WATERSHED ANALYSIS OF THE MYSTIC RIVER AND NEPONSET RIVER WATERSHEDS

TASK 3C TECHNICAL REPORT
MYSTIC RIVER WATERSHED PROPERTY PARCEL ANALYSES

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Table of Contents

Figures

Tables

1 INTRODUCTION

The highly developed Mystic River Watershed drains into Boston Harbor and faces multiple water quality impairments primarily from nutrients (phosphorus and nitrogen) and pathogens from human activity and urban development. These impairments are evidenced by algal blooms and macrophyte growth which contribute to anoxic bottom waters that do not support aquatic life, reduce water clarity, degrade the aesthetic quality of the river, and impair designated uses such as fishing and boating. The Mystic River Alternative TMDL was published in January 2020 and provides an adaptive approach to manage phosphorus nutrient pollution to improve water quality and attain water quality standards (USEPA, 2020). The alternative TMDL identifies stormwater runoff as the main source of nutrient loads within the watershed and calculated that, under existing conditions, a 62-67% reduction of stormwater total phosphorus (TP) loadings is required. On August 24, 2020, the U.S. Environmental Protection Agency (EPA) received a residual designation petition from the Conservation Law Foundation for the Mystic River Watershed. The petition requests that EPA permit stormwater from commercial, industrial, institutional, and multi-family residential (CIIM) properties of one acre or greater under the National Pollutant Discharge Elimination System (NPDES) program to meet water quality standards (WQS) in Boston Harbor.

This report presents a methodology to develop, and analyses of, parcel-level stormwater TP and total nitrogen (TN) loading within the Mystic River Watershed that may be used by EPA Region 1 to support decision making regarding the residual designation petition. Within the context of the Alternative TMDL process, this report makes use of updated stormwater runoff and pollutant loading developed for the Mystic River Watershed (Paradigm Environmental, 2023). These values form the basis against which parcel-level stormwater management strategies can be evaluated. A 62% reduction in stormwater total phosphorus loads was used in this analysis to represent the estimated load reduction required under baseline conditions (USEPA 2020). Key information presented in this report includes an analysis of CIIM parcels, their characteristics such as the amount of impervious cover (IC), and their estimated stormwater nutrient loads. IC is the largest source of stormwater runoff within the watershed and findings from an analysis of the relationship between the number of CIIM parcels, IC area, and TP load are presented to demonstrate potential strategies designating the fewest number of parcels while achieving the largest possible pollutant reduction benefits. The results of this report can be further refined using other considerations, such as where and how communities facing environmental justice (EJ) concerns may be impacted, and apportioned into each municipality within the watershed where, ultimately, progress can be made towards meeting the Alternative TMDL.

2 METHODOLOGY

The general methodology presented here follows the process used in the Charles River Watershed (CRW) Total Phosphorous analysis (U.S. EPA, 2022a Appendix 4, 2022b). Key steps, refinements, and quality assurance checks are detailed in the following subsections.

2.1 Data Inventory

Readily available data necessary for parcel analysis were collected, reviewed, and assessed. Data were obtained from online repositories as well as from EPA staff. Table 2-1 provides an inventory of the GIS data collected and indicates the use of that dataset.

Table 2-1. Data used in the parcel analysis

Name	Use	Source	Source Link	Source Date
2016 Land use and land cover	IC calculation	MassGIS	https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use	May 2019
Hydrologic Response Units (HRUs)	Loading rate and load calculations	Task 3A and 3B (Paradigm Environmental, 2023)		
Parcel boundaries	For summary results	MassGIS	https://www.mass.gov/info-details/massgis-data-property-tax-parcels	Feb 2023
L3 Tax Assessor Table	Parcel details	MassGIS		Feb 2023
Municipal boundaries	For summary results	MassGIS	https://www.mass.gov/info-details/massgis-data-municipalities	April 2022
Mystic River Watershed	For summary results	MassGIS	https://www.mass.gov/info-details/massgis-data-major-watersheds	June 2000
Subwatershed boundaries	For summary results	EPA	Alternative TMDL Admin Record	
Municipal separate storm sewer system (MS4) boundaries	For summary results	EPA	Alternative TMDL Admin Record	
Combined Sewer System (CSS) Drainage	For summary results	EPA	Alternative TMDL Admin Record	

2.2 Parcel Analysis

Parcel analysis includes two main components: 1) GIS-based spatial analysis and 2) summary analysis using a python-based tool. These steps are described below and were formulated to be as accurate, transparent, and reproducible as feasible. The parcel analysis workflow, required inputs, and outputs is shown in Figure 2-1. Results of the parcel analysis are summary attributes for each parcel, as shown in Table 2-2, and additional summaries aggregating the parcel data with other conditions and spatial scales as detailed in Section 3.

Table 2-2. Parcel-level summary attributes calculated

Attribute	Description
Loc_ID	Unique parcel ID
Parcel Type	Tax classification (e.g., TAX, FEE, ROW, WATER)
Municipality Name	City or Town name
Owner	Property owner's name
Owner Address	Property owner's address
Owner City	Property owner's city
Owner Country	Property owner's country
Owner State	Property owner's state
Owner Zip Code	Property owner's zip code
Lot Size (ac)	Deed area (converted to acres in this analysis)
Site Address	Site address
Site Zip Code	Site address zip code
Units	Number of units on the property
Year Built	Year building was built
Public/Private	Owner type (public or private) based on filtering described in Section 2.3.1
FY	Year of data
MS4 (boolean, 1 = within MS4)	Inside or outside of the MS4 area
CSA (boolean, 1 = within CSA)	Inside or outside of the Combined Sewer Area (CSA)
Subbasin	Subbasin name(s) and percentages if multiple
Area in Major Basin (%)	Percentage of parcel area with the watershed
Use Code	Use code from Tax Assessor
L3 Use Description	Use description from Tax Assessor
Dept. Revenue Description	Use description from MA Dept. of Revenue (from Use Code)
Parcel Use Group	Land use classification in the current analysis (from Use Code)
MassGIS Land Use	Land use from MassGIS 2016 LULC
Total Area (ac)	Parcel area calculated in the current analysis
IC Area (ac)	The impervious cover area from the 2016 data
IC Percent	Percent impervious cover calculated from MassGIS 2016 LULC
Wetland Area (ac)	Wetland area on the parcel
Wetland Percent	Wetland percent on the parcel
Water Area (ac)	Water area on the parcel
Water Percent	Water percent on the parcel
Forest Area (ac)	Forest area on the parcel
Forest Percent	Forest percentage on the parcel
Pervious Area (ac)	Pervious area
Pervious Percent	Percent pervious

Attribute	Description
Total Pervious Load (lb/yr)	TP and TN load from the parcel's pervious cover
IC Load (lb/yr)	TP and TN load from the parcel's impervious cover
Total parcel load (lb/yr)	Total TP and TN load from parcel

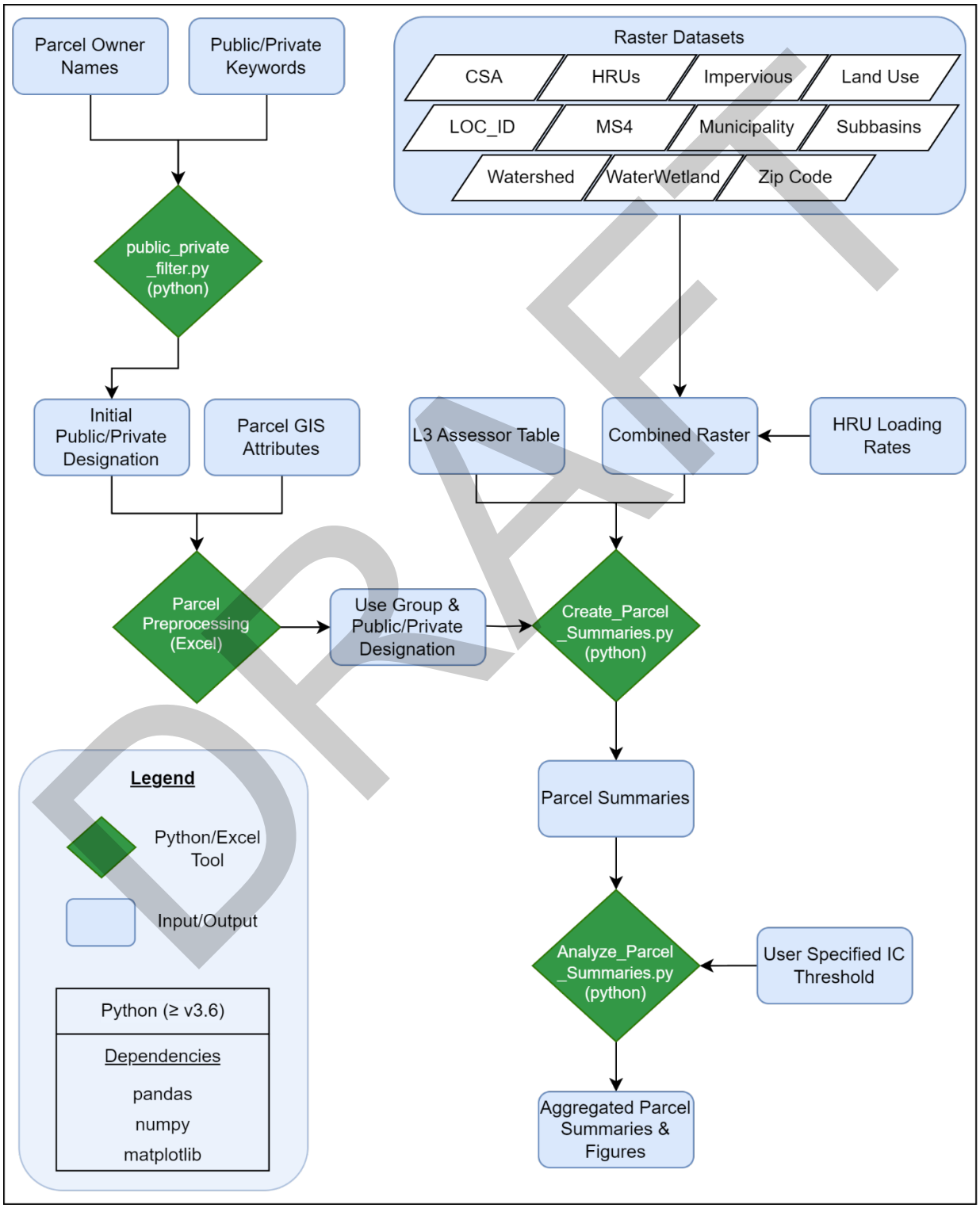

Figure 2-1. Parcel analysis workflow, including relevant requirements, inputs, and outputs.

2.2.1 *GIS-based Spatial Analysis*

The GIS-based processing is raster-based and assembles the required data for parcel-level analysis and summaries at other spatial scales. The output of this step is a combined raster layer and attribute table listing the unique combinations of all input rasters. The major GIS processing steps are:

1. Ensure all layers use the same projection (EPSG: 26986, Massachusetts State Plane Coordinate System, Mainland Zone).
2. Clip all layers to the area of interest (Mystic River Watershed boundary including below the Amelia Earhart Dam).
3. Convert all polygon layers to rasters with 1-square meter cells (e.g., parcel layer). The raster cell values will be a unique identifier (e.g., *LOC_ID* for parcels) to allow the joining of attributes in later steps.
4. Overlay all rasters using the ESRI Combine tool. The output is a combined raster and an attribute table with a unique identifier for each unique combination of input raster values.

The combined raster attribute table is converted into an Excel spreadsheet and the pollutant load calculated based on the HRU by multiplying the area of each unique combination by the appropriate loading rate. The development of loading rates is described in the Task 3A-B memo (Paradigm Environmental, 2023).

Parcel Preprocessing

One additional processing step was performed on the tax parcel polygon layer to create a second input to the python-based processing described below. Namely, once all the parcels were clipped to the Mystic River Watershed, all the unique "Use_Codes" were mapped to a single use group similar to those used in the CRW TP analysis (Table 2-3). This allows users to easily update parcel classifications as additional parcel details or corrections become available, without having to modify the python code. The Use Codes are generally, but not always, standardized codes set by the MA Department of Revenue and provide a greater number of categories than the 2016 LULC dataset (MA Dept. of Revenue Division of Local Services, 2016). For example, the CRW TP analysis grouped several Code 9 Use Code values into institutional groups; these categories do not exist in the MassGIS 2016 LULC dataset but are important for evaluating loading from CIIM parcels. As well as using the CRW Use Code groups, a right-of-way group and water group were added as the current analysis considers all parcels within the Mystic River Watershed. A public or private designation was assigned to each parcel during this preprocessing step (detailed in Section 2.3.1).

