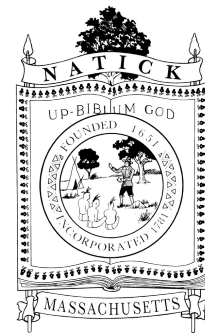
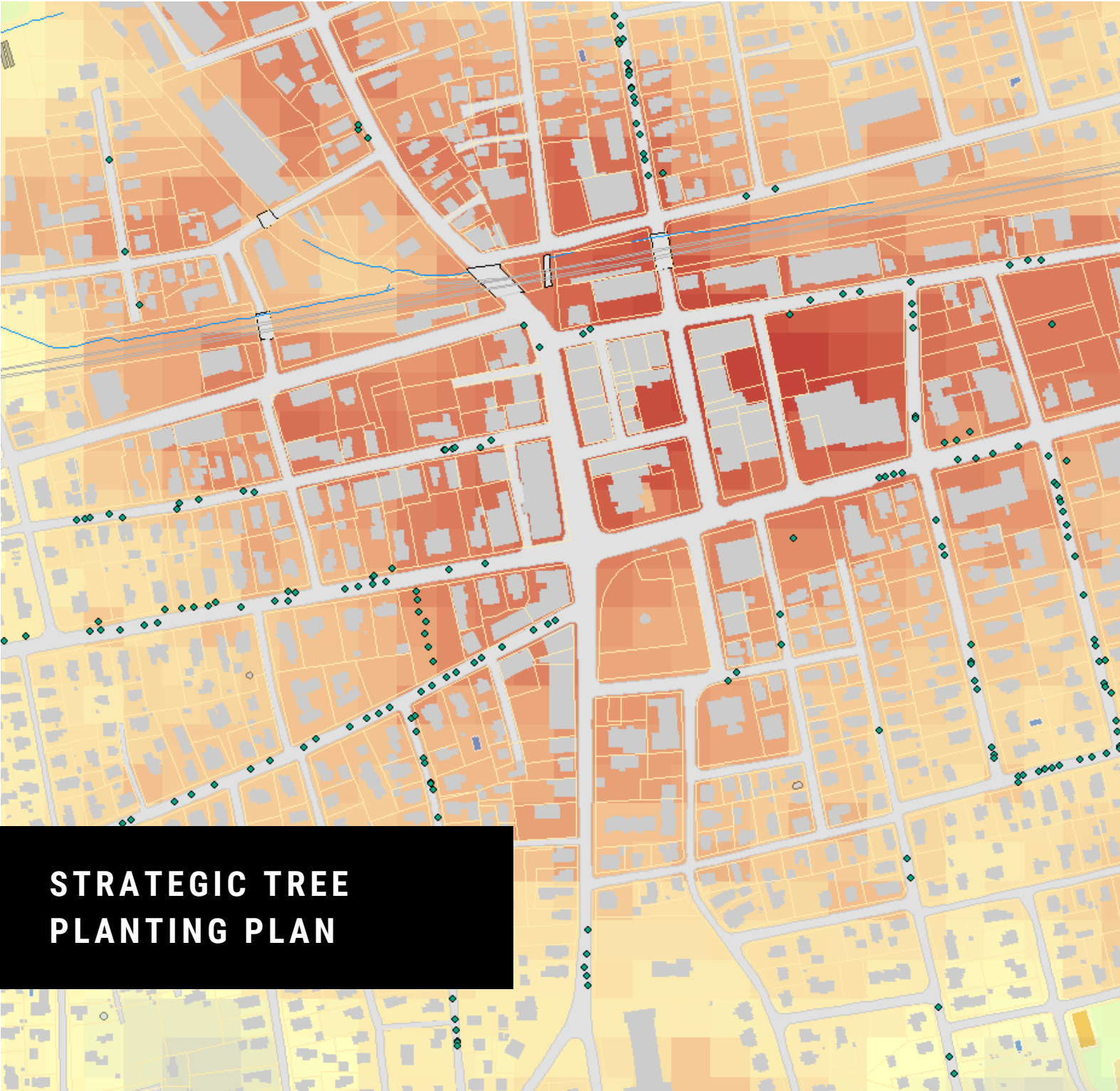


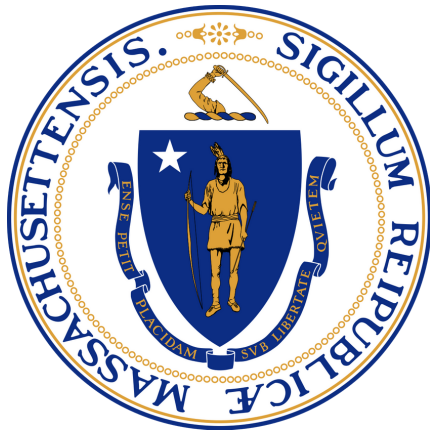
MITIGATING THE HEAT ISLAND EFFECT



ANALYSIS COMPLETED BY
PROFESSIONAL ENVIRONMENTAL SERVICES, LLC



**STRATEGIC TREE
PLANTING PLAN**



This project and the following report was made possible through funding from the Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program.

Golden Triangle/
Natick Mall

Rt 9 and Rt 27
Intersection

HEAT ISLANDS IN NATICK

Land Surface Temperatures along Route 9 in Natick



Urban areas are commonly known for being warmer than their rural counterparts, due to a phenomenon called the “heat island effect.” Heat islands are caused when an abundance of buildings and pavement result in conditions that cause land surface temperatures to exceed air temperatures (Wong, 2014).

However, heat islands are not limited to big cities. An analysis using satellite imagery from August 30, 2010 (a day when the high at Logan Airport was recorded at above 90 degrees) found significant variation in land surface temperatures across the Metro Boston region, with hot spots extending into the suburbs.

In Natick, where more than 25% of the Town is considered impervious surface (MassGIS, 2017), a clear connection between the built environment and surface temperatures was found. Areas including the complex along Route 9 and Natick Center, where large black roofs and parking lots abound, were found to have surface temperatures reaching near 130 degrees Fahrenheit – “hot enough to fry an egg”. (MAPC, 2015).

The negative impact of heat islands and their corresponding high temperatures include:

