2.2 BUILT ENVIRONMENT

LAND USE HISTORY

Prior to European colonization, the Bolin Creek Watershed contained primarily hardwood forest habitat. As the eastern US was settled by European colonists, the land experienced considerable changes. Widespread clear-cutting for farming not only removed large areas of forest, but destabilized the soils, leading to considerable erosion. Sediment from this erosion wound up deposited in floodplains across the eastern US. Where there was enough local land relief, dams were built for running mills, interrupting the natural flow of streams and rivers, and trapping some of that sediment behind the dams. These developments led to significant changes in stream and valley morphology, building up floodplains with sediments high in nutrients derived from eroded fertile topsoil.

More recently, land uses have changed, with a considerable decrease in agriculture and enlargement of urban and suburban area. Increased impervious surface increases the total volume and velocity of runoff, leading to more scouring of stream channels and subsequent erosion down into the floodplain. Increased runoff also leads to the creation of more small stream channels, and more opportunities for direct access of pollutants to stream channels without prior filtration. Increased impervious surface also leads to less groundwater recharge, with subsequent reductions in the amount of water available to streams during dry weather. With less groundwater recharge, once-perennially-flowing streams start to dry out during hot or dry weather, leading to changes in stream ecological conditions.

With removal or neglect of old mill dams, remnant areas of "legacy sediments" remain out of geomorphic equilibrium with the stream. As a result, many streams have cut down sharply through their floodplains, even further or to a greater extent than may be explained by changes in runoff volume or velocity from impervious surfaces. Where floodplains were built up by deposition from excess erosion during colonial times, or deposition behind dams, these soils store large amounts of nutrients that can now be released as the stream cuts down and the floodplain erodes away. As a result, area streams may be carrying large nutrient loads partly because of land use changes centuries ago.

CURRENT LAND USE AND LAND COVER

Current land use is a mix of different urban and suburban intensities, rural residential and undeveloped land, with a pattern of increasing land use intensity as you move from the headwaters to the confluence of Bolin Creek with Booker Creek. This shift in intensity across the watershed can be seen in the 2006 national land use classifications (Figure 9) and current locations of impervious surfaces (Figure 10). Land use intensity is a well-known stressor to freshwater ecosystems. The amounts of different landuse classifications and impervious surfaces in each subwatershed are analyzed in the following chapter on Watershed Impairment . These analyses provide different ways of looking at the same stressor and understanding its relationship to aquatic health.

Figure 9: 2006 Land Use From National Land Cover Dataset

Bolin Creek Watershed
Restoration Plan
November 1, 2012

Legend

- Major Roads
- Bolin Creek Watershed
- Intermittent Stream
- Perennial Stream
- Wetlands
- Lakes and Wide Streams
- Open Water
- Perennial Ice/Snow
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

0 1,250 2,500 5,000 Feet

N

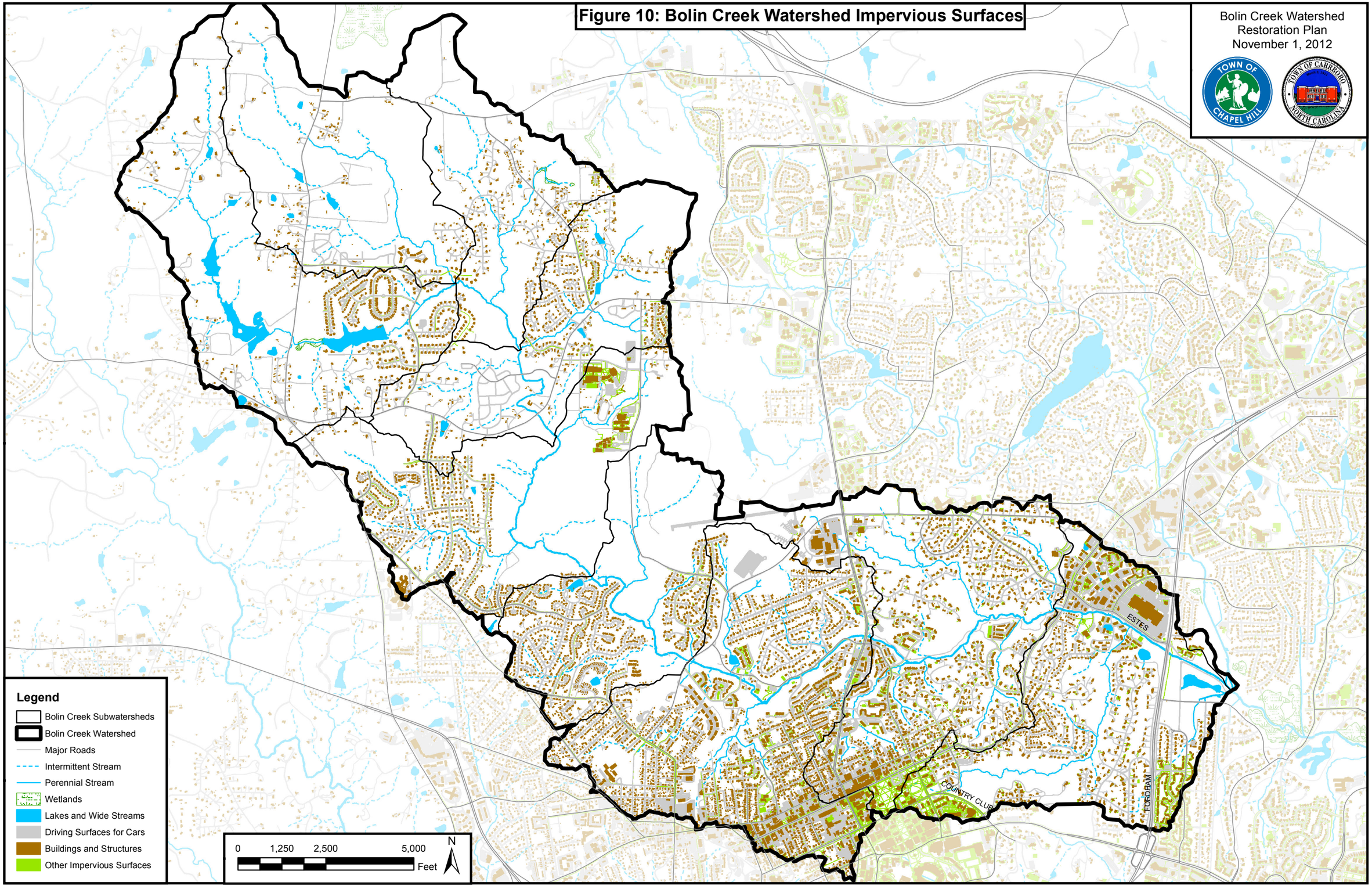
ESTES

COUNTRY CLUB

FORDHAM

Figure 10: Bolin Creek Watershed Impervious Surfaces

Bolin Creek Watershed
Restoration Plan
November 1, 2012



SUBDIVISIONS AND NEIGHBORHOODS

We have observed that different subdivisions and neighborhoods have different drainage characteristics, not necessarily based on natural characteristics such as soil type or slope of the land. Differences in density of housing or intensity of land use, such as more impervious surfaces, change the amount of runoff leaving an area. Similarly, different subdivisions were developed with subtle differences in runoff management that can make a big difference in runoff impacts. In particular, the use of roof drains rather than downspout splashblocks reduces the available area and distance for runoff to infiltrate into the soil before reaching a stream. In some neighborhoods, roof drains are run all the way to property boundaries, nearby stormdrain pipes or structures, or even directly to streams.

Some neighborhoods have curb and gutter along streets, concentrating street runoff into impermeable stormwater pipes, where it is discharged all at a single outlet point. In contrast, other neighborhoods have roadside ditches which concentrate runoff less than curb and gutter, and provide area (the ditches themselves) where some runoff can infiltrate the soil.

