

# Montecito Water District

California Department of Water Resources  
Landscape Area Estimates Project

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Water District ID: MONTECITOWAT228  
Imagery Year: 2018  
Geodatabase Date: 2020-09-26



## Introduction

In August of 2018, the California Department of Water Resources (CADWR) contracted Quantum Spatial, Inc., an NV5 company, with support from Eagle Aerial Solutions, to provide landscape area estimates for single-family and multi-family residential parcels for all urban retail water suppliers in California. The results of this endeavor will aid in the designation of urban retail water use efficiency standards and objectives under Assembly Bill (AB) 1668 and Senate Bill (SB) 606. This report, specific to Montecito Water District, briefly outlines some key summary statistics about the water district area of interest (AOI), the parcels included in the analysis, as well as key results of the analysis.

Note: Results for water districts completed during the Phase 2B pilot stage were generated using one-foot resolution, 4-band imagery collected in 2016. Results for water districts completed during Phase 3 were generated using one-foot resolution, 4-band imagery collected in 2018. The imagery for Montecito Water District was collected in 2018.

Additionally, due to the presence of overlap in the original parcel layers (the ‘A’ layer), a topologically corrected version of the parcel layer (the ‘B’ layer) is created in order to summarize landscape area estimates at the district level without duplicating areas. The parcels selected for training and validating the district model were selected from the topologically corrected parcel layer and then related back to the original layer using the crosswalk table provided in the file geodatabase deliverable.

For reference, the Montecito Water District is shown in Figure 1, along with its location in the state of California.

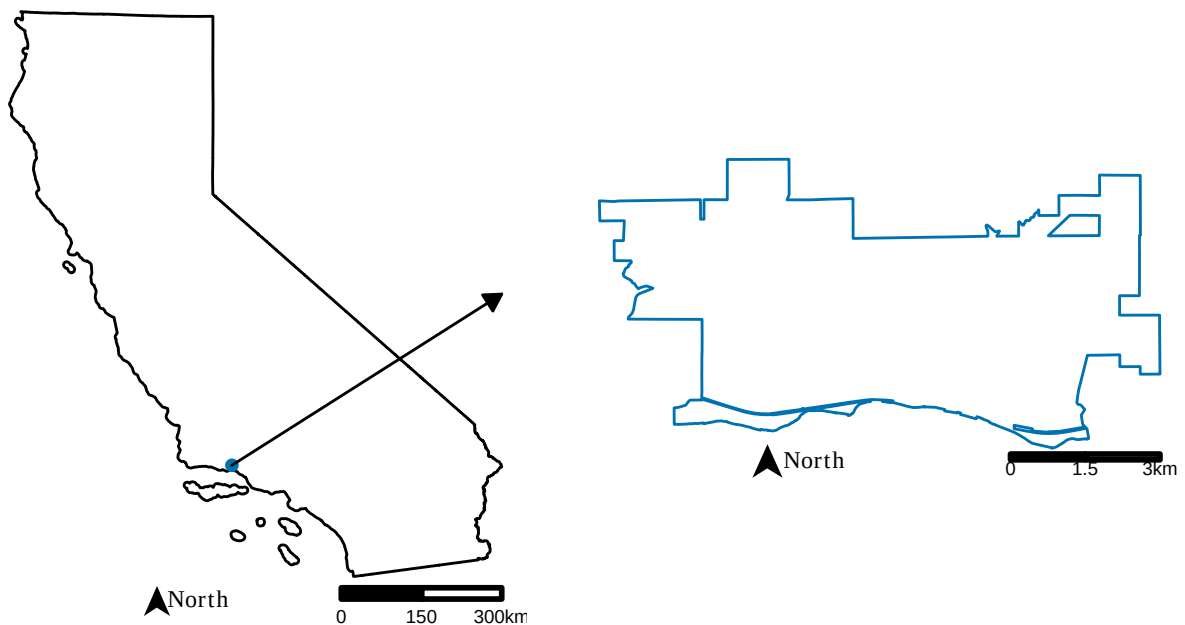


Figure 1: Location of the water district in California (left) and area of interest of the water district (right)

## Landscape Area Estimates Process Overview

In the Landscape Area Estimates Project, remote sensing and advanced machine learning techniques are leveraged in order to measure the landscaped areas of Montecito Water District. Here, we briefly describe a high-level overview of the modeling procedure.

For each water district, four band, one-foot resolution imagery is utilized to model land cover and land use across the parcel areas. In the initial stages, water district imagery is segmented into objects by grouping zones of like-valued pixels called super-pixels. These super-pixels become the foundational classification unit for this project. After the imagery has been segmented, a unique model is trained for each water district using parcel similarity relationships and reference parcel data that are manually digitized by human photo interpreters. A graphic showing the primary phases of imagery classification is shown in Figure 2.

Additionally, manually derived land masks that identify large and challenging to model areas are created by Quantum Spatial’s digitizing team and reviewed by the California Department of Water Resources. Three land masks are used to classify undeveloped lands, agricultural lands, and horse corrals (an example of the derived land masks is shown in Figure 4). These masks are used to ensure that correct land use classifications are captured across the entire water district.

Throughout the modeling process, rigorous internal checks are used to ensure satisfactory model performance. Once modeling has been completed, an independent validation is performed using manually digitized parcel data that was withheld from the modeling process. An example of the final classification for Montecito Water District is shown in Figure 5.

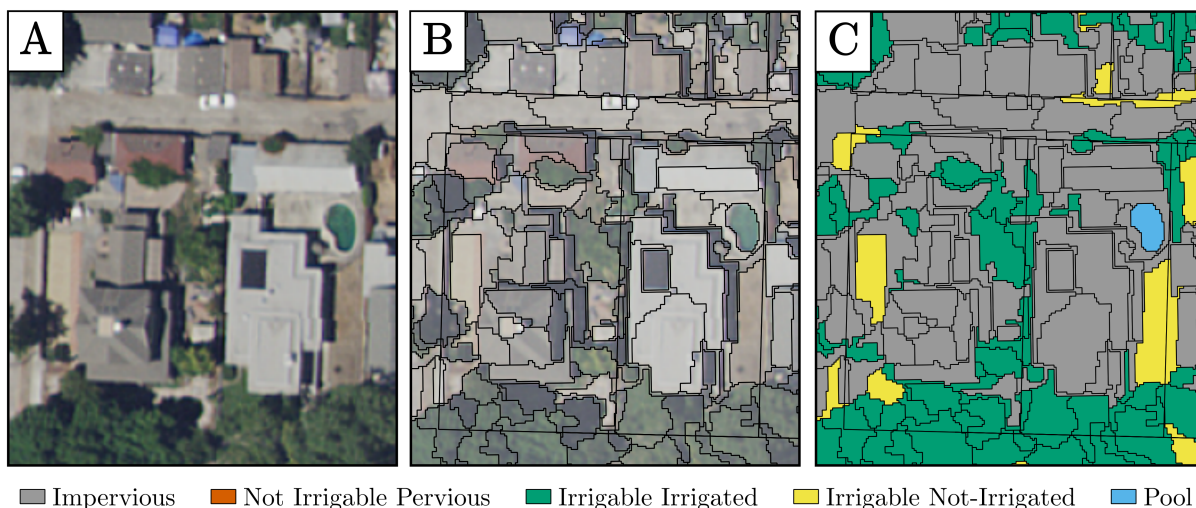


Figure 2: High level modeling process in the Landscape Area Estimates Project. (A) Water district imagery. (B) Imagery segmentation into super-pixel objects. (C) Classified super-pixel objects.

## District Summary Statistics

The area of interest for Montecito Water District is 9,910.61 acres in area. The district as a whole contains 5,422 parcels; 4,523 of these parcels are single-family or multi-family residential. Parcel summary statistics for each land use code (LUC) are provided in Table 1.

Table 1: Per-LUC summary statistics for district and parcel areas. For LUC definitions, please see Table A19 of the appendix.

| LUC  | Count | Percent of area<br>in analysis | Total area<br>(acres) | Mean parcel size<br>(acres) | Median parcel size<br>(acres) |
|------|-------|--------------------------------|-----------------------|-----------------------------|-------------------------------|
| 0010 | 2     | 0.1                            | 3.20                  | 1.60                        | 1.60                          |
| 0020 | 8     | 0.1                            | 8.60                  | 1.07                        | 0.37                          |
| 0021 | 2     | 0.0                            | 1.87                  | 0.94                        | 0.94                          |
| 1001 | 3,826 | 84.1                           | 5,245.96              | 1.37                        | 0.90                          |
| 1004 | 411   | 0.2                            | 15.23                 | 0.04                        | 0.03                          |
| 1006 | 38    | 0.0                            | 0.81                  | 0.02                        | 0.02                          |
| 1008 | 57    | 13.5                           | 840.89                | 14.75                       | 9.00                          |
| 1101 | 152   | 1.1                            | 66.53                 | 0.44                        | 0.23                          |
| 1104 | 13    | 0.1                            | 6.42                  | 0.49                        | 0.29                          |
| 1109 | 1     | 0.0                            | 2.80                  | 2.80                        | 2.80                          |
| 3008 | 11    | 0.0                            | 0.71                  | 0.06                        | 0.02                          |
| 9106 | 2     | 0.8                            | 47.53                 | 23.76                       | 23.76                         |

In addition, histograms for the distributions of single-family and multi-family residential parcel sizes and their summaries are provided in Figure 3 and Table 2, respectively. Single-family residential parcels are defined as those with land use codes between 1000 and 1019. Multi-family residential parcels are defined as those with land use codes between 1100 and 1114, or equal to 1901, 1902, or 1999.

