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The University of Georgia
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January 15, 2020

Revised Report of Probabilistic Seismic Hazard Analysis
Main Athens Campus
The University of Georgia
Athens-Clarke County, Georgia
Geo-Hydro Project Number 191043.20

Dear Ms. Darden:

Geo-Hydro Engineers, Inc. has completed the authorized probabilistic seismic hazard analysis (PSHA) for the main campus of The University of Georgia in Athens-Clarke County. The scope of services for PSHA was outlined in our proposal number 23553.20 dated July 16, 2019. The main purpose of this analysis is to provide seismic hazard parameters that the University can provide to structural engineers for projects that will be designed under the International Building Code (IBC), 2018 Edition. Please note that it is possible that future amendments to the 2018 IBC may require reevaluation of the parameters we present below. In our opinion, this analysis is valid for sites in the area outlined in red on the *UGA Area I - Main Campus, UGA Area II – South Milledge Precinct, and UGA Area 3 – Health Science Campus* Maps attached to this report.

Site-Specific Probabilistic Seismic Hazard Analysis (PSHA)

The following table presents seismic design values interpolated from applicable seismic hazard maps from the building code as well as values determined by the probabilistic seismic hazard analysis performed for this report.

Parameter	2018 IBC	Probabilistic Hazard Analysis
S_s (g)	0.206	0.198
S_1 (g)	0.086	0.076

The methodology for the PSHA is outlined in the following sections.

Seismic Hazard Analysis Methodology

International Building Code 2018

The International Code Council (ICC) is a collaboration of the three major model code groups in the United States. The ICC formed specifically for the purpose of developing a model code to be used throughout the country. The first edition of the International Building Code (IBC) was published in March, 2000. The seismic provisions of IBC 2018 incorporate ASCE 7-16, which is based on the 2015 NEHRP *Recommended Provisions*.

The spectral response acceleration for the maximum considered earthquake ground motion is determined for short periods (S_S, typically calculated at 0.2 seconds) and at 1 second, (S_1). S_S and S_1 are interpolated from contour maps, or are calculated by a site-specific hazard analysis. The S_S and S_1 values are based on a risk-targeted maximum considered earthquake (MCE_R) having a 1 percent in 50 years collapse risk target.

Development of Seismic Hazard Maps

Contour maps of S_S and S_1 used in the IBC 2018 and the NEHRP *Recommended Provisions* were developed with the goal of having the probability of exceeding the design ground motion be roughly the same for all parts of the country. These maps are consensus documents conceived with the notion that "judgment, engineering experience, and political wisdom are as necessary as science" (1994 NEHRP *Commentary*, Page 277).

The contour maps of S_S and S_1 for the NEHRP *Recommended Provisions* were developed by the Building Seismic Safety Council (BSSC) based on National Seismic Hazard Maps developed by the U.S. Geological Survey (USGS). The USGS maps are intended to define the probabilistically calculated maximum considered earthquake ground motion based on a methodology developed by Frankel (1996). This methodology includes different models of seismic hazard combined with large background zones used to quantify hazard in areas with little or no historic seismic activity. The source catalog used for this mapping effort consisted of "merged catalogs from several different sources, and… fairly subjective criteria." Similar to the mapping effort for the 1994 *Recommended Provisions*, modifications to the USGS maps were made using the engineering judgment of the Seismic Design Procedure Group (SDPG), a committee appointed by BSSC to produce the 2015 NEHRP maps of S_S and S_1.

Site Specific Hazard Analysis and Justification

We performed a probabilistic seismic hazard analysis generally following a methodology described by Kramer (1996). This methodology first involves identification and characterization of earthquake sources and their recurrence characteristics. Additionally, we incorporated information included in the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (2012), which was developed by the U.S. Nuclear Regulatory Commission, the U.S. Department of Energy, and the Electric Power Research Institute including research and data from April 2008 to December 2011.

ASCE 7-16 requires the hazard analysis to account for regional tectonic setting, geology, and seismicity, the expected recurrence rates and maximum magnitude of earthquakes on known faults and source zones. This analysis complied with these provisions by using the USGS 2014 National Seismic Hazard Map seismic model as implemented for the EZ-FRISK seismic hazard analysis software from Fugro Consultants, Inc. For this analysis, we used a catalog of seismic sources similar to the one used to produce the 2014 National Seismic Hazard Maps developed by the U.S. Geological Survey (USGS).