The process of development compacts the soil, and usually removes the top layers of soil, affecting runoff infiltration for years. After several decades and protection from heavy use (like parking), the soil may develop better permeability. This process of improved infiltration is accelerated if trees and shrubs are planted. Thus, both the age of the development and the vegetation planted after houses are built further alters the drainage characteristics of a neighborhood.

Neighborhoods also differ in demographics, with different mixes of renters and owners, long-term vs. short-term residents (such as students), ethnicities and cultures, education and income levels. All of which lead to different attitudes towards acceptable landscaping, runoff management, use of fertilizers and pesticides, available resources, and valuing of the natural environment. Part of a long-term watershed management program should therefore attempt to characterize neighborhoods and subdivisions by these differences, as different communication and environmental management strategies will be required for different combinations of factors. Subdivisions and neighborhoods have been mapped out by Subwatershed, as shown on Figures 11 through 19. Appendix 9 is a lookup table that allows you to find the name based on the ID number on the maps.

Broadly speaking, Hogan Farm, Horace Williams and Upper Bolin Creek subwatersheds support moderate to high incomes, owner-occupied residential neighborhoods with a low crime rate. The Middle Bolin Creek subwatershed has eclectic neighborhoods and business districts, including the Northside Community and Downtown Chapel Hill which is composed of mostly rental property and downtown businesses and churches. On the east end of downtown Chapel Hill lays the Historic District, with long-term residency, high incomes, and large lots. Sororities, fraternities and student rentals are also woven into the neighborhood. The Lower Bolin Creek Watershed has high economic diversity with a mix of low-income rental property and higher-income owner-occupied homes. Lower Bolin Creek's residential sections along South Estes Drive include affordable apartments, condominiums, wide roads, and public housing in addition to shopping and business centers and University Mall, most lying within the regulatory floodplain.

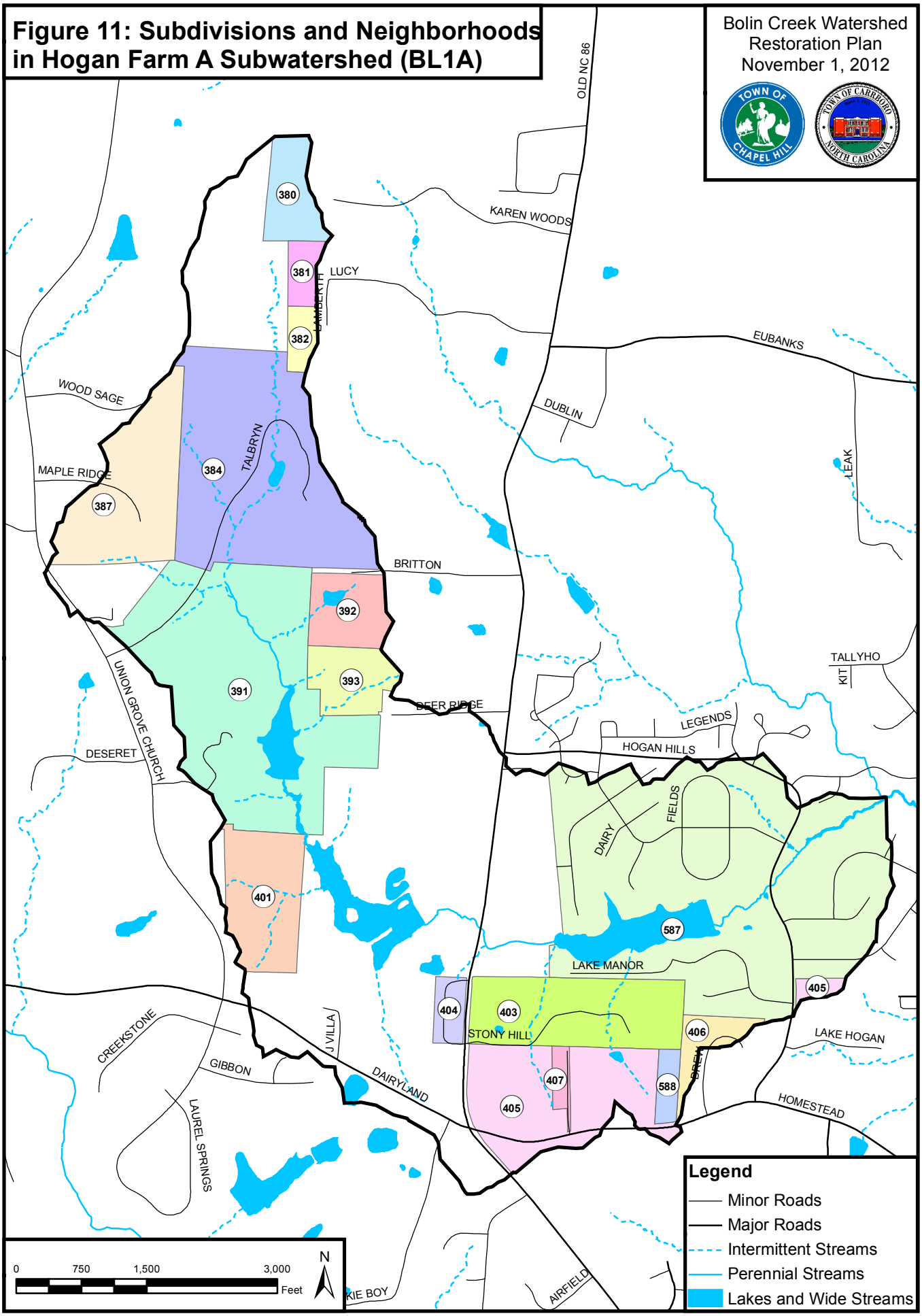


Figure 11: Subdivisions and Neighborhoods in Hogan Farm A Subwatershed (BL1A)
Bolin Creek Watershed Restoration Plan
November 1, 2012
OLD NC 86
KAREN WOODS
LUCY
LAMBERTH
EUBANKS
DUBLIN
LEAK
WOOD SAGE
MAPLE RIDGE
TALBRYN
BRITTON
UNION GROVE CHURCH
DESERET
DEER RIDGE
TALLYHO
KIT
LEGENDS
HOGAN HILLS
DAIRY
FIELDS
LAKE MANOR
LAKE HOGAN
STONY HILL
CREEKSTONE
GIBBON
J VILLA
DAIRYLAND
LAUREL SPRINGS
HOMESTEAD
AIRFIELD
380
381
382
384
387
391
392
393
401
403
404
405
406
407
587
588
0
750
1,500
3,000
Feet
N
Legend
Minor Roads
Major Roads
Intermittent Streams
Perennial Streams
Lakes and Wide Streams

Figure 12: Subdivisions and Neighborhoods in Hogan Farm B Subwatershed (BL1B)