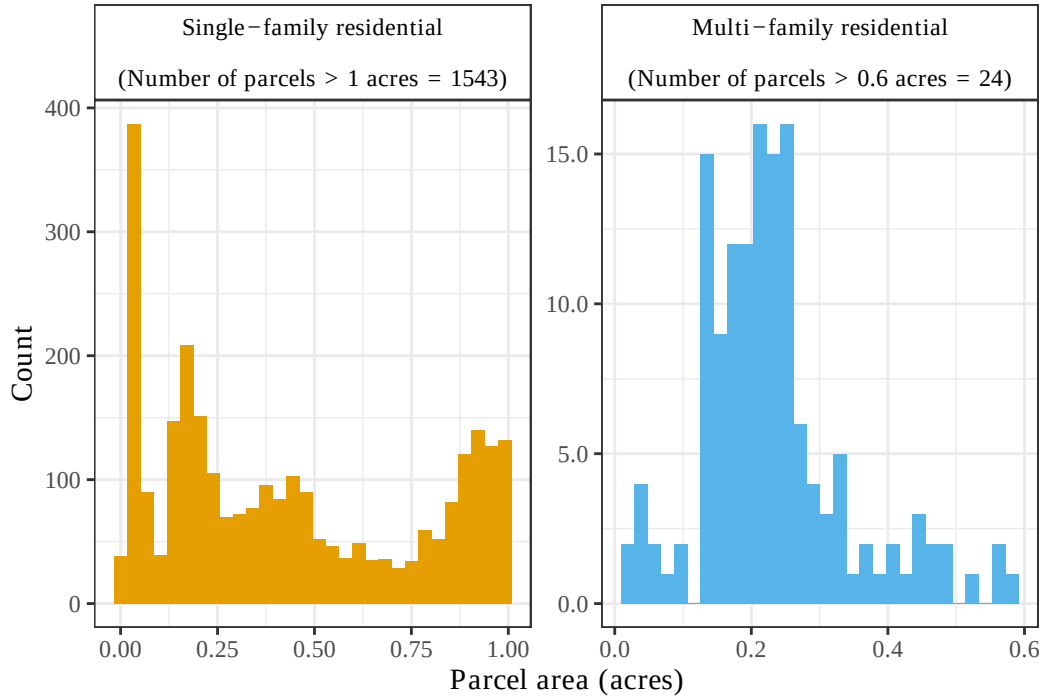


Figure 3: Distribution of parcel sizes for single- and multi-family residential parcels.

Table 2: Distributional summaries for the sizes (in acres) of residential parcels.

| Parcel type               | Min  | Q1   | Median | Q3   | Max   |
|---------------------------|------|------|--------|------|-------|
| Single-family residential | 0.01 | 0.23 | 0.82   | 1.17 | 79.70 |
| Multi-family residential  | 0.02 | 0.18 | 0.23   | 0.35 | 11.85 |

Montecito Water District contains 46 disputed single-family or multi-family parcels. Disputed parcels are identified as parcels that fall within the boundary of two or more water districts. Landscape area estimates for disputed parcels are not included in the parcel or district level summaries of the Landscape Area Estimates product. Table 3 identifies the disputed parcels by disputing water district, count, and total parcel area.

Table 3: Summary of disputed parcels by disputing water district, area, and count.

| Disputing Water District | Contract Number | Parcel Count | Area (sq. ft.) |
|--------------------------|-----------------|--------------|----------------|
| Santa Barbara City of    | 327             | 45           | 2,380,934      |
| Carpinteria City Of      | 66              | 1            | 32,632.02      |

## Derived Land Masks

The derived land masks created as a part of this analysis are used to manually capture regions of undeveloped land, agriculture, and horse corrals due to their visual similarity to other irrigated or irrigable not-irrigated landscapes throughout the water district. When applied to the Landscape Area Estimates product, they classify the covered regions of super-pixels as not-irrigable landscapes. Of the parcels in the analysis, 17 (0.38%) contain some amount of horse corral, 1,218 (26.93%) contain some amount of undeveloped lands, and 113 ( 2.5% ) contain some amount of agricultural lands. In total, the AOI contains 4.65 acres, of horse corral, 1,911.22 acres of undeveloped lands, and 359.73 acres of agricultural lands. Examples of both horse corral and undeveloped lands identification are provided in Figure 4.

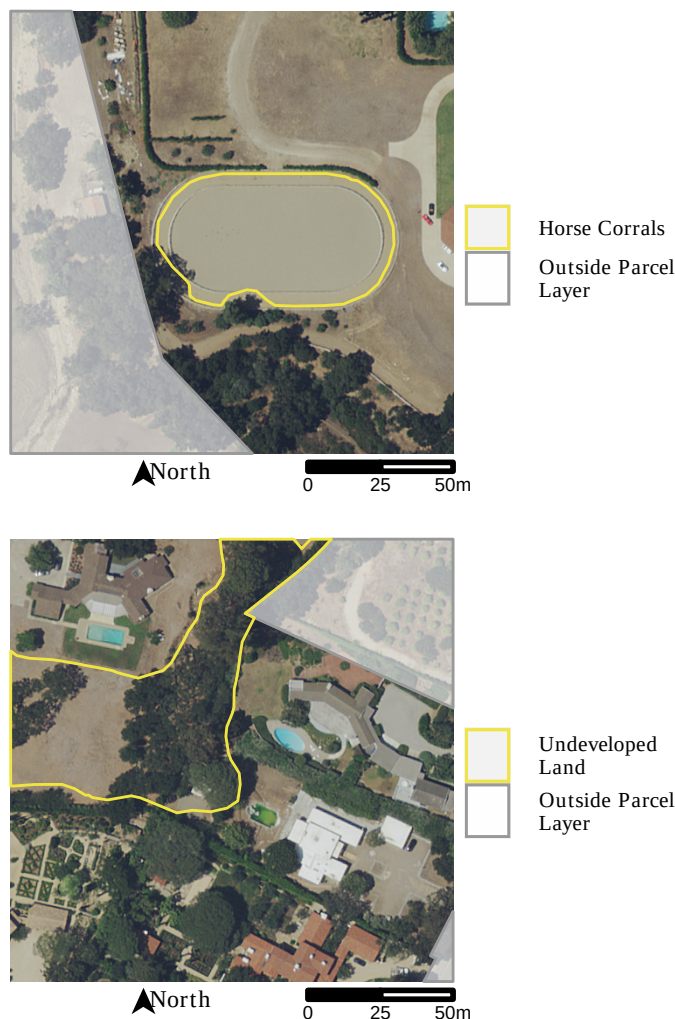


Figure 4: Example of horse corral (top) and undeveloped lands (bottom) identification.

## Classification example

Figure 5 shows an example of model classification for an image tile in the Montecito Water District, to showcase model performance.

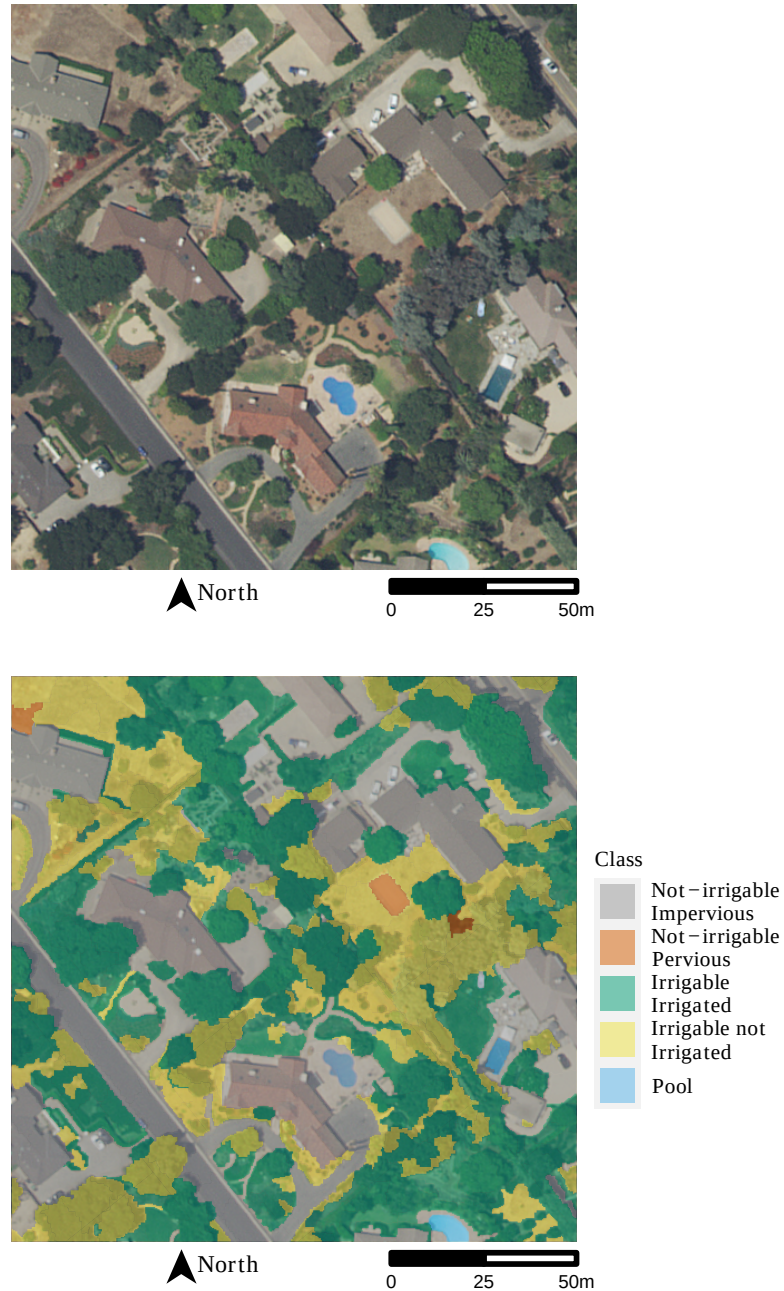


Figure 5: Example of modeling (bottom) on a selected image tile (top). This visualization represents the 8 classes being delivered to DWR. For 8-class definitions, please see the Table A2 of the appendix.