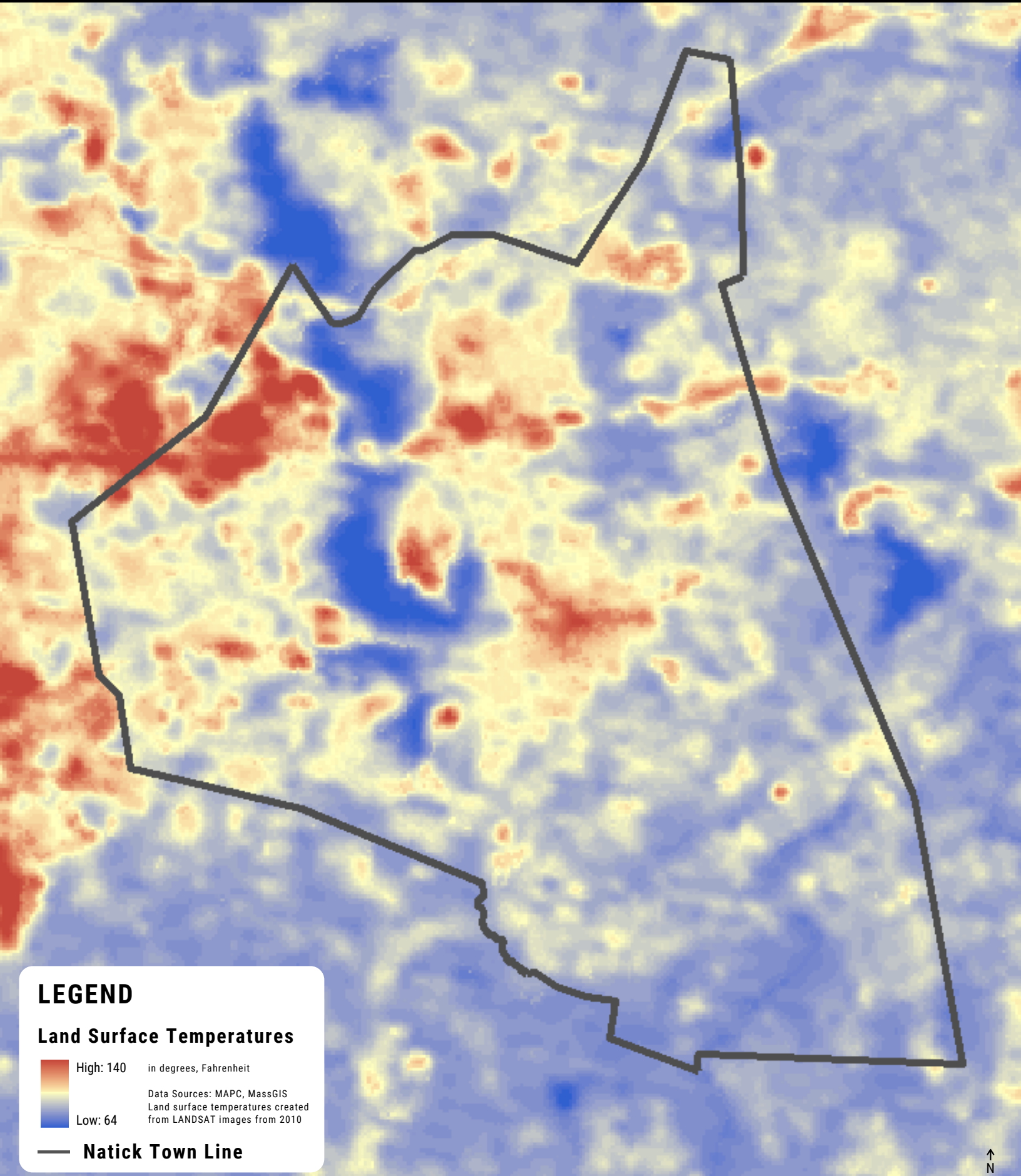
- Compromised human health and comfort,
- Increased energy consumption,
- Impaired water quality, and
- Elevated pollutants and greenhouse gases.

Unfortunately, climate change is expected to compound the heat island effect. Annually, Natick and other communities in the Charles River Basin can expect 10 to 35 more days with daily maximum temperatures over 90 °F by 2050, and 15 to 76 more days over 90 °F by 2100 (Northeast Climate Science Center, 2018). Higher temperatures will mean hotter heat islands.

Climate change will compound the heat island effect.

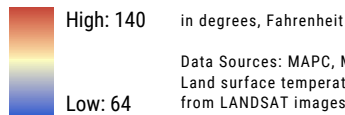
Charles River Basin communities are also expected to experience an increase in heavy rainfall events. **Days with more than an inch of precipitation are expected to increase from approximately 7.6 days/year to 10.6 days/year by 2050** (Northeast Climate Science Center, 2018). In these events, the same impervious area that contributes to high surface temperatures will carry a higher concentration of stormwater pollution into local water bodies.

LAND SURFACE TEMPERATURES IN NATICK



LEGEND

Land Surface Temperatures



Data Sources: MAPC, MassGIS
Land surface temperatures created
from LANDSAT images from 2010

— Natick Town Line

HOW TREES CAN HELP

Trees and vegetation reduce heat islands by providing shade and through evapotranspiration.

Shade from leaves and branches can reduce surface temperatures below the tree canopy by 20-45°F (Akbari, 1997). These cooler surfaces, in turn, reduce the heat transmitted into the atmosphere and nearby buildings.

Evapotranspiration lowers air temperatures by using heat from the air to evaporate water. This process can reduce peak temperatures by 2–9°F (Kurn, 1994).

Trees can also reduce runoff by intercepting rainfall and absorbing water that would otherwise be diverted to municipal storm drains. In Sacramento, trees in full leaf were found to capture more than 35 percent of rainfall that came in contact with their canopies (Xiao, 1998).

MAXIMIZING IMPACT

The most effective heat island mitigation plans focus on planting trees and vegetation in strategic locations to shade pavement and buildings and reduce runoff.

Trees can be planted around and in medians inside parking lots or along streets. Tree box filters are another option in areas where ground surface is sparse. These in-ground

containers direct stormwater runoff to a tree box, where it is filtered by vegetation and soil before entering a catch basin.

When planting near buildings, deciduous trees should be located on the western side, with a goal of shading windows and portions of roof.

ADDITIONAL BENEFITS OF PLANTING TREES

Trees bring benefits beyond mitigating heat islands including:

- **Reduced energy use:** Trees that directly shade buildings decrease demand for air conditioning.
- **Improved air quality and lower greenhouse gas emissions:** By reducing energy demand, trees decrease the production of associated air pollution and greenhouse gas emissions. They also remove air pollutants and store and sequester carbon dioxide.
- **Reduced pavement maintenance:** Tree shade slows the deterioration of street pavement, decreasing the amount of maintenance needed.
- **Improved quality of life:** Trees and vegetation provide aesthetic value, habitat for many species, and reduce noise.

(Taken directly from Wong, 2014)





TREES IN NATICK

According to the Massachusetts Urban & Community Forestry program, Natick has a forest canopy density percentage of 44%. The majority of these trees are located on private property.

While Natick's tree canopy is strong versus peer communities, it is vulnerable. The town continues to experience a high rate of development, which can have an adverse effect on tree preservation. Pests and pathogens and the impacts of climate change are also real threats. Trees on private properties are especially at risk to these threats, as few local regulations exist to protect trees from development and property owners may lack the knowledge and funds to support tree health.

PUBLIC TREES

Public trees, including street trees, park trees and trees on other Town land, are the responsibility of the Town of Natick's Land Facilities and Natural Resources Division. The Division maintains a Public Tree Inventory with information on each tree's species, age class and monetary value. This is a working inventory and trees are added to the inventory in bulk on an annual basis. The database currently has more than 500 trees recorded, which are estimated to have a cumulative value of more than \$7 million.

Once inventoried, trees are tagged with a bronze or silver tag that can be used to inquire about specific attributes of a tree online at: natickma.gov/treeplan

Current Public Planting Priorities

Natick seeks to maximize the social and environmental benefit of every new public tree. Locations for future public trees are prioritized based on tree canopy per capita ratios. Special attention is also paid to the town's low income and environmental justice communities.



NATICK IS A TREE CITY

Natick has received the Arbor Day Foundation's Tree City USA designation, for more than ten years. To receive this designation, Natick must demonstrate it meets four core standards of sound urban forestry management: maintaining a tree board or department, having a community tree ordinance, spending at least \$2 per capita on urban forestry and celebrating Arbor Day.

