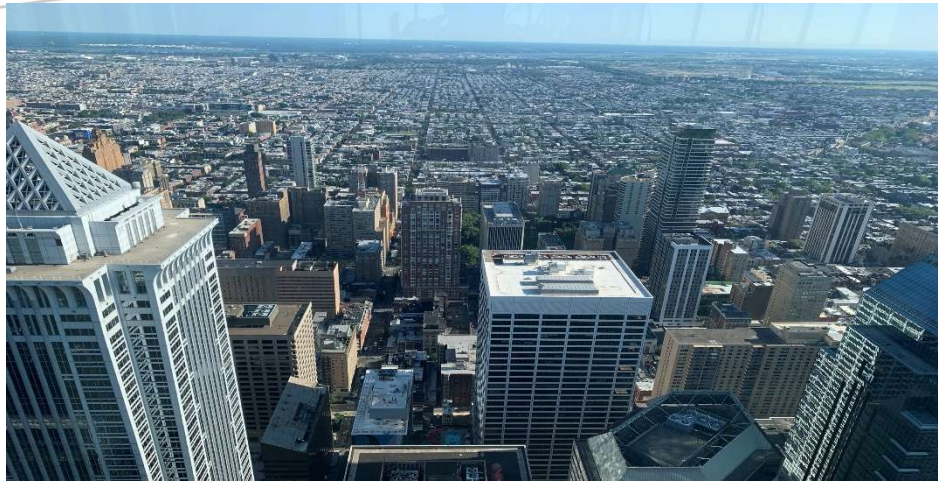




INDEPENDENT RATIO STUDY REPORT – CITY OF PHILADELPHIA JUNE 2026



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SENSIBLE SOLUTIONS.

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Ratio Studies

The International Association of Assessment Officers (IAAO) is a nonprofit, educational and research association that promotes fair and equitable assessments and provides standards for the world-wide assessment industry. IAAO publishes standards for assessment performance and the practice of mass appraisal. This independent ratio study conforms with the IAAO Standard on Ratio Studies. OPA has adopted the IAAO performance standards.

A Ratio Study is a statistical process that compares sales prices to assessed market values. Ratio Studies are commonly used to evaluate the health of assessments. Most jurisdictions report one combined ratio statistic for the entire county. This is common for the purpose of oversight, but for diagnostic purposes greater depth and detail is needed.

For each observation, market value is divided by sale price to calculate the ratio. The resulting ratios are analyzed to calculate the median ratio, the mean ratio, and the weighted mean ratio. Of these, the median ratio is typically used to describe the overall level of assessment. The mean and weighted mean are indicators of the presence of extremely high or low ratios and are compared to the median ratio to determine the degree of distortion or variance from the median ratio. In most jurisdictions, median ratios should be close to 1.00 – which indicates that price and value are equal. The IAAO standard for level of assessment is the median ratio for all classes of property should be between 0.9 and 1.1. It is of greater importance that median ratios for the inventory when stratified – by location, price class, or property type – should be reasonably uniform. If the median ratio for the county is 0.91, all strata should have median ratios close to 0.91.

Ratios are also analyzed for both vertical and horizontal equity. All properties that sell for the same price should have close to the same assessed value. This is called horizontal equity and is usually measured by the Coefficient of Dispersion (COD), which is the average percentage of deviation from the median ratio. Lower scores are generally better. Desirable levels vary depending on the homogeneity of the inventory. For Philadelphia, the target COD is less than 0.15.

Properties in all price ranges or categories should be assessed at the same level. This is called vertical equity and is typically measured by the Price Related Differential (PRD). PRD is measured by dividing the mean ratio by the weighted mean ratio. Scores between 0.98 and 1.03 are ideal and considered to indicate no bias. Higher or lower scores do not necessarily indicate bias but suggest that further study is needed.

Table 1-3. Ratio Study Uniformity Standards indicating acceptable general quality*

Type of property—General	Type of property—Specific	COD Range**
Single-family residential (including residential condominiums)	Newer or more homogeneous areas	5.0 to 10.0
Single-family residential	Older or more heterogeneous areas	5.0 to 15.0
Other residential	Rural, seasonal, recreational, manufactured housing, 2–4 unit family housing	5.0 to 20.0
Income-producing properties	Larger areas represented by large samples	5.0 to 15.0
Income-producing properties	Smaller areas represented by smaller samples	5.0 to 20.0
Vacant land		5.0 to 25.0
Other real and personal property		Varies with local conditions

These types of property are provided for guidance only and may not represent jurisdictional requirements.

