Vote-by-Mail Lead Time Estimator: User Guide

vbmtime.app

PLEJ PARTNERSHIP FOR LARGE ELECTION JURISDICTIONS

Engineering for Democracy Institute

Contents

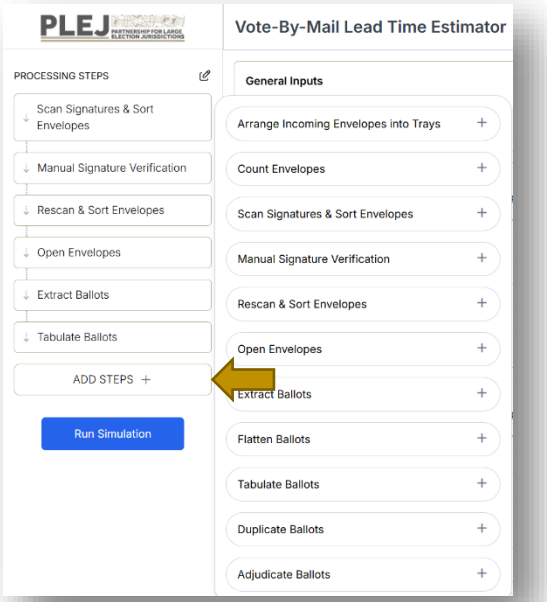
Introduction

In the United States, the use of vote-by-mail has increased dramatically over the last decade. With this trend came the adoption of vote-by-mail options in states that traditionally offered solely in-person voting. While vote-by-mail offers a convenient option for voters to cast their vote, planning and operating vote-by-mail elections can be challenging and more complex than solely in-person elections for election officials. To assist in planning for processing vote-by-mail ballots, the Partnership for Large Election Jurisdictions and the Engineering for Democracy Institute have created the Vote-by-Mail Lead Time Estimator. This tool allows election officials to build a vote-by-mail process and evaluate the time required to process vote-by-mail ballots. Using real election data, the Vote-by-Mail Lead Time Estimator simulates vote-by-mail processing operations to estimate the amount of time that ballots wait throughout the process, the number of working hours required to process all ballots, and the number of staff required.

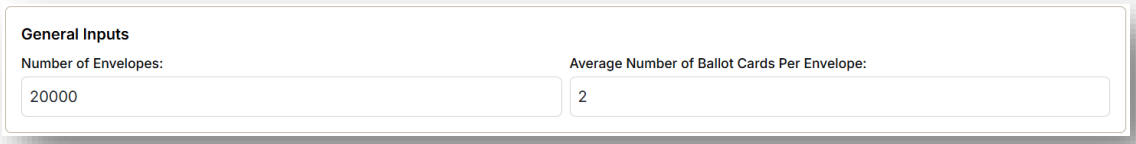
The Vote-by-Mail Lead Time Estimator can be used to assess resource allocation plans, identify processes that require additional resources, and estimate when all ballots will be processed. To use this tool, build a voting process by adding common vote-by-mail processing steps, indicate the number of envelopes to be processed and the number of ballot cards within each envelope, and provide information about each step of the process. A step-by-step example can be found on page 3.

Step-by-Step Example

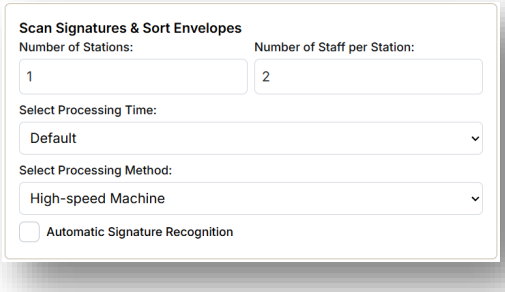
1. Start by adding vote-by-mail process steps. Click the *ADD STEPS* + button on the **left panel**,
2. Select:
   a. "Scan Signatures & Sort Envelopes",
   b. "Manual Signature Verification",
   c. "Rescan & Sort Envelopes"
   d. "Open Envelopes",
   e. "Extract Ballots",
   f. "Tabulate Ballots"
3. This will add the six selected processing steps to the **left panel**.



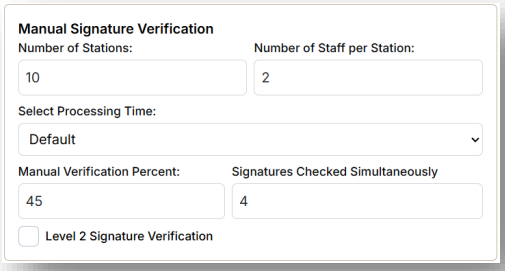
4. Next, populate the **General Inputs** menu:
   a. Enter "20000" into the *Number of Envelopes* input,
   b. Enter "2" into the *Average Ballot Cards Per Envelope* input.