Table 2-3. Use Groups assigned in the CRW and Mystic analyses

CRW Use Group	Mystic Use Groups	Public/Private
Agriculture	Agriculture	Private
Commercial	Commercial	Public or Private
Industrial	Industrial	Public or Private
Open Land	Open Land	Public or Private
Local Institutional	Local Institutional	Public
Private Institutional	Private Institutional	Private
State Institutional	State Institutional	Public
MultiFamily Residential	MultiFamily Residential	Public or Private
Single Family Residential	Single Family Residential	Public or Private
Federal Institutional	Federal Institutional	Public
Two Family Residential	MultiFamily Residential	Public or Private
Three Family Residential	MultiFamily Residential	Public or Private

CRW Use Group	Mystic Use Groups	Public/Private
MultiFamily Residential (4-8)	MultiFamily Residential	Public or Private
MultiFamily Residential (>8)	MultiFamily Residential	Public or Private
	Right-of-Way	Public or Private
	Water	Public or Private

The main steps in parcel Use Group classification are listed below. In general, each step reclassifies unknowns from the preceding steps.

1. Assign from Use Code based on existing CRW classification
2. Assign institutional categories from Use Code 9 parcels unique to the Mystic River Watershed
3. Assign "Unknown" if no Use Code and no Owner
4. Assign Multi-Use (Table 2-4)
5. Assign from major Use Code category (first digit, Table 2-5)
6. Assign from PolyType (only Right-of-Way and Water)
7. Remaining Unknowns classified from the dominant MassGIS 2016 LULC category.
8. Manually reclassify select parcels.

Table 2-4. Reclassification table for Multi-Use parcels

2 Digit Use Code	Use Group
01	MultiFamily Residential
03	Commercial
04	Industrial
06	Open Land
07	Open Land
08	Open Land
09	Private Institutional

Table 2-5. Reclassification table for major Use Code category

1 Digit Use Code	Use Group
1	MultiFamily Residential
2	Open Land
3	Commercial
4	Industrial
5	Unknown
6	Open Land
7	Open Land
8	Open Land
9	Private Institutional

Results of the parcel preprocessing, in terms of total distribution within the Mystic River Watershed, are shown in Figure 2-2 and mapped in Figure 2-3. This analysis shows that more than one-quarter (26.1%) of the watershed area is made up of single-family residences and combined multi-family residences make up 13%. Public institutional groups (local, state, and federal) make up 13% of the watershed area with private institutional totaling just 2.1%. In total, commercial, industrial, and private institutional constitute 18.6% of the watershed area. The distribution of public/private parcels, grouped by Use Code group, is shown in Table 2-7. In total, the current classification has 36.9% public parcels and 63.1% private; non-right-of-way public parcels account for 21.3% of parcel area.

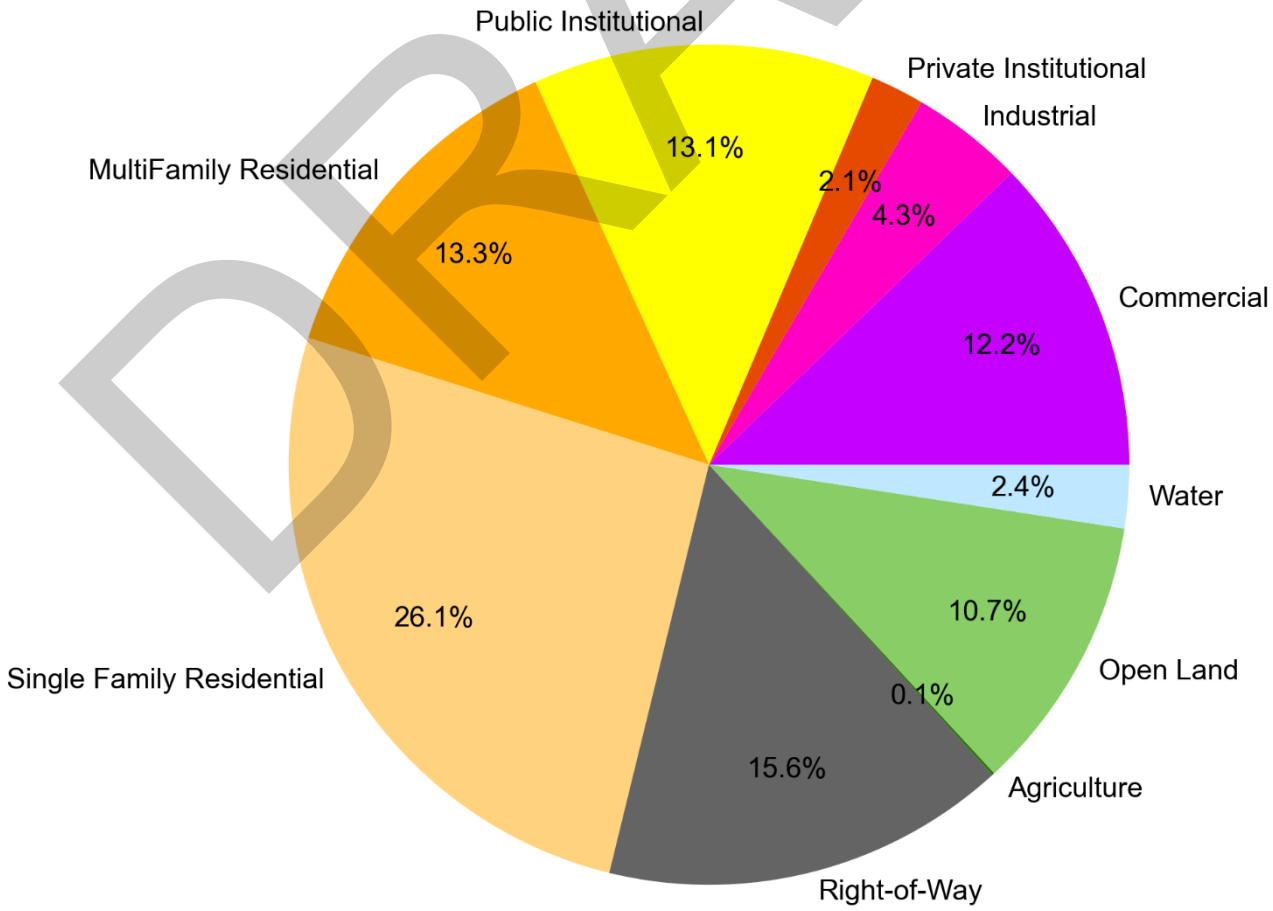

Figure 2-2. Distribution of parcel area by Use Group within the Mystic River Watershed.

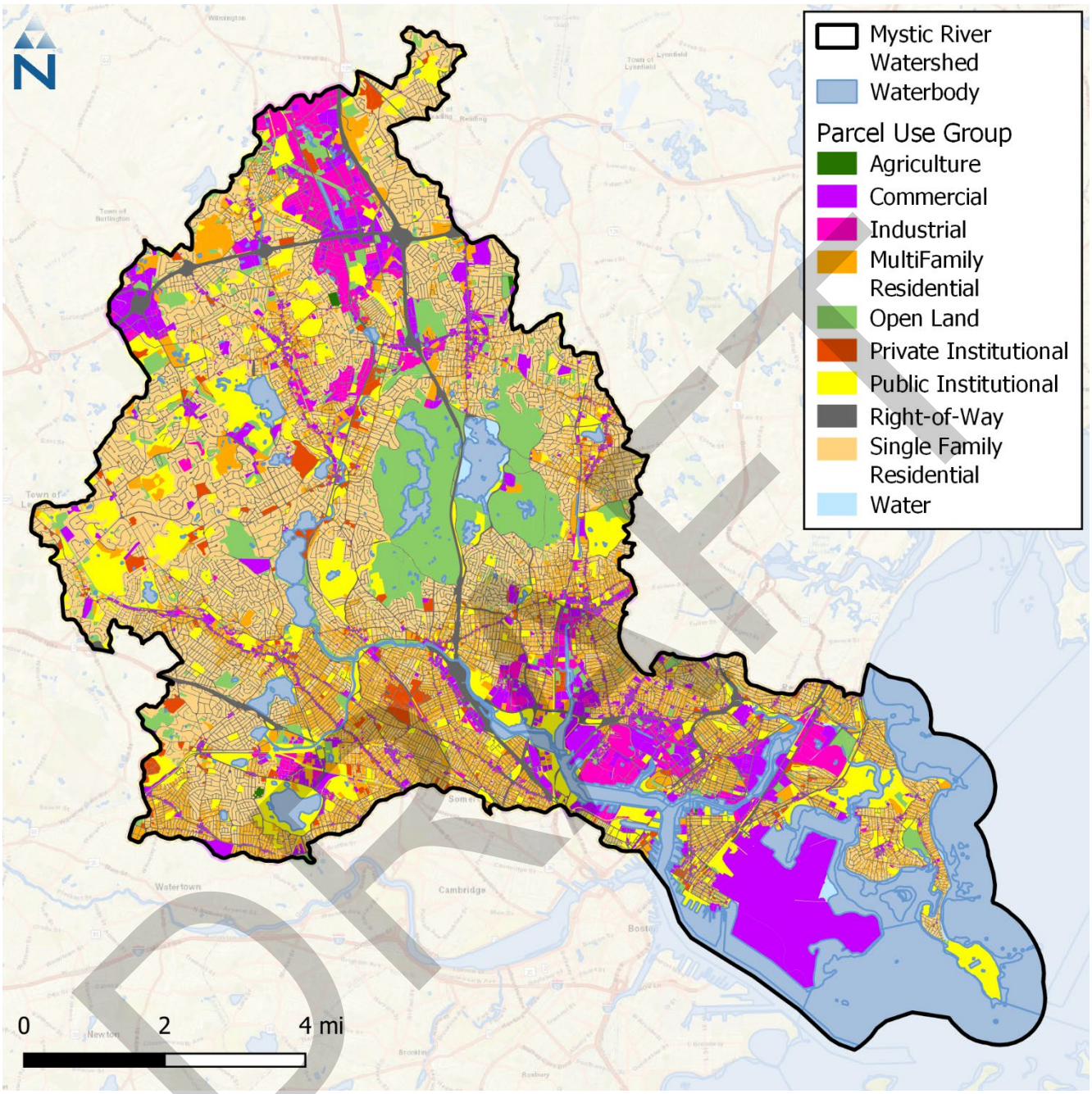

Figure 2-3. Map of parcel Use Groups within the Mystic River Watershed. Note that the resolution of this map is parcel-scale; waterbodies exist within non-Water class parcels and have been added to aid visualization.

Table 2-6. Distribution of public and private parcel areas by Use Group

Public/Private	Use Group	Count	Count (%)	Total Area (ac)	Total Area (%)
Private	Agriculture	33	0.03	43.61	0.09
	Commercial	5,167	4.35	6,134.53	12.20
	Industrial	839	0.71	2,182.61	4.34
	MultiFamily Residential	41,626	35.07	6,707.92	13.34
	Open Land	5,196	4.38	2,504.80	4.98
	Private Institutional	909	0.77	1,042.92	2.07
	Right-of-Way	60	0.05	22.15	0.04
	Single Family Residential	61,671	51.96	13,107.76	26.07
	Water	0	0.00	0.00	0.00
	Subtotal	**115,501**	**97.3**	**31,746.29**	**63.1**
Public	Agriculture	0	0.00	0.00	0.00
	Commercial	4	0.00	6.38	0.01
	Industrial	5	0.00	2.23	0.00
	MultiFamily Residential	0	0.00	0.00	0.00
	Open Land	194	0.16	2,873.67	5.72
	Public Institutional	2,608	2.20	6,606.03	13.14
	Right-of-Way	320	0.27	7,819.71	15.55
	Single Family Residential	0	0.00	0.00	0.00
	Water	65	0.05	1,221.62	2.43
	Subtotal	**3,196**	**2.7**	**18,529.64**	**36.9**
Total		**118,697**	**100**	**50,275.94**	**100**

2.2.2 *Python-Based Summary Analysis*

The raster attribute table output from GIS processing was further processed using a tool developed in python (Figure 2-1). Python is a commonly used programming language for data management and analysis due to its ease of use and readability; all python software and packages used in this analysis are freely available and open source. The output of this processing is an Excel compatible spreadsheet file including every parcel and additional summaries based on aggregating the data with different conditions and spatial scales. The major python processing steps include:

1. Read the combined raster attribute table into a data frame using the pandas python package.
    - This is a powerful data structure that allows for a wide variety of data manipulation and evaluation.
    - Efficient for large-size datasets.
2. Join relevant attribute tables.
    - The parcel *LOC_ID* is used to join parcels with the preprocessed parcel data and the L3 Assessors Table, which provides parcel details such as site address, owner information, and year built.
    - Performing this step outside of a GIS environment should reduce processing time and potential data overlap errors.
3. Calculate parcel-level information.
    - The information shown in Table 2-2 is calculated for each parcel.
4. Generate parcel-level summary tables.
    - A summary spreadsheet file is generated and saved. The file includes all necessary information as shown in Table 2-2 for each property parcel.
    - The code can also optionally generate a summary table for multiple attributes (e.g., the unique intersection of parcel, municipality, and subbasin). This is useful for additional QA of area and loads.
5. Generate additional summaries.
    - Additional summaries of the calculated parcel data are created by aggregating with other conditions and spatial scales.
    - For example, TP loading from IC areas can be summarized for parcels of varying IC areas and Use Groups.

