CDM Smith

Memorandum

To: *Stephen S. Corda, P.E., Managing Director – Cambridge Water Department*

From: *Carol A. Rego, P.E., Vice President*

Date: *June 14, 2012*

Subject: *Evaluation of Hobbs Brook Reservoir Watershed Land Acquisition – DeNormandie Property*

Background

The Cambridge Water Department is considering acquiring two parcels of undeveloped land in its watershed for purposes of water supply protection and enhancement of drinking water quality.

The subject land is referred to as the "DeNormandie property" and consists of a 53.6-acre, 2-parcel tract located adjacent to Route 2 in the Town of Lincoln. The purchase of this parcel will also leverage the donation by the Rural Land Foundation (of Lincoln) of an adjacent 20-acre parcel. The DeNormandie parcel is forested, with moderate to steep slopes; a major stream (Hobbs Brook) and several smaller tributaries traverse the parcel conveying runoff from upland areas directly to Hobbs Brook Reservoir, the primary drinking water supply reservoir for the City. Half of the property is located within the most protective zone for drinking water protection (termed "Zone A").

Overview of Land Acquisition as a Means of Water Supply Protection

This section provides a qualitative analysis of the beneficial effects of land acquisition based on documentation in the literature that demonstrates positive impacts of land preservation on water quality and natural resources.

Land acquisition is one of the most effective and, therefore, important mechanisms to permanently protect drinking water supplies. Effective land acquisition programs target environmentally-sensitive watershed lands for protection to ensure that the watershed continues to be a source of high-quality drinking water. This anti-degradation approach precludes land use changes on undeveloped land, thereby ensuring long-term, permanent protection. Development involves short- and long-term land disturbances and a long-term increase in impervious surfaces. These factors have the potential to introduce increased levels of pollutants, including pathogens, nutrients and sediment (turbidity), into watercourses and ultimately, water bodies used for drinking water supply.

Conditions are exacerbated during storm events when pollutant levels are greater and natural cleansing processes are less effective because of rapid water flow. Once development occurs and land is disturbed, the likelihood of pollutants reaching the drinking water supply is directly related to several

factors, the most significant of which are proximity of the development to surface water features and topography. Water quality benefits of land acquisition accrue over time, as future development would occur at locations with less potential to adversely impact water quality rather than on land already protected. Land acquisition is fully complimentary with the City's other watershed protection and management strategies used to improve water quality, examples of which include real-time water quality monitoring, emergency response preparedness training, invasive species management, and public/private outreach and education programs.

The most effective land acquisition programs focus on preserving compelling parcels – those with significant development potential in close proximity to surface water features. Prioritization of land to be acquired is generally approached as follows. First priority is given to the location within the water supply system. Second priority is based on site-specific characteristics that make land more water quality sensitive and therefore maximizes the water quality benefit. These site-specific characteristics include the presence of critical natural topographical features, such as streams and wetlands, lands with moderate to steep slopes, as well as potential for development. Another site-specific consideration is parcels adjoining previously-acquired land, which can support multiple program objectives including management efficiency, provide substantial contiguous natural corridors, as well as reduce fragmentation, thereby preserving natural habitats.

Literature Review Summary

General Benefits

The importance of preserving undeveloped lands for water quality and ecosystem health is well documented. A study[1] by the National Research Council (NRC) concluded that:

"Purchasing private land is one of the most important nonstructural tools used to protect a watershed…A land acquisition program is potentially one of the most successful strategies for source water protection."

EPA's report[2] "Protecting Water Resources with Smart Growth" states:

"Preserving open space is critical to maintaining water quality at the regional level. Large, continuous areas of open space reduce and slow runoff, absorb sediments, serve as flood control, and help maintain aquatic communities. In most regions, open space comprises significant portions of a watershed, filtering out trash, debris, and chemical pollutants before they enter a community's water system. Open space provides a number of other benefits, including habitat for plants and animals, recreational opportunities, forest and ranch land, places of natural beauty, and important community space."

In a 2003 study[3], the Center for Watershed Protection (CWP) extensively researched imperviousness and how it relates to habitat structure, water quality, and biodiversity of aquatic systems:

"Impervious surfaces collect and accumulate pollutants deposited from the atmosphere, leaked from vehicles or derived from other sources. During storms, accumulated pollutants are quickly washed off and rapidly delivered to aquatic systems. Monitoring and modeling studies have consistently indicated that urban pollutant loads are directly related to watershed imperviousness. Indeed, imperviousness is the key predictive variable in most simulation and empirical models used to estimate pollutant loads.

