptual Design

Stone developed a 30% conceptual design based on characteristics of the reference reach, keeping in mind infrastructure constraints throughout the project area, maintenance of floodplain connection, construction access and reasonable construction costs.

Based on inspection of the longitudinal profile developed from the topographic survey, the average slope of the reference reach was 1.5%. A similar average slope of 1.7% was observed in the unnamed tributary. Considering site constraints and reasonable anticipated construction costs, a slope of approximately 2.0% was used as a basis of design for the pilot channel.

Typical of other dam removal and channel restoration projects, a downstream starting point, or tie in point where the pilot channel would begin was required. As shown on Sheet 7 (Attachment 4), there is a large sediment wedge just downstream of the dam. This material consists of medium to large sized boulders and is most likely comprised of dam material that has broken off over the past few decades, material that has been transported downstream and over the dam during large storm events, and native surficial material that has been exposed due to high erosive forces. We expect that this material is immobile except during extreme storm events. Because most of this material is sourced from the dam itself and its presence in this location is not geomorphically appropriate, we proposed to remove the sediment wedge material and tie in the pilot channel just downstream of the wedge, at the first downstream grade control at approximate station 5+08. It is estimated that the sediment wedge is made up of approximately 550 CY and it is anticipated that this material will be incorporated into other parts of the design (as stone steps, bank stabilization, etc.).

A summary of the final 30% design components is provided below with additional detail in the plans provided in Attachment 4.

Dam Removal – The 30% design plans for the proposed alternative include the removal of approximately 165 linear feet of the dam, plus 30 linear feet of the buried dam, totaling approximately 453 CY of material. The removal includes the embankment section and principal concrete spillway, 67 linear feet of the concrete/stone wall, 70 linear feet of the visible portion of the concrete training wall and 30 linear feet of the buried portion of the concrete training wall. Additionally, large stone material that has accumulated downstream of the dam will be removed. No bedrock will be removed as part of dam removal. See Sheet 5 in Attachment 4 for Dam Demolition plans.

Pilot Channel Construction –The limits of the proposed channel restoration and pilot channel construction are from station 5+08 to 14+00. The overall slope of the pilot channel is 2.1%, with approximately 1’ elevation drops included at proposed step locations. Steps have been incorporated to provide channel bed grade control and channel stability in the vicinity of residential properties and provide the needed elevation drop through the pilot channel. The pilot channel bankfull width will be approximately 31± 2 feet. Existing tree fall in the project vicinity and trees removed to allow for site access will be used as wood additions and bank stabilization practices. See Sheets 6 and 7 in Attachment 4 for additional details on pilot channel design and construction.

Floodplain Bench Construction – The proposed design includes the construction of a 30 ft wide floodplain bench along river left of the pilot channel. The floodplain bench will be tied into existing grades along its extents. The slope from existing grade to the floodplain bench will be approximately 2:1 with a varying width. The slope of the floodplain bench toe to top of bank will be approximately 5%. Live stakes, fascines, vegetation, and stabilization measures from top of bank to existing grade will be determined in 100% designs.

Ancillary Components – Ancillary components of the design include site access, haul out of materials, bypass pumping, and erosion and sediment control. Primary access for pilot channel construction and sediment haul out will be off West Corinth Road (Sheet 4, Attachment 4). While the final design plans will provide an example of site access and bypass pumping, ultimately the Contractor will be required to provide an access and material removal plan to be approved by the Engineer prior to mobilization. During construction, the Contractor will grade and create a temporary ramp into the floodplain, to be restored to existing conditions following dam removal and channel and floodplain work.

1.10.2. Photo Simulation

Stone completed a photographic simulation of post dam removal conditions at the site. The photo simulation was completed using a photo taken downstream of the dam and looking upstream, with the assumption that approximately 195 linear feet of the dam is removed. A photo of the existing conditions at the site is provided in Figure 1 and a photo simulation of the site following dam removal is provided in Figure 2.

Figure 1. Photo of existing conditions at Hands Mill looking upstream.

Figure 2: Photographic simulation of project site following dam removal

1.10.3. Permit Requirements

- Project activities and designs have been developed with input from several local, state, and federal entities to ensure that the proposed scope of work meets all permitting requirements, and that design plans are technically feasible and will result in community and ecosystem benefits. Partnering entities who have ensured the technical feasibility of this project include: 1) The Vermont Department of Environmental Conservation (DEC) - Dam Safety Division; 2) DEC - Floodplains Manager; 3) DEC - River Management Program; 4) DEC - Wetlands Program; 5) Vermont State Historical Preservation Office; 6) Vermont Emergency Management; 7) Vermont Fish and Wildlife Department; 8) United States Army Corps of Engineers; and 9) United States Fish and Wildlife Service. Below is a summary of potential permits needed and relevant regulatory review considerations.
- Local Permits
  - State Floodplain Permit –or– Municipal Flood Hazard Permit and EO11988: Project will include stream channel and stream bank restoration to install a floodplain bench for natural flood control and is not expected to negatively impact the floodplain zone. The project includes construction of 0.41 acres of floodplain bench located directly adjacent to the pilot channel. This bench will contain the majority of floods post dam removal and will also provide a means to minimize impacts to adjacent properties and infrastructure. There is no alternative to operating within the floodplain and wetland as the dam is currently located in the floodplain and is surround by wetlands. Project partners including the State Floodplain Manager and Wetlands staff have provided input on the designs to ensure construction activities minimize long-term impacts to the wetlands and floodplains. The project involves dam removal and the dam is currently mapped by approximate methods as Zone A. The project budget and scope of work includes expenses for developing as-built topography, an updated hydraulic model, and re-delineation of Zone AE at the close of construction. The project is under jurisdiction of the Town of Washington with regards
  - to work in the Special Flood Hazard Area.
- State Permits
  - Stream Alteration Permit: The project will establish a new pilot channel for the Jail Branch within the project limits of disturbance to include new streambank contours and a floodplain bench. If natural grade controls are not found during construction, grade control rock steps will be installed in strategic locations within the pilot channel limits to prevent any rapid changes in bed elevations and prevent upstream migration of a head cut following construction. These grade controls will also prevent bed adjustments in upstream tributaries post-construction. Instream restoration work will require a state Stream Alteration Permit from the River Management Program. To date an engineer from this program has participated in all stakeholder meetings and provided feedback on the design so we foresee no barriers to securing this permit once final designs are completed.
  - Chapter 43 Dam Order Permit: Hands Mill Dam impounds more than 500,000 cubic feet of water and sediment from the lowest non-overflow portion of the dam and therefore falls under the Dam Safety Program's jurisdiction. The project will need a Dam Order under 10 VSA Chapter 43.
  - Stormwater Construction Discharge Permit: This permit is typically required if the project disturbs more than 1 acre of land. The extent of disturbance will be confirmed during the 100% design phase).
  - Wetlands Permit: We anticipate not needing this permit, as the project is considered an 'Allowed Use' under Section 6 of the Vermont Wetland Rules.

- 401 Water Quality Certificate: We anticipate this permit not being required if the project qualifies for a USACE VT General Permit. This will be determined during the 100% design phase.)
- State Historic Preservation Office Concurrence: Anticipated following completion of historic preservation tasks (see Archeological Resources section below).
- Act 250: Not anticipated to be required, however this will be explored during the 100% design phase.

- Federal Permits
  - US Army Corps of Engineers Vermont General Permit, Category 2: The project may qualify for a Pre-Construction Notification (PCN) under General Permit #10 of the Vermont General Permits (GPs).
  - Historical Buildings and Structures: The Area of Potential Effect (APE) includes or is in close proximity to the following buildings and structures older than 50 years: 1) Hands Mill Dam; 2)16 Woodchuck Hollow Road, 3) a shed that is now part of 39 Woodchuck Hollow Road, 4) 110 Woodchuck Hollow Road; 5) 273 West Corinth Road, 6) 53 Vermette Lane, and 7) 111 Vermette Lane. Only the dam and its connected mill foundation is recommended for significance and National Register eligibility and dam removal will result in an Adverse Effect, so the scope of work includes a Historic Resources Documentation Package and Historic Resource Mitigation. SHPO concurs with these recommendations.
  - Archeological Resources: 30% Design Plans show the extent of ground disturbance totaling 1.45 acres largely in-stream and along graded contours. Designs show spatial relationship with three areas delineated as sensitive for pre-Contact Native American Archeological sites. Ground disturbance will avoid two of the three sensitive areas (both upstream). The project is proceeding with Phase 1 and (if necessary) Phase 2 archeological work for the impacted downstream site in 2021 in advance of the Implementation Phase. The project budget includes site delineation for the avoided sensitive sites prior to construction. The APE is recommended as not sensitive for historic period archaeological resources. SHPO concurs with these recommendations.
  - Endangered Species Act and Wildlife Coordination: There are no mapped occurrences of rare, threatened, or endangered species within the APE and VFWD correspondence attached indicates no concerns for aquatic or terrestrial species. The dam site is approximately 6.67 miles from the nearest known occurrence of federally listed Northern Long-eared Bats. The project site is considered "potential summer habitat" but not "known summer or winter habitat." There are 1213 acres of forested habitat within a mile of the project site and proposed vegetation clearing at the project site falls below threshold of concern (1%) for impact. The VFWD supports the project to connect 14.7 miles of Eastern Native Brook Trout habitat. Trees greater that 3” DBH were identified. The Vermont Wetlands Program performed an in-field bio-assessment of plant species within the APE for more refined details on impacted vegetation and will share this information during 100% design work.
  - Clean Water Act, Rivers and Harbors Act, EO11990: Wetlands delineation was completed in summer 2020 and wetland boundaries are included in the 30% Design Plans. The dam impounds a roughly 2-acre pond which is now heavily sedimented and providing ideal wetland habitat. There are no mapped wetlands from the National Wetlands Inventory within the APE, but the Vermont State Wetlands Program determined that a regulated Class 2 wetland is present. Correspondence with wetlands program staff indicates removal of the dam will likely qualify as an Allowed Use under Section 6 of the Vermont Wetland Rules as a restoration activity provided it follows all other applicable laws. Stream restoration projects

including dam removals are an allowed use that do not require a permit if the designs are approved by the Secretary.

- EO12898 (Environmental justice for low income and minorities): A low-income family inhabits a property directly adjacent to the project area (16 Woodchuck Hollow Road). There are no disproportionate effects to these populations. An H&H analysis performed by a certified Professional Engineer has confirmed that this property will not be impacted by any additional flooding risk after dam removal and that the 500-year peak WSE for proposed conditions is still below the existing Finished Floor Elevation. Residents have been contacted regularly throughout the preliminary design phase of this project.

1.10.4. Operations and Maintenance Considerations

The Town, as the owner of the property, will have primary responsibility over the annual maintenance responsibilities and associated operating budget. For this dam removal and floodplain restoration project, we anticipate the annual operating budget will largely consist of monitoring since all dam infrastructure will be removed from the property. As part of project funding applications, the Town of Washington submitted a maintenance agreement that commits the Town to long-term maintenance of the site. The agreement will be refined and updated during the 100% design work to include details about schedule and expected maintenance obligations. Successful maintenance will most likely entail ensuring buffer plant survivorship and protection of the streambank and floodplain from further encroachment. Tree care maintenance costs are expected to be minimal and at the expense of the Town to include regular watering and weeding until the buffer plants are well established (1 year of care) and replacement plantings for three non-consecutive years if survivorship falls below 75% within the five-year monitoring timeframe required by the U.S. Army Corps of Engineers. Total maintenance costs over the life of the project are expected to be roughly $7,308, plus approximately $4,000 for bank sloughing monitoring work over the first five years following construction.

1.10.5. Ecosystem Benefits

Removal of the Hands Mill dam will result in possible positive ecosystem benefits including improved water quality, connection of native Eastern Brook Trout to high-quality refuge habitat, and increased riparian corridor integrity.

Conservative estimates of water quality benefits, in terms of removal of bioavailable phosphorus, indicate that dam removal will have a positive water quality impact. The total amount of phosphorus removed can be estimated based on 1) the extent of the impoundment, 2) an assumption that much of the phosphorus is contained within the active sediment layer (top 10 cm), and 3) an assumption that approximately 30% of the phosphorus is biologically available (value provided by the VANR workgroup). Based on the above assumptions and an average P loading of 311 mg/kg, the total bioavailable phosphorus to be removed associated with the proposed dam removal is 21 kg (or 46 lbs.).

Dam removal will also eliminate the existing risk of flooding due to dam failure. A risk which only increases as climate change brings more frequent and intense storm systems to New England. Hydraulic modeling completed as part of 30% design development indicates that dam removal provides significant reduction in water surface elevations compared to those of the existing conditions, with a peak water surface reduction of 14.64 feet for the 100-year recurrence interval storm event. Similar reductions apply for other significant recurrence intervals (i.e., 10-, 25- and 50-year intervals). Given that dam failure poses the highest flooding risk to the community, removal of the dam will immediately and successfully mitigate this hazard and will provide measurable decreases in community risks in the face of climate change.

Sediment probing completed to determine the existence of underlying bedrock below the dam indicate that there is a path upstream of the dam where bedrock and/or barriers are not present down to the bottom of dam elevation. Consequently, these investigations indicate that removal will provide habitat reconnection benefits. Overall, the project will result in the removal of one stream barrier, the Hands Mill Dam, and reconnection of 14.7 miles of brook trout habitat. Additionally, the project will improve instream habitat and riparian corridor integrity with the construction of a pilot channel restoring 897 linear feet of instream habitat and the inclusion of riparian area plantings.

1.11. Conclusions

The alternatives analyzed for this project varied in scope from no action to full dam removal. Given the existing condition of the dam, potential for mitigating a significant hazard, and opportunity to increase connectivity for brook trout habitat and floodplain restoration, alternative A4 (full dam removal) is recommended as the proposed alternative. Further details regarding design components will be determined during the development of 100% designs for the project. Additional field work and analysis will be completed as needed to develop the 100% design.

Attachment 1: Dam Breach Report

Vermont Department of Environmental Conservation
Water Investment Division
1 National Life Drive, Davis 3
Montpelier, VT 05620
Phone: 802-622-4093

Agency of Natural Resources

MEMORANDUM

TO:	Town of Washington, Care of Carol Davis, Town Clerk, Dam Owner
FROM:	Benjamin Green, PE, Dam Safety Program (DSP), Engineer Katherine King, DSP, Assistant
DATE:	November 18, 2020
SUBJECT:	DSS-Wise Lite Dam Failure Analysis and Flood Inundation Maps Hands Mill Dam, Washington, Vermont State ID No: 225.01 | National ID No: VT00308

This memorandum summarizes the methods, assumptions, and results of dam failure and downstream flood inundation analysis using the Decision System for Water Infrastructural Security (DSS-Wise Lite) model for the Hands Mill Dam. Hands Mill Dam and its floodway are in the Town of Washington. The following attachments are included:

- ***Attachment A:*** Dam Failure Flood Inundation Map
- ***Attachment B:*** DSS-Wise Lite Simulation Results Final Report
- ***Attachment C:*** DSS-Wise Lite Human Consequences Final Report

It should be noted that ***Attachments B*** and ***C*** are automatically generated reports by the DSS-Wise Lite Program.

Purpose:
The analysis was performed to investigate the hazard potential classification of the dam and potential downstream consequences in the event of a dam failure.

Dam Overview:
Hands Mill Dam is a partially breached concrete and stone rubble gravity dam with a principal spillway and outlet works founded on bedrock and/or earth. It is our understanding that dam removal is being considered and a feasibility study is currently underway.

The dam is currently classified as a SIGNIFICANT hazard potential dam. According to our files, the dam has a total length of approximately 325 feet and a structural height of 20 feet. The principal spillway consists of an eroding concrete and stone rubble weir with a total length of about 20 feet. To the left of the principal spillway is an approximately 40-foot long training wall and an old mill foundation comprised of concrete and stone rubble with an abandoned intake and concrete sluiceway. There is no auxiliary spillway. The low-level outlet (LLO) to the right of the principal spillway is an approximately 2-foot by 2-foot square opening on the downstream face that is reportedly inoperable/plugged and abandoned. To the right of the principal spillway is an approximately 300-foot-long non-overflow concrete wall that extends to the right abutment at the valley wall.

Our records dating back to 1950 indicate that the dam was built circa 1860 and was repaired after the 1927 flood. No records exist of repairs as of the 1947 ownership transfer for use as a sawmill. The dam impounds a pond with a surface area of about 2 acres at normal pool elevation that is substantially filled with sediment. It is our understanding the dam and pond currently serve no current social or economic purpose. The upstream drainage area is approximately 4,128 acres. The normal and maximum storage of the dam were estimated as 11.2 and 18.1 acre-feet in 2020 by Stone Environmental, Inc. (STI) an engineering consultant working on the dam removal feasibility study. These storage estimates compare well with historic estimates.

Downstream Conditions:
The Hands Mill Dam flows into the Jail Branch River which flows through the Town of Washington to the East Barre Dam and northerly into the City of Barre. East Barre Dam is a large, State owned and operated flood control dam that would safely contain dam failure flood waters, preventing damage further downstream. It appears that a dam failure could potentially impact several road crossings, several homes and businesses, and a school downstream.

Methods:
The DEC DSP prepared a DSS-Wise Lite model of the Hands Mill Dam and the downstream area. DSS-Wise Lite is a publicly available flood modeling and consequence analysis tool developed by The National Center for Computational Hydroscience and Engineering at the University of Mississippi. DSS-Wise Lite is a web-based program that allows the user to setup an automated two-dimensional dam breach model with minimal inputs and provides results including inundation maps, flood arrival times, hydrographs, and other life consequence information. As noted in program literature, DSS-Wise Lite is a simplified analysis producing rough, approximate results that are not intended to replace more detailed modeling processes/programs. The following limitations of DSS-Wise Lite should be considered:

- While a flood hydrograph can be manually input into DSS-Wise Lite to simulate a storm day dam failure, the program does run most reliably under sunny day failure scenarios. For this reason, a sunny dam failure during maximum pool conditions (water level at the dam crest) was modeled. This scenario is possible assuming that the principal spillway was clogged, and the water level were to rise to the dam crest. This approach also assumes normal, base flow in the downstream channel, allowing for a more easily understood incremental impact of dam breach flooding than would be present during a storm event. The failure is assumed to occur rapidly and completely to model a worst-case scenario.
- The model defaults to the use of publicly available digital elevation models (DEMs). For the area of this project, the resolution of the DEMs used in the model is 1 meter (3.281 feet).
- The program does not allow for the modeling of culverts at downstream road crossings. Accordingly, culverts are not included in the model. This does depict a somewhat worst case but observed scenario where downstream culverts become plugged with debris during a flood flow and are ineffective. Large bridges can be input in the model but are modeled as an opening with no deck.

Model Inputs:
The model inputs are summarized in ***Attachment B***. Based on the DEMs, the following elevation and storage data was used (all elevations reference the North American Datum of 1988, NAVD88, in feet):

- Normal Pool Elevation El. 1,287
- Normal Pool Storage 11.2 acre-feet
- Maximum Pool Elevation El. 1,292.5
- Maximum Pool Storage 18.1 acre-feet
- Dam height 20 feet

Several challenges are present when performing dam breach and flood inundation analyses/mapping at Hands Mill Dam. As noted above, the normal and maximum storage inputs are based on preliminary estimates by STI. STI also estimated the volume of impounded sediment behind the dam at 14,300 cubic yards. This estimated sediment volume is equivalent to about 386,100 cubic feet, or 8.9 acre-feet. With estimated normal and maximum storage volumes of the dam of 11.2 and 18.1 acre-feet, respectively, the impounded sediment makes up approximately 80% of the impounded volume at normal pool and 50% of the impounded volume at maximum pool. It is anticipated that in the event of a dam failure, a portion of this sediment would be mobilized downstream. It is generally recognized that saturated sediment or mud flows can result in a dam failure wave that would move slower, maintain its height and shape further downstream, but perhaps travel less distance overall when compared to its clear water equivalent. This analysis was performed assuming that all impounded liquids would perform as clear water. Accordingly, it is anticipated that in the event of a dam failure, it is possible that flood depths near the dam may be greater than predicted, but the flood wave may also dissipate more quickly.

Model Results:
The DSS-Wise Lite model results are summarized in ***Attachments A*** through ***C***. The estimated inundation limits were overlain on a ANR Atlas satellite image map. The following results are provided at select locations downstream of the dam.

Location	Max. Estimated Flood Depth (ft)	Max. Estimated Flood Flow Velocity (ft/s)	Estimated Arrival Time of Peak Flood (hours)
At Dam	NA[1]	NC[2]	NA
16 Woodchuck Hollow Road	3 to 6	3 to 6	Immediate
Woodchuck Hollow Road crossing	3 to 12	6 to 15	Immediate
39 Woodchuck Hollow Road	0 to 2	3 to 10	
64 West Corinth Road	<1	<1	
29 Woodchuck Hollow Road	<1	0 to 3	
31 Woodchuck Hollow Road	<1	0 to 3	
33 Woodchuck Hollow Road	<1	<1	
57 Fairgrounds Road	<1	0 to 3	
56 Fairgrounds Road	1 to 2	3 to 6	<0.25
73 Fairgrounds Road	<1	1 to 6	
2985 VT Route 110	1 to 2	1 to 3	
2973 VT Route 110 (Baptist Church)	1 to 2	1 to 3	
40 School Lane	1 to 3	3 to 6	
72 School Lane (School)	<1	0 to 3	
School Lane crossing	3 to 6	10 to 15	
Creamery Road crossing	3 to 6	10 to 15	0.25 to 0.5
Tucker Road crossing	2 to 3	3 to 6	1 to 1.5

(1) Not applicable
(2) Not calculated

Hazard Potential Classification:
As noted above, this dam is currently as a SIGNIFICANT hazard. The current hazard potential classification definitions from the Vermont Dam Safety Rule are provided below:

Classification	General Definition
HIGH	Dams where failure or mis-operation will probably cause loss of human life.
SIGNIFICANT	Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
LOW	Dams where failure or mis-operation results in no probable loss of human life and low economic and environmental losses.
MINIMAL	A dam that meets the LOW hazard definition, above, but is only capable of impounding less than 500,000 cubic feet.

The Hazard Consequence Model (HCom) estimated the Population at Risk (PAR) resulting from the simulated dam failure of the Hands Mill Dam. The PAR is the estimated number of people within an inundation limits of a simulated dam failure. The HCom estimated a Nighttime PAR of 40 and a Daytime PAR of 94. The daytime and nighttime PAR vary based on the number of homes where people are typically at night, versus business, churches, or schools, where people are typically during the day.

Based on the results, the primary risk driver is the 16 Woodchuck Hollow Road property immediately downstream of the dam. While the occupancy of this property is not clear, it is noted that there was both a house and a mobile home recently observed on the lot. In the event of dam failure, the estimated depths and velocities at these structures would approach to slightly exceed accepted, survivable limits at the house and would exceed survivable limits at the mobile home. In either case, given the proximity to the dam, there would be little to no warning/evacuation time. Accordingly, there appears to be a potential for probable loss of life at the property during a dam failure.

In addition, approximately 10 buildings, including homes, a farm, and a church, would experience minor flooding that does not appear to rise to the level of probable loss of human life, but is indicative of economic loss. Also, four roadways would be overtopped, but the anticipated low daily traffic and low travel speeds suggest it is not likely this damage would result in probable loss of human life but does infer economic loss. One of the downstream roadways, School Lane, is the primary entry and exit to the Washington Village School, the failure of which could strand or limit access. According to the model results, some minor, low velocity flooding is anticipated up to and around portions of the school. This flooding is not anticipated to cause probable loss of human life but should be given extra consideration given the vulnerable population involved.

Given the results of this study, a hazard classification of HIGH or SIGNIFICANT hazard potential should be considered. A determination of the occupancy status of the 16 Woodchuck Hollow Road property is necessary to classify the dam based on this work. Also, given the close proximity of the school, a more detailed analysis may be warranted to better understand risks associated with this vulnerable population, particularly if dam removal is not pursued in the near future or if either no action or dam rehabilitation alternatives instead considered.

As the feasibility study for the dam removal project is currently underway, a prudent risk reduction measure to undertake until dam removal can be implemented would be the development of an Emergency Action Plan (EAP). The DSP would be happy to assist in the development of an EAP, which would include the flood inundation map attached here-in, pre-planned actions in the case of a dam incident or failure, and identification of key emergency personnel as well as potential evacuees.

Y:\WID_DamSafety\Dams\H\HandsMill\Hazard Classification\Hands Mill Dam (No. 225.01) – DSS Wise Lite Dam Flood Mapping

Attachment A:

Hands Mill Dam - Flood Inundation Mapping

Vermont Agency of Natural Resources

vermont.gov

Note: The dam breach flooding information and inundation areas shown on this map are approximate and should be used only as a guideline for establishing evacuation zones. Actual flooding conditions may differ from those depicted on the map. The results of the maximum pool (water level at dam crest), rapid failure breach scenario is shown.

LEGEND

- Buildings (E911)

Roads
- Interstate
- US Highway; 1
- State Highway
- Town Highway (Class 1)
- Town Highway (Class 2,3)
- Town Highway (Class 4)
- State Forest Trail
- National Forest Trail
- Legal Trail
- Private Road/Driveway
- Proposed Roads

Stream/River
- Stream
- Intermittent Stream

Town Boundary

Flow Direction

NOTES

Prepared by VTDEC Dam Safety Program using DSS-Wise Lite, November 2020. Represents maximum pool, rapid failure estimated flood inundation map.

NORTH

346.0 0 173.00 346.0 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 173 Ft. 1cm = 21 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

Attachment B:

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

DSS-WISE™ Lite Flood Simulation Report

Run #2

Hands Mill Dam

NAXXXXX

November 16, 2020

Contact Information:

DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

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Table of Contents

1.0 Overview

The Decision Support System for Water Infrastructure Security (DSS-WISE™) is an integrated software package combining 2D numerical flood modeling capabilities with a series of GIS-based decision support tools. It was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi and was initiated by the US Department of Homeland Security (DHS) Science and Technology Directorate through the Southeast Region Research Initiative (SERRI) Program.

A simplified, and fully automated, version of the DSS-WISE™ software suite (DSS-WISE™ Lite Ver 1.0) was developed on behalf of the US Army Corps of Engineers (USACE) Critical Infrastructure Protection and Resilience (CIPR) Program and the DHS Office of Infrastructure Protection. This simplified dam break flood modeling capability was available to interested parties through the Dams Sector Analysis Tool (DSAT) secure web portal until November 2014. An updated version with more features was developed on behalf of Federal Emergency Management (FEMA) and is available at dsswiseweb.ncche.olemiss.edu.

The DSS-WISE™ Lite software suite, running on NCCHE servers, automatically processes input files for dam-break modeling scenarios submitted by an user. DSS-WISE™ Lite further simplifies simulations by making several general overarching assumptions in an effort to streamline data preparation and computations.

The results produced by this simplified dam-break flood simulation tool represent a rough approximation. They are not intended to replace more detailed flood inundation modeling and mapping products or capabilities developed by hydraulic and hydrologic engineers and GIS professionals.

The user is, therefore, warned that professional engineering judgment should be used in the interpolation of the results generated by this simplified and automated dam-break flood analysis.

To learn more about DSS-WISE™ and DSS-WISE™ Lite visit us at:
`https://dsswiseweb.ncche.olemiss.edu`

Disclaimer

The National Center for Computational Hydroscience and Engineering (NCCHE), The University of Mississippi, makes no representations pertaining to the suitability of the results provided herein for any purpose whatsoever. All content contained herein is provided "as is" and is not presented with any warranty of any form. NCCHE hereby disclaims all conditions and warranties in regard to the content, including but not limited to any and all conditions of merchantability and implied warranties, suitability for a particular purpose or purposes, non-infringement and title. In no event shall NCCHE be liable for any indirect, special, consequential or exemplary damages or any damages whatsoever, including but not limited to the loss of data, use or profits, without regard to the form of any action, including but not limited to negligence or other tortious actions that arise out of or in connection with the copying, display or use of the content provided herein.

Elevation Datum

All reported elevations use the North American Vertical Datum of 1988 (NAVD 88).

2.0 Modeling Parameters and Conditions

2.1 Project Information

Project Name:	Hands Mill Dam
Scenario Name:	Run #2
NIDID:	NAXXXXX
Scenario Description:	Sudden Failure at maximum pool with 5.5 feet between normal and max pools.
User e-mail:	katherine.king@partner.vermont.gov

2.2 Simulation Parameters

Simulation distance requested (miles):	5
Simulation cell size requested (ft):	15.0
Simulation duration requested (days):	2

2.3 Impounding Structure(s) Characteristics

Number of Structures: 1

Structure Name:	Structure 1
Structure Type:	Embankment
Hydraulic Height (ft):	20.0
Crest Elevation (ft):	1292.5
Length (ft):	495.0

2.4 Bridge(s) to be Removed

Number of Bridges: 0

2.5 Reservoir Characteristics

Selected Reservoir Point (Latitude/Longitude):	44.1054194801/-72.4297714233

Pool Elevation @ Max Storage (ft):	1292.5
Maximum Storage Volume (ac-ft):	18.1
Pool Elevation @ Normal Storage (ft):	1287.0
Normal Storage Volume (ac-ft):	11.2

2.6 Failure Conditions

Structure Name:	Structure 1
Structure Type:	Embankment
Failure Mode:	Total Dam Breach
Breach Type:	Embankment
Pool Elevation @ Failure (ft):	1292.5
Storage Volume @ Failure (ac-ft):	18.1
Breach Location (Latitude/Longitude):	44.105464754/-72.4298403157

3.0 Automated Data Preparation and Job Flow Summary

3.1 Job Flow Summary

1. Prepare Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) tiles for the Area of Interest (AOI) based on requested cellsize and maximum downstream distance.

2. Burn U.S. Army Corps of Engineers (USACE) levee lines into DEM for the AOI.

3. Assign Manning's coefficients based on LULC classifications.

4. Validate user provided simulation input parameters.

5. Remove user identified bridges from the DEM.

6. Estimate reservoir bathymetry.

7. Extend impounding structures if the specified reservoir level cannot be contained.

8. Fill reservoir to specified failure elevation.

9. Prepare boundary condition and all input data for simulation.

3.2 Reservoir Bathymetry and Filling

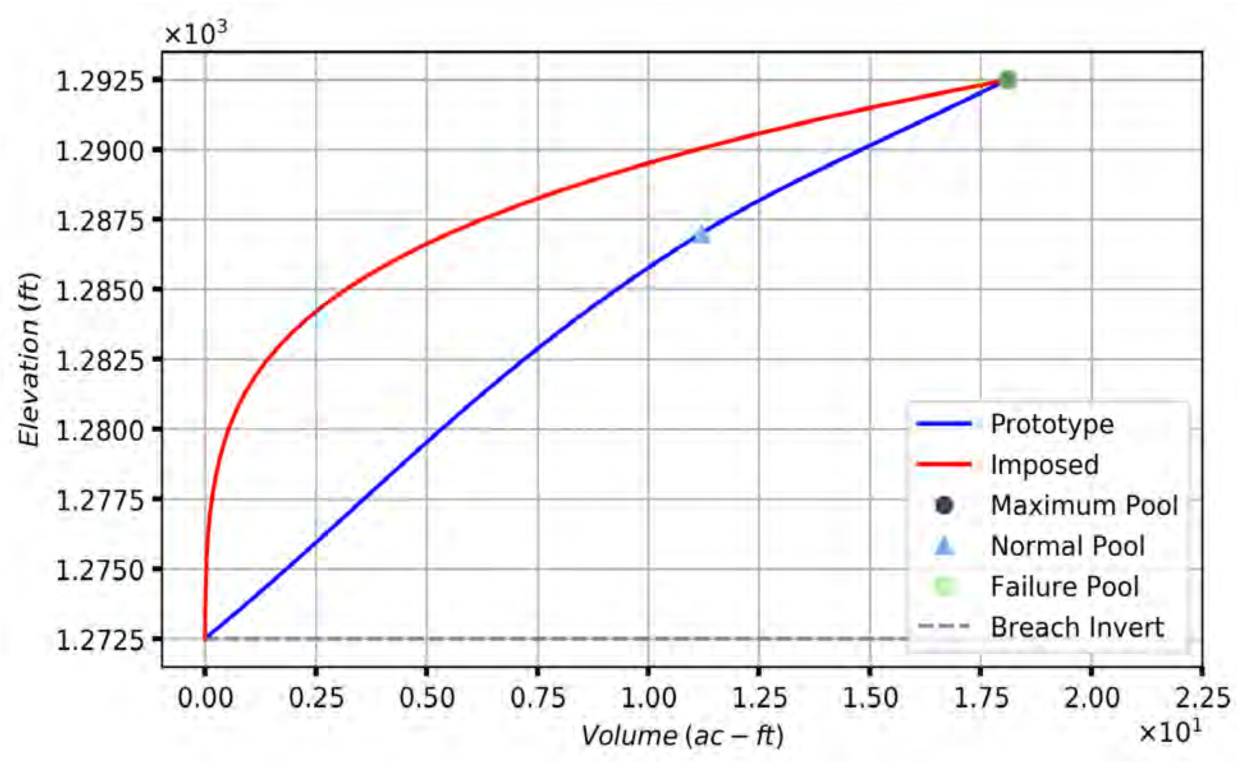

Figure 1. Stage-Volume Curve for Reservoir

Prototype: Theoretical cubic Hermite spline curve generated from user-provided reservoir elevation and volume information.
Imposed: Measured from reservoir bathymetry after filling to the failure elevation.

The reservoir water surface was detected to be in the DEM, so bathymetry estimation was performed using the prototype stage-volume curve shown above.
User-given Storage Volume at Failure (ac-ft): 18.1
Imposed Storage Volume at Failure (ac-ft): 18.1
After filling to the failure elevation, the imposed reservoir volume matched 100.0% of the prototype volume.

3.3 Data Sources

1. Digital Elevation Models

    Sources: USGS 2018 National Elevation Dataset, NOAA, DEM provided by group.

    Resolutions: 2, 1, 1/3, 1/9, 0.15 arc-seconds, 1 meter, and 10 feet based on availability

    Vertical Datum: NAVD88

    Horizontal Datum: NAD83

2. National Land Use/Land Cover Data

    Source: USGS 2016 National Land Cover Database

    Resolution: 30 m

3. National Levee Database

    Source: USACE

3.4 Digital Elevation Model

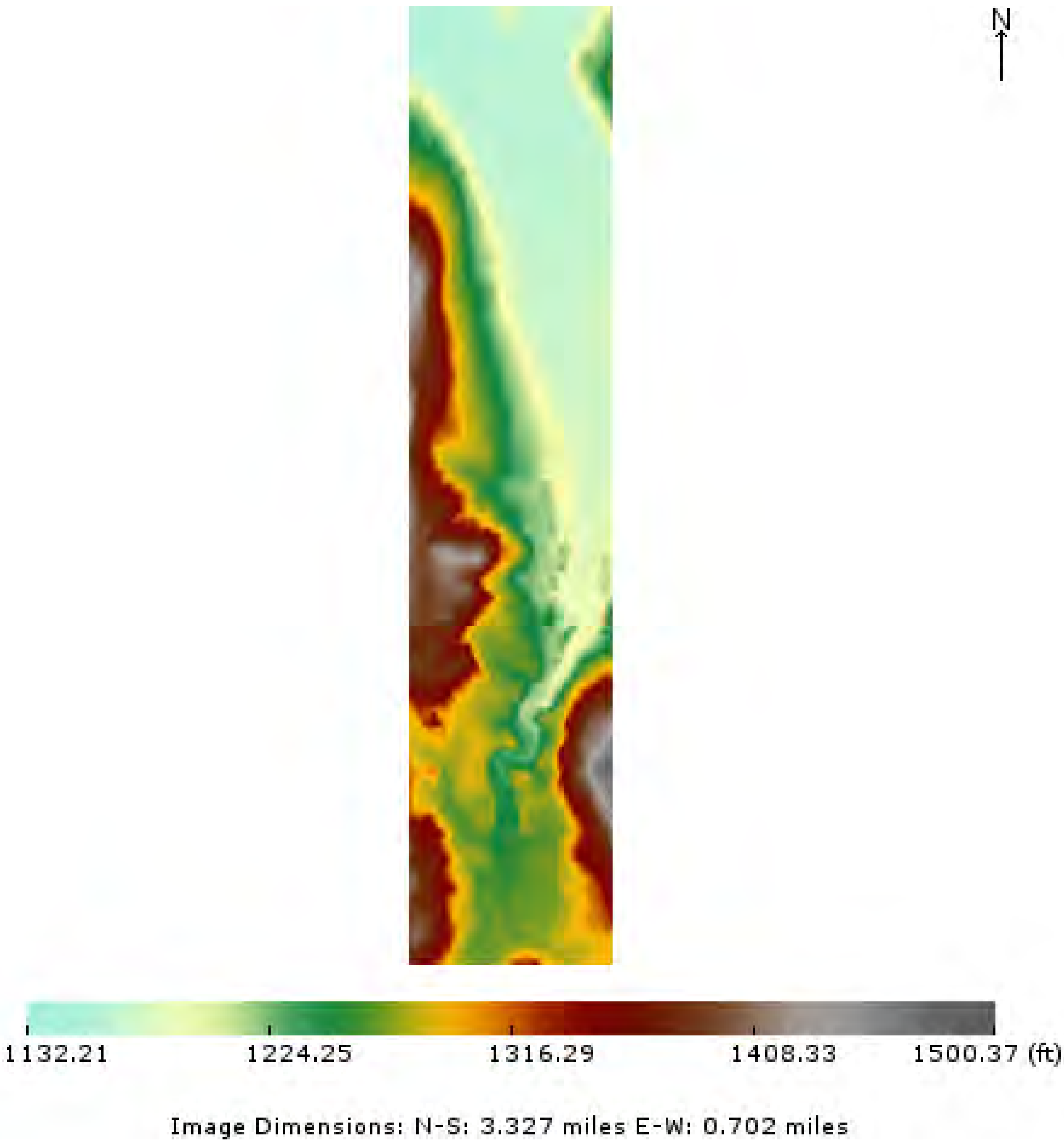

Figure 2. Map of Digital Elevation Model with Levees for AOI.

3.5 Reservoir Boundary and Breaching Structure

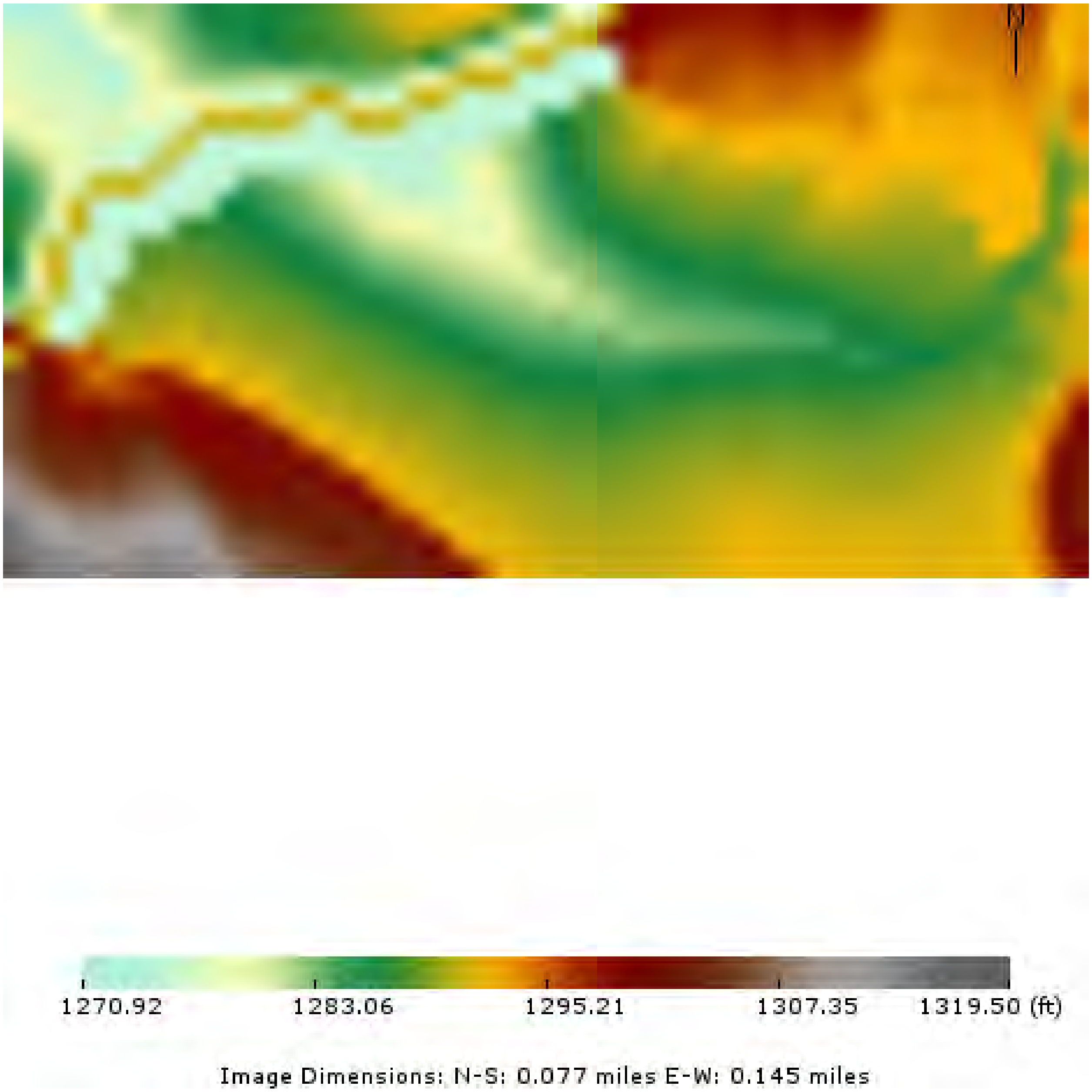

Figure 3. Map of Reservoir Boundary and Breached Structure.