Outputs of the python-based processing are presented and evaluated in the Results and Discussion section. All input data, processing codes, and outputs will be made available to EPA; outputs can be visualized by joining with the *LOC_ID* in the parcel polygon layer.

2.3 Refinements from CRW Analysis

Parcel analysis for the Mystic River Watershed is based on the general methodology used in the Charles River Watershed. Several refinements were made to improve transparency and consistency including:

1. High-resolution (i.e., 1 squared meter cell size) raster-based GIS data processing
2. A consistent source of land use classification (MassGIS 2016 LULC)
3. Binary public or private designation at parcel-scale
4. The long-term annual average loading rates from the Opti-Tool HRU time series (for a period of 2007-2016)
5. The pollutant loading from the pervious areas is based on the HSG classification, providing additional resolution for load calculation.

The GIS processing performed in the CRW TP analysis was based primarily on polygon datasets, which can lead to errors or require additional processing with polygons being duplicated and/or overlapped. For the Mystic River analysis, the raster-based approach (Section 2.2.1) spatially aligns all datasets to eliminate errors such as polygon slivers or overlap of multi-part polygons.

The impervious cover is based on a rasterized version of the MassGIS 2016 LULC dataset, which contains the most recent and detailed IC data currently available. The land cover information in this layer is consistent with the Coastal Change Analysis Program (C-CAP)'s high-resolution land cover classification scheme and the entire LULC layer has been thoroughly vetted and documented by MassGIS (MassGIS, 2016). The CRW analysis used both a MassGIS 2005 IC raster and the 2016 LULC polygon dataset and stated that the 2005 IC raster was overly simplified. However, the 2016 land cover classifications are based on 1-meter aerial imagery and can be converted back to a 1-meter raster with essentially no loss in accuracy. This was evaluated for the Mystic River Watershed and shown in Table 2-8. Additionally, loading rates were calculated from the Opti-Tool Hydrologic Response Units (HRUs) that are primarily based on the MassGIS 2016 LULC dataset and average annual SW HRU pollutant load export rates that were developed in subtasks 3A and 3B (Paradigm Environmental, 2023).

Table 2-7. Comparison of IC cover in polygon and raster versions of the MassGIS 2016 LULC dataset for the Mystic River Watershed

MassGIS 2016 LULC	IC Area (ac)	Difference (%)
1-meter raster	23,217.3	0.005%
Polygon	23,216.2	

2.3.1 *Public/Private Classification*

For the Mystic River Watershed, a binary public/private classification based on similar Use Codes as those used in the CRW analysis was developed. The public/private designation uses keyword filters on the "OWNER1" attribute as an initial designation which is then further refined by looking at the assigned Use Group (Table 2-3). For example, any local, state, or federal institutional groups that were not classified as public in the keyword filtering were changed to public. These keywords are listed in Table 2-9 and were selected by visual inspection of unique code 9 owner names remaining after filtering out CRW use codes for local, state, and federal institutional groups. Binary classification is important to help distinguish between parcels already subject to regulation.

The main steps in creating the public/private designation are:

1. Owner keyword filtering (performed in python script)
2. Update RoW based on parcel PolyType
3. Classify parcels with a "Water" Use Group as public
    a. These parcels are predominately water and account for only 0.1% of the total TP and TN loads (Table 3-2)
4. Classify unknowns based on Use Group
5. Update Residential
    a. If residential and not Use code 9XX: private
6. Manual reclassification of selected parcels

Table 2-8. OWNER1 keywords for initial public/private parcel filtering

Public Keywords		
CITY OF	MASS BAY TRANS AUTHORITY	MASSACHUSETTS COMM OF METRO DIST COMM
COMM OF MASS	MASS BAY TRANS, AUTHORITY	MASSACHUSETTS COMMON OF
COMMNWLTH OF MASS	MASS BAY TRANS. AUTH	MASSACHUSETTS COMMONWEALTH
COMMONWEALTH OF	MASS BAY TRANS. AUTHORITY	MASSACHUSETTS COMMONWEALTH OF
COMMWLTH OF MASS	MASS BAY TRANSP AUTH	MASSACHUSETTS DEPARTMENT
COMWLTH OF MASS	MASS BAY TRANSPORT AUTH	MASSACHUSETTS GOVT LAND BANK
COUNTY OF	MASS BAY TRANSPORTATION	MASSACHUSETTS PORT AUTH
DCR	MASS BAY TRANSPORTATION AUTH	MASSACHUSETTS PORT AUTHORITY
DEPARTMENT OF	MASS BAY TRANSPTN AUTHOR	MASSACHUSETTS TURNPIKE AUTHORITY
DEPT OF	MASS DOT	MBTA
DEPT. OF	MASS ELECTRIC CO	POST OFFICE
FIRE + POLICE BUILDING	MASS PORT AUTHORITY	REDEVELOPMENT ASSOC
FIRE DEPARTMENT	MASS TURNPIKE AUTHORITY	REDEVELOPMENT AUTH
HOUSING AUTH	MASS WATER RESOURCE AUTH	TOWN OF
LIBRARY	MASSACHUSETT PORT AUTHORITY	TOWN OFFICE BUILDING
M B T A	MASSACHUSETTS BAY TRANS AUTH	U S POST OFFICE
MASS BAY AUTHORITY	MASSACHUSETTS BAY TRANSIT AUTHORITY	UNITED STATES OF AMERICA
MASS BAY TRAN AUTHORITY	MASSACHUSETTS BAY TRANSIT AUTHORITY	UNITED STATES POSTAL SERVICE
MASS BAY TRANS AUTH	MASSACHUSETTS COMM OF	UNITED STATES PROPERTY
Private Keywords		
COMPANY	CONDO	LLC
TRUST	TRS	CREDIT UNION
REALTY	RLTY	INC
INCORPORATED		

2.4 Quality Assurance / Quality Control (QA/QC)

Several QA/QC steps have been performed to ensure the highest level of accuracy feasible. The greatest source of uncertainty in this analysis is the parcel attributes from the L3 Tax Assessor table. As seen in Table 2-9, owner names and other details are not standardized and may have typos that make automated processing difficult. To address this, parcels that remain unclassified as public/private after the processing described in Section 2.3.1 were manually examined and updated.

Additional checks include:

- Ensuring parcels have a single MassGIS 2016 land use category by intersecting parcel boundaries and reclassified land use categories.
- Evaluating the fraction of public and private ownership for feasibility
- Checking the sum of all parcel areas within a municipality equals the sum of municipality area and similar checks for other boundaries such as sub-watersheds.

2.5 Limitations

One limitation of this analysis is that parcels crossing the boundary of the Mystic River Watershed will only be evaluated for the portion of their area within the watershed. This is not expected to impact the calculation of load within the watershed, but will impact the calculation of area for different land uses at the parcel scale. For example, a parcel may have IC outside of the watershed boundary, but only the IC area and load within the watershed will be accounted for. The percentage of IC area will be calculated as the IC area within the watershed divided by the total parcel area within the watershed. The impact of splitting parcels on the watershed boundary should be negligible given that this is a small portion of the total number of parcels.

3 RESULTS AND DISCUSSION

This section describes the calculated TP and TN loads from private and public properties based on the parcel Use Group. Analyses include the proportional impact of different private property classes, the proportional impact of different property sizes based on the amount of impervious cover on each property, and a range of the optimal IC size thresholds to reduce the greatest amount of TN and TP while potentially designating the fewest number of properties. Results within this section exclude any parcels within combined sewer system areas. This excluded 9,887 parcels (8.3% of all parcels) and 2,041.22 ac (4.1% of all parcel area). It was assumed that stormwater from these parcels was already treated.

The Mystic River Watershed Alternative TMDL (USEPA, 2020) uses the period 2007-2016 for the calculation of baseline annual average TP loads. Total baseline nutrient loads used in this parcel analysis are from the same time period and represent unattenuated stormwater TP loads of 40,660 lb/yr (Table 3-1). A watershed-wide 62% required reduction in TP load (25,209 lb/yr), as specified in the Alternative TMDL, was calculated from the baseline load. Note that there is 1,254 ac of parcel area outside of any municipality (denoted as "No Data" in Table 3-1). TP load from these areas is 0.2% of the watershed total but was not assigned to any municipality; this corresponds to the approach for calculating municipality loading used in the loading analysis (Paradigm Environmental, 2023).

Table 3-1. Stormwater annual average TP load (2007-2016) for municipalities within the Mystic River Watershed, excluding combined sewer system areas

Municipality	Annual Average (2007 2016) TP Load (lb/yr)			
	Public (%)	Private (%)	Unattenuated	Required Reduction
ARLINGTON	31%	69%	2,905.52	1,801.42
BELMONT	31%	69%	1,955.44	1,212.37
BOSTON[1]	27%	73%	4,599.85	2,851.91
BURLINGTON	25%	75%	971.95	602.61
CAMBRIDGE	27%	73%	999.26	619.54
CHELSEA[1]	27%	73%	2,003.49	1,242.16
EVERETT	15%	85%	2,602.57	1,613.59
LEXINGTON	34%	66%	954.38	591.72
MALDEN	27%	73%	2,192.65	1,359.44
MEDFORD	35%	65%	4,640.40	2,877.05
MELROSE	31%	69%	1,511.82	937.33
READING	38%	62%	853.70	529.29
REVERE[1]	27%	73%	1,318.11	817.23
SOMERVILLE	3%	97%	324.16	200.98
STONEHAM	33%	67%	2,421.79	1,501.51
WAKEFIELD	28%	72%	128.71	79.80
WATERTOWN	18%	82%	253.19	156.98
WILMINGTON	10%	90%	267.09	165.60
WINCHESTER	32%	68%	2,415.24	1,497.45
WINTHROP[1]	23%	77%	1,358.67	842.37
WOBURN	25%	75%	5,887.12	3,650.01
No Data[2]	32%	68%	95.19	59.02
		Total	**40,660.29**	**25,209.38**

[1]These municipalities have area below the Earhart Dam and did not have instream attenuation factors developed in the Alternative TMDL.
[2]Note that there are 1,254 ac of parcel area within the Mystic River Watershed that are not covered by a municipal boundary. These areas represent 0.2% of the total TP load.

3.1 All Parcels

After excluding parcels within combined sewer areas, a total of 108,810 parcels remained for further analysis. The parcels are predominately Multifamily and Single Family Residential, which represent 87% of all parcels by count and 40% by land area. Other major parcel types include private commercial, public institutional, and public right-of-way. Open land makes up 11% of the parcel area and is approximately evenly split between public and private.

Figure 3-1 illustrates the distribution of summary attributes by Public/Private designation for all parcels in the Mystic River Watershed. Private parcels account for 97% of parcels and 63% of total parcel area. Forty-three percent of total parcel area is impervious cover, with private parcels having more than twice as much total IC area as public parcels (67% of total IC area). In terms of nutrient loading, private parcels contribute 72% of the total TP and total TN. Loading from IC within private parcels amounts to 94% of the total TP and TN load from private parcels. Private IC load represents 68% and 67% of total TP and total TN, respectively, from all parcels. These results indicate that private parcels contribute nearly three quarters of the nutrient load and may require further stormwater controls for the watershed to meet its water quality goals. Table 3-2 and Table 3-3 provide additional details summarizing the IC area and load for all non-CSA parcels by Use Group and Private/Public designation for TP and TN, respectively.

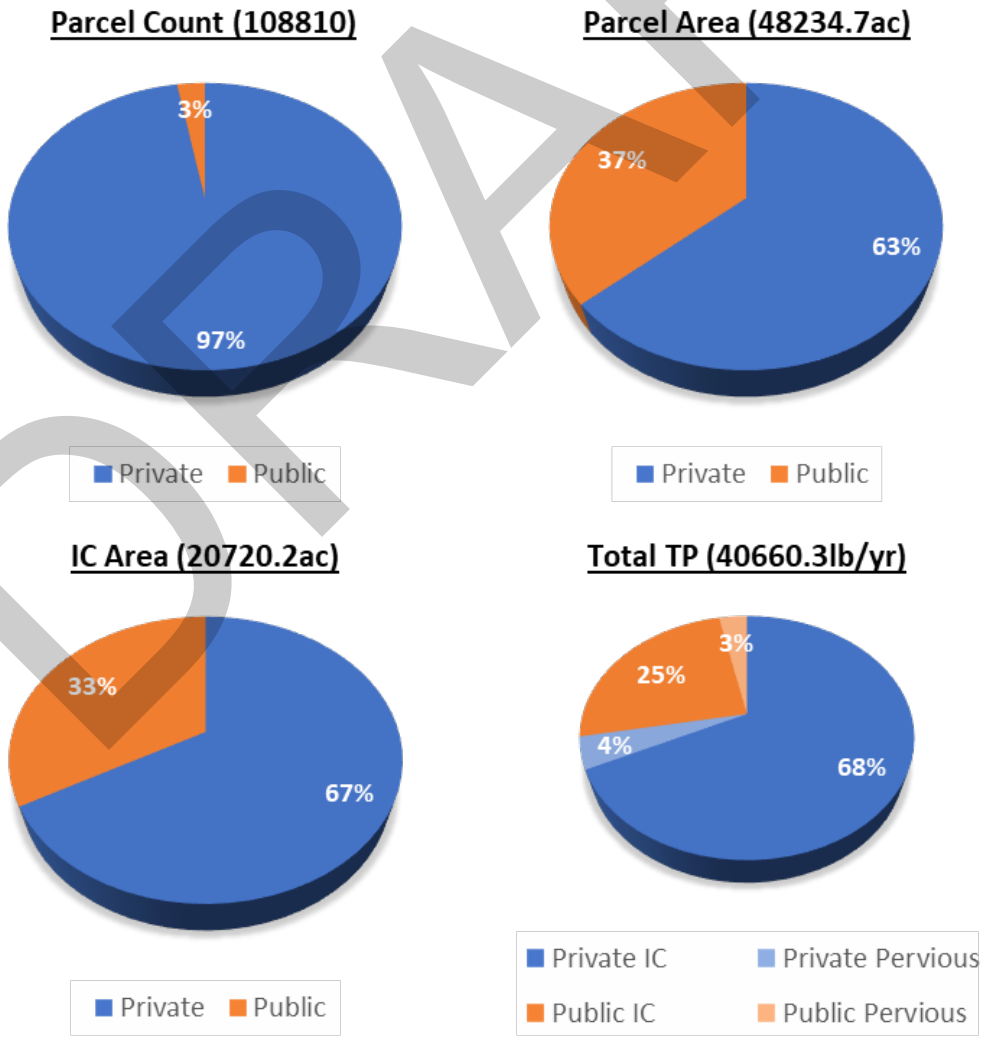

Figure 3-1. Private/Public summaries for all parcels within the Mystic River Watershed.

