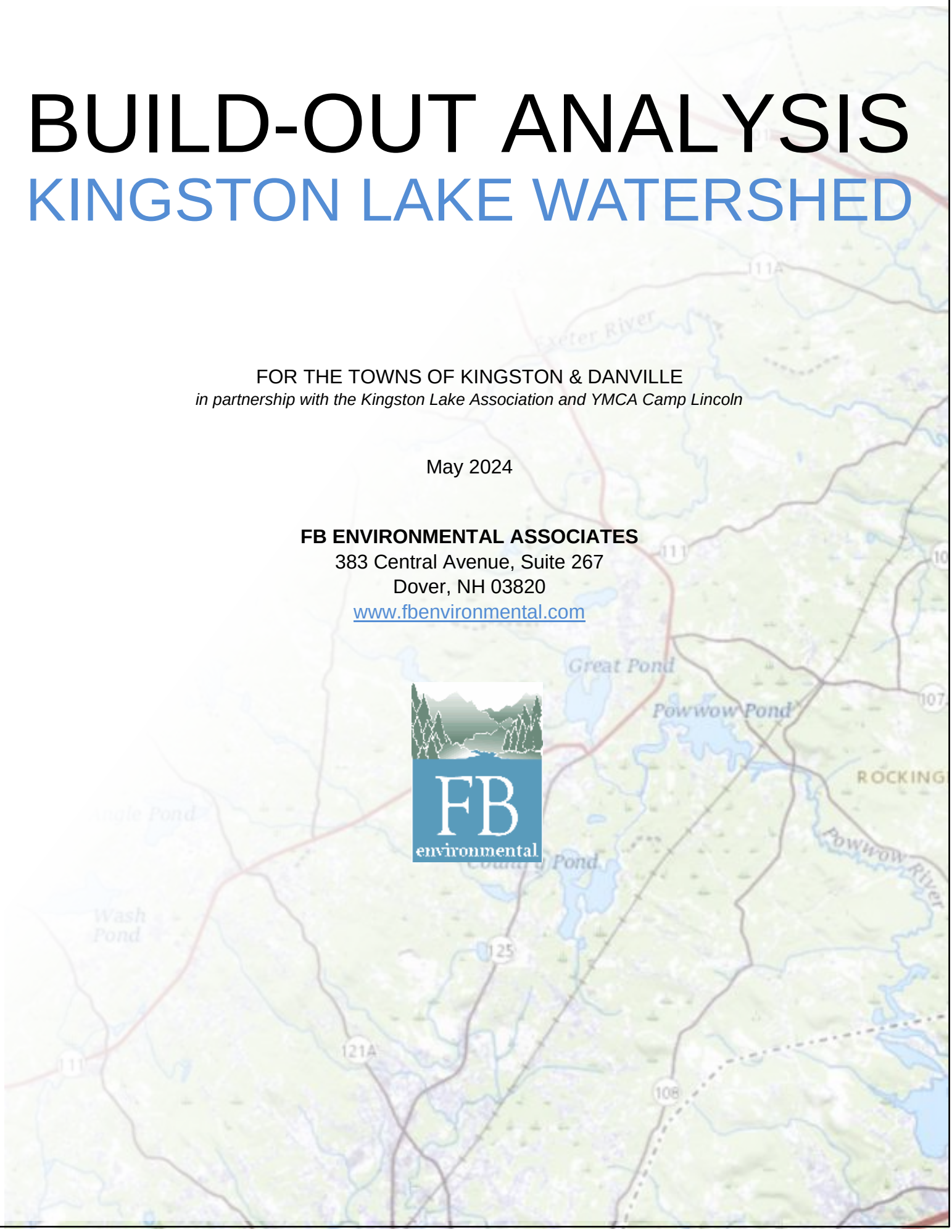
BUILD-OUT ANALYSIS
KINGSTON LAKE WATERSHED

FOR THE TOWNS OF KINGSTON & DANVILLE
in partnership with the Kingston Lake Association and YMCA Camp Lincoln

May 2024

FB ENVIRONMENTAL ASSOCIATES
383 Central Avenue, Suite 267
Dover, NH 03820
www.fbenvironmental.com



BUILD-OUT ANALYSIS

KINGSTON LAKE WATERSHED

Prepared by **FB Environmental Associates**

May 2024

Prepared as part of the development of the Kingston Lake Watershed-Based Management Plan which was funded in part by a grant awarded to the Town of Kingston from the federal government through the American Rescue Plan Act (ARPA) to the State of New Hampshire, Governor's Office of Emergency Relief and Recovery (GOFERR), and NH Department of Environmental Services (NHDES), as approved by the Governor and Executive Council.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Concerned with protecting the water quality and ecological integrity of Kingston Lake, the Town of Kingston, in partnership with the Kingston Lake Association and YMCA Camp Lincoln, hired FB Environmental Associates (FBE) to perform a build-out analysis of the Kingston Lake watershed, as part of the development of the Kingston Lake Watershed-Based Management Plan. The Kingston Lake watershed extends into the towns of Kingston and Danville, NH.

A build-out analysis is a planning tool that identifies areas with development potential and projects future development based on a set of conditions (e.g., zoning regulations, environmental constraints) and assumptions (e.g., population growth rate). The results of the build-out analysis can be used for planning purposes to help guide future development activities in the watershed, as well as target specific areas for conservation. Note that the analyses presented herein provide a full build-out scenario based on Kingston and Danville's current zoning standards (which are subject to amendment) and should be viewed as estimates only. "Full build-out" is a theoretical condition which represents the period when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum conditions permitted by local ordinances.

