ENGINEERING • PLANNING • DEVELOPMENT • MANAGEMENT

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Chandler Engel, PE
Water Resources Engineer

TECHNICAL MEMORANDUM
(120808)

Date: May 17, 2017

To: John Benjamin, Chair of the West Fairlee Planning Commission

Cc: Ron Rhodes, Connecticut River Conservancy

Ned Swanberg, VT DEC River Corridor and Flooplain Protection Program

Subject: Geer Dam Removal – No Rise Analysis

Mr. Benjamin,

This memorandum documents and summarizes the results of hydraulic analysis conducted by DuBois & King, Inc. which demonstrates that the Geer Dam Removal Project is in compliance with the Town of West Fairlee's Flood Hazard Ordinance. The relevant criteria defined in the ordinance is as follows:

Section 9.0 A.2

> *No new construction, substantial improvement, or other development (including fill) shall be permitted within zones A1-A30 and AE on the town's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the town. This provision applies until a regulatory floodway is designated.*

While the removal of a dam is not a typical "development" activity, an analysis was conducted to evaluate the impact on the river hydraulics in the vicinity of the dam.

Analysis Approach

As the nature of this project is a removal of a dam with no significant flood storage capacity, intuitively the post-project flood stages would be expected to be equal to, or less than those under existing conditions. To confirm this assumption, the pre and post project flood conditions were evaluated using a 1-dimensional HEC-RAS hydraulic

model. Cross section data were based on field surveyed geometry around the dam site. The field survey was conducted in 2016 by D&K surveyors with a shot density suitable to generate 1-ft contours of the site topography.

The pre-project, or existing conditions model was based on field surveyed site topography and surveyed geometry of structures influencing the river hydraulics including the dam and a pasture bridge directly upstream of the dam. The bridge was modeled using the bridge crossing routines with a deck, and the dam was modeled as a terrain feature coded into two sequential cross sections, rather than an inline structure due to the significant sedimentation behind the dam. The model extended approximately 150 feet downstream of the dam and 250 feet upstream of the dam.

The post-project model was based on the removal design geometry which includes demolition of the 3 dam bays, with the dam retaining walls and intake structure left intact. The post-project model is identical to the pre-project model, except for modifications to the cross sections containing the geometry of the dam, where the approximately 35 foot wide main dam section was removed, and modifications to the cross sections between the bridge and the dam, depicting the mechanical removal of sediment from directly behind the dam, and modifications to the cross sections directly below the dam to represent the filling-in of the existing scour hole. This post-project condition reflects the approximate field conditions directly after partial removal, where the sediment in the impoundment has not fully mobilized. This is likely a conservative approach, because sediment behind the dam is expected to erode and expose the natural channel which will result in a bed surface with a lower elevation, and therefore flood elevations lower than those predicted by this model may be possible.

The Base Flood (100-yr) flow of 3,750 cfs used in the hydraulic model was based on the published 100-yr peak discharge flow in the effective Flood Insurance Study (FIS), dated December 2, 1992. The model was run using the subcritical flow regime for all cases.

Flooding conditions at this site are significantly affected by a distinct flow path present in the left overbank. The river has access to the overbank approximately 100 feet upstream of the current dam impoundment, and escaping flows run parallel to and independently from the main channel flow, separated by a ridge of high ground. The flow path in the overbank is also clearly shown in the FIS inundation map (attached). This divided flow condition makes accurate modeling of the hydraulics at the dam difficult due to the model's computational requirement that the water elevations across a given cross section must be equal, even if there are two parallel flows present. To address this issue, the model was adapted to only simulate flow in the main channel. It was assumed that of the 3,750 cfs in the 100-yr peak discharge, 2,000 cfs would be conveyed in the left overbank and 1,750 cfs would be conveyed in the main channel based on the preliminary model results which suggested approximately that amount of discharge, and engineering judgement. Flow was isolated to the main channel through

the use of ineffective flow boundaries along the ridge separating the main channel from the left overbank.

This model is based on surveyed topographic information collected in 2016, and is not based on the geometry in the effective model. The calculated water surface elevations for the Base Flood are not identical to the effective model elevations, due to the difference in the geometric basis for the models.