Bolin Creek Watershed Restoration Plan
November 1, 2012

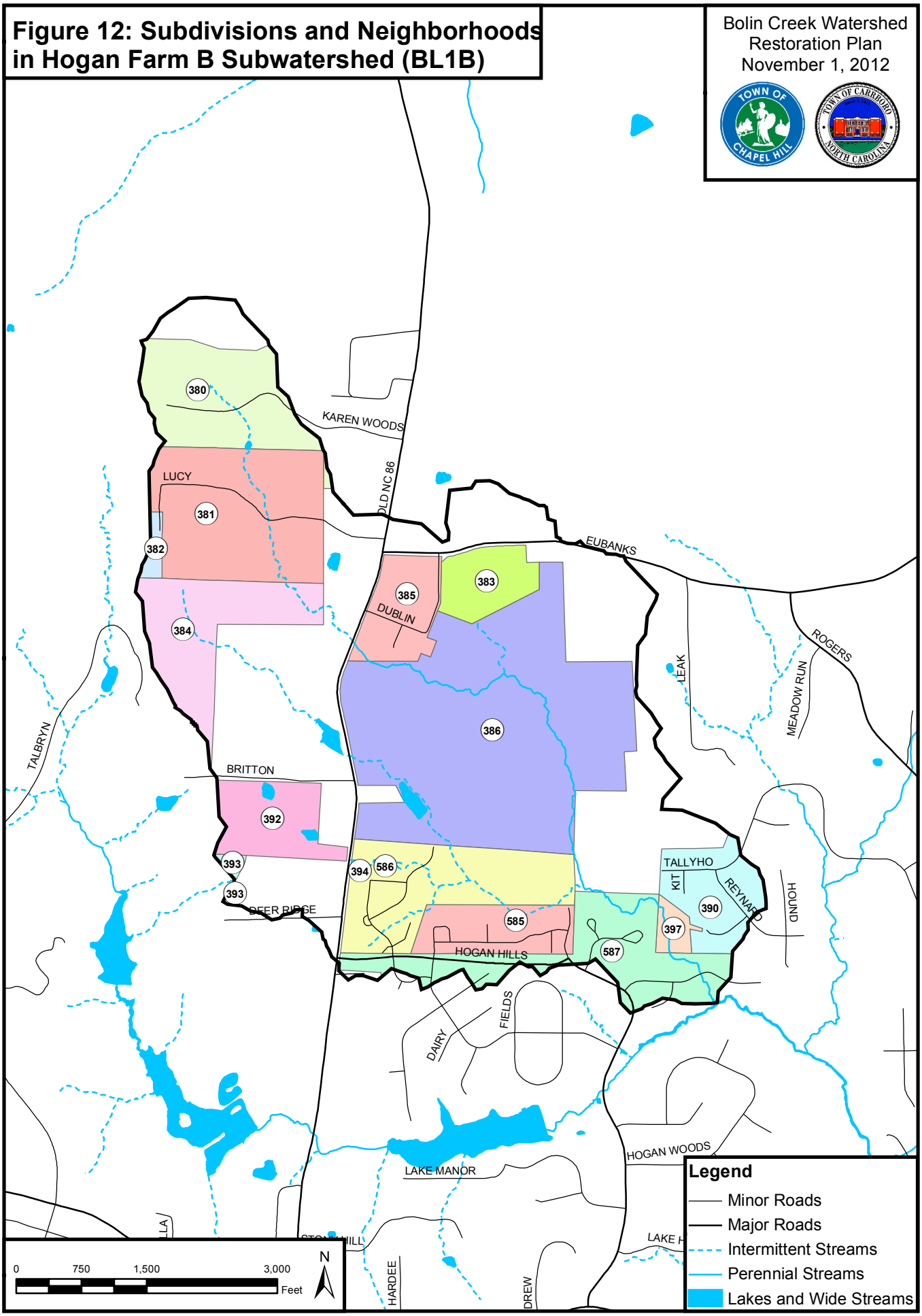


Figure 13: Subdivisions and Neighborhoods in Upper Bolin Creek A Subwatershed (BL2A)

Bolin Creek Watershed Restoration Plan
November 1, 2012

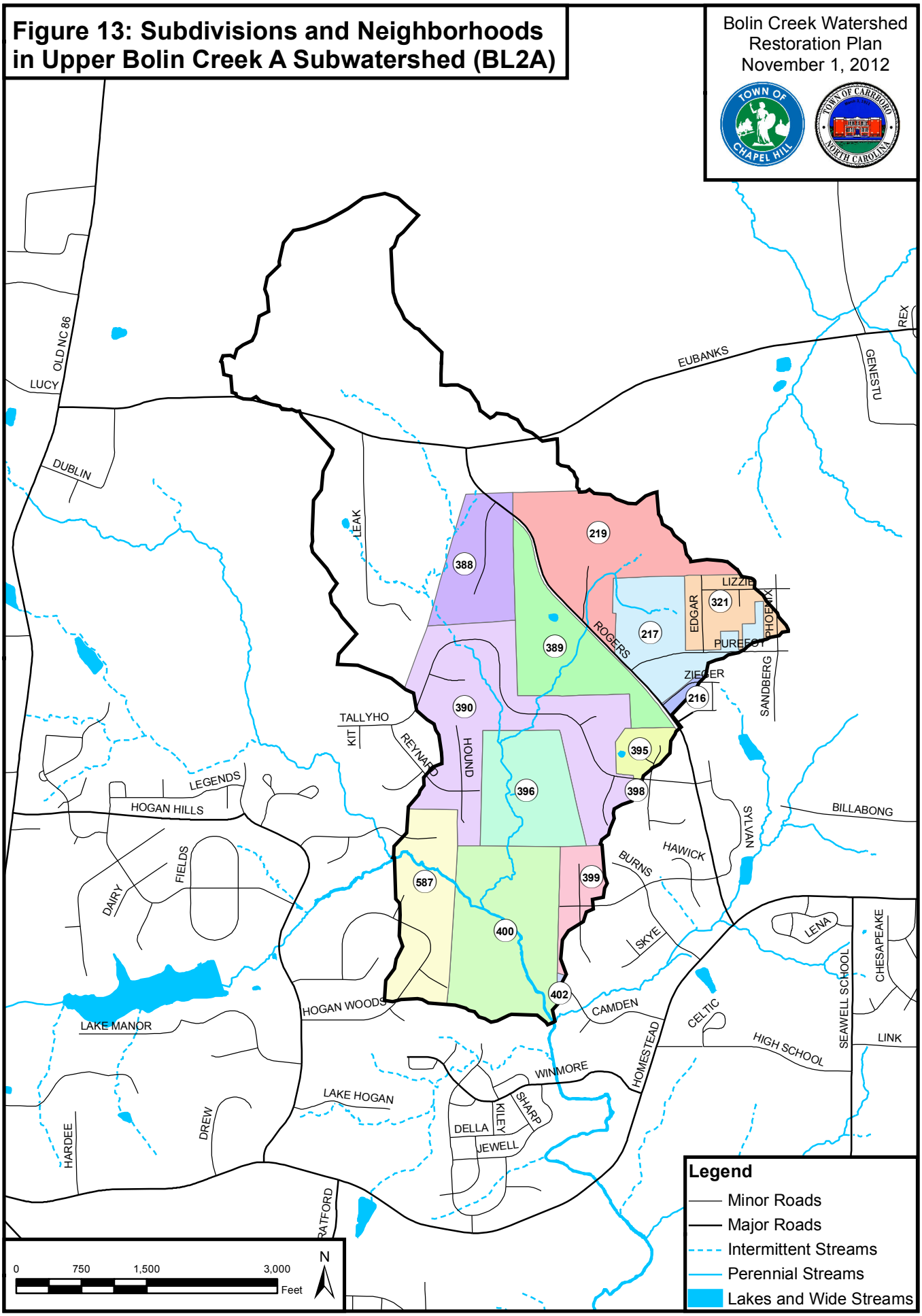
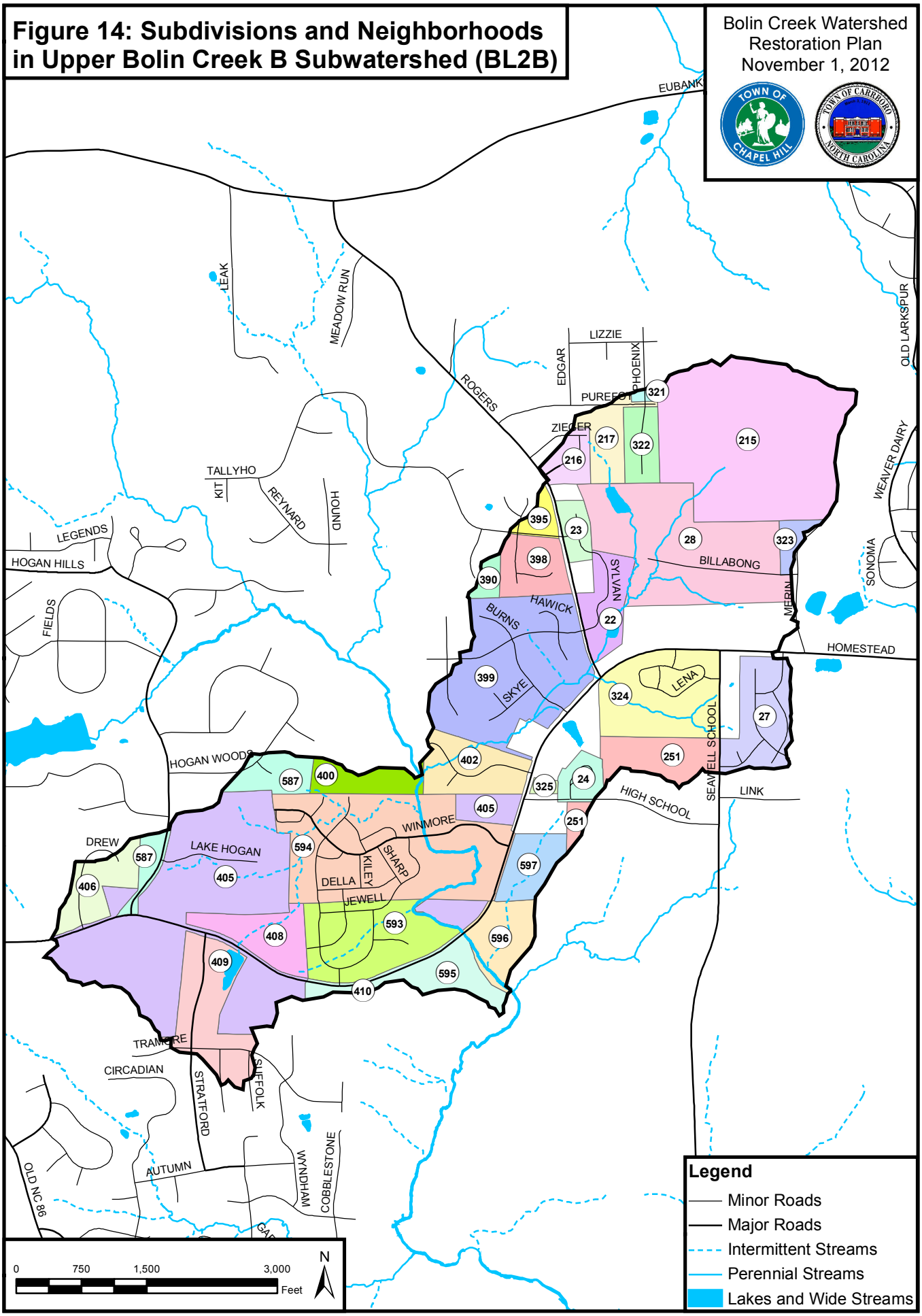


