

Updated Flood History, Great Brook Watershed, Plainfield, Vermont



George Springston
81 East Hill Road
Plainfield, VT 05667
802-454-1220
rosegeo@myfairpoint.net

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Plainfield Flood Committee

On the cover: Photo of debris jam formed during flood of May 26-27, 2011 at bridge on Great Brook in Plainfield village. Photo taken on May 31, 2011 looking upstream from left bank.

Introduction

This report contains a detailed chronology of known floods in the Great Brook watershed, detailed information on rainfall and runoff associated with the storms from 1927 to the present, and available data on economic costs due to the floods. Much of this information has already seen the light of day, but it seems useful to update the earlier reports in the wake of the 2011 floods.

Great Brook is a significant tributary in the Upper Winooski watershed and drains an area of about 14.5 square miles. The headwaters are in the hills of northern Orange and the western part of Groton, and the brook flows northward to its confluence with the Winooski River in the village of Plainfield. The brook is confined to a narrow valley and is generally touching one or both sides of the valley slopes. The highest point in the watershed is Signal Mountain at 3,352 feet above sea level and the lowest point is the confluence with the Winooski River at approximately 712 feet. The brook is approximately 8 miles long and has an average gradient of 3%. The largest concentration of houses is at the bottom of the watershed in Plainfield Village.

Parts of this report are modified from Barg and Springston 2001a and 2001b. Refer to these for detailed discussions of the physical characteristics of the brook and the watershed, as well as the flood history and the history of channel management activities in the brook.

In order to understand the origins of the flooding problems in the Great Brook watershed it is helpful to understand some of the geologic background and the land-use history. For discussions of the geologic underpinnings, see Barg and Springston (2001b) and Springston and Barg (2001). A brief discussion of the land use history is included below.

The flood history has been updated to include the two significant flooding events of 2011: The flash flood of May 26-27 and the lesser flood resulting from Tropical Storm Irene on August 27-28. For updated information on landslides in the watershed see Springston and Thomas (2014).

Appendix A contains data on the ages and dimensions of all of the bridges on Great Brook.

Appendix B is an account of the damage in Plainfield as a result of the 1927 flood.

Appendix C contains estimates of the frequency of extreme precipitation for the Plainfield area.

Land Use History

Prior to settlement in the late 1700s, the Great Brook watershed was almost entirely forested, with the dominant trees probably being beech, maples, spruces, hemlock, and birches (Cogbill, 1999). The early settlers cleared most of the forests in the watershed to make room for the production of wheat, corn, potatoes, and livestock, although maple sugar production records indicate that there were plenty of sugarbushes remaining (Thompson, 1842). Sheep farming boomed in the 1840s, but because of declines in the market for wool in the 1850's, the availability of vastly more productive farmland in the west, and the upheavals of the Civil War, the region subsequently experienced a long decline in population (Johnson, 1980). As farm land was abandoned, the percentage of forest in the watershed gradually increased, although aerial photos taken in 1939 still show far more open land than currently exists.

Although the farming only really flourished for a few decades, its impact on streams appears to have been severe and long-lasting. When forest land is cleared for agriculture, the capacity of the soil to soak up rainwater is drastically altered and runoff to streams tends to increase. The result is that streams then need to become deeper and/or wider to accommodate the increased flows (Center for Watershed Protection, 1999).

Another likely result of nineteenth century agriculture was gullying. Throughout the watershed, on steep wooded hillsides that show signs of having been cleared in the previous century, there are many deep gullies. They often appear overly large compared to their drainage areas. Most of these may have formed, or at least have been widened and deepened, during the nineteenth century when soil conservation practices were, by current standards, quite poor. Although some of them appear to be stabilized by vegetation, many are still actively eroding.

At the present time the watershed is mostly forested, with lesser amounts of active pasture and hay land, abandoned agricultural land, and rural residences. The roads are mostly unpaved.