** Appraisal level for each type of property shown should be between 0.90 and 1.10, unless stricter local standards are required.*

PRD's for each type of property should be between 0.98 and 1.03 to demonstrate vertical equity.

PRD standards are not absolute and may be less meaningful when samples are small or when wide variation in prices exist. In such cases, statistical tests of vertical equity hypotheses should be substituted (see table 1-2).

*** CODs lower than 5.0 may indicate sales chasing or non-representative samples.*

Figure 1 IAAO Ratio Uniformity Standards¹

¹ IAAO Standard on Ratio Studies April 2013 https://www.iaao.org/media/standards/Standard_on_Ratio_Studies.pdf

When the ratio study is stratified, the median ratio and COD are significant for comparing a stratum or submarket to other strata or submarkets. The PRD is less informative, as it only measures vertical equity *within* the stratum. Looking at the PRD for a Style (Row, Single or Twin) only tells us about high versus low valued properties within that Style, not when compared to other Styles. Therefore, the only significant measure of PRD is at the city-wide level or at the Zone level.

Data Sources

For this study, Philadelphia's Office of Property Assessment (OPA) provided a file of 31,494 transactions for single family residences that had been reviewed BY OPA staff and validated for use in the valuation process, ranging in date from January of 2022 through June of 2026.

Disqualifying Transactions

When a property's attributes at the time of sale are principally the same as at the time of valuation, there is a relationship between sale price and market value. When the attributes at time of sale and the attributes at time of valuation are significantly different, that relationship no longer holds true. The sale price may bear little or no relationship to the value. If we are using a ratio study as part of the equity analysis, these transactions must be identified and removed from consideration. Section 3.5 of the Standard on Ratio Studies states:

The appraiser must ascertain whether the property rights transferred, the permitted use, and the physical characteristics of the property on the date of assessment are the same as those on the date of sale. If the physical characteristics of the property have changed since the last appraisal, adjustments may be necessary before including the property in a ratio study. Properties with significant differences in these factors should be excluded from the ratio study.²

It must be emphasized that these sales are disqualified *only* for ratio studies. Because the attributes are matched with the sales prices, they are fine to use for modeling or valuation and representation studies. It is the comparison to *market values* when the attributes have changed that breaks the relationship between attributes and price. This requires data files that allow the analyst to make this distinction. Ratio Studies are easily distorted by including transactions where the attributes of the property at the time of valuation are different than the attributes that were present at the time of sale.

To qualify/disqualify transactions, OPA ran comparisons of neighborhoods, property types, condition of improvements, size category, and building square footage at time of sale to those same attributes at time of valuation, disqualifying 6,440 (17.1%) transactions where any of these attributes were different. Minor changes to a property would not disqualify a transaction through this process.

Outlier Removal

When using sales for valuation, as in building regression models or running a ratio study, it is important to remove transactions that are outliers or do not representative of typical market activity. The most common methods of removing outliers are simple truncation or Inter-Quartile Range (IQR). Both techniques require ranking all ratios from highest to lowest.

Simple truncation removes the same percentage of ratios from the top and bottom of the arrayed data. IAAO allows for removal of up to 10% of ratios from a large sample size through truncation. Determining the optimal percentage of

² IAAO Standard on Ratio Studies April 2013 Section 3.5 https://www.iaao.org/media/standards/Standard_on_Ratio_Studies.pdf

transactions to remove can be problematic. The technique also assumes that outliers are evenly distributed at both ends of the ratio array.

The IQR method calculates the range between the 25th and 75th percentiles, subtracts the range multiplied by either 1.5 or 3 from the 25th and adds the range multiplied by either 1.5 or 3 to the 75th percentile and truncates cases with ratios higher or lower than the result. Many assessment oversight agencies use the IQR method. Either method is useful for reporting one set of statistical performance measures for the entire jurisdiction. Neither should be used if the purpose of the ratio study is diagnostic in nature. If a submarket is highly over-assessed or under-assessed, one runs the risk of eliminating all of the observations that would expose that submarket's performance.

