Preliminary Evaluation of Los Angeles County Vote Center Performance in the March 2020 Primary Elections

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1 Executive Summary

In this report, the *Monitoring the Elections* team at Caltech provides an external and independent analysis, using data provided by the Los Angeles County Registrar-Recorder/County Clerk (LACRR/CC), of Los Angeles County's March 2020 Super Tuesday election. The bulk of the data was provided from the ePulse website (by vendor KnowInk) and is supported by various other supplementary data. The goal of this report is to use all of the currently available data to isolate bottlenecks at vote centers during the March 2020 Super Tuesday election in order to improve the process for the upcoming 2020 November general election.

In 2020, Los Angeles County shifted to a vote center model, under the California Voter's Choice Act (VCA), which differs dramatically from the previous election administration approach in the county.[1] The previous approach utilized a significantly larger number of neighborhood polling places. The vote center approach consolidates polling places into vote centers with more capabilities, such as registering the voter on the spot, both on Election Day as well as during the ten days prior to Election Day (total 11-day voting period), and allowing voters to cast their vote at any vote center location of their choosing. While we expected that some minor issues would arise during this transition, from our research the voting experience of many voters in the March primary may have been seriously impacted by voter center lines and technological issues. In March 2020, we released a preliminary report from our in-person election observation study in Los Angeles County that documented the issues that our project team witnessed during early voting and on Election Day in thirty-five voting centers throughout Los Angeles County, which supplements the analyses presented here.[2]

Our analysis leads to three primary conclusions, given the available data. First, the data collected on voter wait times, which we believe to be an important metric for evaluation of the voting experience, is of low quality, obviating the use of this important metric in this study. Second, in analyzing the second-best metric, the data on provisional ballot usage, we show that the widespread use of provisional ballots may indicate PollPad problems. Third, in these data we see evidence of major challenges with PollPad systems in the vote centers, which when malfunctioning may have produced lines in vote centers, and also may have forced voters to cast provisional ballots needlessly.

For the purposes of this report, we focus on vote center operations, and in particular the PollPads that were used in the vote centers. We recently received data on the Ballot Marking Devices (BMDs) used in the March primary election, and we have other data on the vote center locations. We plan on conducting further analyses of those data, as the BMD operations and vote centers are beyond the scope of this report.

[1] More information about the VCA can be found here, `https://www.sos.ca.gov/elections/voters-choice-act/`.

[2] The final version of our in-person election observation report is available at `https://bit.ly/2Z6HvhS`.

Based on our analysis, we make the following recommendations to prepare for the November 2020 election:

1. We recommend that LACRR/CC strengthen and emphasize the process where **real-time wait times data is frequently collected for each vote center**, and have them **made available to voters and vote center staff in real-time**.
2. We recommend that **additional and independent research regarding why many PollPads malfunctioned in the March primary** continues, especially with regard to the **Internet connection and syncing of PollPads**.

This report complements our Los Angeles County Vote Center Observation Report, 2020 March Primary, and should be understood in connection to our in-person observation report. Our aim is to be of service to the Southern California voting community by offering analyses that will improve the voting experience in Los Angeles County in November 2020. We appreciate that we were provided access to the data used in this study, and we welcome comments and feedback to improve the research reported below.

Please note that the initial version of this report was written prior to the countywide lockdown due to COVID-19 and the Executive Order N-64-20 by California Governor Gavin Newsom on May 8, 2020. We expect that this will change the election logistics considerably, but our conclusions still hold for in-person voting.

2 Introduction

In order to examine potential explanations for long lines in Los Angeles County vote centers in the March 2020 primary, we use a variety of datasets, some from LACRR/CC, some acquired from other sources. In this section, we briefly review the data gathered for this study, and some of the general trends that we see. This section thus provides an introduction to the available data and also yields some insight into voter experiences during the primary's 11-day voting period.

