Rhode Island Risk-Limiting Audit

2022 General Election Report

Prepared for the Rhode Island Board of Elections

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Summary

On November 18 and 21, 2022, the Rhode Island Board of Elections successfully conducted a risk-limiting audit (RLA) of the governor's contest at its office in Cranston. This was Rhode Island's first RLA completed entirely using batch comparison, i.e., hand counts of randomly selected batches of ballots.

The random seed was selected on the morning of November 18, immediately prior to the recounts scheduled for that day. Using the seed, fifteen batches were selected for the audit, containing over 10,600 ballots. Most of these batches had to be retrieved from municipal election offices that day. The hand count was completed entirely on November 21. Overall, the audit results found a decrease of 21 votes (0.2% of ballots audited) in the margin of winning candidate Daniel J. McKee. As discussed below, this change primarily is attributable to a procedural anomaly in the handling of write-in ballots, not errors in either machine or audit counts. Using extremely cautious assumptions, the measured risk was 8.89%: strong evidence that a full hand count would confirm the outcome.

The 2022 General Election

Over 361,000 voters participated in the 2022 general election.[1] About 70% of these voted on election day, about 10% by mail ballot, and about 20% in early voting at municipal halls. The state board opted to audit the governor's contest, the foremost statewide contest. In this contest, Daniel J. McKee (D) defeated Ashley Marie Kalus (R) by about 19 percentage points; other candidates and write-ins accounted for about 3% of valid votes.

As in 2020 (when it was called emergency voting), early voting posed a challenge for audit workload. All ballots cast on one scanner during early voting must be reported together as one batch. These batches can be substantially larger than election day or mail batches, and large batches are more likely to be selected in the audit. Only two of the fifteen selected batches were early batches, but these batches contained over 3,600 ballots, or about 1/3 of all ballots audited.

Ballot Accounting and Data Collection

[1] More specifically, 361,449 voters participated in the election, of whom 175 were eligible to vote only in federal contests. The RLA datafiles therefore include 361,274 ballots.

A trustworthy tabulation audit relies upon rigorous ballot *accounting* and *security*. The **ballot manifest** sums up the ballot accounting: it reports how many ballots were cast and accepted, and how many ballots are stored in each auditable batch. These ballot totals must correspond with information outside the voting system. For instance, at each election day polling place, pollworkers complete an Election Certificate that compares the number of cast ballots (mostly as reported by the polling place scanners) with the number of voters (mostly according to electronic Poll Pad check-ins). Pollworkers are directed to account for any discrepancies in these counts. The Election Certificates and other paper and electronic records redundantly document all cast and accepted ballots. To protect ballot security, Rhode Island uses and tracks numbered, tamper-evident seals on all ballot containers. We assess that Rhode Island's ballot accounting and ballot security procedures are sound, providing a reliable material basis for the risk-limiting audit.

Obtaining data for auditable batches does pose complications. Ballots in Rhode Island are tabulated on Election Systems & Software (ES&S) scanners—hand-fed DS200s for in-person voting, batch-fed DS850s for central-count (primarily mail) ballots—and the totals are reported using ES&S's election management system, Electionware. For in-person (early and election day) voting, all ballots counted on a scanner comprise a batch. For central-count ballots, each set of ballots scanned together comprises a batch. These batches tend to be considerably smaller than the in-person batches.

Although Rhode Island has updated its voting system to EVS 6.0.7.0, which associates central-count ballots with batches, its version of Electionware still cannot directly export batch vote totals by candidate. (The new version does assign batch names, although we did not rely upon these in November.) In short, two data exports—a set of Cast Vote Records that indicate the votes on each ballot, and a "table view" (CVR ID to Tabulator CVR and Batch Table) report—must be combined to obtain batch totals. In addition, as in 2020, Board of Elections staff created a so-called "mail ballot manifest" to track central-count batches. This manifest assigns a short identifier to each batch and records its first and last "Tabulator CVR" numbers, thus identifying the Cast Vote Records associated with each batch. Most of these batch identifiers represented municipality code and sequence number: for instance, the second batch of mail ballots from Coventry (municipality 06) was batch M06-02. Thirteen special batches, primarily remade ballots and provisional ballots (which are not mail ballots, but are centrally counted), were assigned codes M92-01 through M98-02. The mail ballot manifest provides a check upon the number of ballots in each batch.