Figure 14: Subdivisions and Neighborhoods in Upper Bolin Creek B Subwatershed (BL2B)

Bolin Creek Watershed Restoration Plan
November 1, 2012



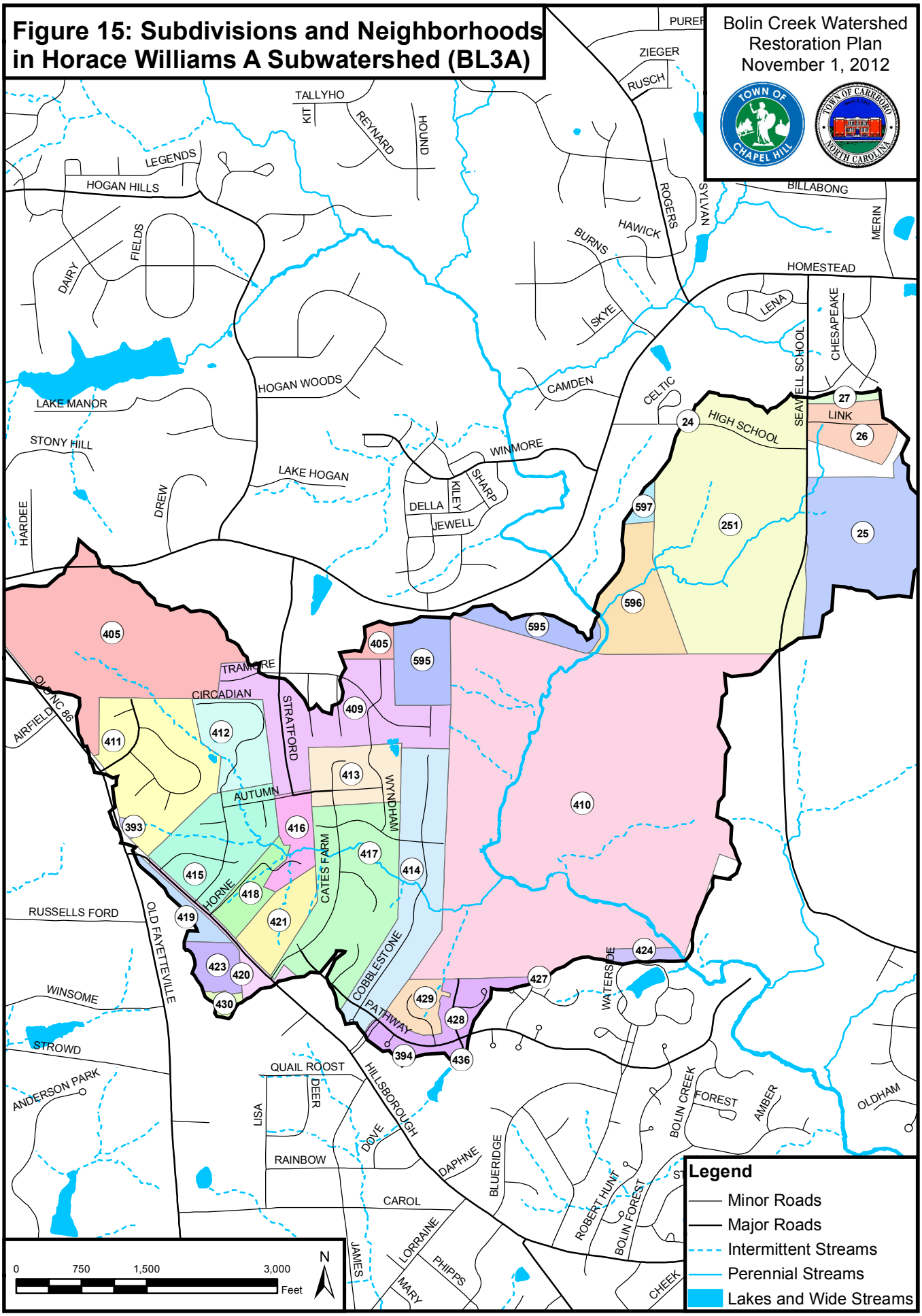


Figure 15: Subdivisions and Neighborhoods in Horace Williams A Subwatershed (BL3A)
Bolin Creek Watershed Restoration Plan
November 1, 2012
TOWN OF CHAPEL HILL
TOWN OF CARRBORO NORTH CAROLINA
PUREF
ZIEGER
RUSCH
TALLYHO
KIT
REYNARD
HOUND
LEGENDS
HOGAN HILLS
FIELDS
DAIRY
ROGERS
SYLVAN
BILLABONG
MERIN
HAWICK
BURNS
HOMESTEAD
LENA
SKYE
CHESAPEAKE
SEAWELL SCHOOL
CAMDEN
CELTIC
HOGAN WOODS
LAKE MANOR
STONY HILL
LAKE HOGAN
WINMORE
DELLA
KILEY
SHARP
JEWELL
DREW
HARDEE
HIGH SCHOOL
LINK
27
26
24
25
597
251
596
595
405
409
411
412
413
410
393
416
417
414
415
418
419
421
423
420
430
424
427
429
428
394
436
TRAMORE
CIRCADIAN
STRATFORD
AUTUMN
WYNDHAM
CATES FARM
HORNE
COBBLESTONE
PATHWAY
WATERSIDE
OLD NC 86
AIRFIELD
RUSSELLS FORD
OLD FAYETTEVILLE
WINSOME
STROWD
ANDERSON PARK
QUAIL ROOST
DEER
LISA
HILLSBOROUGH
DOVE
RAINBOW
DAPHNE
BLUERIDGE
CAROL
JAMES
LORRAINE
PHIPPS
MARY
ROBERT HUNT
BOLIN FOREST
CHEEK
BOLIN CREEK
FOREST
AMBER
OLDHAM
0
750
1,500
3,000
Feet
N
Legend
Minor Roads
Major Roads
Intermittent Streams
Perennial Streams
Lakes and Wide Streams