Approximately 1,721 parcels were identified as within or partially within the watershed, ranging in size from less than one acre to 141 acres. The largest parcel completely within the watershed covers 121 acres. The build-out analysis showed that 47% (2,220 acres) of the study area is buildable under current zoning regulations. FBE identified 1,282 existing buildings within the watershed, and the build-out analysis projected that an additional 414 buildings could be constructed in the future, resulting in a total of 1,696 buildings in the watershed. Three iterations of the TimeScope Analysis were run using compound annual growth rates (CAGR) for 20-, 30- and 50-year periods from 2000-2020 (0.32%), 1990-2020 (0.93%), and 1970-2020 (2.07%), respectively. Full build-out is projected to occur in 2110 at the 20-year CAGR, 2053 at the 30-year CAGR, and 2037 for the 50-year CAGR.

1. INTRODUCTION

Kingston Lake and its watershed are located within the towns of Kingston and Danville in southeastern New Hampshire. Most development is scattered throughout the watershed and within a few concentrated areas north and west of Kingston Lake, as well as near the inflow to Long Pond. Kingston Lake, also known as Great Pond, is classified as a mesotrophic lake by the State of New Hampshire. Kingston Lake is currently on the NHDES 303(d) List of Impaired Waters for Aquatic Life Integrity due to low concentrations of dissolved oxygen and low pH and for Primary Contact Recreation due to elevated levels of *E. coli* near the YMCA Camp Lincoln Beach.

Concerned with protecting the water quality and ecological integrity of Kingston Lake and its watershed, the Town of Kingston, in partnership with the Kingston Lake Association and YMCA Camp Lincoln, hired FB Environmental Associates (FBE) to develop a Watershed-Based Management Plan to address nutrient loading to Kingston Lake. As part of this plan, FBE performed a build-out analysis of the Kingston Lake watershed (hereafter "study area") (FIGURE 1). The results of the analysis provide estimates of the numbers of potential lots and new building units the study area may see developed at some point in the future. "Full build-out" refers to the time and circumstances whereby no more building construction may occur, or the point at which lots have been subdivided to the minimum size allowed and there is no more "developable" land. Performing a build-out analysis shows a locality what land is available for development, how much development can occur, and at what densities. A build-out is best used as a large-scale planning exercise to understand future development. Municipalities can use the analysis as a tool for planning development patterns in the future and understanding development impacts to water quality. However, large-scale planning models such as this build-out analysis require simplifying assumptions. As such, the results should be viewed holistically to better understand development trends and potential future outcomes.

2. METHODS

2.1 COMMUNITY VIZ SOFTWARE

FBE conducted the build-out analysis using ESRI ArcMap v. 10.6 geographic information system (GIS) software and CommunityViz v. 5.2. CommunityViz is a GIS-based, decision-support tool designed to help planners and resource managers visualize, analyze, and communicate about important land use decisions. FBE utilized the software's 'Build-out Wizard' to calculate the development capacity of the study area (numerically and spatially), as well as the 'Time Scope Analysis' tool to project and visualize how future development might occur over time.

The build-out analysis was performed according to the following steps:

1. Collect data on existing conditions in the study area: existing buildings, zoning regulations, and population size(s).
2. Collect and/or create relevant GIS data (e.g., development constraints layers such as wetlands and steep slopes).
3. Analyze build-out potential using CommunityViz's Build-Out Wizard tool.
4. Determine potential dates at which full build-out is reached using CommunityViz's TimeScope Analysis tool.

2.2 DISCLAIMER AND DATA LIMITATIONS

The data used in the analysis represented stock data sets obtained from New Hampshire's Statewide Geographic Information System Clearinghouse (NH GRANIT). Many of these data layers were created from remotely sensed data (e.g., aerial photography, digital orthophotos, and satellite images) and large, landscape-level mapping projects (e.g., Soil Units). As a result, the data layers are intended to be viewed at certain scales (generally 1:24,000 or 1:25,000) due to accuracy levels. NH GRANIT maintains a continuing program to identify and correct errors in these data but make no claims as to the validity or reliability or to any implied uses of these datasets. As a result, the data presented herein should be used for planning purposes only. If greater data precision is required, this report should be supplemented with field surveys or other on-the-ground methods of data collection. There may also be minor data discrepancies throughout this document due to the variety of source materials and mapping standards used. The reader is encouraged to refer to the original referenced sources if specific data inconsistencies need to be resolved.

