

Jewett Brook Watershed Plan

City of Laconia and Town of Gilford, New Hampshire

February 17, 2012



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CITY ON THE LAKES



US Army Corps of Engineers

Acknowledgements

This Jewett Brook Watershed Plan relies significantly on and frequently references two previous studies:

Jewett Brook Watershed Stream Geomorphic Assessment, Laconia and Gilford, New Hampshire, May 2011 by Bear Creek Environmental, LLC. The Watershed Plan quotes from this study when addressing issues such as stream type departure, geomorphic conditions of stream stretches, habitat conditions, and certain recommended remediation measures.

Hydrologic and Hydraulic Analysis of Lower Jewett Brook, Laconia, New Hampshire, February 17, 2012 by DuBois & King, Inc. The Watershed Plan quotes from this study when addressing issues such as hydrology, channel capacity, flooding, sediment deposition, and certain recommended remediation measures.

Jewett Brook Watershed Plan City of Laconia and Town of Gilford, NH

TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY	1
2.0	INTRODUCTION	2
2.1	Background.....	2
2.2	Plan Goals	2
2.3	EPA’s Nine Elements of Watershed Plans	3
2.4	Previous Studies.....	3
3.0	WATERSHED DESCRIPTION.....	4
3.1	Geomorphic Conditions	4
3.2	Habitat Conditions	4
3.3	Historic and Recent Flood Damage	5
3.4	Stressor Identification (EPA Element a).....	5
3.5	Stream Departures (EPA Element a)	7
3.6	Hydraulic modeling results.....	8
4.0	FLOOD FLOW AND DEPOSITION REDUCTION TARGETS (EPA Element b).....	9
5.0	RECOMMENDED PROJECTS AND MANAGEMENT MEASURES (EPA Element c).....	9
5.1	Potential Projects	9
5.2	Additional General Management Measures.....	11
5.3	Project Prioritization / Critical Areas For Implementation Measures	13
6.0	TECHNICAL AND FINANCIAL ASSISTANCE REQUIRED (EPA Element d).....	14
6.1	Engineering Assessment Of Potential Management Measures	14
6.2	Estimates Of Probable Costs For Potential Management Measures.....	14
6.3	Potential Funding Sources; Federal, State, Local	14
7.0	PUBLIC EDUCATION AND OUTREACH PROGRAM (EPA Element e)	14
8.0	IMPLEMENTATION SCHEDULE (EPA Element f).....	15
9.0	INTERIM IMPLEMENTATION MILESTONES (EPA Element g).....	15
10.0	CRITERIA TO DETERMINE IMPLEMENTATION SUCCESS OR NEED FOR PLAN REVISION (EPA Element h)	16
11.0	MONITORING PLAN (EPA Element i).....	16

ATTACHMENTS

- Attachment A Location Maps
- Attachment B Recommended Projects: Location Map and Project Detail Sheets

PREVIOUS STUDIES (Available upon request)

Jewett Brook Watershed Stream Geomorphic Assessment, Laconia and Gilford, New Hampshire.
May 30, 2011. Bear Creek Environmental, LLC, Middlesex, VT.

Hydrologic and Hydraulic Analysis of Lower Jewett Brook, Laconia, New Hampshire. February
17, 2012. DuBois & King, Inc, Randolph, VT.

1.0 EXECUTIVE SUMMARY

The Jewett Brook watershed is located in the City of Laconia and the Town of Gilford, New Hampshire, approximately five miles southwest of Lake Winnepesaukee. The City of Laconia has experienced repeated historic flood damage from the brook in its lower reach from Union Avenue to the mouth of the brook, and the incidence of flood damage appears to be increasing over time.

In response to this on-going problem, the U.S. Army Corps of Engineers New England District conducted initial studies of the brook to determine the feasibility of constructing flood damage reduction measures under the Corps' Section 205 authority. These have included a geomorphic assessment of the brook using the Vermont River Management Program's protocols, a hydrologic and hydraulic analysis of the watershed including the development of several flood reduction alternatives, and the development of this Watershed Management Plan. The local sponsor for these studies has been the City of Laconia.

This Watershed Plan identifies and prioritizes structural and non-structural implementation measures which may be implemented incrementally over time, and which together will provide a watershed-based approach to reducing flooding and flood damages experienced in the lower Jewett Brook watershed. Eleven projects have been identified to reduce flood flows and to reduce channel stream channel instability and the associated sedimentation. Each is identified and prioritized in the table below.

PROJECT	PRIORITY
1. Dredging at Union Avenue	High
2. Stormwater detention at TD Bank	Medium / Low
3. Rock wall removal near TD bank	High
4. Remove channel encroachment near TD	Medium / High
5. Landowner outreach, Hutchinson St. to Highland St.	High
6. Stormwater BMP's, Champagne Ave.	Medium / Low
7. Landowner outreach, Champagne Ave.	High
8. Culvert replacement, Route 3&11	Low
9. Culvert replacement, Country Club Road	Medium / Low
10. Culvert replacement, Swain Road	Low
11. Stormwater improvements, Gilford Ave.	Medium / High

In addition to the eleven recommended projects, five additional general management measures are recommended, as follows:

- Development of Fluvial Erosion Hazard Zones;
- Development of Land Use Guidelines to address stormwater runoff;
- Organization of community volunteer efforts emphasizing clean-up;
- Landowner education and outreach; and
- Development of conservation easements.

2.0 INTRODUCTION

2.1 Background

The Jewett Brook watershed is located in the City of Laconia and Town of Gilford, New Hampshire, approximately five miles southwest of Lake Winnepesaukee. The watershed is 5.4 square miles in size at its mouth (the confluence with the Winnepesaukee River at Opechee Bay). Location maps are included in Attachment A.

While the watershed is relatively small, the City of Laconia has experienced repeated and significant historic flood damage from the brook, and the incidence of flood damage appears to be increasing over time. The bulk of the flooding and flood damage occurs in the vicinity of the Union Avenue (Rt 11A) Bridge, in the midst of the downtown area, thus flooding a primary artery through town. This flooding causes disruption to traffic and emergency services and the need for frequent evacuation of the residents of a senior housing complex. There are a large number of commercial and residential structures that experience flooding when Jewett Brook overflows its banks, causing monetary damage and contributing to potential health issues.

In response to these problems, the U.S. Army Corps of Engineers, New England Division, contracted with consultants to perform initial stream studies, including a Jewett Brook Watershed Stream Geomorphic Assessment accomplished by Bear Creek Environmental, LLC and a Hydrologic and Hydraulic Analysis of Lower Jewett Brook accomplished by DuBois & King, Inc. The COE further contracted with DuBois & King, Inc. to produce this Jewett Brook Watershed Management Plan. The City will use the plan as a guide to ameliorate the flooding problems.

2.2 Plan Goals

The goals of this watershed management plan are to identify the causes and sources of the flood damage problem, and to identify a suite of structural and non-structural restoration measures to address that problem. The plan aims at a holistic watershed approach to the problem, such that contributing factors upstream of the main problem area are addressed while taking direct measures and implementing an on-going maintenance plan at the main problem area (Union Avenue bridge) as needed to relieve acute problems.

Flooding is currently considered to be the most pressing of the water-related issues in the watershed. For that reason, this Watershed Plan focuses on flooding including the stream and watershed characteristics and conditions upstream that contribute to the problem. As with any urban watershed, Jewett Brook has non flood-related issues as well (e.g., chemical water quality, aquatic habitat, etc). While this plan is not intended to directly address these problems, the recommended solutions to the flooding problems have secondary benefits that will extend to these other issues.

2.3 EPA's Nine Elements of Watershed Plans

The US EPA has identified nine elements it believes are key to improving water quality. EPA requires that these elements – known as the “9 minimum elements” – be included in any plan prepared with EPA funds. State agencies such as the New Hampshire Department of Environmental Services (NHDES) typically require that a watershed plan address the 9 minimum elements if federal Section 319 funds (non-point source pollution grant program) are proposed to support a project extracted from that plan. In some cases, funding is reserved for projects that are part of such a plan. The intent of these restrictions is to ensure that public funds to address impaired waters are used effectively.

This Jewett Brook Watershed Plan addresses EPA's 9 minimum elements. They are identified as EPA Elements a – i in the text. Additional support for some of these elements is included in the previous studies described in the next section.

2.4 Previous Studies

Geomorphic Assessment

A Jewett Brook Stream Geomorphic Assessment (SGA) was completed by Bear Creek Environmental, LLC in May, 2011. The study employed fluvial geomorphic science in a holistic, watershed-scale approach to identifying the stressors on the brook's ecosystem health. The data from the study help to identify how changes to land use alter the physical processes and habitat of the brook, and were used to identify 30 potential restoration and protection projects for the watershed.

The SGA identified major problems in the watershed, including undersized culverts, corridor encroachments, increased stormwater runoff from impervious surfaces, channel straightening associated with the construction of roads and development, lack of riparian buffers and degraded water quality. Undersized culverts were identified as causes of localized geomorphic instability and reduced fish passage. Alteration of stream channels were identified as causes of channel degradation resulting in a disconnection between the channel and its adjacent floodplain. High quality streamside buffers were noted as lacking in the lower reaches of the brook and its major tributary.

Potential restoration and conservation projects include river corridor protection through conservation easements or adoption of fluvial erosion hazard zones, replacing undersized structures, improving riparian buffers and water quality through landowner education and outreach, and improved stormwater treatment.

Hydrologic and Hydraulic Analysis

A Hydrologic and Hydraulic Analysis of Lower Jewett Brook (H&H) was completed by DuBois & King, Inc. in November, 2011. The study limits extended from upstream of the Union Avenue bridge down to the mouth of Jewett Brook at the Winnepesaukee

River, a distance of approximately 1200 feet. The study evaluated the hydraulic factors that have contributed to repeated out-of-bank flooding in the lower Jewett Brook, including six bridges or buildings that span the channel, and the accumulation of sediment within the channel. The study also evaluated potential channel modifications intended to reduce the frequency of flooding.

Under existing conditions, flows of approximately the 10-year level exceed the capacity of the Union Avenue bridge and spill toward and down Davis Place. The channel downstream of Union Avenue has additional capacity, but that goes unused because water cannot pass under Union Avenue due to both the small opening of the bridge and to the accumulation of sediment that occurs under and downstream of the bridge.

Current hydraulic capacity guidelines recommend that municipal bridges be sized to pass the 50-year flow with one foot of headspace. The Union Avenue bridge does not meet this criterion even during a 10-year storm. Raising of the bridge and approaches to comply with the 50-year guidelines would be problematic at best given adjacent buildings and intersections.

Three channel modifications intended to reduce the frequency of flooding were evaluated, as follows:

1. Widening of the Union Avenue bridge;
2. Dredging of the channel; and
3. Partial dredging of the channel.

The partial dredging option is preferred, as it would increase the channel capacity approximately 70% (as compared to 80% for full dredging), but would avoid an over-widened channel (full dredging) which would invite increased future sedimentation and which would likely pose a barrier to upstream fish passage under some flow conditions.

3.0 WATERSHED DESCRIPTION

3.1 Geomorphic Conditions

Geomorphic conditions of a stream are determined in relation to the degree (if any) of channel degradation, aggradation, widening and planform adjustment, as presented in the *Jewett Brook Stream Geomorphic Assessment (SGA)*. The SGA identifies the main stem of Jewett Brook to be in “good” geomorphic condition from the headwaters downstream to the Route 3&11 crossing. Below Route 3&11, it is in “fair” geomorphic condition, with the channel and stream corridor influenced by development. The major tributary of the brook is in “fair” geomorphic condition.