Pre-2011 Studies of the Great Brook Watershed

Several studies of the Great Brook watershed have been undertaken since the 1990s. The Plainfield Conservation Commission undertook a detailed study of stream flow, water quality, and stream habitats from 1997 to 2001 (Plainfield Conservation Commission, 2002). This work was undertaken in cooperation with the Vermont Department of Environmental Conservation and the Vermont-New Hampshire office of the U.S. Geological Survey, Water Resources Division. Part of the work was funded by a Watershed Grant from the Vermont Department of Environmental Conservation in 2000. In 2000, the Vermont Geological Survey funded an assessment of fluvial geomorphology and surficial geology in the watershed. The results of the fluvial geomorphology study are in Barg and Springston (2001a and b) and the surficial geology is in Springston and Barg (2002). These studies provided detailed information for guiding restoration work and assessing hazard potential on the mainstem of Great Brook and tributaries.

Great Brook Channel Restoration Project

After completion of the geomorphic studies in 2001, stream channel restoration work was undertaken along parts of Great Brook in 2004 and 2005. Funding included a FEMA Hazard Mitigation Grant of \$100,000 (with \$25,000 of in-kind match from the town), which was combined with grants from the NRCS Wildlife Habitat Incentive Program grant and the US Fish and Wildlife Service Partners in Fish and Wildlife Program totaling \$16,000 with 25% in-kind match from the town). The project included work on 11 sites along about 3 miles of brook to provide grade control using large boulders. Two sites (one at the Recreation Field and the other 2.5 miles up brook) were treated with rock weirs designed by USFW Partners and NRCS. At the other sites boulders were added to stabilize headcuts. This was accomplished by adding boulders to existing boulder steps in the bed or else by scattering boulders in the bed. Stone was donated by landowners and donated labor served as local match. There was no cost to town. Much of this channel restoration work came through the two large floods of 2011 in good condition.

Post-2011 Studies

In the wake of the 2011 floods two studies were undertaken with funding provided by the Central Vermont Regional Planning Commission via Ecosystem Restoration Grants from the Vermont Department of Environmental Conservation, Agency of Natural Resources. These studies include a complete assessment of the fluvial geomorphology of the watershed and a Great Brook Watershed River Corridor Plan (Bear Creek Environmental, 2014) that was undertaken in partnership with the Friends of the Winooski and a detailed landslide assessment (Springston and Thomas, 2014).

History of Floods on Great Brook

Although several large floods are on record in this part of Vermont in the late 1700s and early 1800s (notably those of October 1785, July 1830, and July 1850), the earliest documentary evidence of flooding in the Great Brook watershed dates to 1857. The floods are described below and those from 1927 to the present are summarized in Table 1.

Note that the estimates of streamflow in Table 1 are for the most part very rough. The most accurate of the estimates are probably those for the 1999 and 2000 events, which occurred while a stream-gauging station was being operated by the Conservation Commission. The estimates of recurrence interval or flood frequency are likewise very rough. They are intended only to help make comparisons between the floods.

July 6, 1857

According to a report in the July 18, 1857 issue of *The Caledonian*, a weekly newspaper published in St. Johnsbury, a pond, described as "...a considerable, natural trout pond..." washed out for some unknown reason and sent a flood pouring down the channel of the brook, destroying "about a dozen" of the bridges, washing out the road, and damaging fields and a shop in the village. The damage to roads and bridges was estimated at \$1500. According to the newspaper there had not been any recent rain. The pond is shown on the Wallings map of Washington County of 1858 and a sawmill is shown immediately

downstream. It therefore appears likely that the pond was actually an artificial mill pond. At any rate, it clearly corresponds to the Perkins Pond described in the next item.

April 21, 1869

According to the Daily Free Press and Times (Burlington) for April 26, 1869, “[t]he water in Perkins Pond in Plainfield broke away at its outlet Wednesday carrying away, all the bridges upon the brook to Plainfield village. At the outlet of the pond, Laird’s saw-mill was entirely destroyed.” This appears to be the second failure of the dam referred to above. A town meeting was held on May 22, 1869 at which a motion was passed that if Mr. Laird attempted to rebuild the dam that the Town would sue for damages from the recent flood (Plainfield Town Records, Volume 2, p. 184). It appears that the dam was not rebuilt, as the pond is not shown on the map in Beers’ Atlas of 1873 or any subsequent maps.