2.1 Data Collection

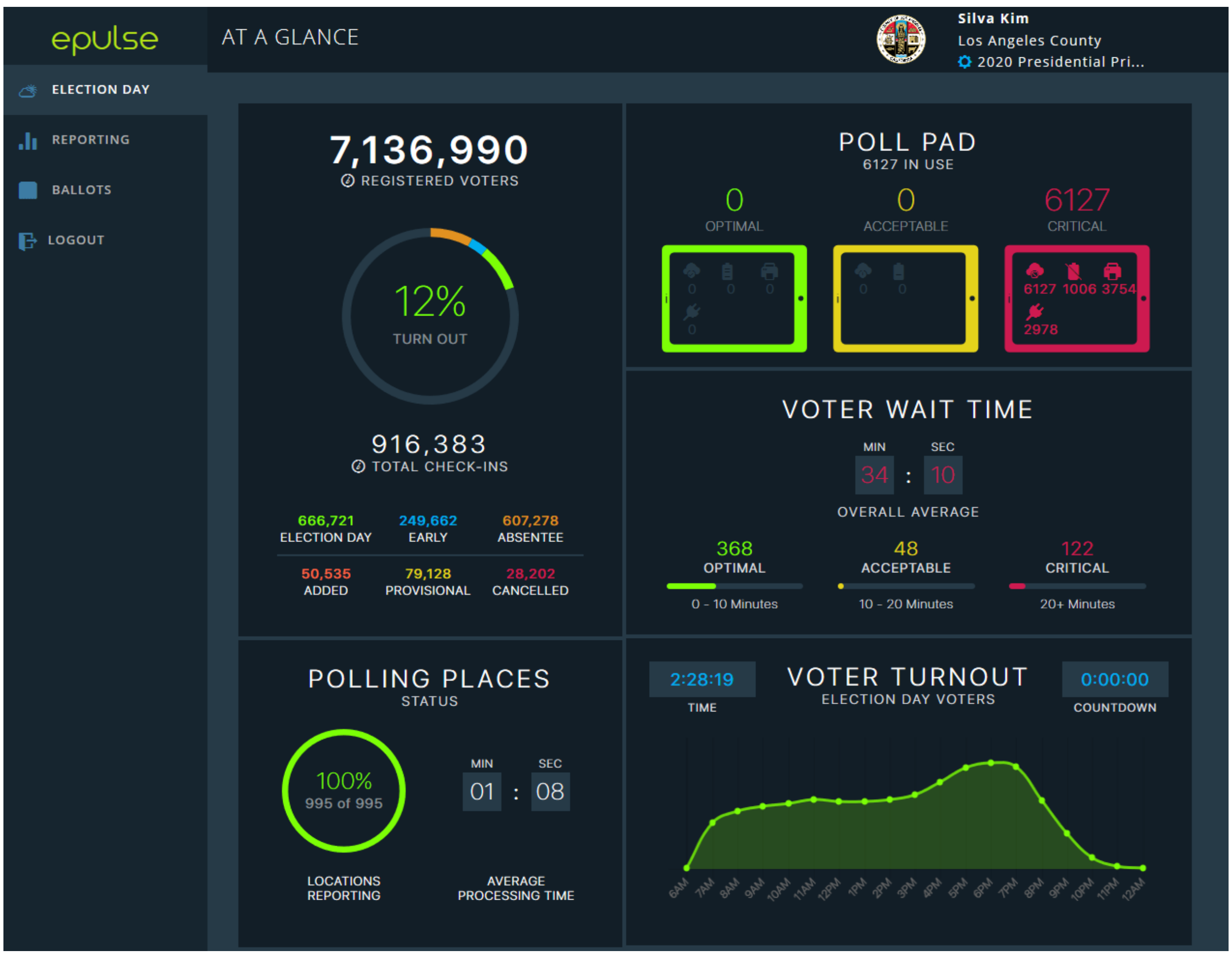


Figure 1: ePulse "At a Glance" Page Screenshot, Retrieved March 17, 2020, at 2:35pm

ePulse Website. The ePulse website, working with the connected PollPads, provides features such as Election Day issue tracking and poll worker time-tracking. The vendor of the PollPads, KnowInk, describes the system as follows:

> ePulse is an all-inclusive election management suite designed to give administrators real-time access to monitor their election as a whole. All Poll Pads connect to this

> central hub where voter check-in data is securely transferred via WiFi or cellular networks in near real-time. This look allows for administrators to oversee the operation of individual precincts and Poll Pads including battery life of the device, average check-in times, number of ballots issued or spoiled; all the while ensuring the election authority can directly contact poll works via video or text message for speedy trouble resolution.[3]

Our data collection from the ePulse website was twofold. First, the available reports at the "Reporting" tab of the ePulse website were downloaded. These included detailed data on reported wait time by vote centers, hourly turnout, number of voters processed by each PollPad, and provisional votes processed. Second, a web scraper was applied to the ePulse "At a Glance" page, where summary statistics were updated real-time as PollPads checked voters in. The scraper was launched every five minutes, starting on Feb 22, 2020, at 7:33pm, and continued days after the election was over. Figure 1 is a screenshot of the page—the access credentials were provided by LACRR/CC.