Perhaps the best method of outlier removal is through the use of studentized residuals. The process precisely identifies and disqualifies transactions that exert undue influence on a regression model. OPA uses this method of outlier removal in its modeling process. For this study, OPA coded transactions that were identified as outliers in the valuation models. Those transactions were removed from this ratio study. This is the best available method of removing outliers, so no further outlier removal was necessary.

Ratio Study Results

To demonstrate the impact of the TY2027 revaluation project, ratio statistics were measured at two points in time. A baseline was established by measuring performance at the start of the project, using time adjusted sale prices (TASP) and certified TY2026 market values. This was compared to ratio statistics that were run using TASP and the final TY2027 market values that have been sent to property owners.

Ratio statistics were stratified by Zones, Style Group (Rows, Twins, and Singles), and Geographic Market Areas (GMAs).

Overall Results

The overall results are very good, with significant improvement over TY2026 performance.

Prior (TY2026) Values: Median: 0.935 Price Related Differential: 1.014 Coefficient of Dispersion: 0.141

Proposed (TY2027) Values: Median: 0.992 Price Related Differential: 1.016 Coefficient of Dispersion: 0.101

The overall median ratio had fallen to .935, which reflects the general increase in values since the last revaluation. A median of .935 falls within the IAAO standard of between .9 and 1.1. Price Related Differential was within IAAO standards and showed good vertical equity. The Coefficient of dispersion of 14.1% is also within the IAAO desired range for a city like Philadelphia.

The proposed TY2027 values result in excellent performance by all statistical measures. A median ratio of .992 is almost perfect. The PRD does not indicate bias. The coefficient of dispersion of 10.18% is well within the IAAO , and is excellent for a city like Philadelphia.

These scatterplots in Figure 2 and 3 visualize comparative assessment performance before and after the TY2027 revaluation project. Each dot represents the point where TASP and value intersect. The fit line is where price and value would be equal. It is desirable for points to fall close to the fit line.

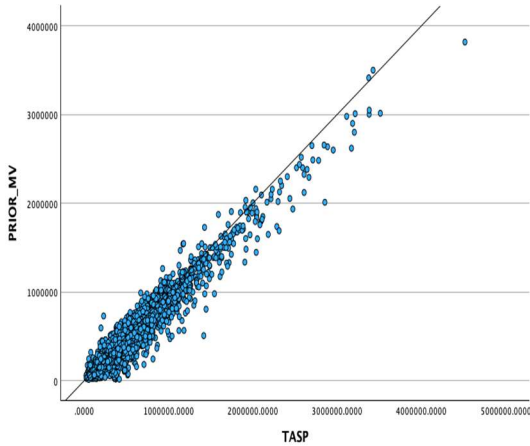


Figure 2 Scatterplot of TY2026 assessment performance

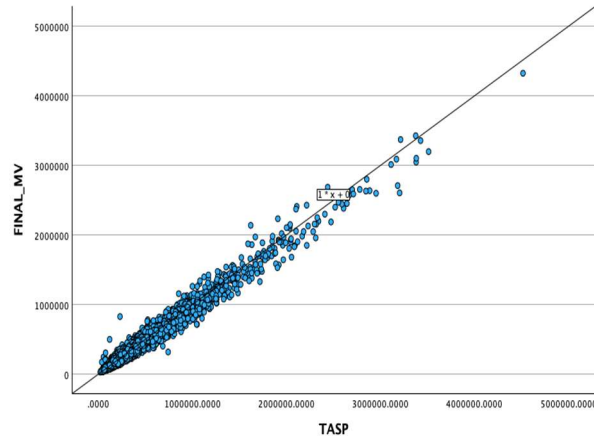


Figure 3 Scatterplot of TY2027 assessment performance

Visualization of the TY2026 assessments in Figure 2 shows that many points fell below the fit line (undervaluation), with the distance from the line increasing as price increases. In general, points are more distant from the fit line throughout the entire spectrum of price.