October 3-4, 1869

The “All-New England Rainstorm of October, 1869” brought torrential rains and terrible flooding to most of New England, with an incredible 12.35 inches falling at Canton, Connecticut. Most of the region received somewhere between 4 and 7 inches and the Great Brook watershed appears to have received on the order of 4.5 to 5 inches (Goodnough, 1928, Plate IV). This accords well with the average storm total of 4.35 inches for the nine Vermont precipitation stations reported in Ludlum (1985, p. 231). Damage throughout Vermont was extensive and in most parts of the state it has have been surpassed only by the 1927 flood and perhaps Tropical Storm Irene of August, 2011. According to The Caledonian “[i]n Plainfield the loss was very great; almost every bridge swept away, and the road so gullied as to be more like the bed of a torrent than a highway. At the village the saw mill of Willis Lane, the brick grist mill, the two buildings just below, and the shops of Mark M. Page were carried off in quick succession, and in a short time were followed by the barn and part of the house of R. Taylor. The loss in the village alone is more than \$50,000, and in other parts of the town at least \$10,000 more (The Caledonian, October 15, 1869). Town records for November 20, 1869 show that a portion of the Brook Road was “swept away” (presumably in the October storm) and had to be relocated (Plainfield Town Records, Volume 2, p. 185).

April 13-14, 1895

Heavy flooding occurred throughout the region but no documentation of damage along Great Brook has been found.

November 3-4, 1927

The 1927 flood was the greatest natural disaster of any kind in the recorded history of the state (Johnson, 1928; Ludlum, 1985) and it clearly had, as indicated by the quote at the head of this article, a dramatic impact in the Great Brook watershed. Table 1 shows precipitation, soil moisture conditions, estimated peak streamflow, and the approximate recurrence interval for that streamflow for the 1927 flood and other twentieth century storms. A more detailed first-hand account of the damage is in Appendix B, transcribed from the special Flood Issue of the Montpelier Evening Argus for January 30, 1928. The accounts indicate that all or most of the bridges along the Brook Road were rendered unusable. It appears that those not swept away were bypassed after they clogged with flood debris. A report from the District Highway Commissioners which appears to date from late November, 1927 lists seven bridges in town where assistance from the State was needed for temporary repairs (microfilm S-3185, Vermont State Archives, Office of the Secretary of State, Montpelier).

Table 1. Rainfall, soil moisture conditions, and estimated or measured flow on Great Brook during several twentieth century floods.

	Date									
	Nov. 3-4, 1927	Sep 17-21, 1938	Jun. 28-30 1973	June 6 - 7, 1984	Aug. 5, 1989	Aug. 6- 7, 1990	Sep. 15-17, 1999	Dec. 16- 18, 2000	May 26-27, 2011	August 28, 2011
Precipitation (inches)	8.0 (1)	4.59 (2)	4.11 (3)	2.09 (3)	6.72 (3)	3.90 (3)	5.35 (4)	3.26 (5)	5.22 (6)	5.10 (6)
Soil moisture conditions	Saturated	Saturated	Dry	Saturated	Moist	Dry	Dry	Frozen	Saturated	Moist
*Estimated peak flow (cubic feet per second)	2540	1819	1978	--	1534	726	1026	1085	2500	1300
Estimated peak flow return frequency (years)	200	50	50- 100	--	25	2-5	10	10	200	10-25

Precipitation Data:

- (1) Estimated from Plate I of Goodnough (1928).
- (2) NOAA National Weather Service records for Northfield Station.
- (3) NOAA National Weather Service records for Barre-Montpelier Airport Station.
- (4) Average of precipitation at homes of Charles V. Cogbill, Walker Lane, Plainfield, and George Springston, East Hill Road, Plainfield (5.15 and 5.55 inches, respectively).
- (5) Average of precipitation at the two Plainfield stations listed above (3.33 and 3.19 inches, respectively).
- (6) Precipitation at home of George Springston, East Hill Road, Plainfield.

*The value for the 1927 flood is arrived at by taking the peak discharge for the U.S. Geological Survey stream gauging station on the White River at West Hartford, Vermont, expressed as cubic feet per square mile of drainage basin, and multiplying this by the area of the Great Brook watershed (14.2 square miles). The values for the 1973 through 1990 floods are calculated in a similar fashion from the U.S. Geological Survey stream gauging station at Northfield Falls on the Dog River and probably underestimate flow on the Great Brook. The values for the 1999 and 2000 events are from the records of the Plainfield Conservation Commission gauging station on Great Brook at Plainfield Village. The values for the 2011 floods are from slope-area calculations made by George Springston. Return frequencies are estimated by comparison with the frequency distribution of peak annual discharges for selected USGS gages after making an adjustment for drainage basin size.