In most RLAs, election officials prepare the (comprehensive) ballot manifest and candidate vote totals for all votes cast in the election. Due to time pressures, Verified Voting generated these files from the data exports and the mail ballot manifest. (Appendix 2 further describes this process.) We confirmed that the reported total ballot count for each vote type matched the reported turnout—which had already been checked during the canvass—and that the candidate vote totals matched the official results. This process is reasonable because Rhode

Island's ballot accounting procedures support the reported ballot counts, not relying on voting system data alone. The audit itself provides a statistical check on the reported ballot counts in the selected batches.

To protect voter privacy, it is important to avoid deanonymized unanimous batches—that is, batches for which some or all voters may be identifiable *and* all votes are cast for one candidate. During processing, we discovered one central-count ballot containing just one ballot, which we combined with another batch. With this one change, no batch was unanimous.[2] However, a few batches were small enough that they *could* have been unanimous. Generally these batches comprised the last few mail ballots from a jurisdiction or the last few ballots of a special type. In some cases it might be possible to determine that a specific voter's ballot is in such a batch. To hedge against that real or perceived possibility, we recommend routinely reviewing batch totals and, if necessary, combining batches before the audit begins to ensure that no batch is unanimous.

Deriving the Audit Sample

As in past elections, the Board of Elections selected a 9% risk limit for the RLA. Thus, if the outcome of the gubernatorial election was wrong—if a full hand count would yield a different winner—there was *at least* a 91% chance that the RLA would uncover the problem. In practice, we believe this chance was much greater, because the underlying statistical method makes extremely conservative assumptions about possible miscounts. (In effect, it assumes that every batch might have been voted 100% for any one of the losing candidates unless the audit proves differently.)

By formula, if the audit had found no discrepancies, auditing 14 randomly selected batches would have sufficed to attain the 9% risk limit. Board staff accepted our recommendation to audit 15 batches, to be more sure of completing the audit in one round even if unexpected discrepancies were found. This additional hand counting reduced the chance of having to retrieve one or more additional batches from, potentially, any jurisdiction(s) in Rhode Island.

The ballot manifest and vote counts were uploaded to Arlo on the morning of November 18. Then participants in a public board meeting—most of them present to observe one of the municipal recounts to follow—took turns rolling 20 ten-sided dice to generate the random seed. Board staff entered this seed into Arlo, and Arlo applied its open-source sampling algorithm to produce the random sample of batches. The fifteen batches in the audit sample are listed below. ("ED" is short for "Election Day.")

[2] The batch totals file shows two apparently unanimous batches, M12-02 and M22-02, which reported votes only for McKee. However, both these batches also contained write-in votes for governor, and so have more ballots than McKee votes.

Table 1: Batches in the Audit Sample

Batch Name	# of Ballots
EARLY Coventry - 1	2570
EARLY Scituate - 1	1110
ED Charlestown 0504 - 1	459
ED Cranston 0725 - 2*	579
ED Little Compton 1801 - 1*	679
ED Pawtucket 2605 - 1*	507
ED Providence 2805 - 2*	72
ED Providence 2855 - 1*	361
ED Tiverton 3303 - 1	504
ED Warwick 3515 - 1	806
ED Westerly 3607 - 1	767
ED West Warwick 3804 - 2	1207
ED Woonsocket 3906 - 1	540
M25-01	344
M28-07	276
TOTALS	**10781**

* one of two batches from this polling place

Five of the eleven election day batches in the audit sample were from one of two scanners assigned to a polling place. Board staff retrieved *all* ballots from these polling places, to hedge against possible errors.[3]

Conducting the Hand Count

The hand count began on the morning of November 21 with a brief training session. Twenty people, most of them temporary election workers, were assigned to ten two-person audit teams. (One person had to leave before the end of the hand count and was replaced.) These audit team members watched a short VotingWorks video that demonstrates the *sort-and-stack* method for conducting hand counts. In brief, to count a set of ballots using sort-and-stack, two-person teams conduct these steps:

- Enter the identity of the set of ballots being counted on a tally sheet. (In the video, the sets of ballots are identified by container number. In Rhode Island, they were identified by batch and "pile number," as further explained below.)
- Sort the ballots into stacks by vote choice (candidate or selection); each person examines each ballot and verbally "calls" the vote to confirm agreement.[4]

[3] West Warwick 3804 - 2 was the *only* scanner assigned to this polling place, despite the "2."