The CWP study found that the ecological health of streams is greatly impacted by impervious cover. Biological and physical indicators of stream quality tend to show observable negative impacts at levels of imperviousness as low as 5 percent; with impervious cover greater than 25 percent, a stream may be unable to support ecological habitat.

In a joint study[4] by the SUNY College of Environmental Science and Forestry/Yale School of Forestry and Environmental Studies, the authors state "*Land use and water quality are inextricably linked"* and have demonstrated that forest cover provides more optimal land cover for protecting water quality than many of the potential uses to which that land may be converted.

Acquiring land through purchase or conservation easements guarantees the most complete and permanent protection. An American Water Works Association (AWWA) Research Foundation study[5] viewed watershed protection as key to protecting drinking water, finding that "*the most effective way to ensure the long-term protection of water supplies is through landownership by the water supplier and its cooperative public jurisdictions*."

Water Treatment Benefits

Although land acquisition is costly, it has been demonstrated to reduce treatment costs, providing significant long-term financial benefits. According to the Environmental Protection Agency[6] (EPA), prevention measures cost communities an average of five times less—and up to 200 times less—than addressing drinking water contamination. Preliminary findings from a study[7] by the South Central Connecticut Regional Water Authority also indicated that investments in open space protection help contain treatment costs.

A 2005 report [8] by AWWA and the Trust for Public Land (TPL) provides further evidence. The study found that, on average, for every 10 percent increase in forest cover in the source area (up to 60 percent forest cover), treatment and chemical costs decreased by approximately 20 percent. The study concludes "*A growing understanding of the role that forests and natural lands play in filtering pollutants and maintaining water quality has led many municipalities and water suppliers, particularly those in growing communities, to consider land protection as part of a multiple-barrier approach to providing safe drinking water*."

This study also states "*For 60 years, the safety of most of America's drinking water has been dependent on technology…. Today, water suppliers are revisiting the idea that watershed protection – the first barrier against contamination—needs to, once again, be an integral part of their water quality protection strategy*."

A follow-on study[9] conducted in 2008 by the Trust for Public Land evaluated the impact of the decline of forest cover and the increase of agriculture or urban land cover in a drinking water watershed on water quality and treatment costs. The study showed that there were significant relationships among percent land cover, source water quality, and drinking water treatment costs. The study found:

"*Increased percent agriculture and urban cover were significantly related to decreased water quality, while decreased forest land cover was significantly related to decreased water quality. Further, low water quality was related to higher treatment cost."*

Potential Contamination Associated with Residential Development

The Massachusetts Department of Environmental Protection has completed a Source Water Assessment Program[10] (SWAP) as required by the federal Safe Drinking Water Act (SDWA) Amendments of 1996. The purpose of the SWAP is to provide decision-makers and the public with detailed information on potential threats to their public water supply sources to enable improved protection of these sources. In determining the susceptibility of water supplies to contamination, the SWAP identified several contaminants of concern associated with residential development, as summarized in **Table 1**.

Table 1. Land Use Pollution Potential Matrix – Residential Development

Residential Development Land Use Practices	**Contaminants of Concern**	
Fuel Oil Storage	VOC/SOC/IOC pyrene fluorene fluoranthene benzoanthracene chrysene benzo(a)pyrene phenanthrene naphthalene 2-methylnaphthalene benzene xylene dibenzo(a,h)anthracene	ethylbenzene xylene toluene arsenic cadmium chromium lead nickel zinc vanadium MTBE MIBK
Lawn Care	SOC/IOC atrazine 2,4 -D methoxychlor glyphosphate	carbaryl arsenic mercury diazinon

Residential Development Land Use Practices	Contaminants of Concern	
	dicamba	
Septic Systems/Cesspools	MIC/VOC/IOC nitrate nitrite benzene toluene xylene ethylbenzene MTBE TCE acetone fluoride methylene chloride sulfate	1,1,1 TCA PCE carbon tetrachloride phenol MEK MIBK styrene p-dichlorobenzene naphthalene cyanide silver

Specific Features/Benefits of the DeNormandie Land Relative to Cambridge's Water Supply Quality

The previous sections of this memorandum discussed the overall approach to land acquisition as a water supply protection strategy, specific results documented in the literature of the benefits to water quality as well as treatment/management costs, and the potential impact of residential development on water quality. This section evaluates the DeNormandie parcels against these approaches and best practices in watershed land acquisition.