September 17-21, 1938

Rainfall from the famous 1938 hurricane resulted in damaging flooding in the Winooski River watershed. According to Dale Bartlett of East Hill Road, Plainfield, the heavy rains washed out the old town road between his land and the Maple Hill Road in Marshfield. This road was subsequently “thrown up” by the Town. Dale Bartlett stated that this storm caused heavy washouts on the Upper Road in the vicinity of the present Maclaren Farm. According to Lyndal Lumbra of Cameron Road, Plainfield, the third bridge from the bottom (at the intersection of Brook Road and Cameron Road) plugged up with flood debris during this storm and the brook washed out the road on both sides of the bridge. Mr. Lumbra confirms that this is the storm that caused the heavy erosion on the Upper Road. A newspaper account in the Barre Daily Times for September 24, 1938 only mentions wind damage associated with this storm.

June 28-30, 1973

The 1973 floods in Vermont were the first statewide floods since the 1938 hurricane. Heavy rains, totaling 4.11 inches at Montpelier, resulted in extensive damage in the Great Brook watershed. Long

sections of the Brook Road were washed out and bridges damaged or rendered useless due to the roads washing out around them after they plugged with flood debris. According to Lyndal Lumbra and Dave McKnight of Cameron Road, Plainfield, a long section of the Brook Road south of the Fowler sand pit was washed out. Mr. Lumbra stated that the two bridges in the village only survived because backhoes were stationed at each of them to clear away flood debris before it could clog them up. At the second bridge up the Brook (the first on Brook Road) the water was within 6 inches of the bottom of the bridge. He said that George Dix (the Town Road Commissioner at the time) stated that the washouts along the Brook Road were as extensive as those he (Mr. Dix) had seen during the 1927 flood.

June 6-7, 1984

Heavy rain on the night of June 6-7 caused flash flooding. The ground was already saturated due to high flows since early April and a 4.36 inches storm earlier in the week (May 29-June 1). The house of Timothy and Vicki Gauthier was washed away and the foundation of the old town equipment shed was undermined by the brook. The rainfall total from the Barre-Montpelier Airport (2.09 inches) is too low to have caused the flooding seen on Great Brook on June 6-7. The rainfall total in the Great Brook watershed must have been much higher. No peak streamflow information is available from the nearby U.S. Geological Survey gauging stations.

Note that the dates of this storm were in error in the earlier reports by Barg and Springston (2001a and b). The flood was mistakenly associated with the storm of May 29-June 1. It's very likely that the rainfall from this earlier storm contributed to the severity of the flooding on June 6-7 by saturating the soil and raising the levels of the streams.

August 5, 1989

Heavy rains caused flash flooding, which resulted in heavy damage to the Brook Road and destroyed two bridges and the home of Melvin and Bertha Grout. The cost of bridge and highway repair and streambank stabilization came to over \$1.8 million.

August 6-7, 1990

Heavy rains resulted in damage to streambanks and roads.

September 15-17, 1999 (Hurricane Floyd), and December 16-18, 2000

These were both relatively small events. Although neither one caused massive damage, they were of sufficient size to cause debris jams, and bank erosion. They are probably representative of many similar floods that have occurred over the years.

May 26-27, 2011

During the evening of May 26, 2011 a series of intense thunderstorms swept across central Vermont, resulting in a period of intense rainfall. The National Weather Service cooperative weather station at Plainfield had a storm total of 5.22 inches, the highest of all reported totals for this event. The rain began after 7 p.m. and most of the total had fallen by midnight. The snowpack had been heavy in the late winter, with 5.17 inches of water stored in the snowpack at the Plainfield station as of March 16. April and May had been very rainy; the April total was 6.01 inches and the May total prior to the 26th was 4.68 inches. As the ground was already saturated, the water ran off quickly and Great Brook responded rapidly to the downpour, cresting in the village sometime around 2 a.m. The Winooski River took longer to respond, reaching its crest at Plainfield sometime between 6 and 7 a.m. Heavy erosion occurred on the banks of the streams in town, destabilizing the slopes in many locations. Erosion was especially severe