Table 3-2. Summary of all non-CSA parcel attributes by Use Group and Public/Private designation with TP*

Public/ Private	Use Group	Count	Count (%)	Total Area (ac)	Total Area (%)	IC Area			TP Load (lb/yr)				
						Acre	% IC of Total Area	Avg. (ac)	IC	Pervious	Total	Total (%)	Total Avg.
Private	Agriculture	33	0.03	43.61	0.09	17.28	39.63	0.52	30.80	7.83	38.63	0.10	1.17
	Commercial	4,762	4.38	5,995.85	12.43	3,722.08	62.08	0.78	6,715.53	281.48	6,997.01	17.21	1.47
	Industrial	814	0.75	2,168.77	4.50	1,577.27	72.73	1.94	2,832.82	70.05	2,902.87	7.14	3.57
	MultiFamily Res.	34,696	31.89	5,949.40	12.33	3,593.34	60.40	0.10	8,447.90	278.43	8,726.33	21.46	0.25
	Open Land	5,083	4.67	2,488.56	5.16	397.82	15.99	0.08	687.76	249.53	937.29	2.31	0.18
	Private Inst.	793	0.73	946.53	1.96	385.86	40.77	0.49	688.51	74.14	762.65	1.88	0.96
	Right-of-Way	53	0.05	21.46	0.04	8.91	41.52	0.17	12.69	0.92	13.61	0.03	0.26
	Single Family Res.	59,572	54.75	12,938.05	26.82	4,150.53	32.08	0.07	8,163.34	749.59	8,912.93	21.92	0.15
	Water	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**105,806**	**97.2**	**30,552.23**	**63.3**	**13,853.10**	**45.3**	--	**27,579.35**	**1,711.97**	**29,291.33**	**72.0**	--
Public	Agriculture	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Commercial	4	0.00	6.38	0.01	4.72	73.98	1.18	8.49	0.33	8.82	0.02	2.21
	Industrial	5	0.00	2.23	0.00	1.49	66.86	0.30	2.68	0.09	2.77	0.01	0.55
	MultiFamily Res.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Land	193	0.18	2,872.88	5.96	23.02	0.80	0.12	37.44	511.22	548.67	1.35	2.84
	Public Inst.	2,447	2.25	6,316.76	13.10	1,280.21	20.27	0.52	2,235.95	576.03	2,811.98	6.92	1.15
	Right-of-Way	293	0.27	7,267.37	15.07	5,546.42	76.32	18.93	7,742.33	209.37	7,951.69	19.56	27.14
	Single Family Res.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water	62	0.06	1,216.86	2.52	11.25	0.92	0.18	19.23	25.79	45.02	0.11	0.73
	Subtotal	**3,004**	**2.8**	**17,682.48**	**36.7**	**6,867.11**	**38.8**	--	**10,046.13**	**1,322.83**	**11,368.96**	**28.0**	--
Total		**108,810**	**100**	**48,234.72**	**100**	**20,720.21**	**43.0**	--	**37,625.48**	**3,034.80**	**40,660.29**	**100**	--

* A darker color gradient represents increasing value within a column.

Table 3-3. Summary of all non-CSA parcel attributes by Use Group and Public/Private designation with TN*

Public/ Private	Use Group	Count	Count (%)	Total Area (ac)	Total Area (%)	IC Area			TN Load (lb/yr)				
						Acre	% IC of Total Area	Avg. (ac)	IC	Pervious	Total	Total (%)	Total Avg.
Private	Agriculture	33	0.03	43.61	0.09	17.28	39.63	0.52	259.41	49.55	308.95	0.10	9.36
	Commercial	4,762	4.38	5,995.85	12.43	3,722.08	62.08	0.78	56,141.75	2,755.27	58,897.03	19.59	12.37
	Industrial	814	0.75	2,168.77	4.50	1,577.27	72.73	1.94	23,965.06	590.49	24,555.55	8.17	30.17
	MultiFamily Res.	34,696	31.89	5,949.40	12.33	3,593.34	60.40	0.10	51,172.35	2,092.52	53,264.87	17.72	1.54
	Open Land	5,083	4.67	2,488.56	5.16	397.82	15.99	0.08	5,274.39	1,927.41	7,201.79	2.40	1.42
	Private Inst.	793	0.73	946.53	1.96	385.86	40.77	0.49	5,773.11	568.83	6,341.94	2.11	8.00
	Right-of-Way	53	0.05	21.46	0.04	8.91	41.52	0.17	94.18	6.75	100.92	0.03	1.90
	Single Family Res.	59,572	54.75	12,938.05	26.82	4,150.53	32.08	0.07	59,014.58	5,344.21	64,358.79	21.41	1.08
	Water	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**105,806**	**97.2**	**30,552.2**	**63.3**	**13,853.1**	**45.3**	--	**201,694.8**	**13,335.0**	**215,029.9**	**71.5**	--
Public	Agriculture	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Commercial	4	0.00	6.38	0.01	4.72	73.98	1.18	71.89	3.62	75.51	0.03	18.88
	Industrial	5	0.00	2.23	0.00	1.49	66.86	0.30	22.73	0.69	23.42	0.01	4.68
	MultiFamily Res.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Land	193	0.18	2,872.88	5.96	23.02	0.80	0.12	300.24	2,951.68	3,251.92	1.08	16.85
	Public Inst.	2,447	2.25	6,316.76	13.10	1,280.21	20.27	0.52	18,645.26	4,574.74	23,220.00	7.72	9.49
	Right-of-Way	293	0.27	7,267.37	15.07	5,546.42	76.32	18.93	57,047.97	1,669.87	58,717.84	19.53	200.40
	Single Family Res.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water	62	0.06	1,216.86	2.52	11.25	0.92	0.18	158.76	166.65	325.41	0.11	5.25
	Subtotal	**3,004**	**2.8**	**17,682.5**	**36.7**	**6,867.1**	**38.8**	--	**76,246.8**	**9,367.3**	**85,614.1**	**28.5**	--
Total		**108,810**	**100**	**48,234.7**	**100**	**20,720.2**	**43.0**	--	**277,941.7**	**22,702.3**	**300,644.0**	**100**	--

* A darker color gradient represents increasing value within a column.

3.2 Commercial, Industrial, Institutional, and Multi-Family Parcels

Commercial, Industrial, Institutional, and Multi-Family parcels make up 37.7% of all parcels and 31.2% of total parcel area in the Mystic River Watershed (Table 3-4). The greatest number of CIIM parcels are Multifamily Residential. On average, however, these parcels have the lowest IC area and total TP and TN loads. Industrial parcels have the highest average IC and load values, followed by Commercial and Institutional. CIIM parcels make up 45% of total IC area and 50% and 49% of total TP and TN load from all IC, respectively. These parcels could be candidates for additional stormwater controls while excluding the designation of the nearly 60,000 private single family residential parcels.

If all private CIIM parcels installed stormwater controls to reduce TP loads from IC by 62%, the resulting reduction would be 11,584 lb/yr of TP. This equates to 46% of the required TP load reductions. If all public parcels also reduced TP IC load by 62%, the cumulative reduction from private CIIM and all public parcels would be 71% of the required TP load reduction. If the pervious load from private CIIM and all public parcels was also treated, they would contribute an additional 3% and 5% of the required reduction, respectively. These results indicate that it may be necessary to designate some of the Single Family parcels and/or require a higher level of treatment from CIIM and public parcels.

Table 3-4. Summary of private commercial, industrial, institutional, and multifamily parcel attributes in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area			TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of Total Area	Parcel Avg. (ac)	IC	Pervious	Parcel Total Avg.	IC	Pervious	Parcel Total Avg.
Commercial	4,762	5,995.85	3,722.08	62.08	0.78	6,715.53	281.48	1.47	56,141.75	2,755.27	12.37
Industrial	814	2,168.77	1,577.27	72.73	1.94	2,832.82	70.05	3.57	23,965.06	590.49	30.17
MultiFamily Residential	34,696	5,949.40	3,593.34	60.40	0.10	8,447.90	278.43	0.25	51,172.35	2,092.52	1.54
Private Institutional	793	946.53	385.86	40.77	0.49	688.51	74.14	0.96	5,773.11	568.83	8.00
Subtotal	**41,065**	**15,060.56**	**9,278.55**	**61.61**	--	**18,684.76**	**704.10**	--	**137,052.27**	**6,007.11**	--
Watershed Total (%)	**37.7**	**31.2**	**44.8**	--	--	**49.7**	**23.2**	--	**51.4**	**27.7**	--

3.2.1 *Analysis of CIIM Parcels by IC Area*

Even though designating all CIIM parcels may not achieve all of the required reduction to meet watershed water quality goals, it may be possible to designate fewer CIIM properties while still getting the majority of the nutrient reduction. The relationship between the number of parcels, the amount of IC area within a parcel, and the total load was evaluated for private CIIM parcels by varying thresholds of IC area as shown Figure 3-2 and Figure 3-3 (Appendix A presents similar plots by individual parcel use group). These plots show that while the IC threshold is relatively large (e.g., ≥ 2 ac), the number of parcels designated is relatively small, but accounts for approximately half of the private CIIM total load. As the IC threshold decreases below 1 ac, the number of parcels designated sharply increases, but with lower increases in the total load. An IC threshold of ≥ 0.1 ac exhibits a large increase in the number of parcels designated because more multifamily residential parcels are included (these parcels have an average IC area of 0.1 ac, as shown in Table 3-4).

