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# Statistical Analysis of Post-Election Audit Data for the November 6, 2018 State Elections

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## Summary

This report presents an analysis of the returns from the post-election audit performed in the State of Connecticut following the November 6, 2018 state elections. The audit involved a random selection of 5% of the precincts in which ballots were cast. In each precinct so selected, the ballots cast on election day were either hand-counted or counted with electronic assistance.<sup>1</sup> This report is based on audits conducted in 2018 but not reflected in an official VoTeR Center report from that period. The analysis in this report was performed by the authors in 2023.

A total of 22 precinct audits were submitted for analysis, comprising 189 audit records. Table 1 provides a list of the selected precincts included in this statistical analysis.

The specific goal of the analysis was to use statistical methods to detect instances of tabulator malfunction. The 22 precinct audit results evaluated show discrepancies between tabulated and audited totals that are consistent with anticipated human error in counting or ballot handling. The analysis revealed no conclusive signs of tabulator malfunction.

## 1 Analysis Description

### 1.1 Audit Records

The audit returns are presented in a result report in which auditors record information about the precinct under audit, the result of their count, and the corresponding count value from the tabulator. This analysis considers the vote totals for each candidate as a separate record. Each record consists of three items: the total votes as reported by the tabulator, the number of bubbles containing an “undisputed mark,” and the number of bubbles containing a “questionable mark.” An “undisputed mark” is a mark that covers the majority of the bubble and is dark enough that all auditors agree that it should have been read as a mark by a working tabulator. A “questionable mark” is a mark that is not large or dark enough to convince all of the auditors that a working tabulator would have recorded it as a mark.

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<sup>1</sup>Auditors are allowed to use an electronic audit assistance tool, provided that they visually examine each ballot to confirm bubble interpretations.

Town	District
Barkhamsted	Barkhamsted Elementary School
Berlin	Willard School
Bristol	Chippens Hill Middle School
East Granby	East Granby Community Center-1
East Hartford	Hockanum School
Hartford	Liberty Christian Center-Formerly Horace Bushnell
Hartford	Y W C A
Harwinton	Assembly Hall
New Britain	Diloreto School
New Haven	Nathan Hale School
Preston	Town Hall
Ridgefield	East Ridge Middle School-1
Salem	Salem Town Office Building
Stamford	Dolan Middle School
Stratford	Lordship Elementary School 121 21
Stratford	Nichols School 121 21
Thomaston	Lena Morton Art Gallery
Torrington	Torrington School 1
Vernon	Vernon Center Middle School
Weston	Weston Middle School-26
Westport	Saugatuck Elementary School Gym
Willington	The Town Office Building

Table 1: Audit precincts analyzed

## 1.2 Expected Vote Ranges

For each record, the undisputed hand-counted mark total and questionable hand-counted mark total are used to define an *expected tabulator total range*. The range is defined as having a minimum that is equal to the undisputed mark count and a maximum that is equal to the sum of the undisputed mark count and questionable mark count. If the total as reported by the tabulator is at least the undisputed mark count and no more than the sum of the undisputed and questionable mark counts, the tabulated results are consistent with the hand-counted results. In this case, the tabulator is considered to be functioning properly.

## 1.3 Discrepancies

**Total Ballot Count Discrepancies.** If the tabulator total falls outside of this expected range then it is considered an unexplained discrepancy. In general, we measure unexplained discrepancies as a percentage of the number of cast ballots. If the total ballot count is different from the total number of ballots counted during the audit, and the discrepancy value falls somewhere between zero and the ballot count difference, then the source of the discrepancy is potentially attributable to the difference in the ballot count. For this reason, it is important that auditors reconcile the tabulator ballot count and the audit ballot count. To be conservative, we evaluate discrepancy as a percentage of the minimum of the tabulator total as reported on the tape and the total hand-counted ballots indicated in the audit report. (This convention can only increase the reported discrepancy in comparison with use of either of the individual numbers.) We call this method **Known Ballots Cast**.

If the total number of tabulated or hand-counted ballots was not recorded on the audit report we instead adopt the total number of votes cast in the largest single-choice race in the district under consideration. This may lead to an underestimate of the total number of cast ballots, and hence can only increase the reported discrepancy as it is treated as a percentage of cast ballots. When this method has been used for either (or both) the total number of tabulated or hand-counted ballots, we say that discrepancies are determined by **Inferred Ballots Cast**. Note that this alternate convention is only relevant for records with nonzero discrepancy so we treat records with a discrepancy of 0 as a single category.

