Memorandum

To: Paul Vlasich, PE
Exeter Town Engineer

Date: December 30, 2016
REVISED December 9, 2019

Project #: 52151.05

From: Dave Cloutier
Jake San Antonio, PE

Re: Dam Breach Analysis
Pickpocket Dam
Exeter, NH

Background

In accordance with RSA 482:12 and Env-Wr 302.02, the New Hampshire Department of Environmental Services, Dam Bureau (NHDES) performed a dam inspection of the Pickpocket Dam on September 10, 2010. The dam is currently owned and operated by the Town of Exeter. Based on the results of the inspection, in addition to subsequent analysis, NHDES issued a Letter of Deficiency (LOD) for the Pickpocket Dam on March 28, 2011 identifying deficiencies and remedial measures that NHDES requires. The LOD required that the Town of Exeter perform a breach analysis for the Pickpocket Dam in accordance with NHDES Env-Wr 500 and report the results to the Dam Bureau.

In October 2016, the Town of Exeter contracted VHB to perform breach analyses for the dam for both the "sunny day" breach, as well as a breach routed with the 100-year flood event, in accordance with NHDES Env-Wr 502. VHB evaluated the downstream effects of a potential dam failure and developed potential dam break inundation mapping in accordance with NHDES Env-Wr 503. VHB provided the initial draft of this memo on December 30, 2016, presenting the results of the dam breach analysis to the Town of Exeter.

DECEMBER 2019 UPDATE:

The initial December 30, 2016 Dam Breach Analysis memo identified potential impacts to multiple residential structures following a dam breach, but because the analysis was based on macro-scale topography at these locations the impacts could not be confirmed. At the request of the Town of Exeter, VHB performed field survey at these locations to determine the first-floor elevations, adjacent ground elevations, and basement elevations (if applicable) for the potentially impacted structures. Survey results indicated that the first floor of at least one residence would be inundated under the predicted dam breach model scenario. VHB provided a revised Dam Breach Analysis memo to the Town of Exeter on December 15, 2017 incorporating this additional data.

The Town of Exeter forwarded the revised Dam Breach Analysis memo to NHDES, who provided review comments in a letter dated February 12, 2018. Based on the results of the Dam Breach Analysis, specifically the model prediction that a dam breach during the 100-year flood event would result in flooding of at least one residential building structure, NHDES reclassified the Pickpocket Dam as a "High Hazard" dam in a letter dated March 15, 2018. NHDES also issued a draft Letter of Deficiency (DSP #18-032) on May 21, 2018.

Following this reclassification of the Pickpocket Dam by NHDES, the Town of Exeter and VHB met with NHDES Dam Bureau staff on June 27, 2019 to discuss the new classification, outstanding dam deficiencies, and NHDES review comments. Based on discussion at this meeting, VHB collected supplemental topographic survey at additional potentially impacted structures identified by NHDES, and prepared a revised dam breach hydraulic model and inundation map incorporating NHDES review comments. The following revised Dam Breach Analysis memo incorporates changes addressing all Town and DES inputs after the initial December 30, 2016 memo date.

101 Walnut Street
PO Box 9151
Watertown, MA 02472-4026
P 617.924.1770

The following sections summarize VHB's hydrologic and hydraulic model results for the required dam breach analyses. The results also include an assessment of all structures potentially impacted by a dam failure, including the depth of flooding at critical structures or groups of structures, and a discussion of the resulting hazard classification update from NHDES. All elevations in this memorandum are reported in feet and are relative to the North American Vertical Datum of 1988 (NAVD88).

Site Description

Pickpocket Dam is located within the Exeter River along the municipal boundary between the towns of Exeter and Brentwood, NH. Pickpocket Dam is an earth embankment dam with a concrete spillway and end walls, and was last repaired/rebuilt in 1969. The dam is 15-feet high (from dam toe to top of abutments), 230-feet in total length, and the main spillway length is approximately 130 feet. During a dam inspection performed by NHDES, and attended by VHB and the Town of Exeter, on December 14, 2016, it was determined that the island located immediately upstream of the dam on river-right likely limits conveyance over the dam. Based on site inspection and review of aerial topography, VHB estimates that conveyance across approximately 45 linear feet across the dam would be limited by the island. The location of the dam is shown in Figure 1.

The contributing drainage area to Pickpocket Dam is approximately 74 square miles. Landcover within the watershed consists predominately of forested, agricultural, and residential. The watershed is hilly with a well-defined river channel and bordering wetlands. The River maintains a sinuous and meandering pattern with an average slope of 0.05 % upstream of the dam and 0.04 % downstream of the dam. River depth upstream of the dam ranges from 1 foot to 10 feet.

Model Input Data Collection

Data for the hydrologic and hydraulic models for this breach analysis were collected from the following sources:

Site Visit and Photographs

VHB staff visited the Pickpocket Dam site and surrounding area on October 12, 2016 and December 14, 2016. Field notes were recorded for information relative to the dam breach including dam geometry, vegetative cover, and structures or critical areas within the potential inundation area.

In response to comments from the February 12, 2018 NHDES Review Comments letter, VHB staff visited the Court Street crossing on April 30, 2019 to measure dimensions and elevations of the precast concrete overflow culvert located approximately 800 feet south of the Court Street bridge over the Exeter River. These measurements were used to incorporate the overflow culvert into a revised hydraulic model addressing NHDES review comments.

Newly Acquired Survey Data

Survey data at Pickpocket Dam was collected by VHB on October 17, 2016. The collected survey data included dam geometry and inverts, fish weir geometry and elevations, 1-ft contour data adjacent to and 200-feet downstream of the dam, and Cross Road bridge geometry, inverts, and elevations.

GIS

Using the New Hampshire GRANIT GIS Clearinghouse, VHB obtained LiDAR data collected by the USGS in winter and spring of 2011. VHB used the LiDAR data to develop a digital elevation model (DEM) for use in developing extracting cross sections for use in the hydraulic model. VHB georeferenced hydraulic input data from the National Flood Insurance Program (NFIP) Effective Flood Insurance Study (FIS) for Rockingham County, dated May 17, 2005, for the Exeter River upstream of Pickpocket Dam and combined this data with georeferenced hydraulic inputs from the NFIP Preliminary model for Rockingham County, dated February 2016, for the reach downstream of Pickpocket Dam.

Previous Studies

VHB collected relevant information from the following sources:

1. NHDES Dam Bureau File for Pickpocket Dam #029.07 provided historic data including inspections, photographs, construction plans for repair, letters of deficiency, and other relevant correspondence.
2. The 2013 rainfall-runoff model developed using HEC-HMS (Hydrologic Engineering Center, Hydrologic Modeling System) software and accompanying report from Weston & Sampson (W&S) was used to develop runoff hydrographs for inputs in the hydraulic model. VHB reviewed model inputs, watershed based hydrologic parameters, and outlet configurations to confirm model applicability for the breach analysis.
3. Two NFIP flood insurance studies, and associated hydraulic models, were used to develop the hydraulic model for the Exeter River both upstream and downstream of Pickpocket Dam. There is an effective study from May 17, 2005 (modeling completed in April 1998) for the Exeter River upstream of the Pickpocket Dam and a preliminary study from February 24, 2016 (modeling completed in April 2014) for the Exeter River from the confluence with the Squamscott River upstream to the Pickpocket Dam.