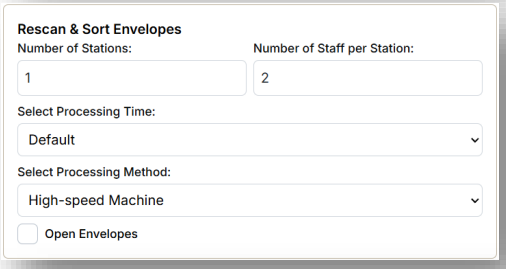
5. Next, populate the **Processing Step** menus:
   a. Scan Signatures & Sort Envelopes:
      i. *Number of Stations:* 1
      ii. *Number of Staff per Station:* 2
      iii. *Select Processing Time:* Default
      iv. *Select Processing Method:* High-Speed Machine



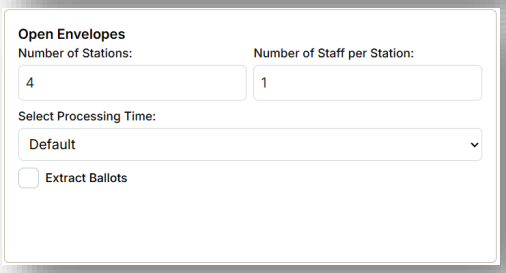
b. Manual Signature Verification:
   i. *Number of Stations:* 10
   ii. *Number of Staff per Station:* 2
   iii. *Select Processing Time:* Default
   iv. *Manual Verification Percent:* 45
   v. *Signature Checked Simultaneously:* 4



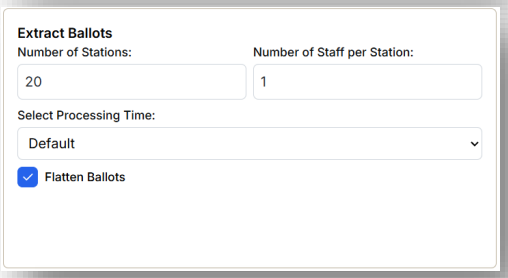
c. Rescan & Sort Envelopes:
   i. *Number of Stations:* 1
   ii. *Number of Staff per Station:* 2
   iii. *Select Processing Time:* Default
   iv. *Select Processing Method:* High-Speed Machine



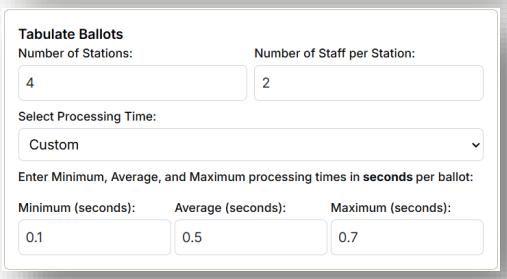
d. Open Envelopes:
   i. *Number of Stations:* 4
   ii. *Number of Staff per Station:* 1
   iii. *Select Processing Time:* Default



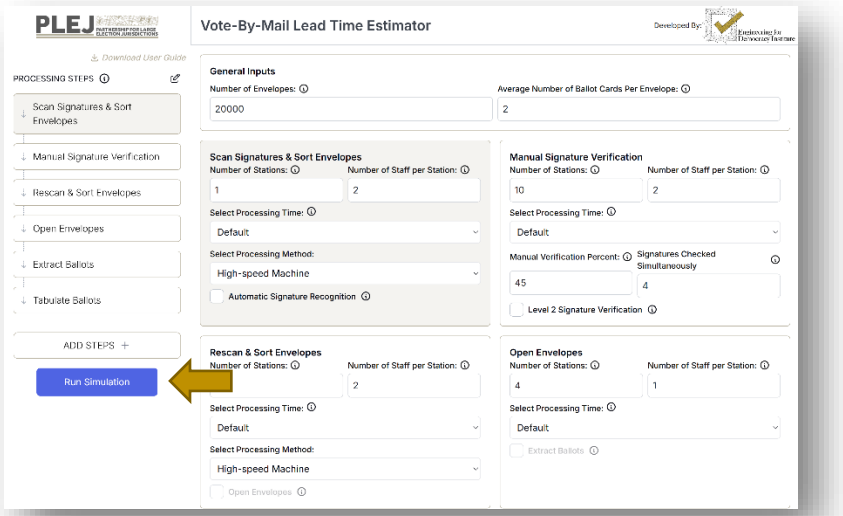
e. Extract Ballots:
   i. *Number of Stations:* 20
   ii. *Number of Staff per Station:* 1
   iii. *Select Processing Time:* Default
   iv. *Flatten Ballots:* Checked



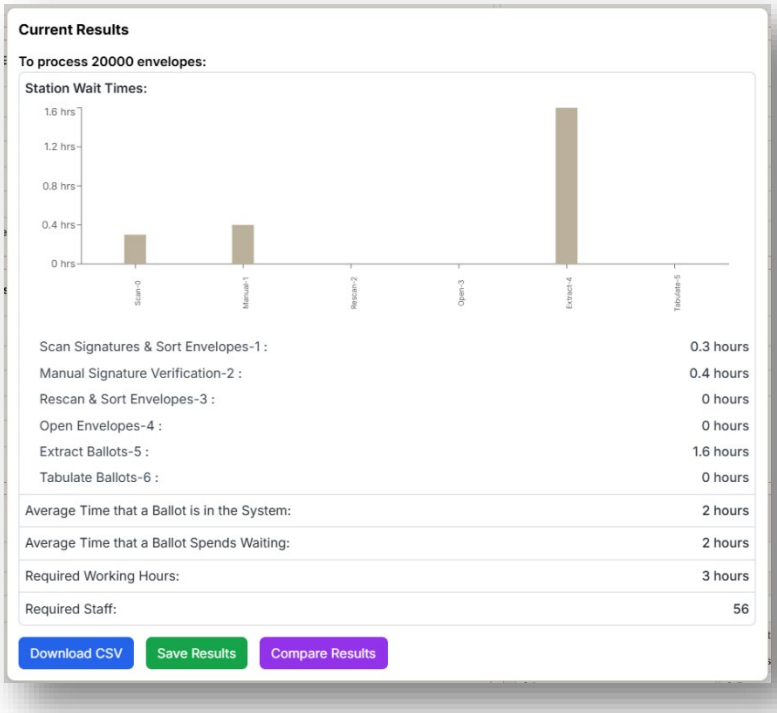
f. Tabulate Ballots:
   i. *Number of Stations:* 4
   ii. *Number of Staff per Station:* 2
   iii. *Select Processing Time:* Custom
   iv. *Minimum (seconds):* 0.1
   v. *Average (seconds):* 0.5
   vi. *Maximum (seconds):* 0.7