3.2 Habitat Conditions

The SGA report identifies habitat conditions of Jewett Brook and its major tributary based on a Rapid Habitat Assessment methodology. Overall, habitat conditions were

similar to geomorphic conditions of the various stream stretches, implying that the ecological health of Jewett Brook is closely related to the geomorphic condition of the stream.

Generally, the habitat conditions are diminished in areas of development, such as the City neighborhoods in the lower watershed, and where the channels pass through multiple road crossing structures or flow parallel to roadways. Field review in preparation for development of the Watershed Management Plan revealed very high quality and aesthetically appealing habitat along the main stem of the brook above Route 3&11.

3.3 Historic and Recent Flood Damage

Out of bank flooding has been a recurring problem in the Lower Jewett Brook. Photographic evidence of flooding at this location dates back to at least 1936. Typically, water is reported to first exit the channel on the upstream side of the Union Avenue bridge. When it does, floodwaters inundate the intersection of Union Avenue and Davis Place and then generally flow down Davis Place (to the left of the Normandeau Square Building) where they rejoin the brook on the downstream side of the Davis Place Bridge.

There are six structures at and below Union Avenue which may restrict flow and contribute to flooding. These include the Union Avenue bridge, two building access ramps, a restored mill building, the Davis Place bridge and a pedestrian bridge. There is also significant accumulation of sediment within the channel that reduces the capacity. There have been public calls over the years for expanding one or more of the crossings and for dredging the accumulated sediment in order to reduce the frequency of flooding.

Anecdotal reports indicate an increase in the frequency of flooding in recent years. Precipitation (as opposed to changes in the stream channel) may be partly responsible for these reports. As reported in the previously-completed H&H report, the years 2005 through 2011 include five of the eight wettest years on record (based on 85 years of annual precipitation records). And the average annual rainfall depth over the last decade (2002-2011) is 20% greater than the long-term average.

Changes in the channel are also responsible for flooding. While no regular records of channel deposition exist to show changes in the Union Bridge / Normandeau Building location, two primary indicators suggest the depth of sediment deposition has increased over time. First, stormdrains that outlet to Jewett Brook under the Union Street bridge are nearly or fully blocked by sediment. Design drawings for the bridge show these pipes to be above the sediment level at that time. Second, the channel adjacent to the Normandeau Building has a concrete bottom for much of its length, and that concrete has long been concealed by sediment deposits.

3.4 Stressor Identification (EPA Element a)

“Stressors” are the causes and sources of negative impacts to stream ecosystem health, and in particular, of flood flow and deposition to be controlled through measures

identified in this Watershed Plan. The *Jewett Brook Stream Geomorphic Assessment* (SGA) identifies the major stressors in the Jewett Brook watershed as undersized stream culverts, corridor encroachments, increased stormwater from impervious surfaces, channel straightening associated with the construction of roads and development, lack of riparian buffers, and degraded water quality. Many of the tributaries and upper reaches of Jewett Brook have undersized culverts that are causing localized geomorphic instability and are reducing or impeding fish passage. Alteration of stream channels has caused major to extreme channel degradation resulting in a disconnection between the channel and adjacent floodplain. High quality streamside buffers are lacking along the lower reaches of Jewett Brook and its major tributary.

The following table identifies stressors in the six stream reaches which received Phase 2 geomorphic assessments in the *Jewett Brook Stream Geomorphic Assessment*.

Table 1. Stressors impacting Jewett Brook

	M01	M02	M03	M04	M05	M02 T1.01	M02 T1.02
Bank armoring	Ext.	Ext.	Mod.	N/A	N/A	Ext.	N/A
Bank erosion	Ext.	Ext.	Ext.	Mod.	Ext.	Ext.	N/A
Stormwater Input Location	6	6	8	5	3	14	N/A
Buffer <25'	Ext.	Ext.	Mod.	Slight	N/A	Ext.	N/A
High priority culvert replacements	1	N/A	1	11	N/A	7	N/A
Corridor encroachments	Ext.	Mod.	Mod.	Mod.	N/A	Ext.	N/A
Channel straightening	Ext.	Ext.	N/A	N/A	N/A	Ext.	N/A

Ext.= extensive, Mod.= moderate

In addition to the stressors identified above, the *Hydrologic and Hydraulic Analysis of Lower Jewett Brook* (H&H) identifies topography as a natural factor that contributes significantly to the flooding at Union Avenue. Specifically, the main channel slope within the majority of the watershed is 2.7%. By contrast, the slope from the Union Avenue Bridge downstream is only 0.7%. This identifies the Union Avenue bridge area as one in which deposition will naturally occur simply as a result of the change in velocity of the water as it hits the gentler channel slope.

Even streams with minimal development in the watershed and with healthy ecosystems will transport a certain amount of sediment downstream as part of their natural processes.

Thus, sediment deposition at the Union Avenue Bridge is expected to continue to some degree regardless of upstream conditions. However, the goal of this Watershed Plan is to identify and mitigate human-induced stressors which increase the sediment transport above background natural levels.

In addition to the stressors identified in the *Jewett Brook Stream Geomorphic Assessment*, an additional potential stressor may be the increase in average annual precipitation observed over recent years.

Field work in preparation for development of this plan revealed no single over-riding cause of the flood damage, and no significant recent increase to any one identified stressor; it appears that the various stressors all contribute incrementally to the problem. Field work also revealed no significant physical change in the watershed in recent times. This lends weight to the hypothesis that the perceived increase in flood damages in recent years may be at least in part due to recent increased precipitation.

3.5 Stream Departures (EPA Element a)

The *Jewett Brook Stream Geomorphic Assessment (SGA)* documents Phase 2 geomorphic assessments of the Jewett Brook watershed, following procedures specified in the Vermont Stream Geomorphic Assessment (SGA) Handbook Phase 2 (Vermont Agency of Natural Resources 2009a). The geomorphic conditions of the various stream stretches were determined based upon the degree of departure of the channel from its reference stream type. Reference stream types are based on the valley type, geology and climate of a region and describe what the channel would look like in the absence of human-related changes to the channel, floodplain, and/or watershed. A stream type departure occurs when the channel dimensions deviate so far from the reference condition that the existing stream type is no longer the reference stream type.

For the main stem of Jewett Brook, the reference and existing stream type is the same for all reaches/segments. Downstream of Maple Street, on the major tributary to Jewett Brook, the existing stream type is a departure from the reference stream type. The departure involves entrenchment of the channel due to encroachment by Gifford Avenue, and stream channelization and lower width to depth ratio. Stream departures have also occurred in the two most downstream segments of the tributary where the stream is channelized and the width to depth ratio is lower than the reference condition.

These stream type departures represent a significant change in floodplain access and stability. Watersheds which have lost attenuation or sediment storage areas due to human related constraints are generally more sensitive to erosion hazards, transport greater quantities of sediment and nutrients to receiving waters, and lack the sediment storage and distribution processes that create and maintain habitat (Vermont Agency of Natural Resources, 2009).

3.6 Hydraulic modeling results

The *Hydrologic and Hydraulic Analysis of Lower Jewett Brook* (H&H) evaluated the hydraulic factors that have contributed to repeated out-of-bank flooding in the lower Jewett Brook, including the six bridges or buildings that span the channel and the accumulation of sediment within the channel. The study also evaluated three potential channel modifications intended to reduce the frequency of flooding, as follows:

1. Widening of the Union Avenue bridge;
2. Dredging of the channel; and
3. Partial dredging of the channel.

The analysis found that widening of the Union Avenue bridge by ten feet (or installing a parallel box culvert with similar dimensions) increases the capacity of the channel and reduces the frequency of overtopping. The improvement is marginal, however; flow capacity increases 20% from 450 cubic feet per second (cfs) to 540 cfs. While this is an improvement, Union Avenue would not be able to pass even the 25-year storm event, and it would remain the limiting hydraulic point in the system.

Dredging sediment out of the channel from the Union Avenue Bridge down to the Normandeau Building increases the capacity of the channel and would reduce the frequency of flooding. With dredged conditions, the capacity at the Union Street Bridge increases approximately 80% from 450 cfs to 820 cfs. Whereas flows only marginally above the 10-year event pass under existing conditions, flows just above the 25 year event can pass under dredged conditions.

Even with improved hydraulic capacity due to dredging, the Union Avenue bridge remains the limiting hydraulic point in the system, which suggests that a dredging operation limited to the bridge and a relatively short distance downstream might be as effective at reducing road overtopping as an operation that dredged all the way to the Normandeau Building. A drawback of dredging is that dredging the full channel width between the walls that form the banks risks creating an over-widened channel that would be even more prone to future sedimentation and would likely pose a barrier to upstream fish passage under some flow conditions.

To address this, an alternative of *partial* dredging was also evaluated. Under this alternative, only a 10-foot wide channel would be dredged, and six inches of sediment would remain elsewhere. Essentially, this would result in a 10-foot wide, 0.5-foot deep pilot channel. With this partial dredging, the capacity at the Union Street Bridge increases approximately 70% from 450 cfs to 770 cfs. While the hydraulic improvement is less than full dredging, partial dredging may none the less be preferable because of the sedimentation and fish passage issues posed by full dredging.

4.0 FLOOD FLOW AND DEPOSITION REDUCTION TARGETS (EPA Element b)

The *Hydrologic and Hydraulic Analysis of Lower Jewett Brook* (H&H) found the hydraulic capacity of the Union Avenue bridge to be the limiting hydraulic point in the system. Current hydraulic capacity guidelines recommend that municipal bridges be sized to pass the 50-year flood flow with one foot of headspace. The H&H report found that it would be impossible to meet this guideline without significantly raising the roadway on either side of the bridge to get a taller opening, and that would be problematic at best given the adjacent buildings and intersections.

However, increasing flood flows that could be passed under the bridge from the current 10-year storm to the 25-year storm, as recommended for secondary municipal roads, would significantly reduce the frequency of flooding in downtown Laconia. Thus, an increase in channel capacity to accommodate the 25-year storm was sought.

Regarding deposition of sediment, the ideal target would be to reduce the deposition to natural, background levels associated with a healthy stream ecosystem. However, given the developed nature of much of the watershed, a complete elimination of human-induced erosion and deposition is impracticable. The target for reduction of sediment deposition is therefore to reduce human-induced erosion and deposition by the incremental implementation of as many identified restoration measures as practicable.

5.0 RECOMMENDED PROJECTS AND MANAGEMENT MEASURES (EPA Element c)

Eleven potential projects and five additional general management measures have been identified to implement reduction measures for flood flow and sediment deposition.

5.1 Potential Projects

Eleven specific potential projects, including both structural and non-structural measures, have been identified. Each is described briefly below. A Location Map and Project Detail Sheets are included in Attachment B.

- 1. Project #1. Remove accumulated sediment to improve channel capacity at the Union Avenue Bridge and Normandeau Mill Building through on-going partial dredging.** (SGA Reach M01) Dredging is recommended from the Union Avenue Bridge downstream to the face of the building. The dredging would create a 10-foot wide, 0.5-foot deep pilot channel. Outside of the pilot channel, any sediment more than six inches above the pilot channel invert would be removed. Such a channel would increase the channel capacity at the Union Avenue bridge by 70% over current conditions, from 450 cubic feet per second (cfs) to 770 cfs. Such partial dredging would avoid over-widening of the channel as would occur with complete dredging. Over-widening is to be avoided, as it would slow the velocities of the water to the

point where sediment deposition would likely increase from current rates, and would likely pose a barrier to upstream fish passage under some flow conditions.