As background, source water protection areas are divided into zones to enable a water system to adopt different management strategies based on separation distances between a potential contaminant source and the intake. Zone A is defined as the protective zone immediately surrounding a water supply. In Massachusetts, it is established as 400 feet from a surface water reservoir and 200 feet from its tributaries.

Table 2 presents a comparison of the DeNormandie parcels to key prioritization criteria and best practices of watershed land acquisition programs as discussed above.

Table 2. Comparison of DeNormandie Parcels to Best Practices in Watershed Land Acquisition

Priority	Best Practices	Explanation	DeNormandie Parcels
First	Proximity to the Water Supply Reservoir	Areas that drain directly into a reservoir are particularly sensitive because an inflow of pollutants can have a large impact on the overall water quality	▪ 50% of the land is within the "Zone A" of Hobbs Brook Reservoir, the City's primary drinking water supply source
Second	Site-Specific Characteristics for Water Quality Sensitivity	The presence of critical natural, topographical features that make land more water quality sensitive and therefore maximize the water quality benefit	▪ DeNormandie parcels are critical riparian corridors in the Hobbs Brook watershed and highly water-quality sensitive
	▪ Streams		▪ Surrounds ~2,800 feet of Hobbs Brook, the primary tributary to Hobbs Brook Reservoir ▪ Provides riparian buffer zone
	▪ Wetlands		▪ 40 to 50% of the land is wetland
	▪ Moderate to steep slopes		▪ Significant portions of the land have moderate slopes (8-15%) and severe slopes (15-35%) with significant erosion potential
	▪ Potential for development		▪ High potential – 11-lot subdivision plan has been proposed ▪ Highly advantageous location in close proximity to major commuting routes, open space, and desirable community

Priority	Best Practices	Explanation	DeNormandie Parcels
	▪ Parcels adjoining previously-acquired land		▪ Acquisition will leverage donation of an additional 20-acre parcel from the Rural Land Foundation of Lincoln ▪ Combined, will create a contiguous 236.5-acre undeveloped permanently protected area

Findings and Conclusions

The following summarizes the major findings presented throughout this memorandum:

- Land acquisition is one of the most effective and, therefore, important mechanisms to permanently protect drinking water supplies. The benefits of preserving undeveloped lands for water quality and ecosystem health are well documented.
- Although land acquisition is costly, it has been demonstrated to reduce treatment costs, providing significant long-term financial benefits.
- Residential development presents several potential sources of contamination to drinking water supplies.
- Acquiring the DeNormandie parcels would limit the potential future amount of impervious surface cover in a highly water-quality sensitive area.
- Selection of the DeNormandie parcels is consistent with best practices for land acquisition based on the presence of critical natural topographical features, including streams and wetlands, proximity to the water supply reservoir, presence of moderate to steep slopes, and potential for development.

In summary, acquisition of the two DeNormandie parcels would contribute to the City of Cambridge's watershed protection program, the overarching goal of which is to ensure that the watershed continues to be a source of high-quality drinking water to the City.

List of References

1. National Research Council, *Watershed Management for Potable Water Supply: Assessing the New York City Strategy,* National Academy Press, Washington, DC, 2000.

2. US Environmental Protection Agency, *Protecting Water Resources with Smart Growth*, Publication Number EPA 231-R-04-002, Washington, DC, 2004. www.epa.gov/smartgrowth

3. Center for Watershed Protection, *Impacts of Impervious Cover on Aquatic Systems*, Ellicott City, MD 2003. www.cwp.org

4. Hall, M., et al., *Predicting Future Water Quality from Land Use Change Projections in the Catskill-Delaware Watersheds*, SUNY College of Environmental Science and Forestry/Yale School of Forestry and Environmental Studies, December 2008, Revised August 2011.

5. Robbins, R.W., et al., *Effective Watershed Management for Surface Water Supplies*, American Water Works Association Research Foundation, Denver, CO, 1991.

6. U.S. Environmental Protection Agency, *Drinking Water Source Protection Programs, Source Water Protection: Best Management Practices and Other Measures for Protecting Drinking Water Supplies*, www.epa.gov/ogwdwooo/dwa/electronic/ swp/swp.pdf, p. I-8.

7. Chaplik, T., presentation *Utility Strategy for Protection and Acquisition of Public Drinking Water Source Lands*, South Central Connecticut Regional Water Authority, Connecticut Drinking Water Source Protection Strategies Forum, April 29, 2003.