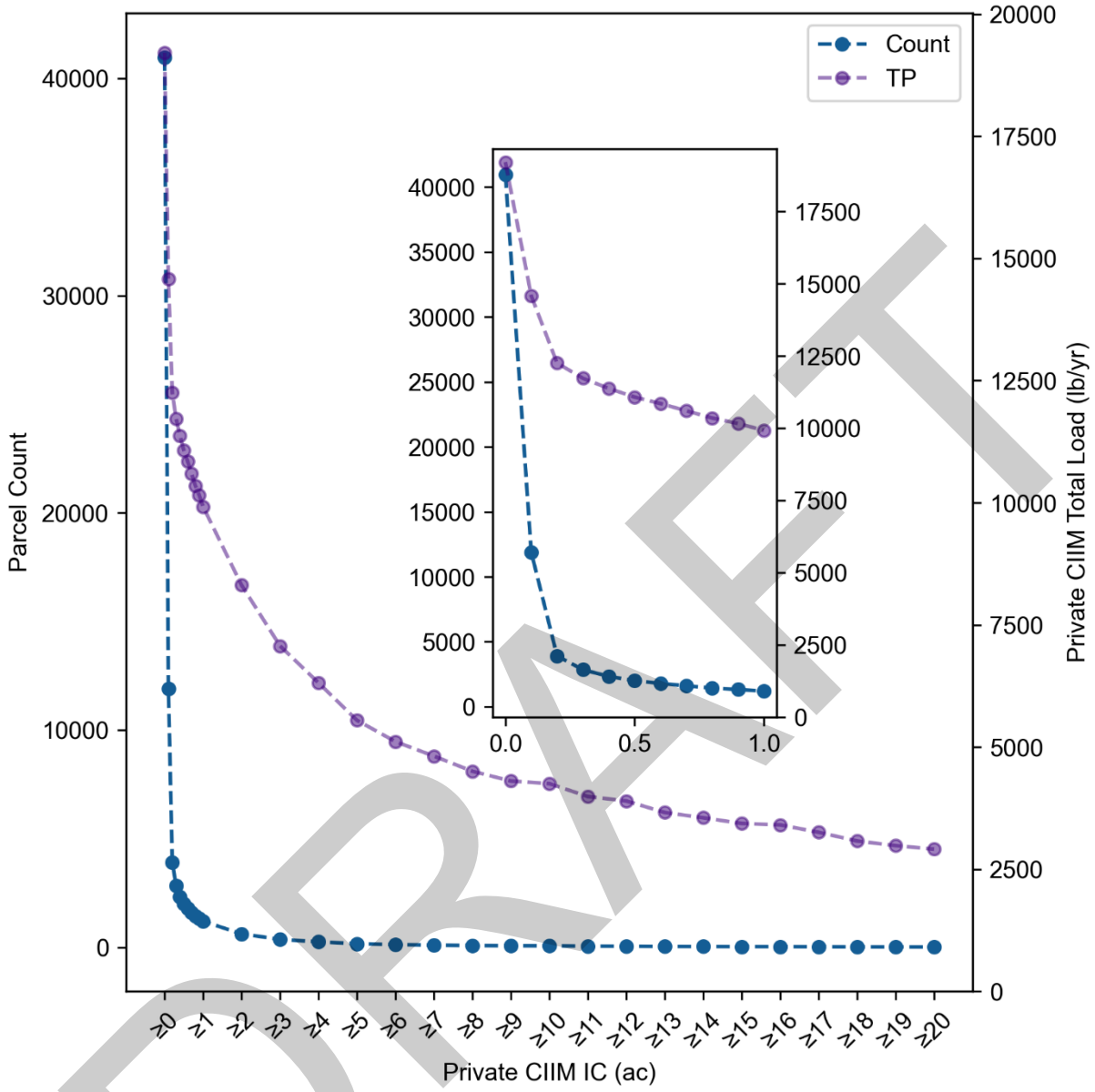

Figure 3-2. Private CIIM parcel count and total TP load by parcel IC area in the Mystic River Watershed. Note that a threshold of ≥ 0ac IC includes all private CIIM parcels.

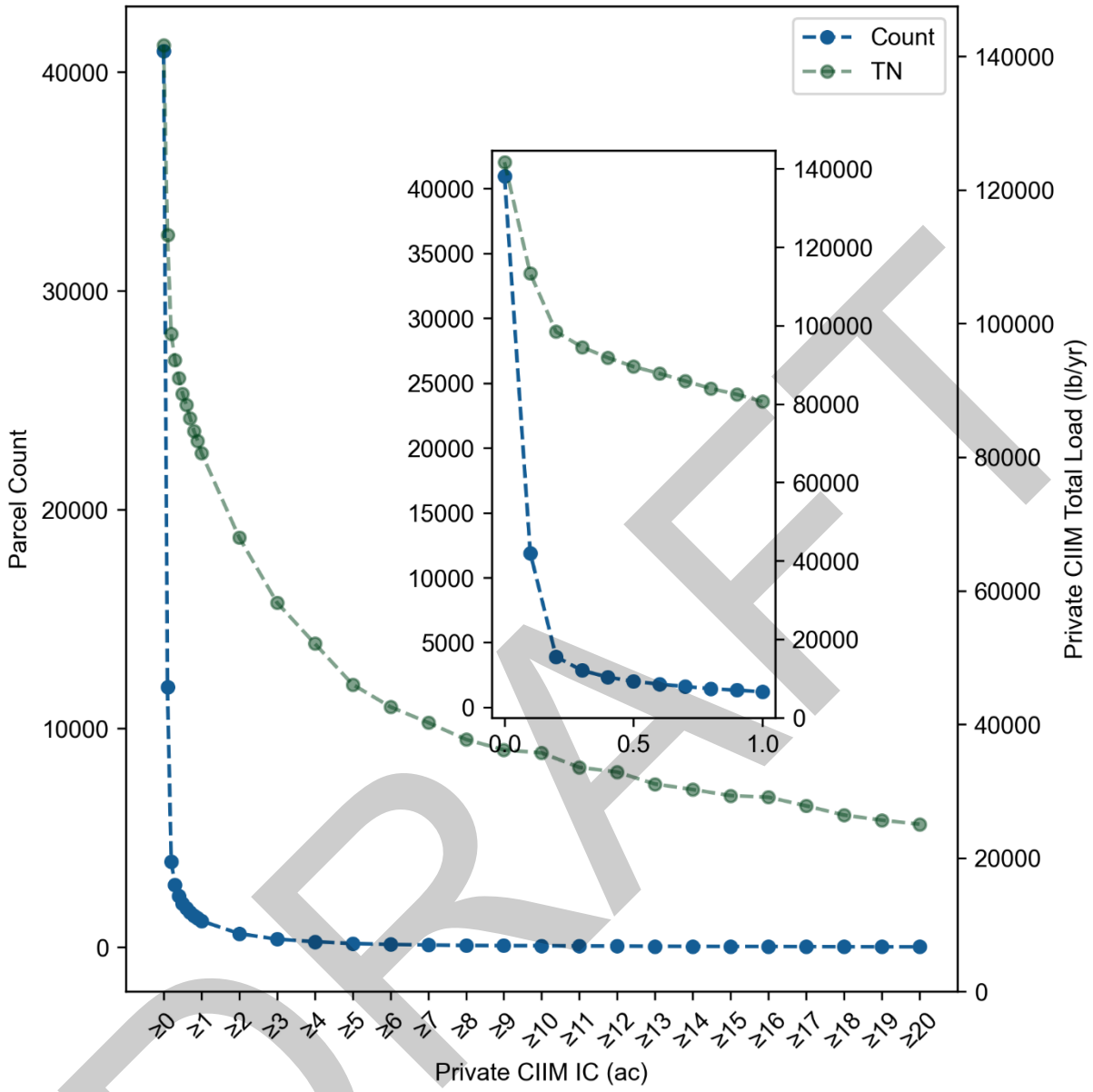

Figure 3-3. Private CIIM parcel count and total TN load by parcel IC area in the Mystic River Watershed. Note that a threshold of ≥ 0ac IC includes all private CIIM parcels.

The parcel count, load, IC relationship was further analyzed for IC thresholds of 0.25 ac, 0.5 ac, 0.75 ac, 1 ac, 2 ac, and 5 ac as shown in Table 3-5 to Table 3-10. These tables show that, for a small percentage of the total number of parcels, a larger proportion of the IC nutrient load can be controlled. For example, private CIIM parcels with ≥ 0.25 ac of IC represent 3% (3,316) of the total number of parcels but account for 31% of the IC TP load and 34% of the IC TN load from all parcels. Larger IC thresholds require designating fewer parcels, but with the potential to treat less of the nutrient load.

Table 3-5. Summary of private commercial, industrial, institutional, and multifamily parcels with IC ≥ 0.25 ac in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area		TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of total Area	IC	Pervious	Total	IC	Pervious	Total
Commercial	1,594	5,564.00	3,389.34	60.92	6,091.80	268.32	6,360.11	51,180.64	2,651.54	53,832.18
Industrial	672	2,127.32	1,559.51	73.31	2,800.93	66.59	2,867.52	23,697.18	564.55	24,261.72
MultiFamily Residential	760	1,699.77	911.48	53.62	2,102.38	114.05	2,216.43	13,020.42	874.77	13,895.19
Private Institutional	290	783.74	341.17	43.53	608.04	61.38	669.42	5,100.45	469.64	5,570.08
Subtotal	**3,316**	**10,174.84**	**6,201.50**	**60.95**	**11,603.15**	**510.34**	**12,113.48**	**92,998.69**	**4,560.49**	**97,559.18**
Watershed Total (%)	**3.0**	**21.1**	**29.9**	--	**30.8**	**16.8**	**29.8**	**33.5**	**20.1**	**32.5**

Table 3-6. Summary of private commercial, industrial, institutional, and multifamily parcels with IC ≥ 0.5 ac in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area		TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of total Area	IC	Pervious	Total	IC	Pervious	Total
Commercial	893	5,266.06	3,146.63	59.75	5,655.32	262.71	5,918.03	47,539.89	2,606.27	50,146.16
Industrial	559	2,073.84	1,517.90	73.19	2,726.12	65.44	2,791.56	23,064.02	555.30	23,619.32
MultiFamily Residential	425	1,521.15	794.61	52.24	1,832.17	107.81	1,939.98	11,358.80	826.63	12,185.43
Private Institutional	162	689.73	295.95	42.91	526.62	55.36	581.97	4,420.23	422.17	4,842.40
Subtotal	**2,039**	**9,550.78**	**5,755.10**	**60.26**	**10,740.23**	**491.31**	**11,231.54**	**86,382.93**	**4,410.38**	**90,793.31**
Watershed Total (%)	**1.9**	**19.8**	**27.8**	--	**28.5**	**16.2**	**27.6**	**31.1**	**19.4**	**30.2**

Table 3-7. Summary of private commercial, industrial, institutional, and multifamily parcels with IC ≥ 0.75 ac in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area		TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of total Area	IC	Pervious	Total	IC	Pervious	Total
Commercial	660	5,066.46	3,002.39	59.26	5,395.24	256.10	5,651.34	45,372.42	2,551.66	47,924.09
Industrial	472	1,984.89	1,463.39	73.73	2,628.68	59.91	2,688.60	22,241.55	504.87	22,746.42
MultiFamily Residential	298	1,407.97	715.34	50.81	1,648.74	103.73	1,752.47	10,228.42	794.89	11,023.31
Private Institutional	110	636.63	263.47	41.39	467.95	52.42	520.37	3,928.81	399.75	4,328.55
Subtotal	**1,540**	**9,095.94**	**5,444.59**	**59.86**	**10,140.61**	**472.15**	**10,612.77**	**81,771.20**	**4,251.17**	**86,022.37**
Watershed Total (%)	**1.4**	**18.9**	**26.3**	--	**27.0**	**15.6**	**26.1**	**29.4**	**18.7**	**28.6**

Table 3-8. Summary of private commercial, industrial, institutional, and multifamily parcels with IC ≥ 1 ac in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area		TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of total Area	IC	Pervious	Total	IC	Pervious	Total
Commercial	511	4,880.41	2,872.52	58.86	5,161.79	248.29	5,410.08	43,436.06	2,486.42	45,922.48
Industrial	394	1,895.59	1,395.21	73.60	2,506.18	57.12	2,563.30	21,204.89	479.59	21,684.48
MultiFamily Residential	227	1,307.45	653.15	49.96	1,503.41	98.97	1,602.38	9,343.60	760.45	10,104.06
Private Institutional	88	606.94	244.81	40.34	434.38	51.31	485.69	3,644.62	390.12	4,034.74
Subtotal	**1,220**	**8,690.39**	**5,165.70**	**59.44**	**9,605.77**	**455.69**	**10,061.45**	**77,629.17**	**4,116.58**	**81,745.75**
Watershed Total (%)	**1.1**	**18.0**	**24.9**	--	**25.5**	**15.0**	**24.7**	**27.9**	**18.1**	**27.2**

Table 3-9. Summary of private commercial, industrial, institutional, and multifamily parcels with IC ≥ 2 ac in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area		TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of total Area	IC	Pervious	Total	IC	Pervious	Total
Commercial	262	4,383.27	2,529.14	57.70	4,546.92	232.40	4,779.32	38,298.65	2,356.38	40,655.03
Industrial	212	1,525.94	1,128.07	73.93	2,026.85	44.65	2,071.50	17,151.32	382.34	17,533.66
MultiFamily Residential	118	1,003.22	499.73	49.81	1,150.90	74.38	1,225.29	7,162.64	588.86	7,751.50
Private Institutional	36	491.33	173.05	35.22	305.91	44.71	350.62	2,567.73	332.96	2,900.69
Subtotal	**628**	**7,403.76**	**4,329.99**	**58.48**	**8,030.58**	**396.14**	**8,426.72**	**65,180.34**	**3,660.53**	**68,840.87**
Watershed Total (%)	**0.6**	**15.3**	**20.9**	--	**21.3**	**13.1**	**20.7**	**23.5**	**16.1**	**22.9**

Table 3-10. Summary of private commercial, industrial, institutional, and multifamily parcels with IC ≥ 5 ac in the Mystic River Watershed

Use Group	Count	Total Area (ac)	IC Area		TP Load (lb/yr)			TN Load (lb/yr)		
			Acre	% IC of total Area	IC	Pervious	Total	IC	Pervious	Total
Commercial	83	3,515.74	1,968.46	55.99	3,535.58	184.35	3,719.93	29,841.07	1,944.87	31,785.94
Industrial	49	810.48	627.09	77.37	1,126.94	22.74	1,149.67	9,537.86	209.80	9,747.66
MultiFamily Residential	27	511.22	223.65	43.75	528.40	44.50	572.90	3,190.35	338.52	3,528.87
Private Institutional	9	248.08	97.27	39.21	169.65	25.95	195.60	1,414.12	192.83	1,606.95
Subtotal	**168**	**5,085.51**	**2,916.47**	**57.35**	**5,360.56**	**277.54**	**5,638.10**	**43,983.40**	**2,686.02**	**46,669.42**
Watershed Total (%)	**0.2**	**10.5**	**14.1**	--	**14.2**	**9.1**	**13.9**	**15.8**	**11.8**	**15.5**

Figure 3-4 further illustrates the tradeoff between pollutant reduction and the number of private CIIM parcels with IC area ranging from ≥20 ac to ≥0 ac (i.e., all private CIIM parcels) that would have to install SCMs. This figure assumes that runoff from IC within a parcel would be treated by SCMs sized to achieve the required load reduction target of 62%. The "knee" of the curve, where the slope begins to flatten, indicates the IC threshold where the fewest number of parcels can provide the greatest benefit in terms of TP reduction. For the Mystic River Watershed, this appears to lie between parcels with ≥0.2 ac and ≥0.75 ac of IC.