Partial dredging would be a cost-effective measure to significantly increase flow capacity and reduce the frequency of overtopping of Union Avenue. However, it is important to recognize that this location, with its relatively wide, flat floodplain, low roadway approaches, flat channel slope and location at a significant break in slope of the watershed is inherently prone to flooding and sediment deposition. Dredging will provide only temporary relief and must be repeated as needed to remove newly-deposited sediment.

2. **Project #2. Stormwater detention behind TD Bank.** (SGA Reach M01) Detain uncontrolled stormwater runoff from roads, roofs and parking lots behind the TD bank, currently flowing into Jewett Brook immediately downstream of the pedestrian bridge. Install stormwater detention system, with either a small, open pond or larger underground chamber, to detain runoff prior to discharge to the brook.
3. **Project #3. Rock wall removal near TD Bank to restore floodplain access.** (SGA Reach M01) Remove stone wall forming left bank to restore brook's access to left floodplain. This would allow for some reduction in peak flows downstream, and would provide a location for natural sediment deposition without impacts to infrastructure.
4. **Project #4. Removal of the channel encroachment near TD Bank.** (SGA Reach M01) Fill in right overbank could be removed, thereby allowing brook access to the right floodplain. This would allow for some reduction in peak flows, and would provide a location for natural sediment deposition without impacts to infrastructure.
5. **Project #5. Landowner outreach/education.** (SGA Reach M01.S1.01) The tributary to Jewett Brook from Hutchinson Street to the outlet above Highland Avenue is narrow and incised due to historic filling. Erosion and undercut banks create a source of sediment to Jewett Brook. Outreach/education efforts are recommended to educate residents about negative downstream consequences of poor management of the channel, and to introduce concept of channel management easements.
6. **Project #6. Stormwater control Best Management Practices (BMP's) at Champagne Avenue.** (SGA Reach M02) Map and document the existing system on Champagne Avenue above Tardiff Park, and identify opportunities to provide detention as either a stand-alone project or in conjunction with eventual system replacement as it ages. The stormdrain system in the vicinity of Champagne Avenue has no detention components, and so delivers runoff to Jewett Brook faster than for undeveloped conditions. The increased volume and rate of runoff contribute to flooding and channel instability.

7. **Project #7. Landowner outreach and education, Champagne Ave.** (SGA Reach M02) Jewett Brook along Champagne Avenue is eroding due to channel encroachment and clearing of natural riparian vegetation. The erosion is contributing sediment to Jewett Brook. Outreach/education efforts are recommended to educate residents about negative downstream consequences of poor management of the channel, and to introduce the concept of channel management easements.
8. **Project #8. Culvert replacement at Route 3&11.** (SGA Reach M03) This culvert is significantly undersized, with high bank erosion below the structure, thus contributing sediments to Jewett Brook. Replace culvert with one appropriately sized for the natural channel that will reduce channel instability associated with the crossing and will also restore aquatic organism passage.
9. **Project #9. Culvert replacement at Country Club Road.** (SGA Reach M04) These culverts are significantly undersized, do not allow aquatic organism passage, and the hard bank armoring is failing above and below the structure. Replace existing culverts with a single-span structure (bridge or culvert) of at least bankfull width.
10. **Project #10. Culvert replacement at Swain Road.** (SGA Reach M05) This culvert is undersized, with reduced aquatic organism passage, but the channel has adjusted so that currently, scouring and undermining are not severe. However the chance of plugging/failure/erosion and deposition of sediments into Jewett Brook in the near future are significant. Replace culvert to adequate dimensions recommended to reduce chances of future severe erosion, and to improve aquatic organism passage.
11. **Project 11. Stormwater Improvements, Gilford Avenue.** (SGA Reach M02T1.01 and M02T1.02) These stream reaches are bordered by roads and development, and there is significant potential for additional impervious surfaces associated with development of currently empty lots, such as exist at the Gilford Common Development. Stormwater improvements could reduce stormwater input in the entire reach. Detention/storage of stormwater prior to its outlet to the stream is recommended. Consideration should be given to underground tanks where space is limited along the stream. Disconnection of impervious surfaces from stream edges is also recommended to increase infiltration, as by adding grassy areas between the outlets and the stream.

5.2 Additional General Management Measures

Additional management measures to reduce sediment deposition and flood damage include planning/zoning measures such as Fluvial Erosion Hazard Zones and land use guidelines to address stormwater runoff. Other measures include community volunteer efforts, landowner education and outreach, and conservation easements.

All of these additional measures can be applied in any/all reaches of the stream. These measures are intended for sediment and flood attenuation, prevention of further channel encroachments, and to promote stability of the stream channels.

A. Fluvial Erosion Hazard Zones

The development of Fluvial Erosion Hazard (FEH) Zones is recommended to prevent increases in man-made conflicts that can result from development in identified fluvial erosion hazard areas; minimize property loss and damage due to fluvial erosion; and prohibit land uses and development in fluvial erosion hazard areas that pose a danger to health and safety. The basis of a Fluvial Erosion Hazard Zone is a defined river corridor, including the course of a river and its adjacent lands. The width of the corridor is defined by the lateral extent of the river meanders, called the meander belt width, which is governed by valley landforms, surficial geology, and the length and slope requirements of the river channel. The width of the corridor is also governed by the stream type and sensitivity of the stream. Information collected during the Phase 2 Assessment including reach sensitivity, reach condition, and stream type can be used to develop these zones.

FEH Zones are intended to delineate for landowners, land use planners, and river managers the area needed to accommodate the natural movement of a balanced or equilibrium stream channel and, if protected from unlimited development, would serve to maximize channel stability and minimize fluvial erosion hazards.

The formal use of FEH Zone maps varies. They can be developed to serve solely as a source of information for landowners and local regulators about possible risks associated with proposed development. They can also be used in a more formal capacity if a community chooses to do so, by incorporating them into local zoning regulations much as is done with FEMA floodplain maps.

Towns have the opportunity to work with the New Hampshire Department of Environmental Services (NHDES) to develop fluvial erosion hazard zones to reduce conflicts within the river corridor. Additional information regarding Fluvial Erosion Hazard Zones is available on the NHDES website <http://des.nh.gov/organization/commissioner/pip/factsheets/geo/documents/geo-10.pdf>, in the Environmental Fact Sheet (New Hampshire Department of Environmental Services, 2010a); and in Chapter 2.9 of the Innovative Land Use Planning and Techniques Handbook: New Hampshire Department of Environmental Services, 2010b.

B. Land Use Guidelines

Land Use Guidelines to address stormwater runoff are recommended as a watershed-level opportunity to reduce sedimentation and flood damages. Stormwater runoff rates are of particular concern in urbanized and agricultural watersheds because stormwater runs off from impervious surfaces rather than naturally infiltrating the soil. The cumulative effect of the increased frequency, volume, and rate of stormwater runoff results in increases in wash-off pollutant loading to streams, destabilization of stream channels, and consequent erosion and deposition. Land Use guidelines for stormwater improvement projects to increase baseflow and decrease peak flow are recommended for the Jewett Brook watershed. Such guidelines should encourage underground detention/storage structures

and disconnection of stormwater outfalls from the stream by the development of intervening grassy areas. Other land use guidelines could encourage landowners and community volunteers to actively participate in stream corridor management and restoration.

C. Community volunteer efforts

Community volunteer efforts are recommended as means to accomplish Land Use guidelines emphasizing clean-up efforts. Discarded tires and other trash are common in stream channels within the Jewett Brook watershed. A significant number of tires were observed even in the upper reaches of the main stem of the brook. The City of Laconia, the Town of Gilford and community groups have the opportunity to sponsor stream cleanup days to remove trash from Jewett Brook and tributaries. This cleanup effort would improve water quality and would offer a connection between local citizens and the stream that runs through their communities.

D. Landowner education and outreach

Landowner education and outreach is recommended to improve the public's understanding of fluvial processes, stressors to stream health, and opportunities for restoration through voluntary streamside plantings and reduction of disposal of yard wastes along streambanks.

E. Conservation easements

Conservation easements are recommended in areas currently free of existing development and stream stressors, in order to protect the integrity of the stream corridors from future encroachments. In the Jewett Brook Watershed, the land surrounding the channel mainstem and tributaries from Hounsell Avenue upstream to Routes 3 and 11 is an example of an area that would benefit from conservation easements. This area currently provides significant flood and sediment load attenuation that has direct positive benefits to the more developed portions of the watershed downstream where sedimentation and flooding is a problem, and the presence of conservation easements would ensure that this land continues to provide these benefits into the future.

5.3 Project Prioritization / Critical Areas For Implementation Measures

Human impacts to Jewett Brook resulting in on-going and perhaps increasing flood damages have been incremental. Restoration measures may also be implemented incrementally as funding allows. However, certain measures are identified as having the best potential for immediate relief from flood damages, and should be implemented earliest. These are considered the critical areas for implementation, and are identified as high priority in the following table:

Table 2. Priority Recommendation for Individual Projects

PROJECT	PRIORITY
1. Dredging at Union Avenue	High
2. Stormwater detention at TD Bank	Medium / Low
3. Rock wall removal near TD bank	High
4. Remove channel encroachment near TD	Medium / High
5. Landowner outreach, Hutchinson St. to Highland St.	High
6. Stormwater BMP's, Champagne Ave.	Medium / Low
7. Landowner outreach, Champagne Ave.	High
8. Culvert replacement, Route 3&11	Low
9. Culvert replacement, Country Club Road	Medium / Low
10. Culvert replacement, Swain Road	Low
11. Stormwater improvements, Gilford Ave.	Medium / High

6.0 TECHNICAL AND FINANCIAL ASSISTANCE REQUIRED (EPA Element d)

6.1 Engineering Assessment Of Potential Management Measures

Initial assessments of potential management measures were accomplished and documented within the *Jewett Brook Watershed Stream Geomorphic Assessment* and the *Hydrologic and Hydraulic Analysis of Lower Jewett Brook*. Additional assessment will be required for design and permitting of any of the recommended measures.

6.2 Estimates Of Probable Costs For Potential Management Measures

Two estimates of probable costs have been developed for each potential project, one for engineering and permitting, and the other for construction. These estimates are provided on the Project Detail Sheets (Attachment B).

6.3 Potential Funding Sources; Federal, State, Local

Sources of potential funding include the FEMA Pre-Disaster Mitigation Grants, New Hampshire Ecological Restoration Grants, the New Hampshire Wetlands Bureau In-Lieu Fee Program, the New Hampshire Section 319 Watershed Assistance Grants Program, the City of Laconia Capital Improvement Annual Budget, American Rivers (for culvert replacements), and The Gulf of Maine Council and Trout Unlimited (for barrier removals).

7.0 PUBLIC EDUCATION AND OUTREACH PROGRAM (EPA Element e)

A Public Informational Meeting was held in Laconia on September 7, 2011. Approximately 50 people, including at least 35 concerned residents, attended. The remaining attendees were City

of Laconia and Town of Gilford staff. DuBois & King presented an overview of the Geomorphic and Hydrologic & Hydraulic Assessments, and gathered input on the direction of the Watershed Plan.

Additional Public Informational Meetings are recommended during the implementation of the Watershed Plan. An initial meeting would serve to introduce the Watershed Plan to residents and other stakeholders and hear feedback on implementation measures and priorities.