ASCE 7-16 further requires that the analysis use appropriate regional characteristics of ground motion attenuation, near source effect, and the effect of subsurface site conditions on ground motions. Attenuation equations are predictive relationships used to determine the probability of a particular ground motion at the site due to a particular earthquake some distance from the site. The ground motions predicted by the attenuation equation for each seismic source are then combined to predict the probable ground motion at the site for a given recurrence period. For this probabilistic hazard analysis, we considered attenuation equations developed by Toro et al. (1997); Campbell (2003); Silva (2002); Tavakoli-Pezeshk (2005); and Atkinson and Boore (2006).

References

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Campbell, K.W. (2003). “Prediction of Strong Ground Motion Using the Hybrid Empirical Method and Its Use in the Development of Ground-Motion (Attenuation) Relations in Eastern North America.” *Bulletin Seismological Society of America*, Vol. 93, No. 3, pp. 1012-1033, June.

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Toro, G.R. (1999) Modification of the Toro et Al. (1997) “Attenuation Equations for Large Magnitudes and Short Distances,” Risk Engineering, Inc., website www.riskeng.com, pp. 4-1 to 4-10.

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GEO HYDRO ENGINEERS

We appreciate the opportunity to serve as your geotechnical consultant for this project, and are prepared to provide any additional services you may require. If you have any questions concerning this report or any of our services, please call us.

Sincerely,

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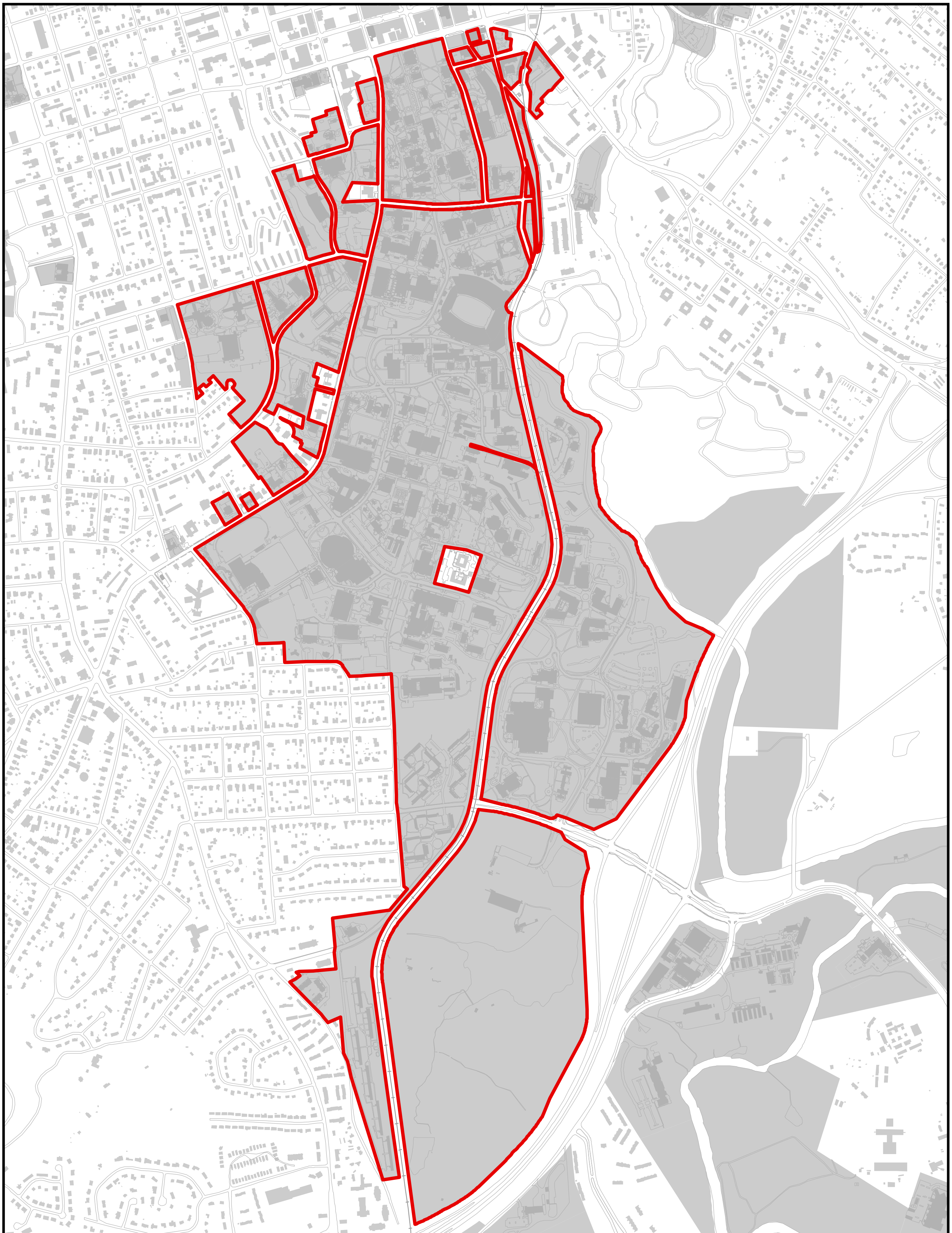
UNIVERSITY of GEORGIA CAMPUS MAP