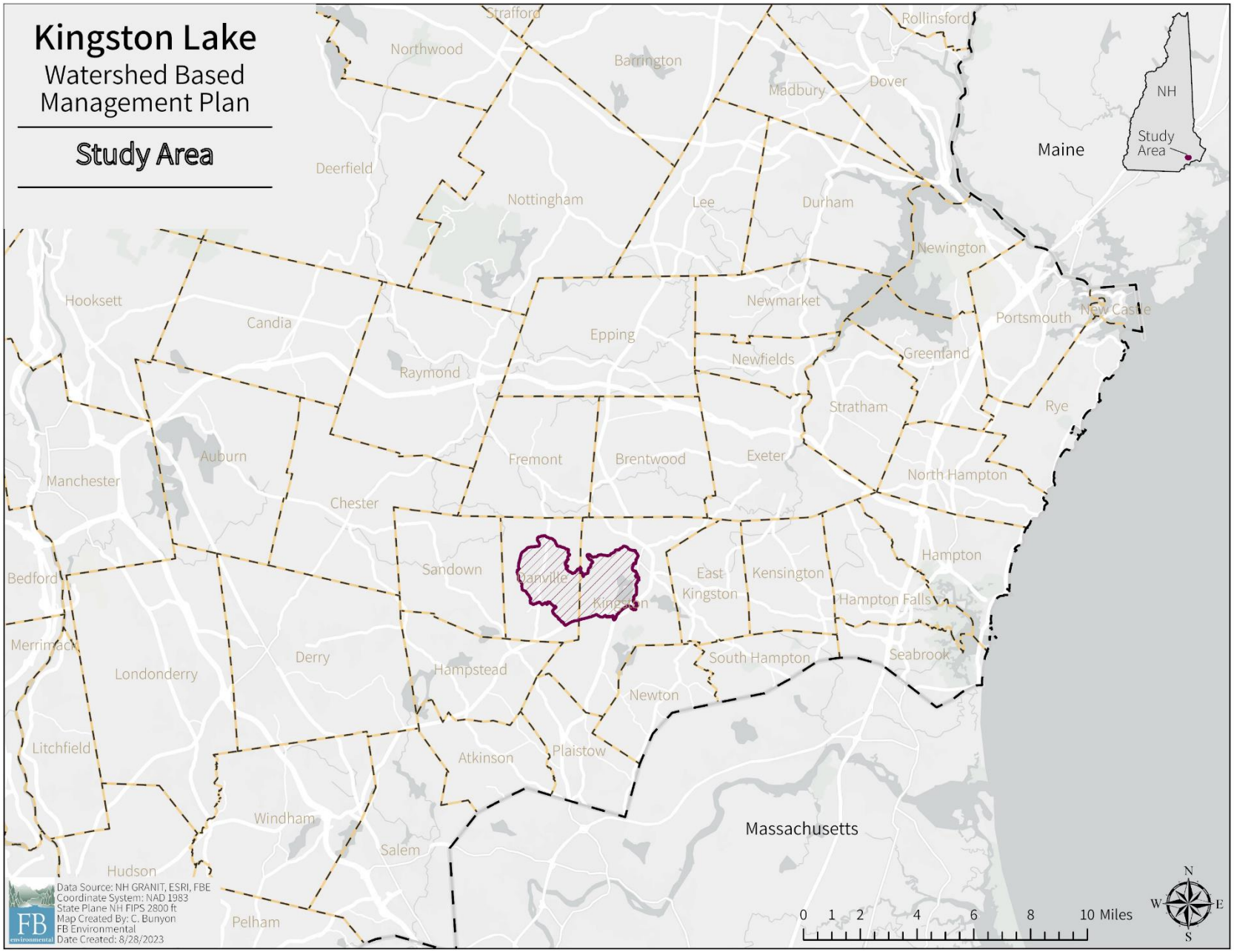


FIGURE 1. The Kingston Lake watershed in Kingston and Danville, NH.

2.3 POPULATION GROWTH RATES

According to the US Census Bureau, Kingston and Danville, NH have experienced steady population growth since the middle part of the last century (TABLE 1). Kingston's population has increased from 2,882 people in 1970 to 6,202 people in 2020 – a 1.54% compound annual growth rate (CAGR). Danville's population has increased from 924 people in 1970 to 4,408 people in 2020 – a 3.17% CAGR. FBE used CAGRs for 10-, 20-, 30-, and 50-year periods to run three iterations of the TimeScope analysis for the study area (refer to Section 3.4).

TABLE 1. US Census Bureau population and growth rates for the towns Kingston and Danville, NH, 1970-2020. Population estimates obtained from the NH Office of Strategic Initiatives.

							Compound Annual Growth Rate			
Town	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**	**50 yr. Avg. 1970-2020**	**30 yr. Avg. 1990-2020**	**20 yr. Avg. 2000-2020**	**10 yr. Avg. 2010-2020**
Kingston	2,882	4,111	5,563	5,905	6,025	6,202	1.54%	0.36%	0.25%	0.29%
Danville	924	1,318	2,474	4,046	4,387	4,408	3.17%	1.94%	0.43%	0.05%
Combined	**3,806**	**5,429**	**8,037**	**9,951**	**10,412**	**10,610**	**2.07%**	**0.93%**	**0.32%**	**0.19%**

2.4 EXISTING BUILDINGS

Existing buildings were downloaded from the Microsoft Buildings Layer (updated 4/13/2022) through ArcGIS Online. FBE extracted the building footprints within the Kingston Lake watershed boundary, verified this data, and provided the necessary edits based on the most recent ESRI World Imagery available (09/26/2021). FBE used this shapefile to create a points shapefile containing the location of principal structures.

Modification of the building footprint shapefile coupled with examination of aerial imagery resulted in the creation of a shapefile having 1,282 points representing principal structures within the study area (FIGURE 2). In areas where it was difficult to discern the presence of a dwelling (typically due to shadows or the presence of trees), ESRI World Imagery was cross-checked using recent Google Earth imagery (5/2018, 10/2020, 8/2023).

2.5 ZONING

Crucial to a build-out analysis is the feasibility of modeling zoning requirements (TABLE 2). Certain zoning requirements are too site-specific to enable incorporation into the analysis. Given this, the analysis makes use of the following qualifications in determining build-out zoning restrictions:

- Future lots were made the smallest size allowable for the zoning district while also accounting for more restrictive overlay districts.
- Potential unit types (e.g., residential house, commercial building) were not specified.