## Summary of Results

The 4,523 single-family and multi-family residential parcels in Montecito Water District are composed of 60.3 percent not irrigable, 24.0 percent irrigated, and 15.7 percent irrigable not-irrigated landscapes. The district-level weighted accuracy of the classification is 97.14% with a confidence interval of [97.11%, 97.17%]. Table 10 shows the water district accuracy statistics at the point, parcel, and district level. The total area at the three-class level for the whole district is provided in Table 4. In addition, the irrigation status summary and mean and median percent of irrigation classes found in parcels of each LUC are provided in Tables 5 and 6. The average class coverage by parcel size and a summary of canopy cover by parcel size are included in Table 7 and Table 8.

Table 4: Total predicted area for the district by irrigation status level. For irrigation status definitions, please see Table A1 of the appendix.

| Class                   | Percent of area<br>in analysis | Total area<br>(sq. ft.) | 95% confidence<br>interval (sq. ft.) |
|-------------------------|--------------------------------|-------------------------|--------------------------------------|
| Not-irrigable           | 60.3                           | 162,392,789.83          | 2,958,549.87                         |
| Irrigable irrigated     | 24.0                           | 64,636,257.15           | 8,215,533.18                         |
| Irrigable not-irrigated | 15.7                           | 42,179,087.96           | 6,618,024.50                         |

Table 5: Total predicted area by LUC at the irrigation status level in square feet. For irrigation status definitions, please see Table A1 of the appendix. For LUC definitions, please see Table A19 the appendix.

| LUC  | Total NI area<br>(sq. ft.) | Total II area<br>(sq. ft.) | Total INI area<br>(sq. ft.) |
|------|----------------------------|----------------------------|-----------------------------|
| 0010 | 97,307.92                  | 24,132.69                  | 17,979.29                   |
| 0020 | 325,652.06                 | 8,547.10                   | 40,239.85                   |
| 0021 | 28,607.08                  | 42,298.13                  | 10,557.36                   |
| 1001 | 125,158,494.23             | 61,835,842.76              | 39,107,054.75               |
| 1004 | 579,613.35                 | 58,245.81                  | 25,444.43                   |
| 1006 | 30,695.97                  | 2,534.94                   | 2,221.43                    |
| 1008 | 32,894,965.73              | 1,481,445.06               | 2,252,698.08                |
| 1101 | 1,603,222.71               | 840,229.53                 | 454,756.76                  |
| 1104 | 162,511.88                 | 85,809.42                  | 31,239.83                   |
| 1109 | 95,498.99                  | 12,169.36                  | 14,483.73                   |
| 3008 | 28,804.49                  | 608.55                     | 1,300.86                    |
| 9106 | 1,588,371.62               | 253,151.51                 | 228,775.38                  |

Table 6: Percent coverage of LUC at the irrigation status level. For irrigation status definitions, please see the Table A1 the appendix. For LUC definitions, please see Table A19 the appendix.

| LUC  | NI         |          | II         |          | INI        |          |
|------|------------|----------|------------|----------|------------|----------|
|      | Median (%) | Mean (%) | Median (%) | Mean (%) | Median (%) | Mean (%) |
| 0010 | 81.2       | 81.2     | 10.8       | 10.8     | 8.0        | 8.0      |
| 0020 | 76.6       | 65.3     | 2.6        | 17.2     | 12.0       | 17.4     |
| 0021 | 35.8       | 35.8     | 51.3       | 51.3     | 12.9       | 12.9     |
| 1001 | 41.7       | 45.3     | 37.0       | 36.1     | 15.9       | 18.5     |
| 1004 | 98.6       | 91.8     | 0.3        | 5.2      | 0.0        | 3.0      |
| 1006 | 89.8       | 85.7     | 1.2        | 7.5      | 0.0        | 6.8      |
| 1008 | 88.5       | 84.0     | 3.4        | 6.1      | 7.1        | 10.0     |
| 1101 | 53.5       | 54.5     | 31.5       | 32.1     | 7.6        | 13.4     |
| 1104 | 62.4       | 62.1     | 29.9       | 27.5     | 7.3        | 10.4     |
| 1109 | 78.2       | 78.2     | 10.0       | 10.0     | 11.9       | 11.9     |
| 3008 | 100.0      | 96.4     | 0.0        | 0.8      | 0.0        | 2.8      |
| 9106 | 73.2       | 73.2     | 14.3       | 14.3     | 12.6       | 12.6     |

Table 7: Mean percent class coverage for 8-Class system by parcel size in acres. For 8-Class status definitions, please see Table A2 of the appendix.

| Parcel size<br>(acres) | Not-irrigable<br>impervious (%) | Not-irrigable<br>pervious (%) | Irrigable<br>irrigated (%) | Irrigable<br>not-irrigated (%) | Pool (%) | Horse<br>corral (%) | Undeveloped<br>lands (%) | Agricultural<br>lands (%) | Parcel<br>count |
|------------------------|---------------------------------|-------------------------------|----------------------------|--------------------------------|----------|---------------------|--------------------------|---------------------------|-----------------|
| 0 - 0.15               | 80.4                            | 0.3                           | 13.0                       | 5.3                            | 0.0      | 0.0                 | 1.1                      | 0.0                       | 718             |
| 0.15 - 0.25            | 47.6                            | 1.1                           | 36.6                       | 13.2                           | 0.1      | 0.0                 | 1.4                      | 0.0                       | 544             |
| 0.25 - 0.5             | 37.2                            | 1.9                           | 41.0                       | 16.2                           | 0.2      | 0.0                 | 3.5                      | 0.0                       | 653             |
| 0.5 - 1                | 26.6                            | 4.7                           | 39.6                       | 22.6                           | 0.3      | 0.0                 | 6.2                      | 0.0                       | 1017            |
| 1 - 3                  | 22.6                            | 5.6                           | 36.2                       | 21.1                           | 0.2      | 0.0                 | 13.8                     | 0.4                       | 1126            |
| 3+                     | 10.5                            | 5.0                           | 16.9                       | 14.8                           | 0.1      | 0.1                 | 45.8                     | 6.7                       | 419             |

Table 8: Percent canopy coverage by parcel size in acres.

| Parcel size<br>(acres) | Mean canopy<br>cover (%) | Median canopy<br>cover (%) | Standard<br>deviation (%) | Parcel count |
|------------------------|--------------------------|----------------------------|---------------------------|--------------|
| 0 - 0.15               | 15.0                     | 6.2                        | 18.2                      | 718          |
| 0.15 - 0.25            | 41.4                     | 40.0                       | 15.3                      | 544          |
| 0.25 - 0.5             | 49.2                     | 49.2                       | 15.1                      | 653          |
| 0.5 - 1                | 56.1                     | 56.7                       | 14.9                      | 1017         |
| 1 - 3                  | 56.9                     | 57.4                       | 15.8                      | 1126         |
| 3+                     | 53.5                     | 55.3                       | 18.2                      | 419          |

## Validation Reporting & Methods

In order to ensure that Montecito Water District was modeled accurately, an independent validation exercise was performed using a set of reference parcels that were manually classified by Quantum Spatial personnel. The reference parcels were selected randomly from parcels greater than 100 square feet in the topologically corrected parcel layer and were not included in any level of modeling. The correct land cover and land use classification, as determined by Quantum Spatial digitizers, was selected for each super-pixel object in the reference parcels to match the water district imagery. These parcels went through multiple review phases to ensure quality and consistency. For detailed information on digitization quality control and Quantum Spatial digitizer agreement, please refer to the Digitizer Agreement section of the Appendix.

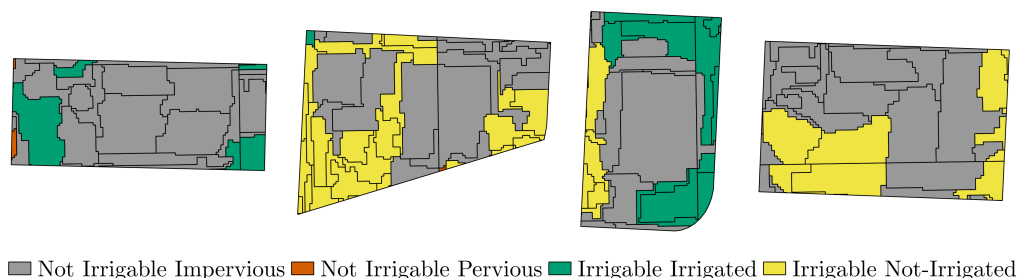


Figure 6: Examples of reference parcels created by Quantum Spatial, Inc., an NV5 company.

Once district modeling was complete, model predictions of irrigation status were compared to the manually classified reference parcels using confusion matrices. Confusion matrices are a powerful way to visualize and measure the performance of a classification model. They are a tabular representation of the correct and incorrect classifications across a predicted space. The column values of the confusion matrices represent the reference data classifications from the manually digitized parcels. The row values of the confusion matrices represent the model predicted classifications. Correct class predictions are shown along the main diagonal of the confusion matrix, where the predicted class matches the reference class. Erroneous classifications are shown in confusion matrix cells off the main diagonal where the predicted class does not equal the reference class. The district-level confusion matrix for the irrigation status classification is shown in Table 9, where values are shown in square feet.