6. Once all process information is entered, press the blue *Run Simulation* button under the Processing Steps menu. The screen will show a loading wheel indicating that the simulation is underway. This may take several minutes to complete.



7. Once the simulation is completed, a results screen will appear. These results contain the average wait time at each station, the average time that ballots wait throughout the entire process, the average time that ballots spend in the process (waiting and in processing), the required working hours to process all ballots, and the number of staff required for the process.



Build the Vote-by-Mail Process

The left panel of the Vote-By-Mail Lead Time Estimator (Figure 1) allows you to build a vote-by-mail process. This may represent your current vote-by-mail process or a new process. The following subsections describe the voting steps that can be added, how to arrange steps in order, and how to remove steps from your process.

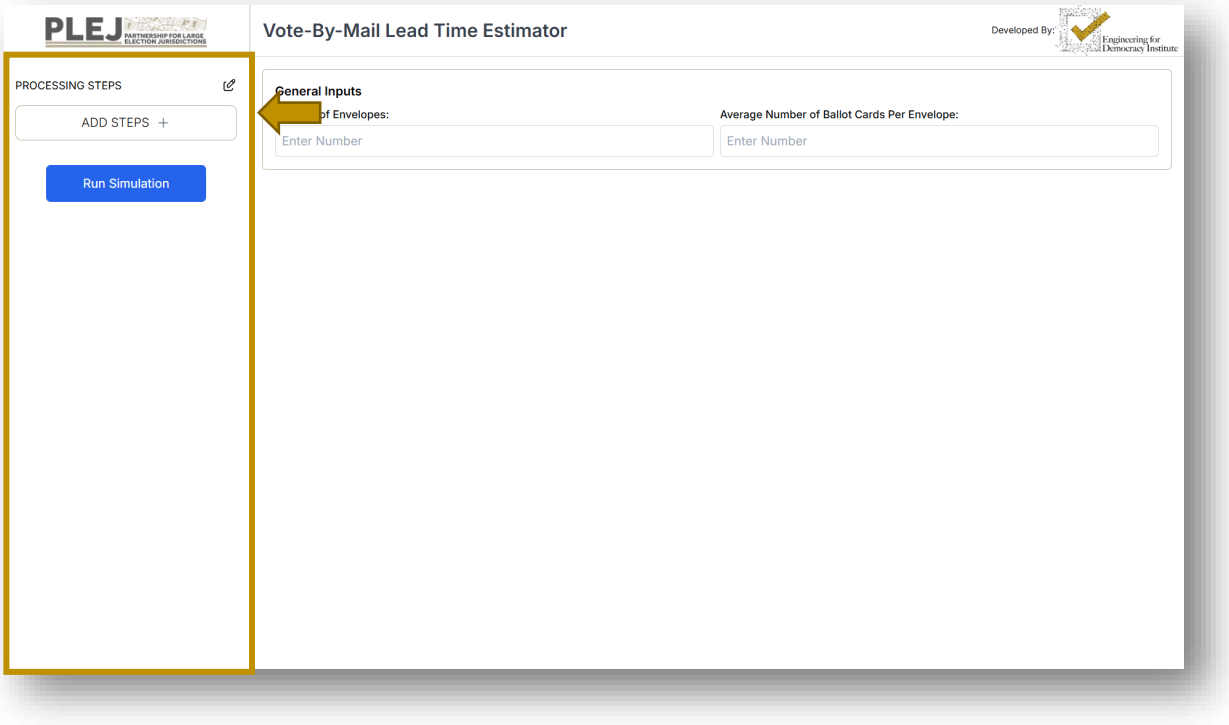


Figure 1. Left panel of the Vote-By-Mail Lead Time Estimator.

Processing Steps

The Vote-by-Mail Lead Time Estimator offers 11 predefined processing steps that can be used to build a vote-by-mail process. These steps include:

1. **Arrange Incoming Envelopes into Trays**: Arranging envelopes from the postal service and/or drop boxes into trays.
   Assumes this is done manually by election staff.
2. **Count Envelopes**: Counting envelopes before or after each process for auditing.
   Option: Default processing times are available for Machine Counting and Counting by Hand.
3. **Scan Signatures & Sort Envelopes**: Scanning envelope barcodes to record them in the system and capturing and storing images of voter signatures (if applicable).
   Options: High-speed Scanning Machine or Handheld Barcode Scanners.
4. **Manual Signature Verification**: Election staff comparing signatures from envelopes to reference signatures on a computer.

Optional Level 2 Signature Verification if signatures cannot be matched during the initial comparison.