Model Results and Discussion

The partial removal of the Geer Dam will create a free-flowing river condition during normal flows and will no longer impound water. Details of predicted performance under lower-flow situations were modeled for a fish-passage evaluation and are included in the dam removal basis of design. Low flow conditions are not particularly relevant to this discussion, which focuses on performance under significant flooding conditions.

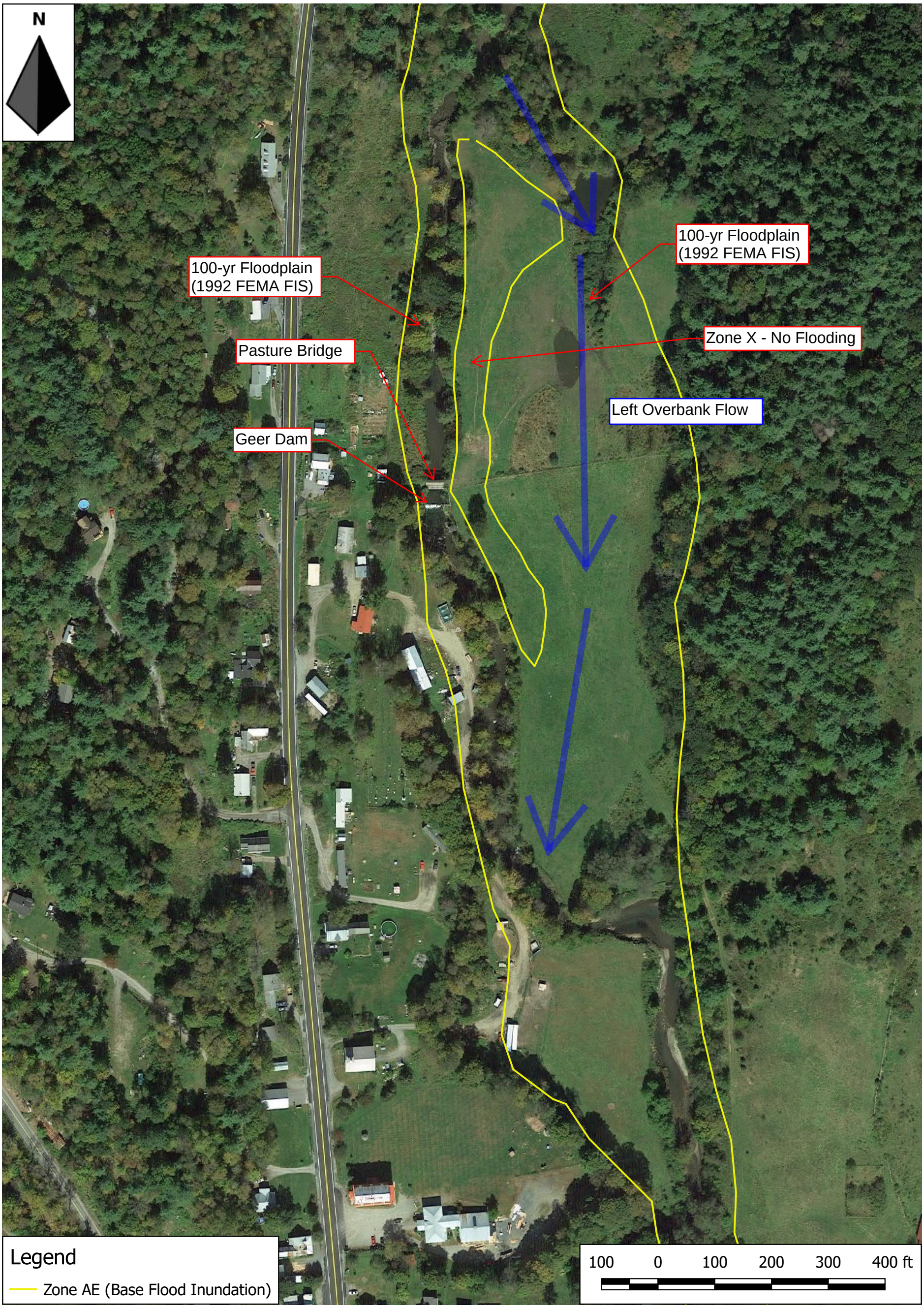
The post-project model results show that during the 100-yr storm, the removal of the dam will have a net reduction in the base flood local to the dam site. The model predicts a reduction in the base flood elevations of approximately 4.0 feet between the dam and the bridge and approximately 0.8 ft in the impoundment.