This is the main dataset that we analyze in this report. There were times, however, that the data monitor went down. Notably, this occurred on (1) Feb 26 from about 11:00am to 12:40pm (100 minutes), (2) Feb 28, which lost the day's entry until 16:22pm (8 hours), (3) Feb 29, which lost most of the day's entry until 16:32pm (8 hours), and (4) Mar 3 (Election Day) from about 7:00pm to 9:00pm (2 hours).[4]

In-person Observations. As mentioned above in the Executive Summary, the data analysis uses implications from and complements our in-person observation report (link here). The team visited thirty-five vote centers, observed the election process for 10-30 minutes in each location, and communicated with vote center staff when possible. These observations allowed us to determine the quantities that we would evaluate as well as verify the data from the observed vote centers. Thus the in-person observation report helps us develop our expectations regarding what we should be looking for in the available data.

Vote Center Equipment Allocations Data. We also received data from the *Los Angeles Times*, which had reported on the list of voting centers and the total number of ballot-marking devices and voter-lookup machines deployed to each, which they received from LACRR/CC.[5] The data we received shows the equipment allocation for the originally designated 978 vote centers. This allowed us to see the proposed equipment allocations and compare that to how many PollPads worked at each vote center on Election Day.

[3] See `https://knowink.com/product-catalog/epulse/`. The Los Angeles County's Election Administration Plan 2019 refers to electronic poll books as "ePollbooks." The vendor uses the term "poll pads." Here, we refer to them as PollPads.

[4] This excludes hours after poll closure, with the exception of Election Day.

[5] (M. Stiles, personal communication, March 11, 2020).

Official Website of Voting Solutions for All People (VSAP). For background and contextual information, we relied on the reports available from the official website of Voting Solutions for All People (VSAP)[6]. In particular, we relied on the *Election Administration Plan (EAP)*[7] and the information regarding the *Vote Center Placement Project (VCPP)*[8].