3.6 Reservoir Initial Depth Profile

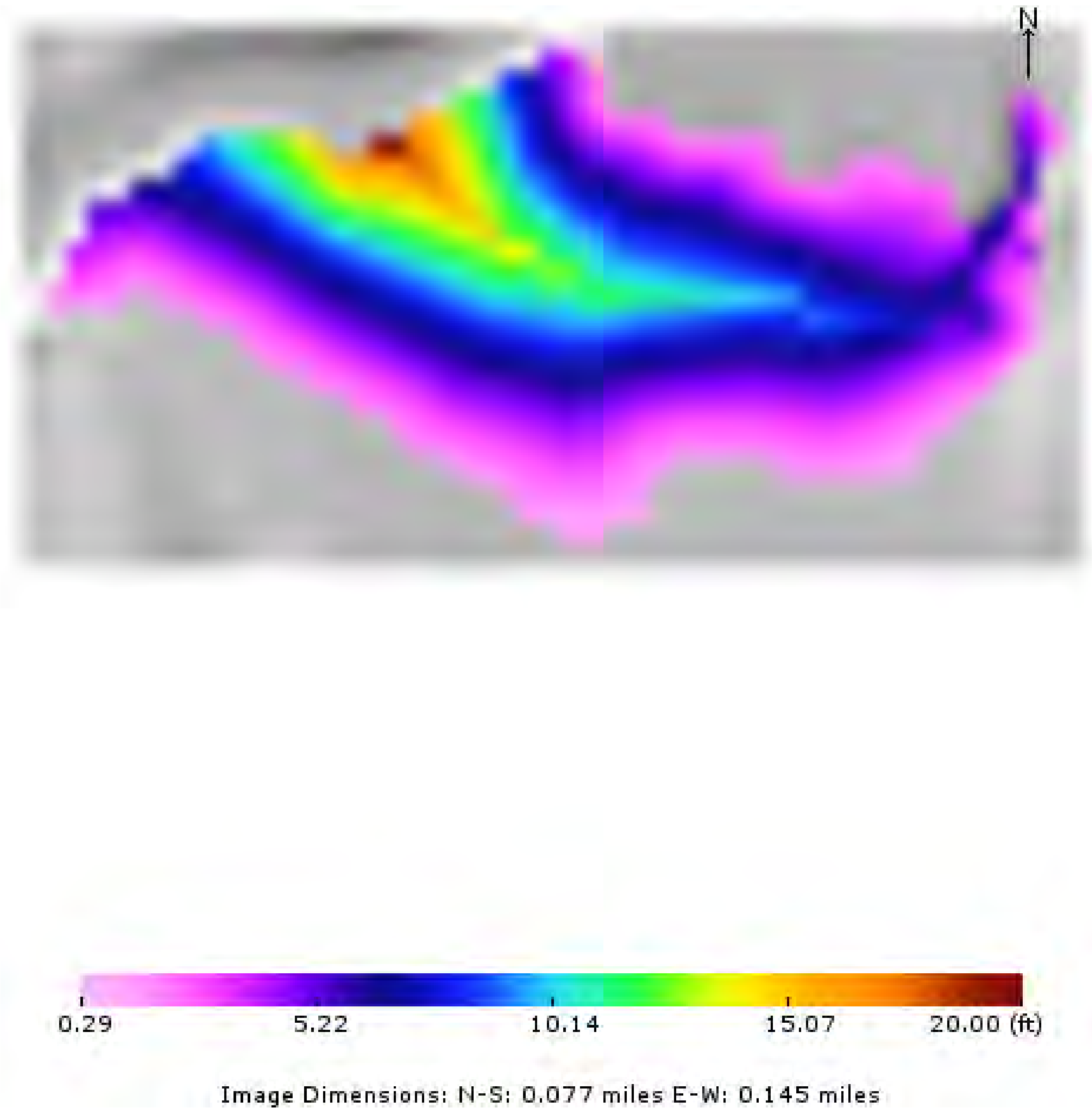

Figure 4. Map of Initial Depths in Reservoir at Failure Conditions.

3.7 Land Use/Land Cover

Figure 5. Map of Land Use for AOI.

4.0 Simulation Results

4.1 Simulation Summary

Simulation Request Received:	06:23 AM CST (11/16/2020)
Simulation Start Time:	06:24 AM CST (11/16/2020)
Simulation End Time:	06:26 AM CST (11/16/2020)
DEM resolution used for simulation (ft):	15.0
DEM resolution requested (ft):	15.0
Final distance reached downstream (miles):	3.3
Maximum downstream distance requested (miles):	5
Elapsed simulation time after breach initiation (hrs):	22.0
Remaining reservoir volume at termination (%):	1.155
Termination condition:	Water stopped spreading.

4.2 Land Use and Manning's Roughness Coefficient for Inundated Area

Land Use Description	% of Inundated Area	n-Value($m^{-1/3}s$)	Code	Color
Hay/Pasture	40.42	0.0350	81	
Woody Wetlands	18.57	0.1500	90	
Evergreen Forest *	12.41	0.1000	42	
Mixed Forest *	8.16	0.1200	43	
Developed, Low Intensity	7.12	0.0678	22	
Developed, Open Space	4.45	0.0404	21	
Developed, Medium Intensity	3.54	0.0678	23	
Deciduous Forest *	3.10	0.1000	41	
Emergent Herbaceuous Wetlands	1.91	0.1825	95	
Barren Land	0.26	0.0113	31	
Developed, High Intensity	0.03	0.0404	24	
unclassified	0.00	0.0350	0	
Open Water	0.00	0.0330	11	
Perennial Snow/Ice	0.00	0.0100	12	
Dwarf Scrub *	0.00	0.0350	51	
Shrub/Scrub	0.00	0.0400	52	
Grassland/Herbaceuous	0.00	0.0400	71	
Sedge/Herbaceous *	0.00	0.0350	72	
Lichens *	0.00	0.0350	73	
Moss *	0.00	0.0350	74	
Cultivated Crops	0.00	0.0700	82	

Note: * indicates a n-value estimated by NCCHE. Other values are taken from literature.

4.3 Coverage and Sources of DEM Raster Datasets

Figure 6. Coverage of DEM Raster Datasets in the Inundation Area.

DEM Source	Source Resolution	Source Dataset	Color
USGS	1 arc-second	usgs_1as	
USGS	1/3 arc-seconds	usgs_13as	
USGS	1 meter	usgs_utm_z18_1m	

Note: The DEM for this job was created from the source DEM raster datasets listed above. These DEM raster datasets were resampled and reprojected to the user defined cell size and UTM zone, respectively. Resampled and projected DEM raster datasets were then stacked in the order specific to the group under which this simulation was submitted.

4.4 Maximum Flood Depth

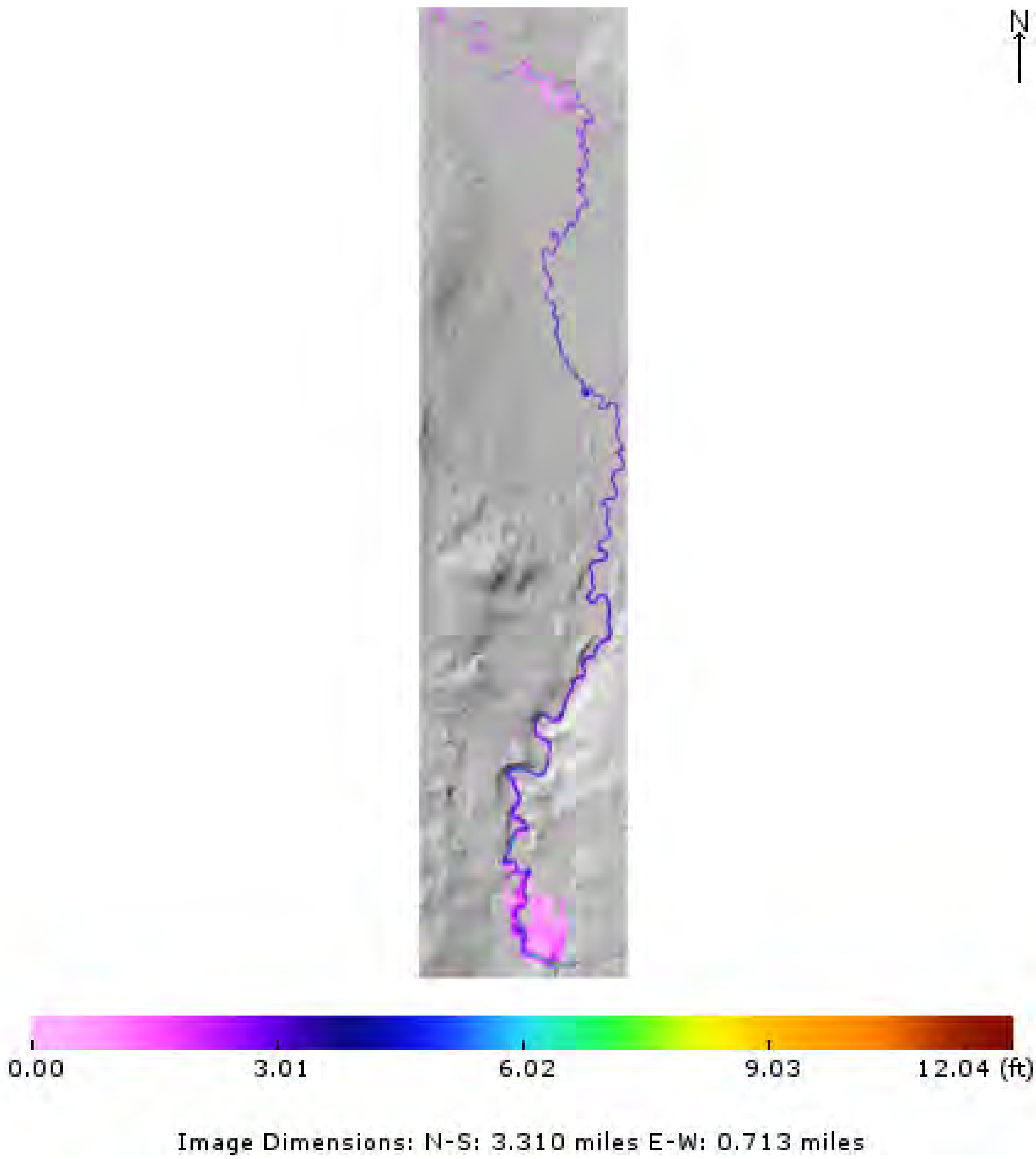

Figure 7. Maximum Flood Depth Map.

4.5 Flood Arrival Time

Flood arrival time is measured from the beginning of the simulation.

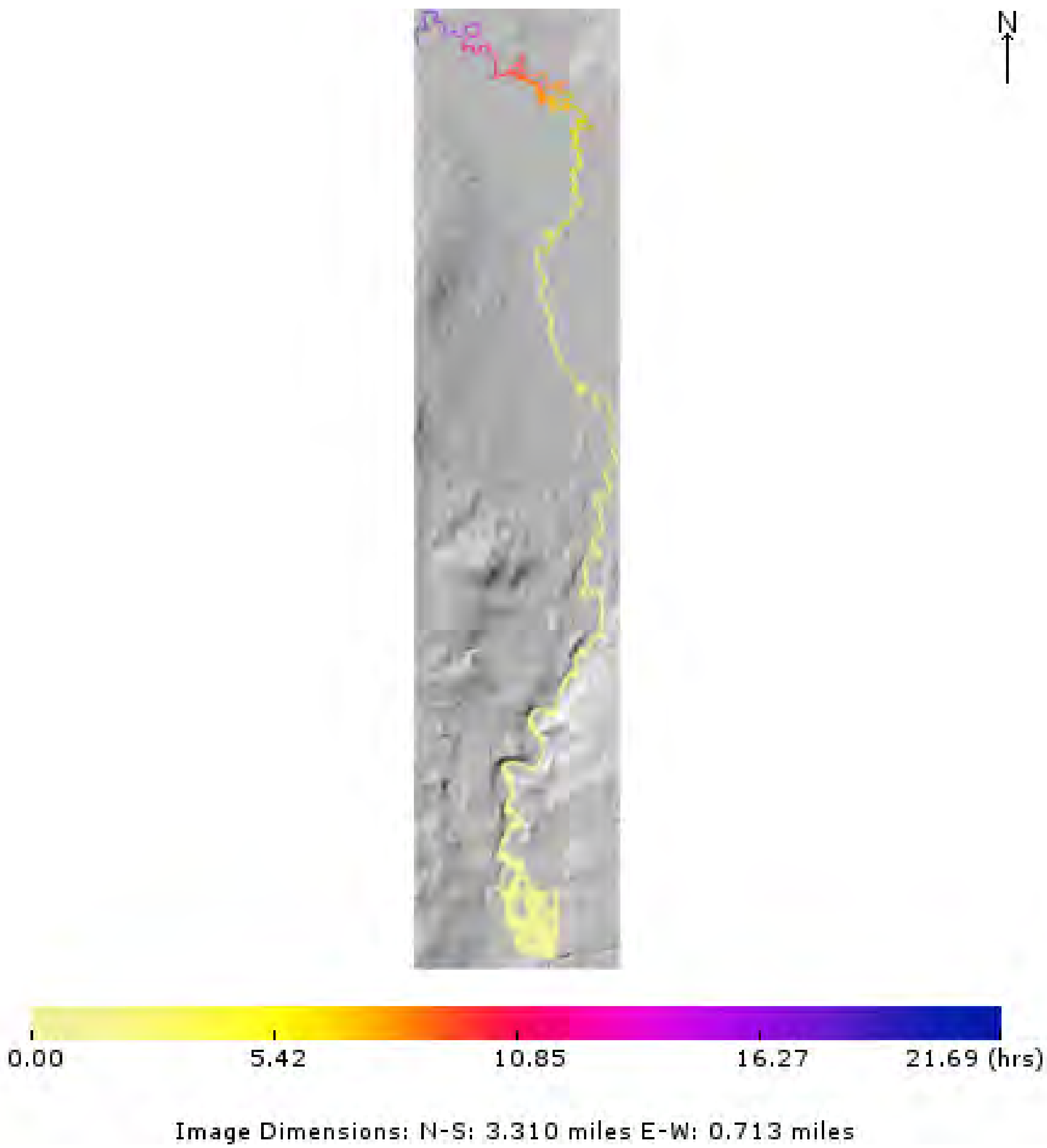

Figure 8. Flood Arrival Time Map.

4.6 Computed Breach Hydrograph through the Breaching Structure

The positive discharges (Q^+) are measured in the positive direction with respect to each observation line.

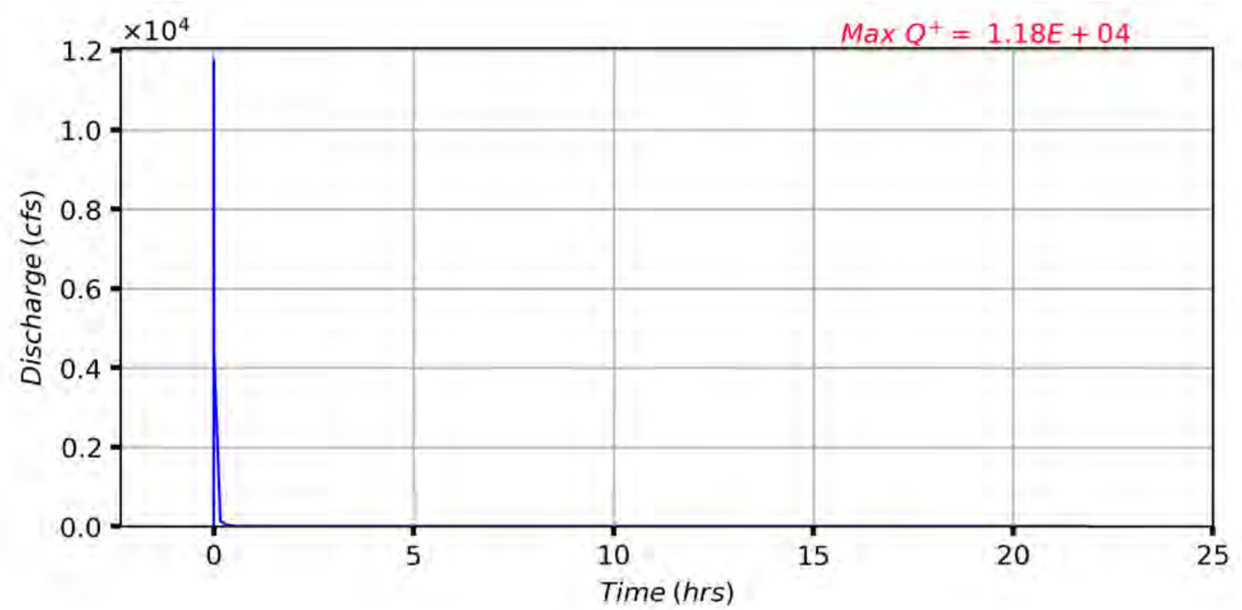

Figure 9. Breach Discharge Measured at: Structure 1.

4.7 Observation Line Hydrograph(s)

The positive discharges (Q^+) are measured in the positive direction with respect to each observation line.

No observation lines were defined.

4.8 Reservoir Time History

The reservoir water surface elevation as a function of time was computed by summing the water depth and bed elevation at a regular interval at the user-specified reservoir point.

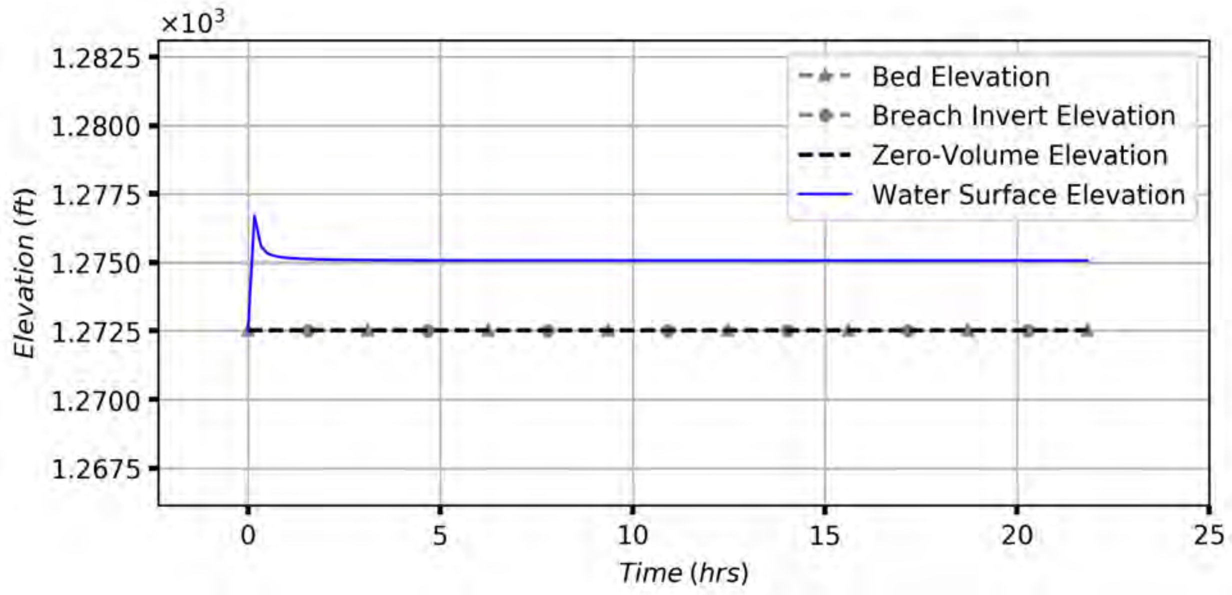

Figure 10. Reservoir Water Surface Elevation.

The reservoir volume as a function of time was computed by the following formula: $V_t = V_{init} - V_{net}$, where V_t is the reservoir volume at a given time, V_{init} is the reservoir's initial imposed volume, and V_{net} is the net volume that has crossed downstream across any part of the breaching structure's centerline up to that point. Since this only considers water which has completely exited the breach, it should be taken as an approximation.

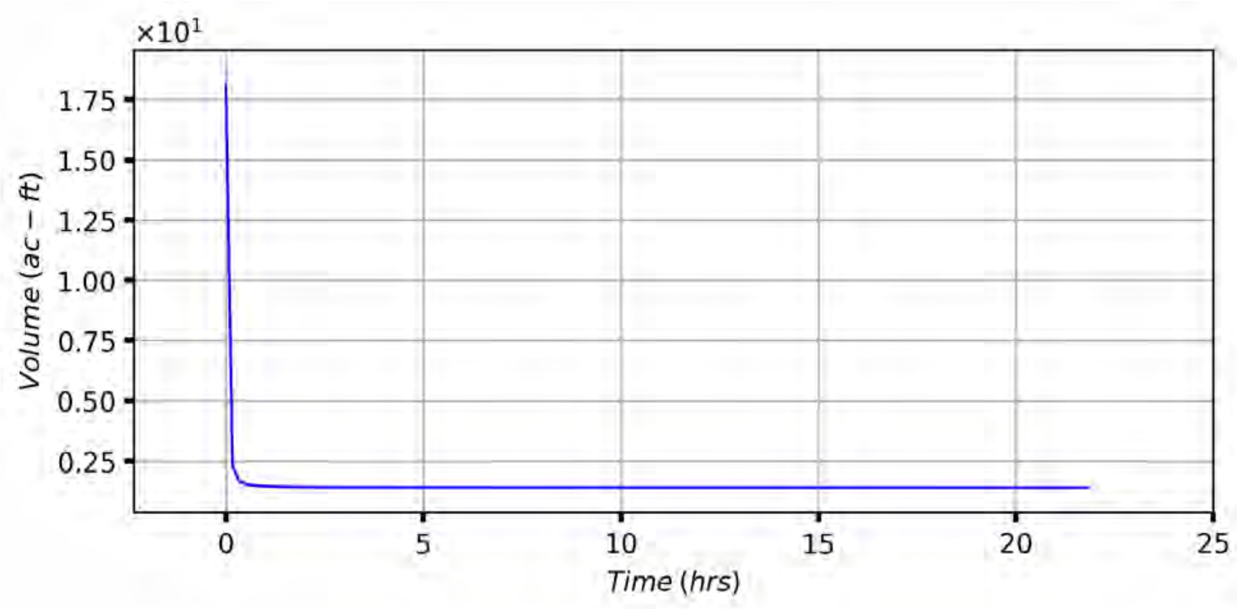

Figure 11. Reservoir Volume.

4.9 Downloading Simulation Results

The simulation results can be accessed at the following web address:

`https://dsswiseweb.ncche.olemiss.edu/download`

Job ID: 34459

Attachment C:

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

DSS-WISE™ HCOM
HUMAN CONSEQUENCE REPORT

Hands Mill Dam

Run #2

NAXXXXX

November 16, 2020

DSS-WISE Lite Simulation ID: 34459

FOR OFFICIAL USE ONLY

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EXECUTIVE SUMMARY

This document reports the human consequences assessment for the DSS-WISE Lite simulation ID: **34459**

INUNDATION EXTENT

Total inundated area (acres)(see figure 1): 63.44

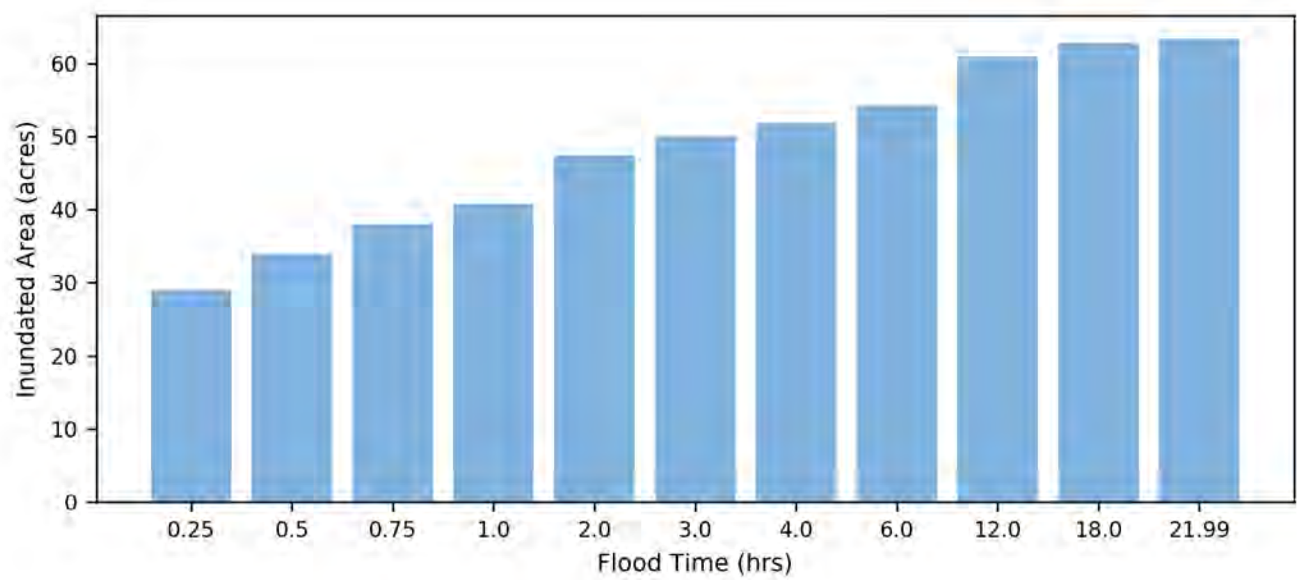

Figure 1. Evolution of total inundated area as a function of time.

ANALYSIS BASED ON CENSUS BLOCK DATA

Population in completely or partially inundated census blocks:	301
Housings in completely or partially inundated census blocks:	130
Number of states in inundated area:	1
Number of counties in inundated area:	2
Number of census blocks in inundated area:	20

ANALYSIS BASED ON GRIDDED LANDSCAN USA DATA

Total Nighttime PAR in inundated area (see figure 2):	40
Total Daytime PAR in inundated area (see figure 3):	94

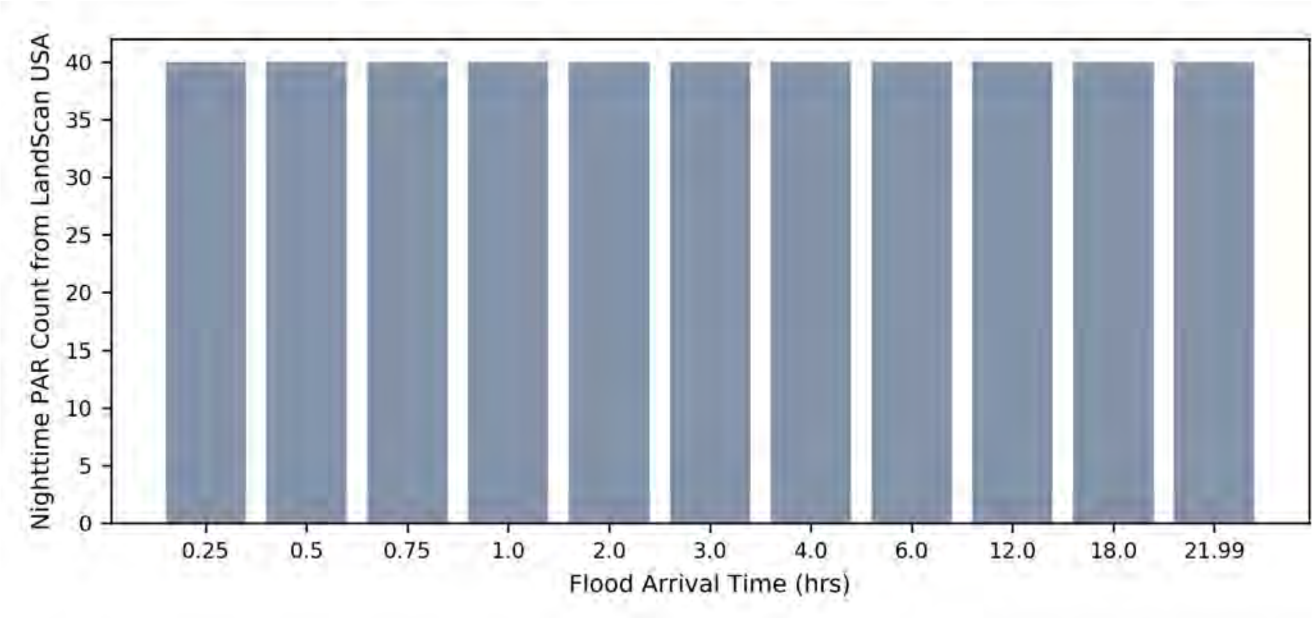

Figure 2. Evolution of nighttime PAR as a function of time.

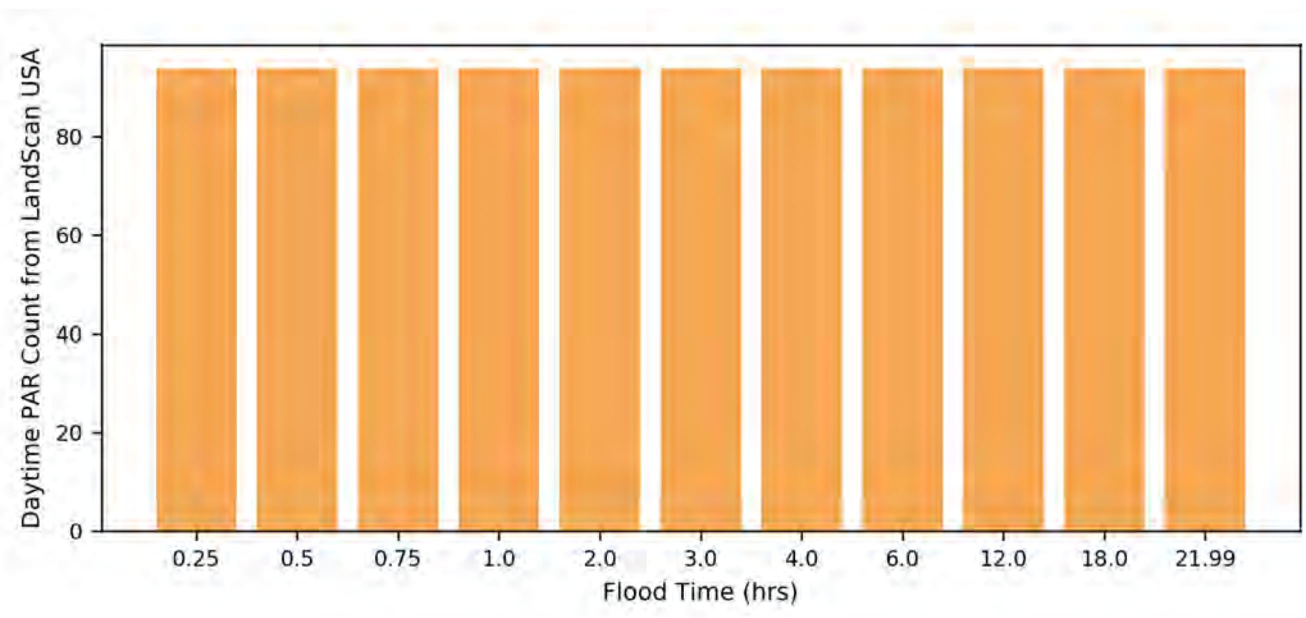

Figure 3. Evolution of daytime PAR as a function of time.

1.0 Overview

This report is produced DSS-WISE HCOM, which is part of the DSS-WISE Web system developed by the National Center for Computational Hydroscience and Engineering, at the University of Mississippi. Funding for DSS-WISE HCOM was provided by the U.S. Federal Emergency Management Agency (FEMA) through a contract with Argonne National Laboratory (ANL).

The results provided to the user by DSS-WISE HCOM include the following:

- the present report,
- a Microsoft Excel file containing data, results and plots, and
- a series of geospatial results files (in the form of polygon shapefiles).

These files can be used for further analysis and decision making for preparedness or during the response to an emergency. The files can also be used for hazard classification, risk prioritization preparing Emergency Actions Plans (EAPs).

DSS-WISE HCOM interfaces two-dimensional flood simulation results provided by DSS-WISE Lite with the population data provided by the U.S. Census Bureau and LandScan USA.

Please send any questions or suggestions to
admin@dsswiseweb.ncche.olemiss.edu

2.0 List of Abbreviations

ft	feet
hrs	hours
ft^2/s	Unit discharge, feet-squared per second
m^2/s	Unit discharge, meters squared per second
ft/s	feet per second
$ft.lb.$	foot-pounds
$m.kg.$	Meter-kilograms
D_{max}	Maximum depth
DV	Depth times velocity, unit discharge
DV_{max}	Maximum depth times velocity, maximum unit discharge
q_{max}	Maximum unit discharge, also called DV_{max}
DSS-WISE	Decision Support System for Water Infrastructural Security
DSS-WISE Web	Decision Support System for Water Infrastructural Security Web, the web-based system housing DSS-WISE Lite and other tools
DSS-WISE Lite	Decision Support System for Water Infrastructural Security Lite, the web-based version of DSS-WISE dam-break and flood modeling software
HCOM	Human Consequence Module
NCCHE	National Center for Computational Hydroscience and Engineering
PLFZ	Potentially Lethal Flood Zones
PAR	Population At Risk
EAP	Emergency Action Plan
NIDID	National Inventory of Dams (NID) Identifier
USCB	United States Census Bureau, or officially the Bureau of the Census
FEMA	Federal Emergency Management Agency
ANL	Argonne National Laboratory
ORNL	Oak Ridge National Laboratory
ESRI	Environmental Systems Research Institute
LSM	Life Safety Model

3.0 HCOM DATA SETS

3.1 DSS-WISE Lite Results Files

The human consequence analysis in this report are provided by DSS-WISE HCOM based on the raster results files for the following dam-break flood modeling simulation with DSS-WISE Lite:

DSS-WISE Lite simulation ID:	34459
Project Name:	Hands Mill Dam
Scenario Name:	Run #2
NIDID:	NAXXXXX
Scenario Description:	Sudden Failure at maximum pool with 5.5 feet between normal and max pools.
Simulation distance requested (*miles*):	5.0
Simulation cell size (*ft*):	15.0
Simulation duration requested (*days*):	2.0

Table 1. DSS-WISE Lite results files used by DSS-WISE HCOM.

File Name	Type	Units	Description
34459_Hmax_ft_upto_final.tif	Raster	ft	Maximum flood depth
34459_Arrival_Time_hr_upto_final.tif	Raster	hrs	Flood Arrival Time
34459_Vmax_ftps_upto_final.tif	Raster	ft/s	Maximum flood velocity
34459_DVmax_ft2ps_upto_final.tif	Raster	ft^2/s	Magnitude of the maximum specific discharge
34459_DVmax_ft2ps_upto_final.tifArrivalTime	Raster	hrs	Arrival time of the maximum value of specific discharge

3.2 Population Data Sets Used by DSS-WISE HCOM

DSS-WISE HCOM uses two different sets of population data to estimate the Population at Risk (PAR) potentially affected by the flood:

1. 2010 Census Block data provided by the United States Census Bureau (USCB), which is federal government agency in charge of producing data about the people and economy of the U.S. A census block is the smallest geographic unit for which USCB collects data from all the houses in the unit (rather than a sample of houses). Census Blocks are bounded by visible features such as streets, roads, streams and nonvisible features such as property lines and limits of city, township, school district, and counties, etc. They are defined as polygons in a shapefile covering the entire territory of the U.S. including Puerto Rico and the Island areas. The attributes of the census block polygons include 2010 Census Housing Unit Count and 2010 Census Population Count. The latter should be considered as 2010 nighttime population data.

2. LandScan USA gridded population data developed and maintained by the Oak Ridge National Laboratory (ORNL) located in Oak Ridge, TN. LandScan USA (https://landscan.ornl.gov/) is a collection of gridded nighttime and daytime population datasets developed by the Oak Ridge National Laboratory (ORNL), Department of Energy. These gridded population datasets are available as raster files with a resolution of 3 arc-second ($90m$ or $295.28 ft.$). They were developed by combining satellite remote sensing data, geospatial infrastructure datasets, and demographic data from USCB. Researchers at ORNL used "Intelligent" dasymetric modeling method to assign the population counts to the grid cells (Dobson et al. 2000 and Bhaduri et al. 2007) by defining a habitability index and by maintaining the total count of cells in a census block to be equal to the total population of the census block. The LandScan USA datasets used in this report are projections for 2016 (McKee et al. 2014). Daytime data is generated using specially developed techniques for population dynamics (Bhaduri 2007).

Detailed explanations on the methodologies used by DSS-WISE HCOM are provided in the technical manual, which can be downloaded from documentation page of the DSS-WISE Web website.

4.0 FLOOD HAZARD MAPPING

Flood-hazard mapping consists of partitioning the inundation extent into zones of predefined potential danger classes for humans. The resulting map is an ESRI shapefile of polygon type. The polygons correspond to different levels of potential danger for humans caught outdoors and indoors.

The potential danger classes are identified based on the ranges of the value of the maximum specific discharge, DV_{max}. The ranges of $q_{max} \equiv DV_{max}$ values are different for persons caught outdoors or indoors.

4.1 Potential Flood Hazard for Humans Caught Outdoors

For humans caught outdoors, the ranges of DV_{max} corresponding to five potential hazard (or danger) levels identified by different color codes are summarized in Table 2, which is adapted from Cox et al. (2010). The potential hazard levels are:

1. "Very Low Hazard: Shallow flow or deep standing water";
2. "Low Hazard: Dangerous to children";
3. "Moderate Hazard: Dangerous to some adults";
4. "Significant Hazard: Dangerous to most adults"; and
5. "Extreme Hazard: Dangerous to all".

The three rightmost columns of Table 2 correspond to the interpretation of five potential hazard levels by Cox et al. (2010) for three population categories defined by an index value corresponding to the product of height (H) and mass (M) of the individual as listed at the bottom of Table 2.

1. "Infants and small Children",
2. "Children", and
3. "Adults";

The five polygons corresponding to the five potential flood hazard levels for people caught outdoors as listed in Table 2 are provided as an ESRI shapefile of polygon type.

Cox et al. (2010) notes that the limits of DV_{max} in Table 2 correspond loosely to the loss of stability of different population categories. However, it is important to note that the ranges of DV_{max} given in Table 2 should not be considered as strict limits. Various other factors may influence the stability of individuals caught outdoors by the flood, such as:

- Bottom conditions (uneven surface, slippery surface, visible or invisible obstacles);
- Flow conditions (floating debris, low temperature, poor visibility, unsteady flow and flow aeration);
- Human subject (standing or moving, experience and training, clothing and footwear, physical attributes, such as height, mass and muscular development, disabilities, and psychological factors); and
- Other factors (strong wind, poor lighting, feeling unsafe or complete loss of footing).

Table 2. Potential flood hazard levels for humans caught outdoors by the flood (adapted from Cox et al. 2010).

DV_{max} m^2/s from	DV_{max} m^2/s to	DV_{max} ft^2/s from	DV_{max} ft^2/s to	Potential Hazard Category	Explanation: Adults	Explanation: Children	Explanation: Infants, Small Children and Frail/Older Persons
0.0	0.4	0.0	4.3	HZ01 Very Low Hazard: Shallow flow or deep standing water	Low Hazard	Low Hazard	Extreme Hazard Dangerous to all Infants, small Children and Frail/Older Persons
0.4	0.6	4.3	6.5	HZ02 Low Hazard: Dangerous to Children		Significant Hazard; Dangerous to most Children	
0.6	0.8[2]	6.5	8.6[2]	HZ03 Moderate Hazard: Dangerous to some adults	Moderate Hazard: Dangerous to some adults		
0.8	1.2[3]	8.6	13[3]	HZ04 Significant Hazard: Dangerous to most adults	Significant Hazard: Dangerous to most adults	Extreme Hazard: Dangerous to all children	
1.2[3]		13[3]		HZ05 Extreme Hazard: Dangerous to all	Extreme Hazard: Dangerous to all		

1) Small children, children and adult categories are defined based on $height(H) \times mass(M)$

Small children: $H \times M \leq 25l(m.kg.)$ $H \times M \leq 181(ft.lb.)$

Children: $25 < H \times M(m.kg.) \leq 50$ $181 < H \times M(m.kg.) \leq 362$

Adult: $50 < H \times M(m.kg.)$ $362 < H \times M(ft.lb.)$

2) Recommended upper limit of tolerable working flow regime for trained safety workers or experience and well-equipped persons

3) Above this value, the hazard is extreme according to majority of the past studies.

Results file package of DSS-WISE HCOM contains an ESRI shapefile of polygon type containing up to five polygons (see Table 6) corresponding to the five potential flood hazard levels for humans caught outdoors by the flood, which are listed in Table 2. For convenience, Map 09 of this report shows the inundation extent colored by the five potential flood hazard levels listed in Table 2.

4.2 Flood Hazard for Humans Caught Indoors

For people caught indoors by the flood, it is assumed that the potential danger is associated with the collapses of the building (see FEMA 2011, p.43). This implicitly assumes that the people indoors are in potential danger of loss of life if the building collapses due to inundation by floodwaters.

Table 3 list the DV_{max} values for the potential collapse of different types of buildings, which are taken from the technical report of the Life Safety Model (LSM) developed by British Columbia Hydro (BCH 2006).

Table 3. Potential flood hazard levels for humans caught indoors based on the BC Hydro LSM Building Stability Criteria.

DV_{max}		Color Code	Building Type
(m^2/s)	(ft^2/s)		
≥5	≥54		HZ06: Poorly constructed building
≥10	≥108		HZ07: Well-built timber building
≥15	≥161		HZ08: Well-built masonry building
≥20	≥215		HZ09: Concrete building
≥35	≥377		HZ10: Large concrete building

Results file package of DSS-WISE HCOM contains an ESRI shapefile of polygon containing up to five stacked polygons (see Table 6) corresponding to the five potential flood hazard levels for humans caught indoors by the flood, which are listed in Table 3. For convenience, Map 10 of this report shows the inundation extent colored by the five potential flood hazard levels listed in Table 3.