TOWN-WIDE TREE INVENTORY

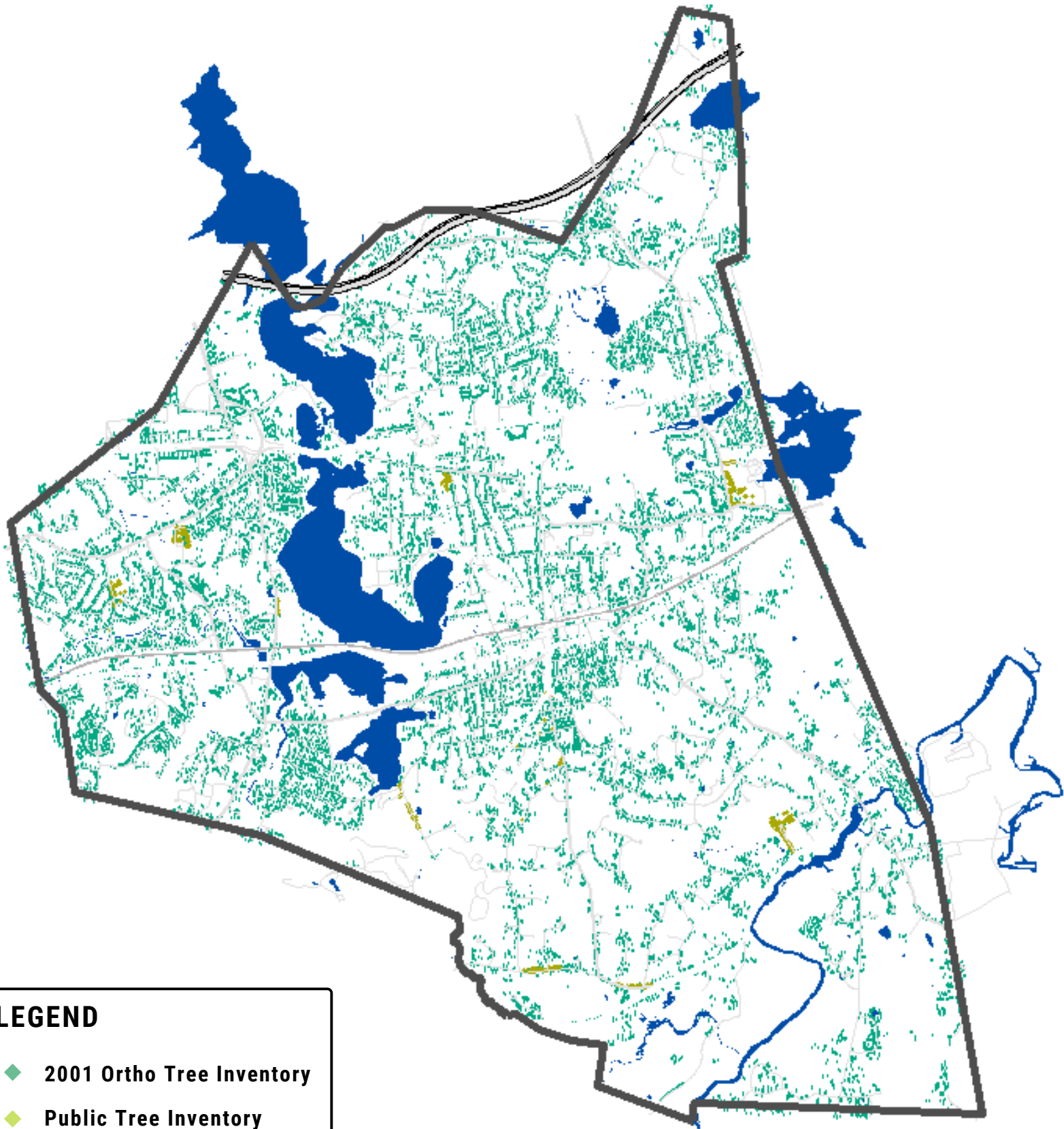
The Town of Natick does not currently track or monitor trees located on private property. However, a 2001 aerial survey of the town identified more than 33,000 trees.

PROJECTS UNDERWAY

Natick is in the process of updating local land use regulations, including its general and zoning bylaws, to support low impact development and tree preservation. Proposed changes are subject to approval by the community's local legislative body, a representative Town Meeting, and are expected to be presented for debate in stages through 2020.

The Town of Natick's Engineering Division is also reviewing opportunities to better incorporate green infrastructure and tree planting into its Complete Streets Plan. It has applied for funds to develop a design for a model Complete, Green Street, and, if awarded the grant, will seek to apply recommended guidelines to future roadway improvement projects.

WORKING TREE INVENTORY



LEGEND

- ◆ 2001 Ortho Tree Inventory
- ◆ Public Tree Inventory
- Natick Town Line



TREE PLANTING PLAN

In collaboration with Professional Environmental Services, LLC, the Town of Natick identified **811 potential tree planting sites focused on reducing heat islands and associated stormwater runoff.**

Potential tree planting sites are located across eight corridors with high recorded surface temperatures, including:

- Golden Triangle (Speen St/Rte 9/Rte 30)
- Rte 9/Rte 27
- Speen St/Rte 135 (shown as two maps)
- Natick Center
- Housing Authority
- Northeast Natick
- Natick Army Labs
- West Natick

Across these corridors, public property and streets were assessed, including:

- **Public tree planting areas** such as sidewalks, municipal buildings, municipal parking lots, public housing complexes, roadways, parks, and other open spaces;
- **Environmental Justice Protocol and Low Income areas**, where populations are especially vulnerable to the impacts that climate change has on their health and energy costs; and
- **Other private property**, particularly parking lots and hardscaped areas, where planting could be targeted through public-private partnerships and future regulations.

Maps of each corridor and recommended planting locations are provided on the following pages.

FIELD SURVEY & SITE ASSESSMENT

Potential tree planting sites were identified using Google Earth maps and validated by an on-the-ground field survey. Each site was assessed for the following:

Tree Category (Utility Corridor/Small Place; Non-Utility Corridor; Parks/Open Space)

Growth Restrictions (Overhead Utilities; Underground Utilities; Sidewalks; Curb Cuts; Line of Vision)

Special Conditions (Setback; Median Strip; Tree Pit)

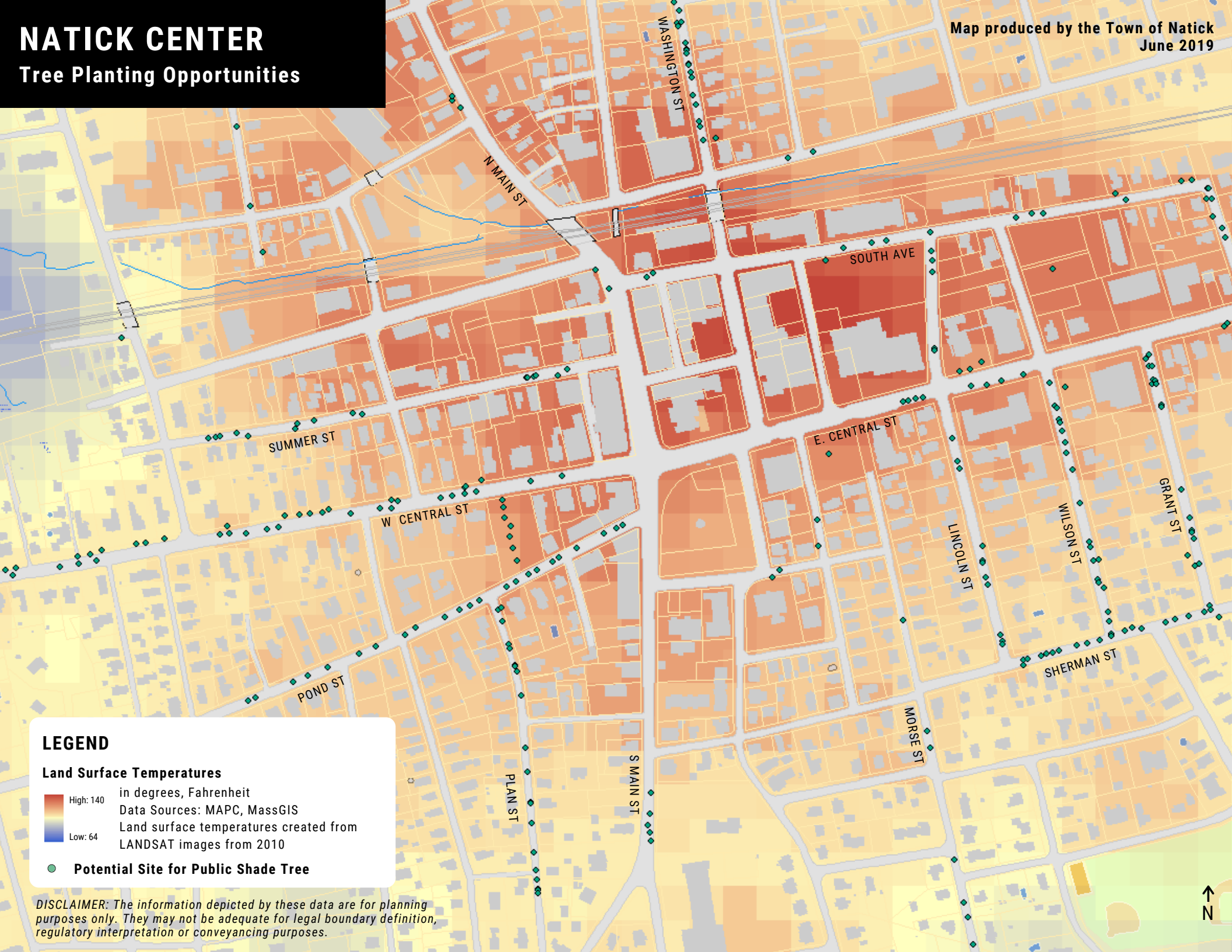
Building Energy Conservation Opportunity (Not Near Building; North, South, East, West of Building)