5. **Rescan & Sort Envelopes**: Scanning envelopes to check their verification status to ensure they are ready to be opened.
   Option: High-speed Scanning Machine (with or without opening) or Handheld Barcode Scanner.
6. **Open Envelopes**: Cutting or unsealing envelopes to prepare for ballot extraction.
   Option: Opening by Hand or Opening by Machine.
   Option: Include Extracting and/or Flattening ballots within this step.
   *Note: If envelopes are opened during the Rescan & Sort Envelopes step, the Opening Envelopes step **cannot** be added to the process.*
7. **Extract Ballots**: Removing the ballot from the opened return envelope.
   Assumes this process is done by hand.
   Option: Include Flattening Ballots during this step.
   *Note: If Extract was selected within the Open Envelopes step, the Extract Ballots step **cannot** be added to the process.*
8. **Flatten Ballots**: Unfolding and flattening ballot cards that have been extracted from envelopes.
   Assumes this process is done by hand.
   *Note: If Flatten was selected within either the Open Envelopes or Extract Ballots step, the Flatten Ballots step **cannot** be added to the process.*
9. **Tabulate Ballots**: Counting the votes for each ballot card.
   Assumes digital scanning machines are used for tabulation.
10. **Duplicate Ballots**: Creating duplicate ballot cards if certain ballot cards are damaged or cannot be scanned.
11. **Adjudicate Ballots**: Interpreting voter intention on ballot cards with marks that cannot be interpreted by the digital scanning machine.

Adding Processing Steps

To construct a vote-by-mail process, click on the ADD STEPS + button in the Processing Steps menu on the left side of the screen (shown in Figure 2). This will present the list of steps that can be added to the process (shown in Figure 3).

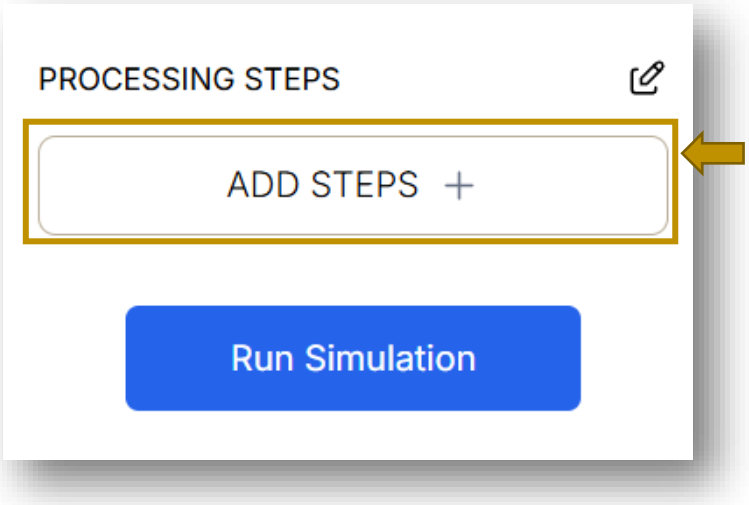


Figure 2. Add Steps Button.

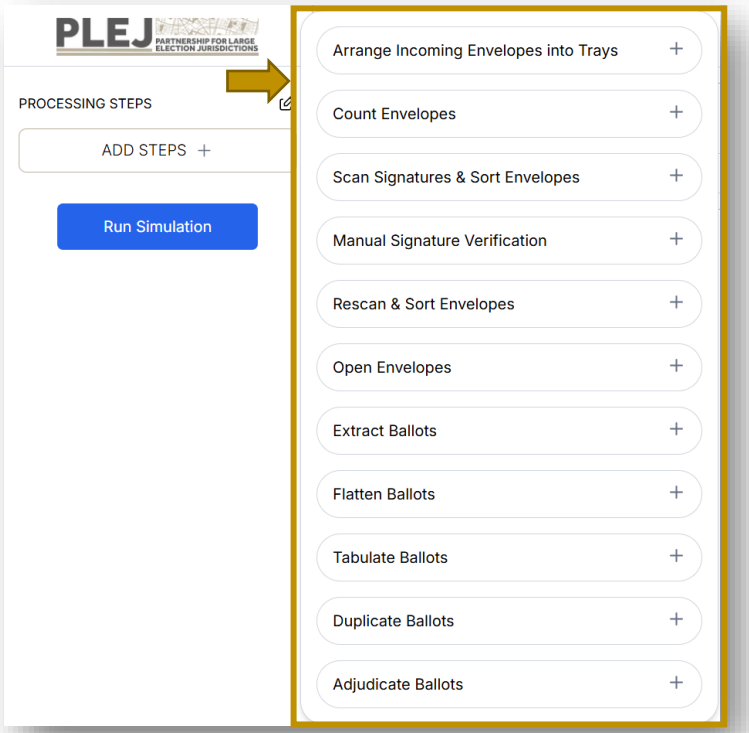


Figure 3. List of Process Steps

Click on steps to add them to the process and they will appear in the Processing Steps menu on the left side of the page (Figure 4). Once all desired steps are added, click anywhere on the page outside of the list of steps to close the list. Review the list of steps within the Processing Steps menu.