Visualization of assessment performance using the proposed TY2027 values in Figure 3 shows significant improvement. Points fall both above and below the fit line and are much closer to the fit line throughout the entire spectrum of price. The magnitude of errors is smaller, and the distribution of errors is more random.

Ratios by Zone

Zones are large sections of the city that share a similar time trend and where the attributes that are significant contributors to value generally have similar effects. There are currently seventeen zones recognized across the city, as shown in figure 4. Each zone contains a different number of GMAs.

It is useful to compare performance for different parts of the city. It is unrealistic to expect the same level of performance across all submarkets. Some variance is normal and expected. OPAs assessments have been excellent in Zones C, D, E and N. Uniformity in Zones A, B, G and H needed improvement. Over time, assessments have been improving across all Zones, and significant strides have been made in the areas that needed the most improvement. These improvements are evident in the comparative performance statistics.

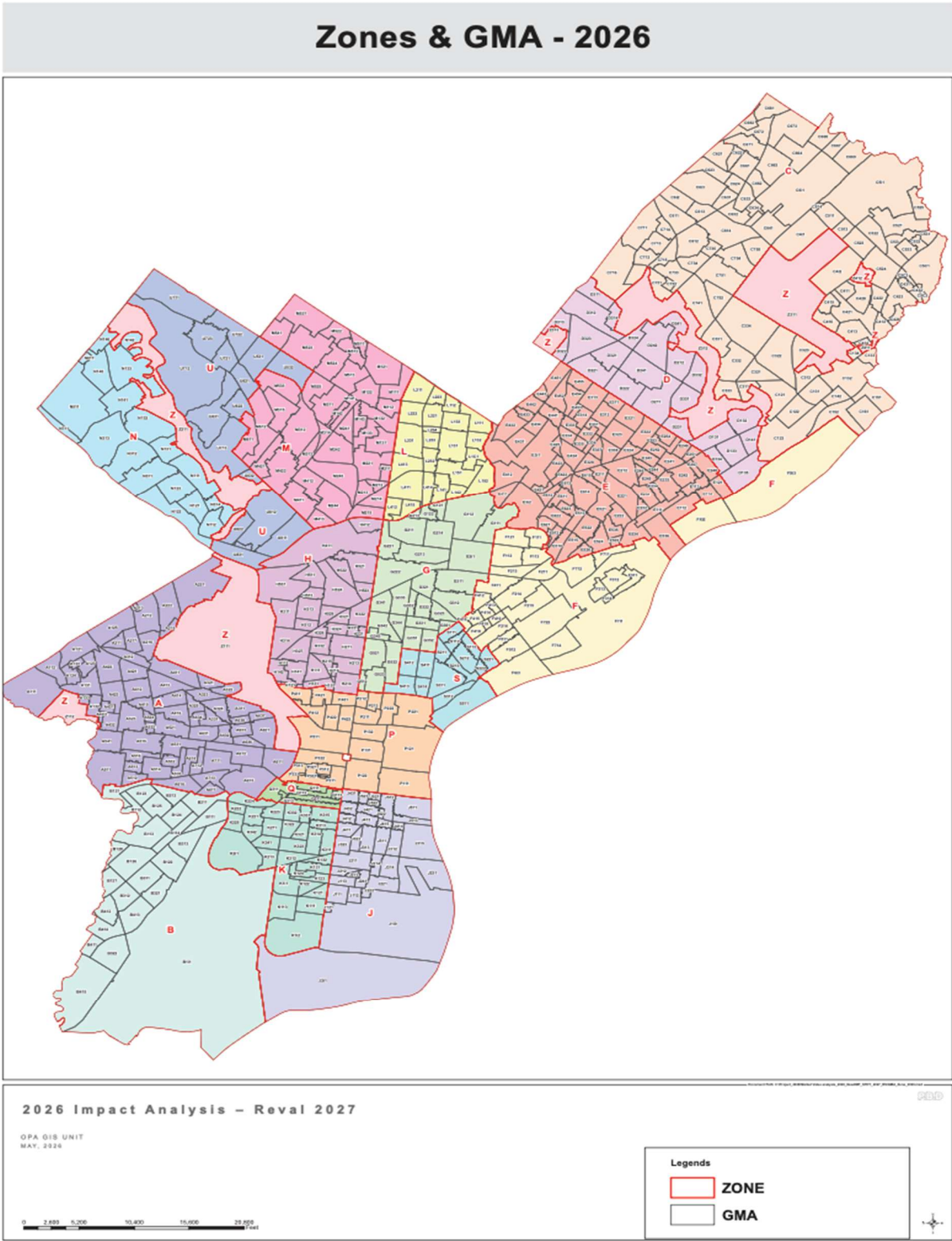


Figure 4 TY2027 Zones and GMAs

Ratio Statistics for PRIOR_MV / TASP

Group	Mean	Median	Weighted Mean	Price Related Differential	Coefficient of Dispersion
A	.926	.942	.915	1.012	.194
B	.850	.846	.803	1.059	.237
C	.909	.905	.902	1.007	.070
D	.942	.938	.935	1.007	.081
E	.959	.957	.949	1.011	.109
F	.907	.911	.890	1.020	.172
G	.907	.885	.881	1.030	.231
H	1.009	1.036	1.014	.995	.222
J	.946	.952	.929	1.019	.122
K	.923	.940	.918	1.005	.145
L	.980	.983	.959	1.022	.155
M	.929	.930	.906	1.024	.172
N	.894	.895	.885	1.009	.089
P	.935	.936	.925	1.012	.093
Q	.965	.961	.951	1.015	.090
S	.987	.983	.963	1.025	.120
U	.919	.920	.908	1.012	.097
Overall	.934	.935	.921	1.014	.141

Figure 5 TY2026 Ratio statistics by Zone