Site Ownership (Public; Private)

NATICK CENTER

Tree Planting Opportunities

Map produced by the Town of Natick
June 2019



LEGEND

Land Surface Temperatures

High: 140 in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010

Low: 64

Potential Site for Public Shade Tree

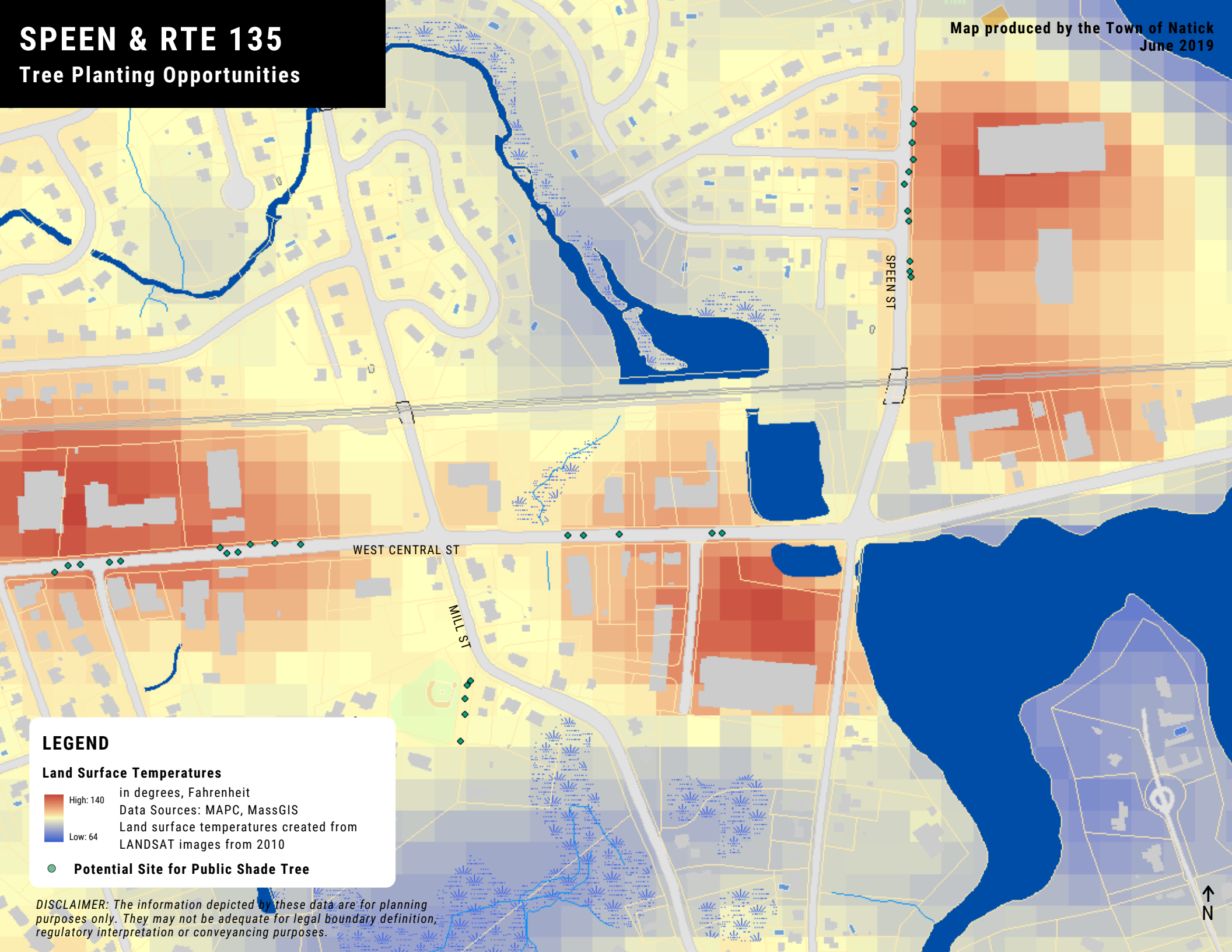
DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.



SPEEN & RTE 135

Tree Planting Opportunities

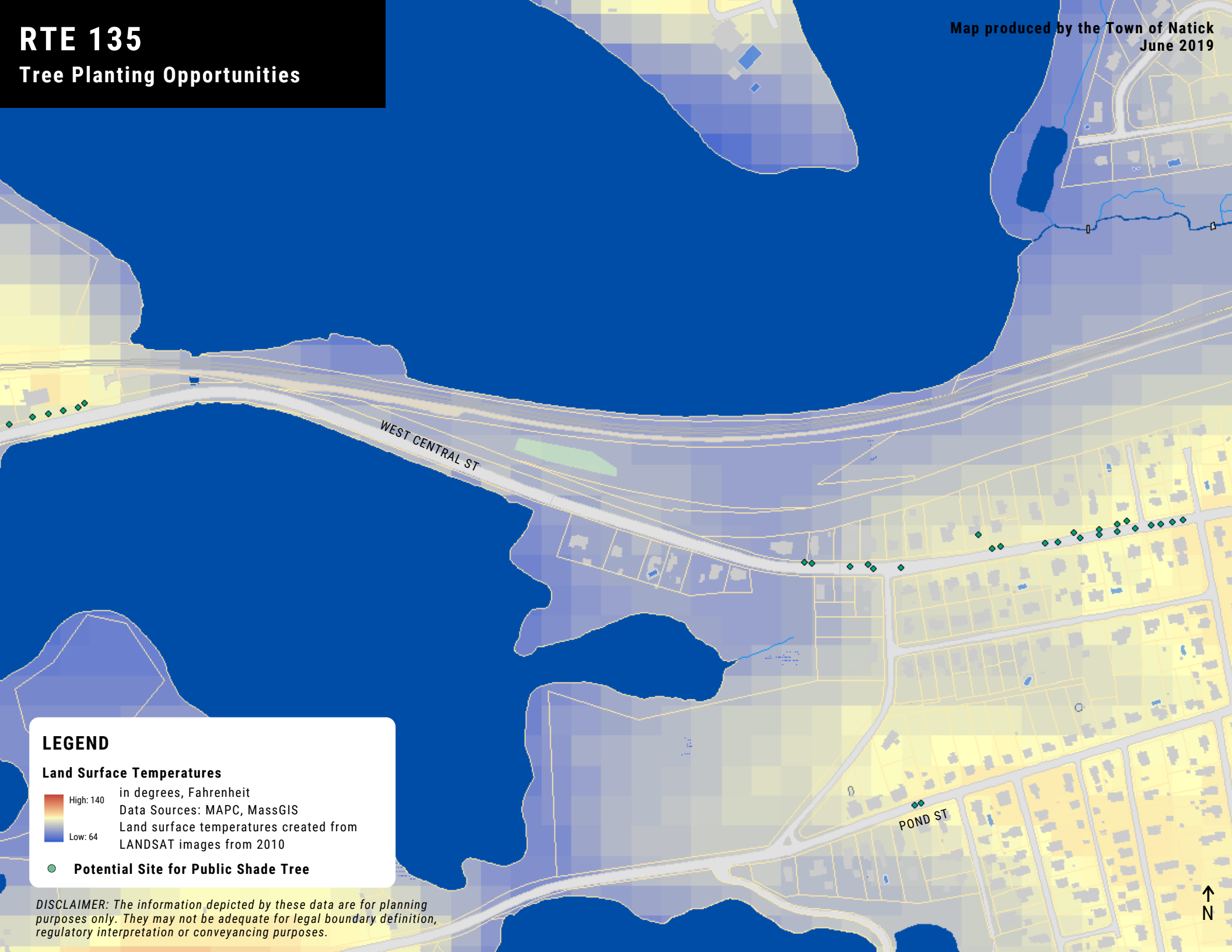
Map produced by the Town of Natick
June 2019