There are four zoning districts within the Town of Kingston and five within the Town of Danville that are within the Kingston Lake watershed. These zones were assigned to each parcel within the study area. Zone boundaries followed parcel line boundaries for Danville. This was not the case for Kingston. Parcels that spanned multiple zones were verified with the Kingston Town Planner, Glenn Greenwood, on 8/31/2023 and assigned to the appropriate zone.

The Aquifer Protection Overlay District was also considered and included in TABLE 2, which overrides and increases a zone's minimum lot size to 3 acres. Additionally, different setbacks are required for different types of commercial development in the Commercial (C3) zone of Kingston, but TABLE 2 reflects the requirements for the one parcel within this zone in the Kingston Lake watershed. The Mobile Home (MH) zone of Danville contains two types of setbacks, one for the mobile home community and a second for the homes within the community. TABLE 2 reflects the setback for homes within the community, not for the entire mobile home community. Lastly, the Highway Commercial and Light Industrial (HCLI) zone of Danville has a front setback of 50 feet as per the town's Site Plan Regulation

TABLE 2. Base zoning standards for the towns of Kingston and Danville, NH within the Kingston Lake watershed. A " * " indicates that the information was not provided in town zoning documents so values were input from the respective town's baseline for lot sizes and setbacks.

Town/Zone	Front Setback (Feet)	Side/Rear Setback (Feet)	Minimum Lot Size (square feet)	Minimum Lot Size (acres)
Kingston				
Single Family Residential District (SFR)	20*	20*	80,000	1.84
Rural Residential District (RR)	30	20	80,000*	1.84*
Historic District (H1)	20*	20*	80,000*	1.84*
Commercial (C3)	100	50	80,000*	1.84*
Aquifer Protection Overlay District	-	-	130,680	3
Danville				
Residential/Agricultural (RA)	30	50	87,120	2
Historic District (HD)	30*	15*	87,120	2
Mobile Homes (MH)	30	30	43,560	1
Highway Commercial/Light Industrial (HCLI)	50	15*	87,120	2
Danville Village District (DVD)	30	15	87,120	2

2.6 DEVELOPMENT CONSTRAINTS

To determine where development may occur in the study area, the build-out analysis first subtracts land unavailable for development due to physical constraints, including environmental restrictions (e.g., wetlands, resource protection zones, hydric soils), zoning restrictions (e.g., shoreland zoning, street Right-of-Ways (ROWs), and building setbacks), and practical design considerations (e.g., lot layout inefficiencies). Existing buildings also reduce the capacity for new development (FIGURE 2). Except for existing buildings, FBE obtained all development constraints data from NH GRANIT, the Web Soil Survey, and USGS printed maps. GIS data used to model development constraints included conserved land, waterbodies and watercourses appearing in the National Hydrography Dataset, wetlands appearing in the National Wetlands Inventory, the wetland and waterbody setbacks for Kingston, steep slopes (slopes 15% and greater for Kingston and slopes 25% or greater for Danville), poorly drained soils for Danville, and existing buildings.

The development constraints considered above do not represent the full range of possible restrictions or resources that may be found in the field. For example, rare and/or state-listed species may be present but are not considered because data regarding their specific location(s) are not available. Small, unmapped wetlands and vernal pools may also be present and would further restrict development.

2.7 BUILD-OUT ASSUMPTIONS

To determine how many building units can be built on the available buildable land, various density and other design factors are considered based on the zoning requirements for the municipalities. However, build-out analyses require some simplifying assumptions. FBE used the assumptions described below in the build-out analysis.

- **Building setbacks** were input based on the front and rear setbacks specified by the municipalities' zoning ordinances (TABLE 2). Setbacks are measured from building center points in CommunityViz. To account for this, building footprints need to be estimated to avoid building overlap. FBE estimated the dimensions of the minimum building footprint to be 35 feet x 35 feet. This number was added to the average front/rear setback for each zone to estimate the "Minimum Separation Distance" used in CommunityViz.
- **Wetland and stream setbacks** were applied as a setback of 100 feet from wetlands, 300 feet from the Powwow River, and 100 feet from all other streams in Kingston, and 75 feet from poorly and very poorly drained soils in Danville. Wetlands and streams were identified from the National Wetlands Inventory and National Hydrography Dataset, respectively.
- **Minimum lot size requirements** used were based on requirements for each zone per parcel (TABLE 2). If town zoning documents did not specify lot size or setback requirements, the town baselines for lot size and setbacks were applied (80,000 square feet with 20-foot front and side setbacks for Kingston, and 2 acres with a 30-foot front and 15-foot side setbacks for Danville). Additionally, the Aquifer Protection Overlay District in Kingston requires a minimum lot size of 3 acres, which overrides lot size requirements in any zone in Kingston.

The build-out analysis models future development based on existing conditions and assumes that all land that could be subdivided will be subdivided, with the intention of modeling theoretical future development based on what is possible under existing conditions.

Building density is difficult to predict with precision in a build-out analysis because the exact siting of construction and development occurs in a somewhat unpredictable fashion. A wide range of factors (in addition to those mentioned above) can decrease the permitted density: stormwater drainage facilities, parcel contiguity, ROWs, setbacks, road frontage, conservation restrictions, subdivision review, soils-based zoning, etc. A standard approach to account for these density losses is to apply an "**efficiency factor**" to the analysis, which is a simple multiplier that adjusts the "lot efficiency," the amount of land on a parcel that is available for construction after addressing all constraints. Simply stated, an efficiency factor is used to account for information that can only be obtained upon on-the-ground inspection of particular parcels. Efficiency factors are entered as a percentage, where 100% means complete efficiency (no density lost) and 0% means no buildings are estimated for a zone. Based on professional experience, FBE used an efficiency factor of 66% for all zones.