[4] In this RLA, ballots with write-in votes or no valid votes were set aside and not counted. Any ballots for which the audit team members could not agree would have been adjudicated by Board staff, but there were no such ballots.

- Count, out loud, each stack in smaller stacks of ten, laying the smaller stacks across each other. (Team members take turns counting and observing.)
- When all the ballots for a vote choice are counted, count the full stacks of ten and then any remaining ballots. Write down each total on the tally sheet.

Rather than require audit teams to count hundreds or thousands of ballots at once, Board staff divided the batches into smaller *piles* of about 100 ballots apiece as the hand count progressed. Staff used a counting scale to create these piles efficiently. (The actual number of ballots per pile could vary because some machine-printed ExpressVote ballots were mixed in with the heavier hand-marked ballots, and because even apparently identical ballots vary in weight.) Staff put each pile in a large envelope labeled with the batch ID and pile number.

With over 100 ballot piles to be audited, careful tracking was essential. A ballot *librarian* used a ballot custody form to check out each pile to an audit team, numbered 1 through 10, and subsequently check each pile back in. Several *runners* delivered piles to audit teams. Each time an audit team completed a pile and tally sheet, it would return the ballots to the pile envelope and signal a runner. The runner would return the envelope and tally sheet to the librarian, who would check out the next available envelope (if any) to the audit team, and then deliver the tally sheet to the data entry table. At the data entry table, a board staff member transcribed the tally sheets into an Excel spreadsheet. This process was projected, allowing observers to track the data entry. It also was live-streamed, although the livestream link was not widely available.

We observed some variation in how teams interpreted the counting instructions. Some teams were stricter than others about double-checking each ballot and vote count. The teams were arranged in a long “L” shape, with some teams very far from other teams and from the librarian and data entry table. This orientation made it harder for teams to observe each other and for election officials to observe the teams. A tighter arrangement, and greater attention to observation and feedback early in the count, might produce greater uniformity and perhaps more accurate counts. (We can confidently attribute at least one of the small discrepancies below to counting and reporting errors.) To reduce possible errors, Board staff compared the tally sheet totals to the expected ballots counts for each pile. In some cases, when they observed differences that they could not attribute to ExpressVote ballots, they asked teams to retally piles to check the results.

Audit Results

The discrepancies observed in the audit generally were small and did not systematically affect one candidate rather than another. Nevertheless, they deserve further discussion, especially for the two mail batches. For readability, the results shown in the following table only include counts for the two leading gubernatorial candidates; Appendix 1 reports complete results for all five named candidates.

Table 2: Reported Results and Audit Results

Batch Name	Reported Votes		Audited Votes		Change in Margin
	McKee	Kalus	McKee	Kalus	
EARLY Coventry - 1	1425	1091	1417	1092	-9
EARLY Scituate - 1	546	528	545	528	-1
ED Charlestown 0504 - 1	219	218	219	218	0
ED Cranston 0725 - 2	413	132	412	132	-1
ED Little Compton 1801 - 1	330	311	330	310	1
ED Pawtucket 2605 - 1	285	202	273	195	-5
ED Providence 2805 - 2	47	21	47	21	0
ED Providence 2855 - 1	273	73	273	74	-1
ED Tiverton 3303 - 1	244	236	245	235	2
ED Warwick 3515 - 1	441	337	444	334	6
ED Westerly 3607 - 1	352	380	352	379	1
ED West Warwick 3804 - 2	540	618	540	619	-1
ED Woonsocket 3906 - 1	266	243	267	242	2
M25-01	233	93	229	89	0
M28-07	211	54	190	48	-15
Total	*5825*	*4537*	*5783*	*4516*	*-21*