Hydrologic Analysis

Weston & Sampson performed a hydrologic analysis of the Exeter River Watershed (which includes the Pickpocket Dam) in 2013 to estimate storm event based peak flows to be used as part of the Great Dam Removal Feasibility Study, completed by VHB. The hydrologic analysis was conducted in accordance with NHDES Env-Wr 403.05 - "Hydrologic Investigations" guidance.

The rainfall-runoff model was developed within HEC-HMS, version 3.5, a hydrologic rainfall-runoff model developed by the US Army Corps of Engineers (USACE). The model utilized the SCS curve number method to estimate runoff hydrographs resulting from storm event based precipitation. Model watershed input parameters include drainage area, development and land use characteristics, hydrologic soil groups, NRCS runoff coefficient (curve number), initial abstraction, and times of concentration. VHB reviewed the model inputs to identify any necessary updates or changes that should be included since the model's development.

- VHB updated model precipitation totals and distribution curves using National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates. NOAA Atlas 14 estimates a 100-year,

24-hour precipitation total of 8.40 inches, which is slightly less than the 8.46 inches used in the original W&S model. VHB obtained the US Department of Agriculture's "Spreadsheet for Rainfall Distributions developed for NOAA Atlas 14 Data" from www.usda.gov. This spreadsheet requires the user to input the rainfall depths for the 5-min, 10-min, 15-min, 30-min, 60-min, 2-hour, 3-hour, 6-hour, 12-hour, and 24-hour design storms and uses the Atlas 14 ratio to develop the distribution curve.

- VHB used the specified hyetograph method to define the depth and distribution for the 100-year storm, which differs from the frequency-based hypothetical storm method used in the original W&S model. The frequency storm method applies an area correction factor to reduce point estimate precipitation estimates for large watershed areas. This analysis evaluated reduced watershed sizes for the Pickpocket Dam as compared to the contributing area to the Great Dam. Based on guidance from NHDES Dam Bureau staff that the analysis should provide a conservative estimate for peak flows in evaluating risk potential, and advice to use NOAA Atlas 14 data and distributions, VHB selected the specified hyetograph method for this analysis.
- Subwatershed times of concentration (Tc) and associated lag times calculated in accordance with National Resources Conservation Service (NRCS) National Engineering Handbook, Part 630 Hydrology, Chapter 15 watershed lag method based on calculated flow times for sheet and overland flow using site topographic and land cover data from the original model were used in the analysis.
- Weighted Runoff Curve Numbers (CNs), which are used to characterize runoff properties for specific land use and soil conditions, calculated in accordance with TR-55 methodologies for each subwatershed during the original model were used in this analysis.

VHB estimated the "sunny day" flow based on the annual daily mean flow for the Exeter River at Pickpocket Dam. VHB obtained flow statistics available from USGS *National Water Information System: Web Interface's* Exeter River at Haigh Road station gage (01073587) and scaled the flows based on the contributing watershed size of the gaged location and the subject location. The analysis of 19 years of complete annual record data resulted in a "sunny day" estimated flow of 136 cfs.

Hydraulic Analysis

VHB developed a dynamic (unsteady state) hydraulic model using the U.S. Army Corps of Engineers HEC-RAS (Hydrologic Engineering Center, River Analysis System) (ver. 5.0.7) software to analyze water surface elevations (WSE) and velocities downstream of Pickpocket Dam. Analysis of the Exeter River in the Flood Insurance Study for Rockingham County, NH, was developed from two hydraulic models:

1. The original (Effective) model for Exeter River upstream of Pickpocket Dam developed in April 1998 in HEC-2 format
2. A revised (Preliminary) model for Exeter River downstream of Pickpocket Dam developed in April 2014 as part of the revised analysis for the preliminary study released in February 2016, in HEC-RAS format

VHB requested both models from the FEMA Engineering Library, and the models were provided on November 11, 2016. Additional details for model development are included in the following sections.

The analysis included a "sunny day" breach and a breach routed with the 100-year flood event. VHB routed the flood wave from Pickpocket Dam downstream along the Exeter River beyond a location where the water surface elevation due to failure was no more than 2 feet above the non-failure condition. The study area includes Camelot Drive on Wadleigh Point and Sir Lancelot Drive to evaluate the impacts to residences, which were identified as potential critical evaluation areas by NHDES Dam Bureau staff in the LOD. Downstream of the Route 108 (Court Street) Bridge, water surface elevations for the 100-year breach and non-breach scenarios are similar, and therefore results of the dam breach analyses focus on areas upstream of this bridge.

Model Setup

The Effective model upstream included 13 cross sections between Crawley Falls Road (6.25 miles upstream of Pickpocket Dam) and Pickpocket Dam. There is one bridge crossing (at Haigh Road) within this reach. VHB georeferenced the HEC-2 model of the Exeter River upstream of the Pickpocket Dam and added additional cross sections along the reach. VHB added 51 additional cross sections for a total of 64 cross sections to estimate the impoundment storage upstream of Pickpocket Dam. VHB used the developed DEM from LiDAR and "burned" in channel bathymetry below the normal water line by interpolating the river profile and cross-sectional data provided in the HEC-2 model to estimate river geometry throughout the entire reach. VHB used Geographic Information System (GIS) software, including HEC-GeoRAS to extract cross sectional elevation data from the developed DEM and export the data to HEC-RAS format. Using HEC-RAS, VHB combined the georeferenced upstream model with the preliminary model developed as part of the preliminary FIS to create a combined continuous model of the Exeter River.

Upstream and downstream boundary conditions were provided for the model. The upstream boundary condition was set as outflow hydrograph from the Brentwood Hydro Dam provided in the revised HEC-HMS model developed as part of this analysis. Additional lateral and uniform hydrographs from the HEC-HMS model were included as inputs along the study reach. The downstream boundary condition was set as normal depth based on the channel slope at the lower limit of the model, reflecting the existing conditions of the Exeter River following removal of the Great Dam in 2016. Model scenarios with the Pickpocket Dam sluice gate open and closed during the dam breach were developed as part of this analysis. VHB also evaluated the impact of removing the fish weir located immediately downstream of Pickpocket Dam on water surface elevations downstream.

Breach Parameters

VHB followed the NHDES guidance (Env-Wr 502.06) for selecting dam breach parameters. VHB met with NHDES staff on November 18, 2016 to discuss proposed dam breach parameters. Following the meeting, VHB submitted proposed parameters for NHDES review in December 2016 and discussed the parameters during the December 14, 2016 meeting. NHDES approved the breach parameters during the meeting for the dam breach analysis. The breach parameters for the Pickpocket Dam are show in **Table 1** below.