Ongoing interaction with the public is also recommended with the intent of:

- Fostering community understanding of the watershed and its issues (especially the flood damage issue);
- Inviting community feedback on specific projects and general management measures;
- Fostering community involvement in watershed improvement efforts.

8.0 IMPLEMENTATION SCHEDULE (EPA Element f)

A recommended priority (Low, Medium, High) has been assigned to each recommended project identified in Section 5. The following corresponding implementation schedule is suggested:

Table 3. Suggested Implementation Timeline by Project Priority

PRIORITY	APPROXIMATE IMPLEMENTATION SCHEDULE (YEARS)
High	1-5
Medium	5-10
Low	10-20

9.0 INTERIM IMPLEMENTATION MILESTONES (EPA Element g)

The following are milestones against which to check on interim implementation of this watershed plan.

1. Monitoring of dredging at time of dredging to verify compliance with plan recommendation.
2. Follow-up monitoring of dredged area after significant storm events, and yearly monitoring in early June to assess effects of spring high water.
3. Yearly monitoring to determine completion of projects per schedule.
4. Fluvial geomorphic field review every five years to assess changes in stream conditions including stability/instability, and identification of new stressors and new potential projects.

10.0 CRITERIA TO DETERMINE IMPLEMENTATION SUCCESS OR NEED FOR PLAN REVISION (EPA Element h)

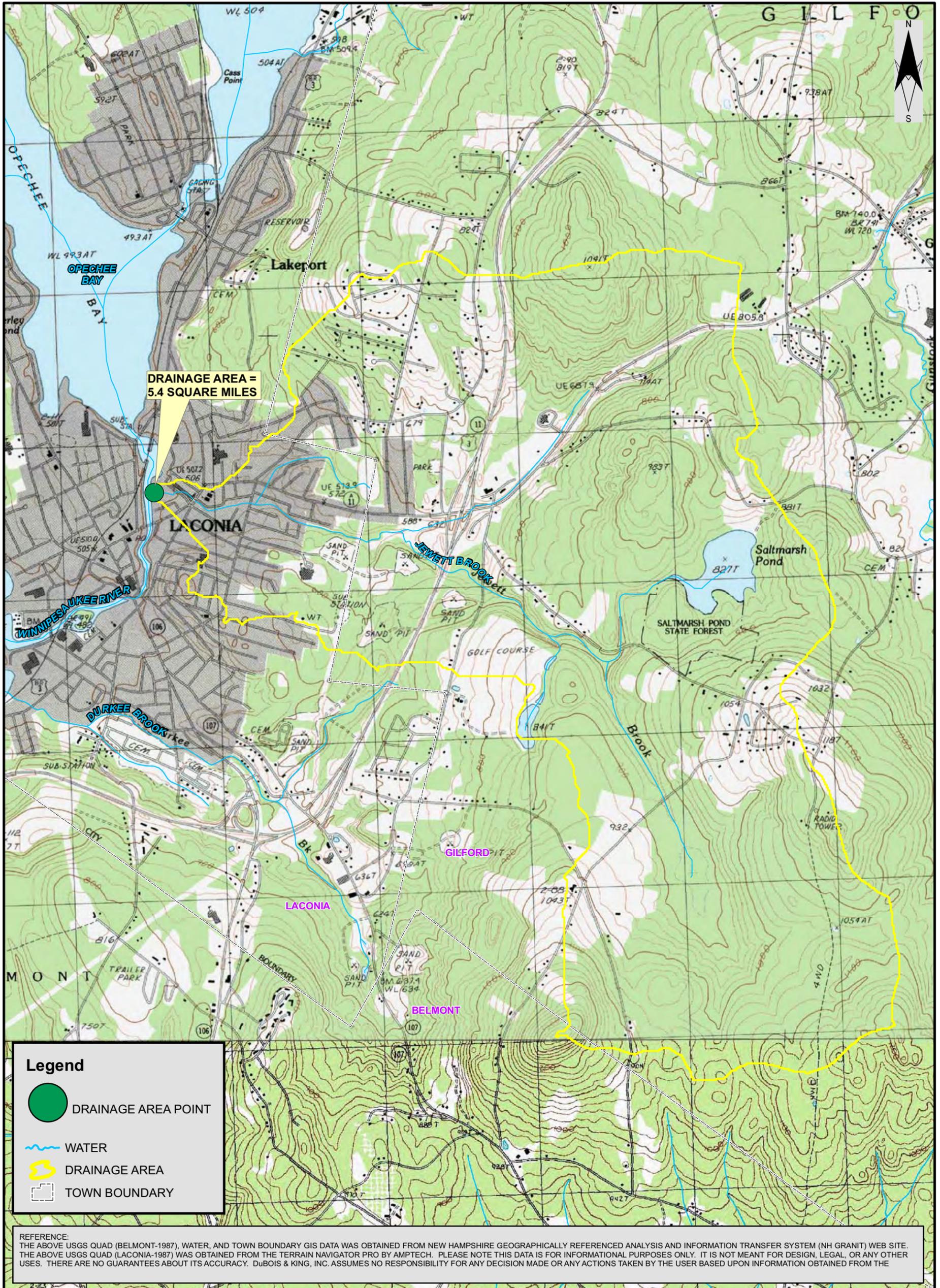
Monitoring by a fluvial geomorphologist on a five-year cycle is recommended to determine the need for plan revision if conditions are worsening, and to identify new encroachments and potential greater need for conservation easements or land use restrictions. Specific criteria include an increase in the incidence of bank armoring, an increase in the extent of bank erosion, additional corridor encroachments, additional channel modifications (e.g., straightening), and loss of additional 25' riparian buffer.

11.0 MONITORING PLAN (EPA Element i)

Yearly monitoring is recommended for the dredging at the Union Avenue Bridge and to determine completion of projects per schedule. Monitoring on a five-year cycle is recommended to assess changes in stream conditions including stability/instability, to identify new stressors and new potential projects, and to assess the need for plan revision. The five-year monitoring would not entail a complete re-assessment of the channel, but rather an abbreviated field review by a geomorphologist using the initial detailed assessment as a baseline.

Attachment A

Location Maps



Legend

-  DRAINAGE AREA POINT
-  WATER
-  DRAINAGE AREA
-  TOWN BOUNDARY

REFERENCE:
 THE ABOVE USGS QUAD (BELMONT-1987), WATER, AND TOWN BOUNDARY GIS DATA WAS OBTAINED FROM NEW HAMPSHIRE GEOGRAPHICALLY REFERENCED ANALYSIS AND INFORMATION TRANSFER SYSTEM (NH GRANIT) WEB SITE.
 THE ABOVE USGS QUAD (LACONIA-1987) WAS OBTAINED FROM THE TERRAIN NAVIGATOR PRO BY AMPTECH. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. DuBOIS & KING, INC. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE

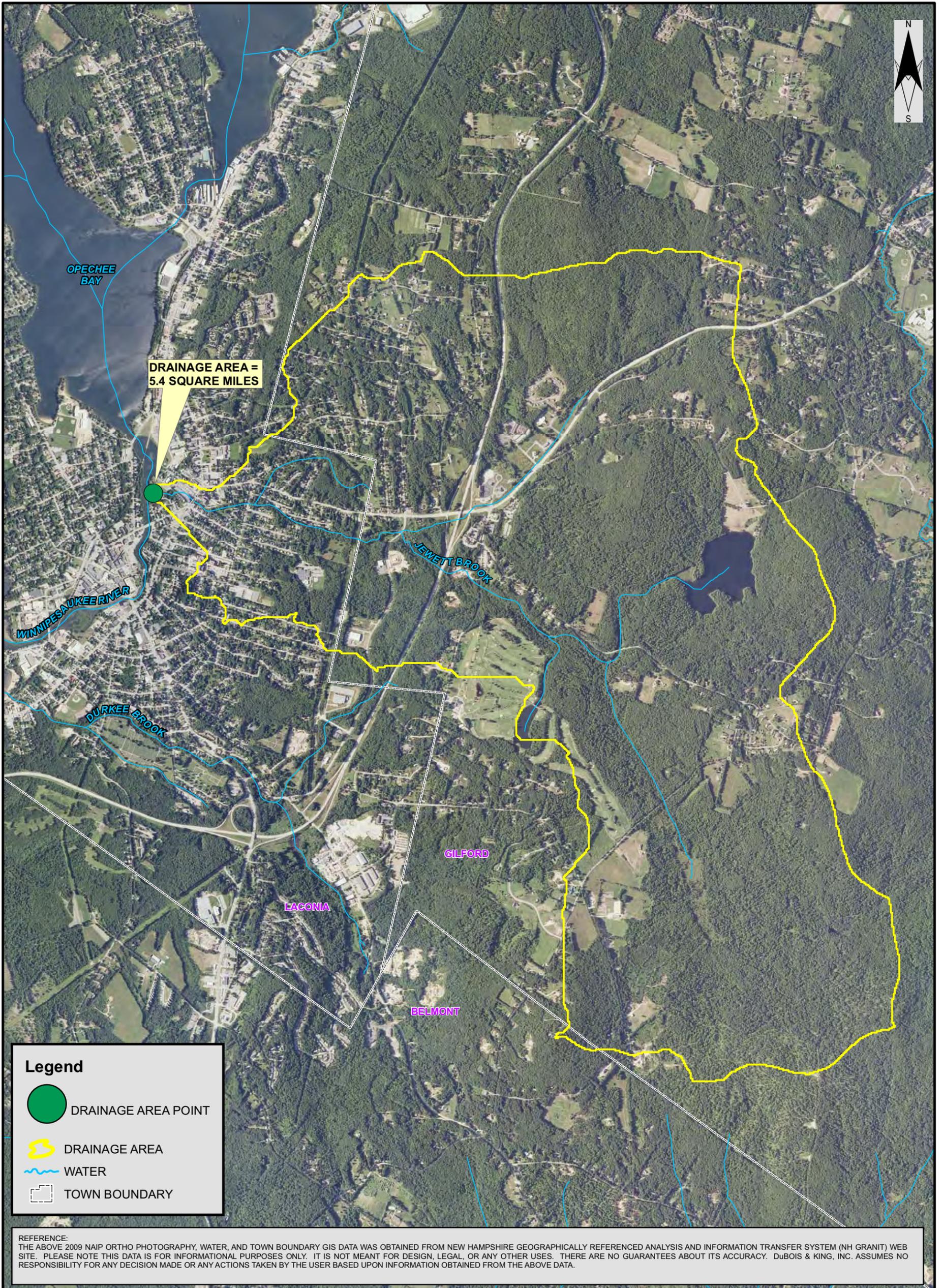


**ENGINEERING • PLANNING
 MANAGEMENT • DEVELOPMENT**

WATERSHED TOPOGRAPHIC MAP

JEWETT BROOK
 WATERSHED ASSESSMENT
 LACONIA, NH
 BELKNAP COUNTY

DRAWN BY:	DPM	DATE:	11-18-10
CHECKED BY:		PROJECT NO:	120490
PROJ. ENG:	CJK	FIGURE NO:	
SCALE:	0 1,000 2,000 4,000 Feet		



Legend

-  DRAINAGE AREA POINT
-  DRAINAGE AREA
-  WATER
-  TOWN BOUNDARY

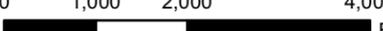
REFERENCE:
 THE ABOVE 2009 NAIP ORTHO PHOTOGRAPHY, WATER, AND TOWN BOUNDARY GIS DATA WAS OBTAINED FROM NEW HAMPSHIRE GEOGRAPHICALLY REFERENCED ANALYSIS AND INFORMATION TRANSFER SYSTEM (NH GRANIT) WEB SITE. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. DuBois & King, Inc. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE ABOVE DATA.