Discrepancies in mail batches

Note that both mail batches had considerably fewer votes audited than initially reported. This disparity owes to unusual handling of central-count ballots that contained one or more write-in votes. (We will call these "write-in ballots" for brevity, but they are standard ballots—not, for instance, Federal Write-in Absentee Ballots where, by design, *all* vote selections must be written in.) DS850 scanners have three ballot bins. In this election, the scanners were configured to redirect write-in ballots to the middle bin, while most ballots were sent to the top bin. This configuration is useful when write-in ballots are used to manually adjudicate write-in votes. (In Rhode Island, election officials use digital images to adjudicate write-in votes.) Through an operational error, most central-count write-in ballots were commingled in a separate container. We had anticipated being able to locate the write-in ballots associated with particular central count batches. Because the almost 2,000 central-count write-in ballots were commingled, we concluded that attempting to locate ballots from specific batches would be difficult and unreliable.

Table 3: Mail Batch Audit Results Without Write-In Ballots

Batch Name	Write-in Ballots	*Ballots without write-ins*				
		Reported Votes		Audited Votes		Change in Margin
		McKee	Kalus	McKee	Kalus	
M25-01	12	232	87	229	89	-5

M28-07	30	188	48	190	48	+2

How should the comparison proceed for these batches? One option is to set aside the reported write-in ballots and base the comparison on the remaining ballots. The CVRs allow us to calculate reported totals for ballots without write-in ballots in these batches. As Table 3 above shows, these totals more closely accord with the audit totals. This "apples-to-apples" comparison is reassuring—and it reduces the total change in margin from -21 votes, as shown in Table 2, to just -9 votes out of over 10,000 audited ballots. However, it disregards the fact that the write-in ballots could not be audited.

On the day of the audit, we entered the observed audit totals without adjusting the reported totals. As seen in Table 2, this approach yields a 15-vote discrepancy in batch M28-07 (because McKee is reported to have received most of the votes on the write-in ballots, which could not be audited). The resulting measured risk, as reported by the Arlo software, is 7.9%.

Here we rely upon a worst-case approach. It is, in theory, possible that *all* the reported write-in ballots from these batches were cast for Kalus or one of the other candidates. That theoretical possibility makes very little sense.[5] Nevertheless, to ensure that we were considering the worst case, we calculated the measured risk as if all differences between ballots reported and ballots audited represented missing ballots cast for Kalus.[6] That measured risk is slightly under 8.9%, still less than the 9% risk limit. Thus, even implausibly grim assumptions about the mail write-in ballots cannot alter the conclusion of the audit.

Pawtucket 2605-1

We also gave special attention to the discrepancies in Pawtucket 2605-1 (election day), where both leading candidates appeared to lose votes in the audit. Moreover, the audit reported 14 votes for independent candidate Zach Hurwitz, compared to just 6 in the reported results. A post-audit review of all ballots from Pawtucket 2605 obtained candidate vote totals very similar to the reported totals, with one vote less for Kalus. This is strong evidence for error during the audit itself.

We are convinced that one error occurred in processing Pile 5. Pile 5 was unusual in that the vast majority of ballot sheets (86, according to the audit) were "Card 2s" that did not contain the governor's race. The audit team's tally sheet reported 8 votes for Kalus and 8 votes for

[5] Although the mail ballots overall strongly favored McKee, one could conjecture that some mail ballots bearing votes for Kalus were falsely reported as bearing votes for McKee *and* having write-in votes in other contests, thus evading audit. This baroque hypothesis is infirmed by evidence. Only about 5.7% of mail ballots (1,949 of 34,129) were reported as having write-ins, about the same as early voting ballots (5.5% of which were write-in ballots), and less than Election Day ballots (7.5%). Moreover, McKee received only about 59.6% of the votes on mail write-in ballots (1,162 of 1,949), compared with 75.5% of the votes on other mail ballots. These results are consistent with accurate tabulation of both write-in status and vote for governor—not with systematic misreporting.

[6] Although the largest discrepancies between votes reported and votes audited came in these two batches, some other batches had small discrepancies as well.

Hurwitz (none for McKee); this was entered in the batch spreadsheet as 8 votes for McKee and 8 votes for Hurwitz (none for Kalus). We believe the true totals were 8 votes for Kalus and 8 votes for McKee (none for Hurwitz). We further believe that a stack of 9 or 10 votes for McKee went unreported in one of the piles, which would account for the slight shortfalls of total ballots and of McKee votes.