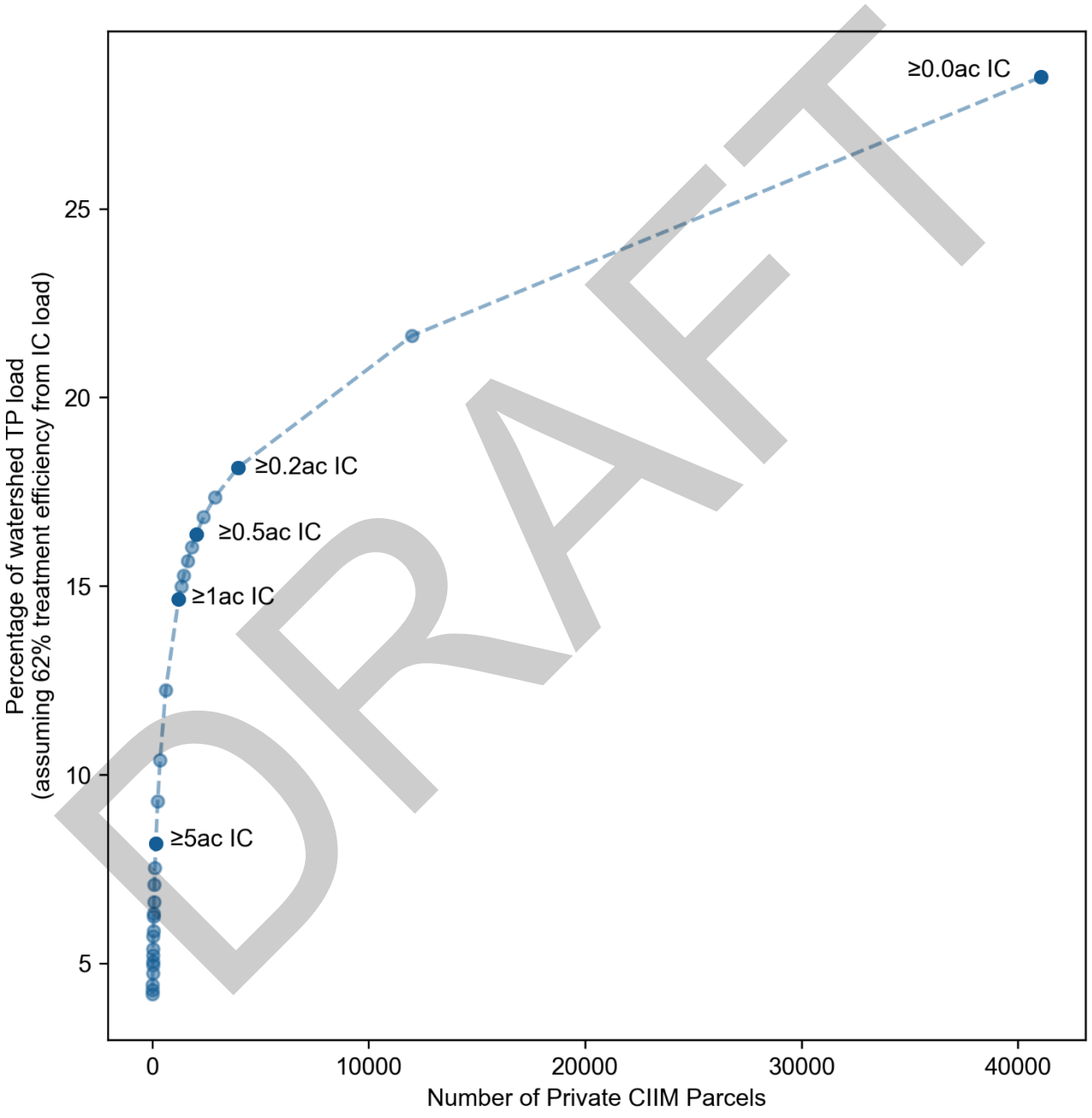

Figure 3-4. Percentage of watershed TP load that can be captured from IC runoff in the Mystic River Watershed, assuming a 62% treatment efficiency, and the corresponding number of private CIIM parcels based on IC threshold. Labels for IC thresholds correspond to the dark blue dots.

4 CONCLUSIONS

This report presented a methodology for summarizing and evaluating stormwater pollutant load from parcels within the Mystic River Watershed that may be used by EPA Region 1 to support decisions regarding the control of stormwater runoff from certain private properties to meet watershed Alternative TMDL goals and WQS. Findings from this analysis include:

1. Private properties contribute nearly three quarters (72%) of the watershed's total TP load.
2. The majority of TP from private properties is generated from impervious cover (94% of load from private properties and 68% of the watershed total load).
3. Private commercial, industrial, institutional, and multi-family residential (CIIM) properties make up 37.7% of all parcels, but have relatively high percentages of IC and therefore contribute a large proportion of the watershed TP load (48%)
4. Selecting private CIIM parcels based on their IC area (which is proportional to the amount of TP generated) can minimize the number of parcels installing stormwater controls, while providing the greatest TP reduction benefit (Table 4-1).

The findings in this report indicate that the Alternative TMDL goals for TP and other WQS in the Mystic River cannot be met without additional reduction of stormwater runoff and pollutant loads from private parcels. Because the Mystic River Watershed is highly developed, most stormwater runoff from private parcels is likely discharged to a local community's MS4, ultimately making that municipality responsible for the phosphorus load under their MS4 Permit. While municipalities will likely be responsible for a large portion of the needed phosphorus reductions, placing the entire burden on municipalities will likely not result in sufficient reduction to reach the Alternative TMDL goals and WQS. Designating stormwater discharges from certain classes of private properties for NPDES permits based on the amount of IC area will help reduce the burden on the community that holds an MS4 permit by targeting properties generating the largest amount of phosphorus in stormwater on a per-property scale and makes meeting watershed-wide goals feasible. In any scenario, municipalities will still need to engage the private property owners with smaller property size or IC size to eventually meet the Alternative TMDL goals and WQS. However, requiring action on private properties with larger amounts of IC now through NPDES permitting provides greater flexibility to the communities in deciding which private properties to target to meet their own MS4 permit obligations.

Table 4-1. Summary of private CIIM parcels installing SCMs based on parcel IC area and the reduction achieved in watershed total TP load

IC Threshold (ac)	Parcel Count	Total TP Load (lb/yr)	IC TP Load (lb/yr)	Total TP Treated (%)*
≥0 (All)	41,065	19,388.86	18,684.76	28%
≥0.25	3,316	12,113.48	11,603.15	18%
≥0.5	2,039	11,231.54	10,740.23	16%
≥0.75	1,540	10,612.77	10,140.61	15%
≥1	1,220	10,061.45	9,605.77	15%
≥2	628	8,426.72	8,030.58	12%
≥5	168	5,638.10	5,360.56	8%

* Percentage calculated as IC load times a 62% treatment efficiency divided by the watershed total TP load of 40,660lb/yr.

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USEPA, 2020. Mystic River Watershed Alternative TMDL Development for Phosphorus Management-Final Report. Boston, MA.

APPENDIX A

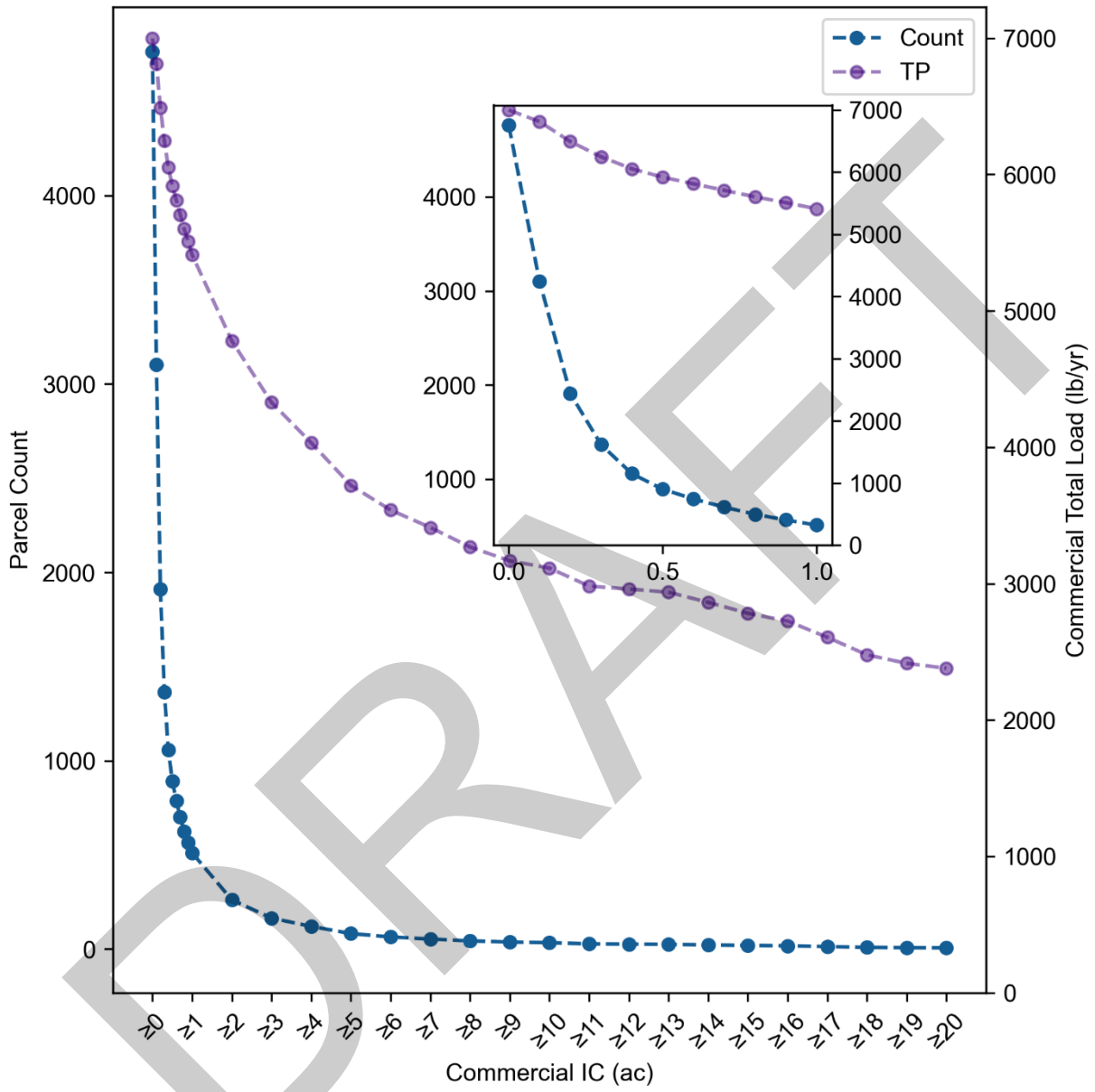

Figure B-1. Private commercial parcel count and total TP load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private commercial parcels.