2.2 Overview: Voter Check-ins by Type Over Time

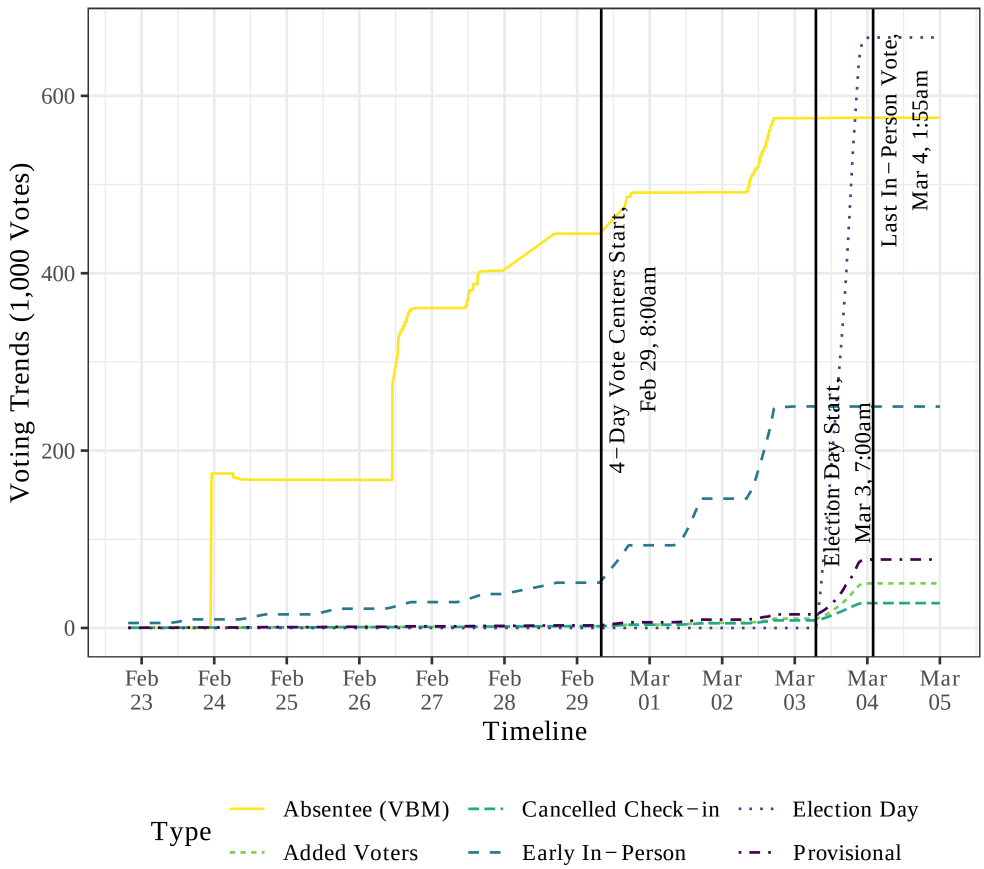


Figure 2: Voting Trends Over Time

To preview the data collected from the ePulse system, we will now present an overview of what the voters went through during the 11-day period. Figure 2 shows the type of check-ins over time, differentiating between four different voting methods (absentee ballot or vote-by-mail; Election Day voting; early voting; and provisional voting), added voters (presumably conditional voter registrations), and cancelled check-ins.[9]

[6] https://vsap.lavote.net.

[7] https://vsap.lavote.net/wp-content/uploads/2020/02/EAP_FINAL-ENGLISH.pdf.

[8] https://lacounty.maps.arcgis.com/apps/MapSeries/index.html?appid=c55578a7a8ff438cbfab31a98efb6e77.

[9] It is worth noting that the flat regions in the cumulative distribution of absentee ballots are probably based on the number of counted/tallied vote-by-mail (VBM) ballots, and not the number of returned/dropped-off ballots, as they continued to increase after poll closure, although truncated in Figure 2.

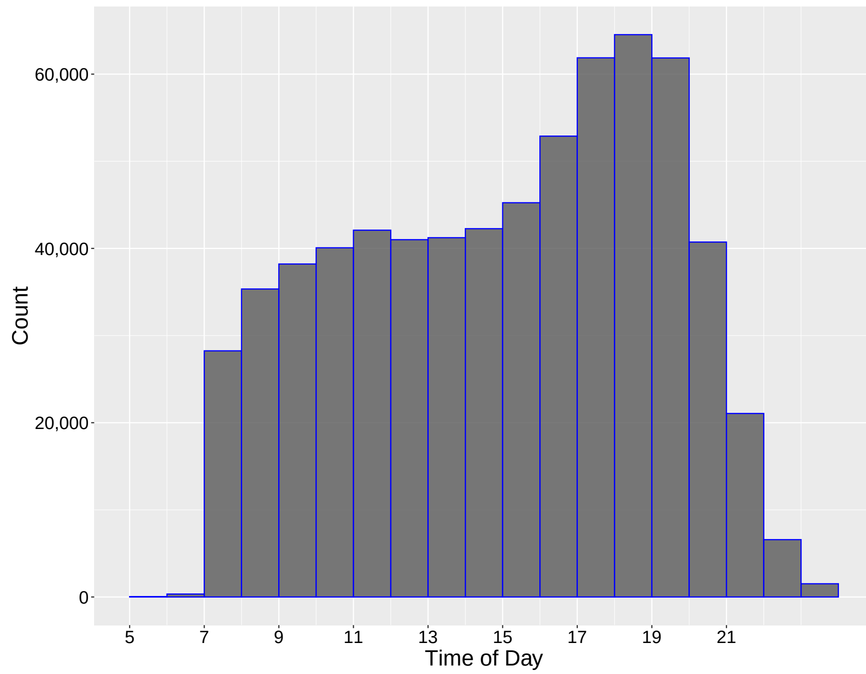


Figure 3: Number of Ballots Cast by Hour on Election Day.
Polls opened at 7am and closed at 8pm.

Early voting was slow in February, but it picked up considerably during last three days of early voting, especially on Monday, the final day before Super Tuesday. Even with this increase, more than twice as many people voted in person on Election Day ($\sim$ 700,000) than in person in the 10-day early voting period ($\sim$ 250,000). This surge partially accounts for why so many vote centers seemed overwhelmed on Election Day following the relative calm in the preceding days.