Summary

The overall discrepancy in the audit results is very small, especially if we use the "apples-to-apples" comparison (excluding write-in ballots) for the mail batches. However, a few discrepancies are larger than we would hope to see.[7] We believe that these larger discrepancies likely are attributable to procedural error in the audit. Although these discrepancies are far too small to raise doubts about the election outcome, it is desirable in future audits to resolve any such discrepancies as conclusively as possible.

Two procedural changes can help. First, we suggest entering audit data in Google Sheets instead of Excel. This approach (used in the audit of the 2020 general election in Windham, NH) allows both staff and observers to monitor the results in real time, and can facilitate identifying and isolating discrepancies. Second, we suggest explicitly planning to explore discrepancies, with a smaller staff, the day after the audit is completed, or on a later day if the audit runs close to a weekend or holiday. Thus, the audit can conclude—and the election can be certified—without abandoning any loose ends.

Recommendations and Suggestions for Future Audits

By and large, this audit went smoothly despite a challenging election calendar. Perhaps the most important improvement was in the mail ballot manifest. Correctly entering pairs of ten-digit tabulator CVR numbers is intrinsically error-prone. In November 2020, the mail ballot manifest contained various typographical errors that could not be corrected before the batch sample was selected. This discovery made necessary a separate ballot polling audit of ballots that were not included in the batch data upload. In 2022, Board staff took great care in preparing the mail ballot manifest. The much improved data quality made it feasible to resolve the remaining anomalies—almost all of which pertained to write-in ballots, as described above—expeditiously before the sample was drawn.

Before ballots are tabulated

- Ensure that DS850s are *not* configured to divert ballots with write-ins to a separate bin. (Alternatively, during tabulation, ensure that any diverted ballots are stored with their batches, not in a separate container.)

[7] One- or two-vote discrepancies are common even in fairly small batches, and discrepancies on the order of 0.1-0.2% are common in batches of 1,000 ballots or more.

- If possible, configure DS850s to incorporate tabulator IDs in ES&S batch names. (If not, the tabulator ID can be inferred from the Tabulator CVR numbers.)
- Routinize the process of exporting CVR and table view data files, so the export can be completed as soon as possible once all ballots have been tabulated.

During tabulation

- Continue to ensure that batch/bin reports are printed for each batch.
- Simplify the central-count manifest ("mail ballot manifest") to use short-form ES&S batch IDs[8] instead of first and last Tabulator CVR numbers. The Electionware upgrade makes this simplification possible.

Preparing for the audit

- When the audit is scheduled, designate a day for any appropriate follow-up after the main counting is completed. (If the audit unexpectedly must continue beyond one round, this may be the day the second round begins.)
- Establish the protocol for publishing audit data at various points in the audit process. We suggest the following:
    - Publishing the ballot manifest and batch vote totals before the audit sample is generated, and posting hash values to allow tech-savvy observers to verify that the files are unchanged.[9]
    - Posting the random seed and random sample as soon as possible after they are generated.
    - Posting the Arlo audit report and additional supporting documentation (presumably including the tally sheets and data entry spreadsheet, plus any relevant follow-up documents) as soon as possible after the audit and follow-up are complete.
- Further routinize the procedures for processing voting system data and ensuring that the resulting audit data files are complete and avoid unanimous batches.
- Widely share the link to the livestream.

Conducting the hand count

- Adjust the audit tables to reduce the distance between audit tables and the front tables, facilitating communication and observation.

[8] Many ES&S jurisdictions assign a distinct letter to each central tabulator, so that short-form batch IDs might be (for instance) A0001 for the first batch tallied on tabulator "A" or C0023 for the 23rd batch tallied on tabulator "C." Alternatively, the four-digit of the numeric tabulator ID can be used, e.g., 0237-A0001 for the first batch counted on tabulator 0237.

[9] One alternative is to pre-publish the ballot manifest but to delay publishing the batch vote totals, thus possibly assuaging concerns that audit teams are attempting to match the reported totals. Because most batches are divided into multiple piles, we do not find this concern compelling.