UGA Area 1 - Main Campus

July 2014



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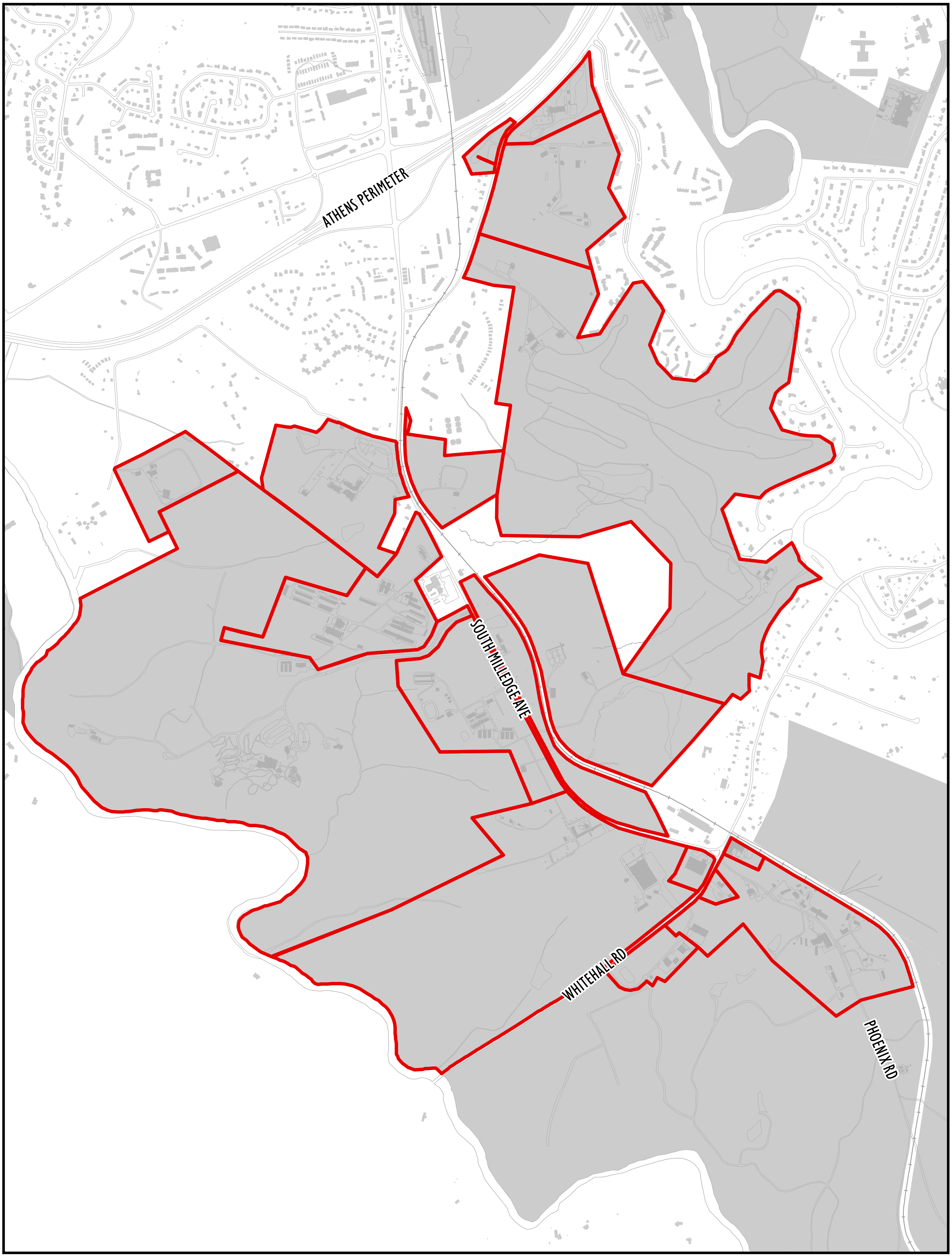
UGA Area 2 - South Milledge Precinct