Table 1: Dam Breach Parameters

Breach Parameter	Sunny Day	100-Year	*Notes*
Average Breach Width (ft)	45	45	*Monolith width*
Bottom Breach Width (ft)	45	45	
Left and Right Side Slopes (Z)	0	0	
Total Time to Failure (hrs.)	0.2	0.2	
Failure Trigger	Set Time (12 hrs. into simulation)	Peak WSE (65.89 ft)	

It was determined dam failure would likely occur from overtopping. VHB evaluated the sensitivity of modifying the total time to failure within the recommended range detailed by NHDES guidance. The sensitivity analysis indicated that there was minimal impact (< 0.05 feet) to water surface elevations, and a failure of 0.2 hrs. was determined to be appropriate.

DECEMBER 2019 UPDATE:

To address comments from the February 12, 2018 NHDES Review Comments letter and the May 21, 2018 NHDES draft Letter of Deficiency, VHB revised the hydraulic model geometry at the Court Street crossing to incorporate the existing 11-foot precast concrete overflow culvert located approximately 800 feet south of the Court Street bridge. This revision also included adjustments to the georeferenced locations of adjacent cross-sections at river stations 19595, 19646, 19704, and 19756; the addition of new intermediate cross-sections at river stations 21701, 22585, 24978, and 25896; and associated adjustments to downstream reach lengths to maintain consistency with georeferenced cross-section locations. Model results for this revised geometry compared to the initial December 15, 2016 model resulted in a difference in WSEs of less than 0.2 feet.

Results

The flows for the sunny day and 100-year storm event were modeled without breaching the dams to provide a baseline to compare the additional impacts caused by a breach of the Pickpocket dam. The breach was then modeled using an unsteady state analysis for the "sunny day" and 100-year event to determine the maximum extent of damage caused by the dam failures. It should be noted flood elevations for the non-breach 100-year storm event are different from 100-year flood elevations presented in the Rockingham County Flood Insurance Study (FIS) because this analysis is based on an unsteady-state model that incorporates the effects of flood storage, while the FIS is based on a simplified steady-state model that does not account for storage.

Model results for scenarios with the Pickpocket Dam sluice gate open and closed during the dam breach resulted in a difference in WSE of less than 0.2 feet. Based on discussions with NHDES staff, only results from model scenarios with the gate closed were used for this analysis. Similarly, results from an alternative scenario with the fish weir located immediately downstream of Pickpocket Dam removed, predicted a difference in WSE of less than 0.2 feet. Based on limited impact of removing the fish weir, results for the breach analyses performed during this study include the fish weir in place.

Inundation mapping was developed for the breach analyses model runs for the "sunny day" and 100-year event. The inundation maps were created using the HEC-RAS tool, RAS Mapper, and the DEM developed as part of this analysis. Figure 2-1 through 2-4 depict the predicted downstream flood water boundaries and the following:

- The location of prominent structures and features adjacent to the river.
- The mean channel velocity during the peak flow condition.
- The peak water surface elevation and resulting increase in flood heights due to dam breach.
- The time from the start of dam breach to the arrival of the flood wave.
- The time from the start of dam breach to the peak water surface elevation.

The following tables summarize hydraulic modeling results at important locations for each breach scenario.

Table 2 – Breach Summary for Sunny Day Event

River Station	Description	Structure Elevation (ft)	Baseline Elevation (ft)	Breach Elevation (ft)	Time to Flood Wave Arrival (min)	Time to Peak WSE (min)	Channel Velocity (ft/sec)
40787	Pickpocket Dam	51.0	61.7	61.7	0:00	0:00	0.1
40628	Cross Rd Bridge	60.0*	46.7	51.2	0:01	0:12	8.8
36392	95 Kingston Road	45.3**	32.1	38.3	0:07	0:32	2.9
36392	97 Kingston Road	46.8**	32.1	38.3	0:07	0:32	2.9
36289	Kingston Road Bridge	45.4*	31.8	38.1	0:08	0:33	5.4
32728	24 Powder Mill Road	40.2***	23.9	29.4	0:20	1:15	3.2
31340	Railroad Bridge	45.1*	23.4	28.8	0:16	1:18	3.7
28054	Camelot Drive (West)	35.6**	22.5	27.0	0:22	1:28	3.4
26908	Camelot Drive (East)	35.1**	22.2	26.5	0:25	1:32	3.1
24978	King Arthur Court	34.6**	21.8	25.8	0:29	1:39	3.1
24483	Linden Street Bridge	35.9*	21.3	25.0	0:30	1:40	5.6
22585	Green Gate Hall	33.3***	20.9	24.5	0:33	1:56	1.9
19756	161 Court Street	34.6***	20.8	24.3	0:37	2:19	2.1
19756	171 Court Street	31.5***	20.8	24.3	0:37	2:19	2.1
19703	Court Street Bridge	31.8*	20.8	24.2	0:38	1:35	2.1

** High chord (top of road) elevation*
***First floor elevation from October 2017 field survey by VHB*
****First floor elevation from August 2019 field survey by VHB*

Table 3 – Breach Summary for 100-Year Event

River Station	Description	Structure Elevation (ft)	Baseline Elevation (ft)	Breach Elevation (ft)	Time to Flood Wave Arrival (min)	Time to Peak WSE (min)	Channel Velocity (ft/sec)
40787	Pickpocket Dam	51.0	65.9	66.4	0:00	0:00	0.1
40628	Cross Rd Bridge	60.0*	53.2	60.4	0:01	0:15	10.8
36392	95 Kingston Road	45.3**	45.6	46.9	0:04	0:59	3.5
36392	97 Kingston Road	46.8**	45.6	46.9	0:04	0:59	3.5
36289	Kingston Road Bridge	45.4*	45.4	46.7	0:05	1:00	5.3
32728	24 Powder Mill Road	40.2***	33.3	34.2	0:20	3:50	3.5
31340	Railroad Bridge	45.1*	32.7	33.6	0:25	3:55	7.0
28054	Camelot Drive (West)	35.6**	32.4	33.2	0:34	5:15	3.4
26908	Camelot Drive (East)	35.1**	31.9	32.6	0:37	6:00	4.4
24978	King Arthur Court	34.6**	31.2	31.7	0:44	6:58	4.3
24483	Linden Street Bridge	35.9*	29.5	30.1	0:45	7:00	7.9
22585	Green Gate Hall	33.3***	27.5	27.9	1:02	6:42	4.8
19756	161 Court Street	34.6***	26.7	27.2	1:34	6:24	6.6
19756	171 Court Street	31.5***	26.7	27.2	1:34	6:24	6.6
19703	Court Street Bridge	31.8*	26.6	27.1	1:35	6:25	6.7

** High chord (top of road) elevation*
***First floor elevation from October 2017 field survey by VHB*
****First floor elevation from August 2019 field survey by VHB*

Hazard Classification

The Pickpocket Dam was previously assigned a classification of "Low Hazard", as indicated in the NHDES Dam Data Sheet. This dam breach modeling was performed to evaluate whether the current hazard classification for Pickpocket Dam is appropriate; the results of the modeling performed for both the sunny day event and 100-year storm event are attached. Following discussion with NHDES dam bureau staff, a "worst case" analysis was used in determining the recommended hazard classification. NHDES indicated that the 100-year event should be used as the "worst case" scenario for this analysis.