Furthermore, it is likely that growth rates may vary within a community. For example, areas next to downtowns and lakefronts will likely be developed before more rural areas. The build-out does not specify the areas of a community that will be developed first. "Full build-out" portrays when all possible growth has occurred and does not distinguish between which areas are likely to be fully built out first.

2.8 PROJECTED BUILDINGS

The build-out analysis is comprised of a numeric and spatial build-out. A numeric build-out is completed first to obtain a number of total projected buildings based on minimum lot size and total area of buildable land. A spatial build-out is then run to place building points on the map, converting numeric building counts into points representing individual structures. The spatial build-out considers the size of projected buildings, geometry of lots, and setbacks to various spatial features incorporated into the build-out (e.g., lot lines, roads, natural features). For example, an oddly shaped lot may have enough total area for two buildings, but due to setback rules or minimum separation distances, it may only fit one unit. Along with development constraints and lot size, the spatial build-out also considers the minimum allowable separation distance between buildings or parcel shapes. During the placement of projected buildings onto buildable area, the user has control over whether the spatial build-out building points are distributed in a random or grid pattern, and if the points should follow existing roads. The grid pattern is best suited for new urban-type development, and the random layout is best for suburban-type development. For this analysis, the random layout was deemed most appropriate.

3. RESULTS

3.1 PARCELS

Approximately 1,721 parcels were identified as within or partially within the watershed, ranging in size from less than one acre to 141 acres. The largest parcel completely within the watershed covers 121 acres.

3.2 BUILDABLE AREA

The build-out analysis showed that 47% (2,220 acres) of the study area is buildable under current zoning regulations (TABLE 3, FIGURE 3).

TABLE 3. Amount of buildable land within the Kingston Lake watershed in Kingston and Danville, NH.

Town/Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area
Kingston			
Single Family Residential District (SFR)	1,482	659	44%
Rural Residential District (RR)	557	281	51%
Historic District (H1)	78	24	31%
Commercial (C3)	3	2	53%
Danville			
Residential/Agricultural (RA)	2,156	1,167	54%
Historic District (HD)	307	6	2%
Mobile Homes (MH)	59	32	54%
Highway Commercial and Light Industrial (HCLI)	50	26	51%
Danville Village District (DVD)	34	25	74%
Total	**4,726**	**2,220**	**47%**

**Total acres only include areas of parcels with these zone classifications and within the watershed area.*

3.3 PROJECTED BUILDINGS

The digitization of existing buildings within the municipalities identified 1,282 principal buildings. Based on the current input parameters, the build-out analysis projected an additional 414 buildings could be constructed in the future, resulting in a total of 1,696 buildings (TABLE 4, FIGURE 4). Because most of the Kingston Lake shoreline parcels are already developed, most of the projected buildings fall outside the direct shoreline area. A significant number of buildings are also projected in larger areas currently undeveloped. Additional roadways would need to be built for these projected buildings throughout the watershed to be accessible.

TABLE 4. Projected increase in buildings by zone within the Kingston Lake watershed in Kingston and Danville, NH.

Town/Zone	No. Existing Buildings	No. Projected Buildings	Total No. Buildings	Percent Increase
Kingston				
Single Family Residential District (SFR)	558	144	700	25%
Rural Residential District (RR)	88	93	181	106%
Historic District (H1)	18	10	28	56%
Commercial (C3)	0	1	1	-
Danville				
Residential/Agricultural (RA)	577	153	730	27%
Historic District (HD)	0	4	5	-
Mobile Homes (MH)	25	4	29	16%
Highway Commercial and Light Industrial (HCLI)	6	3	9	50%
Danville Village District (DVD)	10	4	14	40%
Total	**1,282**	**414**	**1,696**	**32%**