Table 9: District-level model classification confusion matrix for irrigation status classification, by area. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |         |
|------------|-----------|---------|---------|
|            | NI        | II      | INI     |
| NI         | 398,473   | 40,363  | 0       |
| II         | 0         | 464,374 | 14,637  |
| INI        | 4,200     | 0       | 496,440 |

Table 10: Accuracy assessments at the district, parcel, and point level. For accompanying confusion matrices and statistics, please see Tables A6 - A11 in the appendix.

|          | Area-weighted<br>accuracy (%) | Unweighted<br>overall accuracy (%) |
|----------|-------------------------------|------------------------------------|
| District | 97.14                         | 97.42                              |
| Parcel   | 84.45                         | 84.32                              |
| Point    | 78.65                         | 78.31                              |

Multiple confusion matrix statistics are reported in Table 10 in order to fully describe the classification model performance. The variation in these metrics is the result of the cancellation of confusion within different units of observation (point, parcel, or district). When predictions are summarized to a more generalized unit, errors cancel. For example, if 10 square feet of turf is called canopy and 8 square feet of canopy is called turf, at the parcel level, 8 square feet of confusion cancels, with 2 square feet of turf remaining misclassified as canopy. When calculating accuracy at the point level, no cancellation of errors occurs. When calculating the parcel and district-level accuracies, errors are cancelled at the parcel and district levels, respectively. Confusion matrices of classification errors for the water district classification at the 10-class and irrigation status levels are provided in Tables A4-A8 and Tables A12-A14 along with the full confusion matrix statistics in Tables A9-A11 and Tables A15-A17 of the appendix.

The primary metric used to determine whether the district modeling has performed appropriately is the area-weighted accuracy. This accuracy metric utilizes the by-class positive predictive value (PPV) (Equation 3) of the un-masked super-pixel objects and the class rates of prevalence across the district to weight the overall accuracy of the Landscape Area Estimates product (equation shown in Equation 1). The positive predictive value used to weight the area of the masked super-pixel objects is considered to be 100% due to the heads-up digitization of the derived land masks, multiple phases of quality control, and final review by the California Department of Water Resources. The unweighted overall accuracy is also reported and is calculated after the derived land masks have been burned into the reference parcels and the model classification (overall accuracy equation shown in Equation 2). All masked super-pixel objects are given the irrigation status of ‘not-irrigable’. The district-level weighted accuracy of Montecito Water District is 97.14% with a confidence interval of [97.11%, 97.17%]. Table 10 shows the water district accuracy statistics at the point, parcel, and district level, and Table 11 shows the class positive predictive values and prevalence rates at the irrigation status level.

As part of the pilot phase of the Landscape Area Estimates Project, Phase 2B water districts went through an additional independent validation exercise using reference data generated by the California Department of Water Resources and their consulting team. The results of this exercise shaped the model quality standards and external validation metrics used for the Phase 3 water districts. These standards are set in place in order to ensure that the data generated in this project are “reasonably accurate for the data’s intended uses” as directed by AB 1668 and SB 606.

Table 11: District-wide class prevalence rates and positive predictive values derived from confusion matrices at the district, parcel, and point level. Values shown indicate percentages. For accompanying confusion matrices and statistics, please see Tables A5, A6, and A7 in the appendix.

|                                 | Level    | II (%) | INI (%) | NI (%) | Mask (%) |
|---------------------------------|----------|--------|---------|--------|----------|
| Positive Predictive Value (PPV) | District | 90.8   | 96.94   | 99.16  | 100.00   |
|                                 | Parcel   | 68.22  | 71.35   | 83.29  | 100.00   |
|                                 | Point    | 57.24  | 57.76   | 78.29  | 100.00   |
| District Prevalence             | District | 24.01  | 15.67   | 20.55  | 39.77    |

## Equations

$$WeightedAccuracy = (PPV_{II} * Rate_{II}) + (PPV_{INI} * Rate_{INI}) + (PPV_{NI} * Rate_{NI}) + (1.0 * Rate_{Mask}) \quad (1)$$

$$OverallAccuracy = \frac{CorrectPredictions}{TotalPredictions} = \frac{TP + TN}{P + N} \quad (2)$$

$$PositivePredictiveValue = PPV = \frac{TP}{TP + FP} \quad (3)$$

*PPV: Positive predictive value / Rate: Class prevalence rate / P: Positive condition / N: Negative condition / TP: True positive / FP: False positive / TN: True negative*

|                  |   | Reference (Validation) Class |                |
|------------------|---|------------------------------|----------------|
|                  |   | A                            | B              |
| Model Prediction | A | True Positive                | False Positive |
|                  | B | False Negative               | True Negative  |

Figure 7: Example of a two class confusion matrix to label equation variables.

## Appendices

Table A1: Irrigation status identification codes.

| ID  | Class                   | Included classes<br>from 10-class                                                                                           | Codes for included<br>10-class classes |
|-----|-------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| NI  | Not-irrigable           | Impervious, Not-irrigable pervious,<br>Undeveloped lands, Horse corrals, Open water,<br>Artificial turf, Agricultural lands | 1, 5,<br>6, 7, 8,<br>9, 10             |
| II  | Irrigable irrigated     | Pools, Irrigated pervious                                                                                                   | 2, 3                                   |
| INI | Irrigable not-irrigated | Irrigable not-irrigated pervious                                                                                            | 4                                      |

Table A2: 8-class identification codes (as seen in the Classification Example).

| Class                    | Included classes<br>from 10-class  | Codes for included<br>10-class classes |
|--------------------------|------------------------------------|----------------------------------------|
| Not-irrigable impervious | Impervious, Artificial turf        | 1, 9                                   |
| Not-irrigable pervious   | Not-irrigable pervious, Open water | 5, 8                                   |
| Irrigable irrigated      | Irrigated pervious                 | 3                                      |
| Irrigable not-irrigated  | Irrigable not-irrigated pervious   | 4                                      |
| Pools                    | Pools                              | 2                                      |
| Undeveloped lands        | Undeveloped lands                  | 6                                      |
| Horse corrals            | Horse corrals                      | 7                                      |
| Agricultural lands       | Agricultural lands                 | 10                                     |

Table A3: 10-class identification codes.

| Number | Class                            |
|--------|----------------------------------|
| 1      | Impervious                       |
| 2      | Pools                            |
| 3      | Irrigated pervious               |
| 4      | Irrigable not-irrigated pervious |
| 5      | Not-irrigable pervious           |
| 6      | Undeveloped lands                |
| 7      | Horse corrals                    |
| 8      | Open water                       |
| 9      | Artificial turf                  |
| 10     | Agricultural lands               |

## Digitization Quality Control

The model training data, validation data, and the derived land masks represent the manually interpreted aspects of the Landscape Area Estimates project. In recognition of the potential for variation in land cover and land use interpretations, multiple quality control checks were used throughout the creation of these layers.

The derived land masks are generated through an iterative quality control process that starts with the initial creation of the land mask by a human photo interpreter. Once the initial masking effort is completed, a senior editor from Quantum Spatial reviews and adjusts the mask using auxiliary layers and complementary information. Additionally, the mask shapefile is checked for geometry errors and complete parcel coverage. After the mask layers are created and reviewed, they are sent to the California Department of Water Resources for final review and approval.

Every manually classified parcel that was used to train or validate this district's model underwent three phases of interpretation and classification review. Parcel classification began with an intermediate model classifying the super-pixel objects of a parcel. Once complete, three independent digitizers would consecutively review the parcel classification. The changes made in each quality control phase were recorded in order to monitor the level of agreement between digitizers and flag particularly challenging districts that required additional digitization effort. Figure A1 shows the percentage of change in each quality control phase by irrigation status class. The first pass describes the percent change from the initial model classification in the first round of digitizing. The second and final passes describe the percent change during the two subsequent quality assurance checks.

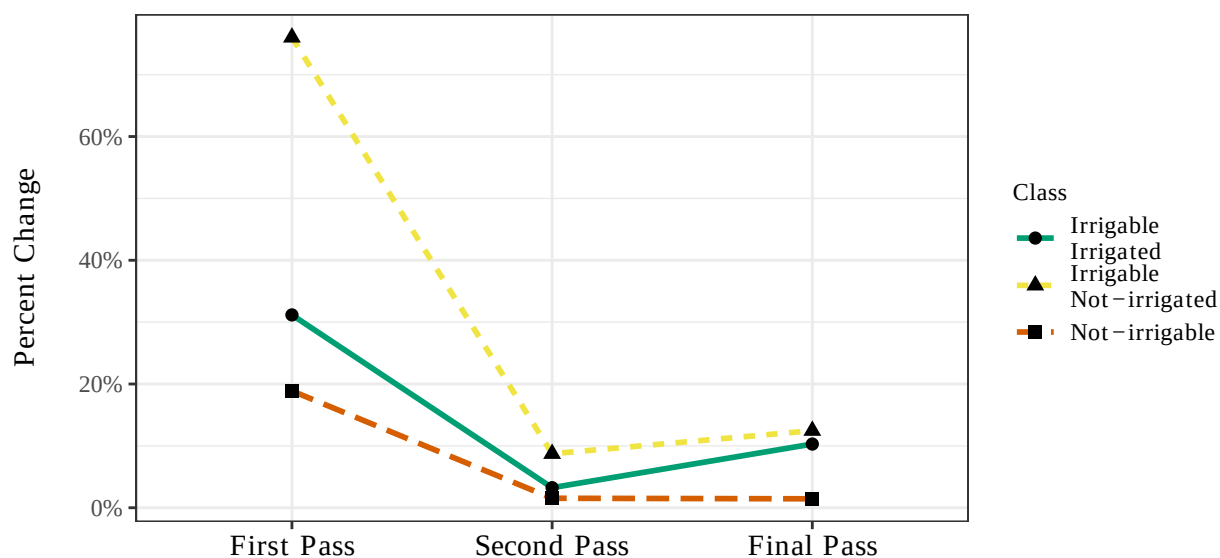


Figure A1: Digitizer disagreement through each quality control phase. This chart shows the percent change in object irrigation status by irrigation class for the three digitization phases of the reference parcels used in this analysis.