- Ensure that all audit team members are clear about the basic concepts of the sort-and-stack method, including how to check each other's work. Ensure that they are familiar with applicable voter intent standards.

Appendix 1: Complete Audit Results

	Reported Totals					Audited Totals				
Batch Name	**Kalus**	**McKee**	**Hurwitz**	**Rianna**	**Gizzarelli**	**Kalus**	**McKee**	**Hurwitz**	**Rianna**	**Gizzarelli**
EARLY Coventry - 1	1091	1425	15	9	13	1092	1417	15	9	13
EARLY Scituate - 1	528	546	17	1	9	528	545	17	1	9
ED Charlestown 0504 - 1	218	219	7	4	5	218	219	7	4	5
ED Cranston 0725 - 2	132	413	13	3	7	132	412	13	3	7
ED Little Compton 1801 - 1	311	330	13	7	6	310	330	13	8	5
ED Pawtucket 2605 - 1	202	285	5	7	4	195	273	14	7	4
ED Providence 2805 - 2	21	47	1	0	0	21	47	1	0	0
ED Providence 2855 - 1	73	273	6	1	3	74	273	6	1	3
ED Tiverton 3303 - 1	236	244	8	8	3	235	245	8	8	3
ED Warwick 3515 - 1	337	441	12	9	5	334	444	12	9	5
ED Westerly 3607 - 1	380	352	6	13	8	379	352	6	13	8
ED West Warwick 3804 - 2	618	540	15	16	12	619	540	16	15	12
ED Woonsocket 3906 - 1	243	266	11	6	6	242	267	11	6	6
M25-01	93	233	4	5	1	89	229	4	5	1
M28-07	54	211	7	0	2	48	190	6	0	2

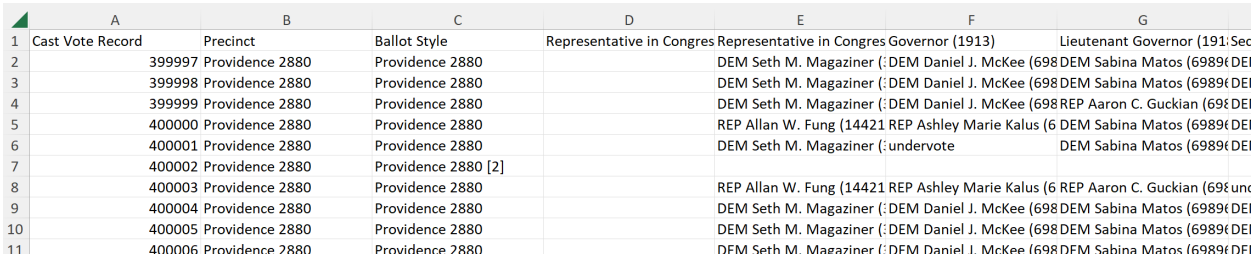
Appendix 2: Constructing the Data Files

The Board provided us with three kinds of files, all in Excel format:

- Six CVR files with up to 100,000 rows each (including a header row)
- Twenty-one table view files with up to 20,000 ballot rows each
- The mail ballot manifest file

The CVR files are very large—about 750 MB in all—because they include 709 columns, most of which contain votes cast in local contests or referenda. A partial image of a CVR file appears below. (For efficiency, we deleted all but the first six columns before further processing.)

Figure 1: CVR File Screenshot



	A	B	C	D	E	F	G
1	Cast Vote Record	Precinct	Ballot Style	Representative in Congres	Representative in Congres	Governor (1913)	Lieutenant Governor (191	Sec
2	399997	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	DEM Daniel J. McKee (698	DEM Sabina Matos (6989(	DEI
3	399998	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	DEM Daniel J. McKee (698	DEM Sabina Matos (6989(	DEI
4	399999	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	DEM Daniel J. McKee (698	REP Aaron C. Guckian (69	DEI
5	400000	Providence 2880	Providence 2880		REP Allan W. Fung (14421	REP Ashley Marie Kalus (6	DEM Sabina Matos (6989(	DEI
6	400001	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	undervote	DEM Sabina Matos (6989(	DEI
7	400002	Providence 2880	Providence 2880 [2]					
8	400003	Providence 2880	Providence 2880		REP Allan W. Fung (14421	REP Ashley Marie Kalus (6	REP Aaron C. Guckian (69	und
9	400004	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	DEM Daniel J. McKee (698	DEM Sabina Matos (6989(	DEI
10	400005	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	DEM Daniel J. McKee (698	DEM Sabina Matos (6989(	DEI
11	400006	Providence 2880	Providence 2880		DEM Seth M. Magaziner (3	DEM Daniel J. McKee (698	DEM Sabina Matos (6989(	DEI