**Anticipated Human Error.** We anticipate that a small amount of error will be present in a hand count. This error presumably depends on a wide variety of factors, including the complexity of the race to be audited, the operational details of the hand counting procedure, and the physical details

of the ballots themselves. The study of Goggin, Byrna, and Gilbert [GBG12] observed an empirical error rate of 1.87% (with a standard error of .678%) for Optical Scan ballots; the study adopted simple two-candidate races and averaged over several counting methods. The study also measured human miscounting of the total ballot population, observing an empirical error rate of 0.95% (with a standard error of 0.328%).

**Records of Interest** With this as a guide, we treat discrepancies of approximately 1% of the audit ballot count as consistent with errors arising from human hand counting; in particular, such error rates are not a conclusive indicator of tabulator malfunction. Historically, the majority of our observed individual discrepancies are less than 1% of the total number of cast ballots, though discrepancies tend to be higher on complicated races where voters can specify multiple candidates.

We treat discrepancies exceeding 1.5% as records of special interest, and include in the report any additional information we have that may put the errors in context.

## 2 Analysis Results

Of the 189 submitted records, 19 records (from the same precinct) were reportedly affected by a breakdown in procedures in the reporting precinct and have been excluded from this statistical analysis. Of the included 170 records, 44 (25.88%) of the audit records exactly confirmed the tabulator count and an additional 76 records (44.71%) represented counts within the expected vote range for a total of 120 records (70.59%) with no discrepancy. The remaining 50 (29.41%) audit records reported a tabulator count that differed from the audit count. Of the records that differed, all 50 records showed a discrepancy less than or equal to 1%. We note that all of the audit reports received include both the total ballot count and the total number of ballots hand-counted at the audit. Therefore, we use the Known Ballots Cast method, outlined above, to evaluate all discrepancies in the audit records included in this analysis.

Category	Record count
Records within expected range	120
Records outside expected range but with $\leq 1\%$ discrepancy:	50
Records excluded due to reported breakdown in procedures	19
Total	189

Table 2: Categorization of audit records

Table 2 shows the audit record categories as well as the number of audit records that fall into that category.

**Further discussion of discrepancies.** Of the 50 records showing a discrepancy between the audit count and the machine count, all 50 are within the 1% threshold of the audit ballot count.

**Inadvertent Mixing of Ballots** 19 records (submitted by a single precinct) appear to have been affected by the inadvertent commingling of ballots that were counted by a tabulator, spoiled ballots, and test ballots. The registrars from this district note “We had spoiled ballots and handwritten test ballots that ended getting mixed up together with machine counted ballots. There were 25 ballots taken off of the moderator’s returns, with no envelopes to separate them, that is why we believe they are mixed in.” The corresponding audit report shows thirty five (35) more ballots were hand counted

at the audit than by the tabulator, as shown on the tabulator tape. The audit report also indicates that “127 paper ballots were not counted in this audit.” There is no further explanation as to which ballots were not counted and the reason for their exclusion from the audit. Due to the breakdown in procedures on election day and the audit, we have excluded these records from our statistical analysis.

### 3 Conclusion

The University of Connecticut Center for Voting Technology Research (VoTeR Center) received data gathered in the post-election audit performed in the State of Connecticut following the November 6, 2018 election. The University of Connecticut Center for Voting Technology Research (VoTeR Center) analyzed this data in 2023. The audit involved the 5% of the precincts at which ballots were cast randomly selected for audits; the audit returns were conveyed by the Office of the Secretary of the State (SotS) to the VoTeR Center. The audit data analyzed by the Center contains 189 records, where each record represents information about a given candidate: date, district, office, candidate, machine counted total, hand counted total of the votes considered unquestionable by the auditors, hand counted total of the votes considered questionable by the auditors, and the hand counted total, that is, the sum of undisputed and questionable votes.

While one always wishes for no discrepancies, the magnitude of the discrepancies (with the exception of those precincts excluded due to presumably compromised hand-count results) is consistent with the anticipated errors arising from hand counting. To conclude, the analyzed audits offer no conclusive evidence of tabulator malfunction in the 2018 state election.

### References

- [GBG12] Stephen N. Goggin, Michael D. Byrne and Juan E. Gilbert. Post-Election Auditing: Effects of Procedure and Ballot Type on Manual Counting Accuracy, Efficiency, and Auditor Satisfaction and Confidence. *Election Law Journal: Rules, Politics, and Policy*. 11(1): 36–51. March, 2012.