Figure 3 shows how the number of ballots cast was distributed during Election Day. While quite even and slowly increasing after 10:00am, the number jumps significantly around 5:00pm, which is likely due to voters who are casting their ballots after work.

Voters did not turn out in large numbers during the early voting period, especially in the first seven days of the 11-day period. Rather, voting is concentrated after work hours on Election Day, hinting that vote centers should be prepared to handle high traffic and rapidly growing lines near closure time of Election Day. However, as we observed in-person and will show in subsequent sections, there seemed to have been severe technical problems at check-in that led to bottlenecks and presumably long wait times.

In the next section, we begin with the analysis of the collected wait time data. For more details on turnout and voter check-in, see Appendix A.

3 Wait Time

3.1 Overview of Voter Wait Time

We begin our analysis with voter wait times, since the most visible issue on Super Tuesday was long lines in certain vote centers. Voters waiting in line is often a symptom of underlying problems in a voting location. Detailed analysis of the reported wait time data gives us more information about where to search for potential problems, and how to solve them.

Our understanding is that the voter wait times data were collected as follows. Each vote center lead was given a stack of small cards called *Wait Time Tracking Document* (see Appendix B) and a token. The token and a card were to be handed to the last voter in line with the current time written down. The voter then returned the token and the card to a vote center staff upon arriving at the check-in table. The difference between the time written on the document and the check-in time would be noted and manually entered in the ePulse system. This was to be repeated when the token was returned to the table, every hour if possible, and a zero was to be entered if there was no waiting time.

However, this data collection process was developed late in the pre-primary period, and this methodology, while potentially useful, is also difficult for busy vote center staff to implement. Our understanding, based on conversations with LACRR/CC, is that because of the late introduction of this process, training for vote center leads and staff may not have communicated effectively the importance of this task.

3.2 Data Quality

Unfortunately, the wait time data is extremely sparse and of low quality. Of the 992 locations, only 537 recorded any wait time information during the entire election period (54.1%), which leaves 45.9% of vote centers with no recorded wait time—including some locations with the most serious wait times reported by the media.[10]

The sparsity of the wait times data is summarized in Figure 4 (See Appendix B's Table 2 for specific percentages), which visualizes the percentage of open locations with a certain number of wait time observations each day. For instance, on the first day of voting 12% of open locations had at least one wait time observation while only 5% had 5 or more. On Election Day, 42% of locations had any observations and 10% of locations had 15 or more observations. Since wait time was supposed to be measured every hour—with most locations open from 8am-5pm in the early voting period, and 7am-8pm on Election Day—we expected most of locations to have at least 9 throughout the voting period.

[10] One of our collaborators was at UCLA Ackerman Union, both at noon and 9:30pm on Election Day, and saw over 1,000 students in line. From discussions with the vote center staff, the line had been similar all day. No records have been input from UCLA Ackerman Union. Hammer Museum also has no reported wait time, a nearby vote center which was also observed and which also experienced severe lines.

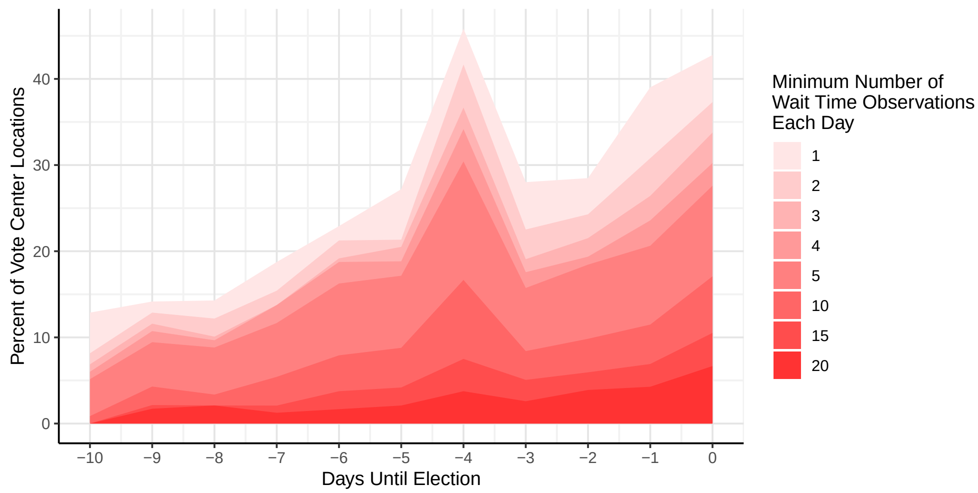


Figure 4: Percent of Open Locations with at Least n Records on Each Day of Voting