**ENGINEERING • PLANNING
 MANAGEMENT • DEVELOPMENT**

WATERSHED ORTHOGRAPHIC MAP

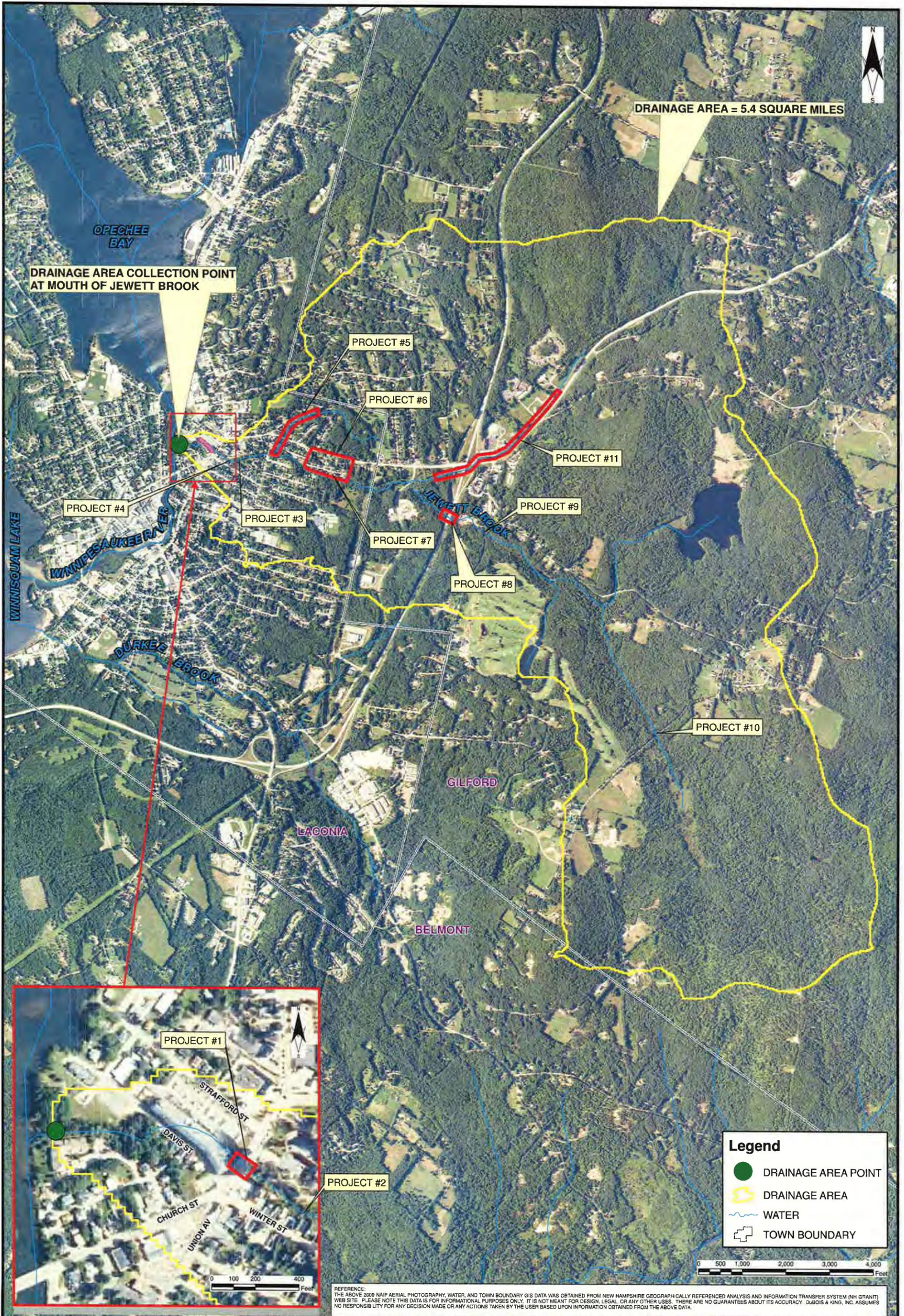
JEWETT BROOK
 WATERSHED ASSESSMENT
 LACONIA, NH
 BELKNAP COUNTY

DRAWN BY:	DPM	DATE:	11-18-10
CHECKED BY:		PROJECT NO:	120490
PROJ. ENG:	CJK	FIGURE NO:	
SCALE:	0 1,000 2,000 4,000		
			Feet

Attachment B

Recommended Projects:

Location Map and Detail Sheets



JEWETT BROOK WATERSHED PLAN PROJECT LOCATIONS			
CITY OF LAGONIA LAGONIA, NEW HAMPSHIRE			
NO	DATE	DESCRIPTION	BY

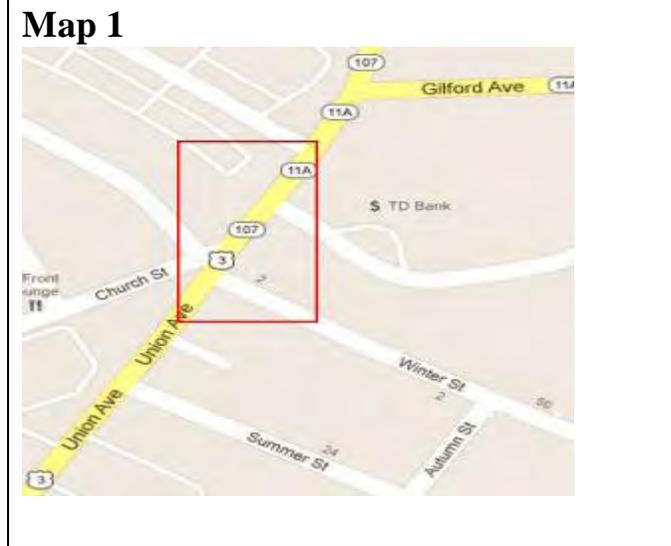
**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 1	Description: Remove accumulated sediment to improve channel capacity at the Union Avenue bridge and Normandin Square Mill Building	Pg 1/3
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Location: Union Avenue Bridge to Normandin Square Mill Building

State Plane X: 1038036
State Plane Y: 376227

Reach ID: M01
(from Geomorphic Assessment Report)

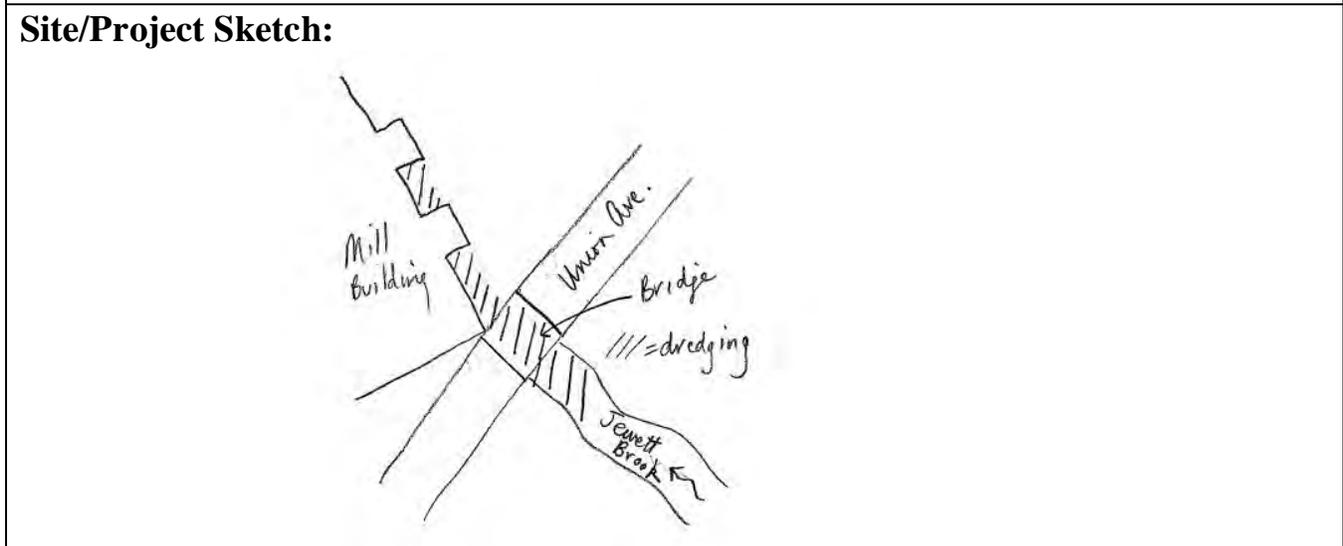


Site Issues and Relevance to the Watershed Plan Objectives:
Sediment deposition at Union Avenue bridge and downstream to the Normandin Mill Building reduces channel capacity and contributes to flood damages. Periodic removal by partial dredging would alleviate flood damage while maintaining aquatic organism passage.

Project Type General **Structural** Non-Structural

Project Type Specific Bank stabilization Wall Stabilization **Dredging**
 Stormwater Control Culvert replacement Landowner Outreach FEH Zone Mapping
 Restore Floodplain Access Easements Riparian Plantings
 Other _____

Project Narrative Description (up/downstream limits, banks(s), etc):
 Partial dredging from the Union Avenue bridge downstream to the face of the Mill Building. Dredging would create a 10'-wide, 0.5'-deep pilot channel. Outside of the pilot channel, any sediment more than six inches above the pilot channel invert would be removed.



Considerations for Prioritization:
 Flood damages associated with sediment deposition are recurrent and expensive, cause disruption to traffic and emergency services, and require frequent evacuation of residents of a senior housing complex. Therefore, priority is high.

Estimated Eng/Permitting Cost Range *	Estimated Construction Cost Range *
<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k	<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k
<input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k	<input type="checkbox"/> \$40 - \$60k <input checked="" type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k
<input type="checkbox"/> other _____	<input type="checkbox"/> other _____

Additional Considerations and Notes:
 This measure would result in immediate relief to the City of Laconia. Other proposed projects in the watershed are designed to reduce the severity of deposition and frequency of required dredging. Care must be taken during design to avoid creating a fish passage barrier. Precise limits of dredging to be determined during design.