There are no habitable structures in the direct vicinity of the dam, and this analysis predicts that there will be no change in flood impact to habitable structures due to the partial removal of the Geer Dam structure.

Certification

This document is to certify that I am a duly qualified engineer licensed to practice in the State of Vermont. It is to further certify that the attached technical data supports the fact that the proposed partial removal of the Geer Dam will not result in a rise to the base flood elevations of the Ompompanoosuc River.

STATE OF VERMONT CHANDLER S. ENGEL, P.E. No. 118335 Civil LICENSED PROFESSIONAL ENGINEER 5-17-17 Seal, Signature and Date	Chandler S. Engel Senior Water Resources Engineer DuBois & King, Inc. 28 North Main Street Randolph, VT 05060



DuBois & King Inc.

ENGINEERING • PLANNING
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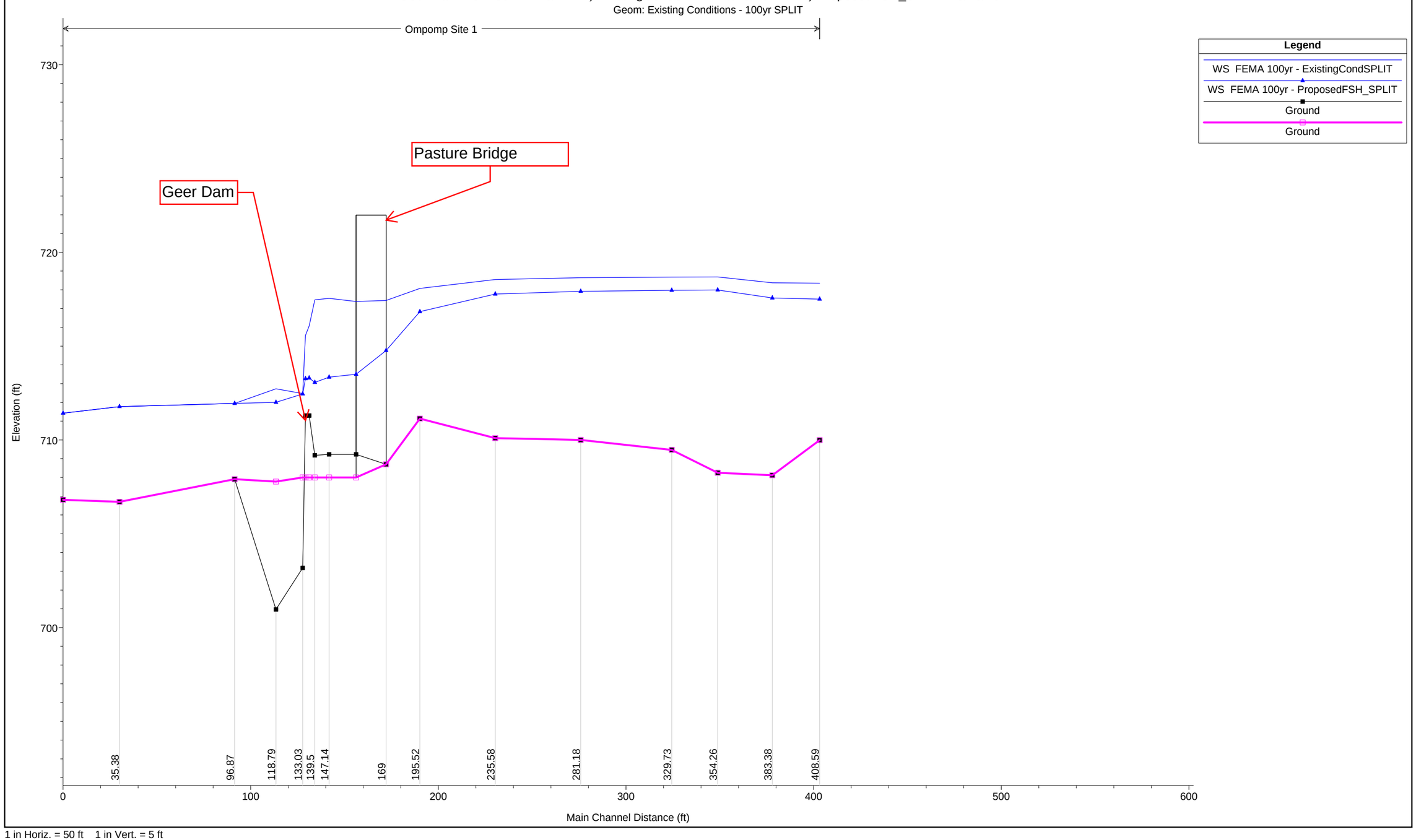
GEER DAM REMOVAL
LOCATION MAP