## Classification Confusion Matrices

In this section, full confusion matrices and their summary statistics are provided for the classification of Montecito Water District. Tables A4 and A5 show the confusion matrix and its accompanying statistics for the 10-class classification scheme in order to display the model performance in the expanded classification. Tables A6-A8 show the irrigation status class performance on the unmasked super-pixel objects at the point, parcel, and district level, respectively. The accompanying confusion matrix statistics are shown in Tables A9-A11. Additionally, Tables A12-A14 show the irrigation status class performance at the point, parcel, and district level, including the masked super-pixel objects. The accompanying confusion matrix statistics are shown in Tables A15-A17.

Table A4: Point-level model classification confusion matrix for 10-class classification, by area. Values shown represent square feet. For 10-class definitions, please see Table A3 of the appendix.

| Prediction | Reference |       |         |         |        |         |   |     |     |    |
|------------|-----------|-------|---------|---------|--------|---------|---|-----|-----|----|
|            | 1         | 2     | 3       | 4       | 5      | 6       | 7 | 8   | 9   | 10 |
| 1          | 416,950   | 869   | 7,667   | 21,509  | 9,494  | 0       | 0 | 0   | 384 | 0  |
| 2          | 0         | 2,489 | 0       | 0       | 0      | 0       | 0 | 239 | 0   | 0  |
| 3          | 5,110     | 0     | 248,688 | 155,635 | 26,675 | 0       | 0 | 0   | 0   | 0  |
| 4          | 11,943    | 0     | 115,272 | 276,659 | 75,137 | 0       | 0 | 0   | 0   | 0  |
| 5          | 13,311    | 0     | 27,688  | 50,934  | 42,436 | 0       | 0 | 0   | 0   | 0  |
| 6          | 0         | 0     | 0       | 0       | 0      | 789,752 | 0 | 0   | 0   | 0  |
| 7          | 0         | 0     | 0       | 0       | 0      | 0       | 0 | 0   | 0   | 0  |
| 8          | 0         | 0     | 0       | 0       | 0      | 0       | 0 | 0   | 0   | 0  |
| 9          | 0         | 0     | 0       | 0       | 0      | 0       | 0 | 0   | 0   | 0  |
| 10         | 0         | 0     | 0       | 0       | 0      | 0       | 0 | 0   | 0   | 0  |

Table A5: Confusion matrix statistics for the point level accuracy assessment at the irrigation status level.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1     | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|--------|------------|-------------------|
| 1     | 93.21       | 97.84       | 91.26                     | 98.35                     | 92.23  | 19.46      | 95.53             |
| 2     | 74.12       | 99.99       | 91.24                     | 99.96                     | 81.79  | 0.15       | 87.06             |
| 3     | 62.28       | 90.13       | 57.02                     | 91.91                     | 59.54  | 17.37      | 76.21             |
| 4     | 54.81       | 88.72       | 57.76                     | 87.47                     | 56.25  | 21.96      | 71.77             |
| 5     | 27.60       | 95.71       | 31.58                     | 94.86                     | 29.46  | 6.69       | 61.66             |
| 6     | 100.00      | 100.00      | 100.00                    | 100.00                    | 100.00 | 34.35      | 100.00            |
| 7     | NA          | 100.00      | NA                        | NA                        | NA     | 0.00       | NA                |
| 8     | 0.00        | 100.00      | NaN                       | 99.99                     | NA     | 0.01       | 50.00             |
| 9     | 0.00        | 100.00      | NaN                       | 99.98                     | NA     | 0.02       | 50.00             |
| 10    | NA          | 100.00      | NA                        | NA                        | NA     | 0.00       | NA                |

Table A6: Point-level model classification confusion matrix for the unmasked super-pixels at the irrigation status level, by area. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |         |
|------------|-----------|---------|---------|
|            | NI        | II      | INI     |
| NI         | 251,177   | 155,635 | 32,024  |
| II         | 115,272   | 276,659 | 87,080  |
| INI        | 36,224    | 72,443  | 391,973 |

Table A7: Parcel-level model classification confusion matrix for the unmasked super-pixels at the irrigation status level, by area. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |         |
|------------|-----------|---------|---------|
|            | NI        | II      | INI     |
| NI         | 299,390   | 111,477 | 27,969  |
| II         | 71,114    | 341,759 | 66,138  |
| INI        | 32,169    | 51,501  | 416,970 |

Table A8: District-level model classification confusion matrix for the unmasked super-pixels at the irrigation status level, by area. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |         |
|------------|-----------|---------|---------|
|            | NI        | II      | INI     |
| NI         | 398,473   | 40,363  | 0       |
| II         | 0         | 464,374 | 14,637  |
| INI        | 4,200     | 0       | 496,440 |

Table A9: Confusion matrix statistics for the point-level accuracy assessment of the unmasked super-pixels at the irrigation status level.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1    | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|-------|------------|-------------------|
| NI    | 62.38       | 81.53       | 57.24                     | 84.54                     | 59.70 | 28.39      | 71.95             |
| INI   | 54.81       | 77.85       | 57.76                     | 75.72                     | 56.25 | 35.58      | 66.33             |
| II    | 76.70       | 88.02       | 78.29                     | 87.02                     | 77.49 | 36.03      | 82.36             |

Table A10: Confusion matrix statistics for the parcel-level accuracy assessment of the unmasked super-pixels at the irrigation status level.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1    | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|-------|------------|-------------------|
| NI    | 74.35       | 86.27       | 68.22                     | 89.46                     | 71.16 | 28.39      | 80.31             |
| INI   | 67.71       | 84.98       | 71.35                     | 82.65                     | 69.48 | 35.58      | 76.34             |
| II    | 81.59       | 90.78       | 83.29                     | 89.75                     | 82.43 | 36.03      | 86.18             |

Table A11: Confusion matrix statistics for the district-level accuracy assessment of the unmasked super-pixels at the irrigation status level.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1    | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|-------|------------|-------------------|
| NI    | 98.96       | 96.03       | 90.80                     | 99.57                     | 94.70 | 28.39      | 97.49             |
| INI   | 92.00       | 98.40       | 96.94                     | 95.70                     | 94.41 | 35.58      | 95.20             |
| II    | 97.14       | 99.54       | 99.16                     | 98.41                     | 98.14 | 36.03      | 98.34             |

Table A12: Point-level model classification confusion matrix at the irrigation status level, including masked super-pixels, by area. Used to assess unweighted overall accuracy. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |           |
|------------|-----------|---------|-----------|
|            | NI        | II      | INI       |
| NI         | 251,177   | 155,635 | 32,024    |
| II         | 115,272   | 276,659 | 87,080    |
| INI        | 36,224    | 72,443  | 1,272,327 |

Table A13: Parcel-level model classification confusion matrix at the irrigation status level, including masked super-pixels, by area. Used to assess unweighted overall accuracy. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |           |
|------------|-----------|---------|-----------|
|            | NI        | II      | INI       |
| NI         | 299,390   | 111,477 | 27,969    |
| II         | 71,114    | 341,759 | 66,138    |
| INI        | 32,169    | 51,501  | 1,297,324 |

Table A14: District-level model classification confusion matrix at the irrigation status level, including masked super-pixels, by area. Used to assess unweighted overall accuracy. Values shown represent square feet. For irrigation status definitions, please see Table A1 of the appendix.

| Prediction | Reference |         |           |
|------------|-----------|---------|-----------|
|            | NI        | II      | INI       |
| NI         | 398,473   | 40,363  | 0         |
| II         | 0         | 464,374 | 14,637    |
| INI        | 4,200     | 0       | 1,376,794 |

Table A15: Confusion matrix statistics for the point-level accuracy assessment at the irrigation status level, including masked super-pixels.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1    | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|-------|------------|-------------------|
| NI    | 62.38       | 90.10       | 57.24                     | 91.86                     | 59.70 | 17.52      | 76.24             |
| INI   | 54.81       | 88.72       | 57.76                     | 87.47                     | 56.25 | 21.96      | 71.77             |
| II    | 91.44       | 88.02       | 92.13                     | 87.02                     | 91.78 | 60.53      | 89.73             |

Table A16: Confusion matrix statistics for the parcel-level accuracy assessment at the irrigation status level, including masked super-pixels.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1    | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|-------|------------|-------------------|
| NI    | 74.35       | 92.65       | 68.22                     | 94.45                     | 71.16 | 17.52      | 83.50             |
| INI   | 67.71       | 92.35       | 71.35                     | 91.04                     | 69.48 | 21.96      | 80.03             |
| II    | 93.24       | 90.78       | 93.94                     | 89.75                     | 93.59 | 60.53      | 92.01             |

Table A17: Confusion matrix statistics for the district-level accuracy assessment at the irrigation status level, including masked super-pixels.

| Class | Sensitivity | Specificity | Positive predictive value | Negative predictive value | F1    | Prevalence | Balanced accuracy |
|-------|-------------|-------------|---------------------------|---------------------------|-------|------------|-------------------|
| NI    | 98.96       | 97.87       | 90.80                     | 99.77                     | 94.70 | 17.52      | 98.41             |
| INI   | 92.00       | 99.18       | 96.94                     | 97.78                     | 94.41 | 21.96      | 95.59             |
| II    | 98.95       | 99.54       | 99.70                     | 98.41                     | 99.32 | 60.53      | 99.24             |

## Error Analysis

After modeling was concluded, an error analysis was conducted to examine the effects of model misclassification. The goal of this exercise was to visually represent the individual class errors identified in the validation procedure at the 10-class level. Figure A2 shows a set of histograms representing the error for each class. The y-axis represents the percentage of the total validation super-pixel objects that contain the error; therefore, having the majority of the histogram bins at or near 0 indicates low levels of error. Negative values along the x-axis indicate under-predictions and positive values indicate over-predictions in that class.