The "Cast Vote Record" numbers are simple serial numbers, starting from 1 in the first CVR file. "Ballot Style" generally is identical to "Precinct" except that the second page of a two-page is identified with a "[2]" in the style. Then all the votes are listed. For the governor's contest, the raw totals for all cards are as follows in descending order:

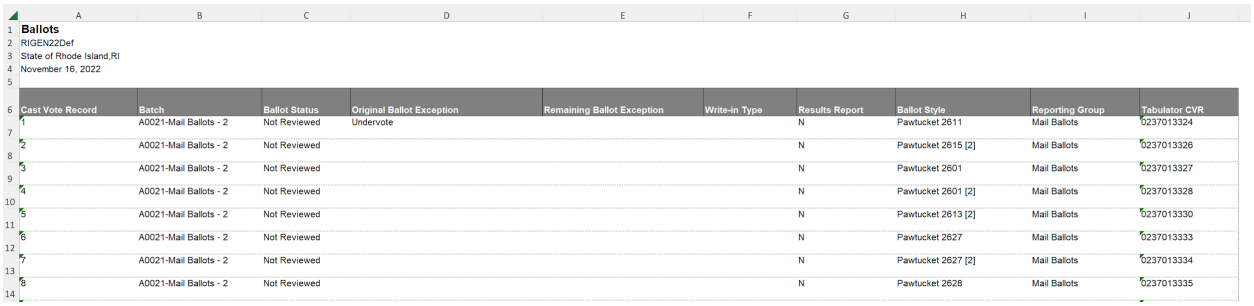
DEM Daniel J. McKee (69894) 207166
REP Ashley Marie Kalus (69895) 139001
[blank] 49621
Ind Zachary Baker Hurwitz 4512
undervote 3485
Ind Paul A. Rianna, Jr. 3123
Lib Elijah J. Gizzarelli 2811
Write-in 1021
overvote 119
No image found 36

(The field is left blank on federal-only ballots and second pages. “No image found” means that the write-in oval was filled but the associated write-in text field appeared to be blank.)

Part of a table view file, including all the columns, is shown below. For our purposes, the relevant columns are the following:

- “Cast Vote Record” contains the same serial number as in the CVR files, allowing us to merge the CVR and table view files.
- “Tabulator CVR” (column J) is referenced in the mail ballot manifest, as further explained below. For central count ballots, the first four digits uniquely identify the tabulator, and the remaining digits are serial with an arbitrary starting point. (In this screen shot, all ballots were counted on tabulator 0237.) For polling place ballots, the tabulator CVR is a 256-bit code in base-16, such as b026be363c91f395. These codes are arbitrarily assigned, protecting voter privacy by obfuscating the order in which the ballots were initially scanned.
- “Batch” is the ES&S batch identifier. These names uniquely identify in-precinct Election Day batches (“Cranston 0725 - 2" is scanner #2 assigned to precinct Cranston 0725) and early voting batches (“Coventry 1” is scanner #1 assigned to Coventry). For central count ballots, as in the screenshot, these identifiers are clumsy (e.g., “ ”). They also are not necessarily unique: for instance, all three tabulators have a batch name “A0001-Mail Ballots—2”.)
- “Write-in Type” usually is blank, but is “Marked” if a write-in is detected. This field normally would not be relevant, but was useful in analyzing the discrepancy described under “Audit Results” above.
- “Reporting Group” is one of “Early Voting,” “Election Day,” or “Mail Ballots”. This is useful for comparison with official totals. Note that provisional ballots are centrally counted *Election Day* ballots, so the mail ballot manifest comprises more than mail ballots.