8. The Trust for Public Land and American Water Works Association, *Source Protection Handbook: Using Land Conservation to Protect Drinking Water Supplies*, San Francisco, CA, 2005.

9. Freeman, J., et al., *Statistical Analysis of Drinking Water Treatment Plant Costs, Source Water Quality, and Land Cover Characteristics*, Washington, DC, 2008.

10. Massachusetts Department of Environmental Protection, *Source Water Assessment Program*, Appendix B, Land Use Pollution Potential Matrix.

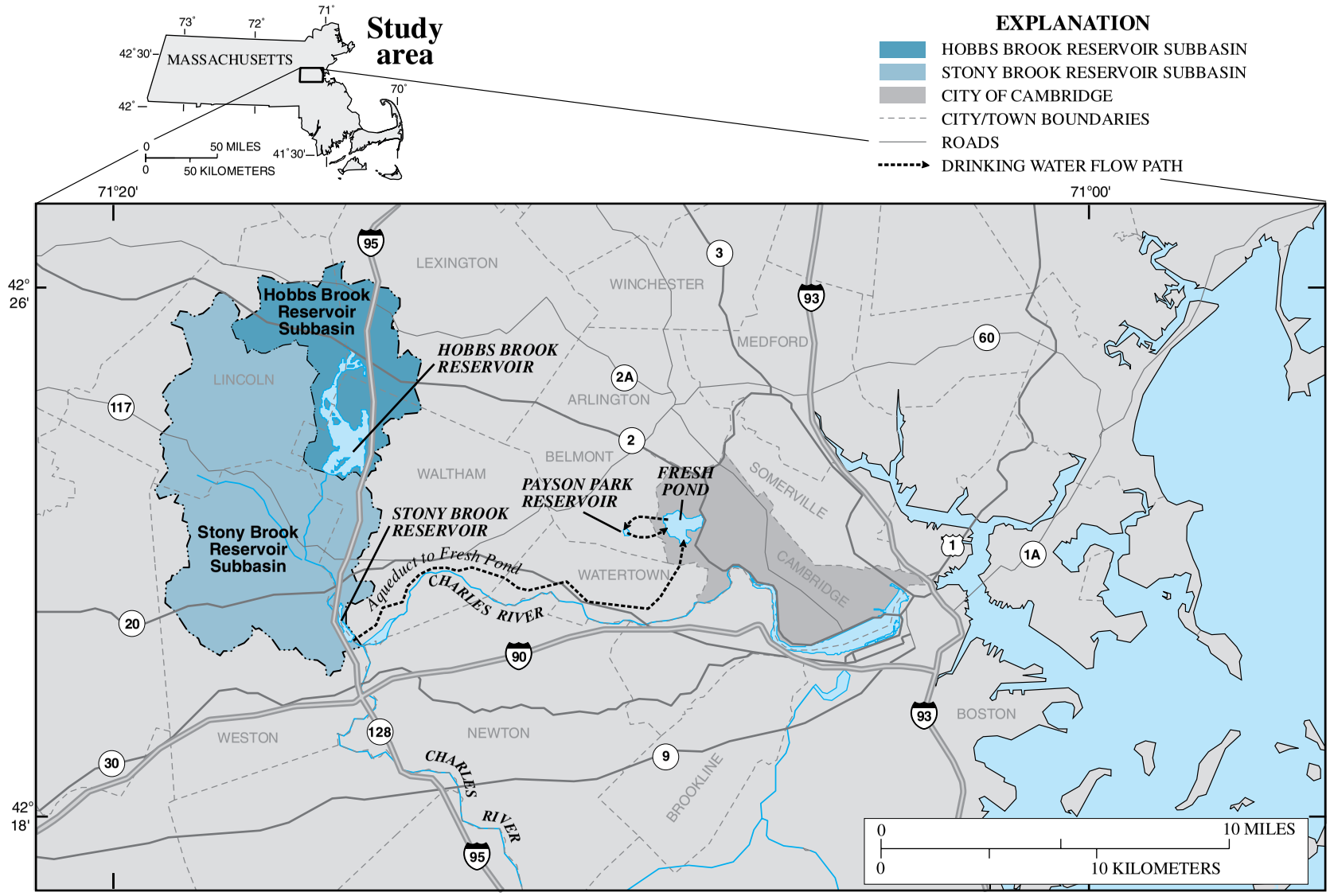
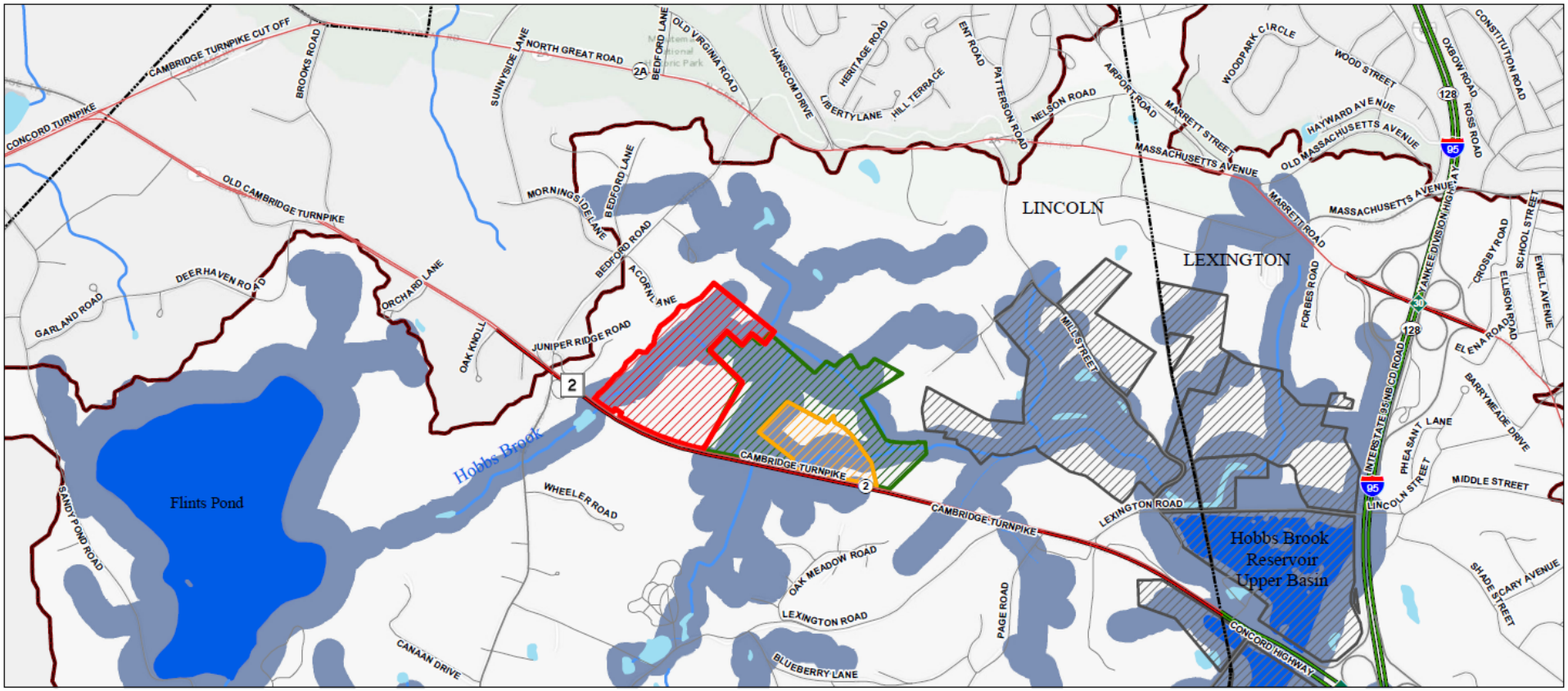