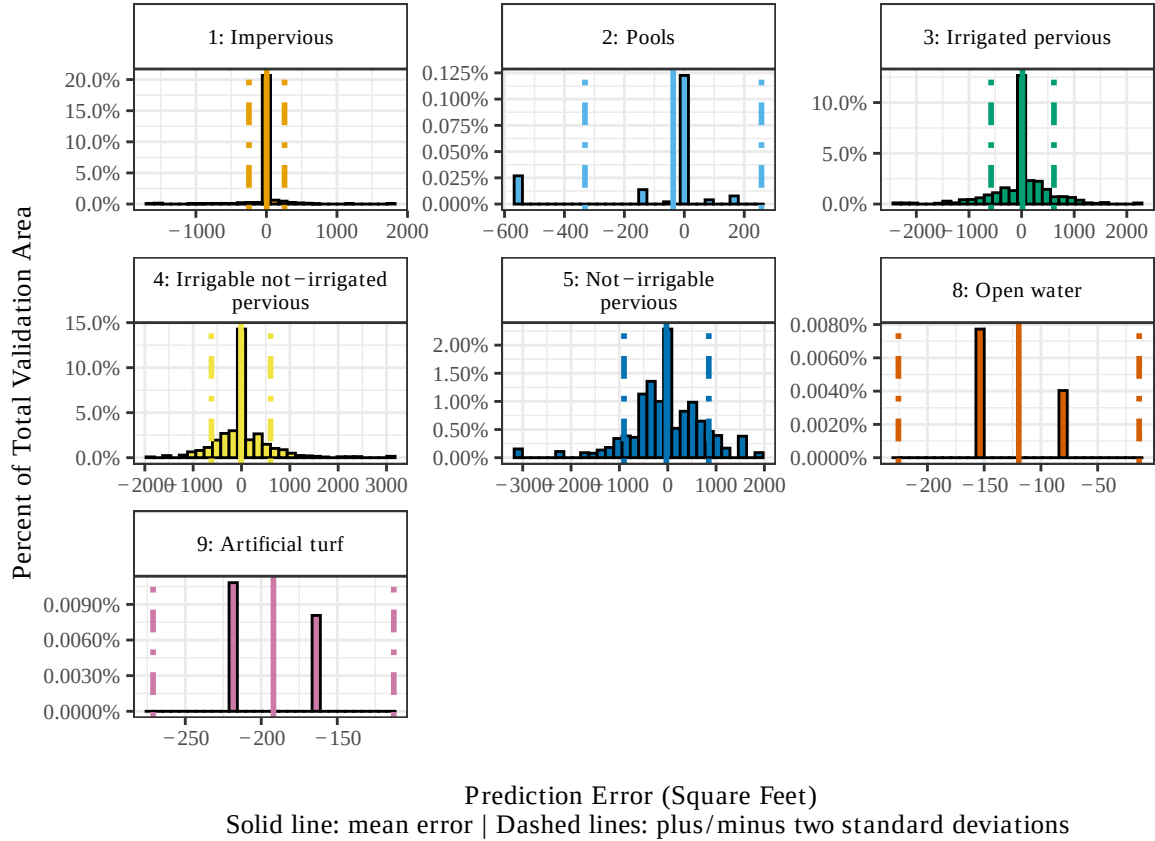


Figure A2: Model prediction error by area, 10-class level. The y-axis represents the percentage of total validation parcel area. The x-axis represents the class error observed, in square feet. All 10 classes may not be present if they were not predicted or present in the reference data. The masking classes (6, 7, and 10) are not present because they are manually digitized and not included in the modeling effort. For 10-class definitions, please see Table A3 of the appendix.

This information is further broken into percentiles in Table A18. The percentiles represent the distribution of error within each class across the validation parcels. Negative values indicate under-predictions and positive values represent over-predictions. The '5%' percentile indicates that 5% of the parcels will have values for that class lower than that listed. For example, 90% of predictions for class 1: Impervious area between -32.1 and 40.0

square feet of error (‘5%’ and ‘95%’) and the median prediction error by parcel is 0.7 square feet.

Table A18: Modeled error percentiles by parcel and class. All values are expressed in square feet. All 10 classes may not be present if they were not predicted or present in the reference data. The masking classes (6, 7, and 10) are not present because they are manually digitized and not included in the modeling effort. For 10-class definitions, please see Table A3 of the appendix. Definitions for the table below are as follow, Class: Class in 10 class system | Mean Area: average object size | SD: standard deviation of object size.

| Class | Mean Area | SD    | 0.5%   | 2.5%   | 5%     | 50%    | 95%    | 97.5%  | 99.5%  |
|-------|-----------|-------|--------|--------|--------|--------|--------|--------|--------|
| 1     | 220.5     | 68.7  | -52.8  | -42.9  | -32.1  | 0.7    | 40.0   | 51.4   | 70.1   |
| 2     | 216.8     | 52.9  | -239.4 | -223.6 | -203.9 | 0.0    | 46.0   | 49.2   | 51.7   |
| 3     | 249.3     | 95.9  | -212.8 | -137.4 | -81.2  | 37.7   | 310.4  | 385.9  | 429.3  |
| 4     | 249.8     | 92.5  | -295.3 | -252.7 | -179.2 | -15.2  | 291.8  | 303.6  | 442.8  |
| 5     | 276.6     | 179.4 | -414.9 | -348.4 | -282.2 | 14.8   | 394.3  | 495.5  | 701.5  |
| 8     | 119.5     | 53.0  | -156.6 | -155.1 | -153.2 | -119.5 | -85.8  | -83.9  | -82.4  |
| 9     | 192.0     | NA    | -192.0 | -192.0 | -192.0 | -192.0 | -192.0 | -192.0 | -192.0 |

Table A19: Land use code (LUC) data dictionary.

| Code                      | Code Description                                                         |
|---------------------------|--------------------------------------------------------------------------|
| 0010 Miscellaneous        | NA                                                                       |
| 0010                      | Miscellaneous (General)                                                  |
| 0011                      | Pipeline or Right-of-Way                                                 |
| 0012                      | Rail (Right-of-way & track)                                              |
| 0013                      | Road (Right-of-way)                                                      |
| 0014                      | Utilities (Right-of-way ONLY)                                            |
| 0015                      | Sub-Surface Rights (mineral)                                             |
| 0016                      | Surface Rights (Grazing, timber, coal, etc.)                             |
| 0017                      | Leasehold Rights (misc.)                                                 |
| 0018                      | Possessory Interest (misc.)                                              |
| 0019                      | Petroleum & Gas Wells (misc.)                                            |
| 0020                      | Water Rights (misc.)                                                     |
| 0021                      | Right-of-Way (not rail, road or utility)                                 |
| 0022                      | Easement (misc.)                                                         |
| 0023                      | Homestead (Misc.)                                                        |
| 0024                      | Common Area (misc.)                                                      |
| 0025                      | Royalty Interest                                                         |
| 0026                      | Working Interest                                                         |
| 0027                      | Vacant parcels with improvements                                         |
| 0500 Personal Property    | NA                                                                       |
| 0500                      | Personal property (general)                                              |
| 0510                      | Vehicles (general)                                                       |
| 0511                      | Motor vehicles (cars, trucks, etc.)                                      |
| 0512                      | Travel trailers                                                          |
| 0513                      | Watercraft (ships, boats, PWCs, etc.)                                    |
| 0514                      | Aircraft                                                                 |
| 0515                      | Rolling stock (railroad)                                                 |
| 0516                      | Spacecraft                                                               |
| 0519                      | Misc vehicles not otherwise classed (antiques, etc.)                     |
| 0520                      | Business personal property (general)                                     |
| 0521                      | Equipment / supplies                                                     |
| 0522                      | Inventory                                                                |
| 0523                      | Goods in transit                                                         |
| 0524                      | Livestock (animals, fish, birds, etc.)                                   |
| 0525                      | Crops (in ground)                                                        |
| 0526                      | Crops (harvested)                                                        |
| 0529                      | Misc Business Personal Property not otherwise classed                    |
| 0530                      | Structures (general)                                                     |
| 0532                      | Structures on leased land (may include Mobile Homes – see "MH Land Use") |
| 0533                      | Temporary structures                                                     |
| 0539                      | Misc structures not otherwise classed (billboards, etc.)                 |
| 0540                      | Intangible personal property                                             |
| 0599                      | Misc personal property not otherwise classed                             |
| 1000 Residential (Single) | NA                                                                       |
| 1000                      | Residential (General) (Single)                                           |
| 1001                      | Single Family Residential                                                |
| 1002                      | Townhouse (Residential)                                                  |
| 1003                      | Cluster home (Residential)                                               |
| 1004                      | Condominium (Residential)                                                |
| 1005                      | Cooperative (Residential)                                                |
| 1006                      | Mobile home                                                              |
| 1007                      | Row house (Residential)                                                  |
| 1008                      | Rural Residence (Agricultural)                                           |
| 1009                      | Planned Unit Development (PUD) (Residential)                             |
| 1010                      | Residential Common Area (Condo/PUD/etc.)                                 |
| 1011                      | Timeshare (Residential)                                                  |
| 1012                      | Seasonal, Cabin, Vacation Residence                                      |
| 1013                      | Bungalow (Residential)                                                   |
| 1014                      | Zero Lot Line (Residential)                                              |
| 1015                      | Misc Residential Improvement                                             |