LiDAR topographic data was used for the initial evaluation of potential impacts to residential structures following a dam breach, identifying potential structural impacts at the following locations:

- 95 & 97 Kingston Road
- 900 – 1018 Camelot Drive
- 15 – 21 Sir Lancelot Drive (including 510 King Arthur Court)

DECEMBER 2019 UPDATE

In addition to these primary locations, NHDES Dam Bureau staff identified additional potential impacts in the February 12, 2018 NHDES Review Comments letter and May 21, 2018 draft Letter of Deficiency (DSP #18-032):

- 24 Powder Mill Road
- 161 & 171 Court Street
- 185 Court Street (Green Gate Hall)

At the request of the Town of Exeter, VHB performed field survey at these locations to determine the first-floor elevations basement elevations (if applicable) for the potentially impacted structures. For mobile homes on Camelot Drive and Sir Lancelot Drive, VHB also surveyed adjacent ground elevations to identify potential impacts to mobile home foundations. VHB then reviewed these elevations against the maximum WSEs predicted by the 100-year flood dam breach model scenario. The results of this survey are summarized in Table 4 (attached).

Model results for the failure of the Pickpocket Dam during the 100-year storm event predict greater than one-foot increase in flood heights that exceed the first-floor elevation of at least one residence with a foundation. Specifically, the model predicts flood waters to exceed the first floor of 97 Kingston Road by 0.1 feet, and a portion of the first floor of 95 Kingston Road by 1.6 feet (the structure of 95 Kingston Road is split-level; part of the first floor is below the flood level and part is above).

Based on these model results, the NHDES Dam Bureau reclassified the Pickpocket Dam as a "High Hazard" structure in a letter dated March 15, 2018. This reclassification was based on the model results meeting specific high hazard criteria in the New Hampshire Dam Safety Rules. Specifically, NHDES Env-Wr 101.21(b) defines dam structures as "High Hazard" in cases where dam failure would result in probable loss of human life as a result of water levels rising above the first-floor elevation of a habitable residential structure when the rise dye to dam failure is greater than one foot.

The NHDES review also considered additional potential impacts identified in the dam breach model results:

- Model results indicate potential flooding impacting the structural supports of mobile residential structures along Camelot Drive. Although field survey indicates that the first floor elevations of all buildings along this road are at least 2 feet above the flood water surface elevation, the ground elevation at some structures is below the peak flood water surface elevation. Structural analysis of these structures was not performed as part of this analysis, but it is possible that Pickpocket dam also meets NHDES Env-Wr 101.21 condition (a): water levels causing the structural failure of a habitable residential structure.
- Additionally, the model results for the failure of the Pickpocket dam during the 100-year storm event predict overtopping of Cross Road (a Class V roadway) and Route 111 (Kingston Road) (a Class II roadway) that would make these roads impassable. The predicted overtopping of Route 111, a Class II roadway, indicates Pickpocket dam could be re-classified as a "Significant Hazard" dam at a minimum, in accordance with NHDES Env-Wr 101.39 condition (c).

Following the re-classification of Pickpocket Dam as a "High Hazard" structure, NHDES issued a revised Letter of Deficiency dated July 25, 2019 that included additional deficiencies of the dam resulting from the reclassification. As of December 2019, the Town of Exeter is in the process of addressing these deficiencies.

Table 4: Summary of Residential Structure First Floor Elevations

Elevation Datum: NAVD 1988
Elevation Units: US Survey Feet

Sir Lancelot Drive			
Unit #	Elevation Location	Floor Elev.	Ground Elev.
15	Front Door Sill	37.8	34.2
16	Front Door Sill	38.7	35.3
17	Front Door Sill	39.5	36.2
18	Front Door Sill	39.9	36.9
19	Front Door Sill	40.9	37.0
20	Front Door Sill	41.0	37.4
21	Front Door Sill	39.8	36.8

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
21.8	25.0	29.5	30.1
21.8	25.0	29.5	30.1
21.8	25.0	29.5	30.1
21.8	25.0	29.5	30.1
21.8	25.0	29.5	30.1
21.8	25.0	29.5	30.1
21.8	25.0	29.5	30.1

Camelot Drive			
Unit #	Elevation Location	Floor Elev.	Ground Elev.
900	Front Door Sill	39.7	38.0
902	Front Door Sill	36.1	34.4
903	Front Door Sill	36.0	33.3
904	Front Door Sill	35.6	32.5
905	Front Door Sill	36.4	34.0
906	Front Door Sill	37.6	33.9
907	Front Door Sill	37.1	33.9
908	Front Door Sill	37.4	34.2
909	Front Door Sill	37.5	34.5
910	Front Door Sill	37.8	34.6
911	Front Door Sill	38.3	34.9
912	Front Door Sill	40.1	34.5
1003	Side Door Sill	39.6	37.0
1004	Front Door Sill	36.9	33.2
1005	Front Door Sill	36.1	32.4
1006	Front Door Sill	35.1	32.4
1007	Front Door Sill	36.4	33.3
1008	Front Door Sill	35.9	33.3
1009	Front Door Sill	36.1	32.2
1011	Side Door Sill	37.0	33.5
1012	Front Door Sill	36.7	33.5
1013	Front Door Sill	37.3	33.3
1014	Front Door Sill	36.6	34.2
1016	Front Door Sill	37.5	34.5
1017	Front Door Sill	37.6	34.4
1018	Front Door Sill	37.7	33.9

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.5	27.0	32.4	33.2
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6
22.2	26.5	31.9	32.6

King Arthur Court			
Unit #	Elevation Location	Floor Elev.	Ground Elev.
510	Front Door Sill	34.6	31.8

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
21.8	25.0	29.5	30.1

Table 4: Summary of Residential Structure First Floor Elevations

Elevation Datum: NAVD 1988
Elevation Units: US Survey Feet

Kingston Road		
Street #	Elevation Location	Elev.
95	Side Door Sill	45.3
95	Front Door Sill Lt	49.2
95	Front Door Sill Mid	50.9
95	Front Door Sill Rt	50.9
97	Basemt Garage Slab	39.5
97	Front Door Sill	46.8

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
32.1	38.3	45.6	46.9
32.1	38.3	45.6	46.9
32.1	38.3	45.6	46.9
32.1	38.3	45.6	46.9
32.1	38.3	45.6	46.9
32.1	38.3	45.6	46.9

24 Powder Mill Road		
Street #	Elevation Location	Elev.
24	Front Door Sill	40.2
24	Finish Floor	40.2
24	Attached Garage Slab	34.8
24	Detached Garage Slab	34.9