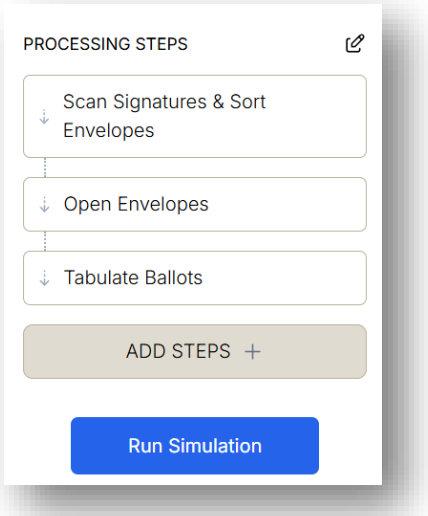


Figure 4. Added Processing Steps

The order of steps listed in the Processing Steps menu indicates the order in which they occur during processing, with the step at the top of the list occurring first and the step at the bottom of the list occurring last.

For example, in Figure 4, envelopes first go to the Scan Envelopes & Signature step, then to the Opening Envelopes step, and finally go to the Tabulate Ballots step.

Press the Edit button (shown in Figure 5) to remove steps or change the order of steps presented. Upon pressing the Edit button, two symbols will appear beside each process step (see Figure 6). Pressing the Trashcan icon will remove the step from the Processing Steps menu. To change the order of steps, click and hold on the six dots and drag the step up or down in the list to the desired location.

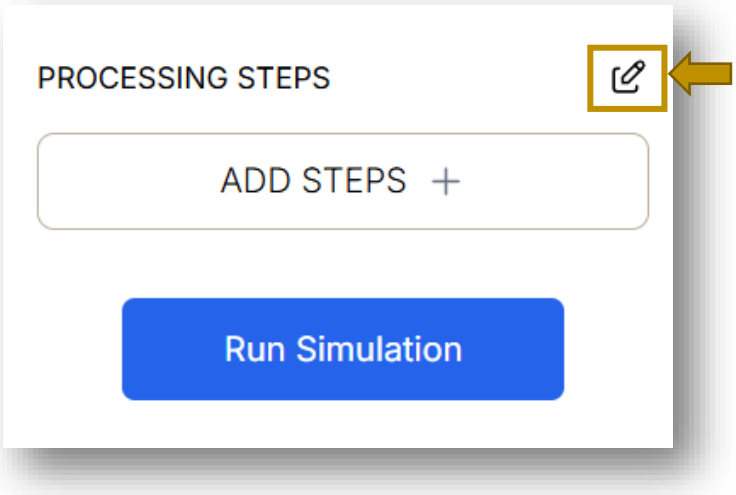


Figure 5. Edit Process Steps Button.

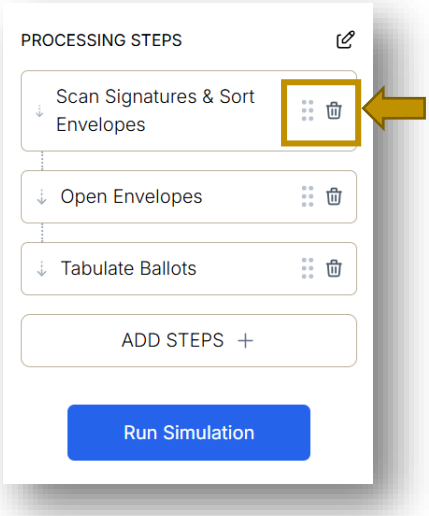


Figure 6. Edit Process Steps Options

Entering Process Information

On the right side of the page, information about the vote-by-mail process and each processing step must be entered. The following sections explain the inputs required by the Vote-by-Mail Lead Time Estimator.

General Inputs

Two general pieces of information are required to use the Vote-by-Mail Lead Time Estimator (shown in Figure 7):

1. **Number of Envelopes**: The number of envelopes to be processed.
2. **Average Number of Ballot Cards per Envelope**: The average number of individual ballot cards (i.e., sheets of paper) within envelopes. If the ballot is double-sided, it counts as one ballot card.

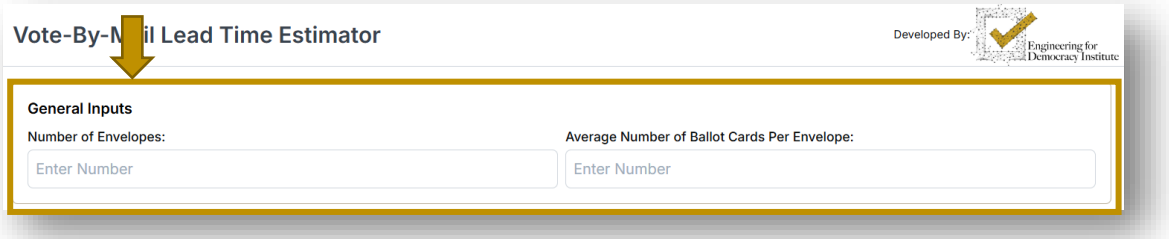


Figure 7. General Inputs

Processing Step Inputs

As steps are added to the Processing Step menu on the left side of the page, input menus will appear for each step on the right side of the page (Figure 8). Depending on the step added, different inputs are required. The following sections explain the inputs necessary for each process step.