Figure 5 shows the performance of the prior (TY2026) assessments. Median ratios were low in all Zones except Zone H. There was a very wide range in COD between Zone C (at 7.0%) and Zone B (at 23.7%). PRD was within IAAO and OPA targets in all Zones except Zone B, which appeared to be slightly regressive. Overall, these are much better baseline measurements than those observed prior to the last reassessment, where the median ratio had fallen to 80.5% and the COD had crept up to 16.3%.

Ratio Statistics for FINAL_MV / TASP

Group	Mean	Median	Weighted Mean	Price Related Differential	Coefficient of Dispersion
A	1.006	.985	.988	1.019	.131
B	1.016	.999	.989	1.027	.148
C	1.001	.994	.995	1.006	.059
D	1.003	.996	.996	1.008	.071
E	1.008	.996	.997	1.011	.089
F	1.009	.994	.994	1.016	.116
G	1.027	.985	.990	1.037	.177
H	1.019	1.015	1.014	1.005	.143
J	.996	.986	.980	1.016	.099
K	1.005	.994	.990	1.015	.102
L	1.003	.989	.991	1.013	.100
M	1.006	.995	.989	1.017	.113
N	1.000	.995	.991	1.009	.075
P	.977	.968	.965	1.013	.076
Q	1.000	.994	.989	1.011	.079
S	1.003	.993	.986	1.017	.094
U	1.005	.994	.999	1.006	.080
Overall	1.005	.992	.989	1.016	.101

Figure 6 TY2027 Ratio statistics by Zone

Figure 6 shows the performance of the TY2027 assessments. Median ratios are within IAAO and OPA targets in all Zones. OPA uses a more stringent standard, targeting median ratio between .95 and 1.02. Median ratios for all Zones meet the OPA standard.

The range in COD is much tighter between Zone C (at 5.9%) and Zone G (at 17.7%). COD is at or below 10% in Zones C, D, E, J, N, P, Q, S and U and is below the 15% target in all but one Zone for the first time in the history of BRT/OPA. PRD is within IAAO and OPA targets in all Zones.

Ratios by Style

Examination of ratio performance by style of property shows improvement and no causes for concern.

“R” refers to row homes; “S” refers to single (detached) homes and “T” refers to twin homes.