5.0 MAPPING POTENTIALLY LETHAL FLOOD ZONES (PLFZs) FOR CHILDREN AND ADULTS

The mapping of potentially lethal flood zones (PLFZs) for humans consists of partitioning the inundation extent into zones of predefined potential lethality classes for humans. The resulting map is an ESRI shapefile of polygon type for each category. The polygons correspond to different levels of potential lethality that are defined based on the maximum depth, D_{max}, and maximum specific discharge, DV_{max}. The PLFZs for different categories of people caught outdoors, cars, mobile homes and typical residential structures are listed in Table 4 (Feinberg, 2017).

Table 4. Definition of potentially lethal flood zones (PLFZs) for different categories (Feinberg, 2017).

Category	Color Code	D_{max} $(ft.)$		DV_{max} (ft^2/s)
Children caught outdoors (tent camping, fishing, hiking, etc.)	(orange)	≥2	or	≥5.4
Adults caught outdoors (tent camping, fishing, hiking, etc.)	(red)	≥4	or	≥6.5
Motor vehicle (compact car) floating	None	≥1	or	≥4.3
Motor vehicle (compact car) sliding/toppling	None			≥5.4
Mobile homes	None	≥2	or	≥30
Typical residential structures	None	≥4	or	≥75

Results file package of DSS-WISE HCOM contains and ESRI shapefile of polygon type containing two stacked polygons corresponding to the first two categories in Table 4. These two polygons were extracted using the maximum flow depth and maximum specific discharge files provided in the results package of DSS-WISE Lite simulation (see Table 6). For convenience, Map 11 of this report shows the extents of these two PLFZ polygons.

The polygons for the remaining PLFZ zones can also be extracted from the D_{max} and DV_{max} raster files using a suitable GIS software.

6.0 POPULATION AT RISK (PAR) ANALYSIS

The population at risk (PAR) analysis aims to provide an estimate of the number of people that will be potentially affected by the propagation of the dam-break flood. DSS-WISE HCOM provides two different types of PAR analysis based on the two different population data sets that are available (see Section 3.2).

6.1 PAR Analysis Using Census Block Population Data

The results of the PAR analysis using 2010 census block population are given in two different forms:

- The list of the census blocks that are inundated (completely or partially) by the dam-break flood is provided in the "CensusBlock_Analysis" worksheet of the MS Excel file accompanying the present report.
- The polygons of the census blocks that are inundated (completely or partially) by the dam-break flood are provided in a shapefile accompanying the present report. The attributes of the census block polygons are the same as the data columns in the MS Excel file.

The polygons of census blocks included in the inundation extent (completely or partially) are provided as an ESRI shapefile (see Table 6) in the results package of DSS-WISE HCOM. The worksheet "CensusBlock_Analysis" lists all the census blocks and their attributes, which include various data extracted by DSS-WISE HCOM. The attributes of the census-block polygons are the same as the columns in the worksheet "CensusBlock_Analysis" of the MS Excel file accompanying the present report.

These attributes of the census blocks are listed and explained in Table 5. Map 06 in this report shows the census block polygon outlines overlaid on the flood extent.

Table 5. Attributes of the census block polygons in the shapefile and the corresponding columns in the worksheet "CensusBlock_Analysis" of the MS Excel file accompanying the present report.

ExcelFile		Shapefile	Unit	Description
Col	Title	Attributes		
A	State Name	STATE_NAME		Abbreviation of the state name
B	County Name	CNTY_NAME		County Name

C	State FIPS CODE	STATEFP10		2010 Census state FIPS code
D	County FIPS CODE	COUNTYFP10		2010 Census county FIPS code
E	Tract CODE	TRACTCE10		2010 Census tract code
F	Tabulation Block Number	BLOCKCE		2010 Census tabulation block number
G	Block ID Number	BLOCKID10		Census block identifier; A concatenation of 2010 Census state FIPS code, 2010 Census county FIPS code, 2010 Census tract code , and 2010 Census block number
H	Partial Block Indicator	PARTFLG		Y = partial block N = whole block
I	Total Number of Housing	HOUSING10	*Count*	2010 Census Housing Unit Count
J	Total Number of Population	POP10	*Count*	2010 Census Population Count
K	Total Area	AREATOT	*Acres*	Total area of the census block. This information is extracted from the geometry of the census block
L	Inundated Area	AREAINUND	*Acres*	Area of the census block inundated. This information is extracted by intersecting the inundation extent with the census block.
M	Percent Area Inundated	AINUND_PCT	%	This quantity is calculated in the MS Excel spreadsheet by the dividing the AREAINUND (column L) by the AREATOT (column K).

N	Flood Arrival Time (Avg)	FLDAT_AVG	hrs	This quantity is extracted from the arrival time raster. It corresponds to the average value of the arrival times of all computational cells within the extent of the census block.
O	Flood Arrival Time (Min)	FLDAT_MIN	hrs	This quantity is extracted from the arrival time raster. It corresponds to the minimum value of the arrival times of all computational cells within the extent of the census block.
P	Flood Arrival Time (Max)	FLDAT_MAX	hrs	This quantity is extracted from the arrival time raster. It corresponds to the maximum value of the arrival times of all computational cells within the extent of the census block.
Q	Flood Maximum Depth (Avg)	HMAX_AVG	ft	This quantity is extracted from the maximum flood depth raster. It corresponds to the average value of the maximum flood depths of all computational cells within the extent of the census block.
R	Flood Maximum Depth (Min)	HMAX_MIN	ft	This quantity is extracted from the maximum flood depth raster. It corresponds to the minimum value of the maximum flood depths of all computational cells within the extent of the census block.
S	Flood Maximum Depth (Max)	HMAX_MAX	ft	This quantity is extracted from the maximum flood depth raster. It corresponds to the maximum value of the maximum flood depth of all computational cells within the extent of the census block.

T	Flood Maximum DV Arrival Time (Avg)	DVMAXATAVG	hrs	This quantity is extracted from the arrival time of maximum specific discharge raster. It corresponds to the average value of the maximum specific discharge arrival times of all computational cells within the extent of the census block.
U	Flood Maximum DV Arrival Time (Min)	DVMAXATMIN	hrs	This quantity is extracted from the arrival time of maximum specific discharge raster. It corresponds to the minimum value of the maximum specific discharge arrival times of all the computational cells within the extent of the census block.
V	Flood Maximum DV Arrival Time (Max)	DVMAXATMAX	hrs	This quantity is extracted from the arrival time of maximum specific discharge raster. It corresponds to the maximum value of the maximum specific discharge arrival times of all the computational cells within the extent of the census block.
W	Flood Maximum DV (Avg)	DVMAX_AVG	ft^2/s	This quantity is extracted from the maximum specific dishcarge raster. It corresponds to the average value of the maximum specific discharge of all the computational cells within the extent of the census block.
X	Flood Maximum DV (Min)	DVMAX_MIN	ft^2/s	This quantity is extracted from the maximum specific dishcarge raster. It corresponds to the minimum value of the maximum specfic discharge of all the computational cells within the extent of the census block.

Y	Flood Maximum DV (Max)	DVMAX_MAX	ft^2/s	This quantity is extracted from the maximum specific dishcarge raster. It corresponds to the maximum value of the maximum specific discharge of all the computational cells within the extent of the census block.

6.2 PAR Analysis Using LandScan USA Gridded Population Data

The PAR analysis using LandScan USA 3 arc-second gridded population data provides three sets of tabular results classified in up to 17 flood times and 10 flood hazard categories based on DV_{max}:

- Tabular summary of inundation areas as a function of flood time is presented in the worksheet "InundatedArea" of the MS Excel file accompanying the present report. The inundation area values are presented as a stacked column plot in the same worksheet.
- Tabular summary of nighttime PAR counts as a function of flood time is presented in the worksheet "Nighttime_PAR" of the MS Excel fle accompanying the present report. The nighttime PAR counts are plotted as a stacked column plot in the same worksheet.
- Tabular summary of daytime PAR counts as a function of flood time is presented in the worksheet "Daytime_PAR" of the MS Excel fle accompanying the present report. The tabular data is also plotted as a stacked column plot.

The nighttime and daytime PAR counts were obtained from nighttime and daytime population densities, which were extracted from LandScan USA following the methologies described in the technical manual for DSS-WISE HCOM. Map 07 and Map 08 in this report show the nighttime and daytime population densities over the inundation area.

7.0 RESULTS FILES GENERATED BY DSS-WISE HCOM

All the results files generated by DSS-WISE HCOM are listed Table 6.

Table 6. List of results files generated by DSS-WISE HCOM.

No	Name	Type	Description
1	34459_HCOM_Final_Report.pdf	PDF	The present report.
2	34459_HCOM_Analysis.xlsx	Ms Excel	Ms Excel file accompanying this report. It contains four worksheets: 1. InundatedArea 2. Nighttime_PAR 3. Daytime_PAR 4. CensusBlock_Analysis
3	34459_HCOM_Census_Block_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains the polygons of the census blocks completely or partially included in the inundation extent. The attributes of the polygons are the same as the columns in the worksheet "CensusBlock_Analysis". They are listed in Table 5.
4	34459_HCOM_Outdoor_Hazard_Categories_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains up to five polygons corresponding to the five potential flood hazard levels for humans caught outdoors by the flood as listed in Table 2 (Section 4.1)
5	34459_HCOM_Indoor_Hazard_Categories_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains up to five polygons corresponding to the five potential flood hazard levels for humans caught indoors by the flood as listed in Table 3 (Section 4.2)

6	34459_HCOM_PLFZ_ polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains up to two stacked polygons corresponding to the PLFZ areas as listed in the first two rows of Table 4.
7	34459_HCOM_NT_PopDensity_ persqmi_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygons type contains polygon of nighttime population density per square mile extracted from LandScan USA data. This file should be treated as **FOUO**
8	34459_HCOM_DT_PopDensity_ persqmi_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygons type contains polygon of daytime population density per square mile extracted from LandScan USA data. This file should be treated as **FOUO**

8.0 REFERENCES

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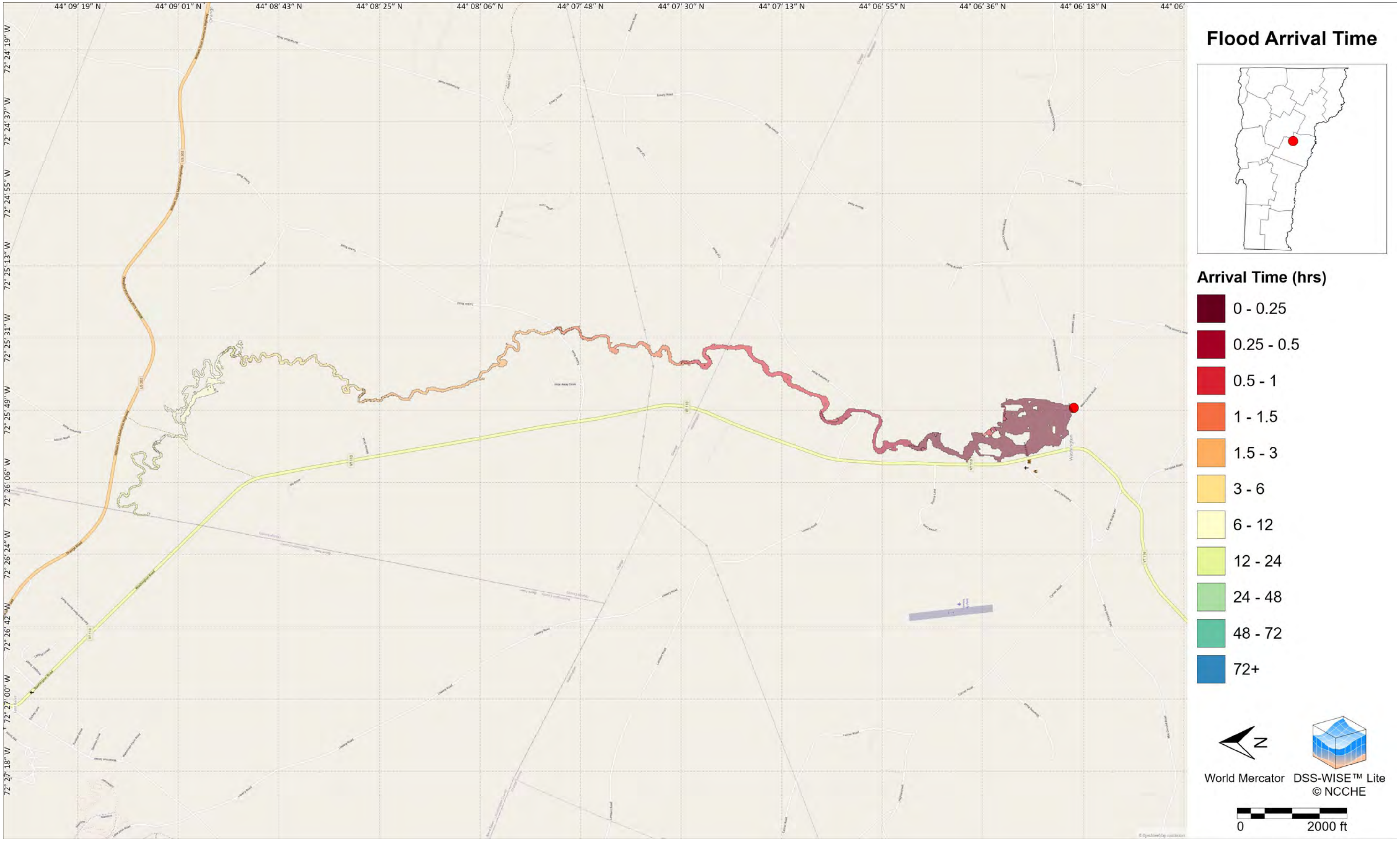
Map 01: Flood Maximum Depth

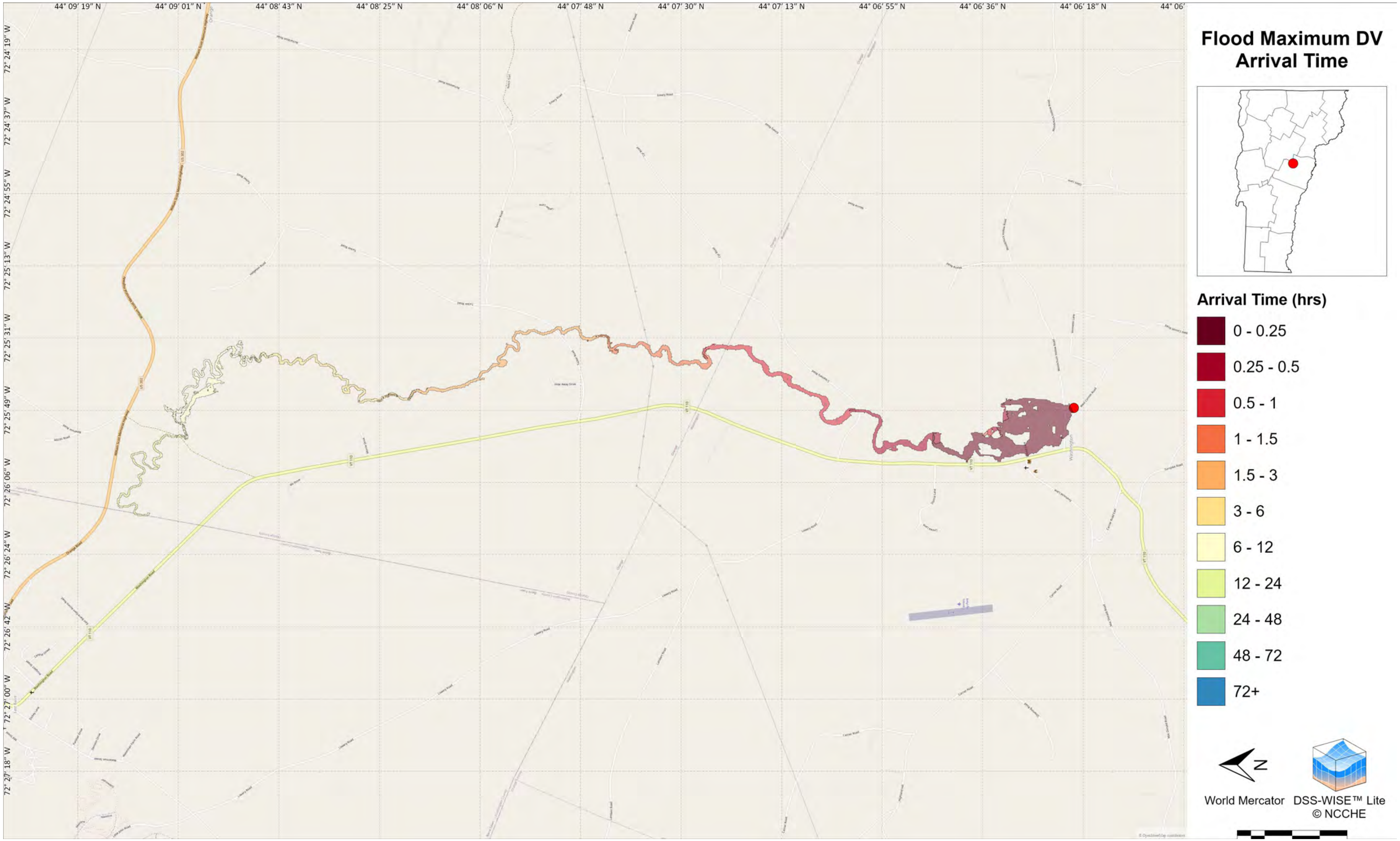
Map 02: Flood Arrival Time



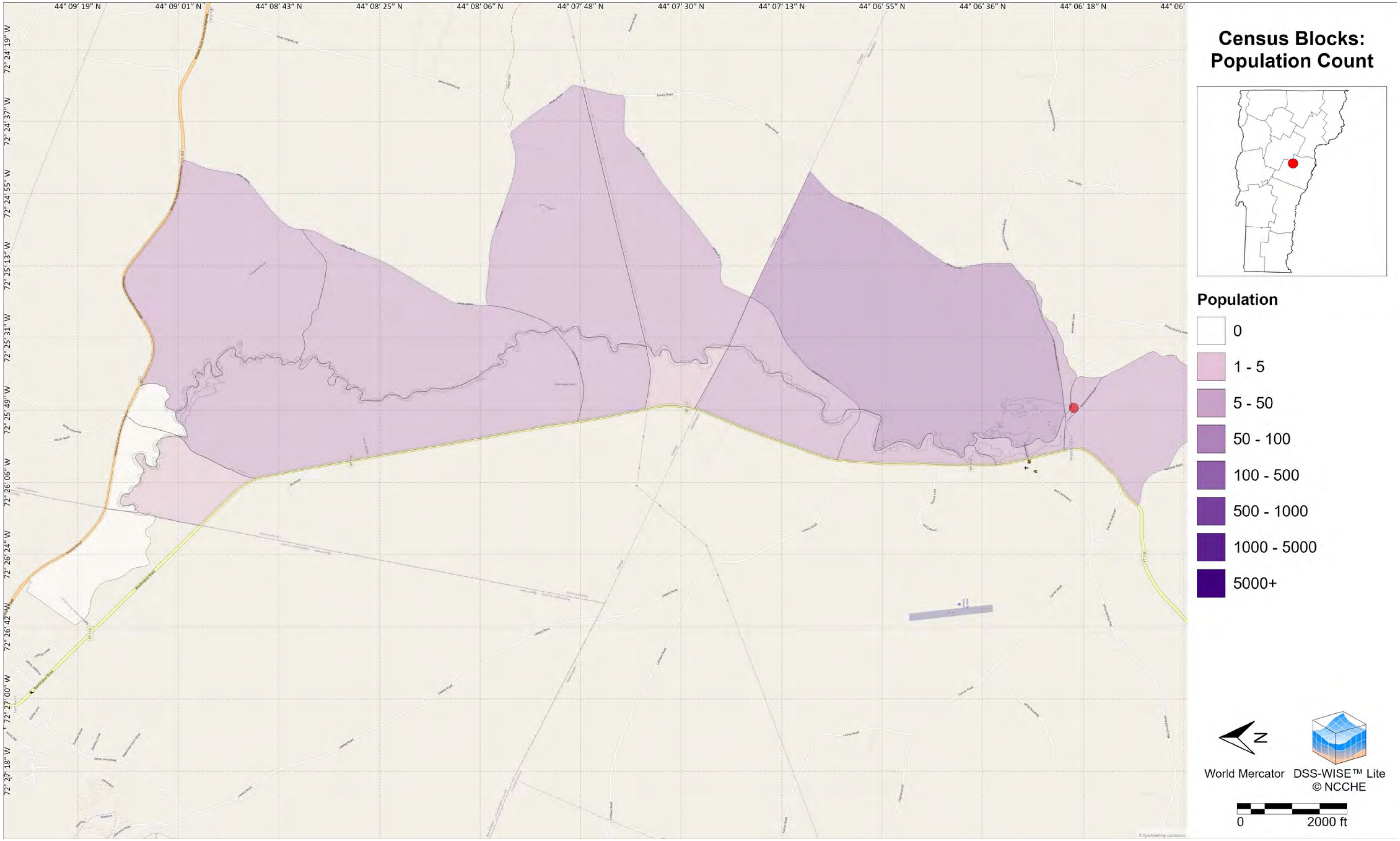
Map 03: Flood Maximum Velocity

Map 04: Flood Maximum DV

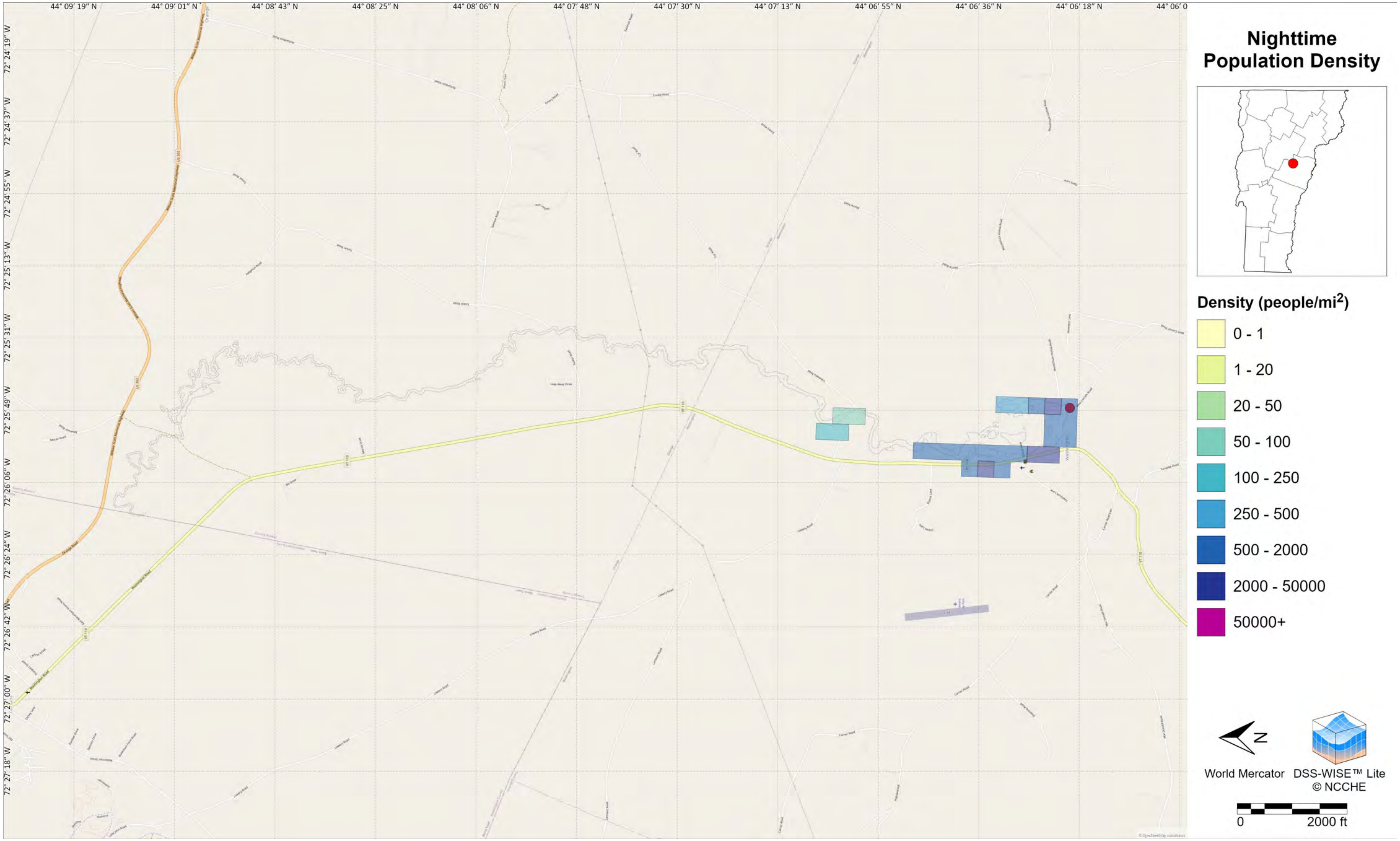
Map 05: Flood Maximum DV Arrival Time



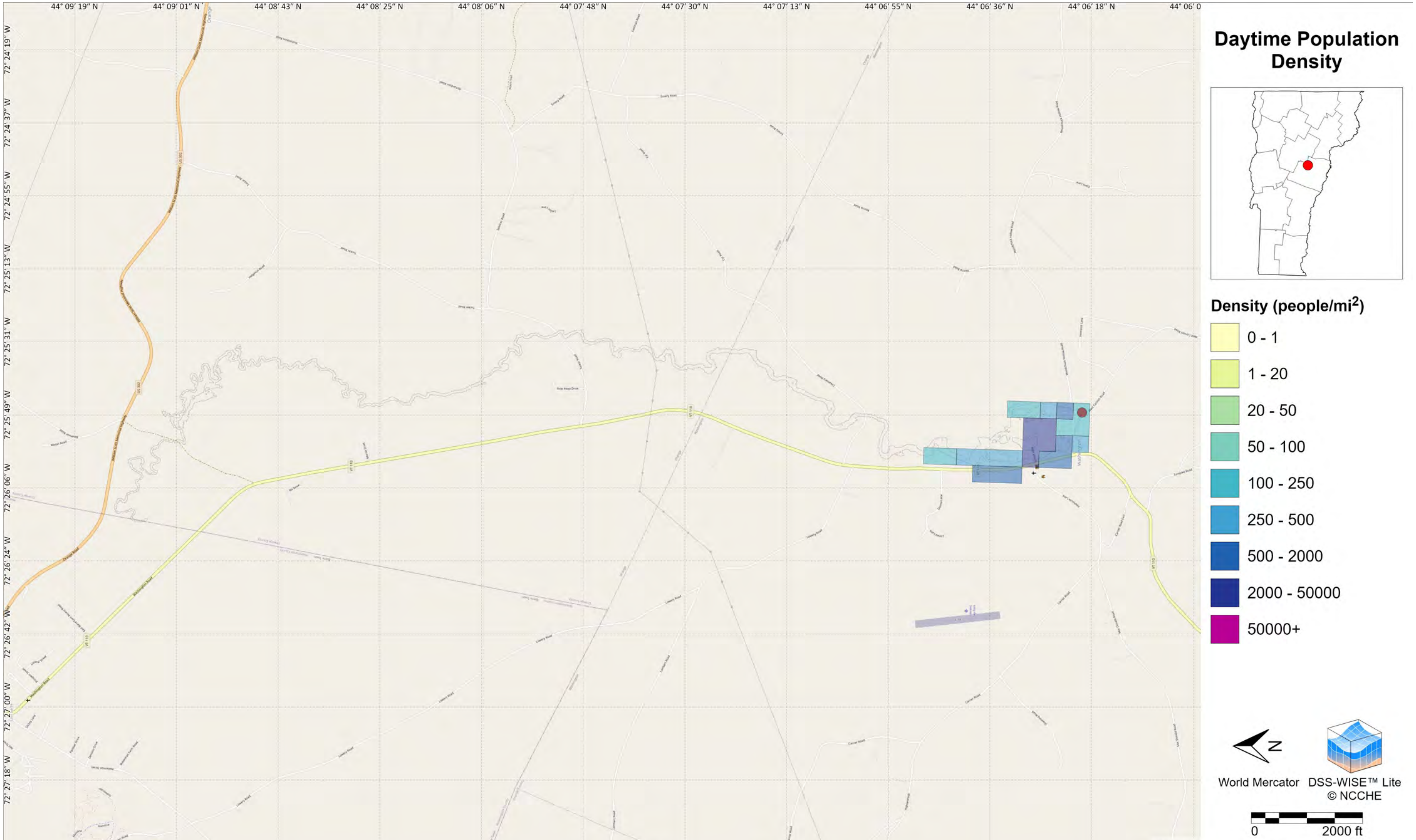
Map 06: Census Blocks: Population Count



Map 07: Nighttime Population Density

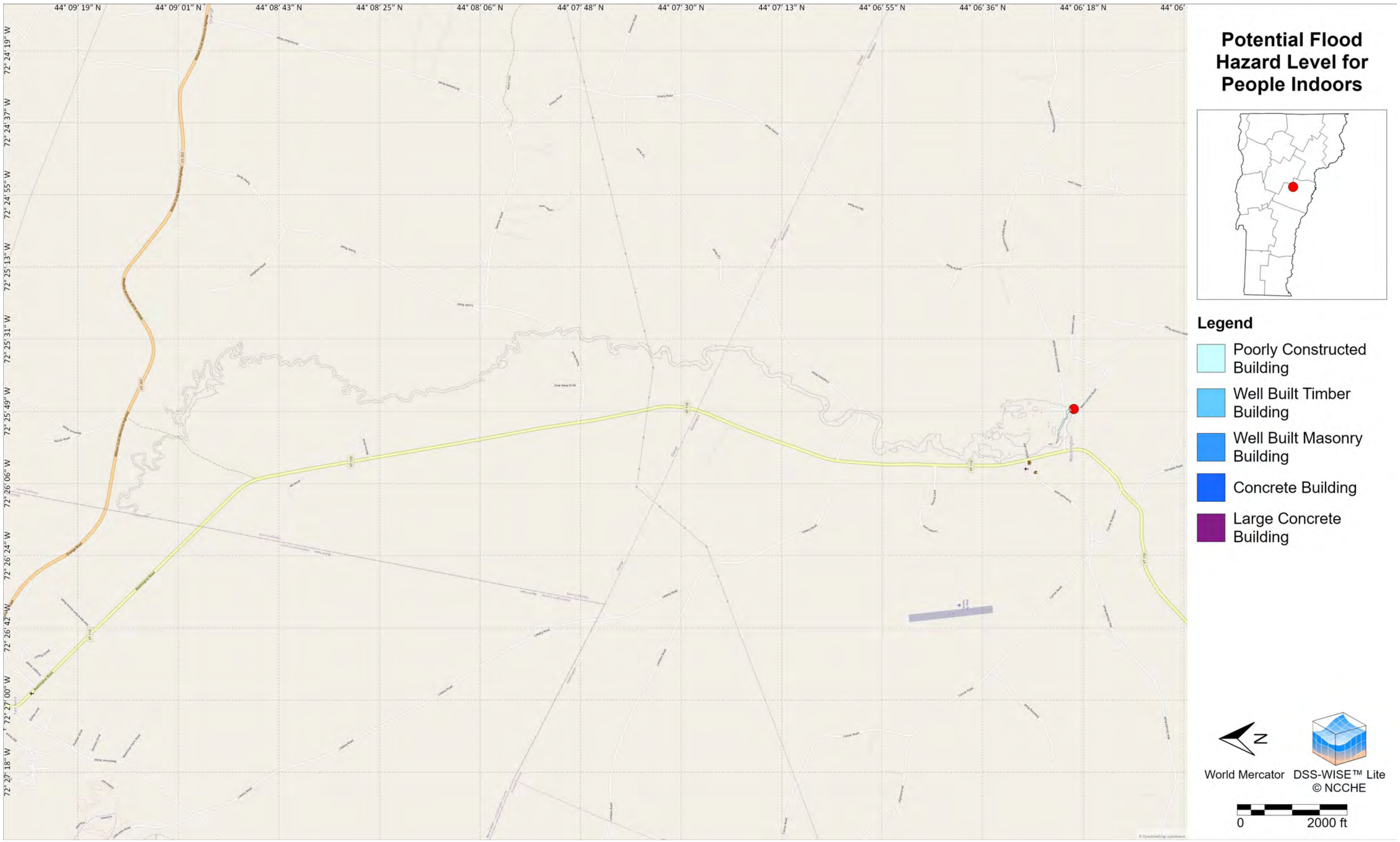


Map 08: Daytime Population Density



Map 09: Potential Flood Hazard Level for People Outdors

Map 10: Potential Flood Hazard Level for People Indoors



Map 11: Potential Lethal Flood Zones (PLFZ)

Attachment 2: Historical Property Information

Listed on State Register
VT ACHP
Date: 9-14-89

STATE OF VERMONT
Division for Historic Preservation
Montpelier, VT 05602

HISTORIC SITES & STRUCTURES SURVEY
Individual Structure Survey Form

SURVEY NUMBER: 0915-26

NEGATIVE FILE NUMBER: 79-A-108-1

UTM REFERENCES:
Zone/Easting/Northing
18/705660/4886580

U.S.G.S. QUAD. MAP: East Barre Quad. 15'

PRESENT FORMAL NAME: Vermette House

ORIGINAL FORMAL NAME: Rodney Clough House

PRESENT USE: Residence

ORIGINAL USE: Wagon Shop

ARCHITECT/ENGINEER: Unknown

BUILDER/CONTRACTOR: Rodney Clough (?)

PHYSICAL CONDITION OF STRUCTURE:
Excellent ☐ Good ■
Fair ☐ Poor ☐

STYLE: vernacular Queen Anne

DATE BUILT: c. 1840, remodled c. 1890

COUNTY: Orange
TOWN: Washington
LOCATION: Adjacent to Old Saw Mill site, at intersection of Woodchuck Hollow Road (T.H.#9) and Corinth Road (T.H.#1).
COMMON NAME: Armand and Edith Vermette House
FUNCTIONAL TYPE: House
OWNER: Armand and Edith Vermette
ADDRESS: Washington, VT 05675

ACCESSIBILITY TO PUBLIC:
Yes ☐ No ■ Restricted ☐

LEVEL OF SIGNIFICANCE:
Local ☐ State ■ National ☐

GENERAL DESCRIPTION:
Structural System
1. Foundation: Stone ■ Brick ☐ Concrete ■ Concrete Block ☐
2. Wall Structure
   a. Wood Frame: Post & Beam ☐ Balloon ■
   b. Load Bearing Masonry: Brick ☐ Stone ☐ Concrete ☐ Concrete Block ☐
   c. Iron ☐ d. Steel ☐ e. Other:
3. Wall Covering: Clapboard ■ Board & Batten ☐ Wood Shingle ☐ Shiplap ☐ Novelty ☐ Asbestos Shingle ☐ Sheet Metal ☐ Aluminum ☐ Asphalt Shingle ☐ Brick Veneer ☐ Stone Veneer ☐
   Bonding Pattern: Other:
4. Roof Structure
   a. Truss: Wood ■ Iron ☐ Steel ☐ Concrete ☐
   b. Other:
5. Roof Covering: Slate ☐ Wood Shingle ☐ Asphalt Shingle ☐ Sheet Metal ■ Built Up ☐ Rolled ☐ Tile ☐ Other:
6. Engineering Structure:
7. Other:

Appendages: Porches ■ Towers ☐ Cupolas ☐ Dormers ☐ Chimneys ■ Sheds ☐ Ells ☐ Wings ■ Bay Window ■ Other:

Roof Style: Gable ■ Hip ☐ Shed ☐ Flat ☐ Mansard ☐ Gambrel ☐ Jerkinhead ☐ Saw Tooth ☐ With Monitor ☐ With Bellcast ☐ With Parapet ☐ With False Front ☐ Other:

Number of Stories: 2½
Number of Bays: 5 x 3
Entrance Location: center, front
Approximate Dimensions: 32' x 24' plus side wing

THREAT TO STRUCTURE:
No Threat ■ Zoning ☐ Roads ☐
Development ☐ Deterioration ☐
Alteration ☐ Other:

LOCAL ATTITUDES:
Positive ■ Negative ☐
Mixed ☐ Other:

ADDITIONAL ARCHITECTURAL OR STRUCTURAL DESCRIPTION:

Although this structure was originally used as a wagon shop, it was substantially remodeled c. 1890 to serve as a residence. Queen Anne Revival style is evidenced by a projecting bay having brackets under the eave. The gable is detailed with shingles, some having a heraldic pattern most freguently found in the Barre Graniteville area. The foundation includes slabs of granite that were split form local field boulders. This part of the foundation may well be part of the original wagon shop foundation. The south gable was damaged by a fire that destroyed the adjacent W. and C.W. Huntington Saw Mill in 1914. (The dam and part of the foundation remain.) A rear corner wing was added in the mid-1900's and the one bay gable-roofed garage was built c. 1950.

RELATED STRUCTURES: (Describe)

1. One bay garage 10' x 16'. Gable roof.

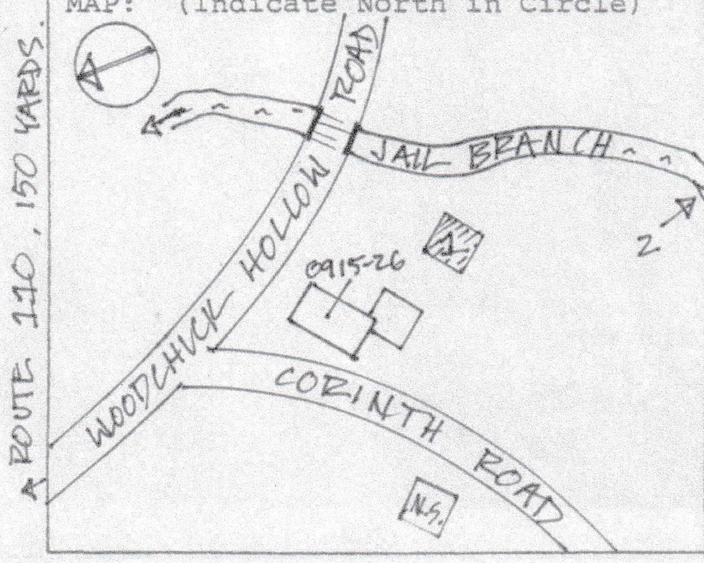
STATEMENT OF SIGNIFICANCE:

This structure was built by Rodney Clough c. 1840 and originally served as a wagon shop. Adjacent ot the shop were the Huntington saw mill and the "Washington Manufacturing Co.". Together, the buildings comprised the industrial center of Washington in the mid-19th century. Although some of the original framing of the wagon shop still exists, the structure was rebuilt as a residence, probably by a member of the Cheney family. The design of the house, especially the gable shingle work, indicates the building associations that Washington had with the Barre/ Graniteville area during the height of the granite industry in the 1890's.

REFERENCES:

1,2,3,4,7.

MAP: (Indicate North in Circle)



SURROUNDING ENVIRONMENT:

- Open Land [x]
- Woodland [ ]
- Scattered Buildings [x]
- Moderately Built Up [ ]
- Densely Built Up [ ]
- Residential [x]
- Commercial [ ]
- Agricultural [ ]
- Industrial [ ]
- Roadside Strip Development [ ]
- Other: C. 200 yards east of Route 110 and the center of Washington Village.

RECORDED BY: Philip C. Marshall

ORGANIZATION: Div. for Historic Preservation

DATE RECORDED: 6/3/79

0915-26

Attachment 3: Dam Inspection Reports

Hands Mill Dam 225.01
Washington

VERMONT

Vermont Department of Environmental Conservation
Facilities Engineering Division
1 National Life Drive, 1 Main [phone] 802-490-6229
Montpelier, VT 05620

MEMORANDUM

TO:	To The File
FROM:	Steven Hanna, Dam Safety Engineer
DATE:	December 9, 2016
SUBJECT:	Inspection of Hands Mill Dam, Washington.

On August 11, 2016, Stephen Bushman, P.E., Steven Hanna and Louisa Deering made a routine inspection of the Hands Mill Pond Dam in Washington, Vermont, State Identification Number 225.01. The inspection was carried out under the provisions of Title 10 of Vermont Statutes Annotated, Section 1105. The Town of Washington owns the dam. A number of photographs and field notes were taken. The dam was last inspected by the Department on August 5, 2013, and the report of that inspection is on file. This report updates previous observations and records additional information.

OVERALL CONDITION

The overall condition of the dam is **POOR** and the dam is currently **Partially Breached.** The dam is continuing to deteriorate and progressively breach.

DOWNSTREAM HAZARD CLASSIFICATION

The dam is classified as a Class 2, "Significant Hazard" dam. Significant hazard potential category structures are those located in predominantly rural or agricultural areas where failure may damage isolated homes, secondary highways or minor railroads, or cause interruption of service of relatively important public utilities. **The potential for loss of life is few and the potential economic loss is appreciable**.

JURISDICTION

Since the dam impounds more than 500,000 cubic feet, any alteration, reconstruction or breaching would require prior approval from the Department under provisions of 10 VSA Chapter 43.

RECOMMENDATIONS FOR OWNER

1. Retain a professional engineer experienced in the design and investigation of dams to develop plans to remove the dam and restore the upstream channel. The dam is progressively breaching. **A failure of the dam could cause public and private property damage and loss of life downstream.**

2. Develop, implement and keep current an Emergency Action Plan (EAP) for use during an unusual or emergency event at the dam. The purpose of an EAP is to reduce the risk of human life loss and injury and minimize property damage. The EAP should be reviewed and tested at least annually. Submit a copy of the EAP to the Dam Safety Program.

3. Clear the dam crest, the upstream slope and the downstream slope of trees, woody vegetation, and debris extending 15 feet beyond the toe of the dam, outlet structure, and both abutments.

INSPECTION

The inspection of the dam was conducted on August 11, 2016 at 1430 hours. The weather was partly cloudy and humid with temperatures in the mid-80s. The ground conditions were dry. The following was observed:

1. Embankment Section: The earth embankment section is primarily left of the spillway tying into the left abutment that was a firm parking lot. The downstream slope of this section was covered in grass and thick brush.