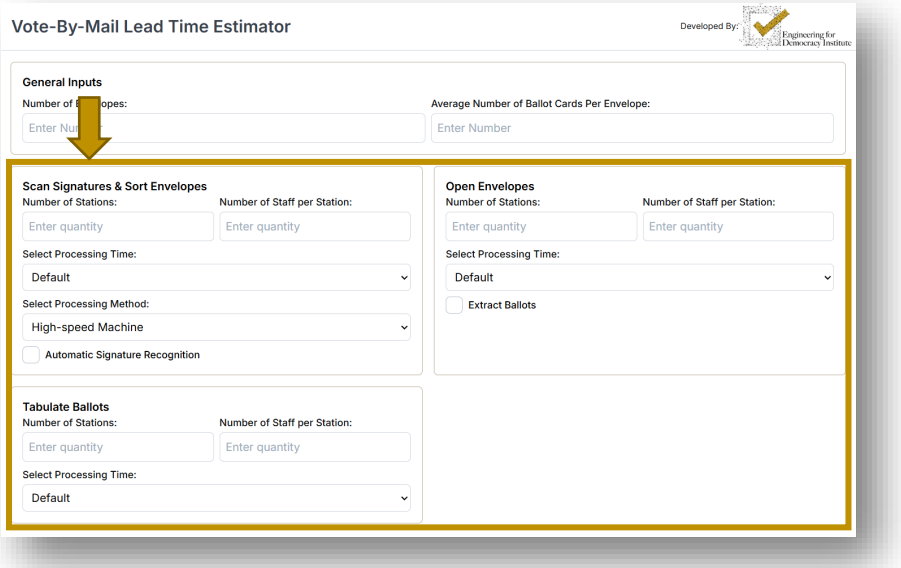


Figure 8. Processing Step Inputs Menu

Arranging Incoming Envelopes into Trays

This step requires inputs for:

- **Number of Stations**: The number of stations at which envelopes are arranged into trays. If all workers are completing the same tasks, then the Number of Stations should be set to the number of election staff at this step.
- **Number of Staff per Station**: The number of election staff arranging envelopes into trays per station. If all workers are separately completing the same task, then the Number of Staff per Station should equal 1. If election staff are working in teams, enter the number of staff per team.
- **Select Processing Time**: Select which type of processing time data is used for the step.
    - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.[1]
    - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per tray, divide the time per tray by the number of envelopes that a tray can hold to estimate time per envelope. Ensure values are entered in seconds.

Count Envelopes

This step requires inputs for:

- **Number of Stations**: The number of stations at which envelopes are counted. If all workers are completing the same tasks, then the Number of Stations should be set to the number of election staff at this step.
- **Number of Staff per Station**: The number of election staff counting envelopes per station. If all workers are completing the same task, then the Number of Staff per Station should equal 1.
- **Select Processing Time**: Select which type of processing time data is used for the step.
    - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
    - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per tray, divide the time per tray by the number of envelopes that a tray can hold to estimate time per envelope. Ensure values are entered in seconds.
- **Select Counting Method**: The method by which envelopes are counted, either by hand or with a machine.

[1] Data used to generate processing times comes from observations of real vote-by-mail process collected by the Engineering for Democracy Institute.

Scan Signatures & Sort Envelopes

This step requires inputs for:

- **Number of Stations**: The number of stations at which signatures are captured, and envelopes are sorted into batches. If all workers are completing the same task, then the Number of Stations should be set to the number of election staff at this step. If machines are used, the Number of Stations should equal the number of machines in use.
- **Number of Staff per Station**: The number of election staff scanning signatures and sorting envelopes into batches per station. If all workers are completing the same task, then the Number of Staff per Station should equal 1.
- **Select Processing Time**: Select which type of processing time data is used for the step.
    - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
    - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per tray, divide the time per tray by the number of envelopes that a tray can hold to estimate time per envelope. Ensure values are entered in seconds.
- **Select Processing Method**: The method by which signatures are recorded and/or envelopes are sorted into batches, either with a high-speed machine or with handheld barcode scanners.

Manual Signature Verification

This step requires inputs for:

- **Number of Stations**: The number of stations at which envelope signatures are manually verified with reference signatures.
- **Number of Staff per Station**: The number of election staff verifying signatures per station. For example, if two workers are simultaneously required to match each signature, then the Number of Staff per Station should equal 2.
- **Select Processing Time**: Select which type of processing time data is used for the step.
    - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
    - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per batch of envelopes, divide the time per batch by the number of envelopes that a batch holds to estimate time per signature. Ensure values are entered in seconds.
- **Manual Verification Percent**: The percentage of all envelopes that go to manual signature verification. For example, enter 45 if 45% of envelopes are verified manually.
- **Signatures Checked Simultaneously**: The number of signatures that appear on screen (if a signature verification software is used) simultaneously. For example, if four signatures are shown and workers match all four signatures prior to moving to the next group of signatures, enter 4.
- **Level 2 Signature Verification**: Select this checkbox if signatures that cannot be matched during the initial manual signature verification step are escalated to a secondary signature verification process.
    - **Number of Level 2 Station**: The number of stations dedicated to performing Level 2 Signature Verification.

- **Number of Staff per Station**: The number of election staff verifying signatures per level 2 verification station. For example, if two workers are simultaneously required to match each signature, then the Number of Staff per Station should equal 2.
- **Percent of all Signatures to Level 2**: The estimated percentage of all envelopes that must go to Level 2 Signature Verification.
- **Select Processing Time**: Select which type of processing time data is used for Level 2 Signature Verification.
  - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
  - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per batch of envelopes, divide the time per batch by the number of envelopes that a batch holds to estimate time per signature. Ensure values are entered in seconds.