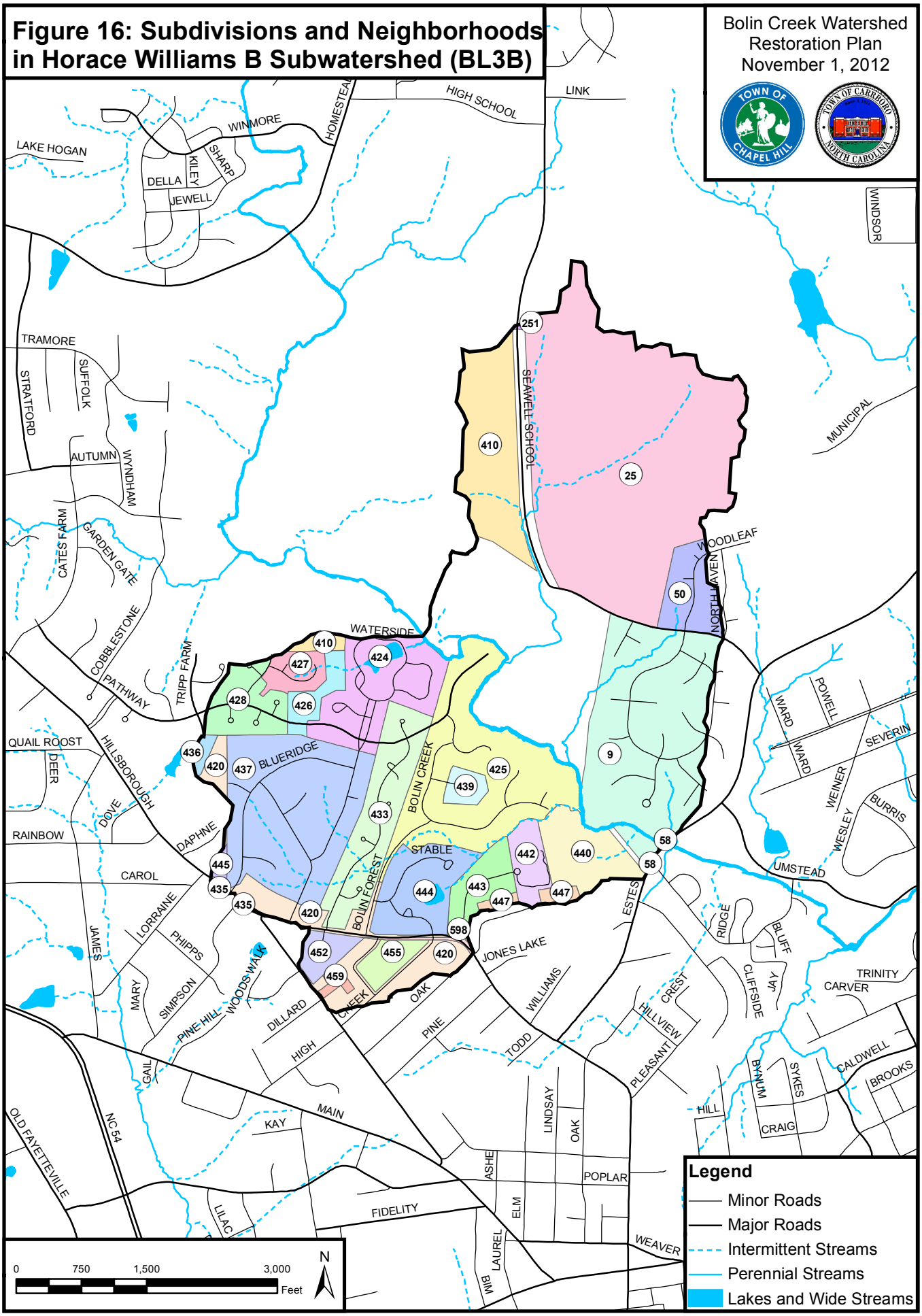


Figure 16: Subdivisions and Neighborhoods in Horace Williams B Subwatershed (BL3B)
Bolin Creek Watershed Restoration Plan
November 1, 2012
TOWN OF CHAPEL HILL
TOWN OF CARRBORO NORTH CAROLINA
LAKE HOGAN
WINMORE
HOMESTEAD
HIGH SCHOOL
LINK
DELLA
KILEY
SHARP
JEWELL
WINDSOR
TRAMORE
STRATFORD
SUFFOLK
AUTUMN
WYNDHAM
CATES FARM
GARDEN GATE
COBBLESTONE
PATHWAY
TRIPP FARM
QUAIL ROOST
DEER
DOVE
HILLSBOROUGH
RAINBOW
DAPHNE
CAROL
LORRAINE
JAMES
PHIPPS
MARY
SIMPSON
PINE HILL
WOODS WALK
DILLARD
HIGH
GAIL
OLD FAYETTEVILLE
NC 54
KAY
MAIN
LILAC
FIDELITY
WEAVER
BIM
LAUREL
ELM
ASHE
POPLAR
LINDSAY
OAK
PINE
TODD
WILLIAMS
JONES LAKE
OAK CREEK
BOLIN FOREST
STABLE
BOLIN CREEK
BLUERIDGE
WATERSIDE
SEAWELL SCHOOL
MUNICIPAL
WOODLEAF
NORTHHAVEN
ESTES
RIDGE
BLUFF
JAY
CLIFFSIDE
CREST
HILLVIEW
PLEASANT
TRINITY
CARVER
CALDWELL
BROOKS
SYKES
BYNUM
CRAIG
HILL
UMSTEAD
WESLEY
WEINER
BURRIS
SEVERIN
POWELL
WARD
WARD
251
410
25
50
9
58
58
410
427
424
428
426
436
420
437
425
439
433
445
435
435
420
444
442
440
443
447
447
598
452
455
420
459
Legend
Minor Roads
Major Roads
Intermittent Streams
Perennial Streams
Lakes and Wide Streams
0
750
1,500
3,000
Feet
N

Figure 17: Subdivisions and Neighborhoods in Middle Bolin Creek A Subwatershed (BL4A)