2. Downstream Wall: The wall consists of cyclopean concrete (concrete with large round stones). The concrete is deteriorating and there are several areas of the wall with significant stone loss. The area to the left of the spillway had a large area of scour and several loose stones where there had been concrete loss. Several large pieces of concrete had fallen off the wall about 50 feet to the right of the spillway. This area also appeared to be impacted by overtopping events. At the extreme left end, the downstream wall consisted of large rounded stone dry-laid. The wall was irregular but appeared more stable than the rest, most likely because it has been less impacted by high flows. Most of the downstream wall had moderate to large trees growing on or adjacent to it. These are also destabilizing the wall. There were multiple areas of seepage on both sides of the spillway.

3. Upstream Wall: The right end of the dam consisted of a concrete wall. Most of the wall was covered in thick brush but the exposed section had significant cracking. The spillway and left end of the dam had significant scour. The additional large stone that has been placed appeared stable at the time of the inspection.

4. Crest: The crest was in poor condition, covered in grass, heavy brush, and trees. There were multiple locations with signs of overtopping, erosion. The dam was partially breached near its mid-section, with fallen concrete and concrete that was leaning up to 10 feet downstream.

5. Toe: Trees, woody vegetation and debris covered the toe.

6. Principal Concrete Spillway:

    a) Approach Channel: The approach channel was clear of debris. The concrete of the spillway was cracked and eroded along the whole width of the channel.

    b) Weir: The weir structure was in poor condition, the left end has been partially breached and the rest of the weir was highly eroded and in poor condition. Large rock had been placed along the contact between the spillway and left crest as protection from high flows. This erosion appears to be a continuing problem, based on previous inspections.

    c) Downstream Section: The downstream section is a cyclopean wall that has eroded. There is stone and concrete loss and water is flowing through (within) the structure.

d) Discharge Channel: The downstream channel was clear of debris.

7. Sluice: The low level sluiceway was in poor condition and is inoperable. The sluiceway channel was about 12 feet long through the dam. The sluice gate was either closed or stop logs were in place and there was seepage coming through the logs. There were multiple seepages with water flowing heavily.

HYDROLOGY AND HYDRAULICS

The drainage area at this site is about 4,130 acres (6.45 square miles). The pond area at the normal pool is 2 acres with storage of about twelve acre-feet including sediments. At the top of the crest the dam stores 16 acre-feet. The maximum spillway capacity is about 800 cubic feet per second.

VERMONT

Vermont Department of Environmental Conservation
Facilities Engineering Division
1 National Life Drive, 1 Main [phone] 802-490-6229
Montpelier, VT 05620

Agency of Natural Resources

MEMORANDUM

TO:	To The File
FROM:	Stephen Bushman, P.E., Dam Safety Engineer
DATE:	August 8, 2013
SUBJECT:	Inspection of Hands Mill Dam, Washington.

On August 5, 2013, Stephen P. Bushman, P.E., and Steve Hanna, made a routine inspection of the Hands Mill Pond Dam in Washington, Vermont. A number of photographs were taken. The dam was last inspected by the Department on May 30, 2007, and the report of that inspection is on file. This report updates that report and records additional information. The inspection was carried out under the provisions of 10 VSA 1105.

OVERALL CONDITION

The overall condition of the dam is POOR. With authorization of the VT Department of Environmental Conservation, the dam should either be removed or repaired.

DOWNSTREAM HAZARD CLASSIFICATION

The dam is a Class 2, "significant hazard" dam.

JURISDICTION

Since the dam impounds more than 500,000 cubic feet, any alteration, reconstruction or breaching would require prior approval from the Department under provisions of 10 VSA Chapter 43.

RECOMMENDATIONS FOR OWNER

1. Retain a professional engineer experienced in the design and investigation of dams to develop plans to either remove or reconstruct the dam and restore the upstream channel. The dam is progressively breaching. **A sudden failure of the dam during regional high water could cause public and private property damage and loss of life downstream.**

2. Until a professional engineer is retained, monitor the condition of the dam. Report any changes to your engineer.

3. Maintenance of the dam should be improved to include clearing and brushing of the dam along the crest, the upstream slope, and the downstream slope. Brushing should be pushed 10-15 feet past the toe of the dam, 15 feet around any outlet structure, and 15 feet surrounding both abutments.

4. An emergency action plan (EAP) should be developed, implemented, and tested. The plan should indicate who would be responsible for routine and flood-time observation of the dam, the conditions

which would be cause for alarm and the way in which people possibly affected downstream would be notified.

INSPECTION

The inspection of the dam was conducted on August 5, 2013, at 1400 hours. The weather was sunny and in the 70's. The ground was dry. The following was observed:

1. Embankment Section: Most of the earth embankment section is left of the spillway (looking downstream). The left abutment was a firm parking lot, and the downstream slope of this section was covered in grass and thick brush.

2. Stone Section:

a) Downstream Wall: The downstream wall consists of cyclopean concrete for about 50 feet to the left of the spillway, in the spillway section, and for about 100 feet to the right of the spillway. There were several areas where significant stone loss had occurred: Immediately to the left of the spillway and about 50 feet to the right. The area to the left of the spillway had a large area of scour in addition to several loose stones where the concrete had been loss. This area appears to be impacted by high flows since it is on the bend of the river. Based on the photos from 2007, this section has deteriorated rapidly, probably as a result of TS Irene and recent high water. About 50 feet to the right of the spillway, several large pieces of concrete had fallen off the wall. This area appeared to be impacted by overtopping also. At the extreme left end, the downstream wall consisted of large rounded stone dry-laid. The wall was irregular but appeared more stable than the rest, most likely because it has been less impacted by high flows. Most of the downstream wall had moderate to large trees growing on or adjacent to it. These are also destabilizing the wall. There were multiple areas of seepage on both sides of the spillway.

b) Upstream Slope: The right end of the dam consisted of a concrete wall. Most of the wall was covered in thick brush but the exposed section had significant cracking. The area to the left of the spillway had significant scour that was noted in the previous inspection. However, additional large stone had been added and the area appeared stable at the time of the inspection.

c) Crest: The crest was found to be in poor condition. The crest was covered in grass, heavy brush, and trees. Structurally, there were multiple signs of overtopping, erosion, and the dam was partially breached near its mid-section. The mid-section of the dam had severe damage with fallen concrete and concrete that was leaning up to 10 feet downstream.

d) Toe: Woody vegetation covered the toe.

3. Principal Concrete Spillway:

a) Approach Channel: The approach channel was clear of debris. The concrete of the spillway was cracked and eroded along the whole width of the channel.

b) Weir: The weir structure was in poor condition. The left end of the weir has been partially breached, and the rest of the weir was highly eroded and in poor condition. Large rock, as noted above, had been placed along the contact between the spillway and left crest as protection from high flows. This appears to be a continuing problem, based on previous inspections.

c) Downstream Section: The downstream section of the spillway is a cyclopean wall. At the time of the inspection a significant amount of water was flowing over it preventing a thorough inspection. Based on the surrounding walls and weir condition, it is expected that there is some stone and concrete loss.

d) Discharge Channel: The outlet channel downstream was clear of debris.

4. Sluice: The sluiceway appeared to be in poor condition. There were multiple signs of seepage with water flowing heavily.

HYDROLOGY AND HYDRAULICS

The drainage area at this site is about 4,130 acres. The pond area at the normal pool is 2 acres with storage of about twelve acre-feet including sediments. At the top of the crest the dam stores sixteen acre-feet. The maximum spillway capacity is about 800 cfs.

VERMONT

Vermont Department of Environmental Conservation *Agency of Natural Resources*
Facilities Engineering Division, Dam Safety and Hydrology Section
103 South Main Street, [phone] 802-241-3450
Waterbury, VT 05671-0511 [fax] 802-244-4516

June 25, 2007

Carol Davis
Town Clerk
2974 VT Route 110
Washington, VT 05675

Re: Inspection of Hands Mill Dam in Washington, VT

Dear Ms. Davis,

Attached is a report of our May 30, 2007 inspection of Hands Mill Dam owned by the Town of Washington in Washington, Vermont. As was identified in 2001 the dam is in poor condition and continues to deteriorate. At that time, a recommendation to retain a professional engineer experienced in the design of dams to develop plans to either reconstruct or remove the dam and restore the upstream channel was made. That same recommendation is being made at this time. The dam is considered a significant hazard, and a sudden failure of the dam would cause probable loss of life and property damage. Consultation with your Town attorney about the liabilities of dam ownership would be prudent.

The report outlines the condition of the dam, recommendations for the owner and information about the jurisdiction of the Department under the statue on dams (10 VSA Chapter 43).

Please contact me if you have any questions on the report or recommendations.

Sincerely,

Stephen P. Bushman, P.E.
Dam Safety Engineer

.VERMONT

Vermont Department of Environmental Conservation
Facilities Engineering Division, Dam Safety and Hydrology Section
103 South Main Street, [phone] 802-241-3450
Waterbury, VT 05671-0511 [fax] 802-244-4516

Agency of Natural Resources

MEMORANDUM

TO: For the File

FROM: Stephen Bushman, P.E., Dam Safety Engineer SB

DATE: June 25, 2007

SUBJECT: Inspection of Hands Mill Dam, Washington.

On May 30, 2007, Stephen P. Bushman, P.E., Brian Terhhune, and Henry Nyenbrink, made a routine inspection of the Hands Mill Pond Dam in Washington, Vermont. A number of photographs were taken. The dam was last inspected by the Department on June 20, 2001, and the report of that inspection is on file. This report updates that report and records additional information. The inspection was carried out under the provisions of 10 VSA 1105.

OVERALL CONDITION

The overall condition of the dam is poor.

DOWNSTREAM HAZARD CLASSIFICATION

The dam is a Class 2, "significant hazard" dam.

RECOMMENDATIONS FOR OWNER

1. The owner should retain a professional engineer experienced in the design of dams to develop plans to either reconstruct or remove the dam and restore the upstream channel. Even though the dam has withstood flood and weather for decades, it will not last forever. A sudden failure of the dam during regional high water could cause public and private property damage and loss of life downstream.

2. Maintenance of the dam should be improved to include clearing and brushing of the dam along the crest, the upstream slope, and the downstream slope to ten feet below the toe of the dam.

3. Remove the trailers and tractors from the left abutment so this area can be properly inspected and monitored for sinkholes.

4. An emergency action plan (EAP) should be developed, implemented, and tested. The plan should indicate who would be responsible for routine and flood-time observation of the dam, the conditions which would be cause for alarm and the way in which people possibly affected downstream would be notified

INSPECTION

The inspection of the dam was conducted on May 30, 2007, between 1430 and 1515 hours. The weather was partly cloudy and in the 60's. The ground was dry. The following was observed:

1. Embankment Section.

a) Upstream Slope. The upstream slope was covered in grass and thick brush. There were multiple signs of erosion. The left abutment was severely eroded while the right abutment appeared sound. There was an exposed concrete cutoff wall near the right end of the dam in a deteriorated condition.

b) Downstream Slope. The slope was covered in grass and moderate brush and trees. At the mid-point of the wall there was an eroded section that was about five-feet wide by twelve-feet high. There were multiple signs of seepage to the right of the spillway. The portion of the downstream embankment with a large rip rap wall was in fair condition.

c) Crest. The crest was found to be in poor condition. The crest was covered in grass, heavy brush, and trees. There were multiple signs of overtopping and erosion near the mid-point of the dam. There was a portion of the concrete on the crest that has failed. There were logs and woody debris along the length of the crest. In June, 2001 a sinkhole was reported on the crest to the left of the spillway. This area is now covered with trailers and tractors, presumable from the adjacent farm, so it could not be inspected.

d) Toe. The toe was wet from the multiple seeps. There was woody vegetation along the toe.

2. Principal Concrete Spillway.

a) Approach. The approach was clear of debris, but the pond is largely filled in with sediment. The concrete of the spillway was cracked and eroded along the whole width of the channel.

b) Weir. The weir structure was in poor condition. The left end of the weir appears to be failing and it is noticeably lower that the remaining structure. Excessive erosion and channel cutting was occurring around the left end of the weir structure.

c) Downstream Section. The downstream slope is a cyclopean wall that had a substantial amount of stone and concrete that was in a deteriorated state or missing. Portions of the wall were covered with seeps, moss, ferns, and small trees.

d) Outlet Channel. The outlet channel was clear of debris.

3. Sluice. The sluice was difficult to inspect but appeared to be in poor condition. There were multiple signs of seepage at the sluice.

HYDROLOGY AND HYDRAULICS

The drainage area at this site is about 4,130 acres. The pond area at the normal pool is 2 acres with storage of about twelve acre-feet including sediments. At the top of the crest the dam stores sixteen acre-feet. The maximum spillway capacity is about 800 cfs.

JURISDICTION

Since the dam impounds more than 500,000 cubic feet, any alteration, reconstruction or breaching would require prior approval from the Department under provisions of 10 VSA Chapter 43.

Please don't hesitate to call me at 241-3450 if I can be of further assistance.

State of Vermont
Department of Environmental Conservation
Dam Safety Section
103 South Main Street
Waterbury, VT 05671-0407

DAM INSPECTION CHECK LIST

Dam HANDS MILL

DEC ID. No.

Town WASHINGTON

NatDam ID No: VT000

Owner TOWN OF

Inspection Date 5-31-07

Address

Time ~~1210~~ 1430-1515

Last Inspected/by

Telephone

Last D/S Haz Class

Right of Entry

PERSONS PRESENT AT TIME OF INSPECTION (Name and Organization)

Inspection Party SPB, BAT, MN

Others

I. Conditions at Time of Inspection

Weather: Today PT CLOUDY, 60s Previous CLEAR, 70s

Ground Conditions DRY Other

Water Level w/r/t

Accessibility

Reservoir Area

Remarks POOR CONDITION, DAM SHOULD BE REMOVED & CHANNEL U/S RESTORED.

110

II. Condition of Main Structure

Type of Construction CYCLOPEAN CONCRETE / EARTH EMBANKMENT

A. Upstream Face or Slope

1. Vegetative Cover GRASS / THICK BRUSH

2. Erosion MODERATE ALONG EMBANKMENT SECTION

3. Slumps, Slides, Cracks

4. Animal Burrows NN

5. Slope Protection

6. Debris

7. Structural

8. Abutments LT ABUTMENT ERODED / RT ABUTMENT SOUND

9. Alignment

10. Movement

11. Remarks EXPOSED CONCRETE CUT-OFF WALL NEAR RT END. DETERIORATED CONDITION.

E. Downstream Face or Slope and Toe

1. Vegetative Cover GRASSES, MODERATE BRUSH & TREES

2. Erosion

3. Slumps, Slides, Cracks MID POINT OF DAM HAS AN ERODED SECTION ≈ 5' WIDE x 12' HIGH

4. Animal Burrows

5. Slope Protection

6. Debris

7. Seepage NOTED JUST RT OF SPILLWAY THROUGH CYCLOPEAN WALL.

8. Piping

9. Boils

10. Toe Drains NONE

11. Scour

12. Structural CYCLOPEAN WALL HAS LOST SUBSTANTIAL AMOUNT OF STONE, IN DETERIORATED STATE

13. Abutments RT SOUND, LT ERODED LT ALSO HAS TRAFFIC & TRACTOR ON THAT [illegible] INSPECTION.

14. Alignment ______

15. Movement ______

16. Remarks STONE WALL SECTION AT RIGHT END BULGES OUTWARD IN SEVERAL PLACES.

C. Top of Dam

1. Vegetative Cover GRASS, HEAVY BRUSH & TREES

2. Erosion ______

3. Evidence of Overtopping YES, ABOUT AT MID-POINT. PORTION OF CONCRETE ON CREST HAS FAILED

4. Settlement, Cracks ______

5. Animal Burrows NN

6. Debris LOGS, WOODY DEBRIS

7. Use of crest (road, trail, etc.) NONE

8. Structural POOR CONDITION

9. Abutments RT : FAIR, LT : SEVERELY ERODED

10. Alignment ____________________

____

11. Remarks ____________________

____

____

III. Condition of Outlet Works

A. Principal Spillway

Type CYCLOPEAN CONCRETE

____

Controlled or Uncontrolled UNC

____

1. Approach Channel CLEAN, BUT IN GENERAL POND U/S OF DAM FULL OF SEDIMENTS

2. Transition ____________________

____

3. Control Section CONCRETE SEVERELY DETERIORATED

____

4. Discharge Channel CLEAN

____

5. Intake Structure ____________________

____

6. Conduit ____________________

____

7. Outlet Structure ____________________

____

8. Trash Racks ____________________

9. Anti-vortex Devices ____________________

10. Stop Logs, Flash Boards ____________________

____

11. Remarks ____________________

____

____

B. Emergency Spillway

Type ____________________

____

Controlled or Uncontrolled ____________________

1. Approach Channel ____________________

____

2. Transition ____________________

____

3. Control Section ____________________

____

4. Discharge Channel ____________________

____

5. Remarks ____________________

____

____

C. Drawdown Facilities, Gates, Drains, Appurtenances, Etc.

1. Drawdown Facility ____________________

____

Condition ____________________

____

115

2. Other Gates, Drains, Appurtenances ______________________

____

Condition ______________________________________

____

3. Remarks ______________________________________

____

____

____

IV. Operation and Maintenance

____

____

____

____

V. Inspection Summary

A. Information Obtained

1. Photographs ______________________________

2. Dimensions ______________________________

3. Other ___________________________________

B. Additional Information Needed

____

____

____

C. Overall Condition of Dam

____

____

____

____

VI Owner Interview   Yes   No   When/where ____________________

(A) Plans, inspection reports, photos, other records? ____________________

____

(B) History of dam ____________________

____

(C) Performance, floods, operation, etc. ____________________

____

(D) Property lines, access, water rights, etc. ____________________

____

(E) Other Information ____________________

____

VII. General Comments

____

____

____

____

Check List completed by Name ____________________

Title ____________________

Date ____________________

Attachments: ____________________

____

____

State of [illegible]

AGENCY OF NATURAL RESOURCES
Department of Environmental Conservation

Department of Fish and Wildlife
Department of Forests, Parks and Recreation
Department of Environmental Conservation
State Geologist
RELAY SERVICE FOR THE HEARING IMPAIRED
1-800-253-0191 TDD>Voice
1-800-253-0195 Voice>TDD

November 14, 2001

Carol Davis
Town Clerk
2974 VT Route 110
Washington, VT 05675

Re: Hands Mill Dam - Washington

Dear Ms. Davis,

Attached is a report of our June 20, 2001 inspection of the dam owned by the Town of Washington in Washington, Vermont. Some items in the recommendations of the reports should be given early attention.

The report outlines the condition of the dam, recommendations for the owner and information about the jurisdiction of the Department under the statue on dams (10 VSA Chapter 43).

Please contact me if you have any questions on the report or recommendations.

Sincerely,

Robert B. Finucane, P.E.
Dam Safety Engineer

cc: Larry R. Fitch, P.E., Director, Facilities Engineering Division.

Regional Offices - Barre/Essex Jct./Pittsford/Rutland/N. Springfield/St. Johnsbury

State of Vermont

AGENCY OF NATURAL RESOURCES
Department of Environmental Conservation

Department of Fish and Wildlife
Department of Forests, Parks and Recreation
Department of Environmental Conservation
State Geologist
RELAY SERVICE FOR THE HEARING IMPAIRED
1-800-253-0191 TDD>Voice
1-800-253-0195 Voice>TDD

MEMORANDUM

TO: For the Record

FROM: Robert B. Finucane, P.E., Assistant Dam Safety Engineer

DATE: November 14, 2001

SUBJECT: Inspection of the Hands Mill Pond Dam, Washington

On June 20, 2001, Robert B. Finucane, and Jennifer Vosburgh, made a routine inspection of the Hands Mill Pond Dam in Washington, Vermont. A number of photographs were taken. A second visit to the site was made on August 3, 2001 to set a benchmark. The dam was last inspected by the Department on November 14, 1984, and the report of that inspection is on file. This report updates that report and records additional information. The inspection was carried out under the provisions of 10 VSA 1105. Permission to inspect the dam was given by Selectman Don Milne in a phone conversation on June 19.

OVERALL CONDITION

The overall condition of the dam is poor. The spillway section is partially failed at the left end and exhibits widespread concrete deterioration, spalling and erosion. The embankment section is overgrown with trees and brush.

RECOMMENDATIONS FOR OWNER

Recommendations for the owner include:

1) The owner should retain an professional engineer experienced in the design of dams to develop plans to either reconstruct or remove the dam. Even though the dam has withstood flood and weather for decades, it will not last forever. A sudden failure of the dam during regional high water could cause public and private property damage and loss of life downstream.

2) Maintenance of the dam should be improved to include clearing and brushing of the dam along the crest, the upstream slope, and the downstream slope to ten feet below the toe of the dam.

3) An emergency action plan (EAP) should be developed, implemented, and tested. The plan should indicate who would be responsible for routine and flood-time observation of the

Regional Offices - Barre/Essex Jct./Pittsford/Rutland/N. Springfield/St. Johnsbury

dam, the conditions which would be cause for alarm and the way in which people possibly affected downstream would be notified

INSPECTION

The inspection of the dam was conducted on June 20, 2001, between 1300 and 1430 hours. The weather was partly cloudy and in the 80's. The pond level on August 3, 2001 was 0.2 feet below the PK nail set in a 4x4 in the crest of the dam and about the same as during the June 20 inspection. The ground was dry. Portions of the first visit to the site were observed by Ann Jennings and Brian Fitzgerald from the Water Quality Division. Washington Selectman, Don Milne was also present. The following was observed:

1. Embankment Section.

a) Upstream Slope. The upstream slope was in fair condition, and was found to be firm, dry, and irregular and heavily overgrown with brush and trees.

b) Downstream Slope. The downstream slope of the dam was also overgrown, steep, dry and irregular. Portions of the slope on the right side of the spillway are covered with riprap. At the right of the spillway, there is evidence of historic overtopping and sloughing of the embankment. On the left side of the spillway, the foundations of the old mill building form the slope.

c) Crest. The crest was found to be in poor condition. The crest to the right of the spillway is narrow, and overgrown with vegetation, including trees twelve inches in diameter breast high. The roots of these trees grow into the embankment generating pathways which allow water to enter and cause the embankment to deteriorate and eventually fail.

A 4-inch diameter, 12 inch deep hole was found in the crest to the left of the spillway, and a grade stake with flagging on it was placed in the hole. When revisited on August 3, the hole had grown to 18 inches diameter and 12 inches deep. It is believed that the hole is caused by topsoil washing into the old stone mill foundation.

d) Toe. The toe was firm, dry, and irregular and overgrown with vegetation on the right side of the spillway. Seepage was found flowing at approximately 5-10 gallons per minute from the old mill sluice that had been previously filled in at the left end of the spillway.

2. Principal Spillway.

a) Approach. The approach was in fair condition. The pond is largely silted in and with the crest of the dam lowered, the stream meanders through the sediments to form a small pool above the spillway.

b) Weir. The weir structure was in poor condition. The height of the dam appears to be the same as it was as it was at the last inspection in 1984. The weir is constructed of cyclopean concrete. Portions of the wall were covered with seepage and moss, ferns, and other small plants. Spalling was observed up to twelve inches in depth on the right side of the spillway, and seepage with various flow rates was found along the entire length of the wall to the right of the spillway. Portions of the wall have failed and debris has collected at the end of the wall on the right side of the downstream slope. Comparison with the 1979 photos documents widespread concrete deterioration.

c) Outlet Channel. The outlet channel is clear. A concrete training wall downstream of the right side of the spillway visible in the 1979 photographs has collapsed.

3. Sluice. The sluice was in fair condition. Minor seepage and efflorescence was observed.

HYDROLOGY AND HYDRAULICS

The drainage area at this site is about 4,130 acres. The pond area at the normal pool is 2 acres with storage of about twelve acre-feet including sediments. At the top of the crest the dam stores sixteen acre-feet. The maximum spillway capacity is about 800 cfs.

DOWNSTREAM HAZARD CLASSIFICATION

The dam is a Class 2, "significant hazard" dam.

JURISDICTION

Since the dam impounds more than 500,000 cubic feet, any alteration, reconstruction or breaching would require prior approval from the Department under provisions of 10 VSA Chapter 43.

Hands Mill Dam, Washington
2001

Spillway. Note vegetation, seepage, and concrete deterioration on walls and rubble in spillway crest.

Spillway from left abutment.

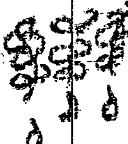
HANDS MILL 8/3/01
RBF
JMV

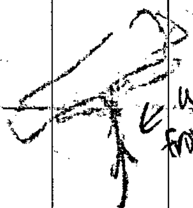
WL = 0.1" below PK nail
set in wood 4x4 in
spillway

Sinkhole in left abut now
18' dia x 12" DEEP
previously noted and
flagged at 4" dia

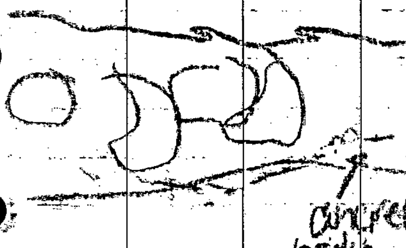
Hands Mill dam

6/20/01
RBF
JMV





right embankment completely saturated by water (bottom ½)



[illegible]

Spoke to Ben Milne,
Westborough Selectman,

He will meet us at the
Town Clerk's Office today
at 1300 to do inspection
of dam.

01-31-01

<)22+01 NNN-02AU 183

DOCUMENTS WERE FOUND STUCK TOGETHER

1-31-24

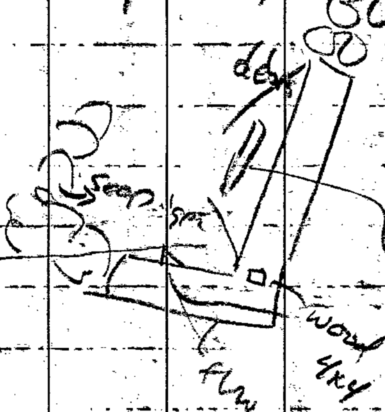
Hands Mill 6/20
[2001]

earth-stone RT embankment
Trees up to 12" dbh
diameter breast high
heavy brush

cyclopian 1300

cyc conc main spillway
milone
bT fetz

ann jennings
RBF
JMV
PC 80s



conc spalled up to 12" deep
seepage generally

end
RT side crest failed
visible d/s wall failed

hole coos[?] lill dud[?]
sticks + flag

old mill sluice filled in
Sh[?]ogan[?]

dam sluice 2 x planks u/s

Filename: Document4
Directory:
Template: C:\Documents and Settings\paulak\Application Data\Microsoft\Templates\Normal.dot
Title:
Subject:
Author: Staff
Keywords:
Comments:
Creation Date: 12/9/2004 10:04 AM
Change Number: 1
Last Saved On:
Last Saved By:
Total Editing Time: 0 Minutes
Last Printed On: 12/9/2004 10:06 AM
As of Last Complete Printing
Number of Pages: 1
Number of Words: 0 (approx.)
Number of Characters: 4 (approx.)

State of Vermont

Department of Fish and Wildlife
Department of Forests, Parks and Recreation
Department of Environmental Conservation
State Geologist
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AGENCY OF NATURAL RESOURCES
Department of Environmental Conservation

Dam Safety Section
Facilities Engineering Division
103 South Main Street
Waterbury, VT 05671-0407

Telephone (802) 241-3451
FAX (802) 241-3273
peter.barranco@anrmail.anr.state.vt.us

May 4, 1999

Carol Davis
Town Clerk
2974 VT. Route 110
Washington VT 05675

Re: Hands Mill Dam - Washington

Dear Ms. Davis:

This will confirm our telephone conversation this morning regarding the Department's request to make a routine safety inspection of the Hands Mill Dam this summer under provisions of 10 VSA Section 1105 (copy enclosed). The dam was last inspected by the Department in 1984 and a report sent to the Town.

It is my understanding that you will bring this to the attention of the Selectmen for their consideration. I would appreciate it if you or the Select Board could write me confirming we have the Town's permission to make the inspection. We will let you know in advance of the inspection date in the event someone from the Town would like to accompany us. A report will be prepared following the inspection and a copy will be sent to the Town.

Thank you for your assistance. Please give me a call if you have any questions or we can be of any help.

Sincerely,

A. Peter Barranco, Jr., P.E.
Dam Safety Engineer

Enclosure as noted.

c: Harry K. Roush, Fire Chief, Washington
Larry R. Fitch, P.E., Director, Facilities Engineering

Regional Offices - Barre/Essex Jct./Pittsford/Rutland/N. Springfield/St. Johnsbury

5/4/99
DPD

Hanks Mill Dam - Washington

5/4/99 @ 0900 tclcon Harry Rauch (Fire Chief) 241-3584

re: status of dam → still partially breach left side, silted in. Advised plan to inspect this summer - who should we contact?

→ Carol Davis TC @ 883-2218

@ 0920 tclcon Carol Davis - OK to do inspection - she will advise Selectmen - Harry Rauch called her already - will send her letter + call again when we have it scheduled (summer sometime).

2974 VT Route 110
Washington VT 05675

7/31/97
ADB

HANDS MILL VT00308 DEC # 225-1

~~Add to Not Dam Inv~~

tentative Class 2 (changed from Class 3 even though silted in until further verified).

USGS 44-B

Lat 44 05 + $\left(\frac{20.3}{37.9}\right)(2.5)$ = 44 06.34

Lon 72 25 + $\left(\frac{8.9}{27.4}\right)(2.5)$ = 72 25.81

dimensions from file - reports

L = 325' (incl. spillway) H = ? 22' SHH

Spillway 68' × 2' (min) cyclo. conc. ? 18' DHS (scale of plan) bot. of conc spill

DA = 6.45 mi² = 4128 A

H ↕ 2.4

C = 2.8 @ 2' to stream bed?

3.1 @ 3' Say H = 20' ±

Orig dam c. 1860 — pond shown of old maps

conc. spill c. 1928 SHH says (1980) at least 45 years do (timber spill washed out in 1927 flood)

1972 survey Top of embank - irregular 2'-3' above spillway crest

Call it 2.5' for no overtopping except possible 0.5' at rt. end spill. very approx

Q = (3.0)(68)(2.5)^1.5 = 806 cfs ≈ 800

(doesn't not include flow through partial breach)

DHS report uses 1025 cfs

VERMONT DAM INVENTORY

Dam name HANDS MILL
Other name
Hydro Fac Name
Hydro Fac Owner

Town WASHINGTON County ORANGE
Latitude 44- 6.34 Longitude 72-25.81
River or Stream JAIL BRANCH
Nearest City/Town WASHINGTON
Distance Nearest City/Town .00 MI
Owner Name(1) TOWN OF WASHINGTON
Address WASHINGTON, VT 05675

Telephone Owner type(1) L
Owner Name(2)
Address

Telephone Owner type(2)
Non-Fed Dam on Fed Prop N

Orig const date 1860 Purpose MILL POWER
Design St Auth NR
Recon/Mod 1 date 1928 Purpose CONC SPILLWAY
Design UNKNOWN St Auth NR
Recon/Mod 2 date 0 Purpose
Design St Auth

Dike Type Height 0 FT Length 0 FT
D/S Haz Stor:Nor 0 AF Max 0 AF

Prin spill CYCL CONC OVERFALL 68'L X 2.5'D
Design cap 0 CFS Max cap 800 CFS
Emer spill NONE
Design cap 0 CFS Max cap 0 CFS

Plans NO Specs NO Des docs NO
Field dwg YES Photos YES Other SURVEY

USGS Quad 44-B Corps L-9 VT7420-16-155
Other AP VT-62-H-47-167 Ortho
Other maps

Remark ORIG DAM MAY DATE TO 1860'S. TIMBER SPILLWAY WASHED OUT IN 1927 FLOOD, REPLACED WITH CONCRETE C.1928. POND SILTED-IN. MAY BE CLASS 3.

State ID	225-1
National ID	VT00308
FERC No	0
Basin No	8
Basin name WINOOSKI RIVER	
State Reg Agency	DEC
Fed Reg Agency	
Downstream Hazard	2
Size Category	
Hazard subclass	
Purposes	O
Year Completed	1860
Status ABANDONED	
Dam type	RE
Constr type EARTHFILL	
Dam height	20 FT
Dam length	325 FT
Maximum storage	16 AF
Nor storage	12 AF
Maximum discharge	800 CFS
Surface Area	2 A
Drainage area(1)	4130 A
Drainage Area(2)	6 SQM
Reservoir type	A
Structural height	20 FT
Hydraulic height	20 FT
Hydro fac type	
Hydro devel date	0
Installed capacity	0 KW
Phase I inspection	N
Phase I insp date	
Phase I report	
Inspection date	11/14/84
Inspected by DEC	
Authority 10 VSA 1105	
Emergency action plan	NR
Last State inspection	1984
Next State insp due	0
RECORD	590

7/31/91

7/19/99

Hounds Mill Dam

7/19/99 1415 Don Milne, Selectman of Washington called to say we have Town's permission to [illegible]. He would like to be there. The town is interested in finding out what they should do with the dam. They're concerned with the [illegible] even though it is rolled [illegible].

828-7247 work

Otherwise we would be glad to have him there and will call in advance. Expect it would be during the first two weeks of August.

VERMONT DEPARTMENT OF WATER RESOURCES

INFORMATION SHEET

Name of Dam Hands Mill Town Washington

Owner Town of Washington Name of Stream Jail Brook

Address ______ Classification ______

Vermont

U.S.G.S. Coordinates: Lat. 44° ~~3'~~ 6' ~~21"~~ 15" Long. 72° ~~23'~~ 26' ~~54"~~ 0"

U.S.G.S. Map East Barre Aerial Photos VT-62-H 47-166 to 167

U.S.G.S. Elev. @ Spillway ______

Total Length of Dam 260' Crest Width of Emergency Spillway 60-70'

Width of Top 2.35' Maximum Height ~~20'~~ 13' check

Spillway Capacity: Principal ______ Emergency ~~3000 cfs~~

Pond Area 2 acres Drainage Area 6.45 sq mi

Pond Volume: Normal Water Level ______ Design High Water Level ______

Maximum Water Depth: Normal Water Level ______ Design High Water Level ______

Storage Before Emergency Spillway is Used ______

Use of Reservoir N/a

Description of Dam: Earth filled with heavy concrete spillway

Description of Spillway(s): Concrete 60-70' wide, 2' below top of dam 3 in 1' downstream 1 in 1' upstream

Designed by ______ Year Built 1928*

Hearing Date ______ Order Date ______

Additional Remarks: * Concrete section; unknown for rest.

State of Vermont

AGENCY OF ENVIRONMENTAL CONSERVATION

Montpelier, Vermont 05602
Department of Water Resources
and
Environmental Engineering

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources & Environmental Engineering
Natural Resources Conservation Council

(802) 828-2761

November 18, 1984

Ms. Patricia Woodward
Town of Washington
P.O. Box 5
Washington, Vermont 05676

Re: Hands Mill Dam - Washington

Dear Ms. Woodward:

Enclosed is a copy of the Department's 1975 report on the Hands Mill Dam which you requested by telephone on November 14.

The dam has been inspected by the Department in 1950, 1953, 1972, 1973, 1975, 1979 and most recently on November 14, 1984. The latter was a cursory inspection due to snow, ice and stream conditions. The dam is judged to be in very poor condition and deterioration has been noted over the years.

Further failure of the structure could occur duing periods of high inflows, or at other times. Since the pond has very small storage due to the sedimentation, damages due to a failure would be less severe than if the pond was at the original capacity. However, a major failure would undoubtedly damage the road and structures below the dam. Direct threat to loss of life due to discharges associated with a failure of the dam itself, i.e. not considering concurrent flooding from the watershed, is probably low in its present silted-in condition.

The Department recommends that the Town either rehabilitate the dam to an acceptable condition or remove part or all of the spillway to reduce the risk of failure and resulting damages. The latter approach would necessitate an acceptable plan to stabilize sediments behind the dam and prevent their release downstream. Since the dam is or was capable of impounding more than 500,000 cu. ft., prior approval from the Department is needed to reconstruct, alter or breach the dam under provisions of 10 VSA Chapter 43, Dams (copy enclosed).

Should you or other town officials have any questions, please get in touch.