RTE 135

Tree Planting Opportunities

Map produced by the Town of Natick
June 2019



LEGEND

Land Surface Temperatures

in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010

High: 140
Low: 64

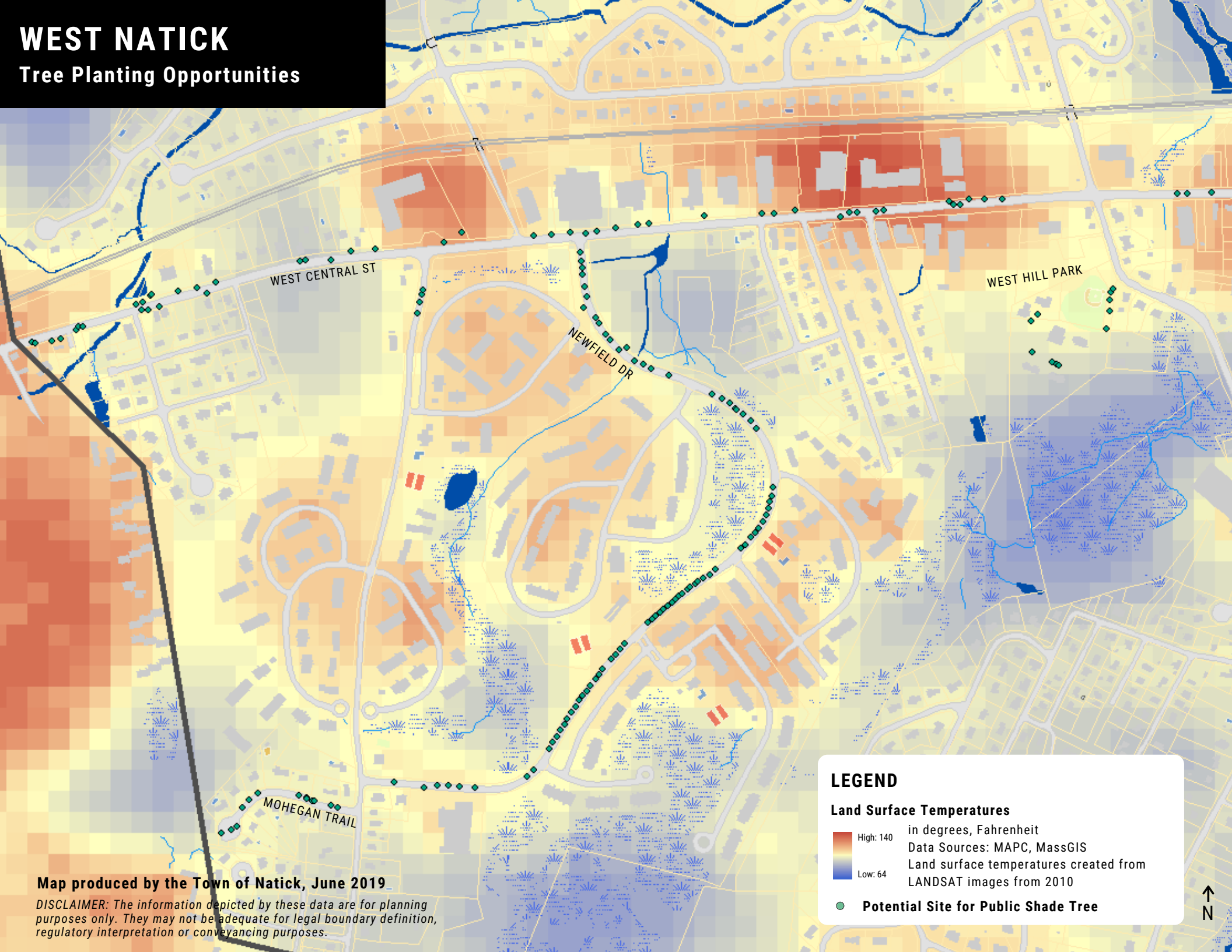
Potential Site for Public Shade Tree

DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.



WEST NATICK

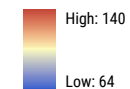
Tree Planting Opportunities



LEGEND

Land Surface Temperatures

in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010



● Potential Site for Public Shade Tree

Map produced by the Town of Natick, June 2019

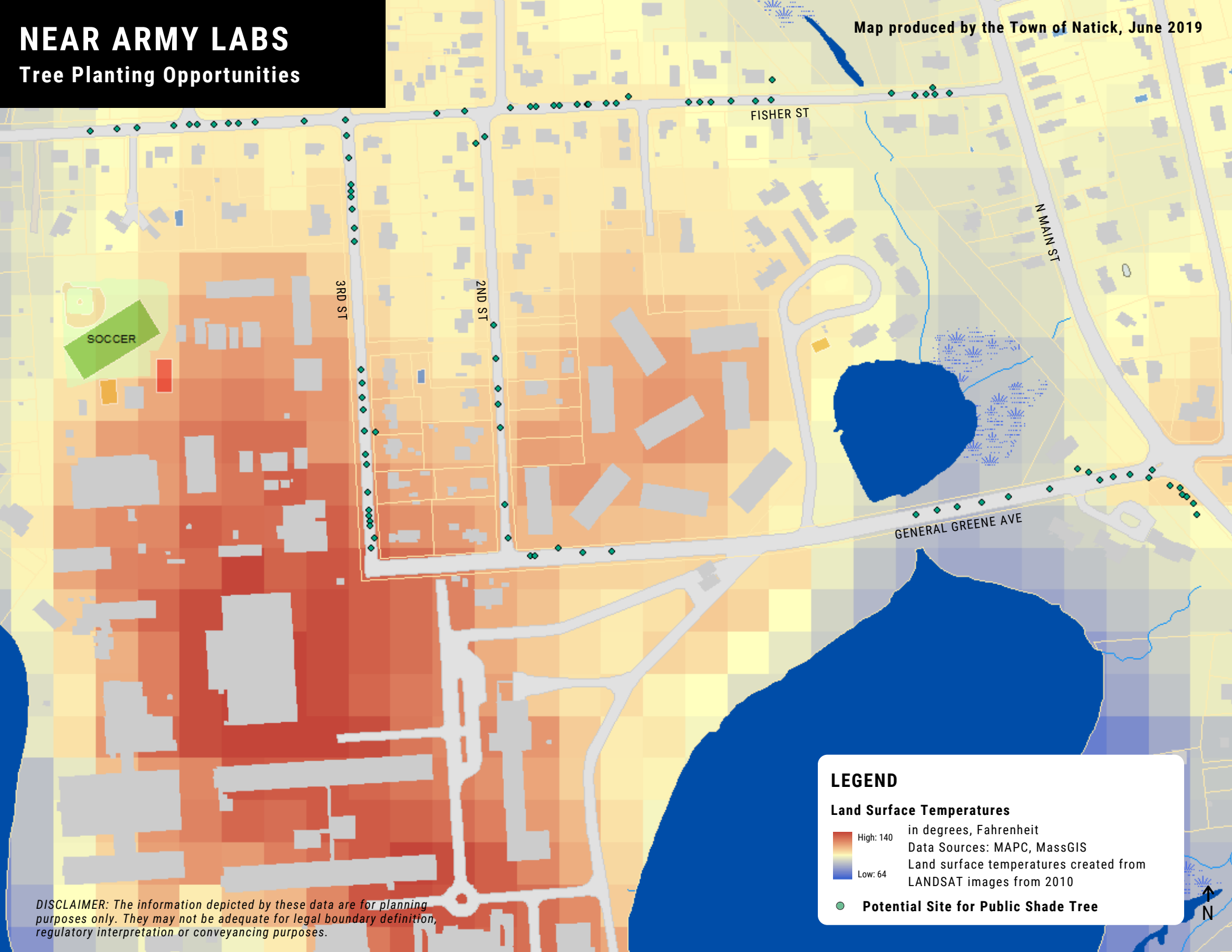
DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.