Figure 2: Table View File Screenshot



Ballots
RIGEN22Def
State of Rhode Island,RI
November 16, 2022

Cast Vote Record	Batch	Ballot Status	Original Ballot Exception	Remaining Ballot Exception	Write-in Type	Results Report	Ballot Style	Reporting Group	Tabulator CVR
1	A0021-Mail Ballots - 2	Not Reviewed	Undervote			N	Pawtucket 2611	Mail Ballots	0237013324
2	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2615 [2]	Mail Ballots	0237013326
3	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2601	Mail Ballots	0237013327
4	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2601 [2]	Mail Ballots	0237013328
5	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2613 [2]	Mail Ballots	0237013330
6	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2627	Mail Ballots	0237013333
7	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2627 [2]	Mail Ballots	0237013334
8	A0021-Mail Ballots - 2	Not Reviewed				N	Pawtucket 2628	Mail Ballots	0237013335

The top of the mail ballot manifest is shown below (not shown is column J, a comment field, that is usually blank). This spreadsheet was filled in by Board staff based on a template to minimize typing. “Batch Name” is constructed from “Code” (a municipality number, or a special code such as 96 for full provisional ballots) and “Batch”, a sequence number. Board staff filled in “Number of Ballots” and “First”/”Last Serial #” from printouts of the DS850 batch/bin reports.[10]

Figure 3: Mail Ballot Manifest Screenshot

Municipality	Abbrev	Code	Batch	Batch Name	Number of Ballots	First Serial #	Last Serial #	Implied Count
Barrington	BARR	01	02	M01-02	196	0462027145	0462027417	273
Barrington	BARR	01	03	M01-03	67	0237024160	0237024229	70
Bristol	BRIS	02	01	M02-01	515	0237008397	0237008987	591
Bristol	BRIS	02	02	M02-02	240	0462027418	0462027691	274
Bristol	BRIS	02	03	M02-03	43	0023702430	0023702484	55
Burrillville	BURR	03	01	M03-01	375	0237014858	0237015440	583

We processed these files essentially as follows:

1. Concatenate the CVR files (using only the first six columns, through the governor’s contest) into one file.
2. In the CVR file, shorten the contest field names (“Governor (1913)” becomes “Governor”) and governor candidate names (use just last names).
3. Concatenate the table view files.
4. Merge the CVR file with the table view file using “Cast Vote Record” to create a ballot file; ensure that no rows are lost in the merge.
5. Check the mail ballot manifest for impossible “implied counts” (see footnote 7), for overlapping serial number ranges, and for central-count ballots whose Tabulator CVR values do not correspond to any batch in the mail ballot manifest. Investigate these discrepancies and adjust serial numbers as appropriate.[11]

[10] The “Implied Count” is the expected number of ballots if no serial numbers are skipped (Last Serial # minus First Serial # plus 1). This count should not be smaller than Number of Ballots, but is larger when some ballots have to be refed, being assigned new serial numbers.

[11] A few discrepancies owed to data entry errors, but most were caused by write-in ballots whose serial numbers (Tabulator CVR ids) did not appear in the batch/bin reports. We were able to correct almost all these errors before the audit. The ballot manifest does include one central-count batch that did not correspond to any batch in the mail ballot manifest, designated “A0005” (from its scanner batch id). We later confirmed that this batch consisted

6. Assign the appropriate batch name to each ballot. For polling place ballots, the batch name is similar to the ES&S "Batch" id, prepending "ED" or "EARLY" to emphasize the batch type. For central count ballots, the batch name begins with "M-" (with one exception described in footnote 10) and derives from the mail ballot manifest.
7. For most purposes, remove data for second pages[12] or federal-only ballots.
8. Generate the ballot manifest and batch vote tallies. Check them to ensure they coincide with the reported totals.

entirely of 16 write-in ballots. Similarly, a batch with just one ballot was omitted from the mail ballot manifest because it consisted of a write-in ballot. (This is the batch mentioned in the discussion of voter privacy on page .) Both batches were attested in other ballot reconciliation documentation.

[12] We referred to the complete dataset, including second pages, to determine the number of ballot *cards* in audit batches with second pages. This was useful for planning purposes.