Table A19: Land use code (LUC) data dictionary. (*continued*)

| Code                                   | Code Description                                             |
|----------------------------------------|--------------------------------------------------------------|
| 1016                                   | Manufactured, Modular, Pre-Fabricated Homes                  |
| 1017                                   | Patio Home                                                   |
| 1018                                   | Garden Home                                                  |
| 1019                                   | Landominium                                                  |
| 1100 Residential Income (Multi-Family) | NA                                                           |
| 1100                                   | Residential Income (General) (Multi-Family)                  |
| 1101                                   | Duplex (2 units, any combination)                            |
| 1102                                   | Triplex (3 units, any combination)                           |
| 1103                                   | Quadruplex (4 units, any combination)                        |
| 1104                                   | Apartment house (5+ units)                                   |
| 1105                                   | Apartment house (100+ units)                                 |
| 1106                                   | Garden Apt, Court Apt (5+ units)                             |
| 1107                                   | Highrise Apartments                                          |
| 1108                                   | Boarding House, Rooming House, Apt Hotel, Transient Lodgings |
| 1109                                   | Mobile Home Park, Trailer Park                               |
| 1110                                   | Multi-Family Dwellings (Generic, any combination 2+)         |
| 1111                                   | Fraternity House, Sorority House                             |
| 1112                                   | Apartments (generic)                                         |
| 1113                                   | Dormitory, Group Quarters (Residential)                      |
| 1114                                   | Residential Condominium Development (Association Assessment) |
| 1901                                   | Residential Parking Garage                                   |
| 1902                                   | Residential Storage Space                                    |
| 1999                                   | Single Family Residential                                    |
| 2000 Commercial                        | NA                                                           |
| 2000                                   | Commercial (General)                                         |
| 2001                                   | Retail Stores ( Personal Services, Photography, Travel)      |
| 2002                                   | Store (multi-story)                                          |
| 2003                                   | Store/Office (mixed use)                                     |
| 2004                                   | Department Store (apparel, household goods, furniture)       |
| 2005                                   | Department Store (multi-story)                               |
| 2006                                   | Grocery, Supermarket                                         |
| 2007                                   | Regional: Shopping Center, Mall (w/Anchor)                   |
| 2008                                   | Community: Shopping Plaza, Shopping Center, Mini-Mall        |
| 2009                                   | Neighborhood: Shopping Center, Strip Center, Enterprise Zone |
| 2010                                   | Shopping Center COMMON AREA (parking, etc.)                  |
| 2011                                   | Veterinary, Animal Hospital                                  |
| 2012                                   | Restaurant                                                   |
| 2013                                   | Drive-thru Restaurant, Fast Food                             |
| 2014                                   | Take-out Restaurant (food preparation)                       |
| 2015                                   | Bakery                                                       |
| 2016                                   | Bar, Tavern                                                  |
| 2017                                   | Liquor Store                                                 |
| 2018                                   | Convenience store (7-11)                                     |
| 2019                                   | Convenience Store (w/fuel pump)                              |
| 2020                                   | Service station (full service)                               |
| 2021                                   | Service station w/convenience store (food mart)              |
| 2022                                   | Truck stop (fuel and diner)                                  |
| 2023                                   | Vehicle Rentals, Vehicle Sales (auto/truck/RV/boat/etc.)     |
| 2024                                   | Auto repair (& related), Garage                              |
| 2025                                   | Car wash                                                     |
| 2026                                   | Dry Cleaner, Laundry                                         |
| 2027                                   | Service Shop (TV, radio, electric, plumbing)                 |
| 2028                                   | Florist, Nursery, Greenhouse (retail/wholesale)              |
| 2029                                   | Wholesale Outlet, Discount Store (Franchise)                 |
| 2030                                   | Printer - Retail (PIP, QwikCopy, etc.)                       |
| 2031                                   | Mini-Warehouse, Storage                                      |
| 2032                                   | Day care, Pre-school (Commercial)                            |
| 2033                                   | Motel                                                        |
| 2034                                   | Hotel                                                        |
| 2035                                   | Parking Garage, Parking Structure                            |

Table A19: Land use code (LUC) data dictionary. *(continued)*

| Code                            | Code Description                                                       |
|---------------------------------|------------------------------------------------------------------------|
| 2036                            | Parking Lot                                                            |
| 2037                            | Funeral Home, Mortuary (Commercial)                                    |
| 2038                            | Casino                                                                 |
| 2039                            | Hotel-Resort                                                           |
| 2040                            | Hotel/Motel                                                            |
| 2041                            | Gas Station                                                            |
| 2042                            | Stores & Apartments                                                    |
| 2043                            | Commercial Building, Mail Order, Show Room (non-auto), Commercial Whse |
| 2044                            | Comm/Ofc/Res Mixed Use                                                 |
| 2045                            | Appliance Store (Circuit City, Good Guys, Best Buy)                    |
| 2046                            | Kennel                                                                 |
| 2047                            | Laundromat (self-service)                                              |
| 2048                            | Nightclub (Cocktail Lounge)                                            |
| 2050                            | Farm Supply & Equipment (Commercial)                                   |
| 2051                            | Garden Center, Home Improvement (Do-It-Yourself)                       |
| 2052                            | Commercial Condominium (not offices)                                   |
| 2053                            | Drug Store / Pharmacy                                                  |
| 2054                            | Bed & Breakfast                                                        |
| 3000 Commercial Office          | NA                                                                     |
| 3000                            | Commercial Office (General)                                            |
| 3001                            | Professional Bldg (legal; insurance; real estate; business)            |
| 3002                            | Professional Bldg (multi-story)                                        |
| 3003                            | Office Bldg (General)                                                  |
| 3004                            | Office Bldg (multi-story)                                              |
| 3005                            | Dental Bldg                                                            |
| 3006                            | Medical Bldg                                                           |
| 3007                            | Financial Bldg (Bank, S&L; Mtge; Loan; Credit)                         |
| 3008                            | Condominium Offices                                                    |
| 3009                            | Skyscraper/Highrise (Commercial Offices)                               |
| 3010                            | Mixed Use (Commercial/Industrial)                                      |
| 3011                            | Common Area (commercial, not shopping center or Association Asmnt.)    |
| 3012                            | Mobile Commercial Units                                                |
| 4000 Recreational/Entertainment | NA                                                                     |
| 4000                            | Recreational/Entertainment (General)                                   |
| 4001                            | Recreation Center                                                      |
| 4002                            | Public Swimming Pool                                                   |
| 4003                            | Boat slips, Marina, Yacht Club (recreation/pleasure), Boat Landing     |
| 4004                            | Bowling Alley                                                          |
| 4005                            | Arcades (Amusement)                                                    |
| 4006                            | Skating rink, Ice Skating, Roller Skating                              |
| 4007                            | Clubs, Lodges, Professional Associations                               |
| 4008                            | Museums, Library, Art Gallery (Recreational)                           |
| 4009                            | Country Club                                                           |
| 4010                            | Stadiums                                                               |
| 4011                            | Arenas, Convention Center                                              |
| 4012                            | Auditoriums                                                            |
| 4013                            | Driving Range (Golf)                                                   |
| 4014                            | Race track (auto; dog; horse)                                          |
| 4015                            | Gym, Health Spa                                                        |
| 4016                            | Dance Hall                                                             |
| 4017                            | Riding Stable, Trails                                                  |
| 4018                            | Campground, RV Park                                                    |
| 4019                            | Fairgrounds                                                            |
| 4020                            | Theater (movie and legitimate)                                         |
| 4021                            | Drive-In Theater                                                       |
| 4022                            | Amusement Park, Tourist Attraction                                     |
| 4023                            | Piers, Wharf (Recreation)                                              |
| 4024                            | Fish Camps, Game Club, Target Shooting                                 |
| 4025                            | Outdoor Recreation: Beach, Mountain, Desert                            |
| 4026                            | Pool Hall, Billiard Parlor                                             |