WEST FAIRLEE, VT

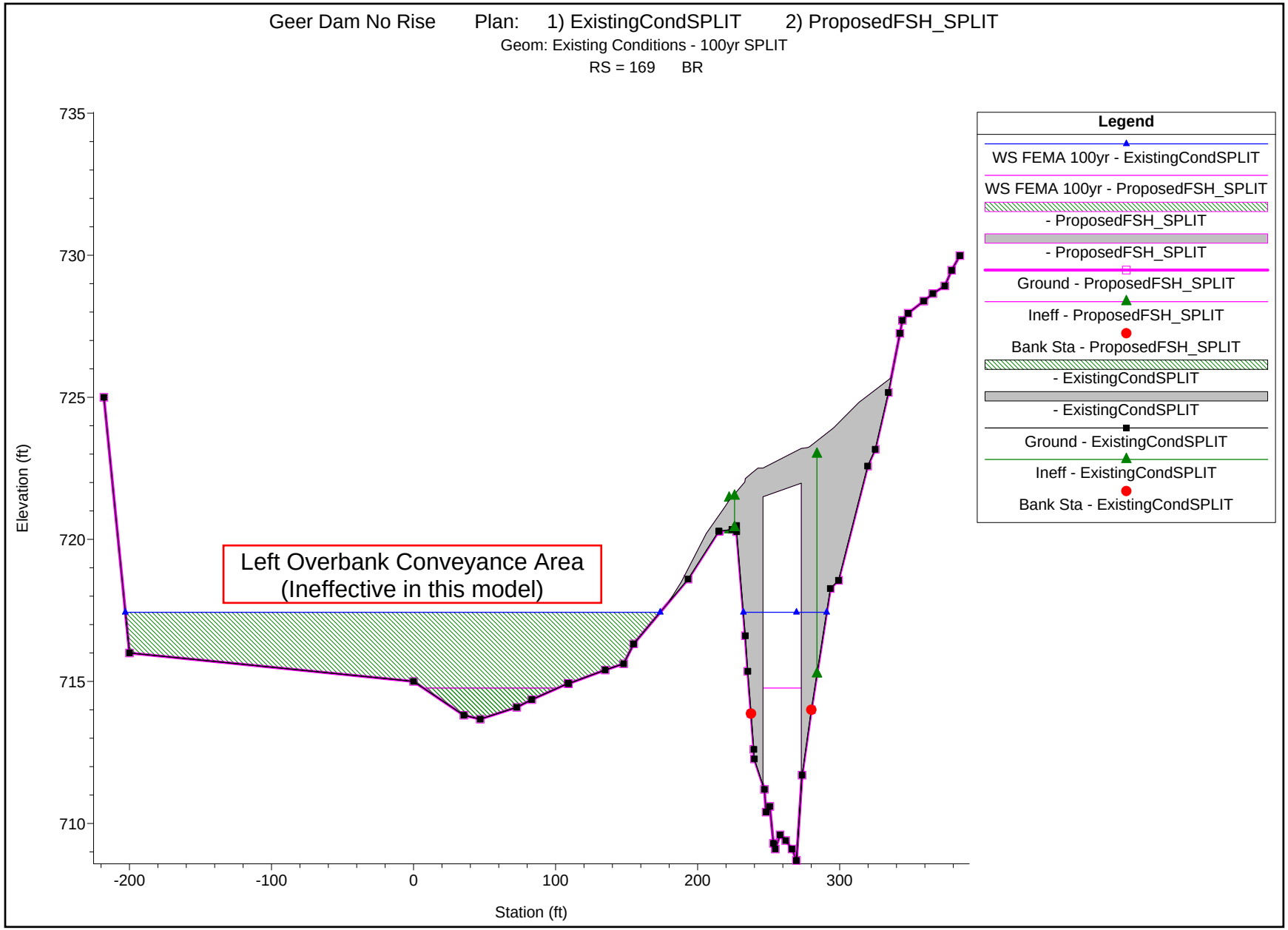
DRAWN BY: CSE	DATE: 4/17/17
CHECKED BY:	PROJECT NUMBER: 123457
PROJECT ENGINEER:	FIGURE NUMBER:
SCALE:	