NEAR ARMY LABS

Tree Planting Opportunities

Map produced by the Town of Natick, June 2019



LEGEND

Land Surface Temperatures

in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010

● Potential Site for Public Shade Tree

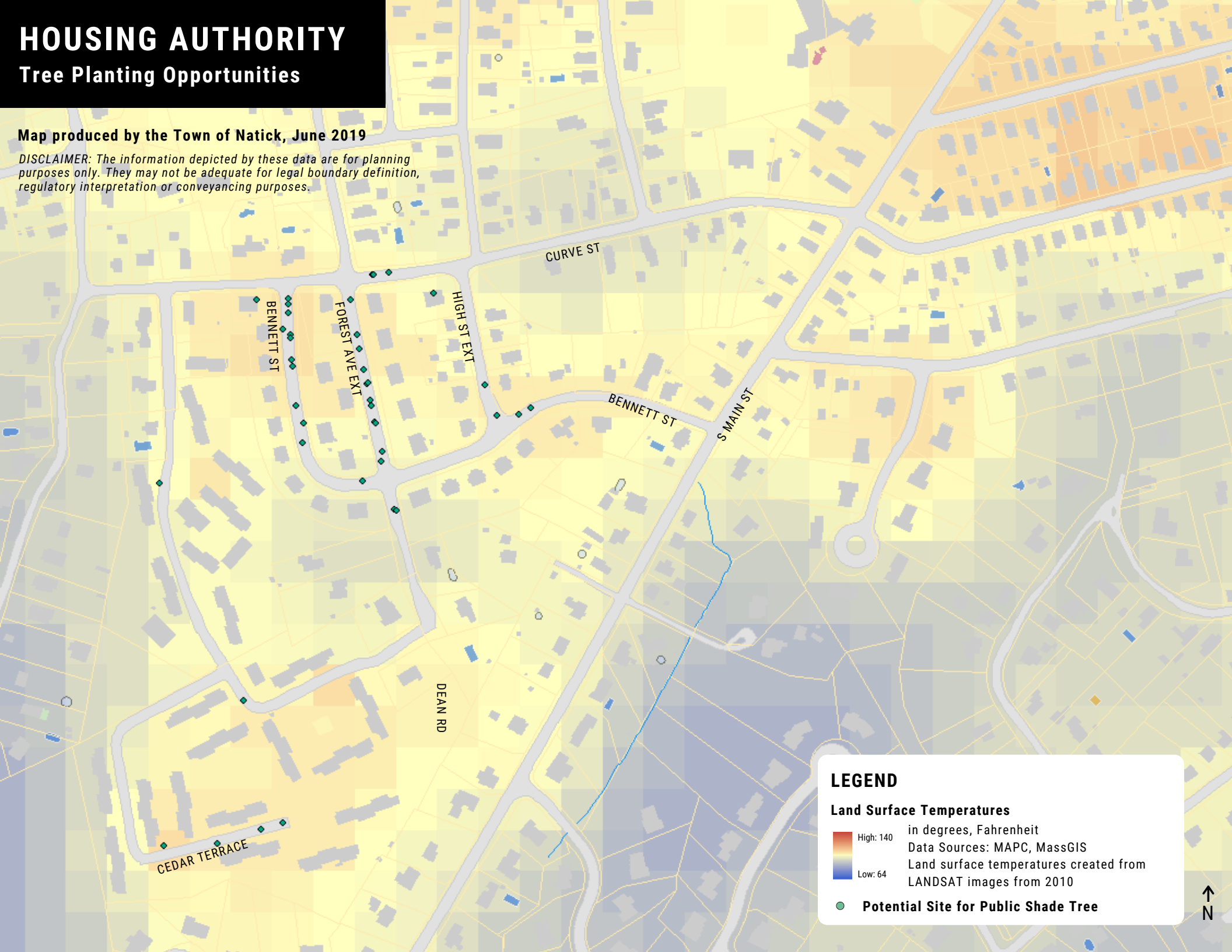
DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveying purposes.

HOUSING AUTHORITY

Tree Planting Opportunities

Map produced by the Town of Natick, June 2019

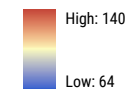
DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.



LEGEND

Land Surface Temperatures

in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010



● Potential Site for Public Shade Tree



GOLDEN TRIANGLE

Tree Planting Opportunities

Map produced by the Town of Natick, June 2019

DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.