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
23.9	29.4	33.3	34.2
23.9	29.4	33.3	34.2
23.9	29.4	33.3	34.2
23.9	29.4	33.3	34.2

161 Court Street		
Street #	Elevation Location	Elev.
161	Front Door Sill	34.6
161	Finish Floor	34.6
161	Garage Slab	31.5
161	Basement Floor	30.6

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
20.8	24.3	26.7	27.2
20.8	24.3	26.7	27.2
20.8	24.3	26.7	27.2
20.8	24.3	26.7	27.2

171 Court Street		
Street #	Elevation Location	Elev.
171	Front Door Sill	31.5
171	Finish Floor	31.5
171	Crawl Space Window Sills	29.5
171	Crawl Space Entrance	27.0

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
20.8	24.3	26.7	27.2
20.8	24.3	26.7	27.2
20.8	24.3	26.7	27.2
20.8	24.3	26.7	27.2

185 Court Street - Green Gate Hall		
Street #	Elevation Location	Elev.
185	Front Door Sill-Level 1	34.4
185	Finish Floor-Level 1	34.4
185	Side Door Sill-Level 2	33.3
185	Finish Floor-Level 2	33.3
185	Basement Door Entrance	26.2

Peak Water Surface Elevations			
Sunny Day	Sunny Day Breach	100-Year	100-yr Breach
20.9	24.5	27.5	27.9
20.9	24.5	27.5	27.9
20.9	24.5	27.5	27.9
20.9	24.5	27.5	27.9
20.9	24.5	27.5	27.9

Notes:

1) All homes on Camelot Drive, Sir Lancelot Drive, and King Arthur Court are manufactured homes on wheels and/or blocks. Ground elevation is the lowest measured elevation below home.

2) The 2 homes on Kingston Rd are wood framed homes on concrete foundations.

3) All elevations were obtained at lowest accessible entry point to home.