Ratio Statistics for PRIOR_MV / TASP

Group	Mean	Median	Weighted Mean	Price Related Differential	Coefficient of Dispersion
R	.936	.940	.924	1.013	.149
S	.911	.910	.902	1.010	.092
T	.930	.923	.917	1.014	.110
Overall	.934	.935	.921	1.014	.141

Figure 7 TY2026 Ratio statistics by Row Single or Twin

Ratio Statistics for FINAL_MV / TASP

Group	Mean	Median	Weighted Mean	Price Related Differential	Coefficient of Dispersion
R	1.006	.992	.987	1.019	.107
S	1.000	.995	.994	1.006	.067
T	1.002	.992	.993	1.010	.081
Overall	1.005	.992	.989	1.016	.101

Figure 8 TY2027 Ratio statistics by Row Single or Twin

Ratios by GMA

It can be useful to examine ratio statistics by GMAs. Within Zones we can see which neighborhoods are performing well and which are in need of improvement. The tabular results for over 620 GMAs both before and after the TY2027 revaluation are attached in Appendix A. Where neighborhoods have a lot of variance in terms of age, size, design or condition in the inventory of properties, there may not be enough sales to represent unsold properties and the ratio statistics may be misleading.

Visualization of Median Ratio

The maps in Figure 9 show median ratio by GMA before and after the revaluation. At the start of the project most GMAs had median ratios below .95. After the revaluation, the vast majority of the GMAs have median ratios between .95 and 1.05. A small number are overvalued, with median ratios between 1.05 and 1.1. A smaller number are above the IAAO target of 1.1. Large scale maps are available where the GMAs are labeled and the median ratio for each GMA is displayed.

Median Ratio by GMA - Single Family (Start to Finish)