Geer Dam No Rise Plan: 1) ExistingCondSPLIT 5/15/2017 2) ProposedFSH_SPLIT 5/15/2017

Geom: Existing Conditions - 100yr SPLIT



1 in Horiz. = 50 ft 1 in Vert. = 5 ft



1 in Horiz. = 100 ft 1 in Vert. = 5 ft

HEC-RAS River: Ompomp Reach: Site 1 Profile: FEMA 100yr

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 1	408.59	FEMA 100yr	ExistingCondSPLIT	1750.00	709.99	718.36	716.72	719.40	0.004668	8.49	225.31	311.80	0.58
Site 1	408.59	FEMA 100yr	ProposedFSH_SPLIT	1750.00	709.99	717.51	716.70	718.99	0.007829	10.02	186.81	287.38	0.74
Site 1	383.38	FEMA 100yr	ExistingCondSPLIT	1750.00	708.12	718.38	715.96	719.25	0.003356	7.82	246.77	304.24	0.49
Site 1	383.38	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.12	717.57	715.95	718.73	0.005091	8.95	211.97	282.77	0.60
Site 1	354.26	FEMA 100yr	ExistingCondSPLIT	1750.00	708.25	718.69	714.96	719.04	0.001150	5.19	391.73	370.89	0.31
Site 1	354.26	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.25	717.99	714.96	718.44	0.001602	5.80	345.90	351.51	0.36
Site 1	329.73	FEMA 100yr	ExistingCondSPLIT	1750.00	709.47	718.68	714.83	719.00	0.001128	4.74	406.18	471.02	0.30
Site 1	329.73	FEMA 100yr	ProposedFSH_SPLIT	1750.00	709.47	717.98	714.83	718.39	0.001618	5.32	355.64	443.08	0.36
Site 1	281.18	FEMA 100yr	ExistingCondSPLIT	1750.00	710.00	718.65	714.63	718.94	0.001007	4.54	425.10	498.30	0.29
Site 1	281.18	FEMA 100yr	ProposedFSH_SPLIT	1750.00	710.00	717.92	714.63	718.30	0.001468	5.13	371.15	479.59	0.34
Site 1	235.58	FEMA 100yr	ExistingCondSPLIT	1750.00	710.10	718.55	714.95	718.89	0.001220	4.85	397.03	475.16	0.31
Site 1	235.58	FEMA 100yr	ProposedFSH_SPLIT	1750.00	710.10	717.78	714.95	718.22	0.001855	5.56	341.57	451.67	0.38
Site 1	195.52	FEMA 100yr	ExistingCondSPLIT	1750.00	711.14	718.08	715.72	718.72	0.002793	6.59	279.76	441.10	0.46
Site 1	195.52	FEMA 100yr	ProposedFSH_SPLIT	1750.00	711.14	716.84	715.72	717.91	0.006081	8.42	215.97	407.80	0.66
Site 1	169			Bridge									
Site 1	147.14	FEMA 100yr	ExistingCondSPLIT	1750.00	709.23	717.55	714.31	718.14	0.002053	6.30	291.61	398.06	0.41
Site 1	147.14	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.00	713.35	713.35	715.44	0.015419	11.61	151.11	36.51	0.99
Site 1	139.5	FEMA 100yr	ExistingCondSPLIT	1750.00	709.18	717.47	713.98	718.11	0.003179	6.44	271.78	370.98	0.41
Site 1	139.5	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.00	713.07	712.85	714.99	0.015924	11.13	157.26	35.01	0.93
Site 1	136.5	FEMA 100yr	ExistingCondSPLIT	1750.00	711.30	716.08	715.58	717.78	0.013530	10.45	167.44	345.42	0.84
Site 1	136.5	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.00	713.30	712.28	714.69	0.009937	9.45	185.26	35.04	0.72
Site 1	134.5	FEMA 100yr	ExistingCondSPLIT	1750.00	711.30	715.57	715.57	717.70	0.019133	11.70	149.51	336.24	1.00
Site 1	134.5	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.00	713.27	712.28	714.67	0.010104	9.49	184.36	35.04	0.73
Site 1	133.03	FEMA 100yr	ExistingCondSPLIT	1750.00	703.18	712.47	709.33	713.26	0.002628	7.18	253.76	35.10	0.45
Site 1	133.03	FEMA 100yr	ProposedFSH_SPLIT	1750.00	708.00	712.45	712.45	714.57	0.018086	11.68	149.79	35.13	1.00
Site 1	118.79	FEMA 100yr	ExistingCondSPLIT	1750.00	700.97	712.73	708.81	713.11	0.001405	5.01	362.84	59.89	0.32
Site 1	118.79	FEMA 100yr	ProposedFSH_SPLIT	1750.00	707.78	712.01	711.51	713.24	0.009342	9.04	200.62	56.41	0.79
Site 1	96.87	FEMA 100yr	ExistingCondSPLIT	1750.00	707.91	711.95	711.42	712.98	0.008727	8.26	219.34	69.02	0.75
Site 1	96.87	FEMA 100yr	ProposedFSH_SPLIT	1750.00	707.91	711.95	711.43	712.98	0.008727	8.26	219.34	69.02	0.75