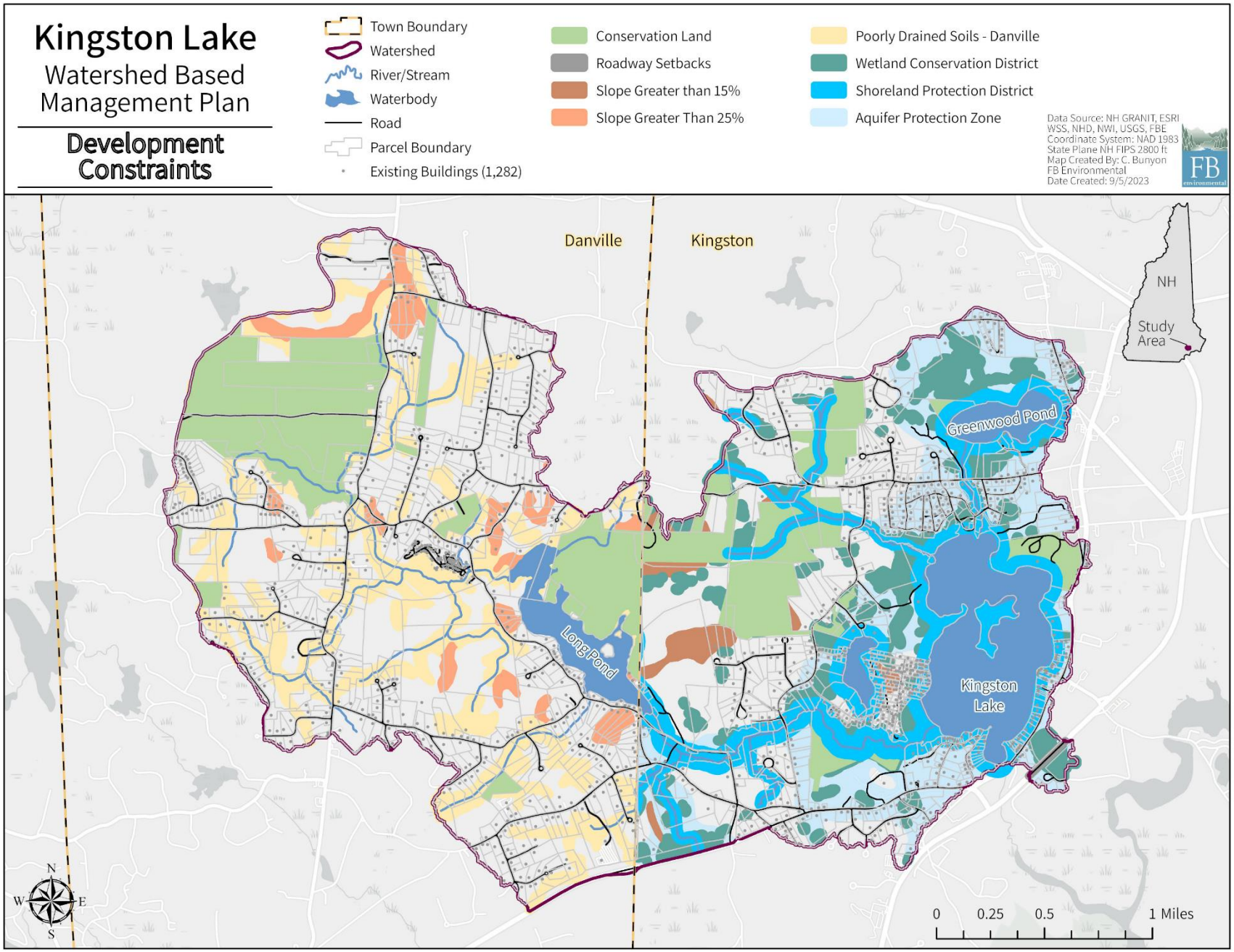


FIGURE 2. Development constraints in the Kingston Lake watershed in Kingston and Danville, NH.

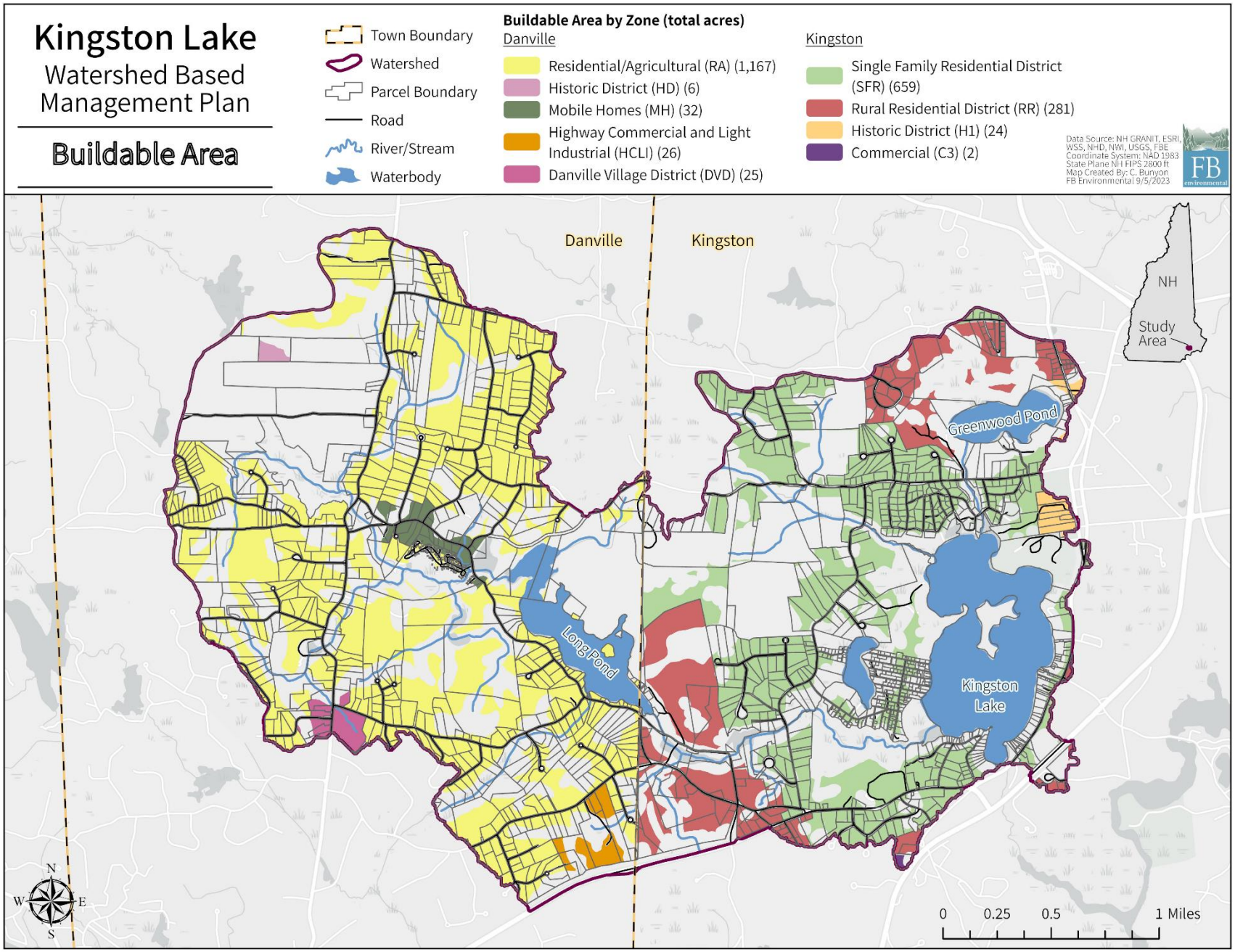


FIGURE 3. Buildable area by zone in the Kingston Lake watershed in Kingston and Danville, NH.