Sincerely,

A. PETER BARRANCO, Jr., P.E.
Dam Safety Engineer

APB:j

cc: Board of Selectman, Town of Washington

encl: (1) 1975 report and transmittal letter
(2) Copy of 10 VSA Chapter 43

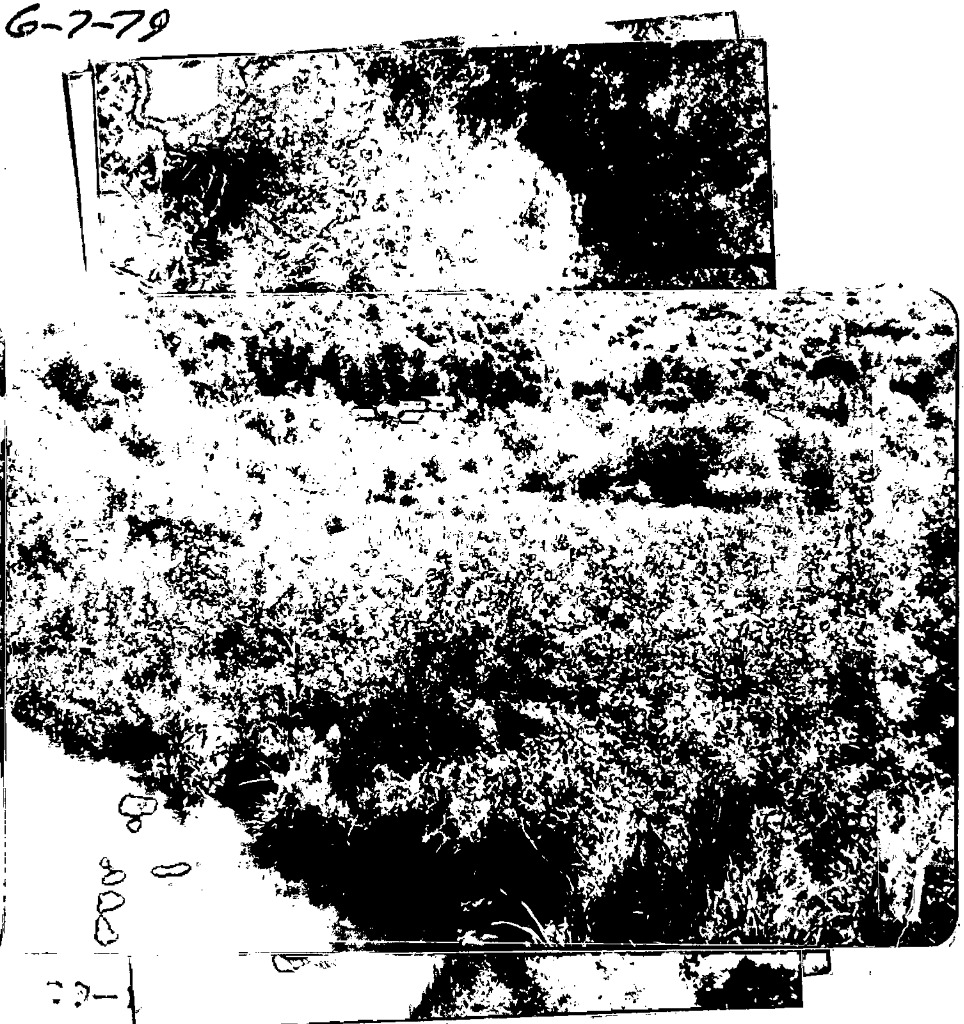
HANDS MILL DAM

6-7-79

79-15-21

↑

CREST OF E/F SECTION



79-

LOOKING U/S @ [illegible]

(SILTED IN)

APB

AGENCY OF ENVIRONMENTAL CONSERVATION

MONTPELIER, VERMONT

AGENCY MEMORANDUM

SUBJECT

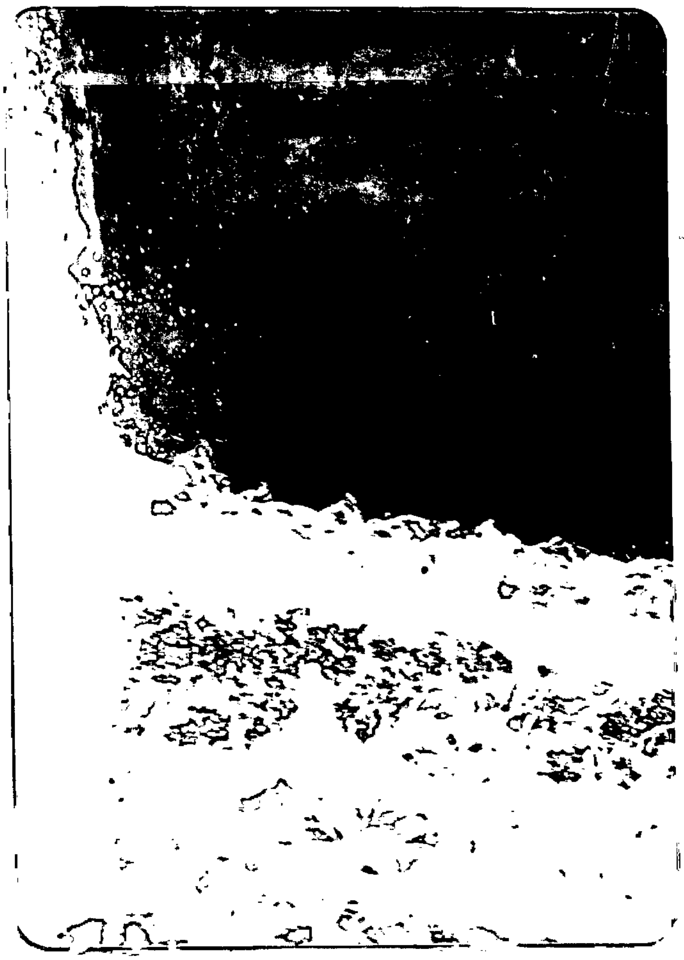
TO:

FROM:

DATE:

H[illegible]IDS MILL DAM
6-7-79

79-15-2[illegible]



79-15-28 WASTE GATE TO RIGHT OF SPILLWAY

APB

AGENCY OF ENVIRONMENTAL CONSERVATION

MONTPELIER, VERMONT

AGENCY MEMORANDUM

SUBJECT

TO:

FROM:

DATE:

HANDS MILL DAM
6-7-79

79-15-3U

UNDERMINING @ RIGHT ABUTMENT OF MAIN ? SECTION

ARB

AGENCY OF ENVIRONMENTAL CONSERVATION

MONTPELIER, VERMONT

AGENCY MEMORANDUM

SUBJECT

TO:

FROM:

DATE:

NDS MILL DAM

~~Washington~~

79-15-25 ... 25

79-15-31 TAIL RACE IN BASE OF LEFT SIDE MILL WALL SHOWN ~~[illegible]~~ PHOTO Δ25

ARB

AGENCY OF ENVIRONMENTAL CONSERVATION

MONTPELIER, VERMONT

AGENCY MEMORANDUM

SUBJECT

TO:

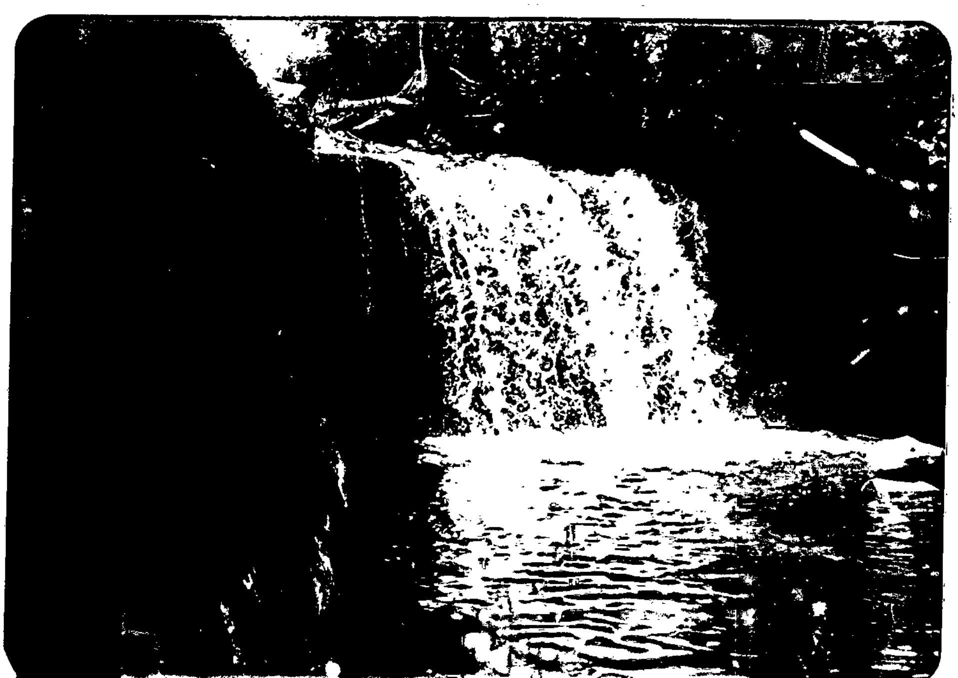
FROM:

DATE:

NDS MILL DAM
Washington
6-7-79

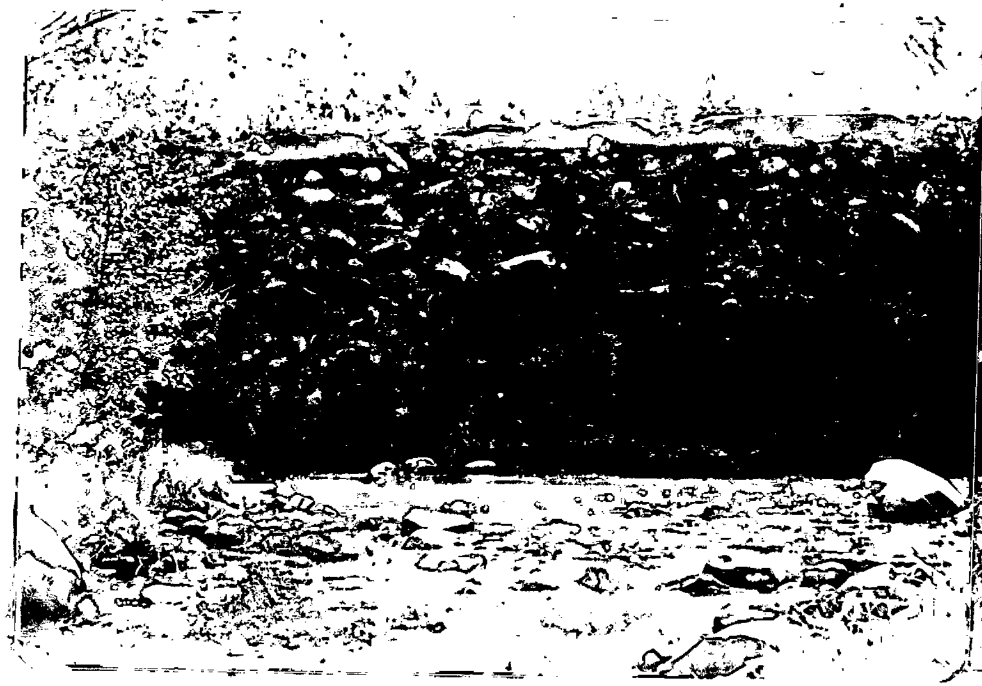
 

79-15-20 79-15-21 ⟶ BREACH



LOOKING ALONG U/S ... OF
⟶ BREACH TO LEFT OF SPILLWAY

ARC



79-15-26

-27

D/S FACE

79-15-18

79-15-19

HANDS MILL DAM
6-2-79

AGENCY OF ENVIRONMENTAL CONSERVATION

MONTPELIER, VERMONT

AGENCY MEMORANDUM

SUBJECT

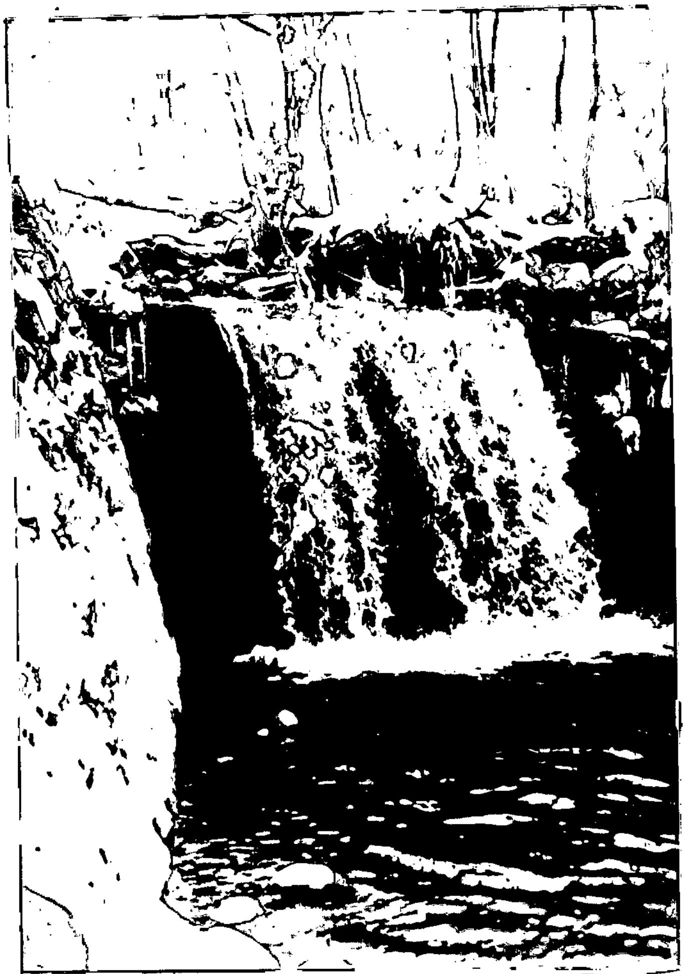
TO:

FROM:

DATE:

HANDS MILL DAM

11-14-84



84-51-25 ↖ 84-51-30 ↑

D/S Face spillway adjacent to breach

84-51-32

 APB

[?]ANDS MILL DAM

11-14-84

Left end breach

84-51-23

Looking d/s along right side mill wall and wheel pit structure.

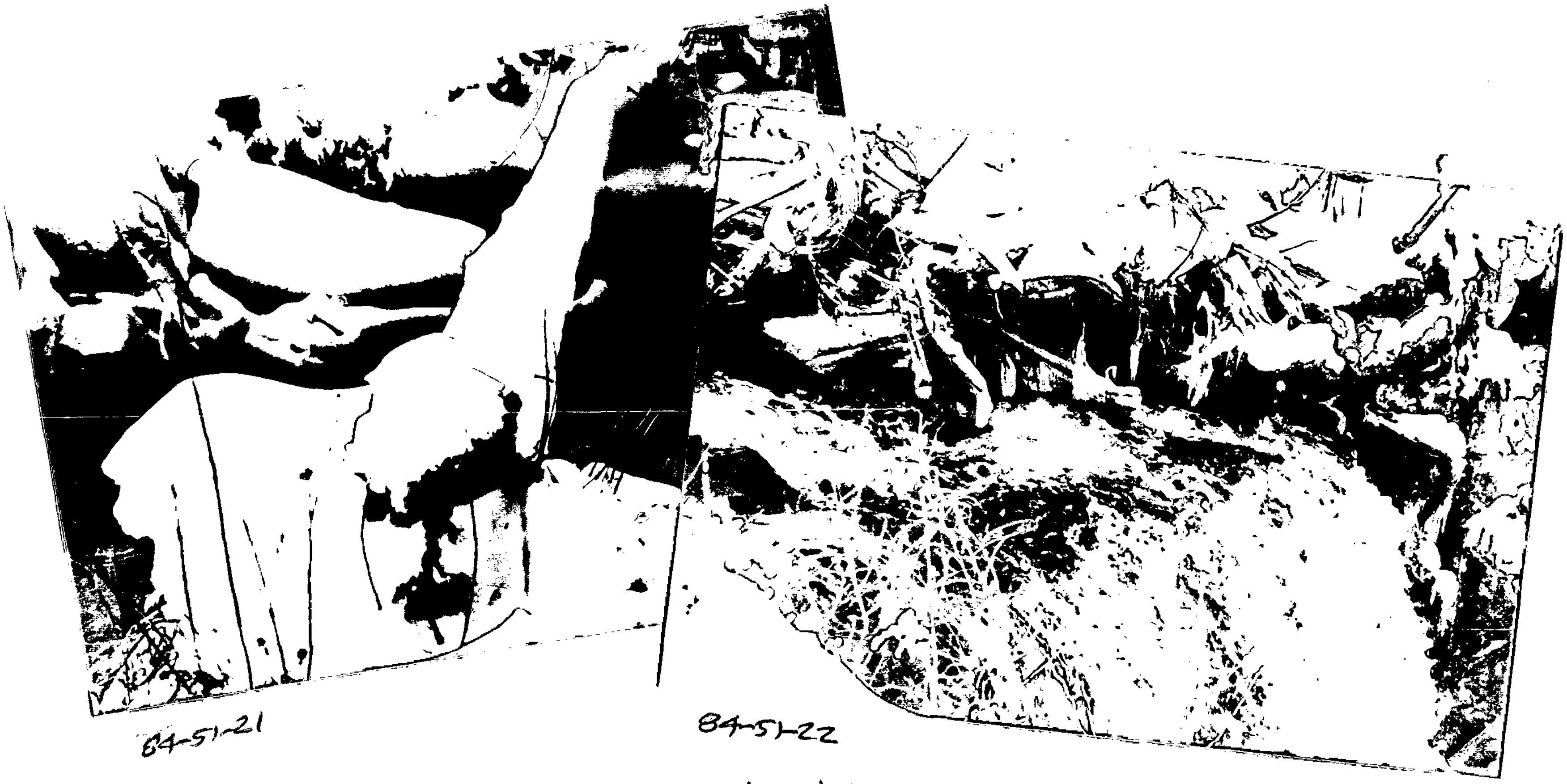
D/S ↖

84-51-24

Collapsed and eroded area at right [?] end spillway at embankment (right).

APB

HANDS MILL DAM
11-14-84



84-51-21 84-51-22

View of breach to left of spillway

APB

HANDS MILL DAM

11-14-84

84-51-19 D/s Channel

8; 51-20 "Reservoir" as viewed from crest of dam on R/s spillway near breach - looking U/s.

APB

HANDS MILL DAM

11-14-84

→D/s

84-51-17

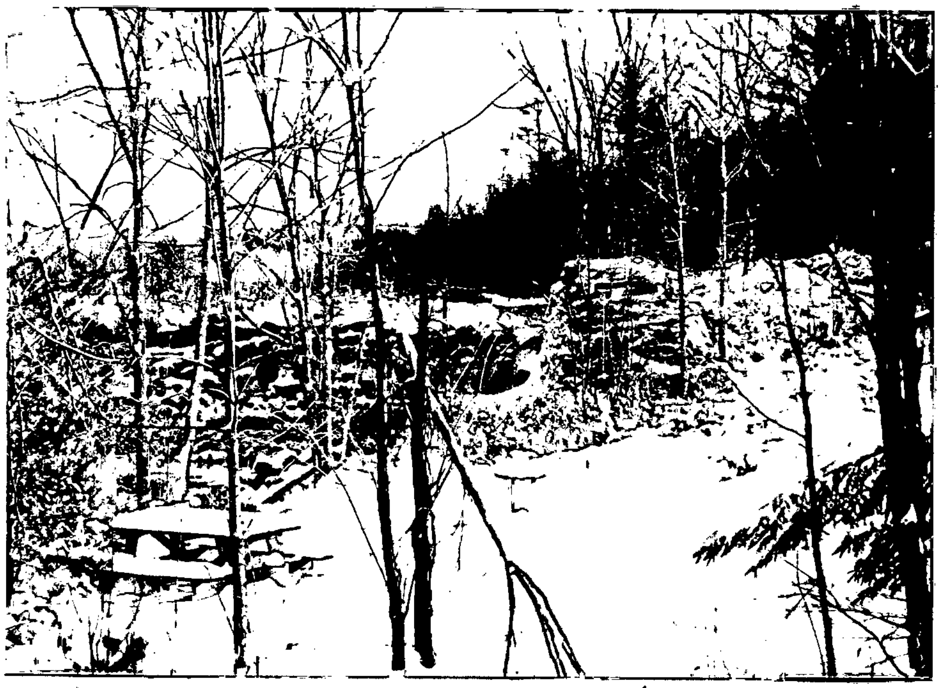
84-51-18

Crest and d/s slope near right abutment.

APB

HA[illegible]PS MILL DAM

11-14-84



← left embankment

84-51-34 ↑ spillway

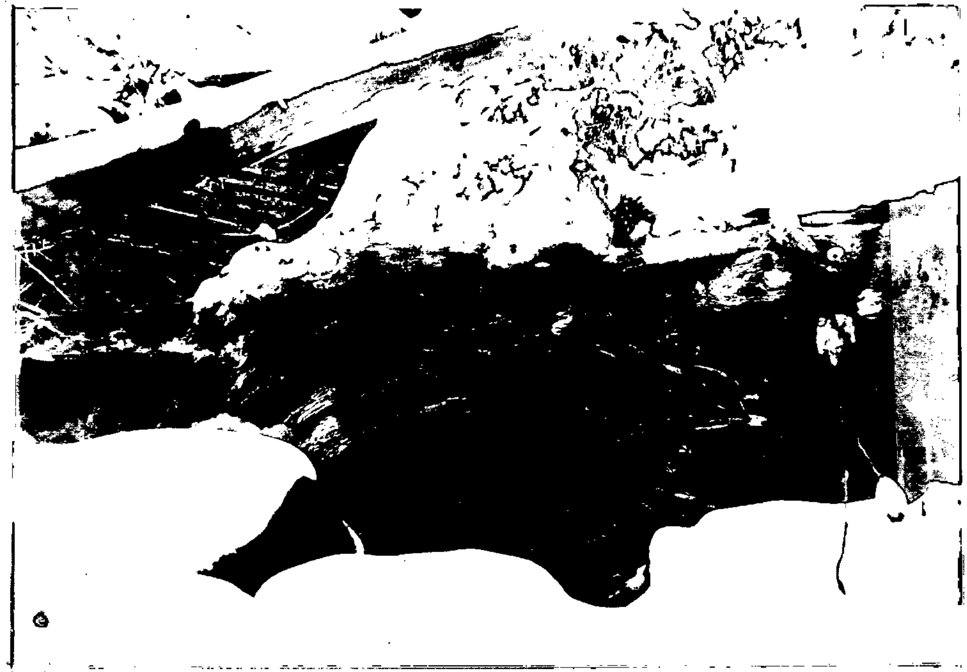
↑ Structure or chamber for wheel (?)

84-51-35 Left embankment and wheel chamber (?)

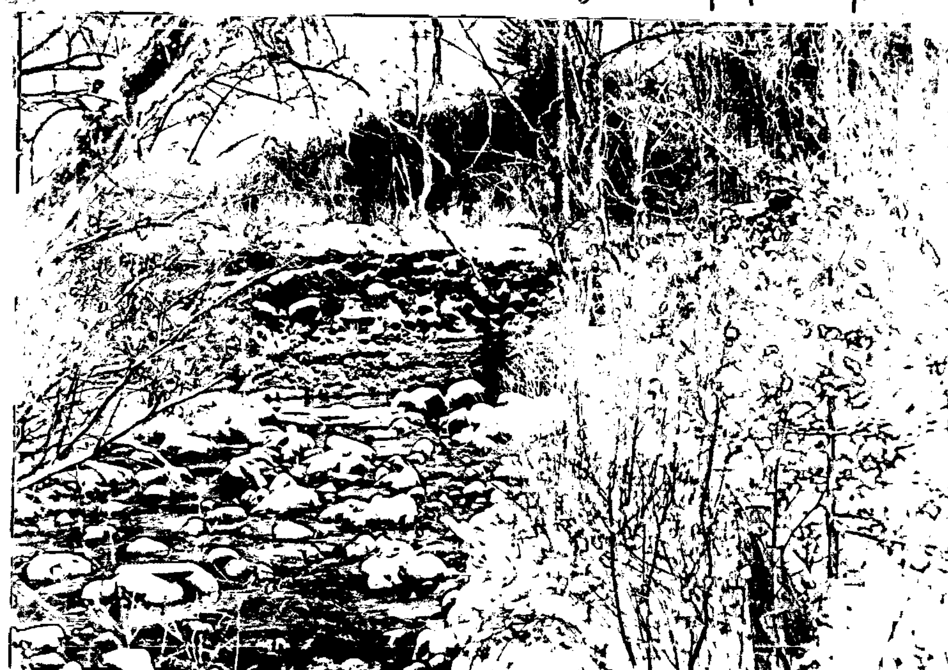
ADB

HANDS MILL DAM
11-14-84

84-51-31 Remnants of wall at right end spillway and embankment



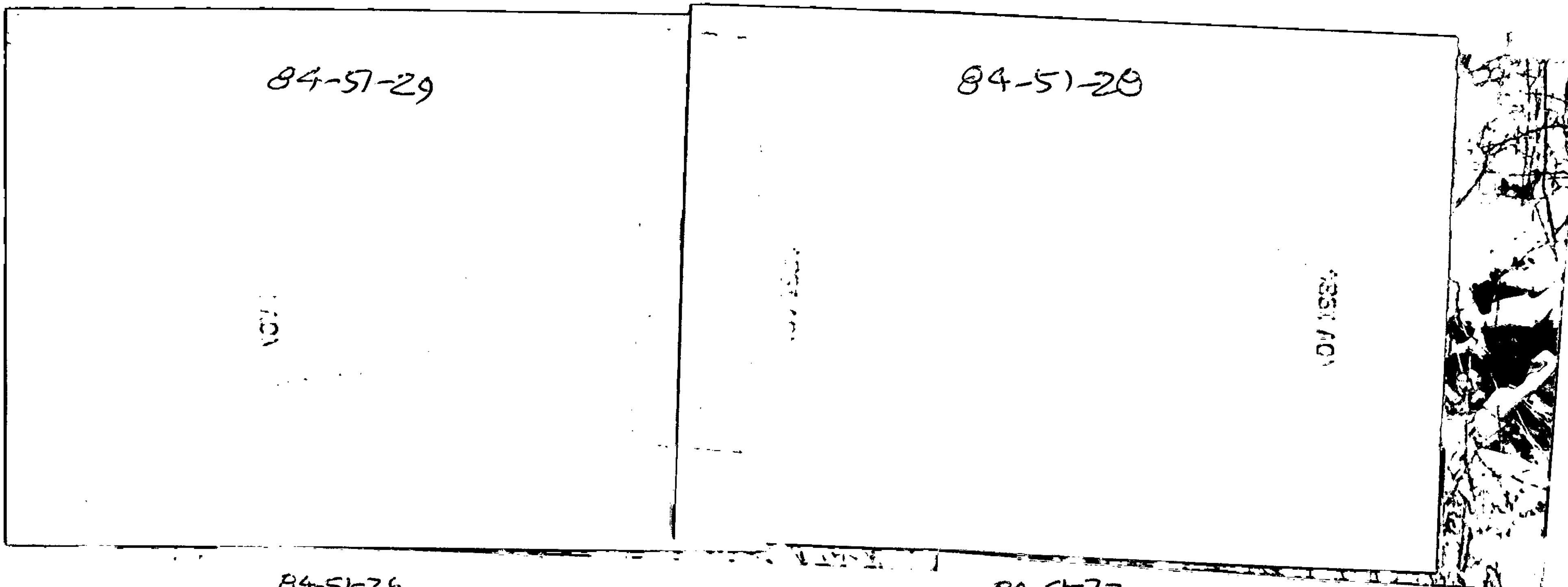
84-51-36 Breach at left end of spillway.



84-51-33

APB

HANDS MILL DAM
11-14-84



84-51-26 84-51-27 84-51-28 & 29

D/S Face of right embankment. Note dry boulder wall containing embankment along part of d/s face.

APS

Wed 11-14-84 APS
35° clear, windy, 4"± snow
Hands Mill Dam on ground

1350 – 1430 inspected dam.

Cursory inspection due to snow, ice and water conditions.

Rt. Embankment: Crest & U/S slope – brush; d/s slope + toe brush, trees up to 18" including large snag: d/s wall intact but irregular and bulging (may be the way constructed – large boulders – not cut stone).

Lt. Embankment: Too much snow to inspect. Brush.

Spillway: d/s face; seepage, deeply eroded, crumbling; cyclopean concrete; crest snow covered.

(OVER)

Hands Hill Dam p. 2
11-14-84

Left spillway abut. - breach looks about the same - est. 0.5' water through breach.

Right Spillway abut: Appear to be further erosion + movement of remnants of abut. wall. Depression in "silt" on u/s side wall in this area - probably passes water at high pond levels or is result of piping.

Overall in very poor condition. Only apparent change is further erosion / undermining at right abutment of spillway.

Photos

DIETZGEN NO. 386-5

3-10-80
MAB

HANDS MILL DAM

$GP = 44\ 05 + \left(\frac{1.50}{5.82}\right)(5) = 44\ 06.29$

$72\ 25 + \left(\frac{0.70}{4.19}\right)(5) = 72\ 25.84$

SA = 2 A

Max vol = 20 × .4 × 2 = 16 AF (silted in)

NW = 16 − 4 = 12 AF (silted in)

<u>Air photos</u> VT-62-H 47-167

VT 7420 16-155

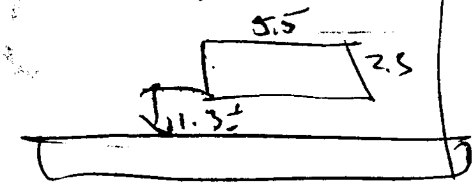
225-1 Harris Mill — Washington 6-7-79 AMB

— leakage base (gate? chamber) (wheel pit?
— partially breached left end (may have been old ~~spillway~~ headworks)
— d/s face eroded — cyclopean concrete
— sand silted in
— right abut — undermined
— stable

pot. { — 3 sty FH ½ way down = ½ up 1st floor — left side before breach
{ — 2 " " 1/s below bldg probably old

(houses no storage)

— repair entire length d/s face from [illegible] toe to 1/2 way up



repair through old tail race

11-12-75

HANDS MILL DAM

"HANDS MILL DAM - WASHINGTON
'BREACH' AT LEFT END OF SPILLWAY.
W/L IS 2.3' BELOW THE CREST
OF THE SPILLWAY.
11-12-75 DON SPIES "

ROUTING

GENERAL

SUSPEND TO

FILE Hand's Mill Dam

MANAGEMENT & ENGINEERING DIVISION

June 25, 1975

Chairman, Board of Selectmen
Washington
Vermont 05675

Gentlemen:

The Department of Water Resources is pleased to present you with a copy of its recently completed report on Hand's Mill Dam in Washington.

Essentially, the investigation found the dam to be in a further deteriorated condition since our previous visit. Your attention is invited to the recommendations contained within the report.

We are, of course, available to meet with you and welcome any comments you may have.

Sincerely yours,

Andre J. [illegible]
Assistant Director

AJR/jef
cc: Catherine Bothell, Water Resources Board

Agency of Environmental Conservation
Department of Water Resources
Management & Engineering Division
June, 1975

INSPECTION REPORT

on

HAND'S MILL DAM
Washington, Vermont

Owner	Town of Washington
Date Built	Prior to 1927 (original construction) 1928 (partial reconstruction)
Type of Structure	Earth fill flanking a concrete gravity spillway
Watershed Area	6.45 square miles
Probable Spillway Capacity	1,025 cfs (no freeboard)
Peak Flood Inflow Used In Analysis	715 cfs (100-year frequency)

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HAND'S MILL DAM

I. INTRODUCTION

Vermont has a long history of major floods during which loss of life and considerable property damage has occurred. The failure of dams has added materially to the peak flood flows and related losses. Basically, many of these failures are a result of either inadequate spillways; improper design and/or construction; or improper or insufficient maintenance.

Under Chapter 43, Title 10, Vermont Statutes Annotated, the Water Resources Board has jurisdiction over all dams impounding more than 500,000 cubic feet of water and not incident to the generation of electric energy for public use. The Department of Water Resources assists the Board by conducting a continuing program of inspection and investigation of existing statute-size dams. These investigations serve as a means of obtaining up-to-date information on existing dams, particularly with regards to their maintenance and their safety. As part of this program, an examination was made of the Hand's Mill Dam.

II. PURPOSE

1. To summarize the findings from the Department's investigation of the Hand's Mill Dam in the Town of Washington, Orange County, State of Vermont.

2. To report on the present condition of the structure and on the adequacy of its maintenance.

3. To determine the capacity of the spillway and evaluate its ability to pass reasonable flood flows.

(Continued)

4. To recommend appropriate action to be taken with regards to any flood hazards associated with the existing structure.

5. To recommend necessary repairs and alterations.

III. SCOPE

The scope of this investigation included a topographic survey and visual inspection of the structure on June 19 and 20, 1972. Additional inspections were made on July 17, 1973 and April 23, 1975. Office studies of the spillway capacity and the ability of the structure to pass flood flows were conducted. The summarization of the various findings have been incorporated into this report.

IV. WATERSHED DESCRIPTION

The watershed above Hand's Mill Dam has a drainage area of approximately 6.45 Square miles (see Appendix 1) and can be divided into two sub-basins— one for the Jail Branch and one for a tributary with its confluence at Hand's Mill Pond. The Jail Branch starts in the southeastern corner of the watershed and drops more than 1,050 feet before reaching the pond; this sub-basin is basically oval-shaped with its major axis oriented along an approximate northwest-to-southeast line. The other stream begins in the northeastern corner of the watershed and has a drop of about 1,075 feet before reaching the pond; this sub-basin is roughly rectangular in shape with its major axis along an approximate northeast-to southwest line. Both streams have steep gradients. The watershed terrains are predominantly hilly and about evenly divided between farm land and forest cover. There are no significant bodies of water above the site.

(Continued)

V. SITE DESCRIPTION

Hand's Mill Pond is an artificial impoundment located on the Jail Branch in the southeast corner of the Village of Washington. The pond has a surface area of approximately two acres and is roughly circular in shape. At the present, the pond is almost entirely silted in. The only apparent purpose the pond now serves is as a home to some waterfowl and beavers.

VI. STRUCTURE

A. DESCRIPTION

Hand's Mill Dam consists of a concrete gravity section, which serves as the spillway, and flanking earth embankment sections. Portions of the embankments adjacent to the spillway are backfilled against dry stone walls which form the downstream face.

Little is known about the history of this dam. It is known a mill existed at the site as early as 1866; since the mill ran on water power, it is assumed there was a mill pond and dam. The concrete section was built after 1927, its timber predecessor having been destroyed during the flood of November in that year.

B. CONDITION

The east embankment is overgrown with trees and brush and also appears to have insufficient cross-section. The west embankment has small brush on its downstream face. No seepage was noted along the embankment sections.

The concrete is badly deteriorated. The downstream face is severely spalled, and there is seepage through much of the section. The downstream

(Continued)

abutment wall at the east end of the spillway has collapsed but doesn't appear to have weakened the spillway. At the west end, a section of the abutment has collapsed allowing water to pass around the end of the spillway. This section has gradually increased in size over the years. The owner of the dam has dumped granite grout on the adjacent embankment to reduce the erosion.

The dam is in poor condition, but it does not appear to be in immediate danger of failing.

C. SPILLWAY ANALYSIS

1. Hydraulic

The existing conditions were analyzed by considering the eroded section as a spillway section. The eroded area was treated as a broad-crested spillway, and the spillway was treated as a sharp-crested weir. With the water level approximately up to the low section of the embankment, the combined flow through the spillway area is approximately 1,025 cubic feet per second (cfs).

2. Hydrologic

Flows of the Hand's Mill Dam were determined from the records of an adjoining gaged watershed. A 100-year-return flood at the dam has a peak flow of about 715 cfs. The surcharge storage in the pond is virtually negligible, resulting is little reduction of the peak in-flow; thus, the peak out-flow will be almost identical to the peak in-flow. For the 100-year flood, the peak water level will be less than six inches below the low section of the embankment.

(Continued)

D. CLASSIFICATION

Each dam under the jurisdiction of the Water Resources Board is classed into one of three categories according to the potential amount of downstream damage that particular dam could inflict should it fail. Class I dams are all structures, due to their size and/or location, a failure of which would result in major downstream damage, including the destruction of buildings, major disruption of utilities and/or transportation facilities, or the posbile loss of human life. Class II dams are those due to size and/or location whose failure would result in some downstream damage including damages to buildings and possible disruption of utilities and/or transportation facilities, but would probably not result in the loss of life. Dams in Class III are those, due to size and/or location, whose failure would result in only minor damage.

Below Hand's Mill Dam is a house, Town Highway No. 9 , and Bridge No.29 which could possibly suffer some damage from a failure of the dam. The house is likely to be limited to minor damage—such as silt and water damage—to the basement and first floor. The highway could suffer erosional damage, particularly the gravel-surface bridge approaches; a severance of the highway would not isolate anyone, but it would force them to go several miles out of their way. The bridge, which has concrete abutments and a cast-in-place concrete deck on steel beams, will probably not suffer any direct damage, but it could become plugged with debris. Therefore, Hand's Mill Dam is classified as a Class II Dam.

VII. RECOMMENDATIONS

Due to the present condition and the continuing deterioration, it is

(Continued)

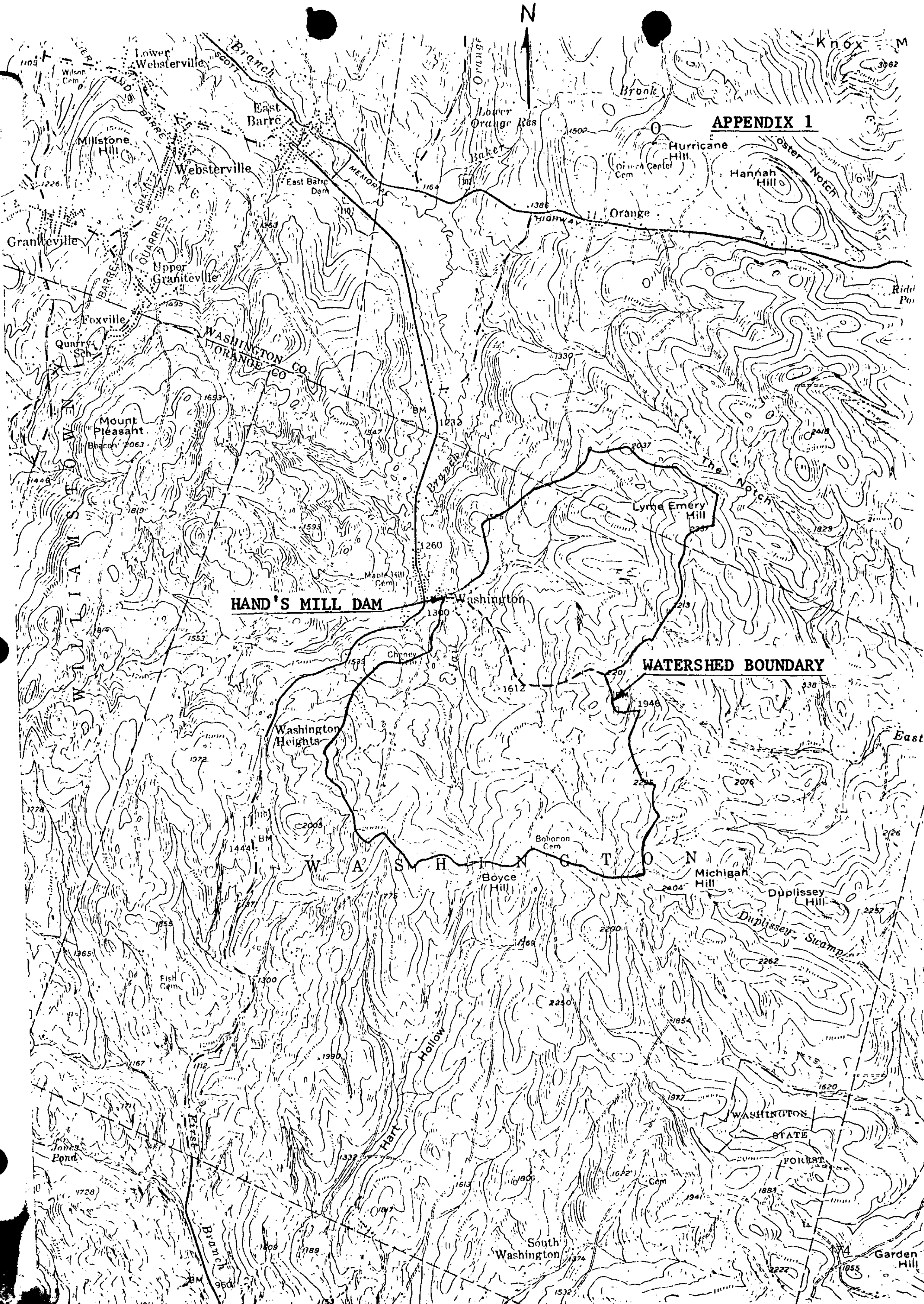
recommended that the concrete spillway be removed. The Town through its Selectmen should prepare a program suitable to the Department of Water Resources for removal of the spillway and removal and/or stabilization of the sediment in the pond.

VIII. SELECTED REFERENCES

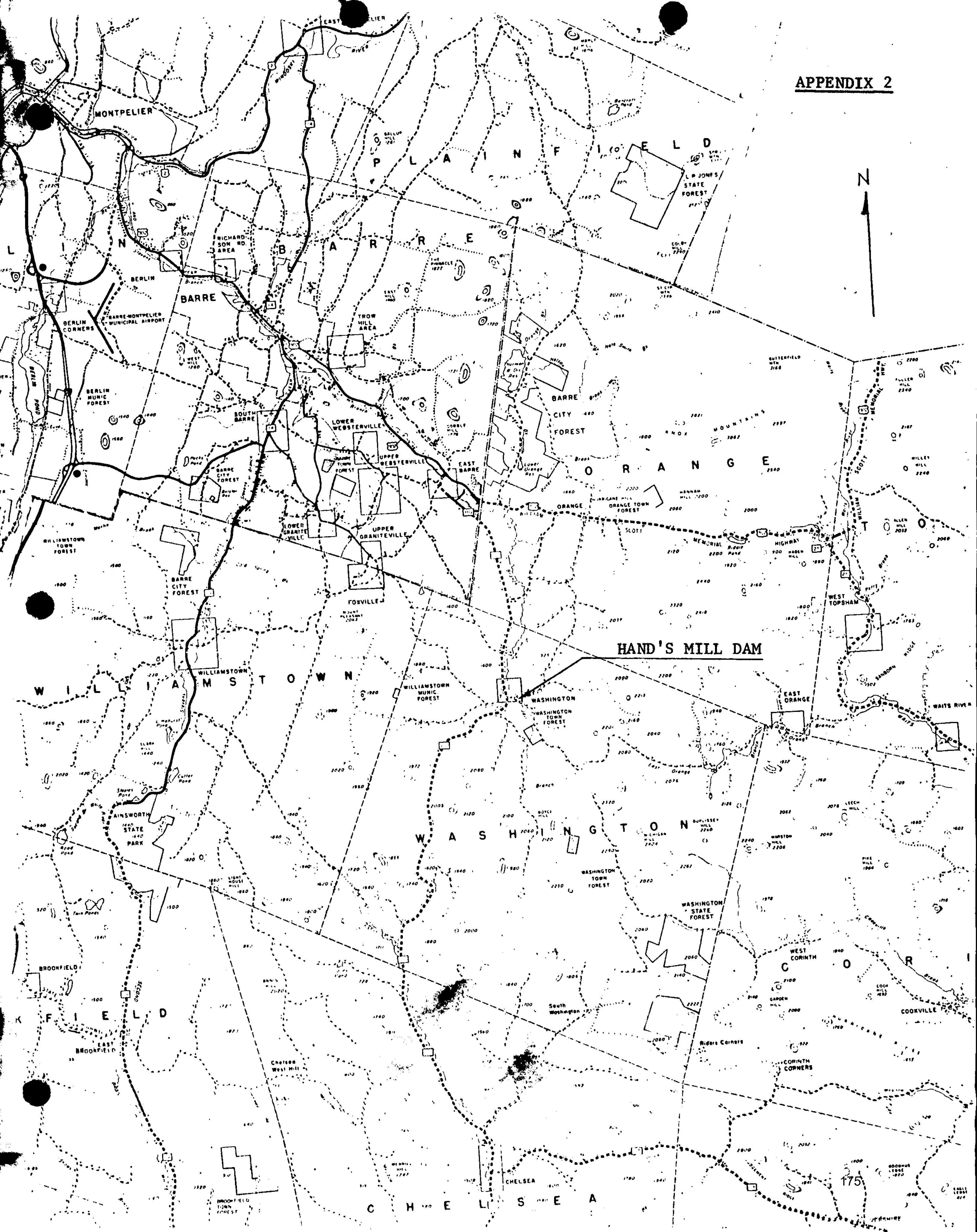
1) "Design Of Small Dams", Bureau of Reclamation, 1973.

IX. APPENDICES

1) Watershed Map.
2) Location Map.
3) Photographs.
4) Plans.