Figure 1. Location, extent, and components of the city of Cambridge drinking-water supply system, eastern Massachusetts.

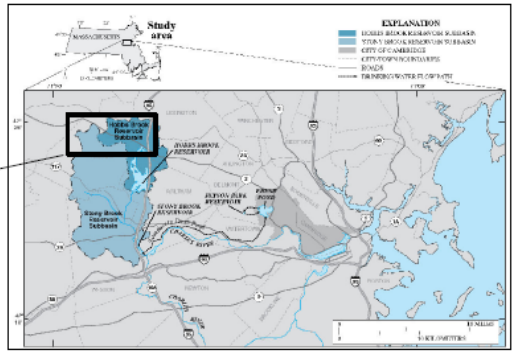


0 0.25 0.5 Miles

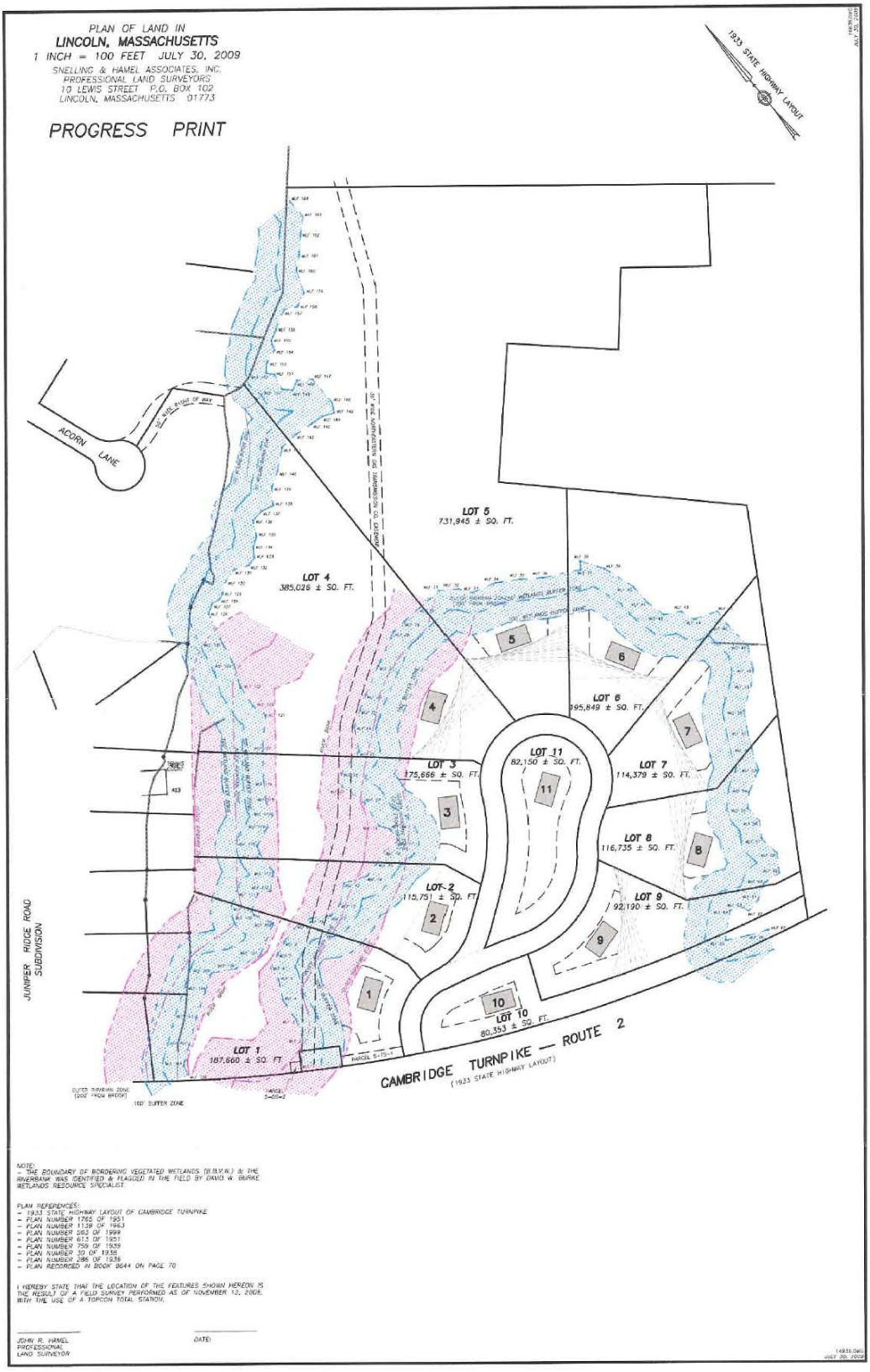
Legend

- DeNormandie Parcels - To Be Acquired
- Lincoln Rural Land Foundation Parcel - RLF To Donate
- D'Arrigo Parcel ~58 Acres
- Cambridge-Owned Parcels
- Watershed Divide
- Water Supply Protection Zone A