along Great Brook from the village up to about Maxfield Road. This led to landslides, which in turn resulted in many trees falling into the brook. Damage in Plainfield and surrounding towns was extensive, with all of Plainfield's roads sustaining moderate to severe damage. The first bridge on the Brook Road (Town Highway Bridge 21) clogged with debris and washed out the Brook Road on the east side. A long stretch of Brook Road just downstream from the intersection with Fowler Road was washed out and took several weeks to repair. Some of the damage in Plainfield and vicinity is summarized in a special section of the Barre-Montpelier Times Argus (Times Argus, 2011). Using the Northeast Regional Climate Center's *Extreme Precipitation in New York and New England* website (Appendix C), this storm appears to have been something on the order of a 200-year storm.

August 27-28, 2011 (Tropical Storm Irene)

The second flooding in 2011 was the result of Tropical Storm Irene. The rain began in Plainfield late on the evening of August 27 and ended around midnight on the 28th. Although damage in Plainfield was quite limited in comparison to many towns in Vermont, 5.12 inches fell within 24 hours at Plainfield and the streams rose to dangerously high levels. The flow on Great Brook peaked in the late afternoon of the 28th. A debris jam had begun to accumulate upstream of Town Highway Bridge 21 on the Brook Road, but it broke up and there was no repeat of the May washout. A small bridge higher up on the Brook Road (Bridge 13, the first one upstream of the Lee Road intersection) clogged with debris and sent water across the road. There were numerous washouts along the roads and several important culverts were washed out, but no major bridges went out. The banks of Great Brook were again eroded and slopes were further destabilized.

Despite the gaps in the historic record, the picture clearly emerges of a brook that occasionally swells dramatically in size and causes serious damage. From the record described above we can see that there have been six major floods in the last 40 years.

Economic Costs of Flooding on Great Brook

The de-stabilization of Great Brook has been extremely expensive. Table 2 summarizes the damage from each recorded flood and the associated economic costs. Estimates of costs, especially for the pre-1927 floods, may not be accurate, both because some damage may be due to flooding on the Winooski River and because of the uncertain basis for the newspaper estimates. Given the penchant for exaggeration in the papers of the time, they may well be highly inflated estimates. Although it is difficult to compare costs over time because of the changing value of the dollar, they appear to have increased significantly following the channelization of the lower half of the brook in the 1970s.

Table 2. Economic losses due to flooding on Great Brook.

DATE	TYPE OF FLOOD DAMAGE	COST
July 6, 1857	“About a dozen” bridges over Great Brook destroyed. Road washed out. Damage to fields and crops and damage to a shop in the village.	\$1500 for bridges and roads. Other costs unknown. (1)
April 21, 1869	All Brook Road bridges destroyed. Laird’s saw mill entirely destroyed.	Costs unknown. (2)
October 3-4, 1869	All but one Brook Road bridge destroyed. In the village the grist mill, saw mill, carding mill, and blacksmith shop destroyed.	Total costs estimated at \$38,000 to \$60,000. (3)
November 3-4, 1927	At least six bridges and several sections of roadway destroyed. Much damage to property, including fields, crops, dwellings, vehicles, businesses, etc. Some outbuildings destroyed. Extensive damage to contents of buildings.	\$35,976 for roads and bridges. (4, 7) \$4,500 for town costs to roads and bridges (5) \$9,955 private property (6) Total \$50,432
1938	Town Highway flood work	\$736 (9)
1973	Flood damage on brook	\$26, 622 (7)
1984	Flood damage at 14 sites along brook from storm of June 6-7, 1984. An earlier storm on May 29-June 1 did not cause significant damage.	\$111, 917 (8) \$95,764 (7,9) \$56,707 bridge (7)
1989	1,870 feet of riprap, build concrete retaining walls, remove debris from 24,000 lineal feet at twelve sites. Replace two bridges Repair damage to road and stream embankments	\$623,389 (8) \$967,308 (7,9) \$227,000 (9)
1990	480 feet of rock riprap at two sites	\$64,524 (8)
1996	Replace rock rip-rap. Flood related to January thaw	\$7,494 (8, 9)
1999	Replace fill, regrade and replace 260 feet of rip-rap in one location and 40 feet of rip-rap in another.	\$45,595 (9)
2011	1. Flash flood on May 26-27, 2011. Heavy damage to culverts and roads throughout town, including Brook Road. First bridge on Brook Road (#21) clogged with debris and washed out road. Major washout on Brook Road downstream of intersection with Fowler Road. 2. Tropical Storm Irene, August 27-28, 2011. Damage to roads and structures along Great Brook was minor, although a debris jam almost formed at first bridge on Brook Road and one bridge higher up on brook was clogged by a debris jam.	\$504,021 for repair of town roads from these two storms. The costs along Brook Road alone exceed \$184,652 (cost of major washout).
Total pre-channelization to 1973 = \$117,290		
Total post-channelization, 1984 to 1999 = \$2,199,698		
Total 2011 damage exceeds \$504,021		