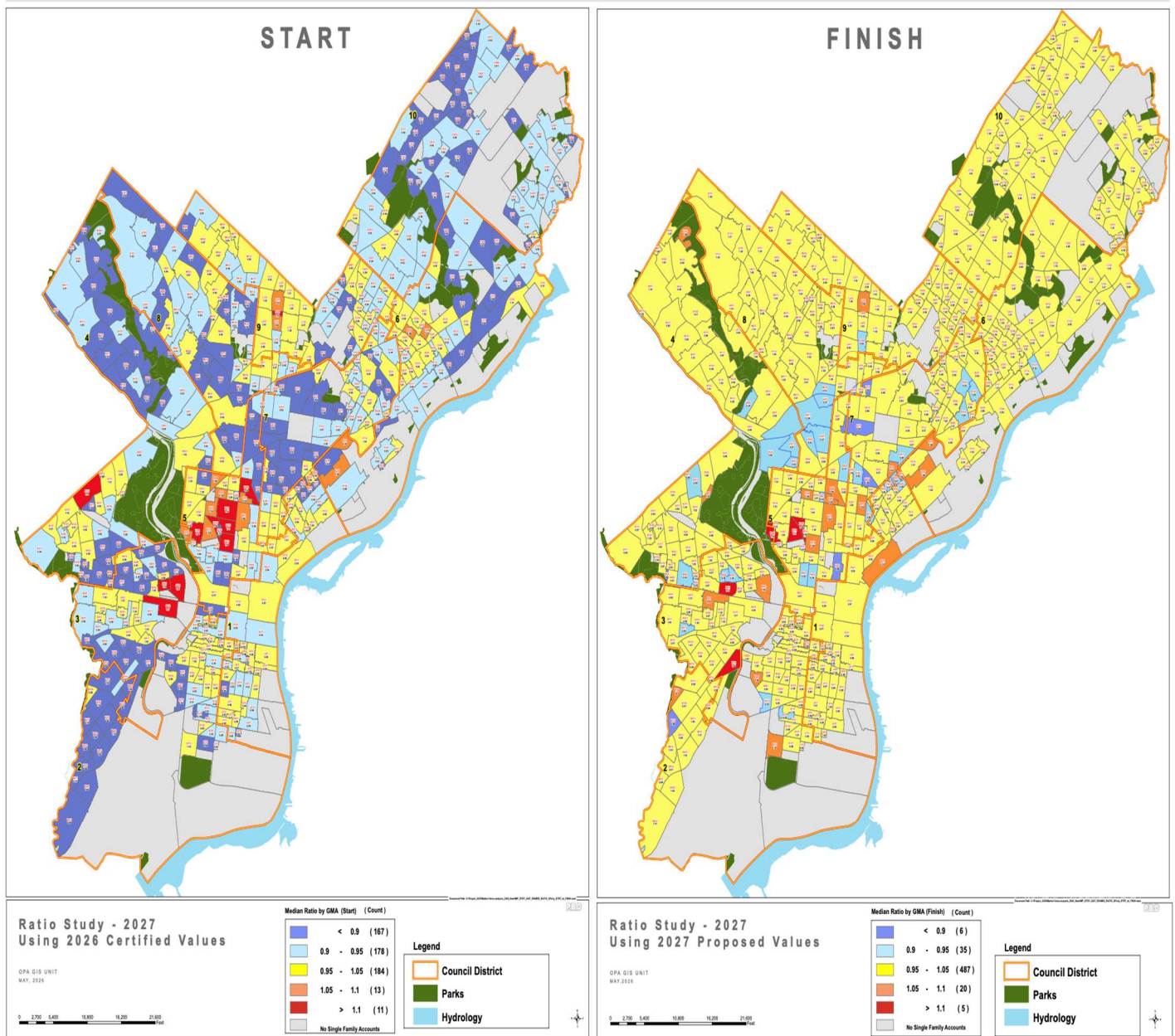


Figure 9 Before and After Median Ratio by GMA

Visualization of Coefficient of Dispersion

The maps in Figure 10 show coefficient of dispersion by GMA before and after the revaluation. At the start of the project the range of COD is fairly large. After the revaluation, the vast majority of the GMAs have CODs of less than 0.15, which is the target for a city like Philadelphia. Large scale maps are available where the GMAs are labeled and the COD for each GMA is displayed.

Coefficient of Dispersion by GMA - Single Family (Start to Finish)