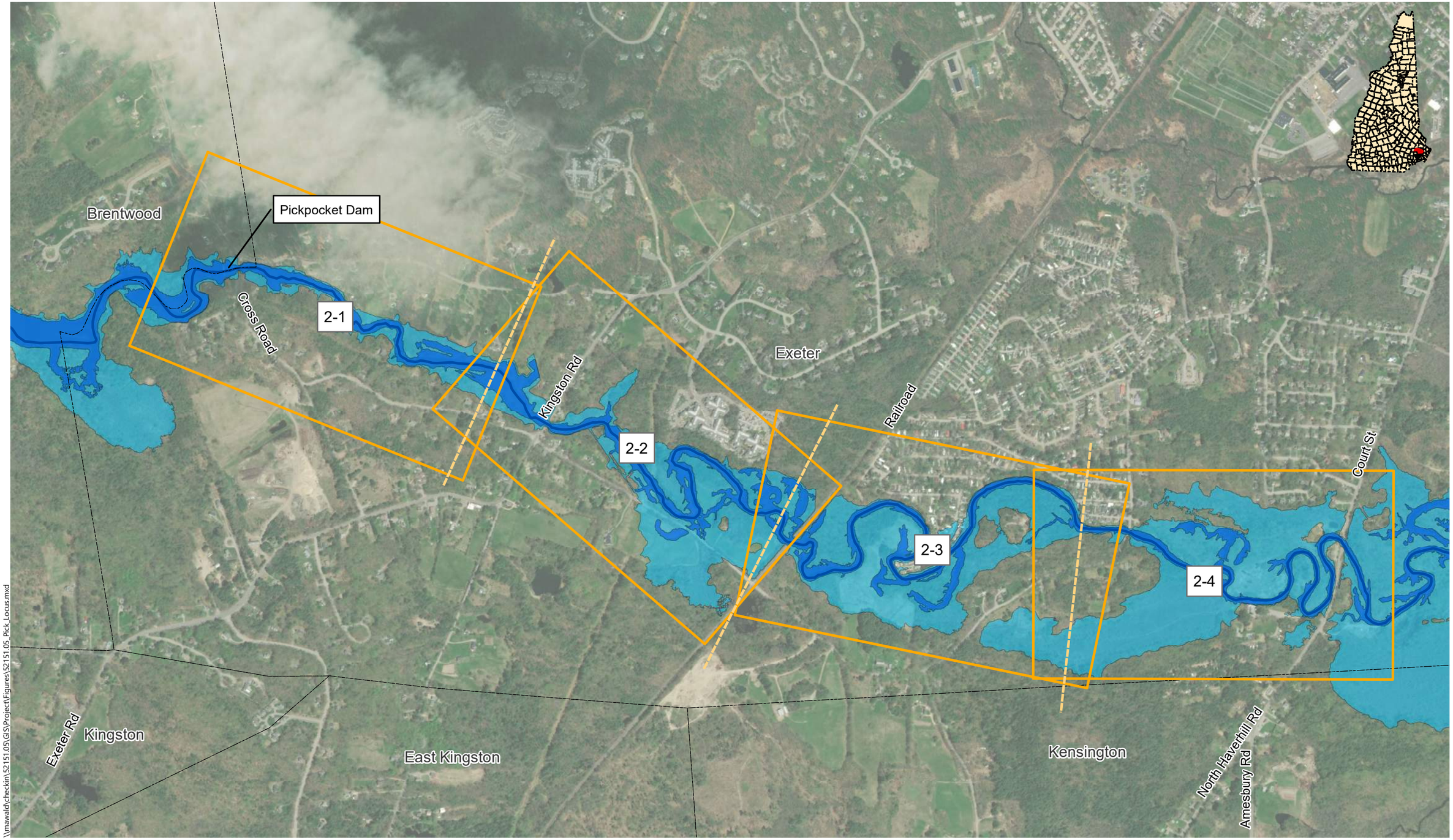

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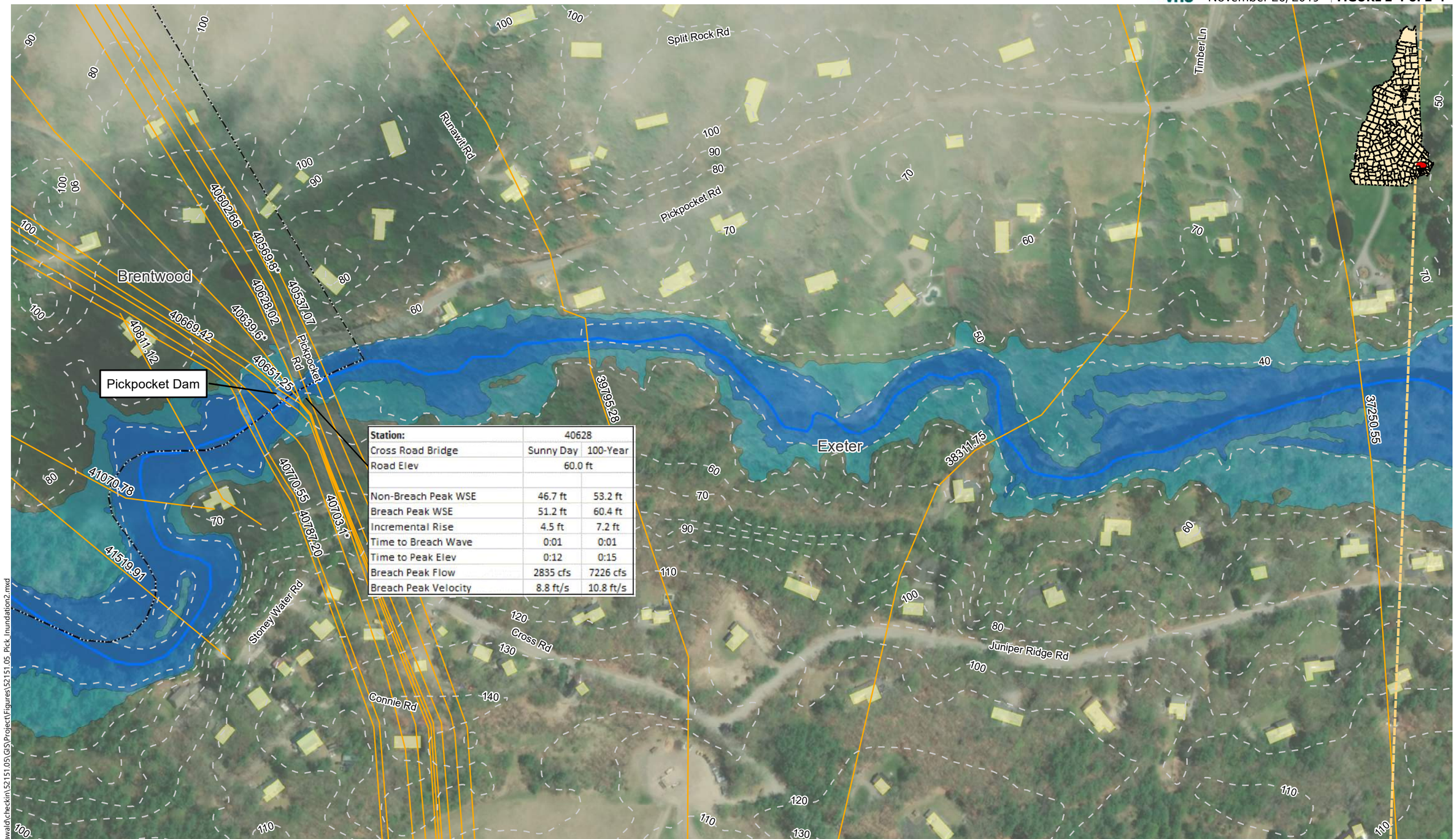
FIGURE 1 - Locus

Source Info: USGS, Google, VHB



Station:	40628	
Cross Road Bridge	Sunny Day	100-Year
Road Elev	60.0 ft	
Non-Breach Peak WSE	46.7 ft	53.2 ft
Breach Peak WSE	51.2 ft	60.4 ft
Incremental Rise	4.5 ft	7.2 ft
Time to Breach Wave	0:01	0:01
Time to Peak Elev	0:12	0:15
Breach Peak Flow	2835 cfs	7226 cfs
Breach Peak Velocity	8.8 ft/s	10.8 ft/s

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Legend

- Matchline
- 10-ft Contours
- HEC-RAS Model Transects
- Breach Inundation Boundary (Sunny Day)
- Breach Inundation Boundary (100-Year)
- Non-Impacted Building
- Impacted Building

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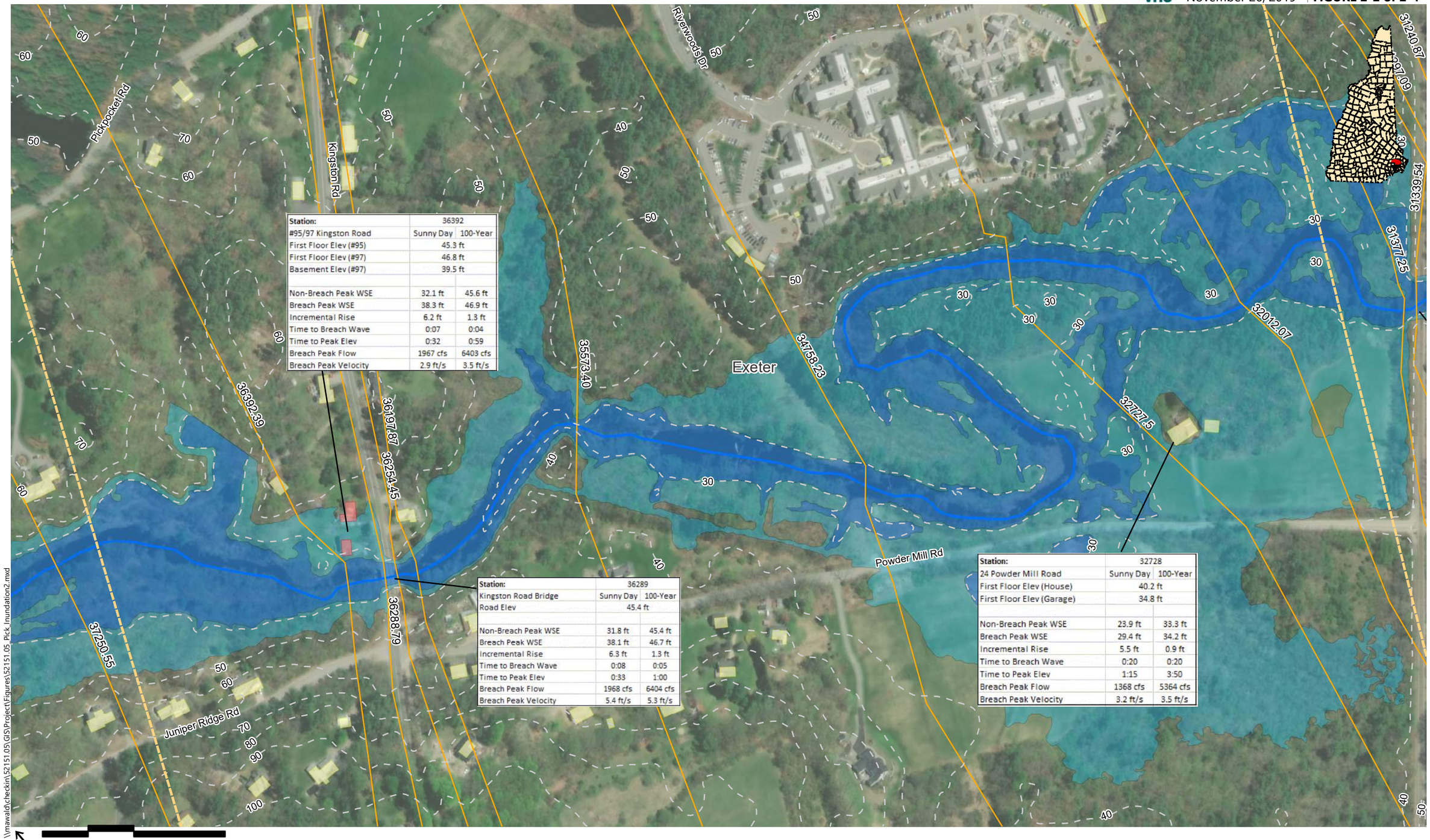
Figure 2-1 - Inundation