Notes:

- (1) The Caledonian, July 18, 1857
- (2) The Daily Free Press and Times, April 26, 1869
- (3) The Daily Free Press and Times, October 12, 1869 (\$38,000) and The Caledonian, October 15, 1869 (\$60,000)
- (4) Report of District Highway Commissioners, probably late November, 1927, microfilm S-3185, Vermont State Archives, Office of the Secretary of State, Montpelier.
- (5) Town of Plainfield Annual Report for year ending Feb. 1, 1928
- (6) VT Flood Survey Committee (1928)
- (7) Town of Plainfield Annual Reports, 1928, 1939, 1974, 1985, 1986, 1996
- (8) Natural Resource Conservation Service Records, Williston, Vermont
- (9) FEMA Disaster Surveys, Vermont Department of Emergency Management

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References

- Barg, Lori, and Springston, George, 2001a, Assessment of Fluvial Geomorphology in Relation to Hazards from Riverine Erosion and Landslides in the Great Brook Watershed in Plainfield, Vermont: manuscript to be submitted to the Vermont Geological Survey, Waterbury.
- _____, 2001b, Floods and the Great Brook in Plainfield, Vermont: Upper Winooski Field Naturalists Contributions Series, No. 2, p. 11-23.
- Bear Creek Environmental, 2014, Great Brook Watershed River Corridor Plan: Manuscript report submitted to the Central Vermont Regional Planning Commission, 89 p. plus appendices. Available at http://centralvtplanning.org/wp-content/uploads/2012/03/GreatBrook_BCE_rep_final_031914_withAppendices.pdf , accessed on May 12, 2015.
- Center for Watershed Protection et. al., 1999, Watershed Hydrology Protection and Flood Mitigation Project Phase II-Technical Analysis. Stream Geomorphic Assessment. Prepared for Vermont Geological Survey.
- Cogbill, C.V., 1999, The Vegetation of Norbury, Vermont in 1773, pp. 11-16 in Gilman, A., and Springston, G., eds. Contributions to the Natural History of the Upper Winooski Valley of Vermont, No. 1, 35p.
- Goodnough, X.F., 1928, Rainfall in New England During the Storm of November 3 and 4, 1927: Journal of the New England Water Works Association, v. XLII, No. 2, p. 150-187.
- Johnson, C.W., 1980, The Nature of Vermont: Introduction and Guide to a New England Environment: University of New England Press, Hanover, New Hampshire, 276p.
- Johnson, L.B., 1928, Vermont in Floodtime: Roy L. Johnson Co., Randolph, Vermont, 209p.
- Ludlum, D.M., 1985, The Vermont Weather Book: Vermont Historical Society, Montpelier, 300p.

Plainfield Conservation Commission, 2002, Great Brook watershed study: Water quality, stream flow, and aquatic habitats: Manuscript report, Plainfield, Vermont, 40 p. plus appendices.

Plainfield Historical Society, 1993, The Town of Plainfield, Vermont: A Pictorial History: Plainfield, 139p.

Springston, G.E., and Barg, Lori, Surficial geology of the Great Brook watershed: Manuscript report submitted to the Vermont Geological Survey, Waterbury, 32 p. plus 2 plates.