APPENDIX 1
N
HAND'S MILL DAM
WATERSHED BOUNDARY
Lower Websterville
East Barre
Millstone Hill
Websterville
Graniteville
Upper Graniteville
Foxville
Quarry Sch
WASHINGTON CO
ORANGE CO
Mount Pleasant
Lower Orange Res
Hurricane Hill
Hannah Hill
Orange
HIGHWAY
MEMORIAL
East Barre Dam
Lyme Emery Hill
The Notch
Washington
Maple Hill Cem
Cherry Cem
Washington Heights
W A S H I N G T O N
W I L L I A M S T O W N
Boyce Hill
Bohoron Cem
Michigan Hill
Duplissey Hill
Duplissey Swamp
Fish Cem
Hart Hollow
First Branch
Jones Pond
WASHINGTON STATE FOREST
South Washington
Garden Hill
Knox

APPENDIX 2


HAND'S MILL DAM
N
MONTPELIER
BARRE
P L A I N F I E L D
B A R R E
O R A N G E
W I L L I A M S T O W N
W A S H I N G T O N
C H E L S E A
WASHINGTON
EAST ORANGE
WEST TOPSHAM
SOUTH BARRE
EAST BARRE
FOXVILLE
WILLIAMSTOWN
BERLIN
BARRE-MONTPELIER MUNICIPAL AIRPORT
BERLIN CORNERS
WEST CORINTH
COOKVILLE
CORINTH CORNERS
EAST BROOKFIELD
BROOKFIELD
AINSWORTH STATE PARK
WASHINGTON STATE FOREST
BARRE CITY FOREST
CHELSEA

HAND'S MILL DAM

Looking across spillway toward east embankment

Upstream face of west embankment

Downstream face of spillway

The undersigned representatives of the U.S. Army Corps of Engineers, New England Division visually inspected the ________________Dam on ____________________1973 between the hours of _______, and _________. On the basis of visual observations, the following comments are made:

____

____

____

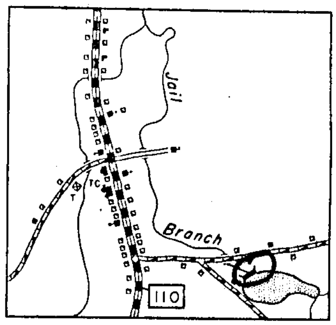
CF:
(Town Official):
Vt. Water Resources Board
Coordinator, COE
Dam Inspection Team
Mr. E. P. Gould

Location: Town of ________________, County of _____________, State of Vermont
Stream:
Map Coords.:
Other:

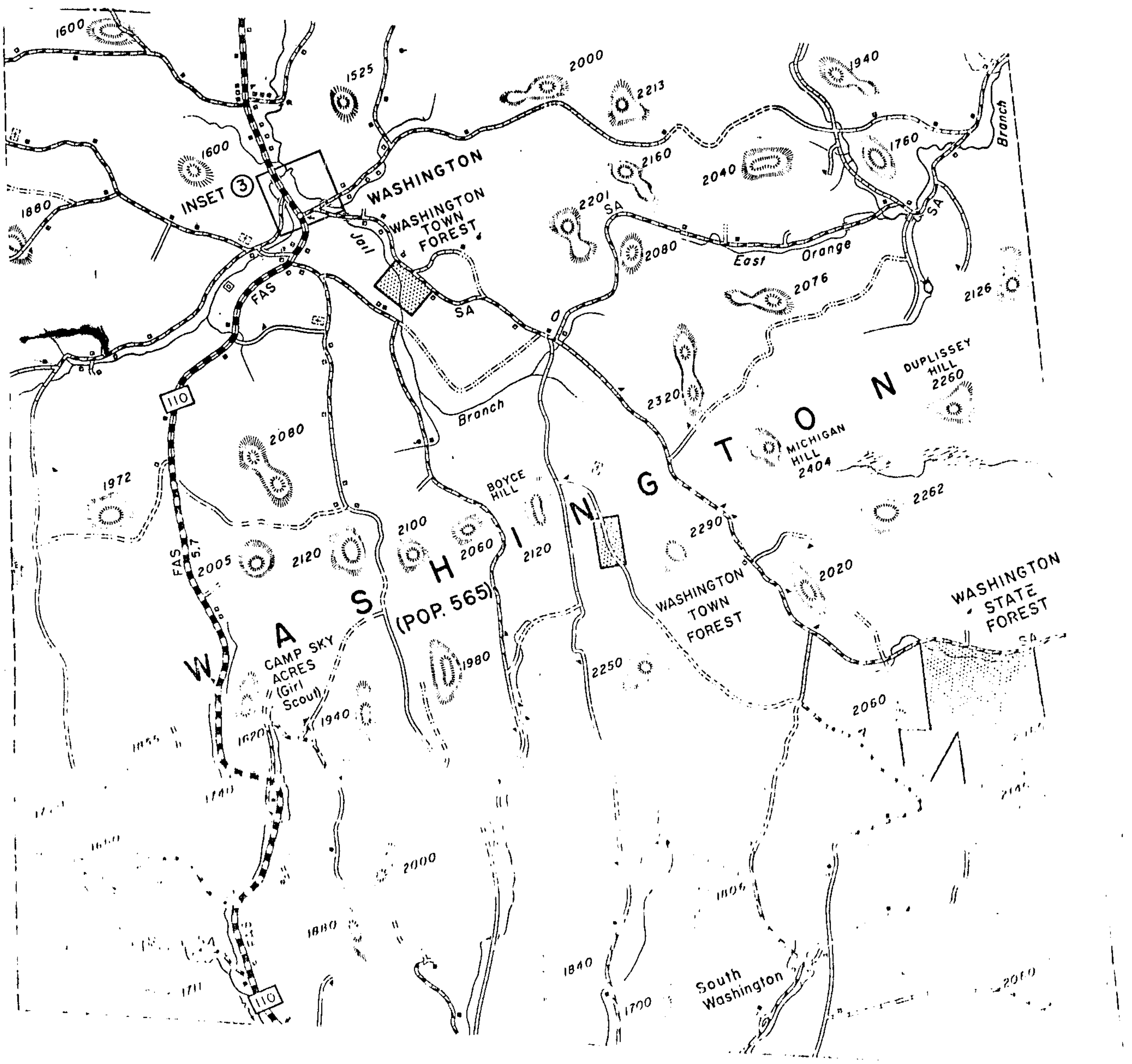
Owner:
Function of Dam:

JULY 17, 1973

Photos taken during damaged survey inspection by DWR & COE following 1973 flood.



INSET (3)
WASHINGTON



Hand's Mill Dam

Washington

6-19-72

Warm
Overcast

Δ Don Spies
N J. Jim Hun[illegible]
Ø J. Jim Thom[illegible]s[illegible]

6-20-72

Warm
Overcast

Δ DHS
N JH
Ø JT

COPY

DIETZGEN NO.

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∠	Vert. ∠
	(BS)	(H.I.)			
BM #1	1.50	101.50			
BM #1	1.50	0.53	53	39°-24'	-
1	3.00	0.69	69	18°-5'	-
2	3.18	0.61	61	2°-14'	-
3	7.07	0.60	60	353°-48'	-
4	4.56	0.33	33	15°-21.5'	-
5	4.57	0.32	32	14°-56'	-
6	7.72	0.39	39	348°-46'	-
7	4.97	0.22	22	348°-46'	-
8	5.41	0.19	19	320°-33'	-
9	7.50	0.22	22	320°-33'	-
10	4.65	0.07	7	320°-33'	-
11	4.99	0.13	13	292°-48'	-
12	5.17	0.27	27	271°-8'	-
13	5.47	0.28	28	283°-43'	-
14	7.43	0.32	32	289°-43'	-
15	7.68	0.35	35	289°-43'	-
16	5.60	0.32	32	281°-0'	-
17	7.22	0.38	38	281°-0'	-
18	7.71	0.42	42	281°-0'	-
19	5.35	0.34	34	273°-10'	-
20	7.74	0.48	48	273°-10'	-
21	5.54	0.43	43	263°-13'	-

Elev. 0° 0' = S 21° 30' E [illegible]

100.00	X chiseled in rock outcrop on east side of road
100.00	
98.5[illegible]	1 edge of road
98.32	2 edge of road
94.[illegible]3	3 bottom of bank
96.9[illegible]	4 edge of [illegible]
96.93	5 top of bank
93.78	6 bottom of bank
[illegible]	7 top of bank
96.0[illegible]	8 top of bank
94.00	9 edge of water
96.[illegible]	10 ℄ of dam
96.[illegible]	11 ℄ of dam
[illegible]	12 ℄ of dam
96.03	13 top of bank
9[illegible].0[illegible]	14 bottom of bank
93.9[illegible]	15 edge of water
95.[illegible]0	16 top of bank
94.28	17 bottom of bank
93.79	18 edge of water
96.15	19 top of bank
93.76	20 edge of water
95.36	21 top of bank

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∠	Vert. ∠
22	9.06	0.52	52	263°-13'	-
23	5.98	0.48	48	261°-0'	-
24	6.43	0.53	53	257°-24'	-
25	6.04	0.47	47	257°-24'	-
26	6.12	0.36	36	259°-36'	-
27	5.56	0.33	33	259°-36'	-
28	8.26	0.33	33	251°-5'	-
29	5.92	0.14	14	252°-0'	-
30	5.10	0.06	6	249°-33'	-
31	5.53	0.06	6	125°-0'	-
32	6.39	0.13	13	126°-53'	-
33	7.92	0.29	29	145°-11'	-
34	8.05	0.31	31	141°-32'	-
35	7.90	0.45	45	116°-59'	-
36	5.05	0.10	10	30°-30'	-
37	8.23	0.12	12	208°-52'	-
38	10.78	0.18	18	176°-8'	-
39	12.02	0.24	24	206°-36'	-
40	12.47	0.29	29	203°-41'	-
41	11.55	0.26	26	187°-0'	-
42	9.16	0.23	23	154°-33'	-
43	7.53	0.13	13	151°-49'	-
44	9.68	0.23	23	245°-47'	-
45	10.49	0.26	26	229°-13'	-

Elev. 0° 0' = mag S 21° 30' E

Elev.		
[illegible]	22	[illegible]
95.[illegible]	23	top of bank
95.07	24	top of bank
95.[illegible]	25	top of bank
[illegible]	26	top of bank
[illegible]	27	top of bank
93.24	28	bank
95.5?	29	top of bank
96.10	30	top of bank
95.97	31	top of bank
[illegible]	32	top of bank
[illegible]	33	top of bank
93.45	34	edge of road
93.6?	35	edge of road
96.45	36	℄ of dam
93.2?	37	bank
90.22	38	bottom of bank
[illegible]	39	bottom of bank
89.03	40	bank
89.95	41	bank
92.34	42	bank
[illegible]	43	bank
[illegible]	44	bank
[illegible]	45	bank

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∡	Vert. ∡
	(BS)	(H.I.)			
BM #1	1.09	101.09			
BM #1	1.09	0.88	88	58°-3'	-
1	4.61	0.40	40	81°-42'	-
2	9.43	0.07	7	197°-38'	-
3	7.55	0.12	12	135°-3'	-
4	8.64	0.15	15	1[illegible]°-15'	-
5	9.70	0.29	29	207°-23'	-
6	6.38	0.42	42	200°-48'	-
~~7~~	~~14.00~~	~~0.19~~		~~162°-[illegible]'~~	~~[illegible]~~
8	12.63	0.33	32	202°-29'	-8°-17'
9	14.51	0.19	19	16[illegible]°-34'	2°-39'
10	8.39	0.17	17	246°-36'	-
11	8.95	0.14	14	228°-35'	-
12	8.88	0.27	27	234°-26'	-
13	8.68	0.22	22	251°-8'	-
14	11.44	0.24	24	250°-47'	-
15	7.13	0.26	26	276°-15'	-
16	8.73	0.22	22	272°-0'	-
17	10.93	0.25	25	269°-25'	-
18	6.99	0.51	51	278°-0'	-
19	6.99	0.88	88	278°-44'	-
20	6.98	0.90	90	280°-14'	-
21	4.84	0.92	92	280°-[illegible]'	-

Elev. 0°-0' = mag S 21°-30'E

100.00

100.00

[illegible]	1	1st setup [illegible]
91.66	2	bottom of bank
93.59	3	top [illegible] wall
92.45	4	top stone wall
[illegible]	5	[illegible]
94.71	6	[illegible]
	7	~~bottom [illegible]~~
83.75	8	bottom corner
85.70	9	bottom [illegible] wall
92.[illegible]	10	bottom of bank
92.14	11	bottom of bank
92.21	12	end of bank
92.[illegible]	13	end of bank
[illegible]	14	top concrete, [illegible] side edge (downstream)
93.96	15	top concrete, outside edge (downstream)
92.36	16	top concrete, outside edge (downstream)
90.12	17	top concrete, outside edge (downstream)
91.20	18	top ~~spillway~~, outside edge (downstream)
[illegible]	19	top spillway, outside edge (downstream)
[illegible]	20	top spillway, outside edge (downstream)
91.25	21	top of ~~[illegible]~~ abutment

Note: width top of spillway = 2.35'

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∡	Vert. ∡
22	14.00	0.88	87	27[illegible]° 4'	4°-57'
23	14.00	0.76	75	274°-31'	5°-28'
24	14.03	0.50	49	274°-6'	9°-28'
25	14.50	0.26	24	260°-10'	16°-41'
	(B.S.)	(H.I.)			
BM #1	2.41	102.41			
BM #1	2.41	1.87	187	82°-46'	-
1	5.92	1.54	154	96°-32'	-
2	6.25	0.19	19	113°-58'	-
3	5.41	0.16	16	113°-58'	-
4	7.85	0.16	16	99°-22'	-
5	8.52	0.17	17	89°-40'	-
6	7.18	0.15	15	137°-36'	-
7	10.66	(0.24) 0.34	(24) 34	150°-9'	-
8	13.38	0.26	26	156°-6'	-
9	9.19	0.08	8	30°-36'	-
10	6.13	0.09	9	193°-6'	-
11	8.42	0.15	15	196°-47'	-
12	14.40	0.16	16	196°-47'	-
13	4.68	0.07	7	281°-40'	-
14	9.38	0.25	25	308°-43'	-
15	4.90	0.23	23	289°-17'	-
16	5.92	0.25	25	274°-6'	-

0° 0' = mag S 21° 30' E

80.89	22 [illegible] spillway wall
79.52	23 bottom spillway wall
78.95	24 bottom spillway wall
79.44	25 bottom spillway wall
100.00	
100.00	
96.49	1 1st sight point
96.14	2 top abutment
[illegible]	3 ℄ dam
[illegible]	4 bottom of bank
93.[illegible]	5 edge of water
[illegible]	6 bank
[illegible]	7 top stone wall
89.03	8 bottom stone wall, [illegible]
93.22	9 edge of water
96.25	10 bank
[illegible]	11 top stone wall
[illegible]	12 bottom stone wall
92.73	13 ℄ of dam
93.03	14 edge of water
[illegible]	15 ℄ of dam
96.49	16 bank

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∡	Vert. ∡
17	14.81	0.29	29	166°-0'	-
18	14.58	0.22	22	201°-0'	-
		6-20-72			
	(B.S.)	(H.I.)			
BM #1	2.49	102.49			
BM #1	2.49	1.88	188	61°-18'	-
1	6.92	1.09	109	103°-49'	-
2	8.23	1.01	101	98°-9'	-
BM #2	6.32	0.19	19	89°-51'	-
	(B.S.)	(H.I.)			
BM #2	7.23	103.40			
BM #2	7.23	0.44	44	89°-36'	-
1	5.19	0.24	24	90°-5[illegible]'	-
2	7.55	0.11	11	161°-31'	-
3	12.79	0.11	11	167° [illegible]	-
4	8.66	0.28	28	286°-22'	-
5	4.60	0.27	27	272°-26	-
6	7.40	0.28	28	254°-56'	-
7	11.65	0.29	29	239°-37'	-
8	13.23	0.33	33	229-24	-

Elev. 0° 0' = mag S21° 30' E

87.14	17	in field
87.88	18	in field

0° 0' = mag S

100.00		
100.00		
100.00		
95.57	1	[illegible]
94.26	2	[illegible]
96.17		top [illegible] of earth fi[illegible]
96.17		
96.17		
98.21	1	3rd s[illegible] point
95.85	2	top stone wall
90.61	3	bottom stone wall
94.74	4	edge of [illegible]
98.80	5	℄ of dam
96.00	6	bank
91.75	7	bottom of bank
90.71	8	in field

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∡	Vert. ∡
9	14.52	0.24	24	168° - 14'	—
10	7.35	0.17	17	24[illegible]	—
11	9.98	0.1[illegible]	17	24[illegible]° 18'	—
	(B.S.)	(H.I.)			
~~BM #2~~	~~6.59~~				
~~BM #2~~	~~6.59~~	~~1.18~~		~~93° 22'~~	—
	(B.S.)	(H.I.)			
BM #2	6.27	102.44			
BM #2	6.27	1.18	118	93° 25'	—
1	4.96	0.74	74	95° - 23'	—
2	9.44	0.31	31	86° - 13'	—
3	4.92	0.29	29	100° - 29'	—
4	8.21	0.28	28	113° - 53'	—
5	11.91	0.30	30	127° 49'	—
6	12.79	0.32	32	135° 20'	—
7	8.69	0.10	10	37° 29'	—
8	8.26	0.08	8	46° - 28'	—
9	4.83	0.08	8	100° - 58'	—
10	7.50	0.07	7	155° - 29'	—
11	10.95	0.11	11	166° 7'	—
12	11.69	0.17	17	170° - 14'	—

Elev. 0° 0' - Mag. S

Elev.	Pt.	Description
88.88	9	in field
96.05	10	end of wall top
93.12	[illegible]	end of wall bottom
96.17		
96.17		
97.48	1	4th setup point
9[illegible].00	2	edge of water
97.52	3	℄ of dam
94.[illegible]5	4	bank
90.58	5	bottom of bank
89.[illegible]5	6	in field
[illegible]3.75	7	edge of water
94.18	8	bottom of bank
97.61	9	℄ of dam
94.[illegible]	10	bank
91.49	11	bottom of bank
90.75	12	in field

Sta.	Rod Reading	Stadia Interval	Distance	Horiz. ∡	Vert. ∡
13	8.68	0.25	25	327°-32'	—
14	8.40	0.20	20	302°-1[illegible]'	—
15	4.10	0.18	18	274°-44'	—
16	6.13	0.20	20	257°-45'	—
17	9.44	0.23	23	242°-3'	—
18	9.65	0.27	27	233°-4'	—
19	8.70	0.41	41	292°-54'	—
20	7.38	0.39	39	283°-31'	—
21	4.10	0.40	40	271°-27'	—
22	6.36	0.42	42	255°-0'	—
23	7.87	0.42	42	247°-24'	—
24	4.36	0.49	49	272°-37'	—
25	6.48	0.63	63	274°-31'	—
26	8.73	0.43	43	235°-11'	—
27	5.49	0.64	64	24[illegible]°-3[illegible]'	—
28	8.22	0.67	67	292°-44'	—
BM#1	2.46	2.76	276	72°-28'	—

elev		0° 0' mag S
93.76	13	edge of water
94.04	14	bottom of bank
90.34	15	℄ of dam
96.31	16	bank
93.00	17	bottom of bank
92.99	18	in field
93.74	19	edge of water
95.46	20	bottom of bank
98.31	21	℄ of dam
96.08	22	bank
94.57	23	bottom of bank
99.08	24	℄ of dam
95.96	25	℄ of dam
93.71	26	in field
96.95	27	in field
94.22	28	in mud flat
99.98		

Hand's Mill Dam | Spillway Capacity | D. H. Spies | 1/2
Washington | | |

~~$Q = CLH^{3/2}$ C = 3.50~~

~~$= 3.50(64)(2.0)^{3/2}$ L = 64'~~

~~$= 224(2.83)$ H = 2.0'~~

~~$= 634$ cfs.~~

revised
5/16/95
DHS

Drainage Area

1st	2nd	3rd	4th	Average
47.22	53.87	60.41	67.04	6.75
40.47	47.22	53.87	60.41	6.65
6.75	6.65	6.54	6.63	6.54
				6.63
				4 | 26.57
				6.64 sq. in.

1 sq. in = 0.973 sq. mi.

D.A. = 6.64 (0.973) = 6.45 sq. mi.


(BARRE)
WILLIAMSTOWN
Mount Pleasant
Washington Heights
WASHINGTON
Washington
Hart Hollow
South Washington
Boyce Hill
Michigan Hill
Duplissey Hill
Duplissey Swamp
Lynde Emery Hill
The Notch
WASHINGTON STATE FOREST
Garden Hill
Marston Hill
West Corinth
East Orange
Leech Hill
Pike Hill
Cook Hill
Sanborn

Hand's Mill Dam

Don Spies
May 16, 1975

Hydrology

Flows at Hand's Mill Dam will be determined from the adjacent East Orange Brook Watershed. The fifty-year and one hundred year peak flows were calaulated for East Orange and transposed to Hand's Mill using the following formula:

$$Q_{at\ site} = Q_{at\ gage}\left(\frac{\text{Drainage Area at Site}}{\text{Drainage Area at Gage}}\right)$$

	Q_{50}	Q_{100}
E. Orange Brook	790	914
Hand's Mill Dam	618	715

Hydraulic

The eroded section will be treated as a broad crested weir with a bottom width of eight feet, crest elevation two lower than the spillway and one end contraction. The spillway will be considered as a sharp crested weir with a crest length of 68' and one end contraction.

flow through eroded area:

$$Q_1 = 2.85\, L_1 \left(H_1 + \frac{V_{a1}^2}{2g}\right)^{3/2}$$

where $L_1 = 8 - 0.1\left(H_1 + \frac{V_{a1}^2}{2g}\right)$

flow over spillway

$$Q_2 = 3.30\, L_2 \left(H_2 + \frac{V_{a2}^2}{2g}\right)^{3/2}$$

where $L_2 = 68 - 0.1\left(H_2 + \frac{V_{a2}^2}{2g}\right)$

and $H_2 = H_1 - 2.0$

Table of Stage versus Discharge

H_1	Q_1	Q_2	Total
0	0	0	0
1	30	0	30
2	84	0	84
3	148	259	407
4	221	804	1025

Assuming a straight line relation for discharge between $H_1 = 3'$ and $H_1 = 4'$ then the stage for the 50-year flow is:

$$H_1 = 3 + \frac{618 - 407}{1025 - 407} = 3 + \frac{211}{618} = 3.34' \quad \text{and}$$

for the 100-year flow is:

$$H_1 = 3 + \frac{715 - 407}{618} = 3 + \frac{308}{618} = 3.50'$$

4-23-75

Hough's Mill Dam

lower bridge conc. ~~to~~ wide concrete deck on

steel ~~beams~~ girders

16' wide x 8.5' high.

clayey material placed on [illegible]

of dam. w/L ~ 1' below top spillway

water going around north end

face of spillway badly deteriorated

sill level practically at top spillway.

Setup # 2

Sta. 8

H.I. = 101.09 ∢ = 8° 17'

R = 0.33 Rod Reading = 12.63

From Table II, Elementary Surveying

h = 97.92 ; v = 14.26

H = 97.92 (0.33) = 32'

V = 14.26 (0.33) = 4.71'

Elev. = 101.09 - 12.63 - 4.71

= 101.09 - 17.34

= 83.75

Sta. 9

H.I. = 101.09 ∢ = 2° 39'

R = 0.19 Rod Reading = 14.51

From Table II, Elementary Surveying

h = 99.78 ; v = 4.62

H = 99.78 (0.19) = 19'

V = 4.62 (0.19) = 0.88

Elev. = 101.09 - 14.51 - 0.88

= 101.09 - 15.39

= 85.70

Sta. 22

H.I. = 101.09 ∡ = 4° 57'

R = 0.88 Rod Reading = 14.00

From Table II, <u>Elementary</u> <u>Surveying</u>

h = 99.25 ; v = 8.60

H = 99.25 (0.88) = 87'

V = 8.60 (0.88) = 7.57'

Elev. = 101.09 − 14.00 − 7.57

= 101.09 − 21.57

= 79.52

Sta. 23

H.I. = 101.09 ∡ = 5° 28'

R = 0.76 Rod Reading = 14.00

From Table II, <u>Elementary</u> <u>Surveying</u>

h = 99.09 ; v = 9.48

H = 99.09 (0.76) = 75'

V = 9.48 (0.76) = 7.20'

Elev. = 101.09 − 14.00 − 7.20

= 101.09 − 21.20

= 80.89

Sta. 24

H. I. = 101.09   ∢ = 9° 28'

R = 0.50   Rod Reading = 14.03

From Table II, Elementary Surveying

h = 97.29 ; v = 16.22

H = 97.29 (0.50) = 49'

V = 16.22 (0.50) = 8.11'

Elev. = 101.09 - 14.03 - 8.11

= 101.09 - 22.14

= 78.95

Sta. 25

H. I. = 101.09   ∢ 16° - 41'

R = 0.26   Rod Reading = 14.50

From Table II, Elementary Surveying

h = 91.75 ; V = 27.50

H = 91.75 (0.26) = 24'

V = 27.50 (0.26) = 7.15'

Elev. = 101.09 - 14.50 - 7.15

= 101.09 - 21.65

= 79.44

Times-Argus
9-21-72

GUS. BARRE-MONT

Water Resources Approves Of Washington Pond

WASHINGTON — The Department of Water Resources has found the water quality of the Hand's Mill Pond to be well within the limit suitable for recreation purposes. The pond has been considered by the Washington Planning Commission as a possible recreation site for the town.

John Malter, an official of Water Resources Department, told members about the survey findings in their meeting at the Town Clerk's Office Wednesday night. He and Donald Spies, also from the department, discussed the site with members.

Spies, who took a survey of the dam, consisting of a concrete spillway and land banks said another spring like the last could cause a slight rupture of the dam. Although he said the danger is not great in the event of the rupture, the cellar of an adjacent home could be flooded. He said trees and shrub on the banks also serve to weaken the structure because they attract and hold water. A report on the structure will be available in the winter and Spies said there is nothing binding about the findings.

Members and officials discussed possible methods of eliminating the hazard which included the possibility of lowering the dam and reducing the pond level.

George Plumb offered to evaluate the pond as a recreation site and he will inspect the site with Paul Vermette, selectman.

Members also approved the extension of a power line requested by the Washington Electric Cooperative of East Montpelier. The extension received earlier approval from town selectmen and the Central Vermont Regional Planning Commission. The line will run adja- [illegible]

DEPARTMENT OF WATER RESOURCES

MEMORANDUM

ROUTING		
GENERAL		
TO	NOTED	DATE
JAM		
RJW		
JEC		
SUSPEND TO		
FILE Hands Mill Dam		

TO: Fred Kent, Chief, Water Resources Laboratory

FROM: John Malter

RE:

DATE: August 14, 1972

The Town of Washington is currently assessing potential water-based recreation sites. The impoundment behind the Hands Mill Dam in Washington is of major interest. I would like three water samples from this site analyzed for total and fecal coliform. This should give us a handle as to whether the water quality at this site is suitable for a water-based recreation area in this town. George Plumb from the Division of Recreation is obtaining the samples.

Thank you for your assistance.

ROUTING		
GENERAL		
TO	NOTED	DATE
JEC		
DHS	DHS	5-17-72
SUSPEND TO		
FILE ✓		

May 17, 1972

Board of Selectmen
Town of Washington
Washington, Vermont 05675

Dear Sir:

The Vermont Water Resources Board is charged with the authority to investigate certain dams under the jurisdiction of the Board. The investigations are primarily to assure the public that the dams are in a safe state of upkeep and repair, and are also adequate to pass the flows of water which may reasonably be expected. This does not in any way relieve the owners of the structure from their usual responsibility, however.

In order to obtain factual data regarding the structure, the Department of Water Resources will be making an investigation which will include an inspection of the structure (dam), an analysis of the capacity and adequacy of the spillway, and other related data, to be submitted in a report form.

Several investigations will be conducted between June 1, 1972 and September 1, 1972. Mand's Mill Dam has been selected for such an investigation. The report and conclusions of the investigations will be available to the owners and other interested parties at the office of the Department of Water Resources. If you have any questions regarding the procedure or information, please feel free to contact this office. Your cooperation with our agents will be greatly appreciated.

Sincerely yours,

John E. Cerutti, Director
Management & Engineering Division

JEC/DHS/kmp

DEPARTMENT OF WATER RESOURCES
MONTPELIER, VERMONT

OFFICE MEMORANDUM

ROUTING		
GENERAL		
TO	NOTED	DATE
TEC		
DHS	DHS	
SUSPEND TO		
FILE Green Dam and Hand's Mill Dam ✓		

TO: File

FROM: Donald H. Spies

SUBJECT: Meeting of Board of Selectmen, Washington, Vermont

DATE: May 21, 1971

On May 19, 1970, this writer attended the subject meeting in order to keep informed of the situation regarding the town road at the Green Dam site and also, to inform the Selectmen of the situation at the Hand's Mill Dam. Mr. Raymond Green and a neighbor, Mr. Harold Heinzelman, were present and gave testimony on their own behalf in favor of having the road removed from the town lists and changing it to a trail. The Selectmen were in favor of abandoning the road, however, they were hesitant to do so because they were not sure of the legalities involved. The end result, so far as the Department is concerned, is that the Town will attempt to have the road removed from their list, and if this is not possible, Mr. Green will have the road relocated around his impoundment. The Selectmen are to send a letter to this writer stating their views and the final decision reached at the meeting.

After the above discussion, this writer informed the Selectmen of the erosion of the west abutment of Hand's Mill Dam. It was pointed out to the Selectmen that immediate action was not absolutely essential, but that they should consider some sort of remedial action. They stated that the matter would be taken into consideration.

April 12, 1953

Inspection by John E. Cerutti
Dept. of Water Resources

April 2 1953

Washington Dam - jec

North wing wall has fallen down and water has started to erode the earth embankment behind it.

Earth embankment is 3' above spillway section and appears quite stable.

Section of dam south of spillway appears to be in worse condition. Water is leaking thru the south abut. of spillway. Old retaining wall is badly broken up & water going thru it. Water is leaking thru part of dam that forms foundation of mill.

There is about a 30' section of dam to south of the mill. This section has been overtopped and the downstream slope is eroded. Top of this section is about 2' above spillway.

Although there may be a short apron at the bottom of the spillway the water appears to be quite deep and it is believed some erosion is taken place & may be working back under the spillway apron.

jec

STATE OF VERMONT
WATER CONSERVATION BOARD

MONTPELIER, VERMONT

REPORT ON HAND'S MILL DAM
IN WASHINGTON, VERMONT

A report is made herein on the weakened condition of a dam in the town of Washington, Vermont.

GENERAL

This dam is located on Jail Branch on the upstream edge of the Village of Washington. It is presently owned by Mr. Clarence H. Hand who acquired the property in 1947. The mechanical power feature of this development has been abandoned, its principle purpose now is for the storage of logs for the saw mill at the site.

For this dam the pondage is small being about 2 acres in surface area and a little over 500,000 cubic feet in volume. The drainage area is 6 square miles.

Layout of the dam

The dam, about 260 feet long, is made up of an earth embankment section flanking a heavy concrete spillway section. This spillway section is between 60 and 70 feet long and reaches a maximum depth of 22 feet above channel bottom.

In cross section, it indicates a flat crest 2 feet wide and 2 feet below the top of the dam, with both faces sloping outward about 3 on 1 on the downstream side and 1 on 1 on the upstream side. Rubble concrete end-walls retain the embankment. Also a short concrete apron 5 to 6 feet wide, is provided at the downstream toe. No flashboards are used on the crest.

Extending northward from the spillway is an earth embankment about 180 feet long and about 10 feet high at maximum section. It has an average top width of 8 feet and side slopes at a natural angle of repose. A short length of this embankment is retained on the downstream side by a stone wall.

To the south of the spillway is a short embankment section which also serves as part of the foundation for the saw mill. It is topped by a masonry wall, partly extended into the embankment. An abandoned intake and a sluicway exist at this end of the spillway.

Observations and comments

From an examination of the dam, made on May 23, 1950, the writer noted the physical condition of the dam as follows:

The dam is an old structure (probably over 45 years) in a somewhat abandoned stage. Originally, it has a timber spillway section, but this was destroyed in the November 1927 flood, and afterwards replaced by the present massive concrete section. This "newer" section is in the best condition. As indicated in Figure 1, it has a minor degree of surface scaling. Some scour of the soft foundation material underneath the apron has occurred, particularly along the north half, but its progress has not reached a stage where stability of the section might be seriously concerned.

The older, original masonry end sections, are badly broken up. In such a condition is the south abutment wall shown in Figure 2. This is the top portion which has partly failed and leaks considerably. The lower portion of the section is still in a sound condition.

Figure 3 shows the condition of the north abutment wall which also serves to retain the embankment. The poor quality concrete has been eroded away in time so that stability of the wall is in question. Not only has the base of this wall been decomposed but also some of the material behind it has been washed out. A deep hole, about 6 feet in diameter and 10 feet deep now exists. Here is a likely point of failure, much so if aggravated by high water.

The embankment section, in general, has settled and stabilized itself. It is uneven and overgrown with brush. Beavers have burrowed into the section and have caused small local cave-ins. Some seepage was detected. The nature of the material making up the embankment is not known.

A check on the probable maximum flood (in proportion to the November 1927 flood) indicates that a peak flow of 3600 c.f.s. is possible. Because of a limited discharge capacity, the dam would be overtopped with this size of flood. With this type of dam, overtopping would mean failure.

CONCLUSIONS

From a routine investigation the writer comes up with this dam which, in his opinion, is in a weakened condition. The impending failure of the dam would cause flooding in the vicinity. However, the extent of flood damage is limited because of the relatively small storage volume involved.

The dam needs immediate repairs to restore its stability. Consideration should also be given to improving the discharge capacity.

Stephen H. Haybrook

Stephen H. Haybrook
Hydraulic Engineer

July 6, 1950
Report # 141

Figure 1.-Spillway face and apron of the dam. The north embankment section continues in the background.

Figure 2.-Disintegrated condition of the south abutment wall.

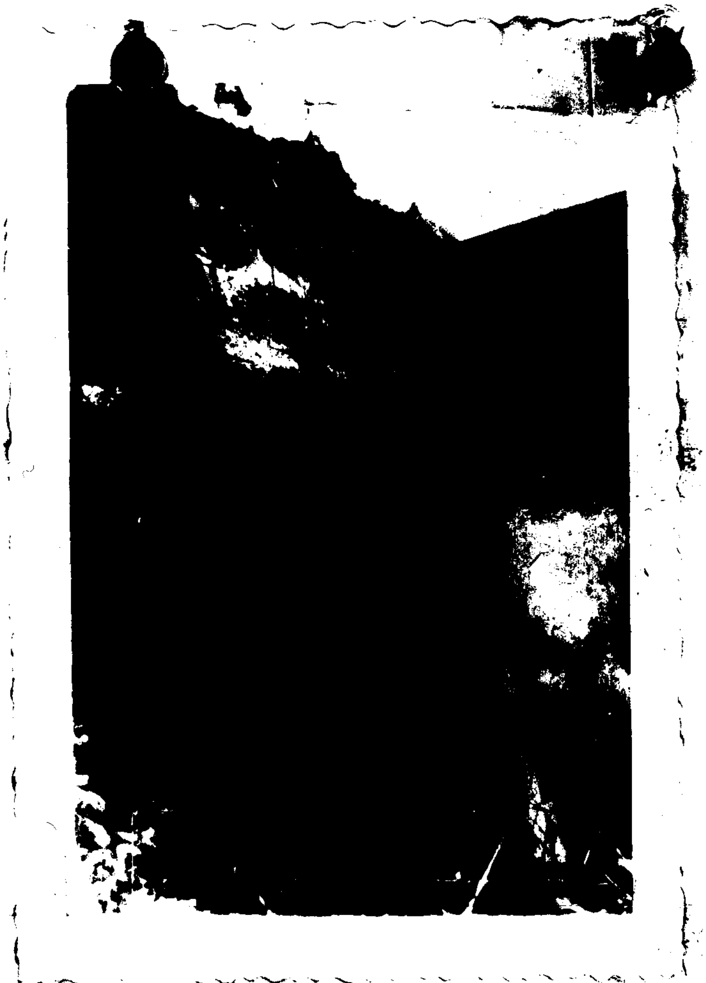


Figure 3.-A closeup of the north abutment wall. Note the scour through and under the section.

Attachment 4: Final 30% Designs

HANDS MILL DAM REMOVAL
AT JAIL BRANCH
TOWN OF WASHINGTON, VERMONT

PREPARED FOR:

WINOOSKI NATURAL RESOURCES
CONSERVATION DISTRICT

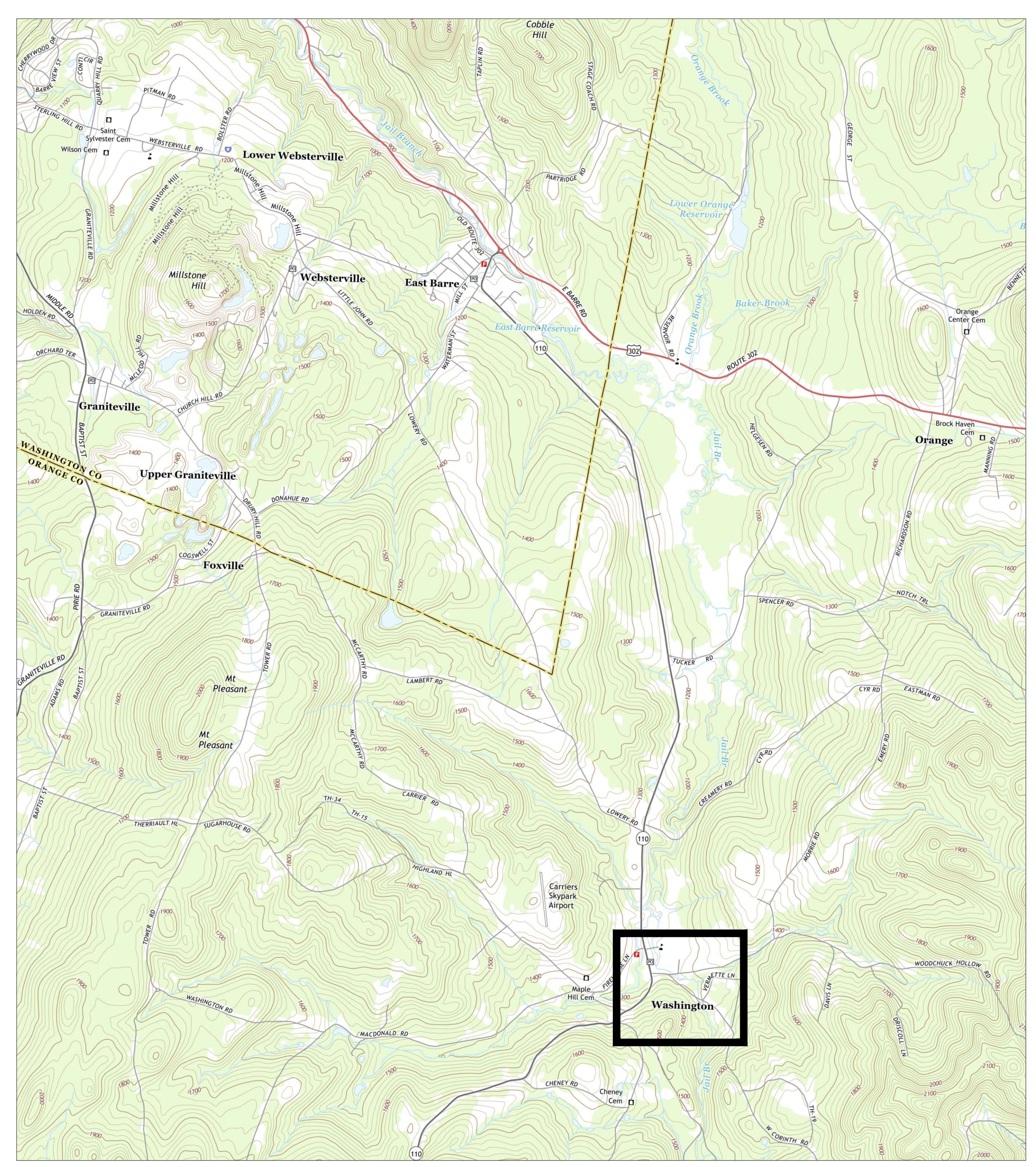
PREPARED BY:

STONE ENVIRONMENTAL, INC.