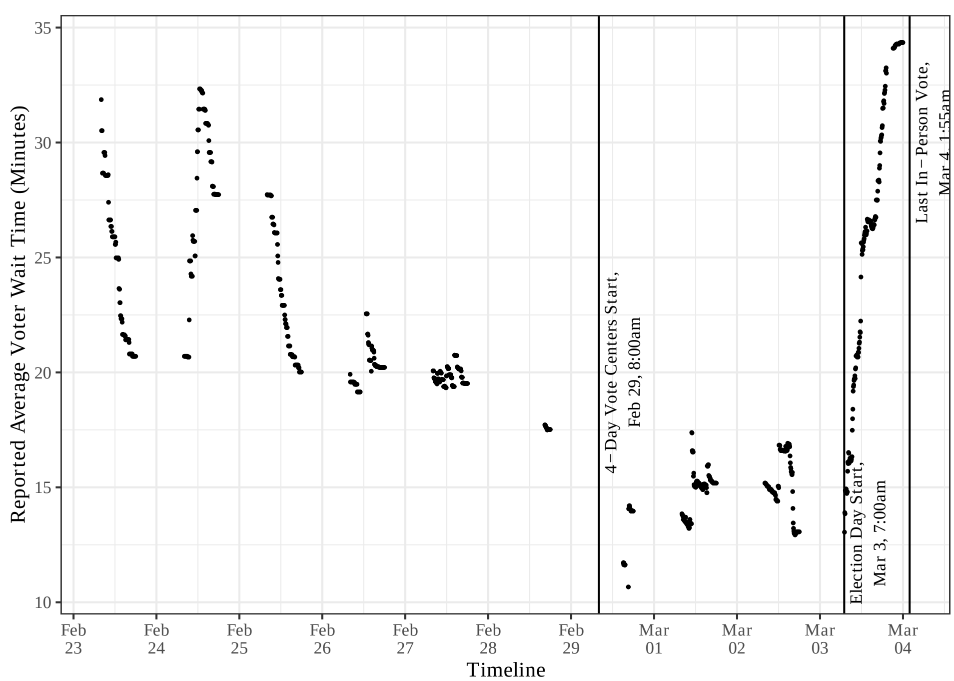


Figure 5: Reported Average Voter Wait Time from ePulse "At a Glance" Page,
Time-Series for 11-Day Voting Period

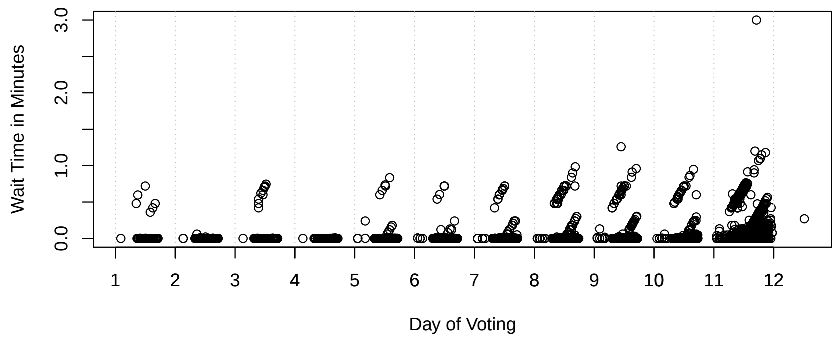


Figure 6: All Wait Times Recorded, Assuming Recording Unit is Milliseconds

In addition to the sparsity of wait time recording reports, our efforts to validate the recorded data leads us to believe that it is not reliable. In Figure 5, the average voter wait time over the entire voting period is presented, as collected from the ePulse “At a Glance” page. It shows average wait times greater than 20 minutes, similar to Election Day, in the first seven days of the voting period. This seems inconsistent with relatively low turnout in vote centers before Election Day, as shown in Figure 2.2. In contrast, Figure 6 plots all of the wait time observations from the downloaded reports. We were informed that the unit of analysis recorded in ePulse was milliseconds. Assuming this is true, the records translate into a maximum wait time of 3 minutes at any location at any time. This is inconsistent with the observations the team made on Election Day, where in certain vote centers, voters waited in lines that lasted hours. Not only are both records questionable, but they also contradict each other. More details on wait time data quality, including a discussion on record units, can be seen in Appendix B.