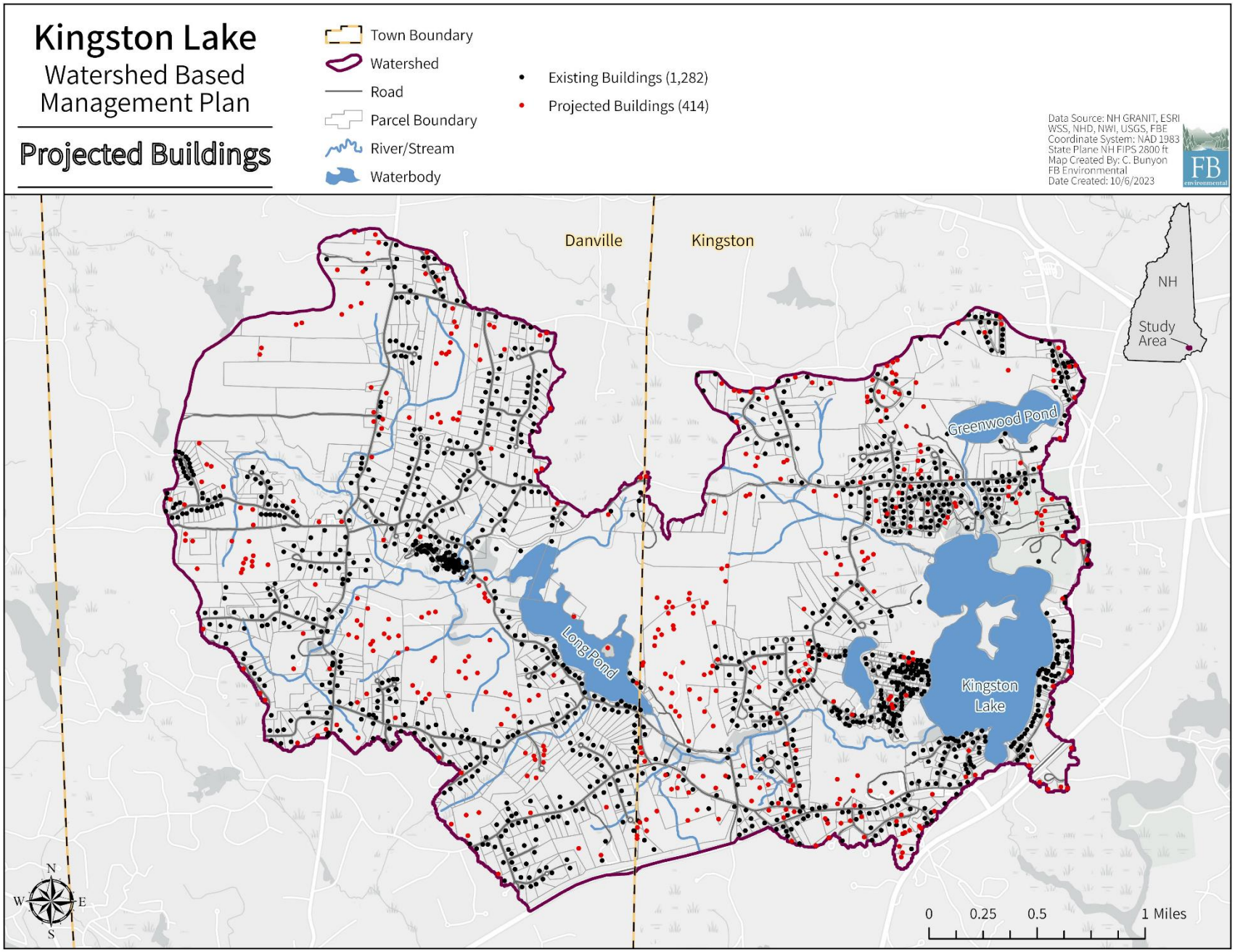


FIGURE 4. Projected buildings in the Kingston Lake watershed in Kingston and Danville, NH.

3.4 TIMESCOPE ANALYSIS

A TimeScope analysis is used to determine the year at which full build-out will occur by using CAGRs for 20-, 30- and 50-year periods from 2000-2020 (0.32%), 1990-2020 (0.93%), and 1970-2020 (2.07%) to project the rate of new development into the future, respectively (TABLE 1). Two of the three growth rates were too small for this analysis to be conducted using the TimeScope Analysis tool. The results of the 20-year and 30-year CAGR iterations showed no growth was present because the model continuously rounds the number of buildings down from the previous year to calculate the number of buildings for the next year. For example, the model would assume 1.9 buildings to be 1 building, not 2. Therefore, when the growth rates are too small and the model continuously rounds the number of buildings down to the next whole number, no growth is projected. To combat this challenge, FBE calculated the full build-out year for each of the three iterations manually using Microsoft Excel. The number of buildings from the previous year was not rounded down to project the number of buildings for the next year. For example, 1.9 buildings were kept as 1.9 buildings.