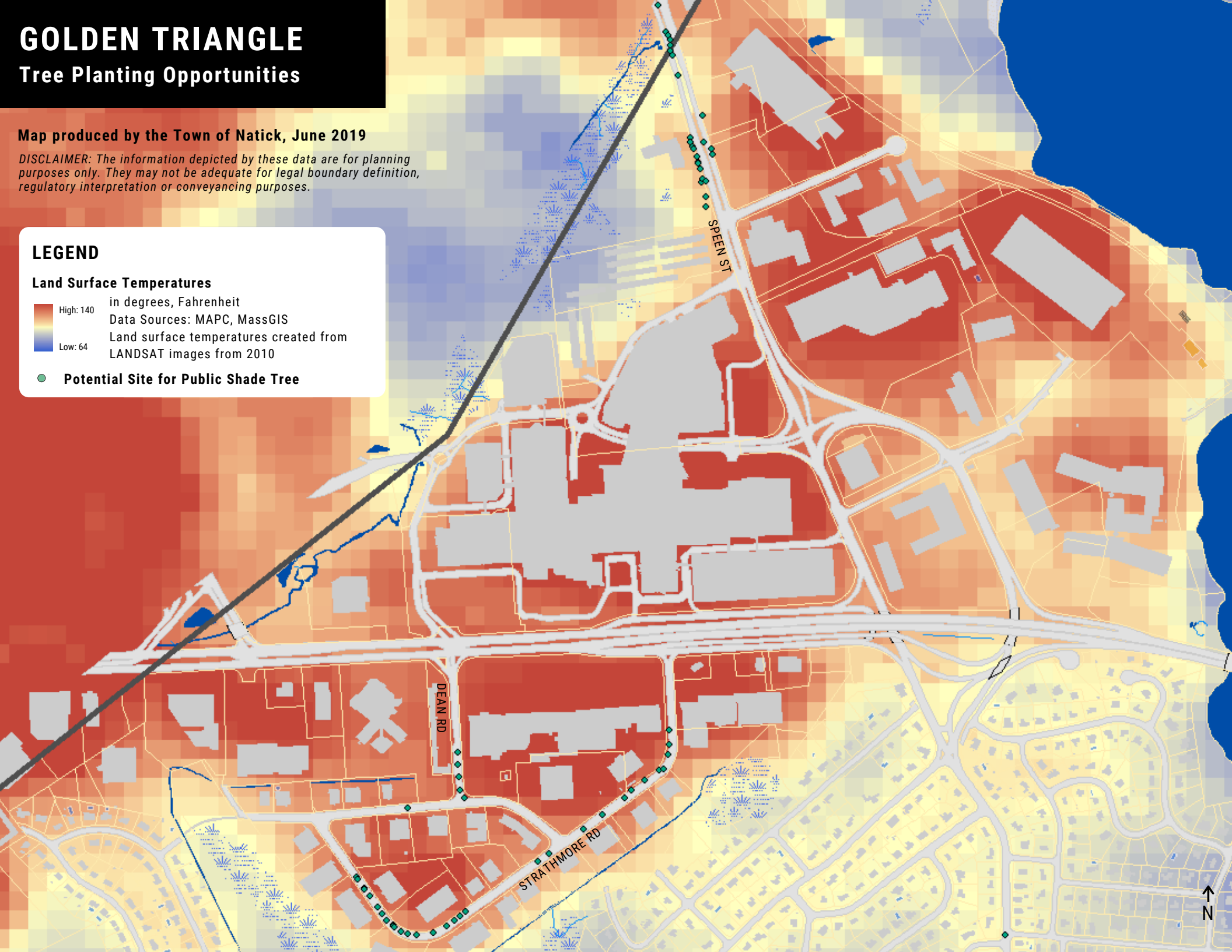
LEGEND

Land Surface Temperatures



High: 140
Low: 64
in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010

● Potential Site for Public Shade Tree



NORTHEAST NATICK

Tree Planting Opportunities

LEGEND

Land Surface Temperatures



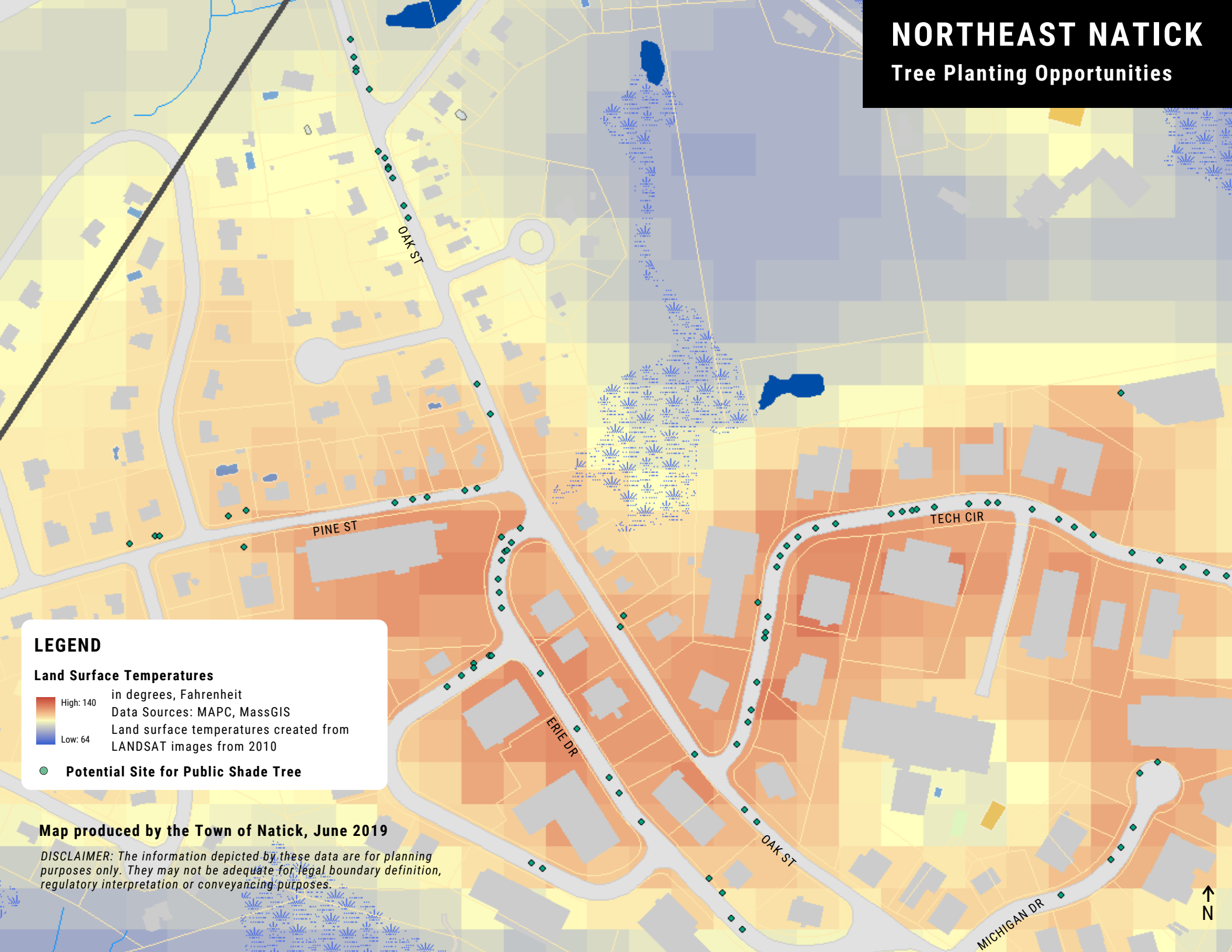
High: 140
in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010



Potential Site for Public Shade Tree

Map produced by the Town of Natick, June 2019

DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.