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 2	Description: Stormwater detention system at TD bank to reduce peak flows	Pg 1/2
------------------------	---------------------------------------------------------------------------------	---------------

Location: Approx. 300' upstream of Union Avenue, behind TD Bank

State plane X: 1038214 State plane Y: 376042	Reach ID: M01 (from Geomorphic Assessment Report)
---------------------------------------------------------------	-------------------------------------------------------------

Map 1 	Map 2 
---------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------

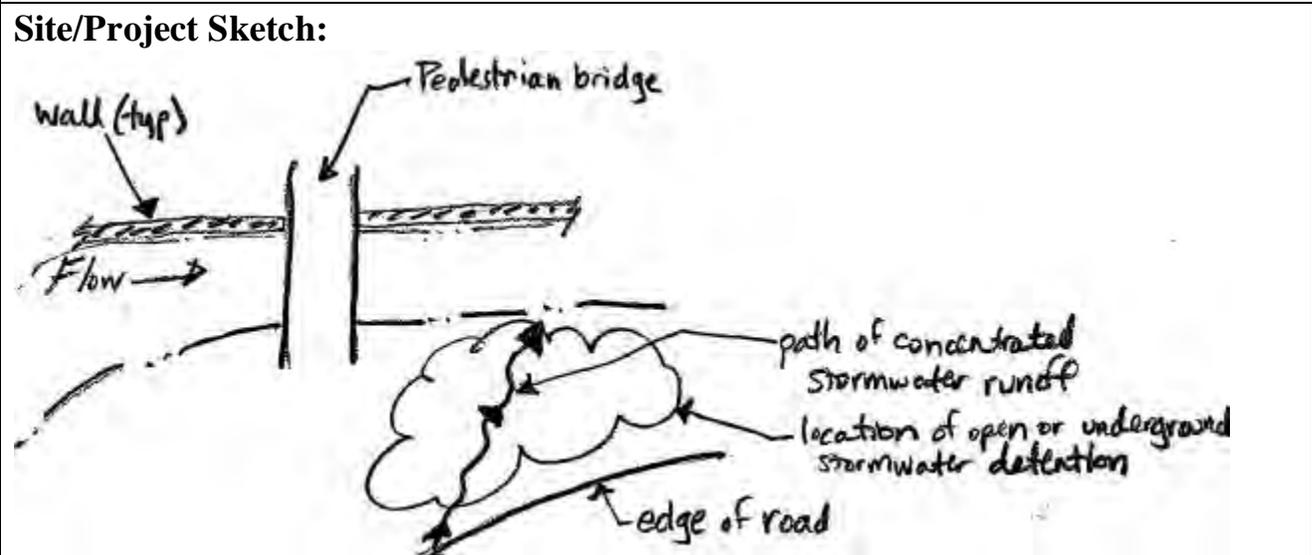
Photo 1  Area for potential stormwater pond or underground tank.	Photo 2  Source area for stormwater flows.
------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------

Site Issues and Relevance to the Watershed Plan Objectives:
Stormwater runoff from adjacent roads, roofs and parking lots collects and flows uncontrolled into the brook immediately downstream of pedestrian bridge. Detaining this flow would reduce peak flow and flood potential at Union Avenue bridge.

Project Type General **Structural** Non-Structural

Project Type Specific Bank stabilization Wall Stabilization Dredging
 Stormwater Control Culvert replacement Landowner Outreach FEH Zone Mapping
 Restore Floodplain Access Easements Riparian Plantings
 Other _____

Project Narrative Description (up/downstream limits, banks(s), etc):
 Install stormwater detention system – either small open pond or larger underground chamber – to detain runoff prior to discharge to brook.



Considerations for Prioritization:
 This project would be relatively expensive for the expected stormwater detention benefits. Therefore, the priority rating is low to medium.

Estimated Eng/Permitting Cost Range	Estimated Construction Cost Range *
<input type="checkbox"/> <\$10k <input checked="" type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> other _____	<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> other _____

Additional Considerations and Notes:
 Coordinate with project #4, which could use this and adjacent area for restoration of floodplain access.

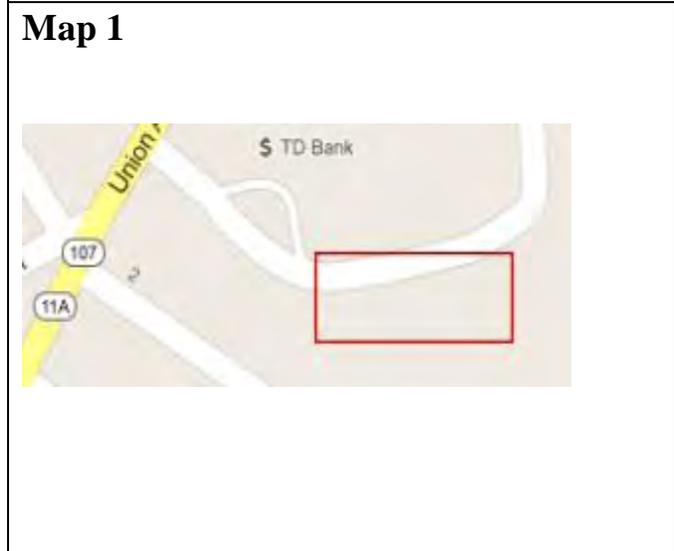
* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 3	Description: Wall removal near TD bank to restore floodplain access	Pg 1/2
------------------------	----------------------------------------------------------------------------	---------------

Location: Approx. 600 feet upstream of Union Avenue behind TD Bank

State Plane X: 1038551 State Plane Y: 376033	Reach ID: M01 (from Geomorphic Assessment Report)
---------------------------------------------------------------	-------------------------------------------------------------

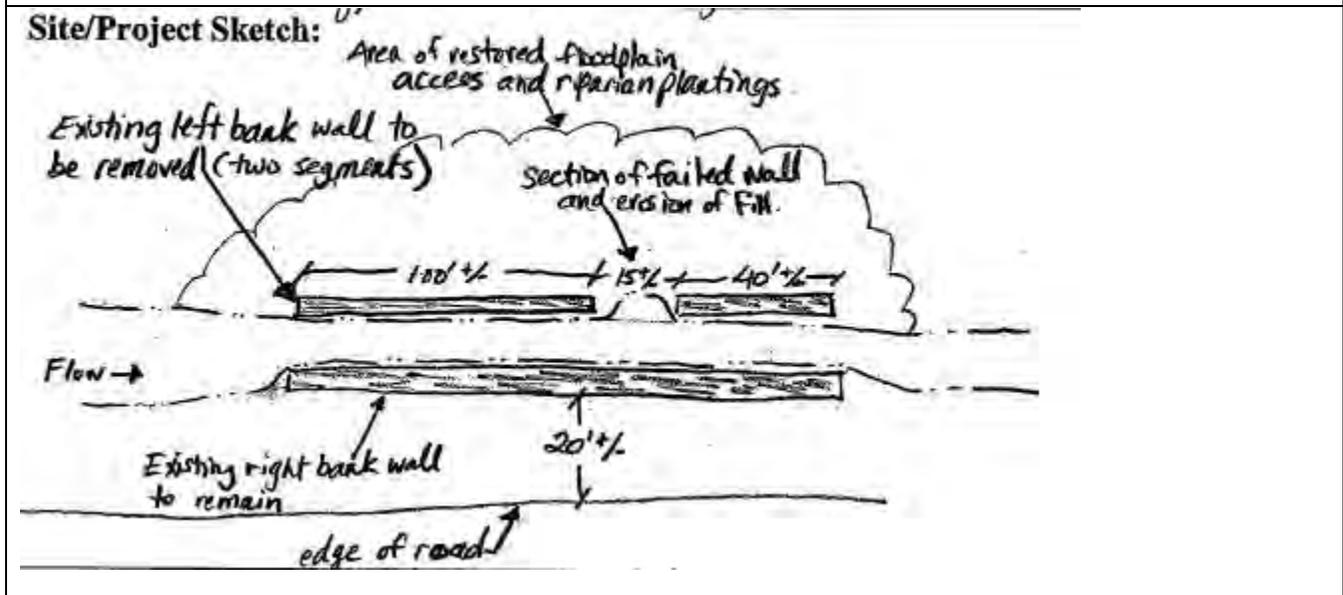


Site Issues and Relevance to the Watershed Plan Objectives:
 Stone wall forming the left bank prevents flows from accessing the left floodplain. Wall removal would allow for some reduction in peak flows downstream and would provide a location for natural sediment deposition without impact to infrastructure.

Project Type **General** **XStructural** Non-Structural

Project Type Specific Bank stabilization Wall Stabilization Dredging
 Stormwater Control Culvert replacement Landowner Outreach FEH Zone Mapping
 XRestore Floodplain Access **XEasements** **XRiparian Plantings**
 Other _____

Project Narrative Description (up/downstream limits, banks(s), etc):
Remove 140' +/- of intact stone wall on left bank of brook. Remove fill behind wall. Regrade floodplain over a distance of approximately 175'. Minor channel realignment and shaping of new left bank necessary over approximately 80'. Some revegetation of floodplain recommended.



Considerations for Prioritization:
If wall fails on its own, which has already occurred in one location, sediment/fill behind will erode downstream. Thus recommend high priority to intervene before additional wall fails.

<p>Estimated Eng/Permitting Cost Range *</p> <p><input type="checkbox"/> <\$10k <input checked="" type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input checked="" type="checkbox"/> other <u>Possible real estate/easement expenses</u></p>	<p>Estimated Construction Cost Range *</p> <p><input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> other _____</p>
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Additional Considerations and Notes:
Consider easement to protect investment. May be wetland impacts to be addressed.

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 4	Description: Fill removal near TD Bank to restore floodplain access	Pg 1/2
------------------------	----------------------------------------------------------------------------	---------------

Location: Approx. 450' upstream of Union Avenue, behind TD Bank

State Plane X: 1038396
State Plane Y: 375994

Reach ID: M01
(from Geomorphic Assessment Report)

Map 1



Map 2



Photo 1



Looking downstream toward fill removal area.

Photo 2



Looking upstream toward fill removal area.

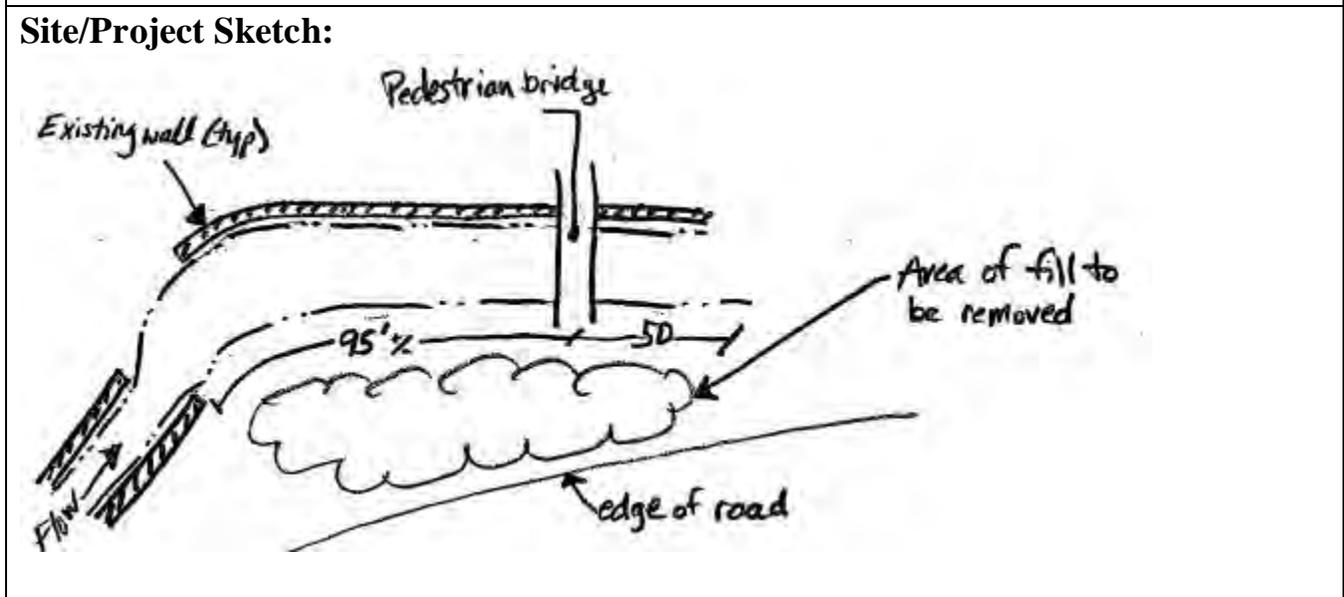
Site Issues and Relevance to the Watershed Plan Objectives:

Fill in right overbank prevents flows from accessing the right floodplain. Removal would allow for some reduction in peak flows and would provide a location for natural sediment deposition without impacts to infrastructure.