Full build-out is projected to occur in 2110 at the 20-year CAGR, 2053 at the 30-year CAGR, and 2037 for the 50-year CAGR (FIGURE 5). Note that the growth rates used in the TimeScope Analysis are based on town-wide census statistics but have been applied here to a portion of the municipalities. Also note that the population growth rate in these municipalities is decreasing, so the 20-year estimate is likely more accurate than the 50-year estimate. Using census data to project population increase and/or development has inherent limitations. For instance, the building rate may increase at a different rate than population such as when considering commercial versus residential development. As such, the TimeScope Analysis might over or underestimate the time required for the study area to reach full build-out. Numerous social and economic factors influence population change and development rates, including policies adopted by federal, state, and local governments. The relationships among the various factors may be complex and therefore difficult to model.

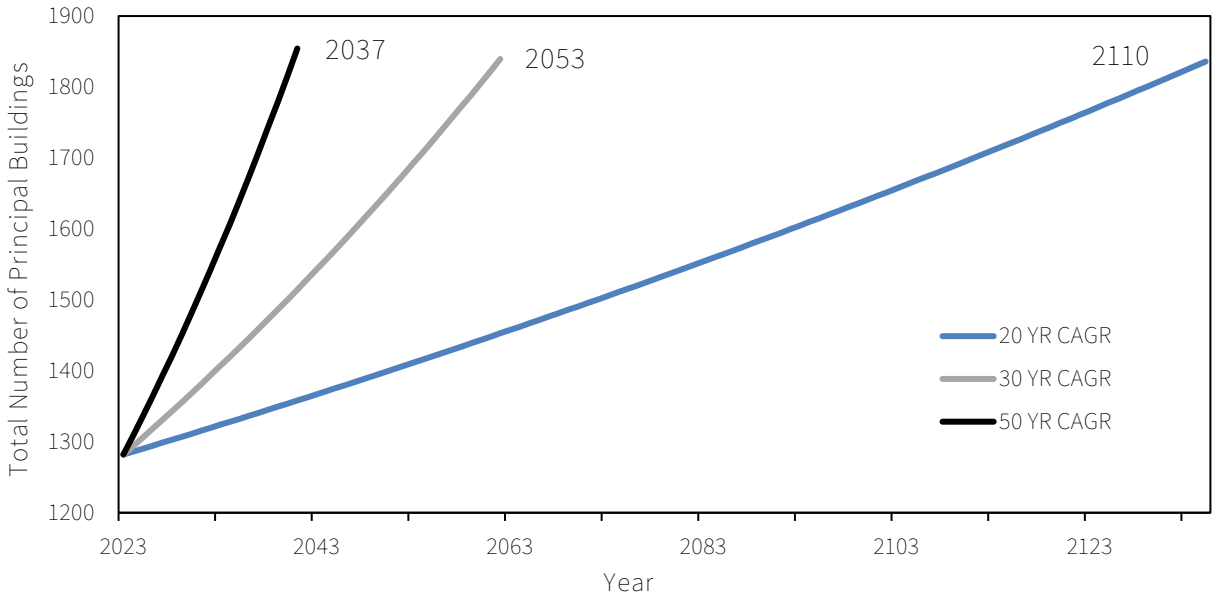


FIGURE 5. Full build-out time projections of the Kingston Lake watershed in Kingston and Danville, NH (based on compound annual growth rates reported in Table 1).

4. CONCLUSION

A build-out analysis can confirm where existing development along the lake shoreline or within the watershed is the densest and where future development may expand into if zoning regulations remain the same, and therefore may indicate increased vulnerability to the lake due to pollutants, impervious surfaces, or septic system malfunction or failure, or other watershed risks. Currently, existing buildings are the densest in communities directly north and east of Kingston Lake, as well as near the inlet to Long Pond. Conservation lands, setbacks and current ordinances in the watershed will continue to restrict existing and future development. The build-out analysis can be used in a land use model to identify which areas of the watershed have the greatest pollutant loading in the future and their subsequent

impact on water quality, as well as to guide future development and conservation activities in the watershed. For example, conservation measures around the forested and emergent wetlands and headwater streams, in addition to the lakes and ponds, could aim to reduce future development in those critical areas. Increasing the minimum lot size, enacting a setback from wetlands and streams, or encouraging cluster development where development is grouped together to set aside remaining land for conservation, are some different tools that can be strategically used to control development and protect the water quality of Kingston Lake. The build-out analysis serves as a useful planning tool, but the reader is cautioned that the spatial and numerical information provided herein are estimates and should be treated accordingly.

5. REFERENCES

Danville, New Hampshire. 2023. Zoning Ordinance.

Kingston, New Hampshire. Ordinances, Rules & Regulations.

Rockingham Planning Commission. 2015. Kingston Zoning Map.

USGS. 1992. Geohydrology and Water Quality of Stratified-Drift Aquifers in the Lower Merrimack and Coastal River Basins, Southeastern New Hampshire. Report and Map.

6. Response to Comments

The following provides response to comments following review by the watershed municipalities.

Kingston

Comment: *No edits*

Response: NA

Danville

Comment: “It looks good. Other things that you didn't take into account (or I missed it) are conservation easements inside that area. For example, most of our Historic District is in a conservation easement and therefore not buildable (and I believe there are a few privately held ones, as well). But that aside, the zoning and regulations look accurate.”

Response: Thank you for your review and for pointing out this important detail. We used conservation data from the state GIS database which typically includes all conserved areas. I investigated parcels in the Historic District that did not overlap with the conservation data layer from the state and only found one complete parcel.

Through additional correspondence, FBE learned the one parcel that did not overlap with the conservation data layer does not have a conservation easement.