As we have mentioned, the data collection design was developed late in the pre-primary planning process, and many not have been well communicated to vote center leads and staff during their training. In addition, the data entry process itself might not have imposed necessary steps that might have made it easier for vote center staff to enter the data free from error. In sum, we believe that with better training on these procedures, a better data entry process, and an increased emphasis on the importance of collecting the wait times data, these data could be collected from the vote centers in an accurate and timely manner in November 2020. We will work with LACRR/CC to help improve this data collection process.

We believe that the accurate and frequent collection of wait time data is important for two purposes. First, the data is the first-best metric to diagnose the voting experience. Their analysis can help reduce long lines and improve the voting experience across the county. Second, if publicly disseminated real-time, this will itself help optimize the distribution of voters, as voters and vote center staff are informed about the wait time situation, and voters can choose to go to locations with little or no lines.

4 Provisional Ballots

While the wait time metric is the most important quantity to assess the quality of the voting experience, Section 3 makes it clear that it is not reliable and thus it is not very informative. Therefore, in this section, we explore the records on provisional voting and see if we can draw any conclusions about the March 2020 primary from the provisional voting data.

4.1 Summary Statistics

Provisional ballots are available as a fail-safe for voters.[11] For voters who have not received or lost their VBM ballot or whose name is not in the voter registration roster, provisional ballots are available to ensure that they can cast a ballot in the election. These ballots are then authenticated by the Registrar-Recorder/County Clerk prior to being included in tabulation. In theory, the number of provisional ballots should be expected to be lower in the vote center model than in the former system of neighborhood precincts. This is because (1) a voter can register on the spot in a vote center, and (2) there are no longer "incorrect" places to vote, as voters can use any vote center in Los Angeles County. However, provisional ballots still were used in the March 2020 primary—and they are the second-best metric to look for in our preliminary assessment. While provisional ballots are an important fail-safe procedure to ensure that eligible voters can participate in the election, the process of voting provisionally can significantly add administrative time in busy vote centers. Therefore, unusually large numbers of provisional voters could indicate places with increased wait time.

As of 1pm on March 31, 2020, 79,160 votes were provisionals,[12] whether these were accepted or rejected. This is 4.9% of total ballots cast, and 8.0% of all in-person ballots cast. Compare this to the June 7, 2016 primary: there were 271,318 provisional ballots cast (236,788 accepted), which was 13.4% of total ballots cast, and 20.8% of all in-person, precinct ballots cast.[13] Based on these data, the vote center model seems to have been successful in reducing the proportion of provisional ballots. However, it is still worth investigating when and where they manifested and what might have caused them, because they can still slow the administration of the election significantly.

Using the VPH Provisional Report from March 31,[14] 79.1% of the provisionals reported were

[11] See https://www.lavote.net/home/voting-elections/voting-options/at-the-polls/provisional-voting.

[12] Note that VPH Provisional Report available at the Velocity Report tab of the ePulse website reports the number as 82,958.

[13] Statistics calculated from Statement of Vote by Secretary of State, available at https://elections.cdn.sos.ca.gov/sov/2016-primary/2016-complete-sov.pdf, and Provisional Ballots Final Counts from LACRR/CC, available at https://lavote.net/Documents/Election_Info/06072016-Provisional-ballot-final-counts.pdf. We have not been able to find 2014 and 2018 equivalents of provisional count reports. Note that 2016 had much lower turnout in terms of eligible voters at 32.68%, while 2020's equivalent is 38.50% of eligible voters. Also note that 35.7% of ballots were vote-by-mail in 2016, while 37.9% were in 2020 (see https://www.lavote.net/docs/rrcc/news-releases/03032020_certified-results.pdf).

[14] Report was exported at 11:48pm. While the total count of provisionals are 82,958, there were many voters who

on Election Day. This is higher than the concentration of in-person voting on Election Day as opposed to the early voting period, which is 72.8%. The rest of the provisionals are also concentrated in the last three days of early voting, with less than 4% of provisionals cast during the early voting period. That is to say, provisionals happened more frequently on Election Day compared to the turnout trend.