Source Info: USGS, Google, VHB



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0 125 250 500 Feet

Legend

- Matchline
- 10-ft Contours
- HEC-RAS Model Transects
- Breach Inundation Boundary (Sunny Day)
- Breach Inundation Boundary (100-Year)
- Non-Impacted Building
- Impacted Building

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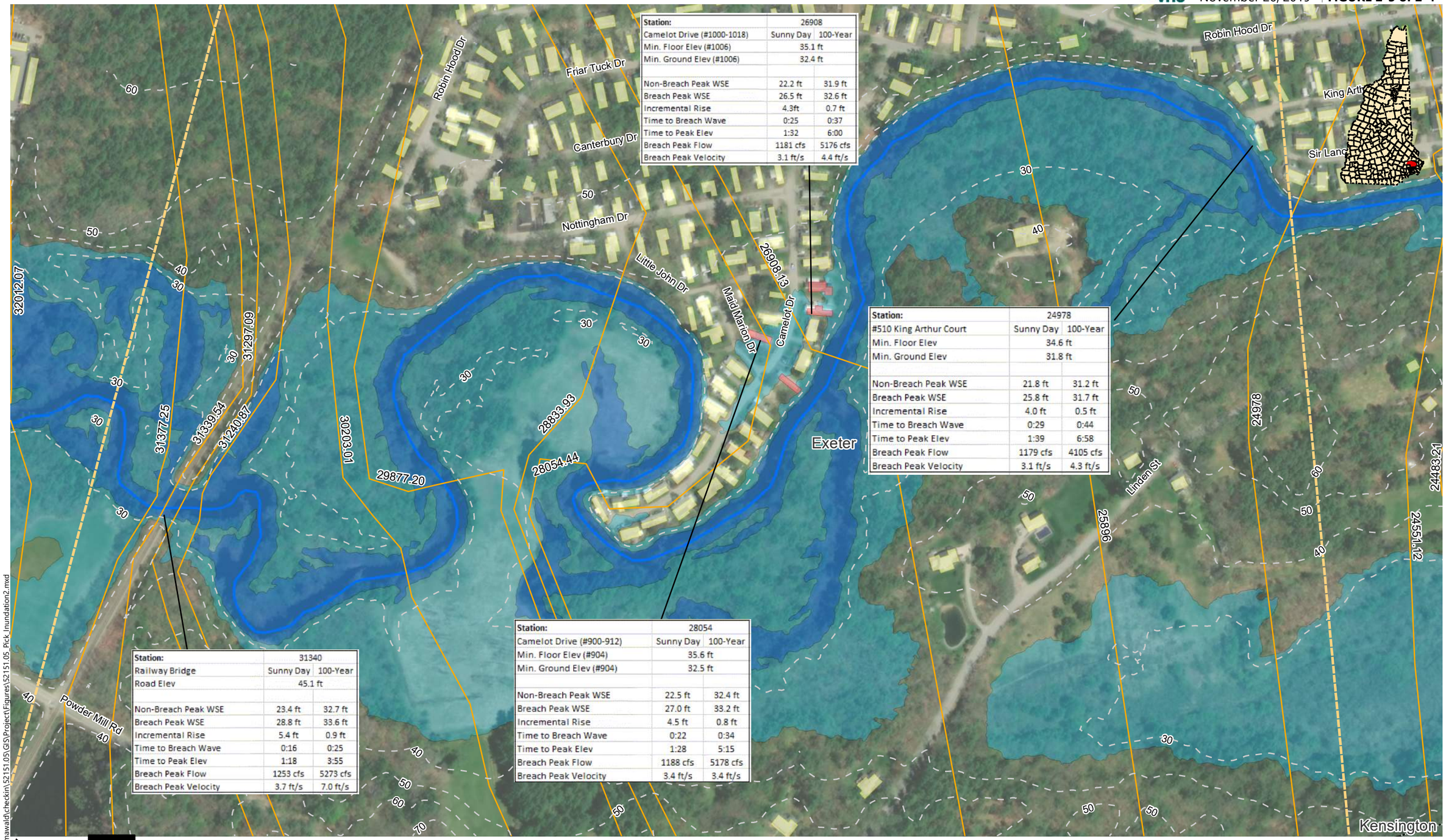
Figure 2-2 - Inundation

Source Info: USGS, Google, VHB



Station:	26908	
Camelot Drive (#1000-1018)	Sunny Day	100-Year
Min. Floor Elev (#1006)	35.1 ft	
Min. Ground Elev (#1006)	32.4 ft	
Non-Breach Peak WSE	22.2 ft	31.9 ft
Breach Peak WSE	26.5 ft	32.6 ft
Incremental Rise	4.3ft	0.7 ft
Time to Breach Wave	0:25	0:37
Time to Peak Elev	1:32	6:00
Breach Peak Flow	1181 cfs	5176 cfs
Breach Peak Velocity	3.1 ft/s	4.4 ft/s

Station:	24978	
#510 King Arthur Court	Sunny Day	100-Year
Min. Floor Elev	34.6 ft	
Min. Ground Elev	31.8 ft	
Non-Breach Peak WSE	21.8 ft	31.2 ft
Breach Peak WSE	25.8 ft	31.7 ft
Incremental Rise	4.0 ft	0.5 ft
Time to Breach Wave	0:29	0:44
Time to Peak Elev	1:39	6:58
Breach Peak Flow	1179 cfs	4105 cfs
Breach Peak Velocity	3.1 ft/s	4.3 ft/s

Station:	31340	
Railway Bridge	Sunny Day	100-Year
Road Elev	45.1 ft	
Non-Breach Peak WSE	23.4 ft	32.7 ft
Breach Peak WSE	28.8 ft	33.6 ft
Incremental Rise	5.4 ft	0.9 ft
Time to Breach Wave	0:16	0:25
Time to Peak Elev	1:18	3:55
Breach Peak Flow	1253 cfs	5273 cfs
Breach Peak Velocity	3.7 ft/s	7.0 ft/s

Station:	28054	
Camelot Drive (#900-912)	Sunny Day	100-Year
Min. Floor Elev (#904)	35.6 ft	
Min. Ground Elev (#904)	32.5 ft	
Non-Breach Peak WSE	22.5 ft	32.4 ft
Breach Peak WSE	27.0 ft	33.2 ft
Incremental Rise	4.5 ft	0.8 ft
Time to Breach Wave	0:22	0:34
Time to Peak Elev	1:28	5:15
Breach Peak Flow	1188 cfs	5178 cfs
Breach Peak Velocity	3.4 ft/s	3.4 ft/s