Table A19: Land use code (LUC) data dictionary. (*continued*)

| Code                                 | Code Description                                                       |
|--------------------------------------|------------------------------------------------------------------------|
| 4027                                 | Park, Playground, Picnic Area                                          |
| 4028                                 | Golf Course                                                            |
| 4029                                 | Racquet Court, Tennis Court                                            |
| 4030                                 | Zoo                                                                    |
| 4031                                 | Go-carts, Miniature Golf, Water slides                                 |
| 5000 Industrial                      | NA                                                                     |
| 5000                                 | Industrial (General)                                                   |
| 5001                                 | Manufacturing (light)                                                  |
| 5002                                 | Light Industrial (10% improved office space; Machine Shop)             |
| 5003                                 | Warehouse (Industrial)                                                 |
| 5004                                 | Storage yard, Open Storage (light equipment, material)                 |
| 5005                                 | Food Packing, Packing Plant (fruit; vegetable; meat, dairy)            |
| 5006                                 | Assembly (light industrial)                                            |
| 5007                                 | Food Processing (candy; bakery; potato chips)                          |
| 5008                                 | Recycling (metal; paper; glass; etc.)                                  |
| 5009                                 | Communications (see 6500 series)                                       |
| 5010                                 | Condominiums (Industrial)                                              |
| 5011                                 | R&D Facility, Laboratory, Research Facility, Cosmetics, Pharmaceutical |
| 5012                                 | Industrial Park                                                        |
| 5013                                 | Multi-Tenant Industrial Bldg.                                          |
| 5014                                 | Marine Facility/Boat Repairs (small craft or sailboat)                 |
| 5015                                 | Lumber & Wood Product MFG (including furniture)                        |
| 5016                                 | Paper Product MFG & related products                                   |
| 5017                                 | Printing & Publishing (Light Industrial)                               |
| 5018                                 | Industrial Loft Building, Loft Building                                |
| 5019                                 | Construction/Contracting Services (Industrial)                         |
| 5020                                 | Common Area (Industrial)                                               |
| 6000 Heavy Industrial                | NA                                                                     |
| 6000                                 | Heavy Industrial (General)                                             |
| 6001                                 | Transportation                                                         |
| 6002                                 | Distribution Warehouse (Regional)                                      |
| 6003                                 | Mining (oil; gas; mineral, precious metals)                            |
| 6004                                 | Storage yard (junk; auto wrecking, salvage)                            |
| 6005                                 | Distillery, Brewery, Bottling                                          |
| 6006                                 | Refinery, Petroleum Products                                           |
| 6007                                 | Mill (feed; grain; paper; lumber; textile; pulp)                       |
| 6008                                 | Factory (apparel, textile products, leather, medium mfg.)              |
| 6009                                 | Processing Plant (minerals; cement; rock; gravel; glass; clay)         |
| 6010                                 | Lumberyard, Building Materials                                         |
| 6011                                 | Shipyards/Storage - Built or Repaired (seagoing vessels)               |
| 6012                                 | Slaughter House, Stockyard                                             |
| 6013                                 | Waste Disposal, Sewage (processing; disposal; storage; treatment)      |
| 6014                                 | Quarries (sand; gravel; rock)                                          |
| 6015                                 | Heavy Manufacturing                                                    |
| 6016                                 | Labor Camps (Industrial)                                               |
| 6017                                 | Winery                                                                 |
| 6018                                 | Chemical                                                               |
| 6019                                 | Foundry, Industrial Plant (metal; rubber; plastic)                     |
| 6020                                 | Cannery                                                                |
| 6021                                 | Bulk Storage, Tanks (gasoline, fuel, etc.)                             |
| 6022                                 | Grain Elevator                                                         |
| 6023                                 | Dump Site                                                              |
| 6024                                 | Cold Storage                                                           |
| 6025                                 | Sugar Refinery                                                         |
| 6500 Transportation & Communications | NA                                                                     |
| 6500                                 | Transportation & Communications (General)                              |
| 6501                                 | Airport & related                                                      |
| 6502                                 | Railroad & related                                                     |
| 6503                                 | Freeways, State Hwys                                                   |
| 6504                                 | Roads, Streets, Bridges                                                |

Table A19: Land use code (LUC) data dictionary. *(continued)*

| Code                          | Code Description                                                     |
|-------------------------------|----------------------------------------------------------------------|
| 6505                          | Bus Terminal                                                         |
| 6506                          | Telegraph, Telephone                                                 |
| 6507                          | Radio or TV Station                                                  |
| 6508                          | Truck Terminal (Motor Freight)                                       |
| 6509                          | Cable TV Station                                                     |
| 6510                          | Harbor & Marine Transportation                                       |
| 6511                          | Microwave                                                            |
| 6512                          | Commercial Auto Transportation/Storage                               |
| 6513                          | Pollution Control                                                    |
| 7000 Agricultural / Rural     | NA                                                                   |
| 7000                          | Agricultural / Rural (General)                                       |
| 7001                          | Farm (Irrigated or Dry)                                              |
| 7002                          | Ranch                                                                |
| 7003                          | Range land (grazing)                                                 |
| 7004                          | Crop land, Field Crops, Row Crops (all soil classes)                 |
| 7005                          | Orchard (fruit; nut)                                                 |
| 7006                          | Vineyard (Agricultural)                                              |
| 7007                          | Poultry Farm (chicken; turkey; fish; bees; rabbits)                  |
| 7008                          | Dairy Farm                                                           |
| 7009                          | Timberland, Forest, Trees (Agricultural)                             |
| 7010                          | Wildlife (Refuge)                                                    |
| 7011                          | Desert or Barren Land                                                |
| 7012                          | Pasture, Meadow                                                      |
| 7013                          | Misc. Structures - Ranch, Farm, Fixtures                             |
| 7014                          | Grove (Agricultural)                                                 |
| 7015                          | Feedlots                                                             |
| 7016                          | Livestock                                                            |
| 7017                          | Horticulture, Growing Houses, Ornamental (Agricultural)              |
| 7018                          | Well Site (Agricultural)                                             |
| 7019                          | Truck Crops                                                          |
| 7020                          | Reservoir, Water Supply                                              |
| 7021                          | Irrigation, Flood Control                                            |
| 7022                          | Natural Resources                                                    |
| 7023                          | Rural Improved / Non-Residential                                     |
| 8000 Vacant Land              | NA                                                                   |
| 8000                          | Vacant Land (General)                                                |
| 8001                          | Residential-Vacant Land                                              |
| 8002                          | Commercial-Vacant Land                                               |
| 8003                          | Industrial-Vacant Land                                               |
| 8004                          | Private Preserve, Open Space-Vacant Land (Forest Land, Conservation) |
| 8005                          | Institutional-Vacant Land                                            |
| 8006                          | Government-Vacant Land                                               |
| 8007                          | Multi-Family-Vacant Land                                             |
| 8008                          | Agricultural-Unimproved Vacant Land                                  |
| 8009                          | Waste Land, Marsh, Swamp, Submerged-Vacant Land                      |
| 8010                          | Recreational-Vacant Land                                             |
| 8011                          | Water Area (Lakes; River; Shore)-Vacant Land                         |
| 8012                          | Unusable Land (Remnant, Steep, etc.)                                 |
| 8013                          | Abandoned Site, Contaminated Site                                    |
| 8014                          | Under Construction                                                   |
| 8500 Special Purpose          | NA                                                                   |
| 8500                          | Special Purpose                                                      |
| 8501                          | SBE - Special Assessments                                            |
| 8502                          | Regulating Districts & Assessments; Tax Abatement                    |
| 8503                          | Redevelopment Agency or Zone                                         |
| 8504                          | Centrally Assessed                                                   |
| 9000 Exempt (full or partial) | NA                                                                   |
| 9000                          | Exempt (full or partial)                                             |
| 9001                          | Indian Lands                                                         |
| 9100 Institutional            | NA                                                                   |

Table A19: Land use code (LUC) data dictionary. *(continued)*

| Code                         | Code Description                                                       |
|------------------------------|------------------------------------------------------------------------|
| 9100                         | Institutional (General)                                                |
| 9101                         | Religious, Church, Worship (Synagogue, Temple, Parsonage)              |
| 9102                         | Parochial School, Private School                                       |
| 9103                         | College, University, Vocational school-PRIVATE                         |
| 9104                         | Hospital-PRIVATE                                                       |
| 9105                         | Medical Clinic                                                         |
| 9106                         | Homes (retired; handicap, rest; convalescent; nursing)                 |
| 9107                         | Children's Home, Orphanage                                             |
| 9108                         | Cemetery (Exempt)                                                      |
| 9109                         | Crematorium, Mortuary (Exempt)                                         |
| 9110                         | Charitable organization, Fraternal                                     |
| 9111                         | Recreational Non-Taxable (Camps, Boy Scouts)                           |
| 9112                         | Private Utility (Electric; Water; Gas; etc.)                           |
| 9200 Governmental/Public Use | NA                                                                     |
| 9200                         | Governmental/Public Use (General)                                      |
| 9201                         | Military (office; base; post; port; reserve; weapon range; test sites) |
| 9202                         | Forest (park; reserve; recreation, conservation)                       |
| 9203                         | Public School (administration; campus; dorms; instruction)             |
| 9204                         | Colleges, University-PUBLIC                                            |
| 9205                         | Post Office                                                            |
| 9206                         | Cultural, Historical (monuments; homes; museums; other)                |
| 9207                         | Govt. Administrative Office (Federal; State; Local; Court House)       |
| 9208                         | Emergency (Police; Fire; Rescue; Shelters, Animal Shelter)             |
| 9209                         | Other exempt property                                                  |
| 9210                         | City, Municipal, Town, Village Owned (Exempt)                          |
| 9211                         | County Owned (Exempt)                                                  |
| 9212                         | State Owned (Exempt)                                                   |
| 9213                         | Federal Property (Exempt)                                              |
| 9214                         | Public Health Care Facility (Exempt)                                   |
| 9215                         | Community Center (Exempt)                                              |
| 9216                         | Public Utility (Electric; Water; Gas; etc.)                            |
| 9217                         | Welfare, Social Service, Low Income Housing (Exempt)                   |
| 9218                         | Correctional Facility, Jails, Prisons, Insane Asylum                   |
| 9219                         | Hospital-PUBLIC                                                        |
| 9300 Historical-Private      | NA                                                                     |
| 9300                         | Historical-PRIVATE (General)                                           |
| 9301                         | Historical Residence                                                   |
| 9302                         | Historical Retail                                                      |
| 9303                         | Historical Warehouse                                                   |
| 9304                         | Historical Office                                                      |
| 9305                         | Historical Transient Lodging (hotel/motel)                             |
| 9307                         | Historical Recreation, Entertainment                                   |
| 9308                         | Historical Park, Site, Misc.                                           |
| 9309                         | Historical District                                                    |