Springston, G.E. and Thomas, E.J., 2014, Landslide hazard analysis of the Great Brook watershed, Plainfield, Vermont: Report prepared for the Central Vermont Regional Planning Commission, Montpelier, Vermont, 34 p., plus 1 plate (1:10,000). Available at <http://centralvtplanning.org/wp-content/uploads/2012/03/GreatBrookLandslideReportFinal03172014.pdf> , accessed on May 12, 2015.

Thompson, Z., 1842, History of Vermont: Charles Tuttle Co, 238 p.

Times Argus, 2011, Flood 2011: May 26-27 and beyond: Barre-Montpelier Times Argus, Barre, Vermont, p. 1-12.

Vermont Flood Survey Committee, 1928, Flood Loss and Damage Survey: Statement of Returns to March 1, 1928: Vermont Flood Survey Committee, Montpelier.

Wheeler, B.J., 1850-1898, Manuscript journal, Vermont Historical Society, Montpelier, 13 volumes.

Appendix A. Bridges on Great Brook

The table below is from Barg and Springston (2001a) and includes data on all of the bridges on Great Brook. It is interesting to note that of the 14 bridges along the Brook Road with dates on them, five were built prior to the 1927 flood. Three of the bridges have been standing since 1929. Five bridges have been replaced in the last 11 years, three of those along the first two miles of the Brook. While the older bridges have experienced floods that have outflanked and cut new channels around them, the bridges themselves remained after the flood.

Channel constriction is present at every bridge, except for the new bridge downstream of Reach 8 by the sandpit. Most of the bridges are narrower than the bankfull width and floodprone width. The angle of flow is a problem on approach to five bridges including two built in the early 1990s.

Table A1. Bridges on Great Brook. Modified from Barg and Springston (2001a). The column entitled "Nearest cross-section" refers to sections measured during the Barg and Springston study.

Location (with Town Highway Bridge Number in parentheses)	Year built	Brook Road mileage from village	Bedrock or concrete apron	Width measured along road (feet)	Width measured square (feet)	Bankfull Width	Nearest cross-section	Height (feet)	Depth measured center to center (feet)	Angle of flow problem on approach to bridge
In village, near Hudson Ave. (20)	1929		N	29		44	3	7	28	N
Brook Road in Village (21)	1920	0.09	Y	22	20.5	46	4	7.3	23	Y
Near Cameron Road (22)	1929	0.38		33.5	33	34	6	9.5	24	N
u/s sand pit (23)	1991	0.9	N	44	34	33	8	14.5	38	Y
Tributary	1991	1.35	Y	13.5				6	32	N
d/s white trailer (24)	1929	1.78	N	24		33	12	13	24	N
u/s white trailer (12)	1991	1.85	N	24	23	34	13	13.5	30	Y
Private bridge:		2.4	N	31		26	17	9	12	N
Bedrock tributary		2.47	Bedrock	7				7.5	21	N
Lee Rd. Bridge (26)	1991	3.15	N	23		29	22	8.5	21.5	Y
(13)	1919	3.4	Y	14		29	23	8	20	N
(14)	1923	3.5	Y	18	16	29	23	8	24	
(25)	1925	3.6	Y	24		29	24	9.3	21	
Before East Hill (15)	1920	4.1	Y	18.5	14.5	29	26	8.9	25	Y
Maxfield Rd (18)	1991	4.37	Bedrock		16	19	29	11	17	
New/Old bridge (2)	1919/1999	4.85	Y		10		NA	6.5	25.5	N
Orange	culvert	4.95	n/a		4			4		
Driveway in Orange	culvert	4.93	n/a		4			4	12	
Gore Rd	culvert		n/a		10			10		

Appendix B. Account of the 1927 Flood

A contemporary account of the November, 1927 flood in Plainfield. Published in a special Flood Edition of the Montpelier Evening Argus for Monday, January 30, 1928. The spelling and punctuation of the original are maintained.