30% DESIGN
ISSUED: JANUARY, 2021

DRAWING INDEX:

SHEET	TITLE
1	COVER SHEET
2	SURVEY EXTENTS PLAN & LIMITS OF DISTURBANCE
3	EXISTING CONDITIONS PLAN
4	SITE ACCESS & MATERIAL REMOVAL PLAN
5	EXISTING DAM & DEMOLITION PLAN
6	CHANNEL RESTORATION PLAN
7	CHANNEL RESTORATION PROFILE & DETAILS



Project Vicinity
Scale: 1" = 4000'

Project Location
Scale: 1" = 400'

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS
DRAWN ON: 11/2/2020
DRAWN BY: GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

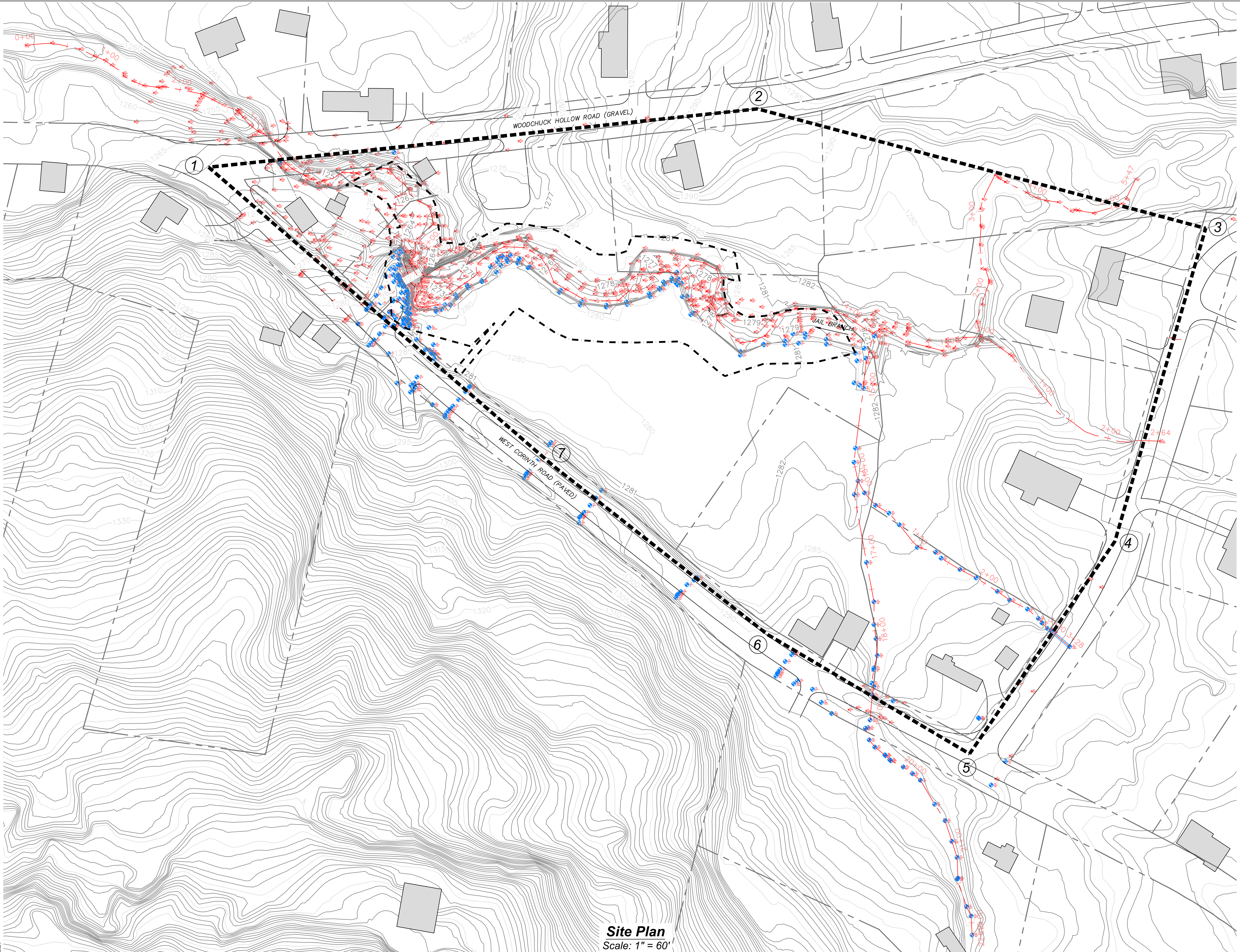
DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11X17

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

HANDS MILL DAM REMOVAL
AT JAIL BRANCH
COVER SHEET

WASHINGTON VERMONT

FIGURE NO. 1



Site Plan
Scale: 1" = 60'

Limits of Disturbance Point Table		
Point	Latitude	Longitude
1	44.105868	-72.430835
2	44.106068	-72.428349
3	44.105635	-72.426226
4	44.104637	-72.426656
5	44.103929	-72.427335
6	44.104311	-72.428325
7	44.104845	-72.429264

Legend

- 1280 — Major Contour
- 1275 — Minor Contour
- Parcel Boundaries
- Edge of Road
- Proposed Limits of Disturbance
- (1) Proposed Limits of Disturbance Point

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS
DRAWN ON: 9/4/2020
DRAWN BY: BAM/GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE
DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17
60 0 60 120 240 ft
12 0 30 60 m
1 inch = 60 feet
(1 : 720)

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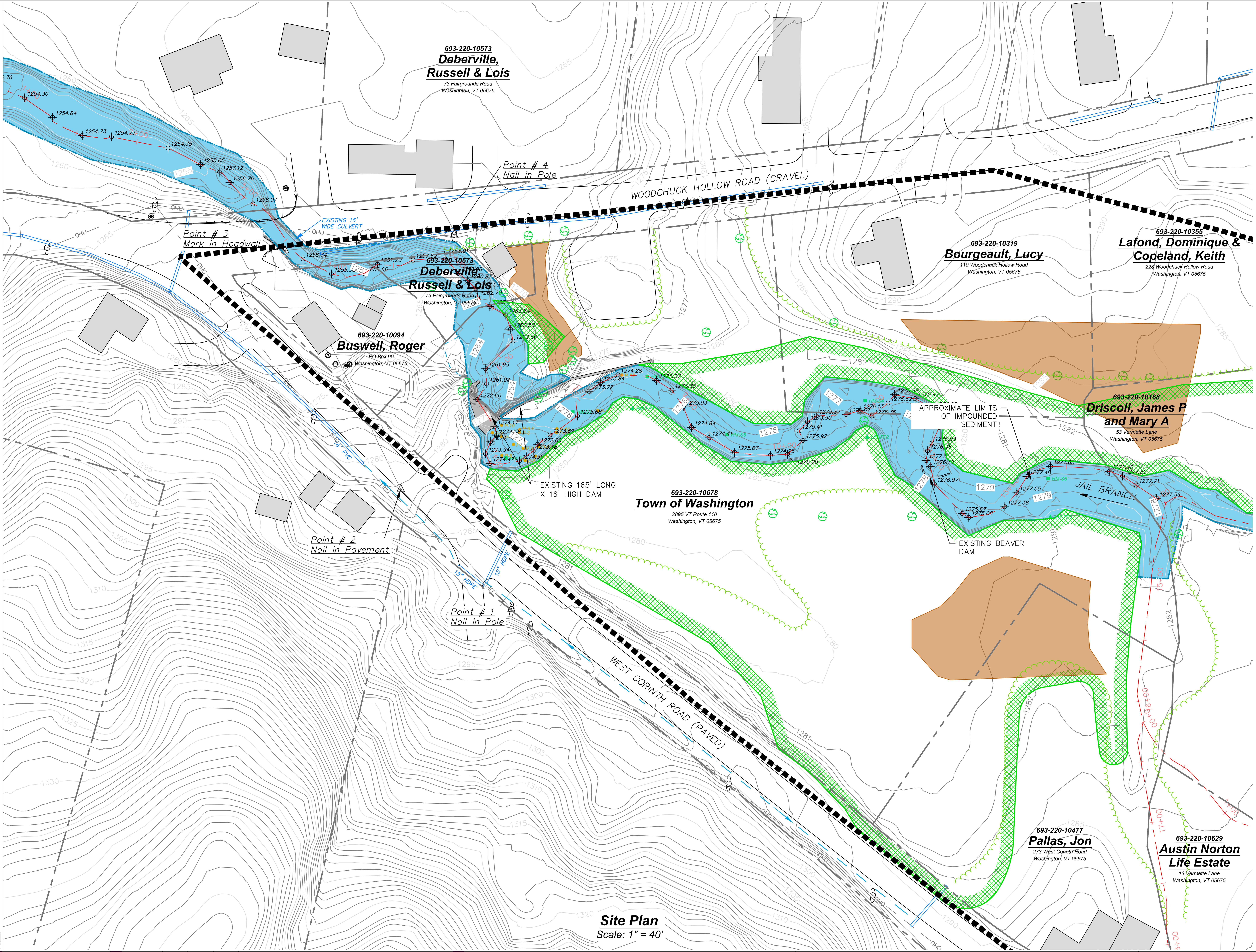
HANDS MILL DAM REMOVAL
AT JAIL BRANCH
SURVEY EXTENTS PLAN AND LIMITS OF DISTURBANCE
WASHINGTON VERMONT

FIGURE NO.
2



Site Plan

Scale: 1" = 40'

Point Table				
Point	Description	Northing	Easting	Elevation
1	Nail in Pole	585021.9815'	1658864.2012'	1286.60'
2	Nail in Pavement	585119.0352'	1658774.6143'	1281.21'
3	Mark in Headwall	585312.4075'	1658681.0191'	1266.12'
4	Nail in Pole	585325.0713'	1658817.8600'	1268.96'

Legend

- Survey Control Point
- 1280 Major Contour
- 1275 Minor Contour
- Parcel Boundaries
- Edge of Road
- Guard Rail
- OHU Overhead Utility
- Vegetation Line
- Tree
- River Top of Bank (OHW)
- Existing Wetland (See Note 6)
- 1277.38 Thalweg Spot Elevations
- Utility Pole
- Manhole
- Sanitary Manhole or Septic Cover
- Well
- Vent
- Hydrant
- Water Valve
- 36" CMP Stormwater Pipe
- Stormwater Swale
- P-6 Sediment Probing Location
- HM-S1 Sediment Sampling Location
- HM-FP1 Floodplain Boring Location
- Archaeological Sensitive Areas
- Proposed Limits of Disturbance

Survey Notes:

1. The horizontal datum refers to Vermont State Plane Grid NAD83. The vertical datum is arbitrary. Contour interval = 1 foot.
2. Contours were created using two sources of data: 1) a topographic survey of the channel bed, banks, floodplains and structural features collected by Stone Environmental (see Note 3 below), and 2) LiDAR data of upland features, obtained from the Vermont Center for Geographic Information.
3. Site survey was performed on August 11 and 12, 2020 by Gabe Bolin, PE, of Stone Environmental, Inc. using a Stonex S900 GPS base and rover.
4. Survey data provided in these plans do not represent a boundary survey.
5. Utility locations shown on this plan should be considered approximate. Contractor is required to verify utility locations prior to work.
6. Wetland boundaries shown on this plan were delineated by Karina Dailey of the Vermont Natural Resources Council (VNRC) on October 8, 2020. The wetland delineation was performed in accordance with the U.S. Army Corps of Engineers Wetland Delineation Manual, Technical Report Y-87-1, January 1987, Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), January 2012, and Section 3.2 of the Vermont Wetland Rules.
7. Archaeological sensitive areas identified by the University of Vermont Consulting Archaeology Program, October, 2020.

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS

DRAWN ON: 9/4/2020
DRAWN BY: BAM/GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

1 inch = 40 feet
(1 : 480)

STONE ENVIRONMENTAL
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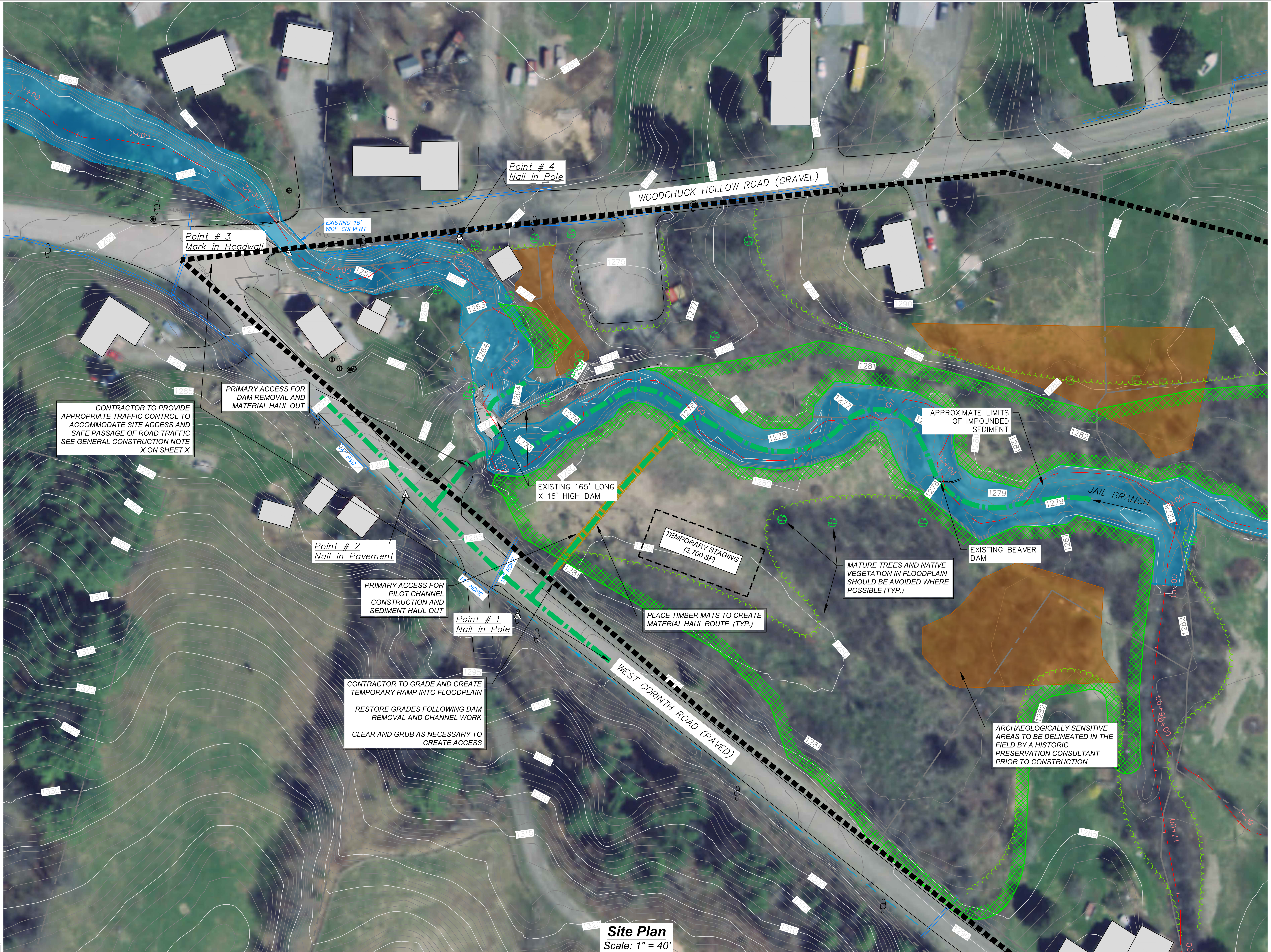
802.229.4541 / info@stone-env.com / www.stone-env.com

HANDS MILL DAM REMOVAL
AT JAIL BRANCH
EXISTING CONDITIONS PLAN

WASHINGTON VERMONT

FIGURE NO. 3



Site Plan
Scale: 1" = 40'

Legend

- Survey Control Point
- Major Contour
- Minor Contour
- Parcel Boundaries
- Edge of Road
- Guard Rail
- Overhead Utility
- Vegetation Line
- Tree
- River Top of Bank (OHW)
- Existing Wetland
- Thalweg Spot Elevations
- Utility Pole
- Manhole
- Sanitary Manhole or Septic Cover
- Well
- Vent
- Hydrant
- Water Valve
- Stormwater Pipe
- Stormwater Swale
- Sediment Probing Location
- Sediment Sampling Location
- Floodplain Boring Location
- Archaeological Sensitive Areas
- Proposed Limits of Disturbance
- Proposed Site Access Route
- Proposed Timber Mats

Site Access & Material Removal Notes:

1. Utility locations shown on this plan should be considered approximate. Contractor is required to verify utility locations prior to work.
2. The suggested site access shown on this sheet is an example and for the purposes of project bidding.
3. The Contractor shall submit an Access and Material Removal Plan for approval by the Engineer prior to mobilization. The plan can follow the suggested route, or vary based on revised project sequencing. Overall, the Plan will be the Contractor's plan that meets all permit requirements and is subject to approval by the Engineer. See specifications.

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS
DRAWN ON: 9/4/2020
DRAWN BY: GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE
DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17
40 0 40 80 160 ft
8 0 20 40 m
1 inch = 40 feet
(1 : 480)

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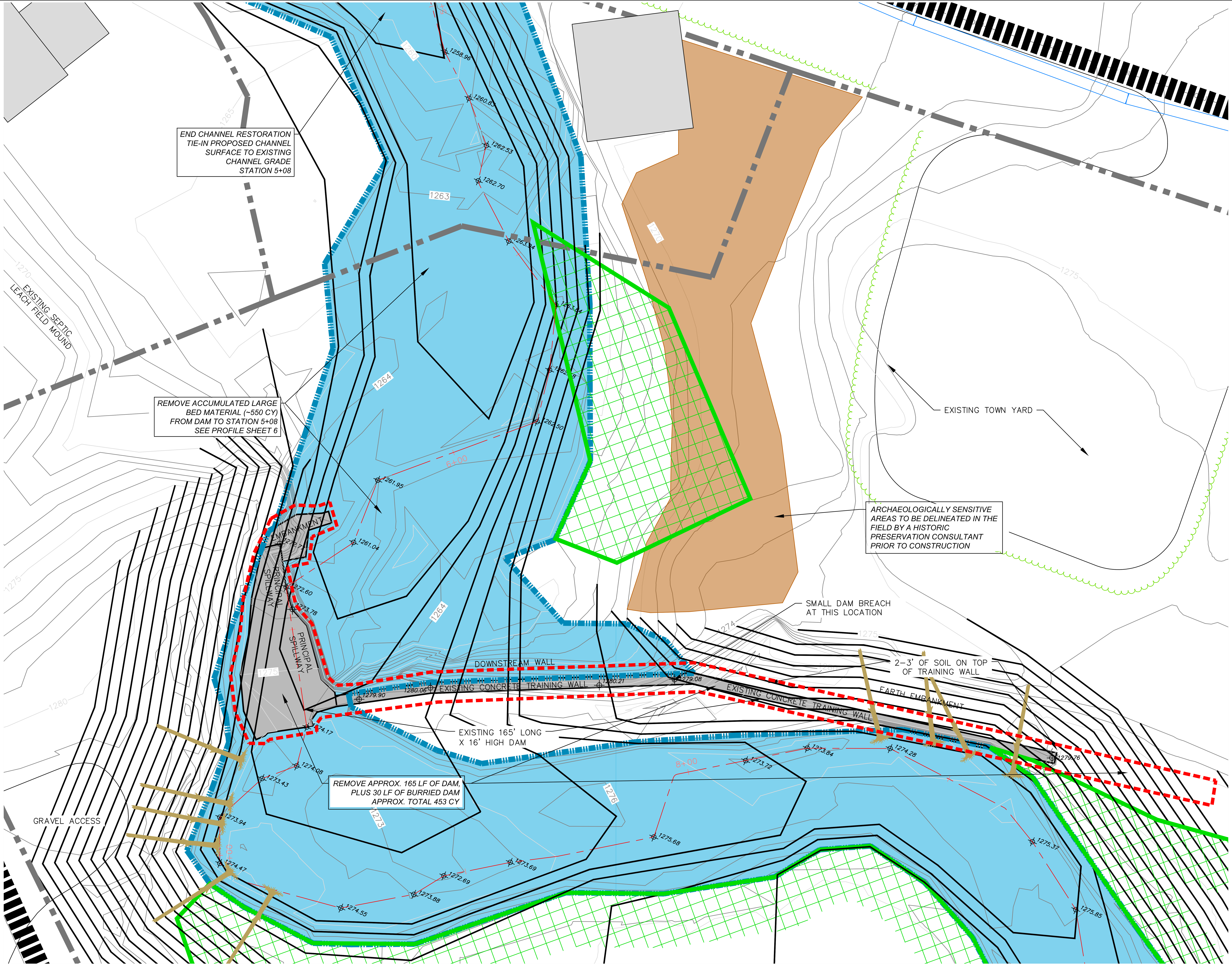
HANDS MILL DAM REMOVAL
AT JAIL BRANCH
SITE ACCESS & MATERIAL REMOVAL PLAN
WASHINGTON VERMONT

FIGURE NO.
4



Dam Vicinity - Plan View

Scale: 1" = 10'

Legend

- Survey Control Point
- Major Contour
- Minor Contour
- Parcel Boundaries
- Edge of Road
- Overhead Utility
- Vegetation Line
- Tree
- River Top of Bank (OHW)
- Existing Wetland
- Spot Elevations
- Utility Pole
- Sanitary Manhole or Septic Cover
- Vent
- Archaeological Sensitive Areas
- Proposed Limits of Disturbance
- Proposed Contours
- Dam Removal Line

Dam Demolition Plan Notes:

1. Potential limits of structures, as indicated on this sheet are based on surveys, probing data and assumed geometry of structures, and are therefore unconfirmed and should be verified by the contractor.
2. Note that there will be no removal of bedrock at the dam and throughout the extent of the project.

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS

DRAWN ON:	9/4/2020
DRAWN BY:	GMB
CHECKED ON:	
CHECKED BY:	
PROJECT NO:	20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

1 inch = 10 feet

(1 : 120)

STONE ENVIRONMENTAL
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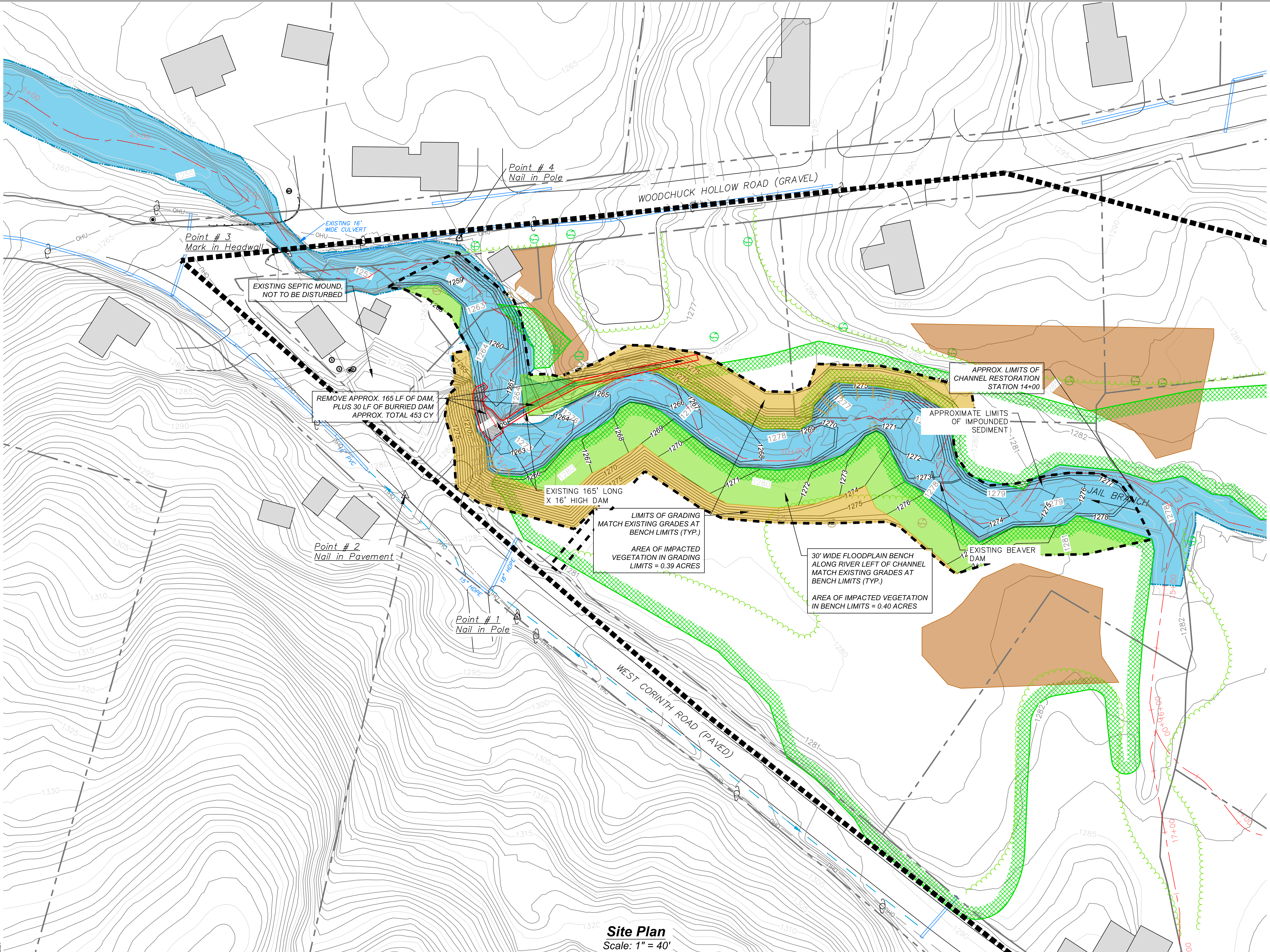
802.229.4541 / info@stone-env.com / www.stone-env.com

HANDS MILL DAM REMOVAL
AT JAIL BRANCH
EXISITNG DAM & DEMOLITION PLAN

WASHINGTON VERMONT

FIGURE NO. 5



N

Legend

- Survey Control Point
- 1280 Major Contour
- 1275 Minor Contour
- Parcel Boundaries
- Edge of Road
- Guard Rail
- OHU Overhead Utility
- Vegetation Line
- Tree (Brown Color Indicates to be Removed)
- River Top of Bank (OHW)
- Existing Wetland (See Note 6)
- 1277.38 Thalweg Spot Elevations
- Utility Pole
- Manhole
- Sanitary Manhole or Septic Cover
- Well
- Vent
- Hydrant
- Water Valve
- 36" CMP Stormwater Pipe
- Stormwater Swale
- Archaeological Sensitive Areas
- Proposed Limits of Disturbance
- Extents of Ground Disturbance
- 1276 Proposed Contours
- Dam Removal Line

Channel Restoration Plan Notes:

1. Contractor to clear and grub as necessary to provide access, remove dam and construct bank stabilizations (Item 201.10).
2. Contractor to install topsoil and seed along disturbed floodplains and other areas of disturbance per the direction of the Engineer.
3. See the 'Typical Channel Cross Section' on Sheet 6 for a depiction of the pilot channel cross section to be constructed per the extents shown on this sheet.
4. Final channel and floodplain grading associated with the limits of pilot channel construction and bank stabilizations shown on this plan may be further revised in 100% design plans.

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS

DRAWN ON: 9/4/2020
DRAWN BY: GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

40 0 40 80 160 ft
8 0 20 40 m

1 inch = 40 feet
(1 : 480)

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HANDS MILL DAM REMOVAL
AT JAIL BRANCH
CHANNEL RESTORATION PLAN

WASHINGTON VERMONT

FIGURE NO.

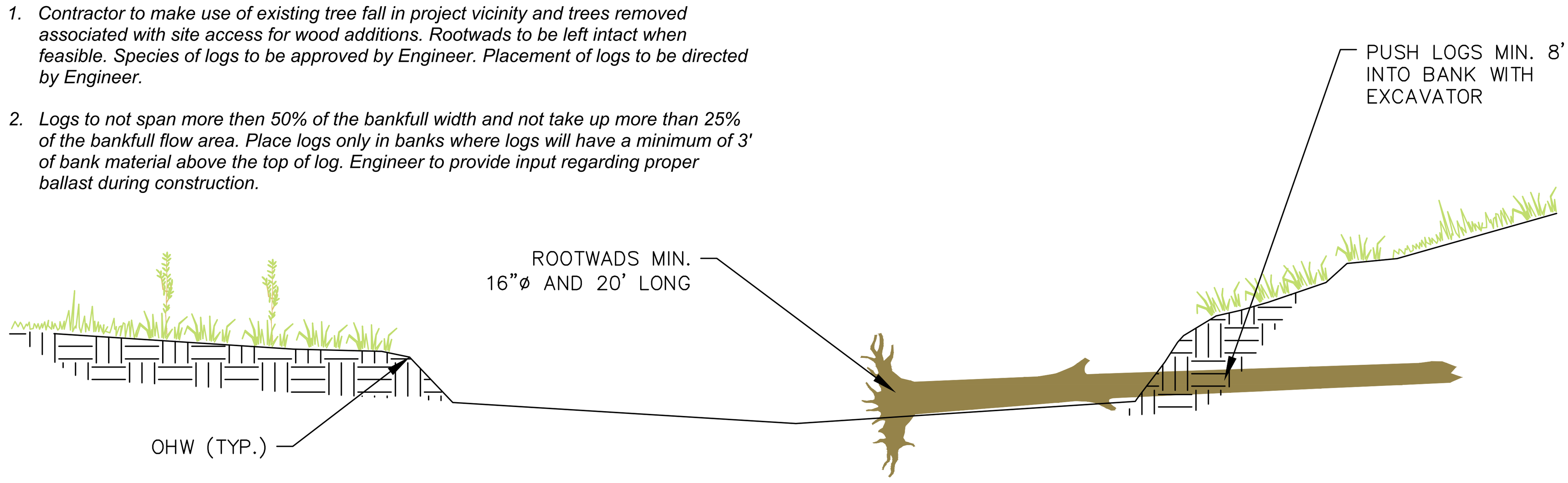
6

Channel Restoration Profile Notes:

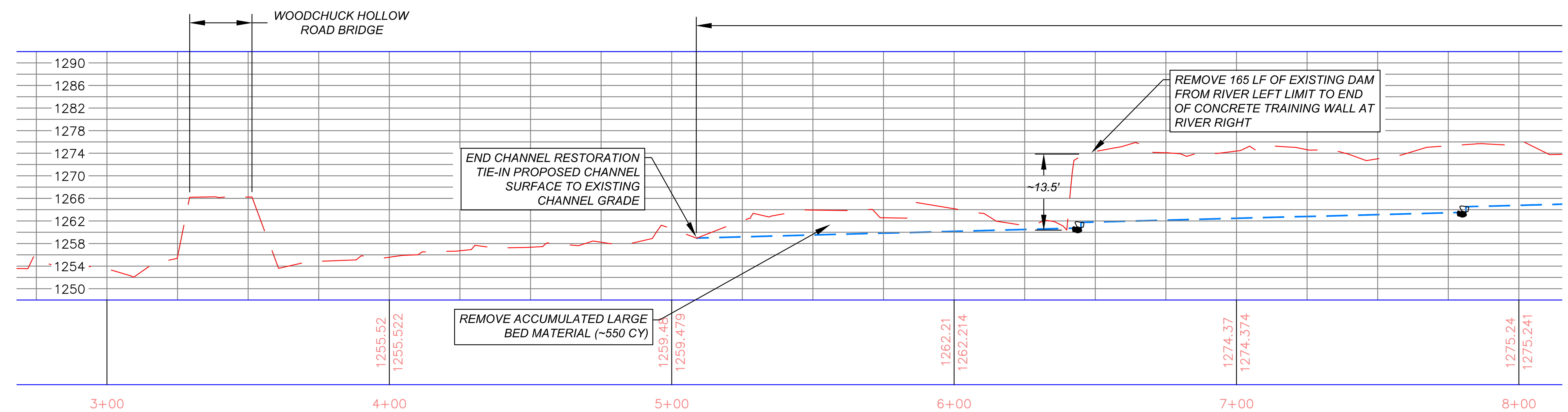
1. The profile has a vertical scale exaggeration of 2.
2. Steps have been incorporated into the design to 1) provide for channel bed grade control to ensure channel stability in the vicinity of nearby residential properties and 2) provide for the required elevation drop within project limits following removal of the ~14' high dam. During construction, if natural/relic bed features are found and provide grade control, steps may not be needed. If required, steps will be installed per the direction of the Engineer. Step construction will be added to the construction bid documents as an add-alternate, enabling their installation as optional and based on field conditions.
3. Overall slope of pilot channel from Station 5+08 to 14+00 is 2.1% and includes drops at proposed steps. All riffles downstream of proposed steps are set to 1.3%.
4. Hydraulic drops at proposed steps do not exceed 1'.

Wood Addition Notes:

1. Contractor to make use of existing tree fall in project vicinity and trees removed associated with site access for wood additions. Rootwads to be left intact when feasible. Species of logs to be approved by Engineer. Placement of logs to be directed by Engineer.
2. Logs to not span more then 50% of the bankfull width and not take up more than 25% of the bankfull flow area. Place logs only in banks where logs will have a minimum of 3' of bank material above the top of log. Engineer to provide input regarding proper ballast during construction.

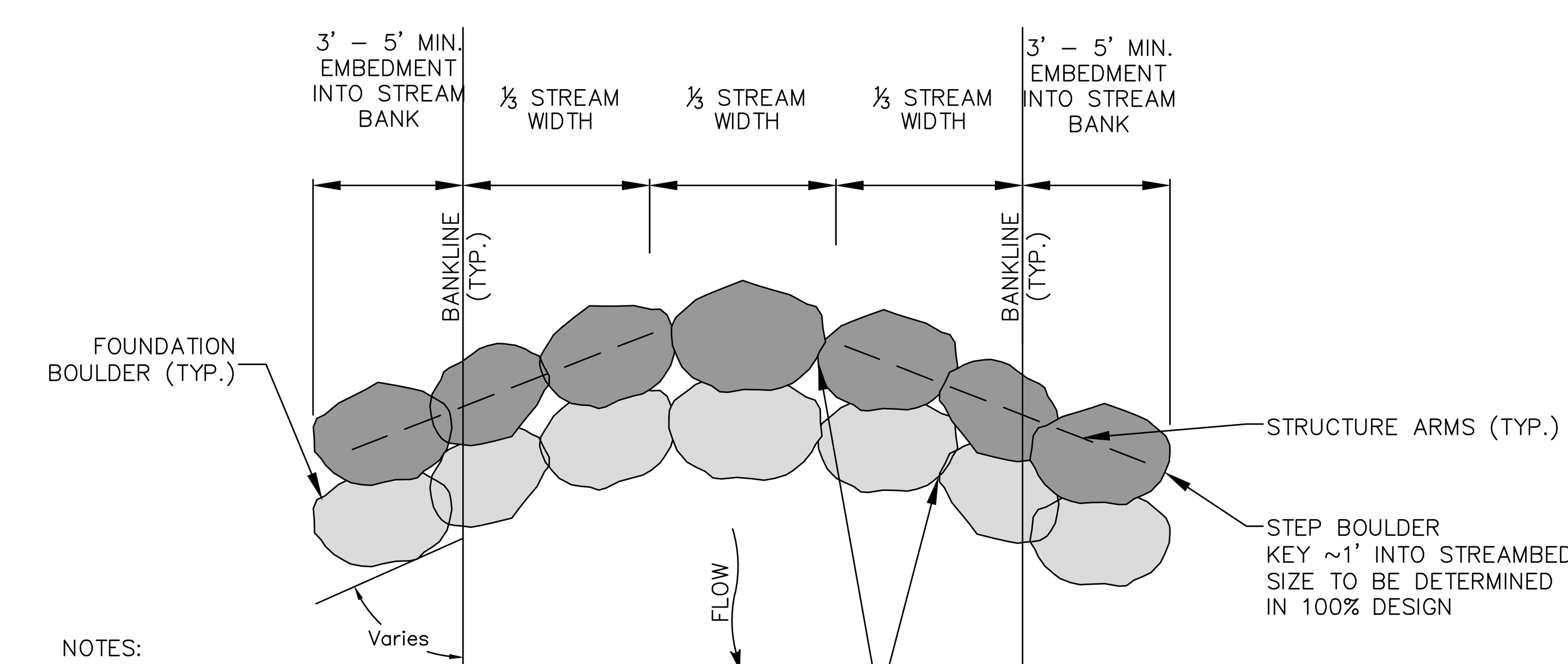


Wood Addition Detail - Section View
Scale: 1" = 2'



Legend
Existing Channel Thalweg
Proposed Pilot Channel Thalweg

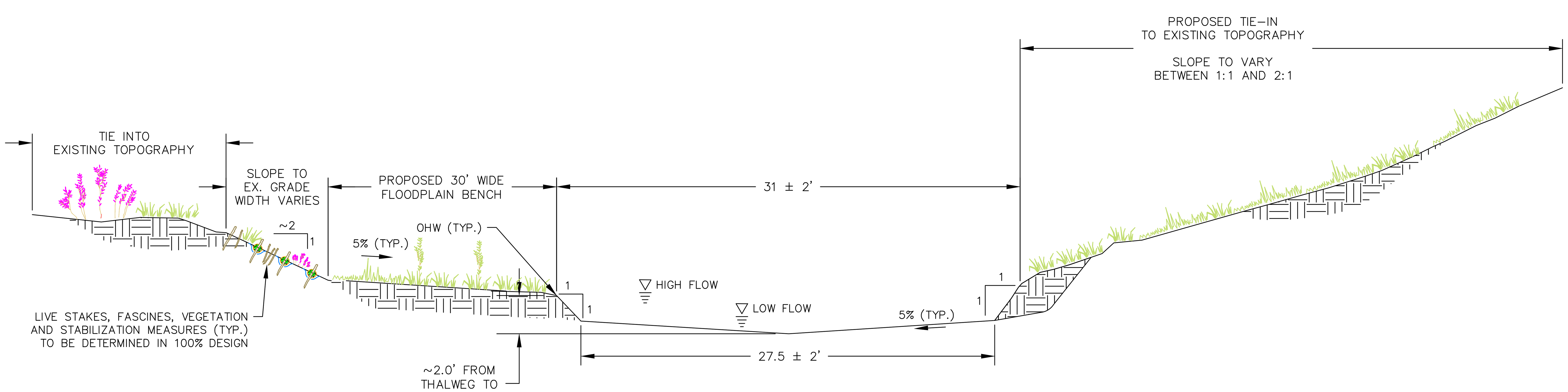
Existing and Proposed Longitudinal Profile
Horizontal Scale: 1" = 30'
Vertical Scale: 1" = 15'



NOTES:

1. ROCK STEP AND BOULDER PLACEMENT TO BE DETERMINED BY ENGINEERING DURING CONSTRUCTION.
2. FINISHED ELEVATION OF THE TOP OF EACH ROCK VARIES. ALL ROCKS PROTRUDE ABOVE THE STREAMBED 0.5 – 1 FOOT.
3. ITEM 613.0002

Rock Step - Plan View
Scale: NTS



Typical Channel Cross Section
Scale: 1" = 5'

30% DESIGN PLANS, NOT FOR PERMITTING OR CONSTRUCTION

FILE:

DRAWING CREDITS
DRAWN ON: 9/4/2020
DRAWN BY: GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 20-007

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11X17

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HANDS MILL DAM REMOVAL
AT JAIL BRANCH
CHANNEL RESTORATION PROFILE & DETAILS
WASHINGTON VERMONT

FIGURE NO.
7

Attachment 5: Geotechnical Memo

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100% EMPLOYEE OWNED
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802.229.4541 / info@stone-env.com / www.stone-env.com

November 16, 2020

MEMO

To: Gianna Petito, District Manager, Winooski Natural Resources Conservation District

From: Matt Schley, Gabe Bolin, PE, Meghan Arpino, Stone Environmental, Inc.

Stone Project No. 20-007
Subject: Hands Mill Dam Removal – Geotechnical Report

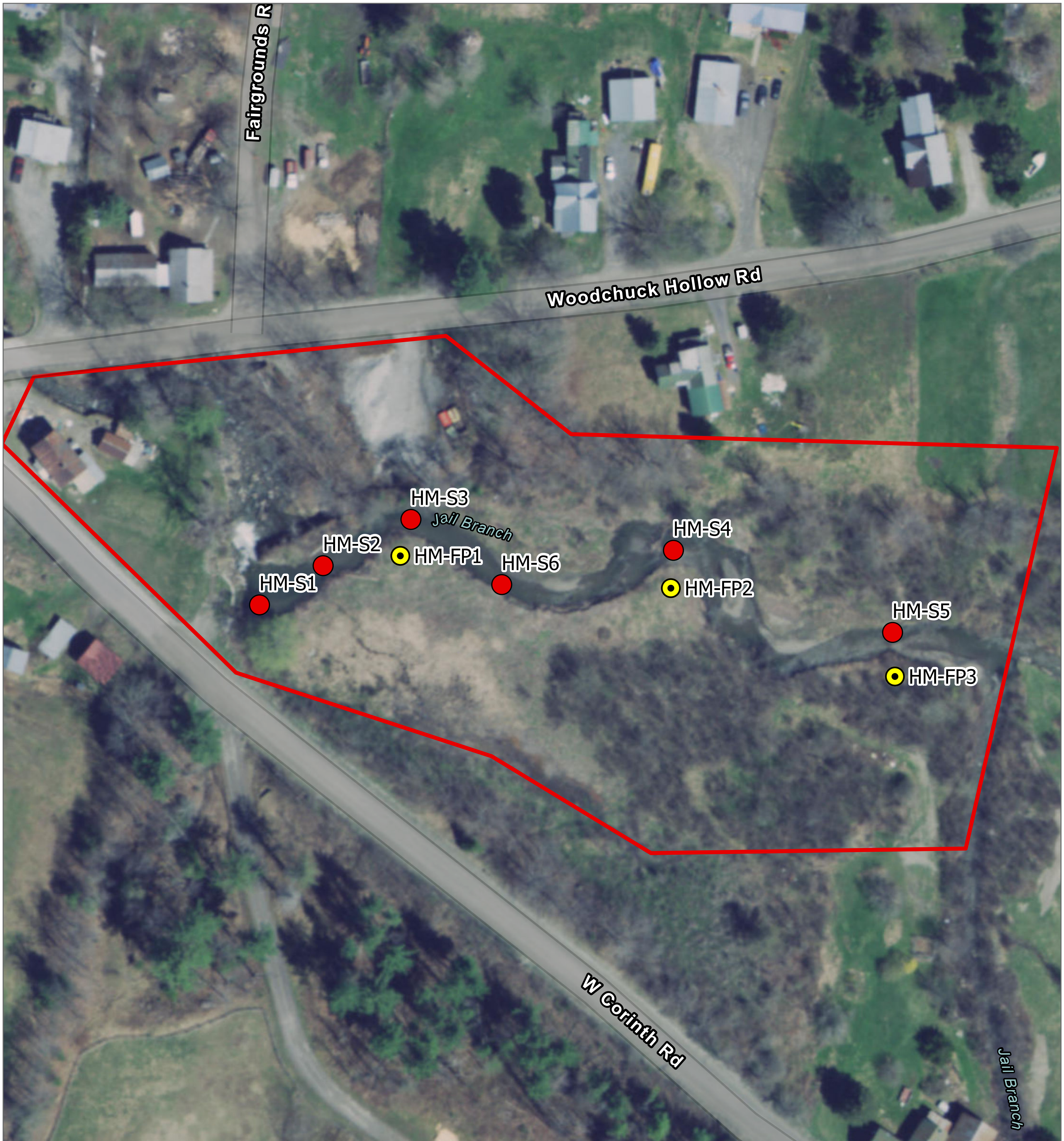
Stone Environmental, Inc. (Stone) has completed desktop, field, and laboratory geotechnical investigations at the Hands Mill Dam as part of the overall 30% design effort. This memo provides a summary of these investigations including field and laboratory methods, data logs, and the implications of the data for site design and construction processes.

1. Desktop Evaluation

A preliminary desktop evaluation was performed to determine the potential extents of sampling. Aerial imagery of the Hands Mill Dam location (44.10569, -72.43000) from Google Earth shows aggradation of sediment, likely coarse grained, for approximately 750 linear feet upstream of the Hands Mill Dam (See Figure 1 on the following page for approximate project extents). This area was further investigated in the field to confirm sampling locations. The number of channel samples to be collected (six in total) was predetermined and was to include a combination of pebble counts and laboratory grain size analyses (methodologies defined below). The number of floodplain samples to be collected (three in total) was also predetermined to represent the spatial extent of the left-bank floodplain.

2. Field and Laboratory Investigations

An initial site evaluation was utilized to confirm the extents of sampling. Though Google Earth aerial imagery showed aggraded sediments for approximately 750 linear feet upstream of Hands Mill Dam, visible changes in bed slope and material indicated that the direct impact of the dam on sediment impoundment was likely limited to approximately 600 linear feet upstream. Channel sediment sampling was therefore focused within this extent. Exact sampling locations were selected to maximize the range of outcomes of the grain size analyses in order to assess the variability of grain size distribution throughout the channel. One sample, HM-S6, was excluded from further analysis and was sent to archive due to extensive similarity to sample HM-S4. Floodplain samples were spaced at equidistant intervals (approximately 150 - 200 feet apart) throughout the left bank floodplain.



LEGEND

- Bed Sediment Sampling Locations
- Floodplain Soil Borings
- Approximate Limits of Disturbance

N

0 25 50

Feet

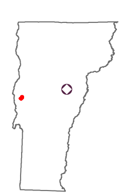


Figure 1: Site Map

Hands Mill Geotechnical Memo

West Corinth Road
Washington, Vermont

STONE ENVIRONMENTAL

Source: Esri World Imagery, VCGI - Parcel Boundary
Path: O:\PROJ-20\WRM\20-007 Hands Mill Dam\GIS\MapDocuments\PresentationsAndReports\Hands Mill Site Map\Hands Mill Site Map.aprx

Grain size analyses were performed using one (or more) of three methods at each channel sampling location: modified Wolman pebble count, laboratory sieve analysis, and/or laboratory hydrometer analysis. The modified Wolman pebble counts were performed using the methodology of Leopold (1970) where individual grains are selected using heel-to-toe spacing along cross-sectional transects. For laboratory testing, bulk sediment samples were collected to a depth of approximately 6-10 inches below the surface using a hand shovel. The samples were sent to the University of Vermont (UVM) Agricultural & Environmental Testing Laboratory (Lab) given the Lab's ability to perform a specific phosphorus content test. Laboratory sieve analyses were performed on the coarse fraction of bulk sediment samples, and laboratory hydrometer analyses were performed on the fine fraction of bulk sediment samples. Bulk sediment samples were also sent to the UVM laboratory for phosphorus content analysis via microwave digestion and inductively coupled plasma (ICP) analysis. Results of the laboratory analysis are included as Attachment 1.