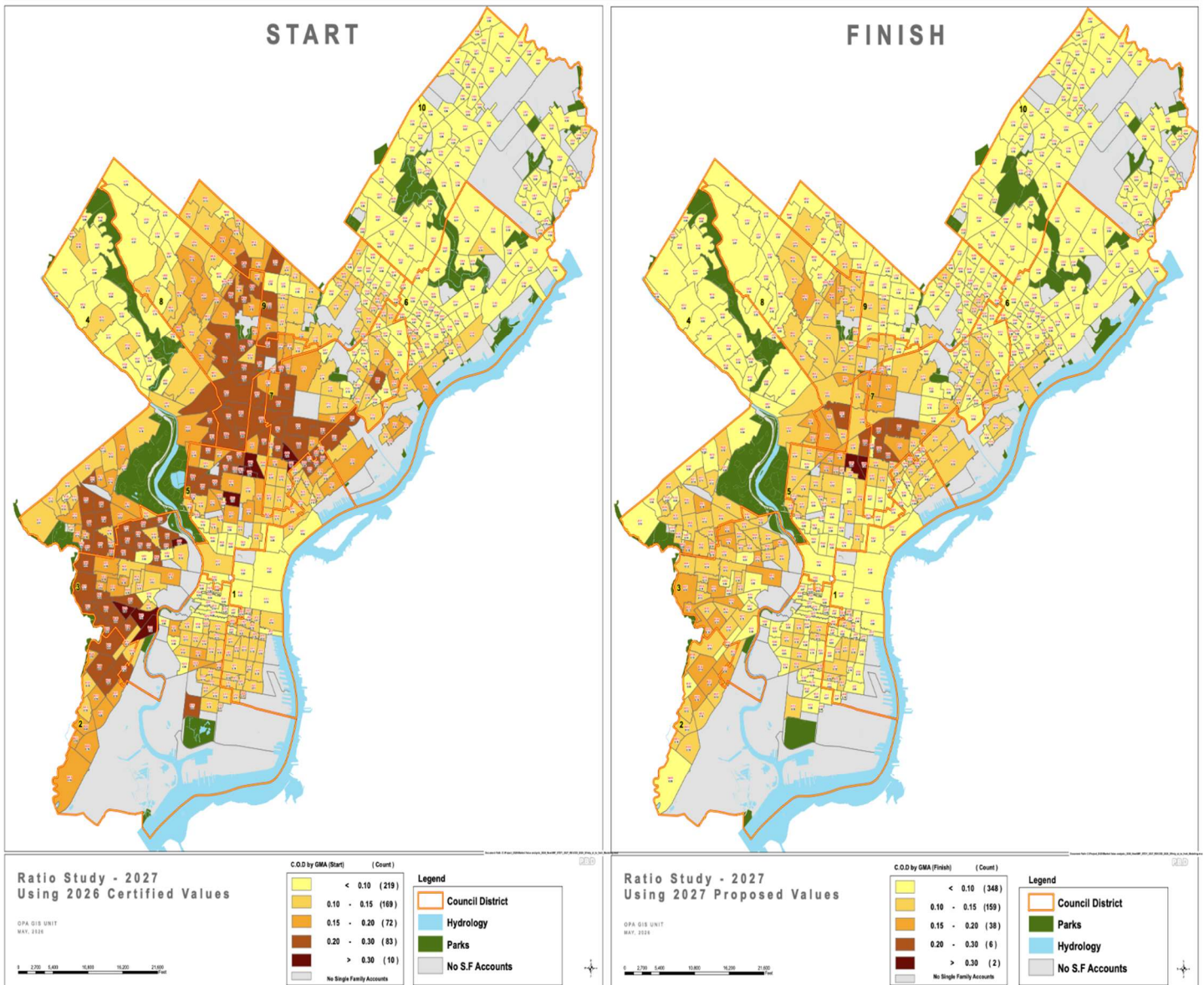


Figure 10 Before and After Coefficient of Dispersion by GMA

Ratio Study Conclusions

After adjusting prices for time, removing outliers, and disqualifying transactions where attributes at time of sale were different than current attributes, the ratio study for the previous set of assessments (TY2026) shows:

- Level of assessment was above .90, which is within the IAAO and OPA target for all groups of properties when stratifying by Zones or property types.
- COD of 0.141 met the IAAO target of less than 0.15.
- Vertical equity measured by PRD 1.014 which was within the ideal range by the IAAO standard.

The set of assessments for the TY2027 revaluation project are much improved.

- Level of assessment is excellent when stratifying by Zones or property types.
- The overall COD of 0.101 is excellent. Only Zone G has a CODs that is slightly higher than the target of 0.15, and no Zones are excessively high.
- Vertical equity measured by PRD was 1.016, which is within the ideal range by the IAAO standard.

These results are by far the best that OPA has yet achieved, and would once have been thought to be unattainable. In general, it is safe to conclude that OPA's valuation process is working well, and that the subsystems that create the valuation process – Sales Validation; Data Collection; Neighborhood Delineation; Modeling and Market Value Review – are producing good results. The results of the TY2027 revaluation are excellent, especially considering the inherent difficulties presented by the wide range of property types, age, size, neighborhoods, quality of construction, and condition of improvements in the inventory of properties. Performance in many GMAs and Zones is excellent, and there is very little room left for improvement. There are a relatively small number of neighborhoods (GMAs) that are not performing well. There are many reasons why this may be true. If those reasons can be isolated and understood, performance in those GMAs can be greatly improved in future revaluation projects.

Qualifications

I have worked in mass appraisal for over thirty years. Most of my experience has been with the City of Philadelphia, where I served as a real property evaluator; mass appraisal analyst; real property supervisor; GIS manager; appeals, customer service, and exemptions administrator; residential administrator; modeling director; and director of mass appraisal and analysis. I personally designed and directed over 16 major revaluation projects. Over a period spanning decades, I was part of an ongoing effort to build an assessment system that was more objective and fair. I created custom neighborhood definitions; built a CAMA system; introduced GIS to the department; created a sales file to support mass appraisal; instituted a system of sales validation; created persistent and consistent groups to support valuation and analysis; developed a catalog of regression models that are used to estimate values and promoted a well-documented process that improved transparency and public understanding of assessments. I have trained many appraisers, modelers and analysts. I have mentored and worked with offices and practitioners from around the world. I have been a frequent presenter and workshop facilitator at IAAO and URISA conferences. I have retired from my position with the City of Philadelphia and now serve as a mass appraisal consultant, with current clients in Michigan, North Carolina, Washington and Wisconsin as well as clients in several other states in various stages of contracting for services.