Story of the Damage Done in Plainfield (By Flora E.B. Cate)

It rained all Wednesday, Wednesday night, and Thursday. No one really seemed to think it was much of a rain until Thursday noon when the brooks and river began to be very high and still it was raining. Schools kept as usual. In the afternoon trees and wreckage came floating down all the brooks and the Winooski river. At dark the big brook from Perkinsville had washed away many bridges and undermined cement foundations but leaving the Waldo Perkin's bridge high and dry having washed away the road on both sides. The brook changed its course in many places. There were many landslides, and trees thus up-rooted were deposited under the Brook street bridge. All this wreckage under the bridge caused the brook to change its course and the water first came over the road in front of the Hamel home. The river was rising rapidly up over the lawn, steps, and then the front porch. About this time the family left their home expecting to see it float off at any time. Soon after they left, however, the brook changed again and went around the other side of the bridge, cutting away some of Mrs. Jones' garden besides several roads of the road [sic], lawns, gardens and part of the corner foundation of the Hamel home and the wall of the garages and wood shed. It was then that the wood and things in their cellar were washed away.

About this time the people near the blacksmith shop bridge in Plainfield village began to move to higher ground. Their cellars were full of water and wood piles were being washed away. The bridge went out about 8 o'clock taking the wall of Mrs. Laura Sanborn's house. The store house at the Batchelder mill was washed away with a carload and a half of grain. It was here that the wagon shed went out and also many stacks of lumber. Some of the latter were salvaged on F.W. Coburn's meadow. The Batchelder loss was the heaviest in Plainfield. It was reported that the roof of their store house at the mill was literally covered with rats just before it was washed away. George Bolle's little meadow was washed away leaving only a patch of rocks. His garage tipped over with a car in it.

The Winooski river continued to rise until 2 o'clock Friday morning, bringing down wreckage of all sorts. The people living in the houses near the river left their houses and went to the other side of the road. Cellars filled with water, produce was ruined or washed away. Land was lost near the rivers and some damage done to the cemetery.

Plainfield was without electric light less than one-half hour during the night. Eleven bridges were washed away at a great loss to the town. A temporary bridge was built near the blacksmith shop by Saturday noon and other temporary bridges were soon erected. No lives were lost or any cattle. The flood reminded the older resident of the flood of 1869 which did so much damage to the little village.

Appendix C. Estimates of Extreme Precipitation

The table below shows estimates of precipitation based on an analysis of historic rain gauge data from throughout the region. This is intended to be used to give a rough idea of the frequency of storms of differing magnitude. The recurrence interval is shown in the left hand column. The storm duration in minutes or hours is shown on the top row. Note that a 10-year storm is a storm that has a one-in-ten chance of occurring in any given year. As an example, consider a storm that lasts for 12 hours and has a one-in-ten chance of occurrence. The table predicts that such a storm could yield 2.82 inches of rain.

The storm of May 26-27, 2011 had a duration of around 6 hours and a storm total at Plainfield of 5.22 inches, and thus appears to be somewhat greater than the 200-year rainfall for that duration. By contrast, rainfall from Tropical Storm Irene on August 27-28, 2011 had a duration of about 24 hours and a storm total of 5.10 inches and would thus appear to be between a 50- and a 100-year storm for that duration.

Table C1. Estimates of extreme precipitation in the Plainfield area, simplified from the Northeast Regional Climate Center website at <http://precip.eas.cornell.edu/> . Accessed on June 25, 2012. Rainfall amounts are in inches.

Recurrence Interval (years)	Duration							
	30-min	60-min	120-min	3-hr	6-hr	12-hr	24-hr	2-day
1	0.66	0.82	1.01	1.15	1.38	1.65	1.97	2.26
2	0.75	0.94	1.17	1.33	1.62	1.95	2.34	2.65
5	0.91	1.17	1.46	1.66	2.01	2.40	2.85	3.21
10	1.06	1.38	1.73	1.97	2.38	2.82	3.30	3.71
25	1.29	1.71	2.16	2.46	2.95	3.47	4.01	4.50
50	1.50	2.02	2.56	2.92	3.48	4.06	4.66	5.21
100	1.76	2.39	3.03	3.45	4.10	4.75	5.40	6.05
200	2.05	2.83	3.59	4.10	4.84	5.56	6.28	7.01
500	2.53	3.53	4.49	5.11	6.00	6.85	7.65	8.55

George Springston
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