Rescan & Sort Envelopes

This step requires inputs for:

- **Number of Stations**: The number of stations at which envelopes are rescanned and sorted based on their verification status.
- **Number of Staff per Station**: The number of election staff rescanning and sorting envelopes. If all workers are completing the same task, then the Number of Staff per Station should equal 1.
- **Select Processing Time**: Select which type of processing time data is used for the step.
  - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
  - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per /batch of envelopes, divide the time per tray/batch by the number of envelopes in the tray/batch to estimate time per envelope. Ensure values are entered in seconds.
- **Select Processing Method**: The method by which envelopes are scanned and sorted into batches, either with a high-speed machine or with handheld barcode scanners.
  - **[If High-speed Machine] Open Envelopes**: Select this checkbox if envelopes are opened by a high-speed sorting machine during this step.

Open Envelopes

If Open Envelopes is checked off on the Rescan & Sort Envelopes step, then this step cannot be added. This step requires inputs for:

- **Number of Stations**: The number of stations at which envelopes are opened in preparation for ballot extraction.
- **Number of Staff per Station**: The number of election staff opening envelopes per station. If all workers are completing the same task, then the Number of Staff per Station should equal 1.
- **Select Processing Time**: Select which type of processing time data is used for the step.
  - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.

  - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per tray/batch, divide the time per tray/batch by the number of envelopes in a tray/batch to estimate time per envelope. Ensure values are entered in seconds.

- **Extract Ballots**: Select this checkbox if ballots are extracted as they are opened.
  - **[If Extract Ballots is Selected] Flatten Ballots**: Select this checkbox if ballots are flattened as they are opened and extracted.

Note: If Extract Ballots and Flatten Ballots are selected, the Number of Staff per Station should account for staff opening envelopes, extracting ballots, and flattening ballots. For example, if one staff member opens envelopes and passes them to another staff member to extract ballots, then the Number of Staff per Station should be set to 2. If after opening, the staff member extracting ballots then passes the folded ballots to another staff member who flattens the ballots, then the Number of Staff per Station at this step should equal 3.

Extract Ballots

If Extract Ballots is checked off on the Open Envelopes step, then this step cannot be added. This step requires inputs for:

- **Number of Stations**: The number of stations at which ballots are extracted from open envelopes.
- **Number of Staff per Station**: The number of election staff extracting ballots. If all workers are completing the same task, then the Number of Staff per Station should equal 1.
- **Select Processing Time**: Select which type of processing time data is used for the step.
  - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
  - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per envelope. If you have estimates per tray/batch, divide the time per tray/batch by the number of envelopes that in a tray/batch to estimate time per envelope. Ensure values are entered in seconds.

- **Flatten Ballots**: Select this checkbox if ballots are flattened as they are extracted.

Note: If Flatten Ballots is selected, the Number of Staff per Station should account for staff extracting ballots and flattening ballots. For example, if one staff member extracts ballots and passes them to another staff member to flatten ballots, then the Number of Staff per Station should be set to 2.

Flatten Ballots

If Flatten Ballots is checked off on the Open Envelopes step or on the Extract Ballots step, then this step cannot be added. This step requires inputs for:

- **Number of Stations**: The number of stations at which ballots are flattened.
- **Number of Staff per Station**: The number of election staff extracting ballots per station. If all staff complete the same task in this process, then the Number of Staff per Station should equal 1.
- **Select Processing Time**: Select which type of processing time data is used for the step.
    - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
    - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per ballot. If you have estimates per batch, divide the time per batch by the number of ballots that a batch contains to estimate time per ballot. Ensure values are entered in seconds.

Tabulate Ballots

This step requires inputs for:

- **Number of Stations**: The number of stations at which ballots are tabulated. Assumes the use of digital/optical ballot scanners.
- **Number of Staff per Station**: The number of election staff tabulating ballots per station.
- **Select Processing Time**: Select which type of processing time data is used for the step.
    - **[If Default] No additional input required**: Data collected by the Engineering for Democracy Institute is used to estimate processing time.
    - **[If Custom] Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per ballot. If you have estimates per batch, divide the time per batch by the number of ballots that a batch contains to estimate time per ballot. Ensure values are entered in seconds.

Duplicate Ballots

This step requires inputs for:

- **Number of Stations**: The number of stations at which damaged ballots are duplicated.
- **Number of Staff per Station**: The number of election staff required to duplicate ballots per station.
- **Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per ballot. Ensure values are entered in seconds.

Adjudicate Ballots

This step requires inputs for:

- **Number of Stations**: The number of stations at which ballots containing marks that a scanner cannot interpret are adjudicated.
- **Number of Staff per Station**: The number of election staff required to adjudicate ballots per station.
- **Min, Avg, and Max**: In seconds, enter estimates for the Minimum, Average, and Maximum time to complete the step per ballot. Ensure values are entered in seconds.

Output & Simulation Results

Once all inputs are entered and the blue *Run Simulation* button is pressed, the Vote-by-Mail Lead Time Estimator will run a simulation of the vote-by-mail process and record statistics. This process may take several minutes depending on the number of envelopes that must be processed. When the simulation is completed, a results window will display on screen (see Figure 9). The results window will show several statistics about the process including Station Wait Times, Average Time that a Ballot is in the System, Average Time that a Ballot Spends Waiting, Required Working Hours, and Required Staff. Each of these results is described in additional detail in the following sections.