Project Type General Structural Non-Structural

Project Type Specific Bank stabilization Wall Stabilization Dredging
 Stormwater Control Culvert replacement Landowner Outreach FEH Zone Mapping
 Restore Floodplain Access Easements Riparian Plantings
 Other _____

Project Narrative Description (up/downstream limits, banks(s), etc):
Remove fill placed in the right overbank between the downstream limits of existing stonewall and the existing pedestrian bridge (approx.. 95'). Consider extending an additional 50' downstream using culverts to keep path to bridge elevated/dry. Add vegetation to new floodplain.



Considerations for Prioritization:
Project has strong connection to flow/sediment reduction goals of Watershed Plan, and few apparent constraints. Recommend Medium to High Priority.

<p>Estimated Eng/Permitting Cost Range * <input checked="" type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> other _____</p>	<p>Estimated Construction Cost Range * <input type="checkbox"/> <\$10k <input checked="" type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input checked="" type="checkbox"/> other <u>Increase if pedestrian bridge work required.</u></p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Additional Considerations and Notes:
Coordinate with project #2, which would use some of this area for stormwater control.

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 5	Description: Landowner outreach/education for residents along tributary.	Pg 1/2
------------------------	---------------------------------------------------------------------------------	---------------

Location: Tributary of Jewett Brook from Hutchinson Street crossing to outlet 100' +/- upstream of Highland Street.

State Plane (Hutch. St): 1039865/376947
State Plane (outlet): 1039327/376135

Reach ID: M01.S1.01
 (from Geomorphic Assessment Report)

Map 1



Map 2

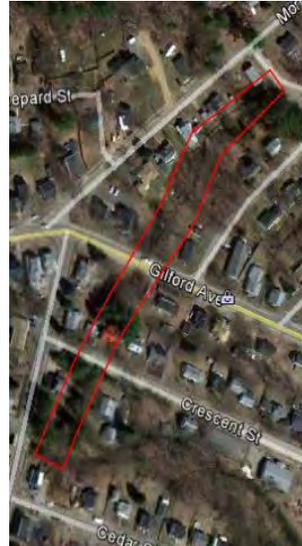


Photo 1



Looking downstream from Hutchinson Street.

Photo 2



Looking downstream from Crescent Street.

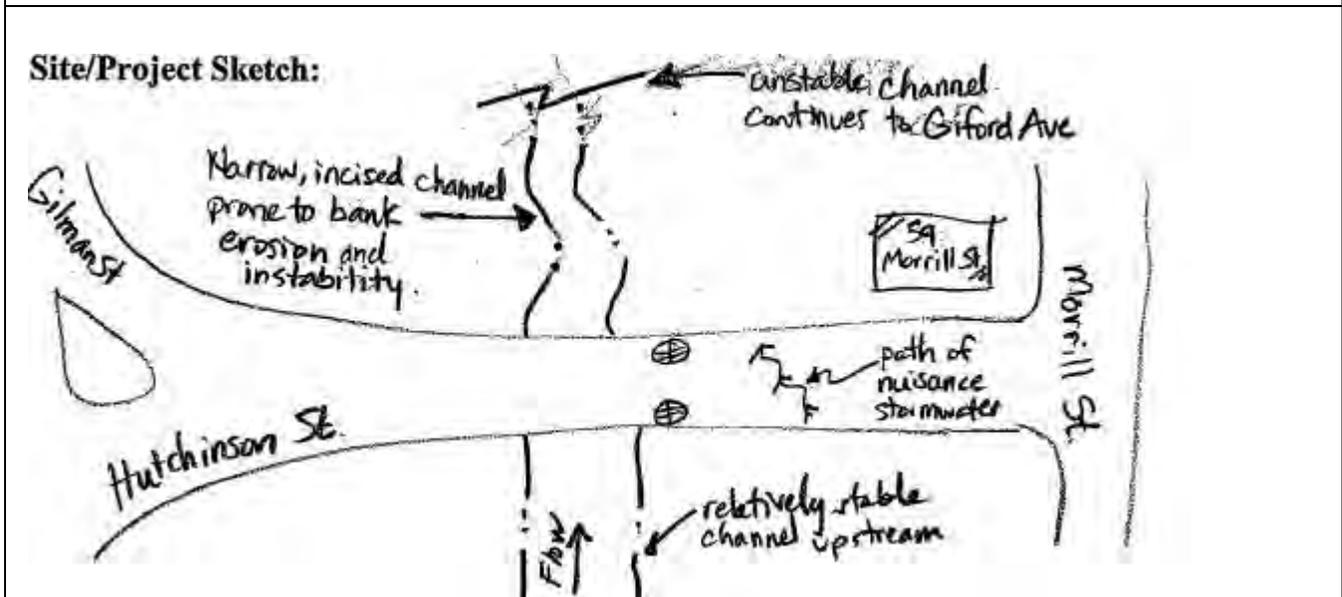
Site Issues and Relevance to the Watershed Plan Objectives:

Mowed yards to channel are common, particularly above Gilford Avenue, and the channel is narrow and incised due to historic filling. Erosion and undercut banks are common, which represents a source of sediment to Jewett Brook.

Project Type General Structural Non-Structural

Project Type Specific Bank stabilization Wall Stabilization Dredging
 Stormwater Control Culvert replacement Landowner Outreach FEH Zone Mapping
 Restore Floodplain Access Easements Riparian Plantings
 Other _____

Project Narrative Description (up/downstream limits, banks(s), etc):
 Conduct landowner outreach with residents abutting the stream to: 1) educate them about the negative downstream consequences of poor management of the channel, introduction to fluvial geomorphology/stream mechanics, and begin discussing the concept of channel management easements; 2) introduce fluvial geomorphology/stream mechanics; and 3) begin discussion of concept of channel management easements.



Considerations for Prioritization:
 The volume of sediment from this tributary is potentially relatively high, and landowner outreach is relatively inexpensive. Thus recommend High Priority.

Estimated Eng/Permitting Cost Range * **Estimated Construction Cost Range ***
 <\$10k \$10 - \$20k \$20 - \$40k <\$10k \$10 - \$20k \$20 - \$40k
 \$40 - \$60k \$60 - \$100k >\$100k \$40 - \$60k \$60 - \$100k >\$100k
 other _____ other None

Additional Considerations and Notes:
 Eventually, education could lead the way toward voluntary easements along the channel.

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 6	Description: Investigate stormwater control BMPs for closed stormdrain system above Tardiff Park.	Pg 1/2
------------------------	----------------------------------------------------------------------------------------------------------	---------------

Location: Along Champagne Avenue and contributing side streets

State Plane X: 1040515 State Plane Y: 375812	Reach ID: M02 (from Geomorphic Assessment Report)
---------------------------------------------------------------	-------------------------------------------------------------

Map 1



Map 2



Photo 1



Stormwater control BMP study area.

Photo 2



Stormwater control BMP study area.

Site Issues and Relevance to the Watershed Plan Objectives:
 Stormdrain system has no detention components (e.g., pond) and thus delivers runoff to Jewett Brook faster than undeveloped conditions. The increased volume and rate of runoff contribute to flooding and channel instability.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 7	Description: Landowner outreach and education for residents along Champagne Avenue	Pg 1/2
------------------------	-------------------------------------------------------------------------------------------	---------------

Location: East bank, in vicinity opposite to end of Brook Street

State Plane X: 1040497
State Plane Y: 375681

Reach ID: M02
(from Geomorphic Assessment Report)

Map 1



Map 2



Photo 1



Looking downstream, near Champagne Avenue/Brook Street Intersection.

Photo 2



Looking upstream, near Champagne Avenue/Brook Street Intersection.

Site Issues and Relevance to the Watershed Plan Objectives:

Landowners have removed natural riparian vegetation and extended fill and mowed lawns to the edge of the streambank. The resulting instability of the stream channel is causing erosion of the streambanks and deterioration of existing riprap, thereby contributing sediment to Jewett Brook.

Field Assessment Date: 1/26/2012	Assessed by: MTM/CWB	Pg 2/2
Project Type General <input type="checkbox"/> Structural X Non-Structural		
Project Type Specific <input type="checkbox"/> Bank stabilization <input type="checkbox"/> Wall Stabilization <input type="checkbox"/> Dredging <input type="checkbox"/> Stormwater Control <input type="checkbox"/> Culvert replacement X Landowner Outreach <input type="checkbox"/> FEH Zone Mapping <input type="checkbox"/> Restore Floodplain Access X Easements X Riparian Plantings <input type="checkbox"/> Other _____		
Project Narrative Description (up/downstream limits, banks(s), etc): Landowner outreach to: 1) educate about the negative downstream consequences of poor management of the channel; 2) introduce fluvial geomorphology/stream mechanics; 3) begin discussion of concept of channel management easements; and 4) suggest riparian plantings.		
Site/Project Sketch: N/A		
Considerations for Prioritization: The volume of sediment from this tributary is potentially relatively high, and landowner outreach is relatively inexpensive. Thus recommend High Priority.		
Estimated Eng/Permitting Cost Range * Estimated Construction Cost Range * X<\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> other _____ X other <u>None</u>		
Additional Considerations and Notes: Eventually, education could lead the way toward voluntary easements along the channel.		

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 8	Description: Culvert replacement at Route 3&11	Pg 1/2
------------------------	-------------------------------------------------------	---------------

Location: Mainstem of Jewett Brook at crossing of Route 3&11.

State Plane X: 1043369
State Plane Y: 374714

Reach ID: M03
(from Geomorphic Assessment Report)

Map 1



Map 2



Photo 1



Culvert outlet.

Photo 2



Downstream of culvert outlet.

Site Issues and Relevance to the Watershed Plan Objectives:

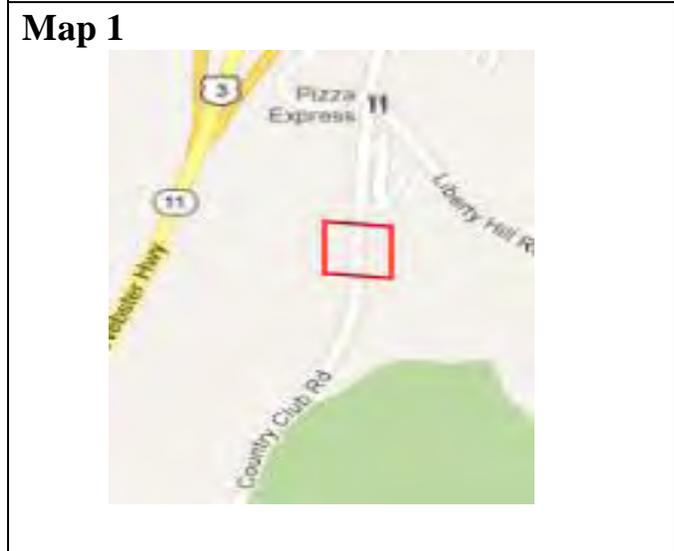
The culvert is perched, with a drop of 2.3 feet, precluding aquatic organism passage. It is also undersized, with high bank erosion below the structure, contributing sediments to the brook..