Bolin Creek Watershed Restoration Plan
November 1, 2012

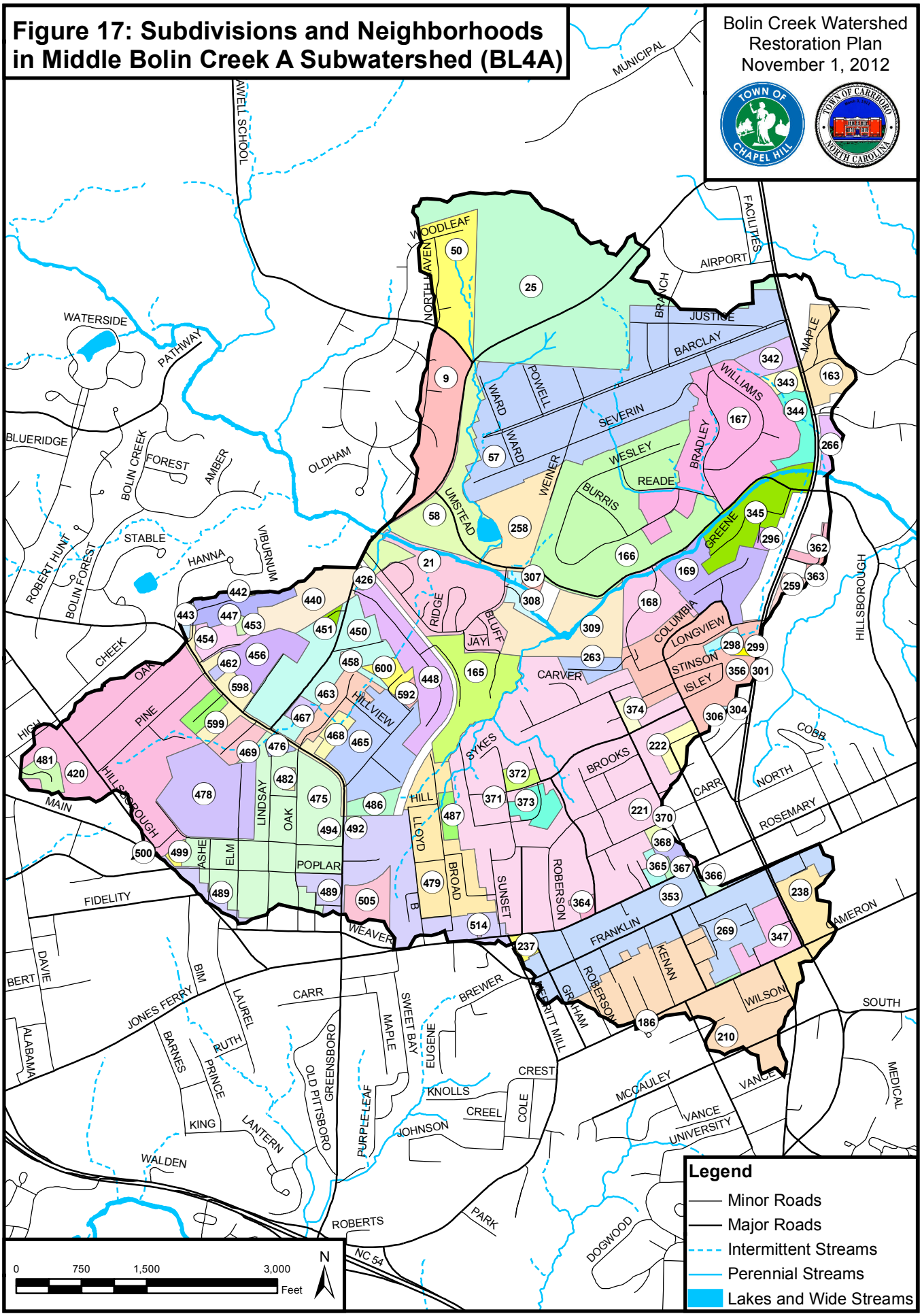


Figure 18: Subdivisions and Neighborhoods in Middle Bolin Creek B Subwatershed (BL4B)

Bolin Creek Watershed Restoration Plan
November 1, 2012

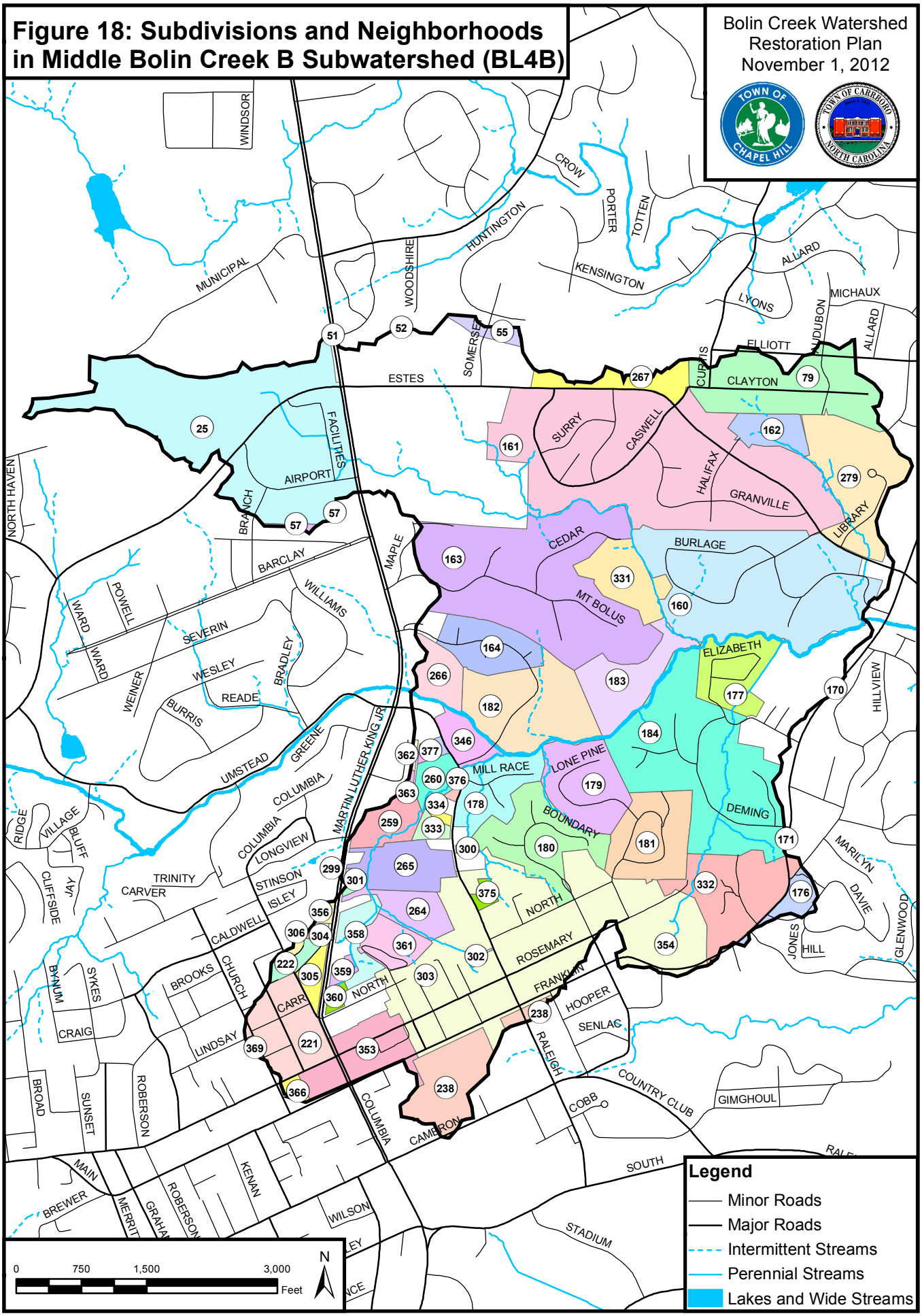
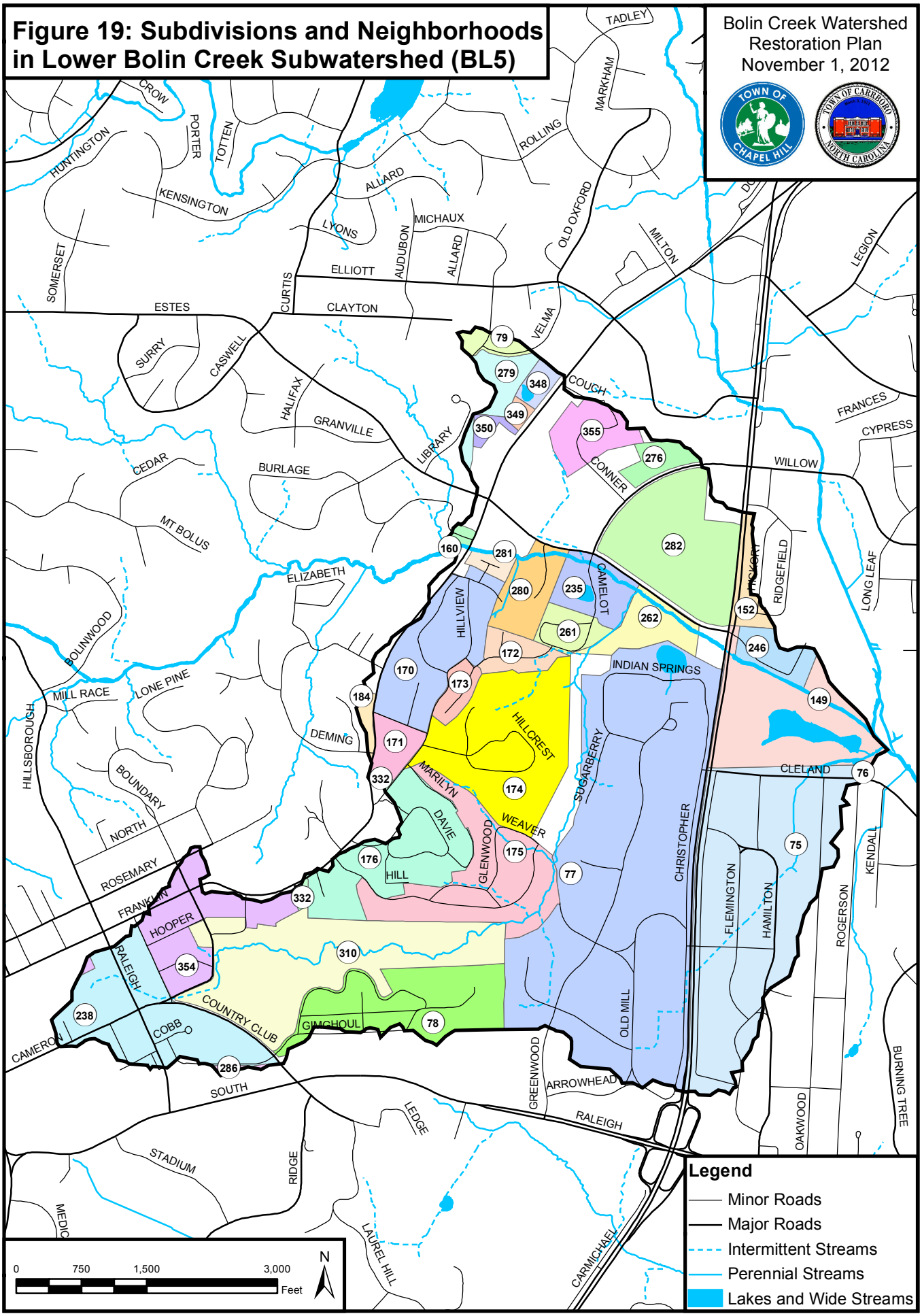