Area Enlarged

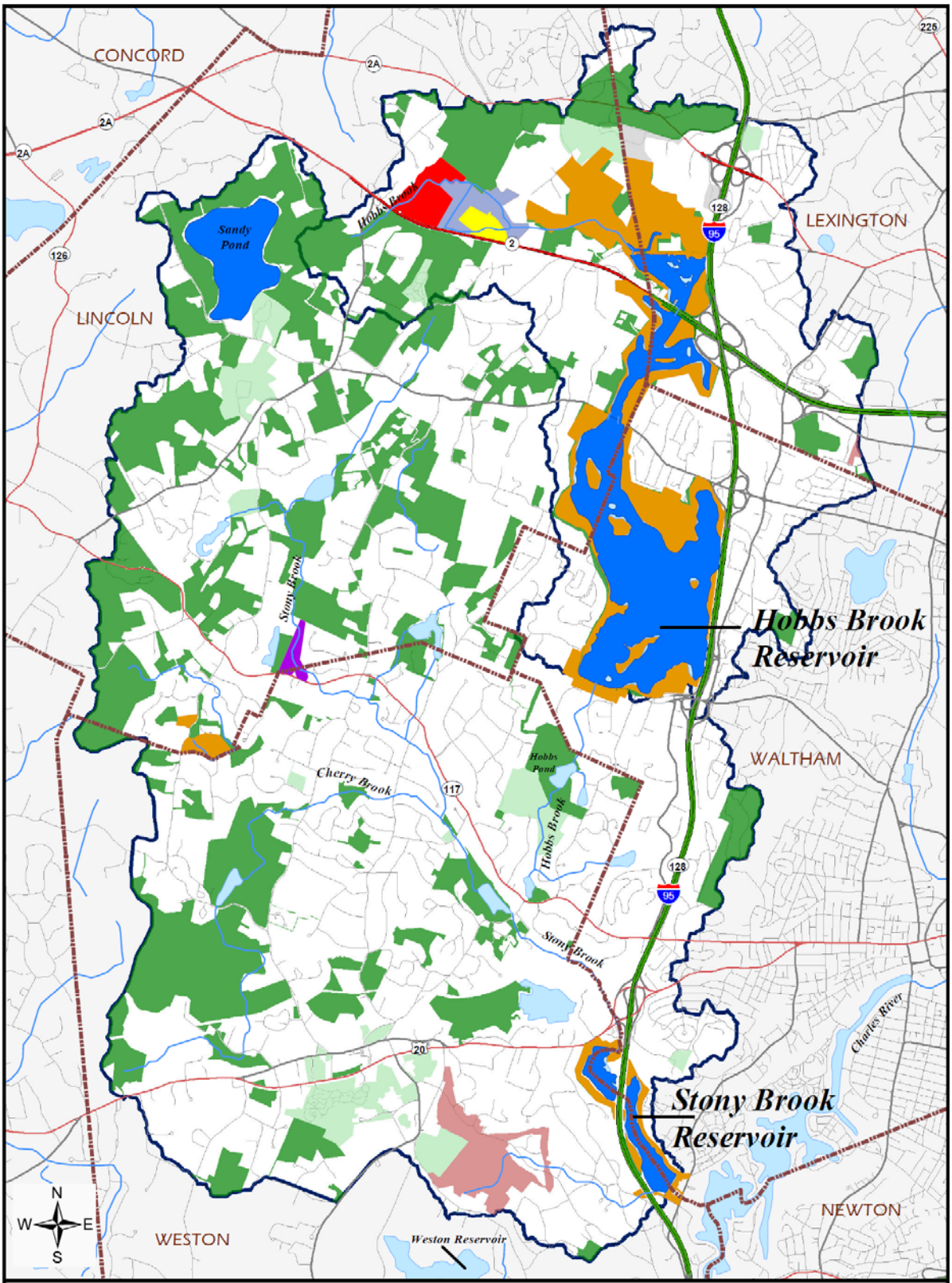


DeNormandie Land Acquisition Project



SITE/DEVELOPMENT PLAN

The Subject Property



Legend

- DeNormandie Parcels
- RLF Parcel
- Harrington Parcel
- D'Arrigo Parcel
- Cambridge Owned Parcels

