



VoTeR Center

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Statistical Analysis of Post-Election Audit Data for the November 2, 2021 municipal 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 2, 2021 municipal 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.¹

A total of 33 precinct audits were submitted for analysis, comprising 336 audit records. One town selected for audit, Derby, was later exempted as a result of a town-wide recount.

The specific goal of the analysis was to use statistical methods to detect instances of tabulator malfunction. The 33 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.

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

Town	District
Bloomfield	District-1
Bolton	District-1
Bristol	District-1-2
Bristol	District-3-3
Cheshire	District-3
Darien	District-3
Derby	Central AB Counting Location
Guilford	District-2
Hamden	District-2
Hamden	District-7
Hartland	Hartland School
Mansfield	District-2
Middletown	District-3
New Britain	District-15
New Haven	District-20
New Haven	District-24
New Haven	District-29
Newington	District-1
Newtown	District-1-1
North Stonington	Education Center
Plainville	Linden Street School
Prospect	District-89-1
Prospect	District-89-2
Rocky Hill	District-2
Stamford	District-16
Thompson	District-1
Thompson	District-2
Watertown	District-4
Watertown	District-68-03
Watertown	District-68-04
Weston	Weston MS
Westport	District-3
Willington	District-1
Wolcott	District-2

Table 1: Audit precincts analyzed

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.

1.2 Expected Vote Ranges

For each record, the undisputed mark total and questionable mark total are used to define an *expected tabulator total range*. The range is defined as having a minimum that is the undisputed mark count and a maximum that is 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. 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 ballot count. For this reason, it is important that auditors reconcile the tabulator ballot count and the audit ballot count. If these counts differ, then the audit’s conclusion is weakened—any significant differences between the tabulator ballot count and the audit ballot count are grounds for further investigation.

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. With this as a guide, we treat individual discrepancies not exceeding 1.87% 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, we rarely experience individual discrepancies greater than 1% of the total number of cast ballots.

Unexplained Discrepancies. The analysis concludes by considering all unexplained discrepancies that are greater than 1.87% of the audit ballot count or significant disagreements between tabulator ballot counts and audit ballot counts. Any such discrepancies will trigger a recommendation for further investigation, but do not necessarily constitute evidence of a tabulator malfunction.

2 Analysis Results

Of the 336 submitted records, 194 (57.7%) of the audit records exactly confirmed the tabulator count. Tabulator results were not included in the audit report for 13 records. Hand count totals were not included for 8 records. The remaining 121 audit records reported a tabulator count that differed from the audit count.

Category	Record count
Records within expected range	194
Records outside expected range but with $\leq 1\%$ discrepancy:	113
Records with discrepancies larger than 1%	8
— Discrepancy $> 1\%$ explained by mixing of ballots hand-counted on election night	6
— Discrepancy $> 1\%$ explained by choice of multiple candidates	1
— Discrepancy in single-candidate race	1
Records with hand-count totals omitted	8
Records that did not include tabulator count	13
Total	336

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 121 records showing a discrepancy between the audit count and the machine count, 113 are within the 1% threshold of the audit ballot count, 117

are within the 1.87% threshold and are therefore considered within the range of anticipated human error. Eight of records show ballot counts that are greater than the 1% error we historically observe in audits.

Inadvertent Mixing of Ballots First, we observed eight records affected by the inadvertent commingling of ballots that were counted by a tabulator and ballots that were hand-counted on election night. Six of these records showed a discrepancy greater than 1% and four of these records showed discrepancy greater than 1.87%. We stress that all instances of an error rate greater than 1.87% belong to this category.

Choice of Multiple Candidates One race, which showed a discrepancy of 1.41%, allowed voters to select up to two of the two candidates listed on the ballot; such settings permitting multiple cast votes in a race have historically led to larger errors in hand counting.

Single Candidate Race The last case, a race with a single candidate, yielded an error of 1.5%, larger than we typically expect to see as a result of hand counting but within the 1.87% threshold indicated by empirical experiments.

Insufficient Data For Analysis In addition, twenty one records were affected by the omission of essential data from the audit, including the totals for undisputed or questionable votes in the hand-count or tabulator total counts. The missing data prevented the accurate comparison of audit totals and tabulator totals. These are not indicative of tabulator malfunction.

Total Ballot Count Discrepancies Any discrepancy between the total number of ballots counted by the tabulator and the total number of ballots counted in the audit is a concern and weakens the audit's conclusion. The audit returns from eight of the analyzed precinct audits reported a difference in the number of ballots counted by the tabulator and the number of ballots counted on audit day. Details can be seen in Table 3.

Precincts	Delta(Election → Audit)	Explanation
P1,P2,P3	-1	-
P4	+2	-
P5	-2	-
P6	+26	Mixing of hand-counted ballot on election night
P7	+3	No explanation
P8	1000 ballots	No tape from election night reporting the number of votes cast

Table 3: Ballot count discrepancies.

In precincts $P1, P2, P3$, the tabulator ballot count was one less than the audit ballot count. In $P4$, two additional ballots were seen during the audit while in $P5$, 2 ballots were missing from the audit. In $P6$, a mixup (confusion) on which ballots were (or were not) counted by hand on election day seem to be the underlying cause for the discrepancy.

No explanations were provided for the additional 3 ballots in $P7$ and a copy of the ticker tape was missing for $P8$, so it was not possible to establish a discrepancy.

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 2, 2021 election. 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 336 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 numbers for precincts that submitted complete information is consistent with human errors and are not causes for alarm. To conclude, the analyzed audits offer no conclusive evidence of tabulator malfunction in the 2021 municipal 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.