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0 125 250 500 Feet

Legend

- Matchline
- 10-ft Contours
- HEC-RAS Model Transects
- Breach Inundation Boundary (Sunny Day)
- Breach Inundation Boundary (100-Year)
- Non-Impacted Building
- Impacted Building

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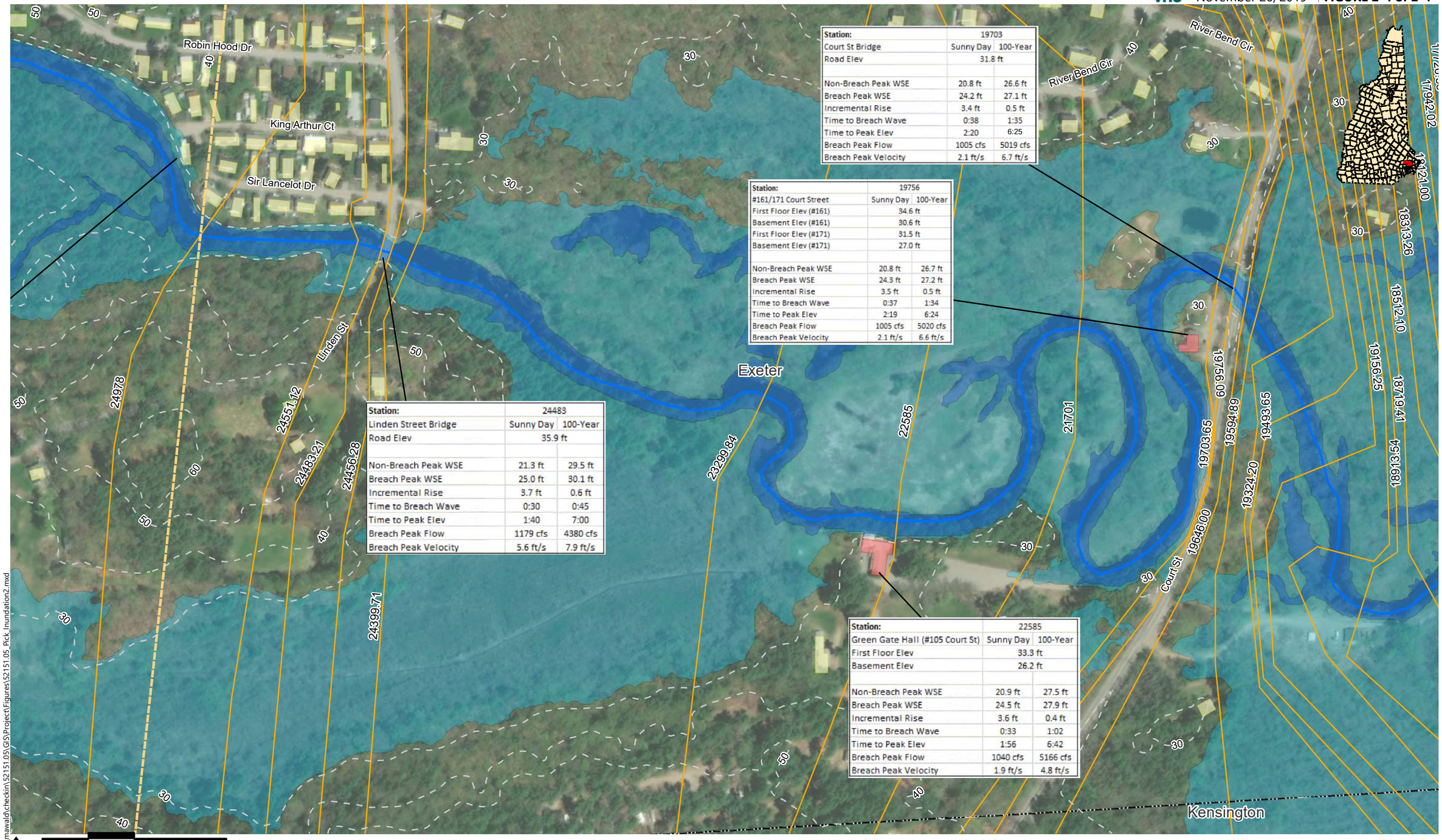
Figure 2-3 - Inundation

Source Info: USGS, Google, VHB



Station:	19703	
Court St Bridge	Sunny Day	100-Year
Road Elev	31.8 ft	
Non-Breach Peak WSE	20.8 ft	26.6 ft
Breach Peak WSE	24.2 ft	27.1 ft
Incremental Rise	3.4 ft	0.5 ft
Time to Breach Wave	0:38	1:35
Time to Peak Elev	2:20	6:25
Breach Peak Flow	1005 cfs	5019 cfs
Breach Peak Velocity	2.1 ft/s	6.7 ft/s

Station:	19756	
#161/171 Court Street	Sunny Day	100-Year
First Floor Elev (#161)	34.6 ft	
Basement Elev (#161)	30.6 ft	
First Floor Elev (#171)	31.5 ft	
Basement Elev (#171)	27.0 ft	
Non-Breach Peak WSE	20.8 ft	26.7 ft
Breach Peak WSE	24.3 ft	27.2 ft
Incremental Rise	3.5 ft	0.5 ft
Time to Breach Wave	0:37	1:34
Time to Peak Elev	2:19	6:24
Breach Peak Flow	1005 cfs	5020 cfs
Breach Peak Velocity	2.1 ft/s	6.6 ft/s

Station:	24483	
Linden Street Bridge	Sunny Day	100-Year
Road Elev	35.9 ft	
Non-Breach Peak WSE	21.3 ft	29.5 ft
Breach Peak WSE	25.0 ft	30.1 ft
Incremental Rise	3.7 ft	0.6 ft
Time to Breach Wave	0:30	0:45
Time to Peak Elev	1:40	7:00
Breach Peak Flow	1179 cfs	4380 cfs
Breach Peak Velocity	5.6 ft/s	7.9 ft/s

Station:	22585	
Green Gate Hall (#105 Court St)	Sunny Day	100-Year
First Floor Elev	33.3 ft	
Basement Elev	26.2 ft	
Non-Breach Peak WSE	20.9 ft	27.5 ft
Breach Peak WSE	24.5 ft	27.9 ft
Incremental Rise	3.6 ft	0.4 ft
Time to Breach Wave	0:33	1:02
Time to Peak Elev	1:56	6:42
Breach Peak Flow	1040 cfs	5166 cfs
Breach Peak Velocity	1.9 ft/s	4.8 ft/s

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0 125 250 500 Feet

Legend

- Matchline
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- HEC-RAS Model Transects
- Breach Inundation Boundary (Sunny Day)
- Breach Inundation Boundary (100-Year)
- Non-Impacted Building
- Impacted Building

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Figure 2-4 - Inundation

Source Info: USGS, Google, VHB