Floodplain soil/sediment samples were collected to a depth of approximately three (3) feet using a hand auger. Soil characteristics, including color, moisture, consistency, and field-assessed USCS classifications were recorded on a soil boring log for each of the three samples (see Attachment 2). Field-assessed USCS classifications were determined in accordance with ASTM standards D-2487 and D-2488.

3. Results

The results of the channel and floodplain investigations are shown in Tables 1 through 3. Pebble count data were aligned with the size classes tested via hydrometer and sieve analyses at the UVM Lab for direct comparison. Figure 2 shows the cumulative grain size distribution at each of the channel sampling sites (note that the curves for HM-S4 and HM-S5 were generated from pebble count data).

Table 1 – Grain Size Distribution of Channel Samples										
Sampling Site	**Sample Type[1]**	**Cumulative Percent Retained (%)**								
		Larger than 3/4 Sieve[2]	**3/4 Sieve**	**1/2 Sieve**	**1/4 Sieve**	**#5 Sieve**	**#10 Sieve**	**Sand**	**Silt**	**Clay**
HM-S1	B/L	-	100.0	100.0	100.0	99.9	99.7	5.9	2.0	0.1
HM-S2	B/L	-	100.0	85.0	73.3	60.8	55.2	46.6	4.7	1.2
HM-S3	B/L	-	100.0	99.9	99.9	99.3	98.6	95.8	3.4	1.6
HM-S4	B/L	-	100.0	99.4	90.2	77.3	69.8	52.4	3.4	1.0
		Cumulative Percent by Size Class (%)								
		Larger than 3/4 Sieve	**3/4 Sieve**	**1/2 Sieve**	**1/4 Sieve**	**#5 Sieve**	**#10 Sieve**	**Sand**	**Silt**	**Clay[2]**
HM-S4	PC	100.0	88.0	70.0	48.0	38.0	36.0	4.0	0.1	-
HM-S5	PC	100.0	66.7	56.6	49.5	42.4		9.1	0.1	-

[1]B/L are bulk samples sent to the UVM lab for analysis; PC are pebble count samples.

[2]Results not recorded for this combination of methodology and size class.

Table 2 – Phosphorus Content of Channel Samples		
Sampling Site	**Test Description**	**P-Content (mg/kg)**
HM-S1	Phosphorus (P) from ICP	267.9
HM-S2	Phosphorus (P) from ICP	343.3
HM-S3	Phosphorus (P) from ICP	206.1
HM-S4	Phosphorus (P) from ICP	426.5

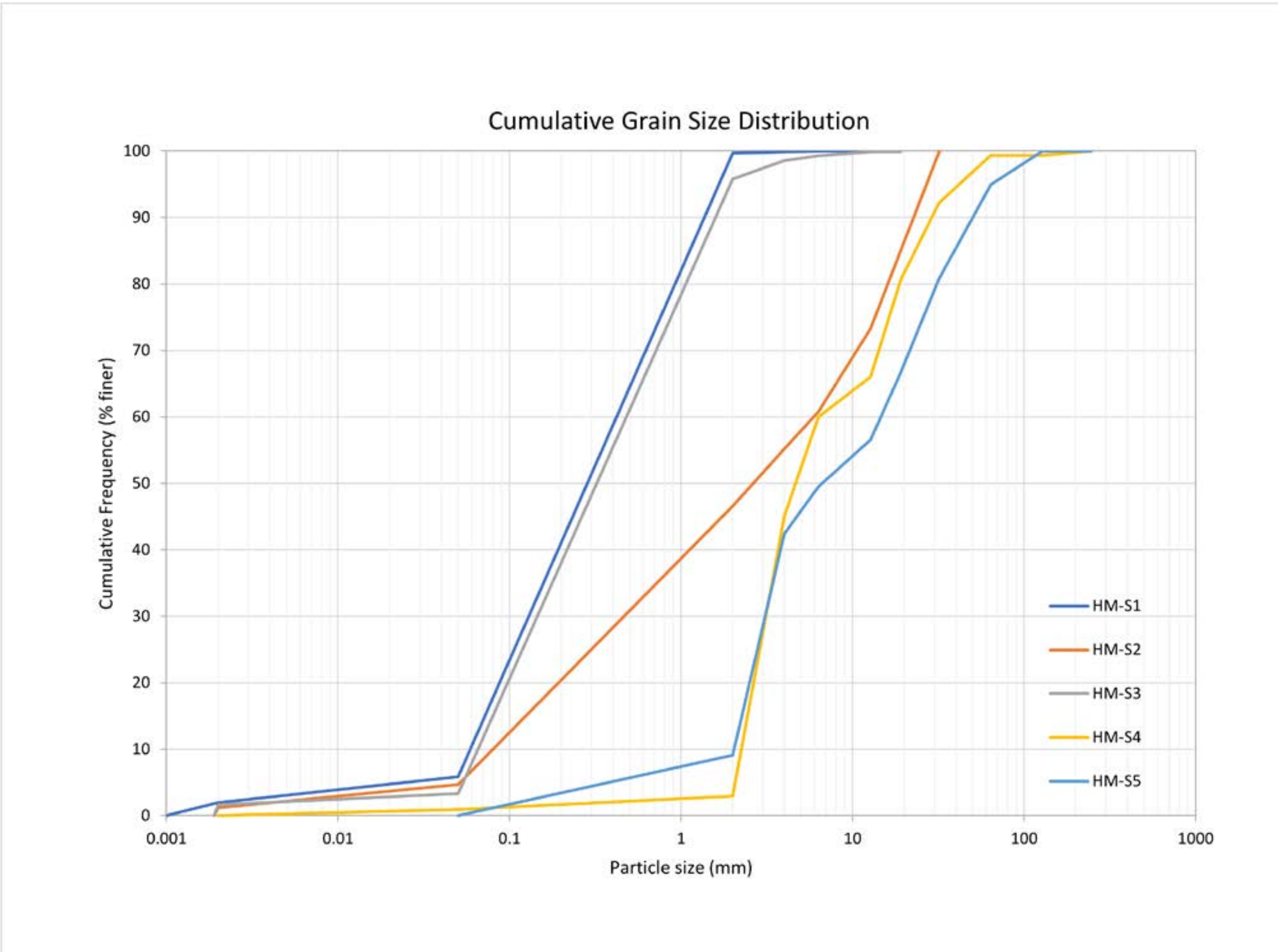


Figure 2 – Cumulative grain size distribution curves for channel samples HM-S1 through HM-S5. HM-S4 and HM-S5 curves were generated using pebble count data.

Table 3 – Soil Characteristics of Floodplain Samples[3]			
Sampling Site	**Composite Relative Soil Moisture**	**Composite Soil Color**	**Predominant USCS Classification**
HM-FP1	Moist to Wet	Dark Brown	SM (Silty Sand)
HM-FP2	Moist to Wet	Brown	SM (Silty Sand)
HM-FP3	Moist to Wet	Brown/Grey Brown	SM/ML (Silt with Fine Sand)

[3]See individual soil boring logs for more detailed information at respective soil layers.

4. Discussion

As is common with pebble counts, the sampling data show that the pebble count samples tended towards the coarser fraction of the impounded bed sediment material than the Lab tested bulk samples. However, both the Lab samples and pebble counts indicate that the median grain size (d_{50}) of the channel material is less than 10 mm (1 cm) in diameter. Particles of this size are highly mobile via both rolling and entrainment during common storm events. Both sample types also indicate that approximately 75% or more of the impounded bed sediment is finer than 25 mm (approximately 1 inch) in diameter. Coarse gravel in this size class is still likely to mobilize during storm flow events based on a simple incipient motion approximation using the critical Shields Number.

The average phosphorus (P) content of the impounded channel sediment is approximately 311 mg P/kg sediment. The total amount of phosphorus removed can be estimated based on 1) the extent of the impoundment, 2) an assumption that the majority of the phosphorus is contained within the active sediment layer (top 10 cm), and 3) an assumption that approximately 30% of the phosphorus is biologically available (value provided by the VANR workgroup). Review of publicly available LiDAR and aerial photography, and confirmation with field-run survey yields a total area of approximately 15,000 ft^2 of sediment impoundment. Based on the above assumptions and an average P loading of 311 mg/kg, the total bioavailable phosphorus to be removed associated with the proposed dam removal is 21 kg (or 46 lbs.). This estimate is limited to the sediment impounded within the confines of the channel. Floodplain sediments were not tested for P content, however utilizing the same assumptions as above, the same loading rate of 311 mg/kg, and the surface area of the proposed floodplain bench excavation (approximately 18,000 ft^2) an additional 25 kg (55 lbs.) of phosphorus would be removed. If the entire impounded depth was assumed to contain phosphorus-laden sediments, the total P removals from channel and floodplain sediments would increase to 317 kg (699 lbs.) and 381 kg (840 lbs.), respectively. See Attachment 3 for supporting calculations.

Field evaluation of floodplain soils revealed that the floodplain soils are predominantly silty sands, or USCS classification SM. Based on this characterization, the soils are likely limited to a maximum grade of 2H:1V outside of the channel limits. The internal friction angle of SM soils is approximately 30 to 35 degrees, depending upon the fractions of silt and sand, therefore precluding the ability to permanently grade these soils to a slope exceeding 2H:1V. Sandy soils do not generally achieve high levels of compaction in comparison to silty or clayey soils, and silty soils are subject to the highest relative amounts of post-construction settlement, particularly in regions with highly active freeze-thaw. Caution should therefore be taken to limit steep grading to the maximum extent practicable.

5. References

Leopold, L.B. 1970. An improved method for size distribution of stream-bed gravel. Water Resources Research. 6(5):1357-1366.

Town of Washington and Central Valley Regional Planning Commission, 2013. Local Hazard Mitigation Plan. Created August, 2013 – Adopted April, 2014.

Attachment 1: UVM Laboratory Analyses

Laboratory Analysis Report

Agricultural & Environmental Testing Laboratory
and UVM Extension

Prepared For:

Meghan Arpino
Stone Env. Inc.
5353 Stone Cutters Way
Montpelier, VT 05602

marpino@stone-env.com
845 323-3436

Order #: **10372**

Received: 9/9/2020
Reported: 10/7/2020
VT County: Washington

Particle Size Analysis (Hydrometer)

Bouyoucos Hydrometer

Lab #	*Sample Name*	*Description*	*Value*	*Unit of Measure*
70001	**HM-S1**			
		Sand (0.05 - 2 mm)	94.1	% (dry wt)
		Silt (0.002 - 0.05 mm)	3.9	% (dry wt)
		Clay (< 0.002 mm)	2.0	% (dry wt)
		Texture class	Sand	
70002	**HM-S2**			
		Sand (0.05 - 2 mm)	90.0	% (dry wt)
		Silt (0.002 - 0.05 mm)	7.5	% (dry wt)
		Clay (< 0.002 mm)	2.5	% (dry wt)
		Texture class	Sand	

Laboratory Analysis Report

Agricultural & Environmental Testing Laboratory and UVM Extension

70003 HM-S3

Sand (0.05 - 2 mm)	96.4	% (dry wt)
Silt (0.002 - 0.05 mm)	1.8	% (dry wt)
Clay (< 0.002 mm)	1.7	% (dry wt)
Texture class	Sand	

70004 HM-S4

Sand (0.05 - 2 mm)	93.5	% (dry wt)
Silt (0.002 - 0.05 mm)	4.5	% (dry wt)
Clay (< 0.002 mm)	2.0	% (dry wt)
Texture class	Sand	

If you have questions about these results, contact the lab at agtesting@uvm.edu.

Laboratory Analysis Report

Agricultural & Environmental Testing Laboratory and UVM Extension

Prepared For:

Meghan Arpino
Stone Env. Inc.
5353 Stone Cutters Way
Montpelier, VT 05602

marpino@stone-env.com
845 323-3436

Order #: 10372

Received: 9/9/2020
Reported: 10/7/2020
VT County: Washington

Particle Size Analysis (Large Sieve)

Large Sieve

Lab #	*Sample Name*	*Description*	*Value*	*Unit of Measure*
70005	**HM-S1**			
		Retained by 3/4 Sieve	< 0.1	% (dry wt)
		Retained by 1/2 Sieve	< 0.1	% (dry wt)
		Retained by 1/4 Sieve	< 0.1	% (dry wt)
		Retained by #5 Sieve	0.1	% (dry wt)
		Retained by #10 Sieve	0.4	% (dry wt)
70006	**HM-S2**			
		Retained by 3/4 Sieve	15.0	% (dry wt)
		Retained by 1/2 Sieve	11.7	% (dry wt)
		Retained by 1/4 Sieve	12.5	% (dry wt)
		Retained by #5 Sieve	5.6	% (dry wt)
		Retained by #10 Sieve	8.6	% (dry wt)

70007 HM-S3

Retained by 3/4 Sieve	< 0.1	% (dry wt)
Retained by 1/2 Sieve	< 0.1	% (dry wt)
Retained by 1/4 Sieve	0.6	% (dry wt)
Retained by #5 Sieve	0.7	% (dry wt)
Retained by #10 Sieve	2.8	% (dry wt)

70008 HM-S4

Retained by 3/4 Sieve	0.6	% (dry wt)
Retained by 1/2 Sieve	9.2	% (dry wt)
Retained by 1/4 Sieve	12.9	% (dry wt)
Retained by #5 Sieve	7.5	% (dry wt)
Retained by #10 Sieve	17.4	% (dry wt)

If you have questions about these results, contact the lab at agtesting@uvm.edu.

Laboratory Analysis Report

Agricultural & Environmental Testing Laboratory
and UVM Extension

Prepared For:

Order #: **10372**

Meghan Arpino
Stone Env. Inc.
5353 Stone Cutters Way
Montpelier, VT 05602

marpino@stone-env.com
845 323-3436

Received: 9/9/2020
Reported: 10/7/2020
VT County: Washington

Lab - Microwave digest + ICP analysis

Lab #	*Sample Name*	*Description*	*Value*	*Unit of Measure*
70009	**HM-S1**			
		Phosphorus (P) from ICP	267.9	mg/kg
70010	**HM-S2**			
		Phosphorus (P) from ICP	343.3	mg/kg
70011	**HM-S3**			
		Phosphorus (P) from ICP	206.1	mg/kg
70012	**HM-S4**			
		Phosphorus (P) from ICP	426.5	mg/kg

If you have questions about these results, contact the lab at agtesting@uvm.edu.

Attachment 2: Floodplain Soil Boring Logs

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535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

Boring Log Form

Hands Mill Dam Removal in Washington, Vermont

Sponsor Study Number: **Stone Study Number: 20-007**

Described By : Matt Schley	**Date: 11/5/2020**
Recorded By: Matt Schley	**Location: Washington, Vermont**
Vegetation: Dense, Wet-Tolerant	**Topographic Setting: Floodplain**
Slope: Very Low (Floodplain)	**Land use: Scrub/Shrub**

Comments: ~65 degrees F and sunny at time of sample; recent snowmelt increased soil moisture conditions

Boring # HM-FP1 (Most Downstream)

Depth (ft)	Color	Mottles	USCS Classification	Moisture	Consistence	Boundary Distinctness	Comments
0 – 1′	Dark Brown	F/1/F	SM (Silty Sand)	D/M	VFR	G	Some organic material throughout
1 – 2′	Dark Brown	F/1/F	SM (Silty Sand)	M/W	FR	G	Silt fraction declines with depth
2 – 2.5′	Dark Brown	F/1/F	SM (Silty Sand)	W	FR	G	GW Encountered @ 26” BGS
2.5 – 3′	Brown	C/2/P	SW (Well-Graded Sand)	W	L	A	

Key:
Color: MunsellSoil Color Chart (1994) codes refer to Hue, Value & Chroma
Mottles: Expressed as abundance/size/contrast
Abundance: f=few;m=many;c=common
Size: 1=fine;2=medium;3=coarse
Contrast: f=faint; d=distict; p=prominent

Moisture: m=moist, w=wet, d=dry
Consistence: l=loose, fr=friable, fi=firm, vfr=very friable, vfi=very firm, xfi=extremely firm
Boundary: Distinctness (D) g=gradual, a=abrupt
ESHGW= estimated seasonal high groundwater table
BGS= below ground surface

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Boring Log Form

Hands Mill Dam Removal in Washington, Vermont

Sponsor Study Number: **Stone Study Number: 20-007**

Described By : Matt Schley	**Date: 11/5/2020**
Recorded By: Matt Schley	**Location: Washington, Vermont**
Vegetation: Dense, Wet-Tolerant	**Topographic Setting: Floodplain**
Slope: Very Low (Floodplain)	**Land use: Scrub/Shrub**

Comments: ~65 degrees F and sunny at time of sample; recent snowmelt increased soil moisture conditions

Boring # HM-FP2

Depth (ft)	Color	Mottles	USCS Classification	Moisture	Consistence	Boundary Distinctness	Comments
0 – 0.5′	Dark Brown	F/1/F	SM (Silty Sand)	D/M	VFR	G	Some organic material throughout
0.5 – 1.5′	Brown	F/1/F	SM (Silty Sand)	M	FR	G	Silt fraction declines with depth
1.5 – 2.5′	Brown	F/1/F	SM (Silty Sand)	M/W	FR	G	
2.5 – 3′	Grey Brown	M/1/F	SP (Poorly-Graded Sand)	W	FR	G	GW Encountered @ 32″ BGS ▼

Key:
Color: MunsellSoil Color Chart (1994) codes refer to Hue, Value & Chroma
Mottles: Expressed as abundance/size/contrast
Abundance: f=few;m=many;c=common
Size: 1=fine;2=medium;3=coarse
Contrast: f=faint; d=distict; p=prominent

Moisture: m=moist, w=wet, d=dry
Consistence: l=loose, fr=friable, fi=firm, vfr=very friable, vfi=very firm, xfi=extremely firm
Boundary: Distinctness (D) g=gradual, a=abrupt
ESHGW= estimated seasonal high groundwater table
BGS= below ground surface

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Boring Log Form

Hands Mill Dam Removal in Washington, Vermont

Sponsor Study Number: **Stone Study Number: 20-007**

Described By : Matt Schley	**Date: 11/5/2020**
Recorded By: Matt Schley	**Location: Washington, Vermont**
Vegetation: Dense, Wet-Tolerant	**Topographic Setting: Floodplain**
Slope: Very Low (Floodplain)	**Land use: Scrub/Shrub**
Comments: ~65 degrees F and sunny at time of sample; recent snowmelt increased soil moisture conditions	

Boring # HM-FP3 (Most Upstream)

Depth (ft)	Color	Mottles	USCS Classification	Moisture	Consistence	Boundary Distinctness	Comments
0 – 0.5'	Dark Brown	F/1/F	ML (Silt with Fine Sand)	D/M	VFR	G	High organic material content throughout
0.5 – 1.5'	Brown	F/1/F	SM (Silty Sand)	M	VFR	G	
1.5 – 2.5'	Grey Brown	F/1/F	SM (Silty Sand)	M/W	FR	G	
2.5 – 3'	Grey Brown	F/1/F	ML (Silt with Fine Sand)	W	FI	G	

Key:
Color: MunsellSoil Color Chart (1994) codes refer to Hue, Value & Chroma
Mottles: Expressed as abundance/size/contrast
Abundance: f=few;m=many;c=common
Size: 1=fine;2=medium;3=coarse
Contrast: f=faint; d=distict; p=prominent

Moisture: m=moist, w=wet, d=dry
Consistence: l=loose, fr=friable, fi=firm, vfr=very friable, vfi=very firm, xfi=extremely firm
Boundary: Distinctness (D) g=gradual, a=abrupt
ESHGW= estimated seasonal high groundwater table
BGS= below ground surface

Attachment 3: Phosphorus Loading Calculations

Hands Mill Dam P Removal Calculations

	Assume full sediment depth	Assume 10-cm sediment depth (active layer)[1]	Full sediment deph over floodplain bench	10-cm sediment depth over floodplain bench	
Area of impounded sediment	0.34	0.34	0.41	0.41	acres
Area of impounded sediment	15000	15000	18000	18000	ft^2
Sediment depth[2]	5	0.328	5	0.328	ft
Total sediment volume	75000	4921	90000	5904	ft^3
Sediment density (estimated)	100	100	100	100	lb./ft^3
Sediment mass	7,500,000	492,126	9,000,000	590,400	lb.
Sediment mass	3,401,943	223,225	4,082,331	267,801	kg
Sediment TP conc. (estimated)[3]	311	311	311	311	mg P/kg sediment
Total P mass	1,058	69	1,270	83	kg
Bioavailable P fraction[1]	0.3	0.3	0.3	0.3	g/g
Total bioavailable P mass	317	21	381	25	kg

1. Constants assumed per preliminary guidance of ANR's *P Capture by Natural Resources Restoration Projects Workgroup* (November 26, 2019)
2. Average 5-ft sediment depth over area of impoundment is an assumption based on impoundment
3. Assumed representative value (total P in impounded sediment behind Levesque Dam near East Montpelier, VT) from: Chalmers, A. 1998. Distribution of Phosphorus in Bed Sediments of the Winooski River Watershed, Vermont, 1997. USGS Fact Sheet FS-108-98.

Area of Impoundment Calculations

Average Channel Width:	25	ft
Length of Impoundment:	600	ft
Area of Impoundment:	15000	ft^2
Floodplain Bench Width:	30	ft
Length of Bench:	600	ft
Area of Bench:	18000	ft^2

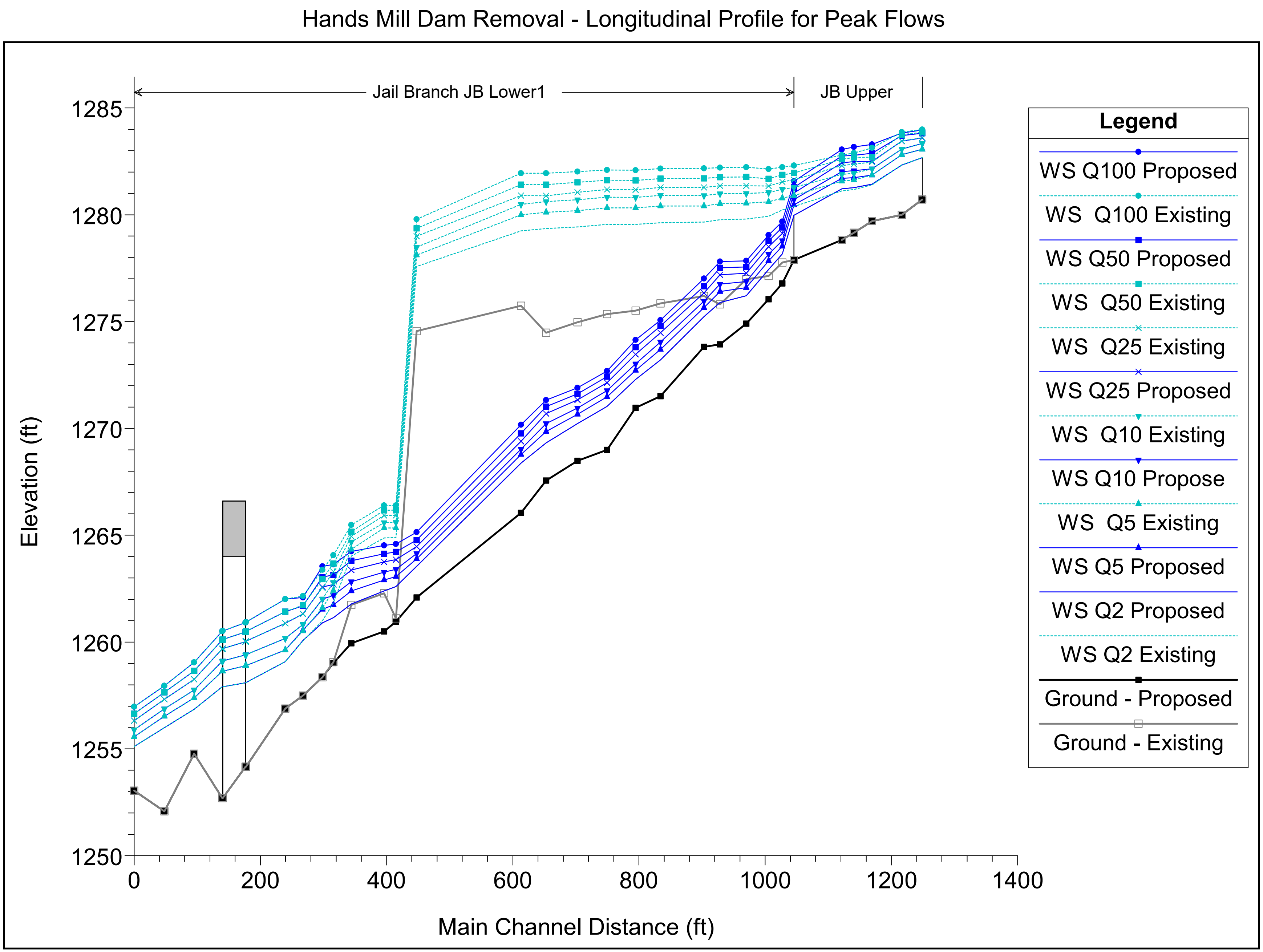
Attachment 6: Opinion of Probable Cost (OPC)

Hands Mill Dam Removal
Alternative A4 - 30% Design OPC
Stone Environmental, 12/2020, V4

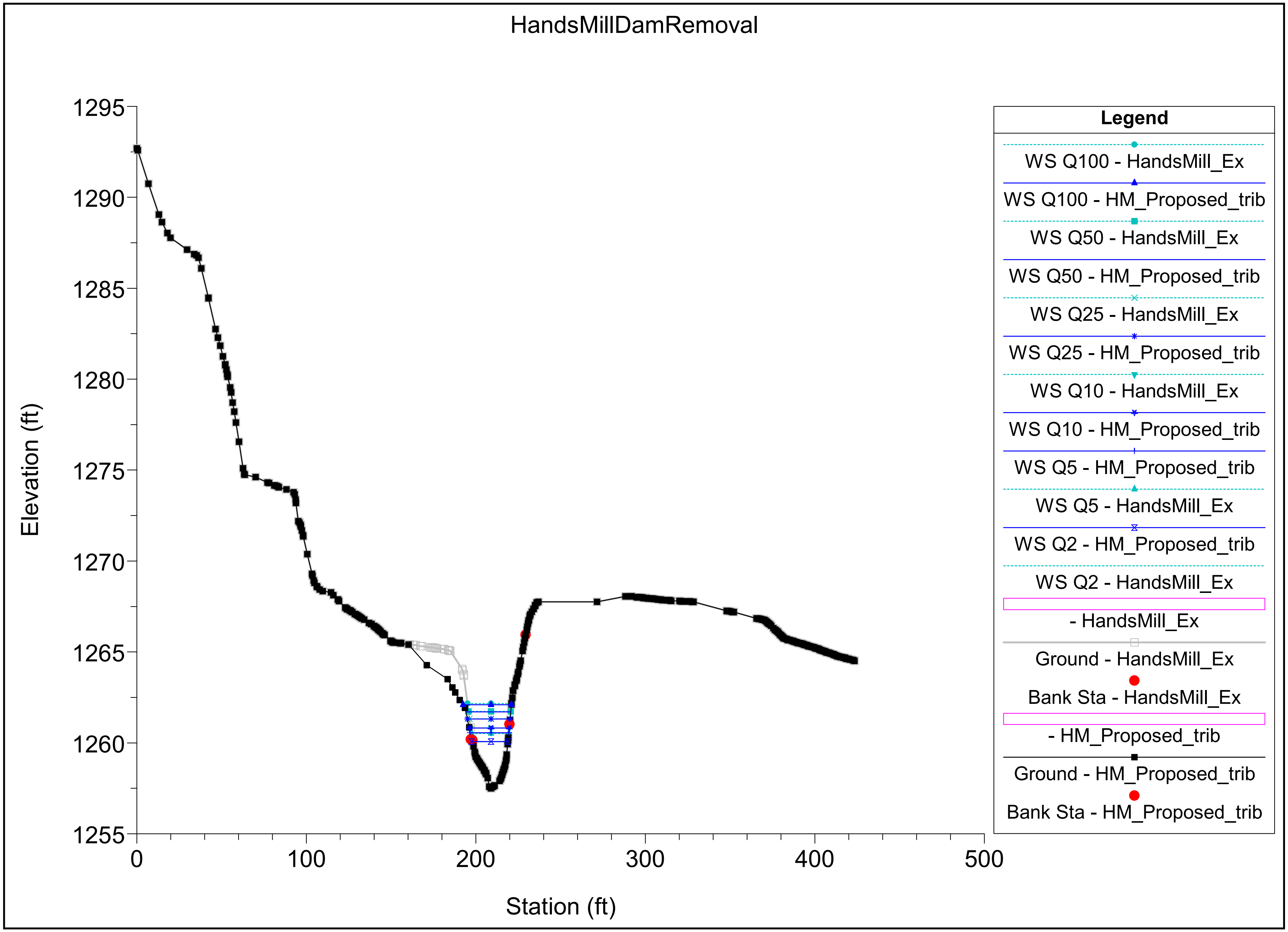
ITEM #	ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
General					
1	SURVEY LAYOUT	1	LS	$4,000.00	$4,000.00
2	CONSTRUCT ACCESS	1	LS	$10,000.00	$10,000.00
3	EPSC MEASURES	1	LS	$8,000.00	$8,000.00
4	FLOW BYPASS AND DEWATER SITE	1	LS	$10,000.00	$10,000.00
Dam Removal					
5	DEMO DAM AND HAUL OUT STONE	453.00	CY	$220.00	$99,660.00
Channel Restoration					
6	COMMON EXCAVATION (CHANNEL AND FLOODPLAIN BENCHES)	13940	CY	$7.50	$104,550.00
7	SEDIMENT HAUL	13386	CY	$7.50	$100,395.00
8	CHANNEL REALIGNMENT	1	LS	$5,000.00	$5,000.00
9	INSTALL STONE STEPS, POOLS AND ROOTWADS	1	LS	$15,000.00	$15,000.00
10	PLACE SEED, MULCH AND FASCINES	1	LS	$10,000.00	$10,000.00
				CONSTRUCTION TOTAL	***$366,605***
				MOBILIZATION / DEMOBILIZATION (10%)	***$36,661***
				CONSTRUCTION CONTINGENCY (20%)	***$73,321***
				TOTAL (ROUNDED TO NEAREST $100)	***$476,600***

Design, Permitting and Construction Services	
FINAL DESIGN & PERMITTING (10%)	***$36,661***
BID AND CONSTRUCTION PHASE SERVICES (6%)	***$21,996***

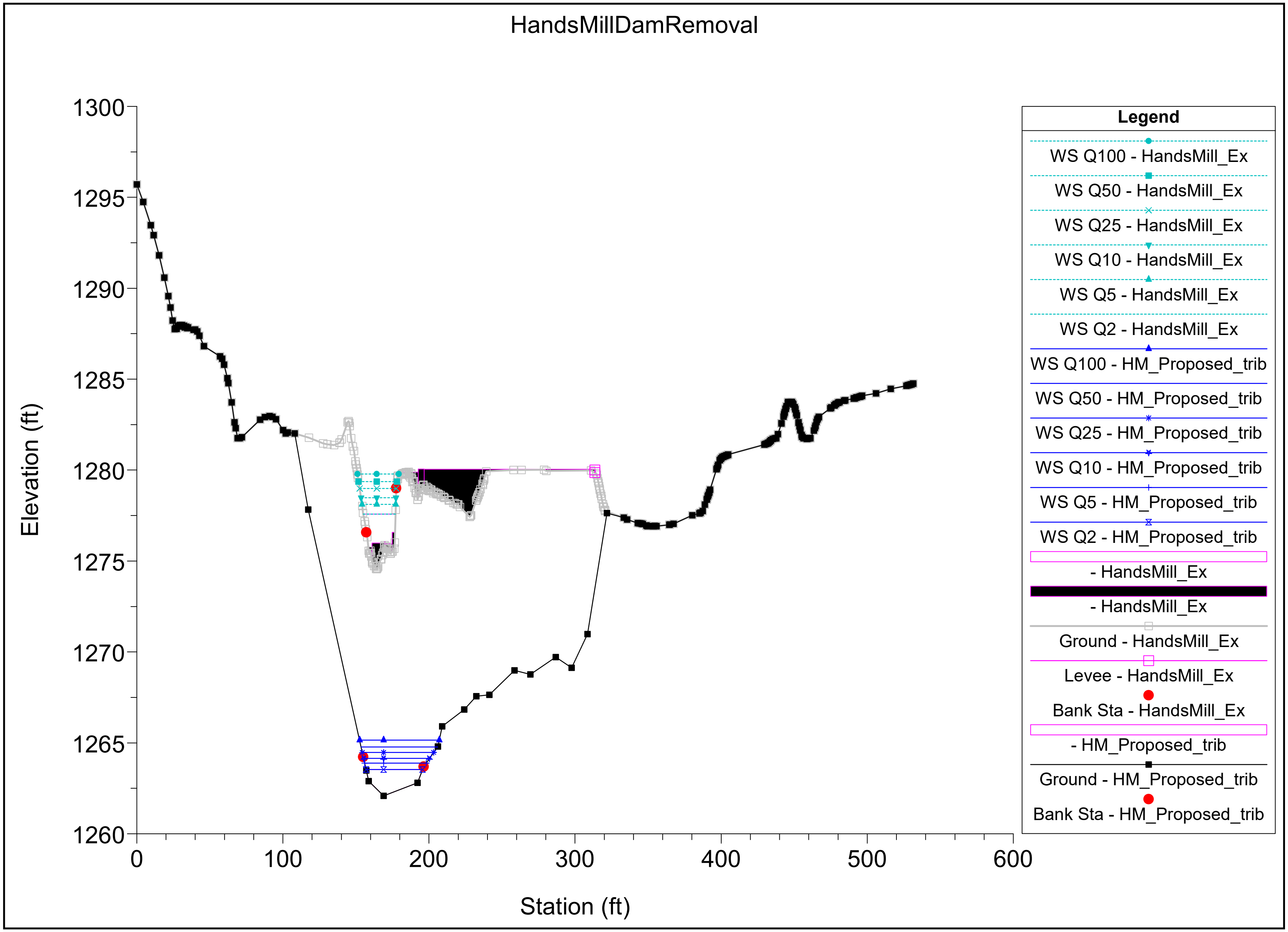
Attachment 7: Hydraulic Modeling Output



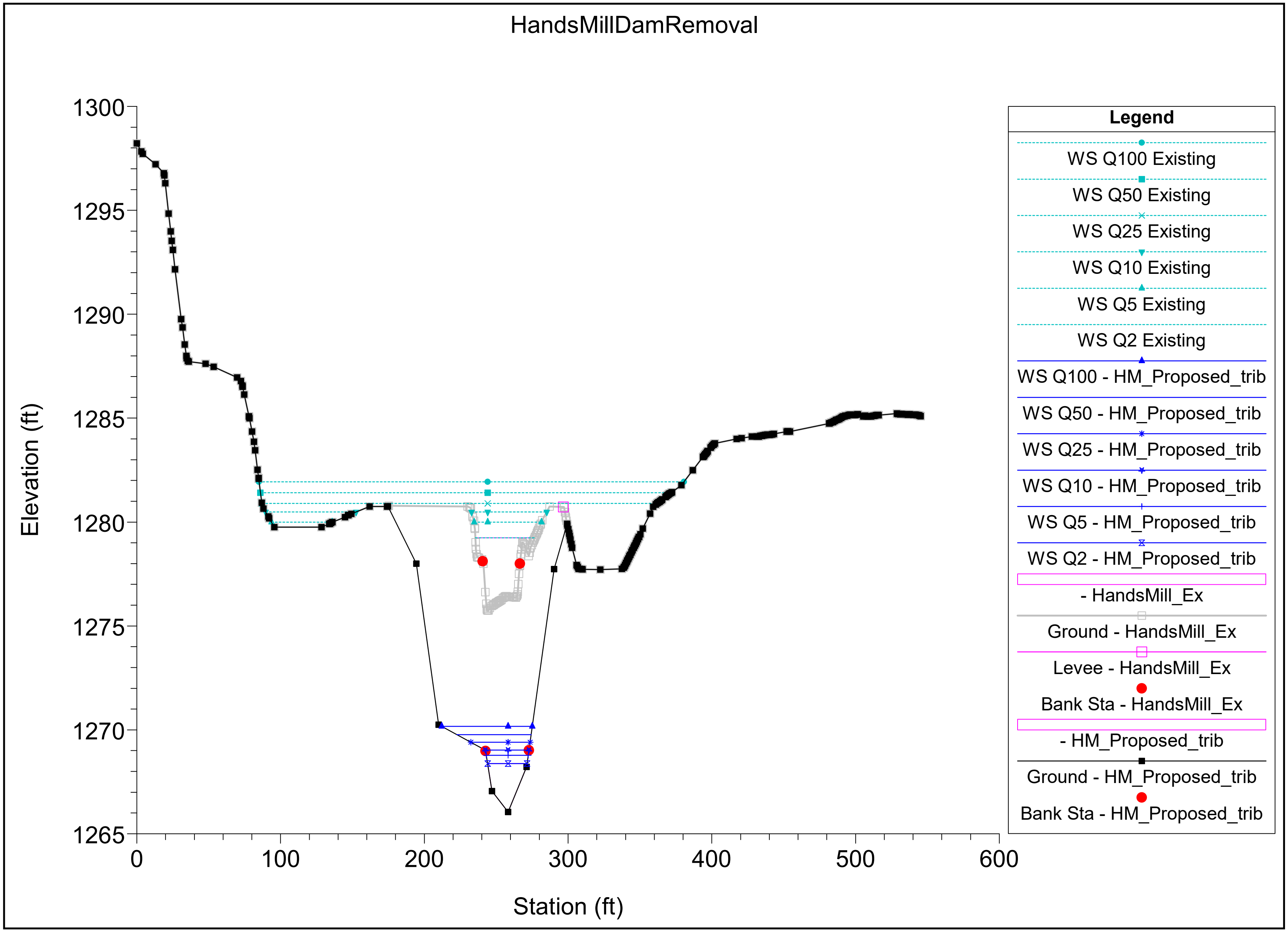
Hands Mill Dam Removal - Longitudinal Profile for Peak Flows
Jail Branch JB Lower1
JB Upper
Elevation (ft)
1285
1280
1275
1270
1265
1260
1255
1250
0
200
400
600
800
1000
1200
1400
Main Channel Distance (ft)
Legend
WS Q100 Proposed
WS Q100 Existing
WS Q50 Proposed
WS Q50 Existing
WS Q25 Existing
WS Q25 Proposed
WS Q10 Existing
WS Q10 Propose
WS Q5 Existing
WS Q5 Proposed
WS Q2 Proposed
WS Q2 Existing
Ground - Proposed
Ground - Existing



HandsMillDamRemoval
Elevation (ft)
Station (ft)
1295
1290
1285
1280
1275
1270
1265
1260
1255
0
100
200
300
400
500
Legend
WS Q100 - HandsMill_Ex
WS Q100 - HM_Proposed_trib
WS Q50 - HandsMill_Ex
WS Q50 - HM_Proposed_trib
WS Q25 - HandsMill_Ex
WS Q25 - HM_Proposed_trib
WS Q10 - HandsMill_Ex
WS Q10 - HM_Proposed_trib
WS Q5 - HM_Proposed_trib
WS Q5 - HandsMill_Ex
WS Q2 - HM_Proposed_trib
WS Q2 - HandsMill_Ex
- HandsMill_Ex
Ground - HandsMill_Ex
Bank Sta - HandsMill_Ex
- HM_Proposed_trib
Ground - HM_Proposed_trib
Bank Sta - HM_Proposed_trib



HandsMillDamRemoval
Elevation (ft)
Station (ft)
1300
1295
1290
1285
1280
1275
1270
1265
1260
0
100
200
300
400
500
600
Legend
WS Q100 - HandsMill_Ex
WS Q50 - HandsMill_Ex
WS Q25 - HandsMill_Ex
WS Q10 - HandsMill_Ex
WS Q5 - HandsMill_Ex
WS Q2 - HandsMill_Ex
WS Q100 - HM_Proposed_trib
WS Q50 - HM_Proposed_trib
WS Q25 - HM_Proposed_trib
WS Q10 - HM_Proposed_trib
WS Q5 - HM_Proposed_trib
WS Q2 - HM_Proposed_trib
- HandsMill_Ex
- HandsMill_Ex
Ground - HandsMill_Ex
Levee - HandsMill_Ex
Bank Sta - HandsMill_Ex
- HM_Proposed_trib
Ground - HM_Proposed_trib
Bank Sta - HM_Proposed_trib



HandsMillDamRemoval
Elevation (ft)
Station (ft)
1300
1295
1290
1285
1280
1275
1270
1265
0
100
200
300
400
500
600
Legend
WS Q100 Existing
WS Q50 Existing
WS Q25 Existing
WS Q10 Existing
WS Q5 Existing
WS Q2 Existing
WS Q100 - HM_Proposed_trib
WS Q50 - HM_Proposed_trib
WS Q25 - HM_Proposed_trib
WS Q10 - HM_Proposed_trib
WS Q5 - HM_Proposed_trib
WS Q2 - HM_Proposed_trib
- HandsMill_Ex
Ground - HandsMill_Ex
Levee - HandsMill_Ex
Bank Sta - HandsMill_Ex
- HM_Proposed_trib
Ground - HM_Proposed_trib
Bank Sta - HM_Proposed_trib