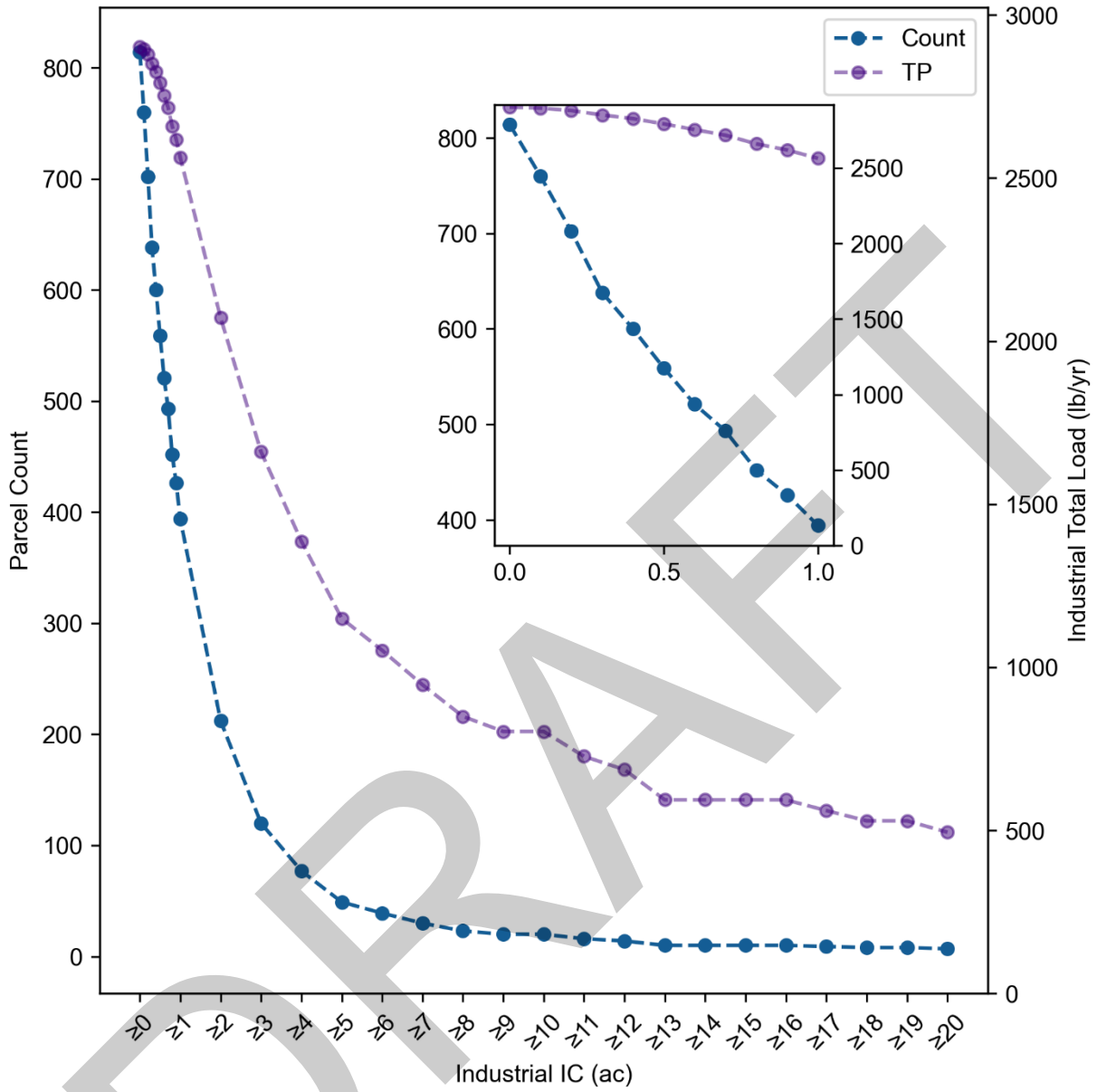

Figure B-2. Private industrial parcel count and total TP load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private industrial parcels.

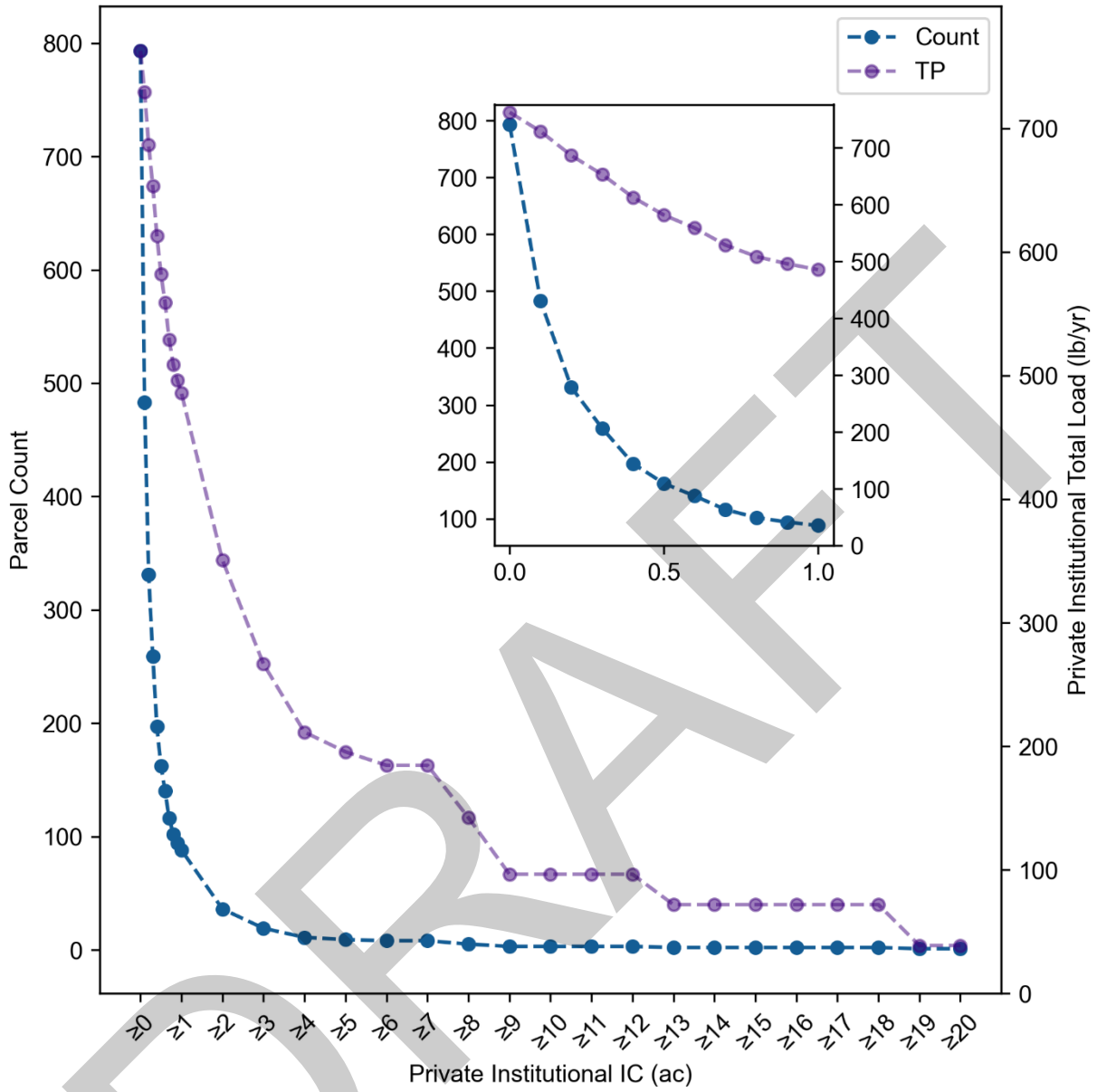

Figure B-3. Private institutional parcel count and total TP load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private institutional parcels.

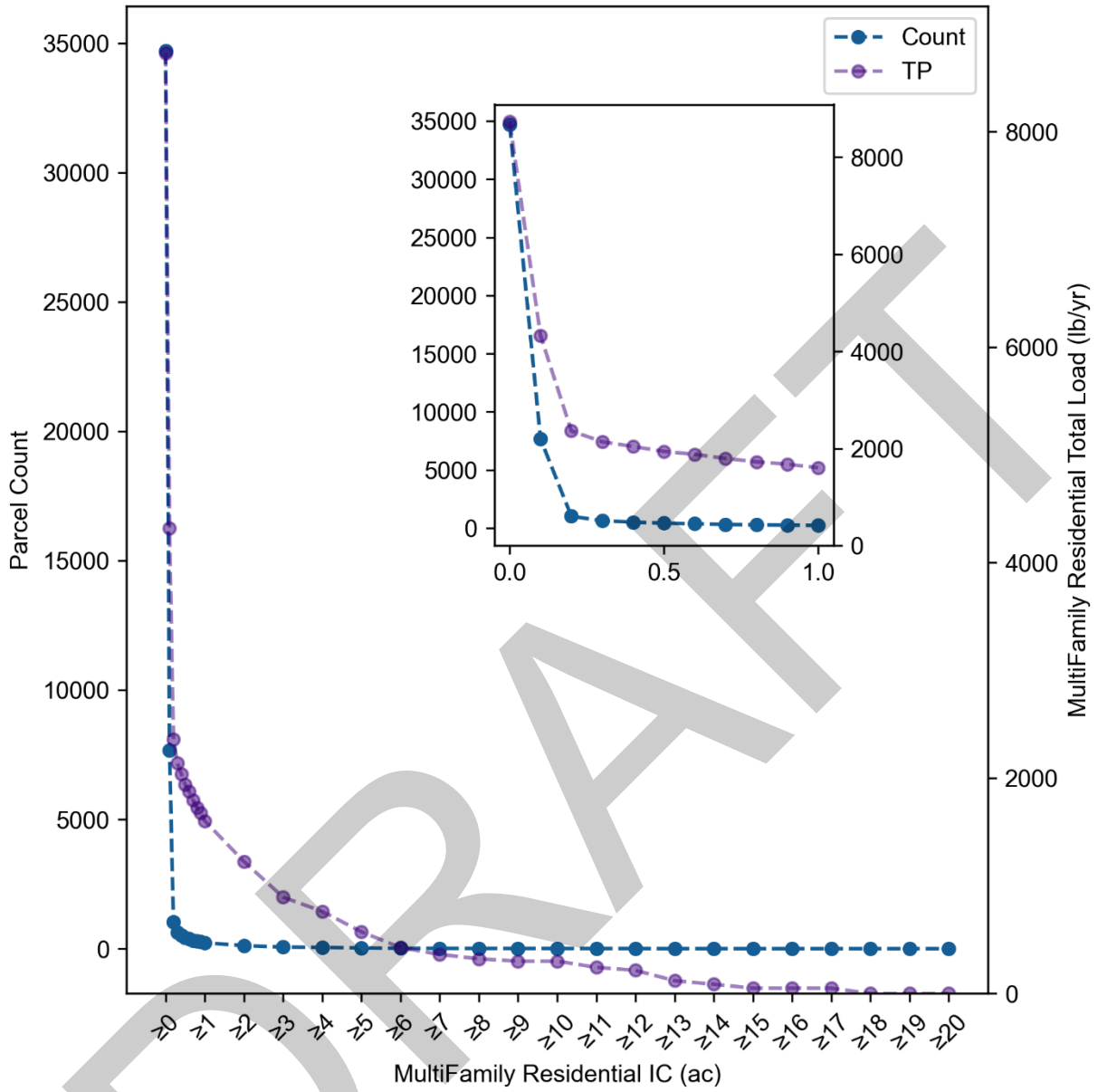

Figure B-4. Private multifamily residential parcel count and total TP load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private multifamily residential parcels.

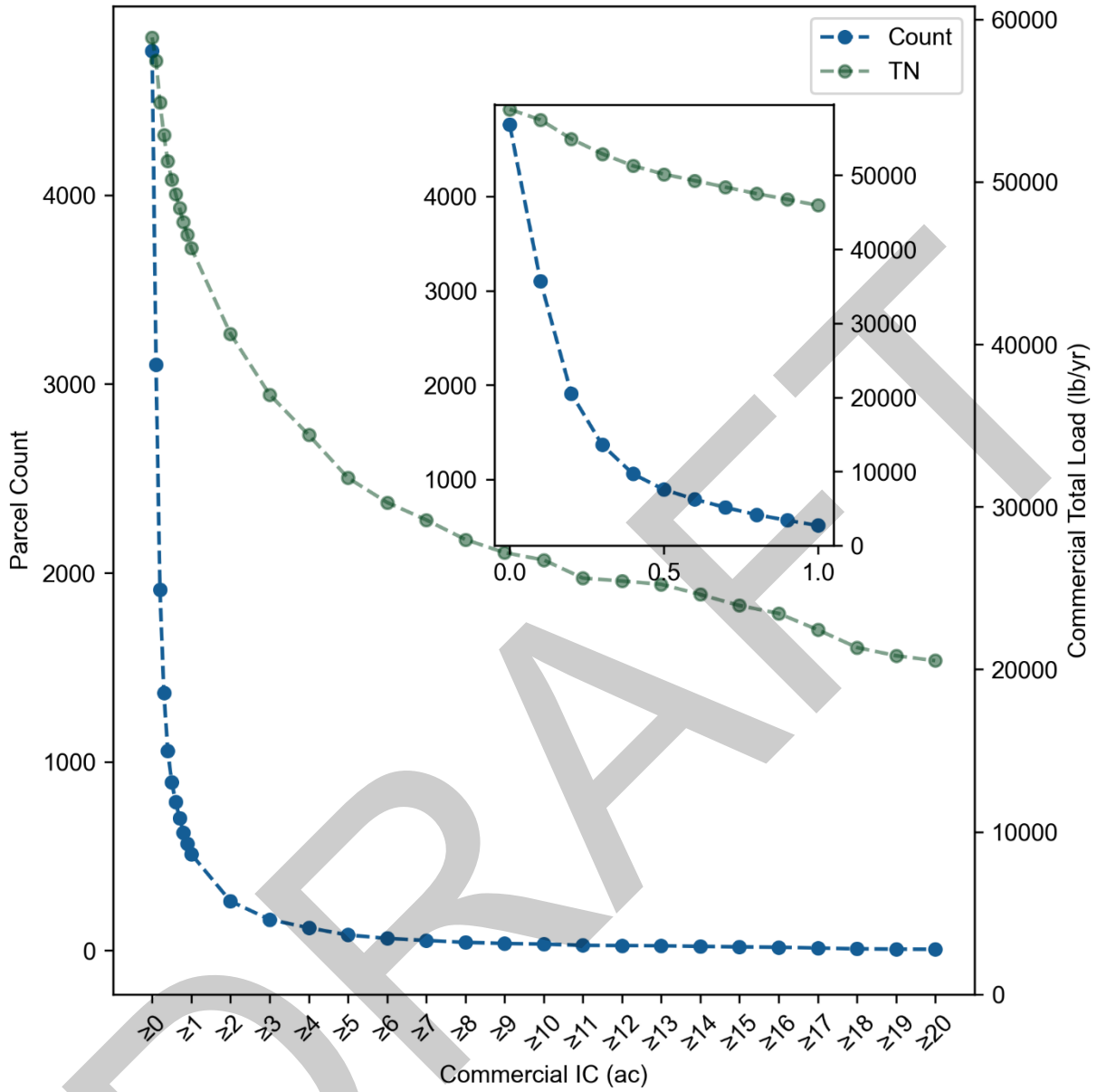

Figure B-5. Private commercial parcel count and total TN load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private commercial parcels.