July 2014

UNIVERSITY of GEORGIA CAMPUS MAP



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UGA Area 3 - Health Science Campus

November 2019

UNIVERSITY of GEORGIA CAMPUS MAP

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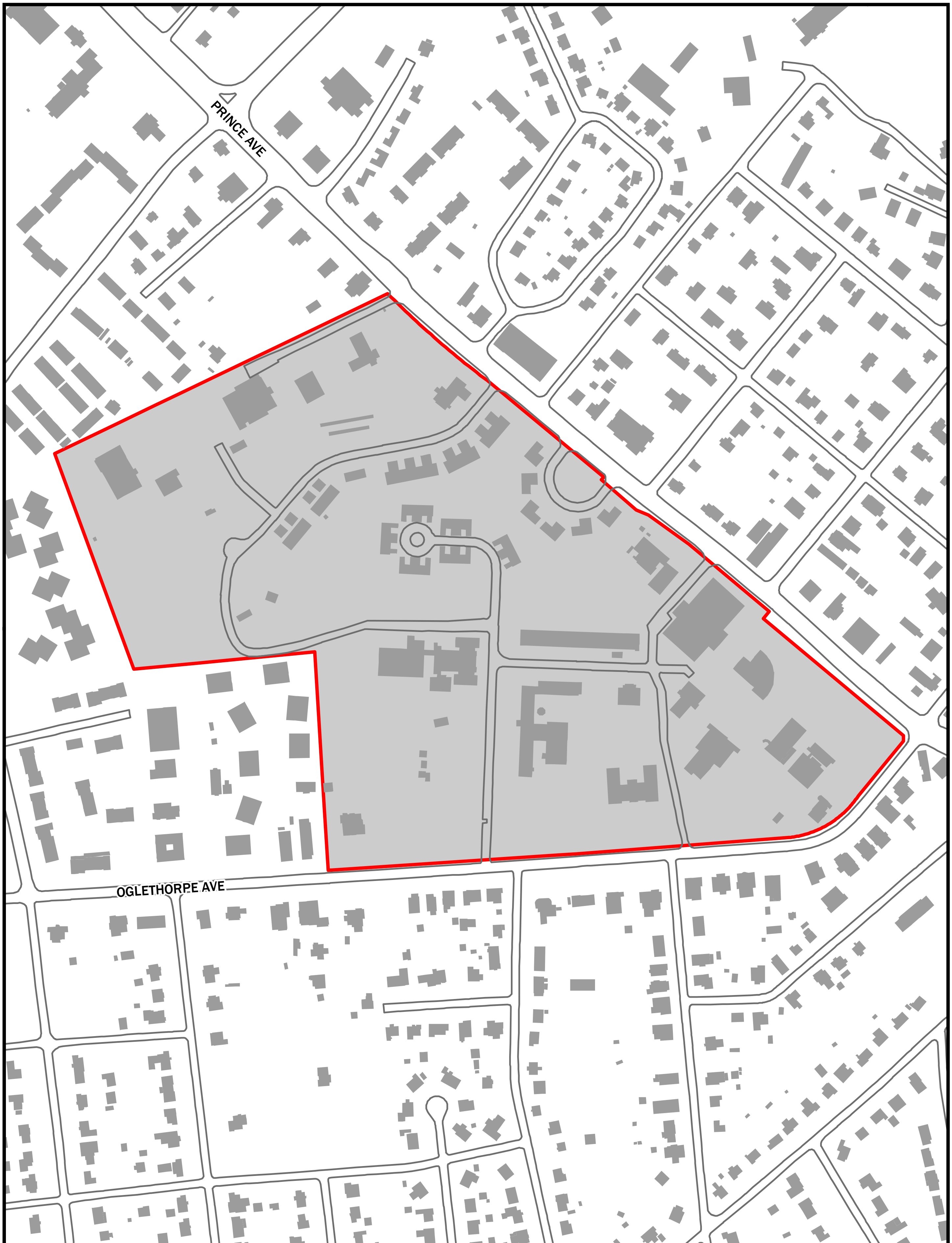

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