Figure 19: Subdivisions and Neighborhoods in Lower Bolin Creek Subwatershed (BL5)

Bolin Creek Watershed Restoration Plan
November 1, 2012



POPULATION DEMOGRAPHICS

Together, Chapel Hill and Carrboro have an estimated 8,433 households in the Bolin Creek Watershed. A little over half of the Bolin Creek Watershed residents rent property and are more likely to be students and/or short-term residents: rentals are primarily located in the Middle Bolin Creek sub-basin. According to the results of a 2006 Chapel Hill Community Based Survey to measure residents' perceptions, knowledge and interest in stormwater issues, the only factor that correlated with a lack of knowledge regarding stormwater management and creek health in Chapel Hill was the amount of time lived in Chapel Hill being less than five years. Residents who rent may to a certain extent also correlate with a lack of adoption of the town as a lasting home and therefore may have a lesser interest in community action and participation. Rental property owners may also have a lesser probability of having a "willingness to pay" for property improvements to benefit water quality. Expenses for maintenance of special landscaping or stormwater BMPs would not likely be a high priority. Yard care, if any, may not go beyond routine grass cutting as property owners want to maximize their income on rental property. They also may not have responsible tenants to care for the property. Table 2 shows demographic factors within each of the five sub-watersheds. Figure 20 shows the percent of residents who have moved in the past year.

Outreach in Middle Bolin Creek Watershed must target transient populations such as students and property managers and must be repeated periodically and consistently in order to have much effect. In the late 1990's, during a recycling survey of the Northside community in Middle Bolin Creek subwatershed Eagle Scouts conducted a house to house, in-person survey to address low recycling participation and what could be done to increase the number and quality of recycling bin set outs. It was found that residents were motivated by "wanting to help." After the survey, set outs were tallied and participation increased by 35% over several months. Data is not available for longer term participation. The success of "neighbor to neighbor" or in-person outreach is supported by annual visits of UNC, Town and Recycling representatives who visit rental housing communities in August, soon after the fall semester move-in, to educate new residents about being good neighbors by showing courtesy to others and by following local rules and regulations about occupancy, parking, alcohol, noise, and trash. This outreach has improved compliance rates, showing that *direct communication* with residents motivates them to become involved in their community.

According to the April 2010-April 2011 total of 911 calls for service, Lower and Middle Bolin Creek sub-watersheds had almost triple the number of calls as any other watershed. The nature of calls to 911 varied considerably and included those for medical or accident assistance, or to report fires, robberies, assaults, suspicious behaviors, and noise among other things. In all, calls coming from the Middle Bolin Creek watershed comprised 37.6% of total calls going to Chapel Hill and Carrboro police. In contrast, the Upper Bolin Creek Watershed had the lowest number of police calls. This correlates directly with median household incomes and home values (see Table 2), but also reflects Chapel Hill's major business district and nightlife, which comprises a large portion of Middle Bolin Creek.

Crime statistics are significant. One reason some property owners do not want to maintain high vegetation, especially along creeks, is the fear of (potential) criminals (and snakes unrelated to crime) being able to hide. Call-for-assistance statistics also support perceptions that downtown has safety issues. This is especially true for restaurant and bar employees in the downtown area who have outdoor duties such as disposing of trash and grease after closing at night.