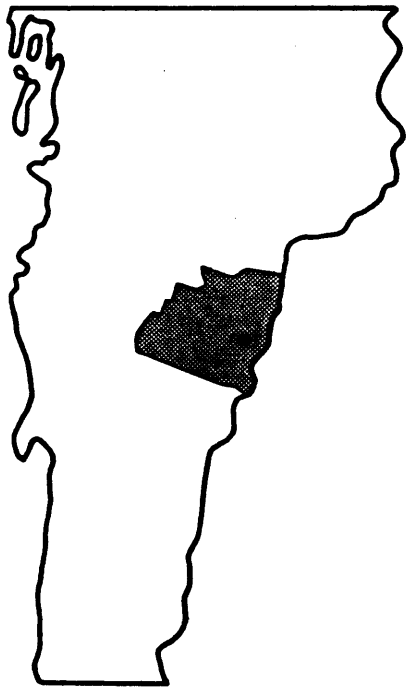
Dam

HEC-RAS River: Ompomp Reach: Site 1 Profile: FEMA 100yr (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 1	35.38	FEMA 100yr	ExistingCondSPLIT	1750.00	706.70	711.78	710.56	712.51	0.004677	7.03	262.83	69.91	0.57
Site 1	35.38	FEMA 100yr	ProposedFSH_SPLIT	1750.00	706.70	711.78	710.55	712.51	0.004677	7.03	262.83	69.91	0.57
Site 1	5.26	FEMA 100yr	ExistingCondSPLIT	1750.00	706.81	711.43	710.66	712.33	0.006502	7.88	238.45	71.42	0.67
Site 1	5.26	FEMA 100yr	ProposedFSH_SPLIT	1750.00	706.81	711.43	710.65	712.33	0.006502	7.88	238.45	71.42	0.67