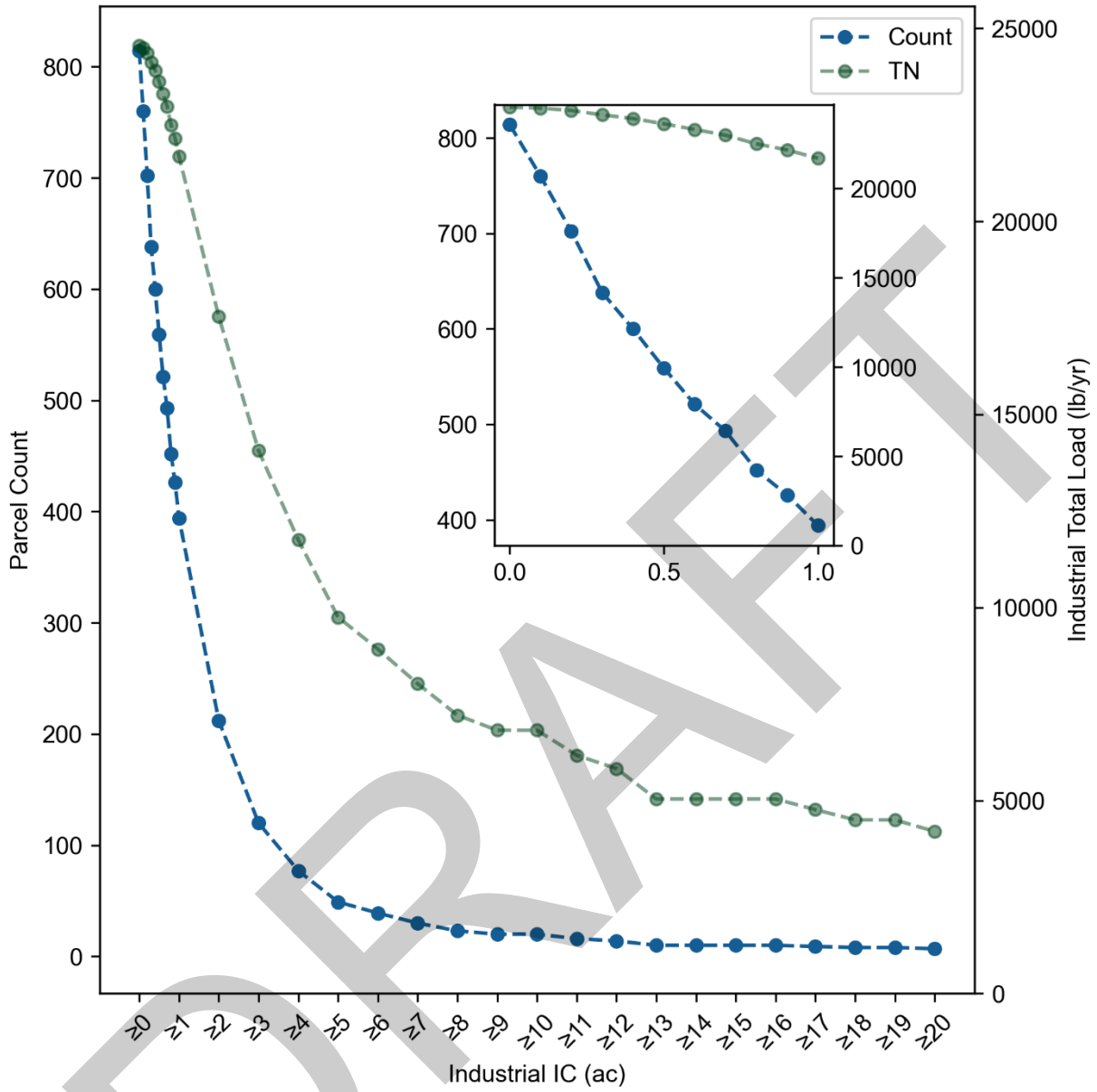

Figure B-6. Private industrial parcel count and total TN load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private industrial parcels.

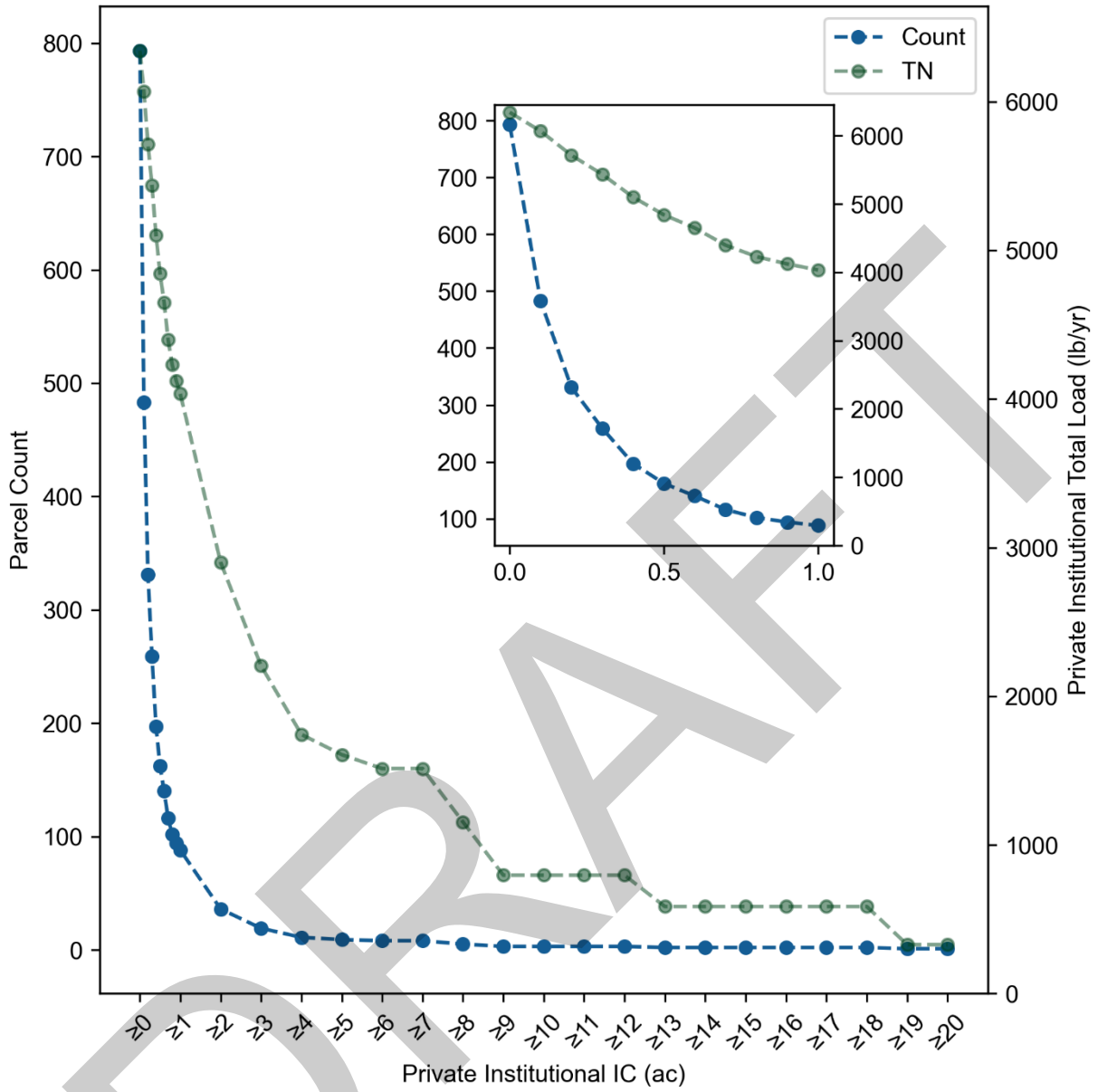

Figure B-7. Private institutional parcel count and total TN load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private institutional parcels.

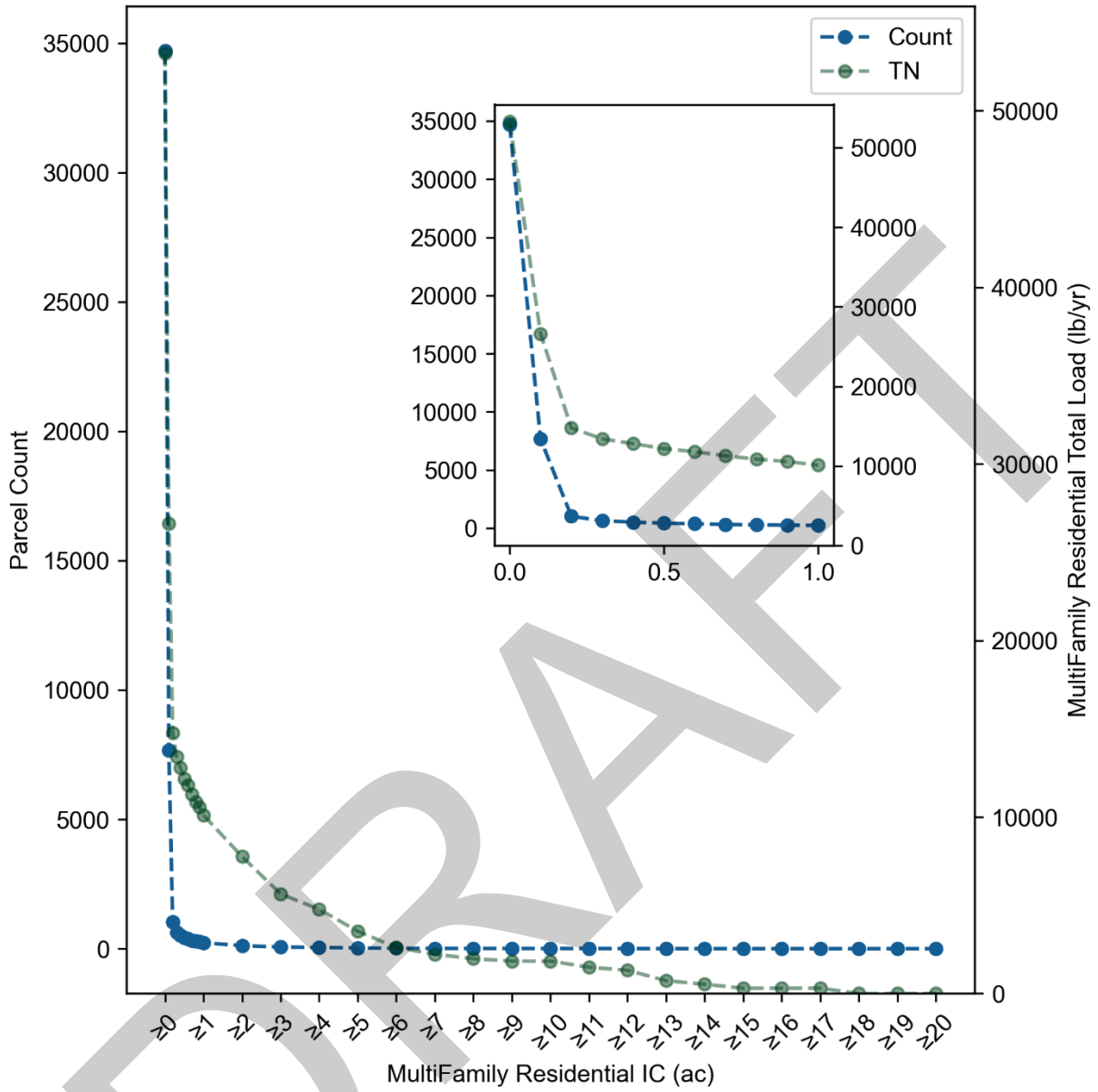

Figure B-8. Private multifamily residential parcel count and total TN load by parcel IC area. Note that a threshold of ≥ 0ac IC includes all private multifamily residential parcels.