Table 2: Demographics of Subwatersheds Within Bolin Creek Watershed

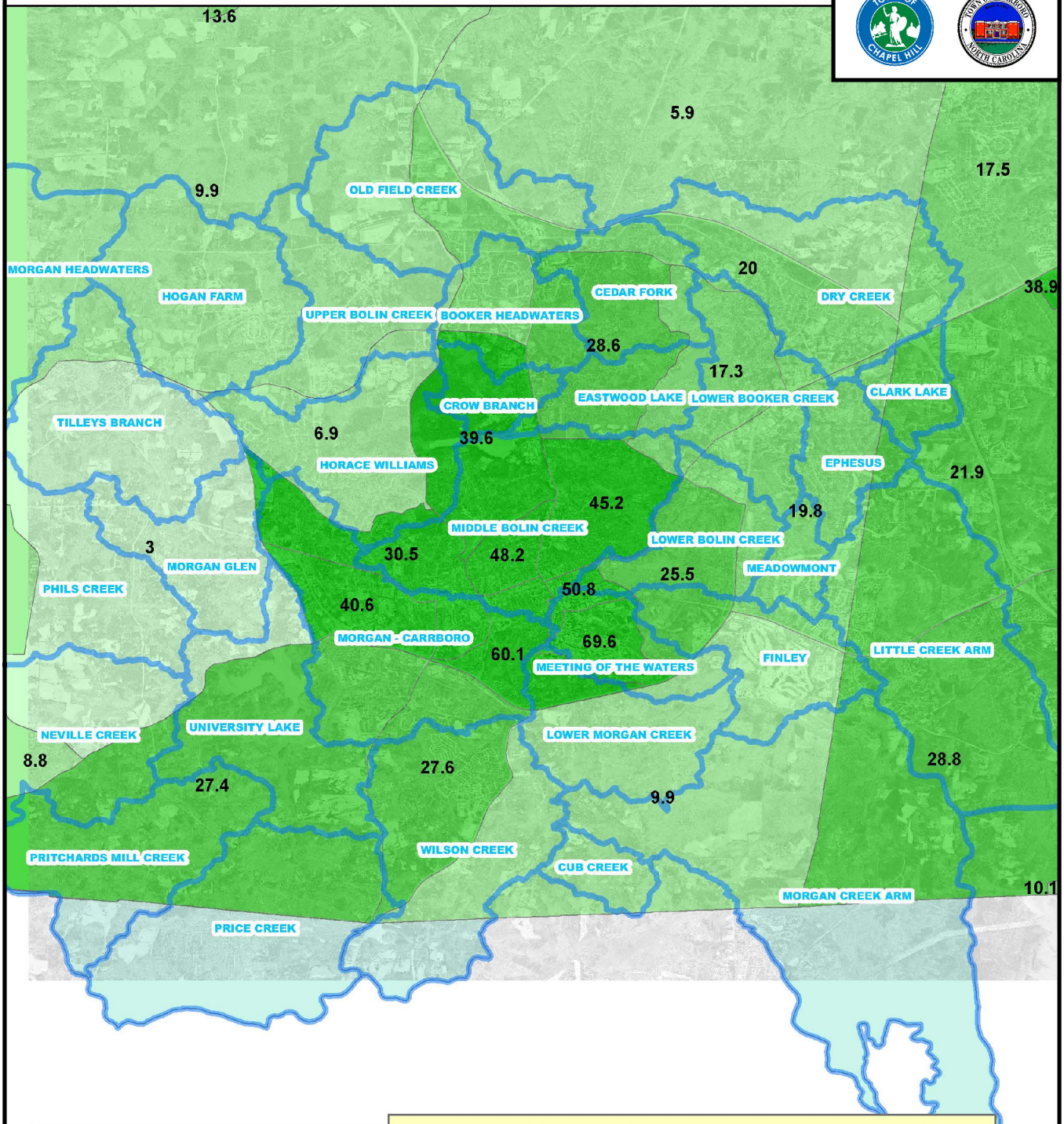
Demographic Factor	Subwatersheds within Bolin Creek Watershed: Hogan Farm	Horace Williams	Upper Bolin Creek	Middle Bolin Creek	Lower Bolin Creek	Total Bolin Creek Watershed
Sum of Home Units	635	1208	461	4945	1184	8433
Number / % All Rentals in SubWatershed	82 / 1.9%	119 / 2.7%	29 / 0.7%	3393 / 78%	730 / 16.8%	4353 rentals / 51.6% HH
Median HH Income	$133,323	$65,417	$122,722	$34,624	$44,257	$80,068
Median Home Value (Owner Occupied Units)	$400,100	$314,958	$392,186	$273,253	$458,636	$367,827
911 Calls for Service (Police/Fire/Medical, Traffic Accidents or Vehicle Problems) April 2010 - April 2011	57	385	60	11,121	2,687	14,310
% Caucasian Residents: Distribution* within subwatershed / % within subwatershed	8.6% /74.8%	15.4% / 79.1%	6.2% / 68.3%	53.3% /71.8%	16.4% /74.4%	73.30%
% of African American Residents: Distribution* within subwatershed / % within subwatershed	3.4% /3.3%	3.8% / 2.3%	4.7% / 5.9%	70% / 10.9%	18.1% /9.4%	8.40%
% Hispanic Latino: Distribution* within subwatershed / % within subwatershed	8.3% / 8.2%	17.6% / 10.3%	11.1% / 14%	49.0% /7.5%	14.0% / 7.2%	8.40%
% Asian: Distribution* within subwatershed / %within subwatershed	13.7% / 8.2%	13.6% / 6.3%	10.6% / 10.5%	45.9% /5.6%	16.1% /6.6%	6.60%
Notable: % Total Impervious Surface Including Roads, Parking, Roofs, Sidewalks, Pavement, Pools	6.20%	8.40%	12.70%	30.60%	21.80%	16.40%

Demographic data condensed from 2010 US Census Data, Town of Chapel Hill Planning Department

*Distribution is number of residents of certain race in subwatershed, divided by total number of residents of same race in the Bolin Creek Watershed. Race demographic within Bolin Creek Watershed (last column) is total number of residents of certain race divided by total number of residents in Bolin Creek Watershed.

Figure 20

Bolin Creek Watershed Restoration Plan
November 1, 2012



Percent

- 3.000000 - 5.000000
- 5.000001 - 10.000000
- 10.000001 - 20.000000
- 20.000001 - 30.000000
- 30.000001 - 100.000000

Percent of Residents who moved in the past year

Source: American Community Survey 2010

Note: These percentages are derived from survey responses sent to a small sample of the population within each Census Tract. The margin of error can vary for each area.

2.3 REGULATORY AND POLICY ENVIRONMENT

WATER USES AND CLASSIFICATIONS

Streams and lakes in our area are classified for particular uses, or ecological functions, by the State in order to set a standard against which we can rate their functioning. Streams, lakes, ponds, and reservoirs ("waters") can have designated uses ranging from "fishable/swimmable" to water supplies with various amounts of protection. Waters may have multiple classifications based on being nutrient sensitive, high quality, or having other characteristics. All waters must at least meet the standards for Class C, also known as "fishable/swimmable". The descriptions of surface water classifications can be found in Table 3. The highest classification assigned for local waterbodies is shown on Figure 21. Note that all waters in our area are at a minimum designated for Class C uses and all are determined to be Nutrient Sensitive Waters. All Water Supply II waters are also designated High Quality Waters.

Table 3: Surface Water Classifications for Local Waterbodies

DWQ Primary Classifications	**Description**
Class C ("fishable / swimmable", "aquatic life")	Waters protected for secondary recreation (wading, boating, and other incidental human body contact), fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses suitable for Class C. No restrictions on watershed development or types of discharges.
Class B ("primary contact")	Waters used for primary recreation (swimming, diving, water skiing and similar) and other uses suitable for Class C. There are no restrictions on watershed development or types of discharges.
WS-II ("Water Supply II")	Waters used as sources of potable water where a WS-I classification is not feasible. These waters are generally in predominantly undeveloped watersheds and only general permits for discharges are allowed. All WS-II are High Quality Waters by definition.
WS-IV ("Water Supply IV")	Waters used as sources of potable water where WS-I, WS-II, or WS-III classification is not feasible. These waters are generally in moderately to highly developed watersheds or Protected Areas, and involve no categorical restrictions on discharges.
WS-V ("Water Supply V")	Waters protected as water supplies which are generally upstream of and draining to Class WS-IV waters or waters used by industry to supply their employees with drinking water or as waters formerly used as water supply. These waters have no categorical restrictions on watershed development or wastewater discharges.
DWQ Secondary Classifications	**Description**
Nutrient Sensitive Waters (NSW)	Waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation.
High Quality Waters (HQW)	Classification to protect waters with quality higher than state water quality standards. WS-II waters are High Quality Waters by definition. There are associated wastewater treatment and development controls enforced by DWQ.

From NC DENR webpage: Guide to Freshwater Classifications Chart. See this document for more details on requirements for watershed protection, critical areas, and other restrictions and requirements for specific land uses.