FLOOD INSURANCE STUDY

TOWN OF WEST FAIRLEE, VERMONT
ORANGE COUNTY



REVISED:
DECEMBER 2, 1992

Federal Emergency Management Agency

COMMUNITY NUMBER - 500079

and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

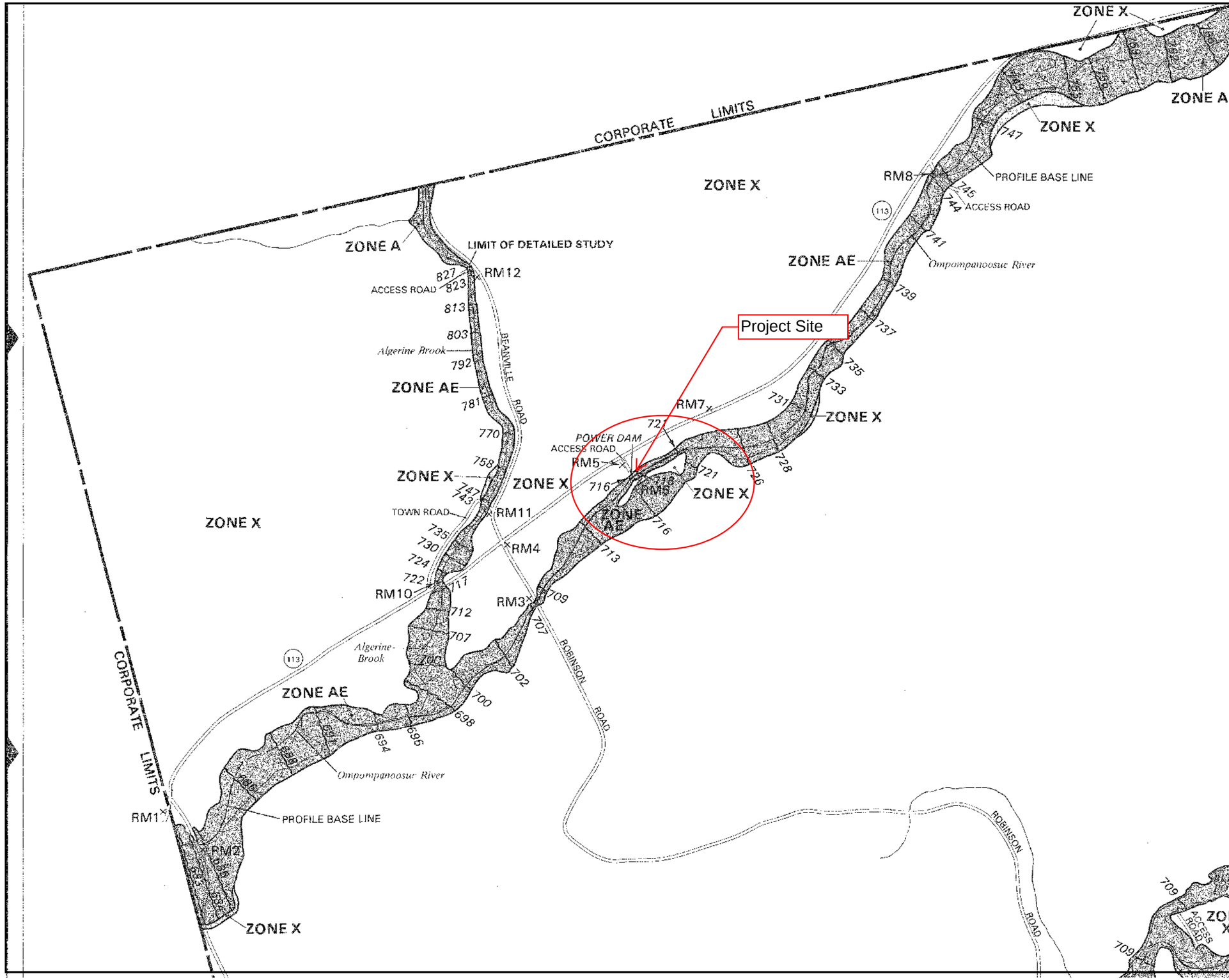
Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Flood runoff volumes and flow rates were developed using the SCS computer model described in Technical Release No. 20 (Reference 3). Flow-frequency values from this hydrologic model were adjusted as necessary in analyzing them along with values from similar gaged watersheds. Floodplain geometry and hydraulic characteristics were acquired by field surveys along the river systems. Flood-frequency surfaces were computed using the adjusted flows from the hydrologic model as inputs to water surface profile development, using the SCS's Technical Release No. 61 (Reference 4).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 -- SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR
OMPOMPANOOSUC RIVER					
At County Route 1	29.7	2,850	4,800	5,900	8,000
At Confluence of Algerine Brook	29.1	2,900	4,900	5,900	8,000
At Power Dam	19.3	1,800	3,050	3,750	5,100
ALGERINE BROOK					
At State Route 113	9.5	1,350	2,250	2,800	3,800