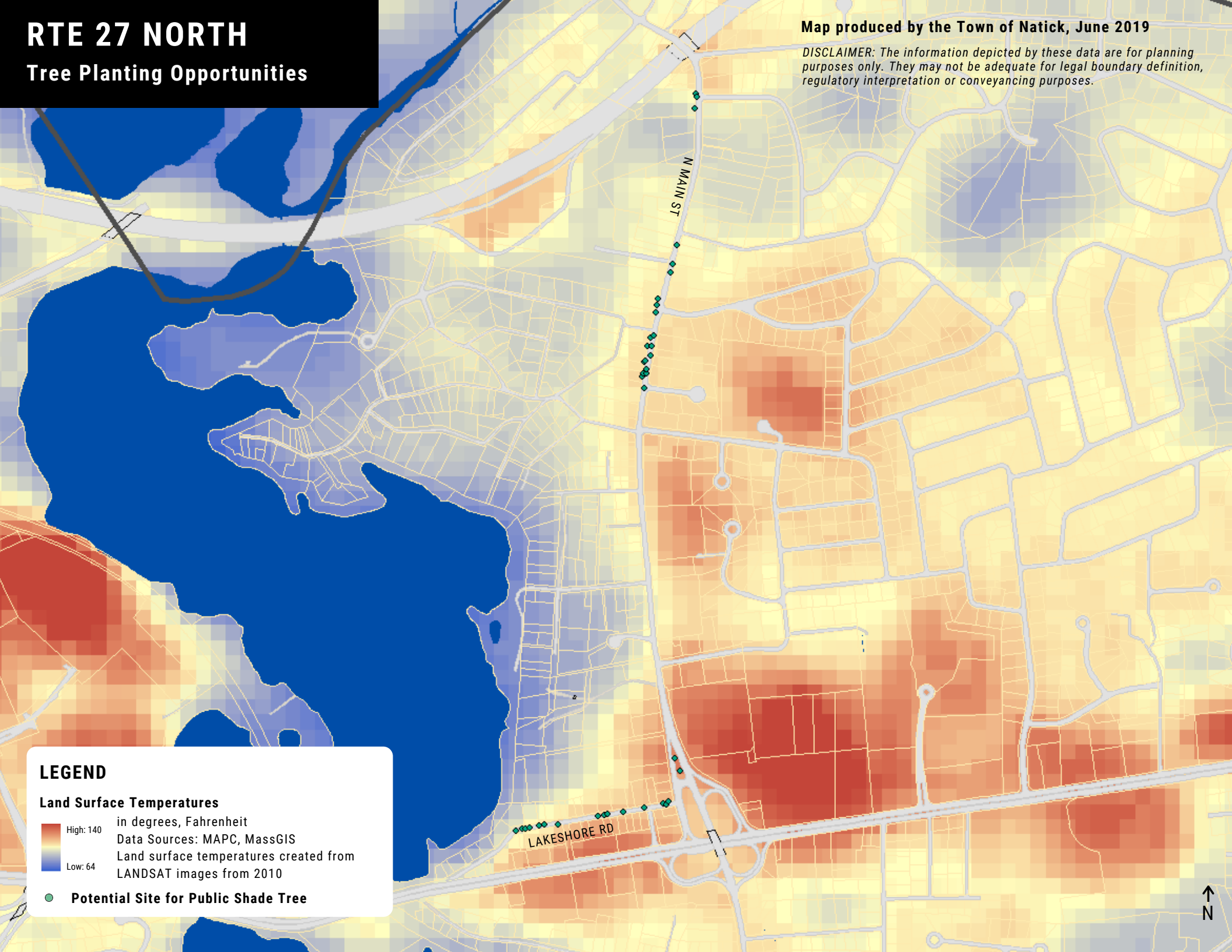


RTE 27 NORTH

Tree Planting Opportunities

Map produced by the Town of Natick, June 2019

DISCLAIMER: The information depicted by these data are for planning purposes only. They may not be adequate for legal boundary definition, regulatory interpretation or conveyancing purposes.



LEGEND

Land Surface Temperatures

in degrees, Fahrenheit
Data Sources: MAPC, MassGIS
Land surface temperatures created from
LANDSAT images from 2010

High: 140
Low: 64

Potential Site for Public Shade Tree

N

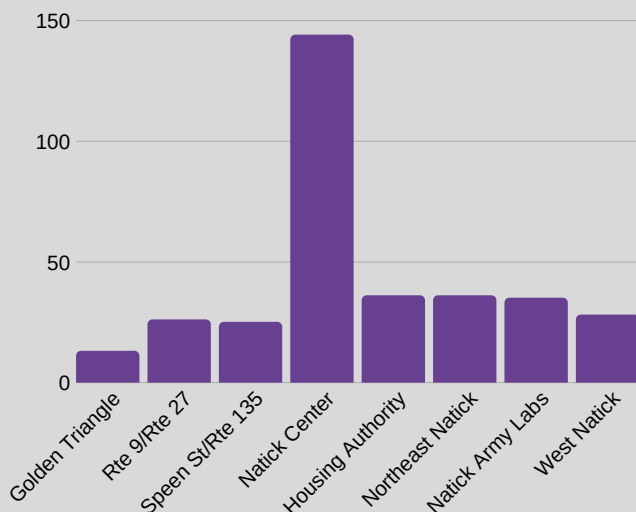
NEXT STEPS

Each of the 811 potential tree-planting sites has unique attributes and working with public and private property owners will be instrumental to successfully planting and maintaining new shade trees.

Of the eight corridors assessed, Natick Center was identified as the area having the greatest opportunity for tree plantings.

In addition, approximately half (420) sites were identified as potential setback opportunities, and 134 were found to be prime energy conservation opportunities, based on their proximity to the west side of a nearby building. 343 of the sites were on or abutting private property.

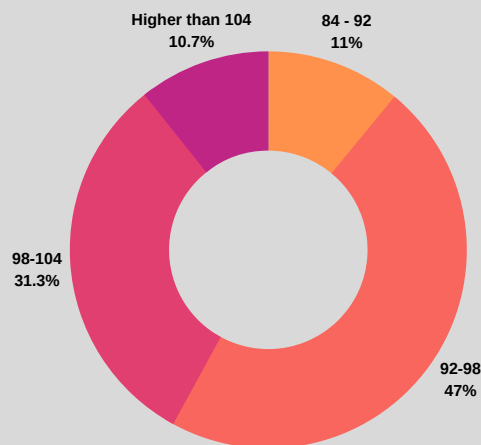
SITES ON/ABUTTING PRIVATE PROPERTY



Potential Impact on Heat Islands

Of the 811 proposed planting locations, 262 were located in areas with recorded land surface temperatures of greater than 100 degrees Fahrenheit.

LAND SURFACE TEMPERATURES OF PROPOSED TREE PLANTING SITES



In the future, the Town of Natick plans to complete an analysis of potential planting locations to determine their impact on land surface temperatures after ten years of tree growth. Following Akbari's conclusions regarding tree canopy and reductions in land surface temperatures (Akbari, 1997), a ten year old tree could yield 50 sq ft of canopy coverage and deliver a conservative 20 degree reduction in land surface temperatures. If each of the 811 proposed trees are planted, more than 40,000 square feet (an acre) of land across Natick could experience temperature reductions of 20 degrees or more.

NEXT STEPS

Targeted letters from the Natick Tree Warden and the Natick Sustainability Coordinator were sent to the 343 private property owners with land on or adjacent to the potential tree-planting sites identified in this report. This report and an application to participate in the Town's free public shade tree program are available at natickma.gov/treeplan.

Moving forward, the Town of Natick will incorporate this report's recommendations into its strategic tree planting plan and will seek additional resources to implement the proposed tree planting sites.

SOURCES

Akbari, H., D. Kurn, et al. (1997). *Peak power and cooling energy savings of shade trees*. *Energy and Buildings* 25:139–148.

Grubisich, M. (2012). *Tree Strategies for Heat Island Reduction*. Retrieved from https://www.epa.gov/sites/production/files/2014-07/documents/8_aug_2012-4_mattgrubisich.pdf

Kurn, D., S. Bretz, B. Huang, and H. Akbari. (1994). *The Potential for Reducing Urban Air Temperatures and Energy Consumption through Vegetative Cooling*. ACEEE Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy. Pacific Grove, California.

MAPC. (2015) “Mapping the Heat: Surface Temperatures in the MAPC Region.” MassGIS, LandSAT, 2010, www.mapc.org/learn/data/.

Massachusetts Executive Office of Energy and Environmental Affairs, Northeast Climate Science Center at University of Massachusetts Amherst. (2018). Massachusetts Climate Change Projections. Retrieved from <https://www.mass.gov/files/ma-statewide-and-majorbasins-climate-projections-final.pdf>

MassGIS, Impervious Surface (2017). Retrieved from <http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/impervioussurface.html>

US EPA. (2016) *Using Trees and Vegetation to Reduce Heat Islands*. Retrieved from <https://www.epa.gov/heat-islands/using-trees-and-vegetation-reduce-heat-islands#1>

Wong, E. (2014). *Reducing Urban Heat Islands: Compendium of Strategies Urban Heat Island Basics*. Retrieved from <https://www.epa.gov/sites/production/files/2014-06/documents/basicscompendium.pdf>

Xiao, Q., E.G. McPherson, J.R. Simpson, and S.L. Ustin. (1998). *Rainfall Interception by Sacramento's Urban Forest*. *Journal of Arboriculture*. 24(4):235-244.