OpenSpace by Level of Protection

- In Perpetuity
- Limited
- None
- Unknown

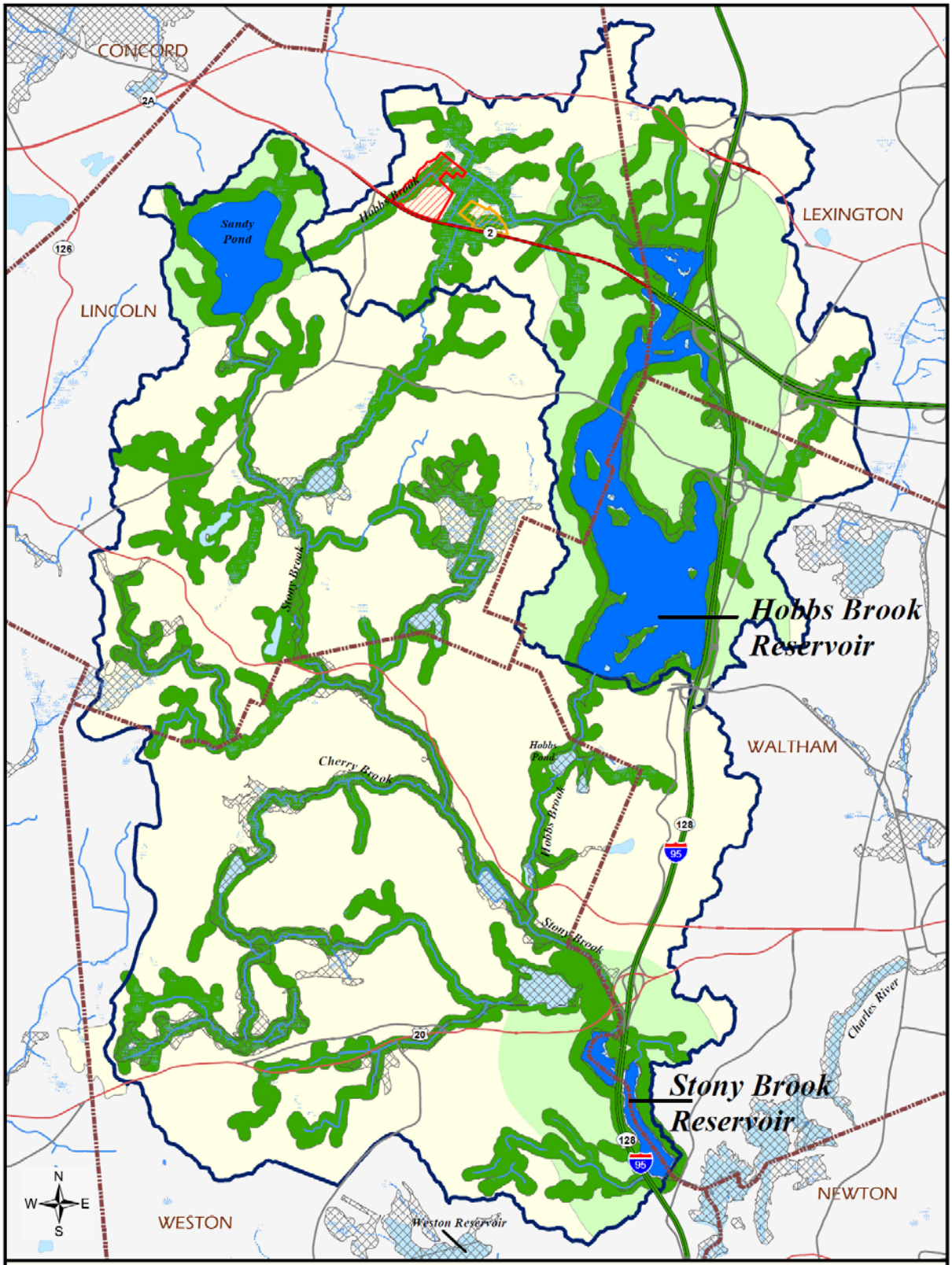
- Hobbs/Stony Brook Watershed
- Reservoirs
- Lakes and Ponds
- Rivers and Streams
- Town Boundary

0 0.25 0.5 0.75 1 Miles

0 0.25 0.5 0.75 1 Kilometers

City of Cambridge Water Department
Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts EEA
February, 2011

Surface Water Supply Protection Plan
Cambridge Watershed
Protected Open Space



Legend

- ZONE A
- ZONE B
- ZONE C
- FEMA Flood Zone
- Town Boundary
- Reservoir
- Wetland
- Submerged Wetland
- Lakes and Ponds
- Rivers and Streams
- Limited Access Highway
- Multi-lane Hwy, not limited access
- Other Numbered Highway
- Major Road, Collector
- DeNormandie Parcels
- RLF Parcel

0 0.25 0.5 0.75 1 Miles

0 0.25 0.5 0.75 1 Kilometers

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City of Cambridge Water Department
Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts EEA
March, 2011

Surface Water Supply Protection Plan

Cambridge Watershed

DEP Protection Zones