insurance agent or call the National Flood Insurance Progra

APPROXIMATE SCALE

1000

NDEX

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
and
STREET INDEX

TOWN OF
WEST FAIRLEE,
VERMONT
ORANGE COUNTY

ONLY PANEL PRINTED

MAP LOCATOR DIAGRAM

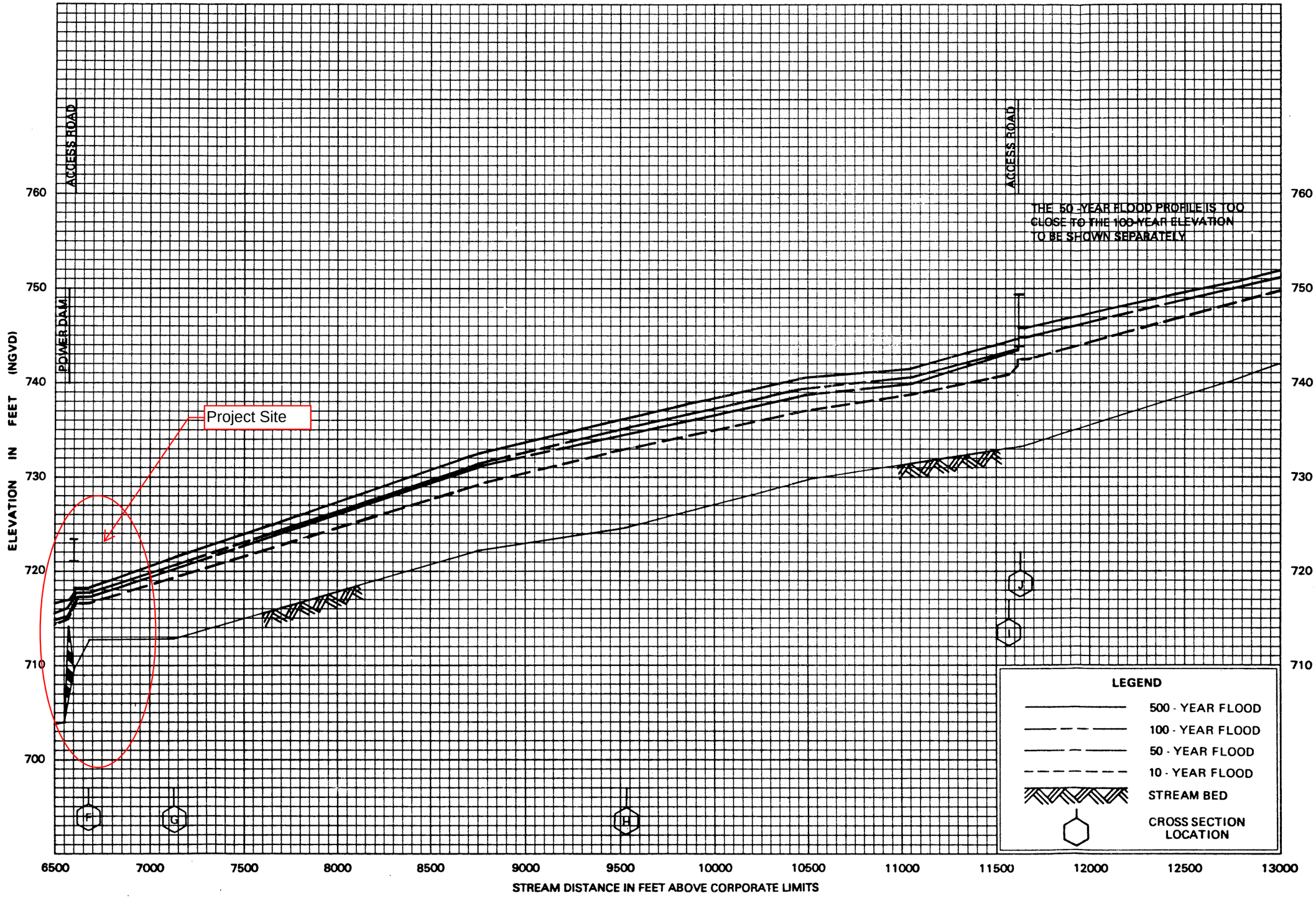
*PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS

COMMUNITY-PANEL NUMBER
500079 0005 B

MAP REVISED:
DECEMBER 2, 1992

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



FLOOD PROFILES

OMPOMPANOOSUC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF WEST FAIRLEE, VT

(ORANGE CO.)

02P