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 9	Description: Culvert replacement at Country Club Road	Pg 1/2
------------------------	--------------------------------------------------------------	---------------

Location: Mainstem of Jewett Brook at Country Club Road crossing

State Plane X: 1044192 State Plane Y: 374370	Reach ID: M04 (from Geomorphic Assessment Report)
---------------------------------------------------------------	-------------------------------------------------------------



Site Issues and Relevance to the Watershed Plan Objectives:
 The culvert is significantly undersized, and the hard bank armoring is failing above and below the structure, thus contributing sediment to Jewett Brook. During major flood events, undersized culverts such as these can trigger significant channel instability that results in the erosion of bed and bank material.

Field Assessment Date: 1/26/2012	Assessed by: MTM/CWB	Pg 2/2								
Project Type General <input checked="" type="checkbox"/> Structural <input checked="" type="checkbox"/> Non-Structural										
Project Type Specific <input type="checkbox"/> Bank stabilization <input type="checkbox"/> Wall Stabilization <input type="checkbox"/> Dredging <input type="checkbox"/> Stormwater Control <input checked="" type="checkbox"/> Culvert replacement <input type="checkbox"/> Landowner Outreach <input type="checkbox"/> FEH Zone Mapping <input type="checkbox"/> Restore Floodplain Access <input type="checkbox"/> Easements <input type="checkbox"/> Riparian Plantings <input type="checkbox"/> Other _____										
Project Narrative Description (up/downstream limits, banks(s), etc): Replace culvert with one of adequate size, both to arrest erosion associated with undersizing and to provide aquatic organism passage. Replace existing culverts with a single-span structure (bridge or culvert) of at least bankfull width.										
Site/Project Sketch: N/A										
Considerations for Prioritization: This culvert does not currently represent a significant source of sediment from channel instability, but there is a significant risk of debris blockage and road failure during flooding. Such failure would create a significant sediment source. Therefore, this project warrants low to medium priority.										
<table border="0"> <tr> <td>Estimated Eng/Permitting Cost Range *</td> <td>Estimated Construction Cost Range *</td> </tr> <tr> <td><input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k</td> <td><input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k</td> </tr> <tr> <td><input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k</td> <td><input type="checkbox"/> \$40 - \$60k <input checked="" type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k</td> </tr> <tr> <td><input type="checkbox"/> other _____</td> <td><input type="checkbox"/> other _____</td> </tr> </table>			Estimated Eng/Permitting Cost Range *	Estimated Construction Cost Range *	<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k	<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k	<input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k	<input type="checkbox"/> \$40 - \$60k <input checked="" type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k	<input type="checkbox"/> other _____	<input type="checkbox"/> other _____
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Additional Considerations and Notes: Existing culvert prone to debris blockage. During major flood event, road could overtop and fail. FEMA pre-disaster mitigation funds may be applicable.										

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

Project ID #: 10	Description: Swain Road Culvert Replacement	Pg 1/2
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Location: Mainstem of Jewett Brook at Swain Road crossing

State Plane X: 1048122
State Plane Y: 369768

Reach ID: M05
(from Geomorphic Assessment Report)

Map 1



Map 2

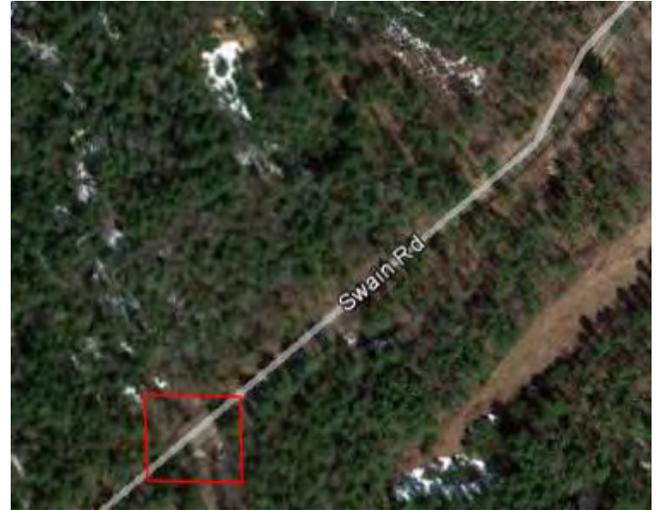


Photo 1



Culvert, looking upstream at the outlet.

Photo 2



Culvert inlet.

Site Issues and Relevance to the Watershed Plan Objectives:

The culvert is significantly undersized, with reduced AOP, but the channel has adjusted so that currently, scouring and undermining are not severe. However, the chance of plugging/failure/erosion and deposition of sediments into Jewett Brook in the future are significant.

Field Assessment Date: 1/26/2012	Assessed by: MTM/CWB	Pg 2/2								
Project Type General <input checked="" type="checkbox"/> Structural <input checked="" type="checkbox"/> Non-Structural										
Project Type Specific <input type="checkbox"/> Bank stabilization <input type="checkbox"/> Wall Stabilization <input type="checkbox"/> Dredging <input type="checkbox"/> Stormwater Control <input checked="" type="checkbox"/> Culvert replacement <input type="checkbox"/> Landowner Outreach <input type="checkbox"/> FEH Zone Mapping <input type="checkbox"/> Restore Floodplain Access <input type="checkbox"/> Easements <input type="checkbox"/> Riparian Plantings <input type="checkbox"/> Other _____										
Project Narrative Description (up/downstream limits, banks(s), etc): Culvert replacement to adequate dimensions recommended to reduce chances of future severe erosion, and to improve aquatic organism passage.										
Site/Project Sketch: N/A										
Considerations for Prioritization: Low priority—culvert is functioning adequately at present.										
<table border="0"> <tr> <td>Estimated Eng/Permitting Cost Range *</td> <td>Estimated Construction Cost Range *</td> </tr> <tr> <td><input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k</td> <td><input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k</td> </tr> <tr> <td><input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k</td> <td><input type="checkbox"/> \$40 - \$60k <input checked="" type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k</td> </tr> <tr> <td><input type="checkbox"/> other _____</td> <td><input type="checkbox"/> other _____</td> </tr> </table>			Estimated Eng/Permitting Cost Range *	Estimated Construction Cost Range *	<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input checked="" type="checkbox"/> \$20 - \$40k	<input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k <input type="checkbox"/> \$20 - \$40k	<input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k	<input type="checkbox"/> \$40 - \$60k <input checked="" type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k	<input type="checkbox"/> other _____	<input type="checkbox"/> other _____
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<input type="checkbox"/> other _____	<input type="checkbox"/> other _____									
Additional Considerations and Notes:										

* The costs presented here are D&K's opinion of probable cost based solely on field observations, the conceptual project descriptions presented above, and professional judgment informed by experience with similar projects. Unforeseen conditions encountered during preliminary or final design could significantly change these estimates.

**JEWETT BROOK WATERSHED PLAN
PROJECT DETAIL SHEET**

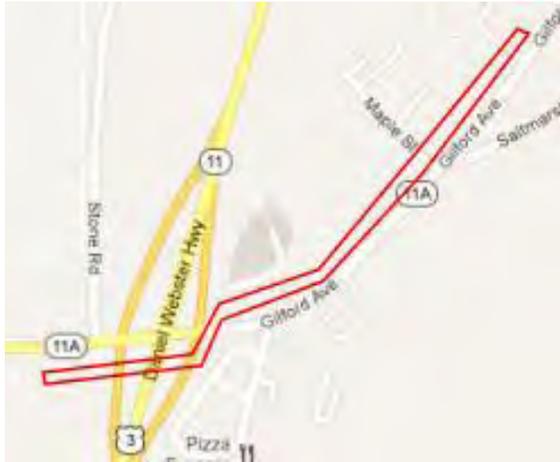
Project ID #: 11	Description: Investigate stormwater control BMP's along Gilford Avenue.	Pg 1/2
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Location: From the confluence of the tributary and mainstem of Jewett Brook upstream along the tributary to the end of the reach.

State Plane X (lower): 1042438/375536
State Plane Y (upper): 1046031/377915

Reach ID: M02T1.01 and M02T1.02
(from Geomorphic Assessment Report)

Map 1



Map 2

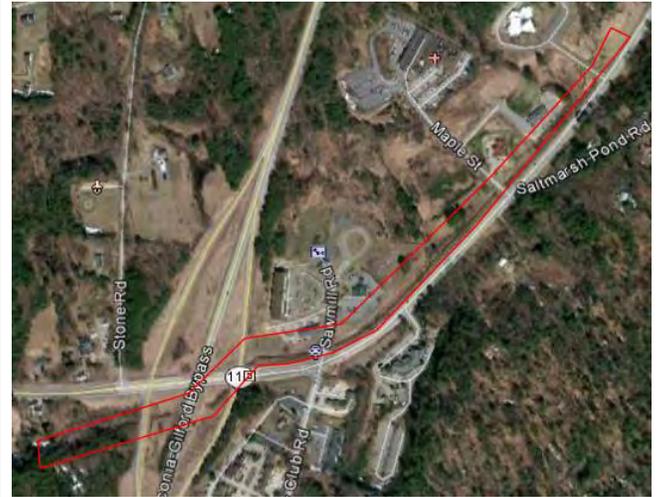


Photo 1



Gilford Common Development

Photo 2



Maple Street to Savage Road

Site Issues and Relevance to the Watershed Plan Objectives:

These stream reaches are bordered by roads and development, and there is significant potential for additional impervious surfaces associated with development of currently empty lots, such as exist at the Guilford Common Development

Field Assessment Date: 1/26/2012	Assessed by: MTM/CWB	Pg 2/2
Project Type General <input type="checkbox"/> Structural X Non-Structural		
Project Type Specific <input type="checkbox"/> Bank stabilization <input type="checkbox"/> Wall Stabilization <input type="checkbox"/> Dredging X Stormwater Control <input type="checkbox"/> Culvert replacement <input type="checkbox"/> Landowner Outreach <input type="checkbox"/> FEH Zone Mapping <input type="checkbox"/> Restore Floodplain Access <input type="checkbox"/> Easements <input type="checkbox"/> Riparian Plantings X Other Investigation/study		
Project Narrative Description (up/downstream limits, banks(s), etc): Stormwater improvements could reduce stormwater input in the entire reach. Detention/storage of stormwater prior to its outlet to the stream is recommended. Consider underground tanks where space is limited along the stream. Disconnection of impervious surfaces from stream edges is also recommended to increase infiltration, as by adding grassy areas between the outlets and the stream.		
Site/Project Sketch: N/A		
Considerations for Prioritization: Stormwater detention in the upper portion of a watershed such as this is often more beneficial than at a downstream location. As development continues, there will be less space available for stormwater detention, and retrofits are typically more expensive and less effective. Therefore, this project warrants a medium to high priority.		
Estimated Eng/Permitting Cost Range * Estimated Construction Cost Range * <input type="checkbox"/> <\$10k X \$10 - \$20k <input type="checkbox"/> \$20 - \$40k <input type="checkbox"/> <\$10k <input type="checkbox"/> \$10 - \$20k X \$20 - \$40k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> \$40 - \$60k <input type="checkbox"/> \$60 - \$100k <input type="checkbox"/> >\$100k <input type="checkbox"/> other _____ <input type="checkbox"/> other _____		
Additional Considerations and Notes: There are multiple opportunities for stormwater detention in this area.		

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