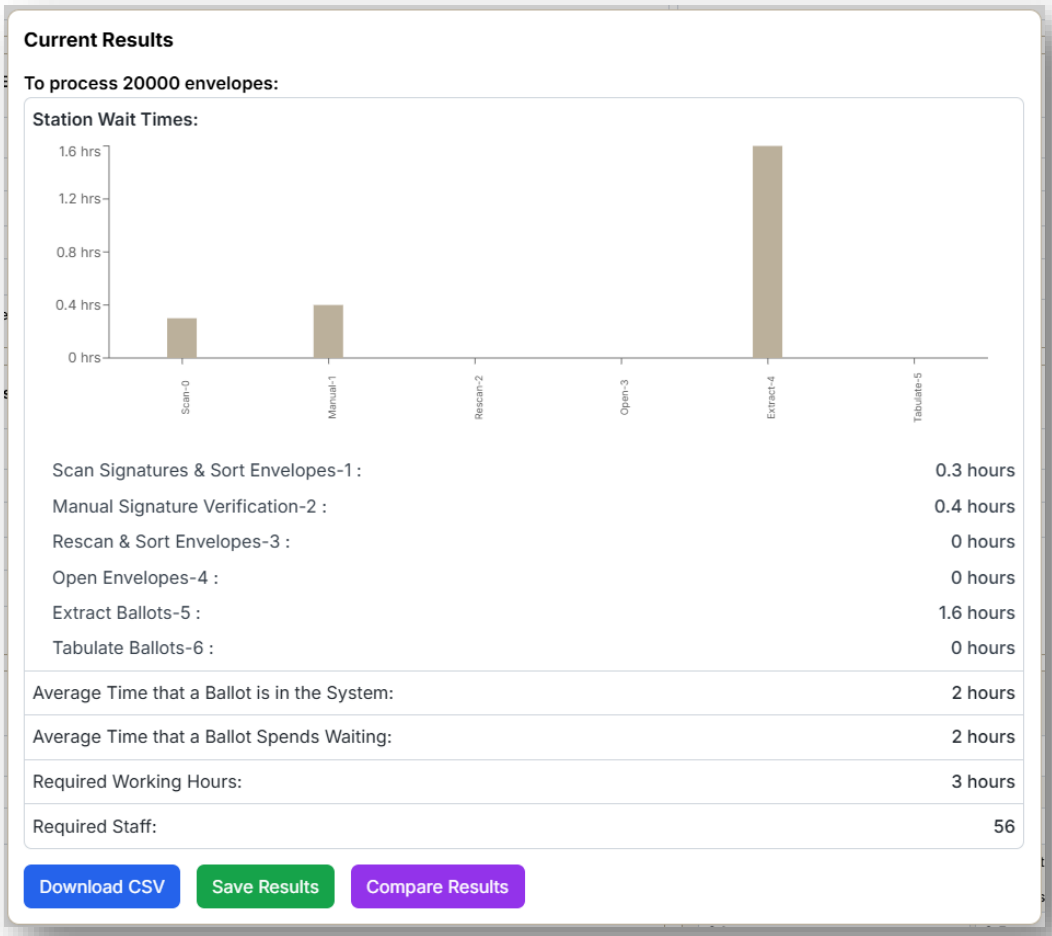


Figure 9. Results Window

Station Wait Times

The Station Wait Times results present the average wait time per step of the vote-by-mail process. These results are presented both graphically and numerically. The Station Wait Times plot shows process steps on the *x*-axis (horizontal) and average wait times in hours on the *y*-axis (vertical). Below this plot, the average wait time per process step is listed.

Average Time that a Ballot is in the System

This value represents the average amount of time that a ballot spends in the vote-by-mail process, including processing time and waiting time. This estimates the amount of time it takes a ballot to get through the process from when the envelope arrives at the processing facility to when the ballot is tabulated or adjudicated.

Average Time that a Ballot Spends Waiting

This value represents the average time that a ballot waits to be processed throughout the entire vote-by-mail process. For example, if a ballot waits for three processing steps, then the Time that a Ballot Spends Waiting will be the sum of the three corresponding wait times.

Required Working Hours

This value estimates the number of working hours required to process all envelopes. In this context, working hours refer to the time at which the vote-by-mail process is fully staffed and operating. For example, if the Required Working Hours is 40 hours, this could be five 8-hour shifts or four 10-hour shifts.

Required Staff

This value indicates the number of staff required to operate all stations in the vote-by-mail process. This value is calculated by multiplying the number of stations by the number of staff working per station for each of the process steps and adding them together. For example, if 5 stations perform manual signature verification and 2 workers are required per station and tabulation has 2 stations with 1 staff each, the Required Staff is 12. This value assumes that staff do not move between stations throughout the process.

Downloading Results

The numeric results presented in the results window can be downloaded as a CSV file by pressing the Download CSV button at the bottom of the results window. The CSV file can be opened in Excel or other spreadsheet editing software.

Save Results

Press the Save Results button to store the results shown on screen to compare them to the results of a future simulation. [2] Only one set of results can be saved at a time. Results are saved while the web browser window is open. Once the page is refreshed or closed, all values are reset and saved results are removed.

[2] Results are stored locally on your browser. The creators of this tool cannot see your inputs or results.

Comparing Results

If a previous set of results have been saved, press the Compare Results button to compare results between processes with various inputs. The results window will expand to display your current results on the left and the saved results on the right (Figure 10).

Figure 10. Comparing Results

Thank you for using the Vote-by-Mail Lead Time Estimator! Feel free to share feedback with the Engineer for Democracy Institute (edi@etal.uri.edu).