According to the report, Table 1 is the distribution of reasons for having to vote provisionally, with the second column listing reasons for all provisionals.

Reason for Voting Provisionally	All Voters	Conditional Registrants	Others
(Blank)	56.10	91.23	1.48
PollPad Offline	35.89	8.00	79.25
Voted	5.89	0.69	13.98
VBM-returned	1.49	0.00	3.80
PollPad Offline, Voted	0.51	0.08	1.18
PollPad Offline, VBM-returned	0.06	0.00	0.16
No ID	0.05	0.00	0.14

Table 1: Reasons for Provisional Ballots, VPH Provisional Report of March 31, 2020, in percentages

Table 1 provides an overview of provisional ballots cast. The third column shows the reasons only for provisional voters who are conditional registrants (60.9% of all provisional voters), and the fourth column for other provisional voters (39.1% of all provisional voters).[15] The distinction between conditional registrant and other provisional voters help distinguish about 50,000 voters who would have voted provisionally regardless of any technical or vote-center specific issues. These newly added voters make up 5% of in-person voters during the primary.

By linking the individual provisional vote records with added voter records, we can see that although not the majority of provisional voters, most provisional voters who were not conditional registrants voted provisionally due to the PollPad being offline. These PollPad malfunctions will be further dissected in the following section.

4.2 Relationship to PollPad Malfunctions

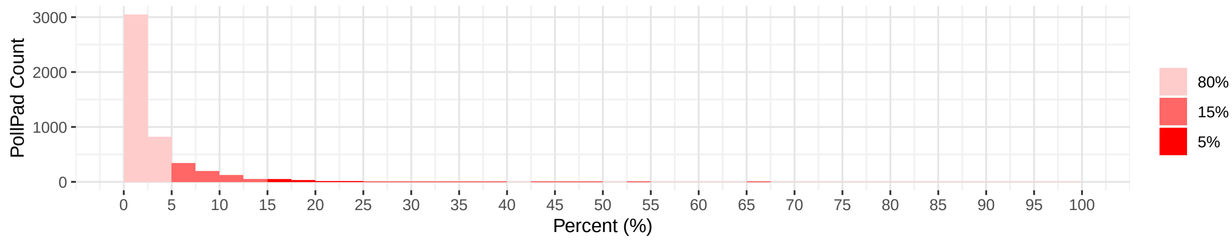
In order to look at the relationship between provisional ballots and PollPad malfunctions, we will first look at the distribution of provisional ballot shares per PollPad. We will exclude the PollPads that did not have a single ballot printed—the existence of never-used PollPads will be discussed in Section 5. In addition, in this section we will limit our analysis to the $\sim$ 30,000 votes

have different attempts to vote provisionally at the same location at different times. There are 4,502 such records—all tables and figures include these.

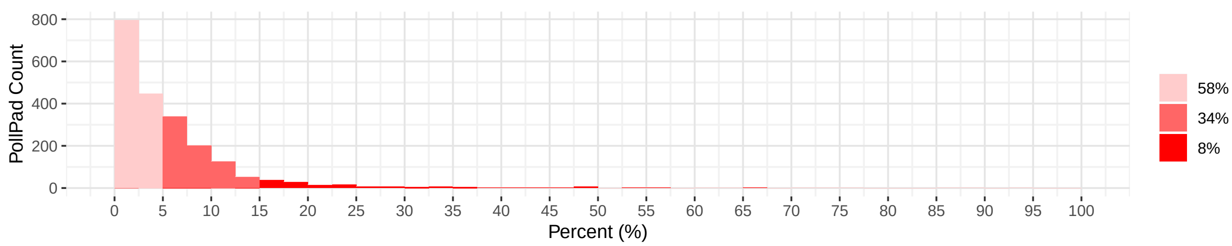
[15] The merged file for Table 1 was created by eliminating duplicates in the added voter file when *Name*, *Precinct*, and *Address* were identical, and then merging with the provisional records on the same three fields. All individual provisional reports were kept, so an added voter could have been matched to multiple provisional records. This merged file was then deduplicated based on identical *Name*, *Address*, *Ballot Style*, and *Precinct*.

that were not due to new registration. When we say provisional votes in this section we mean provisional votes *not* due to new registration. In Appendix C.2, analysis of all provisional votes can be seen to a strikingly similar effect.

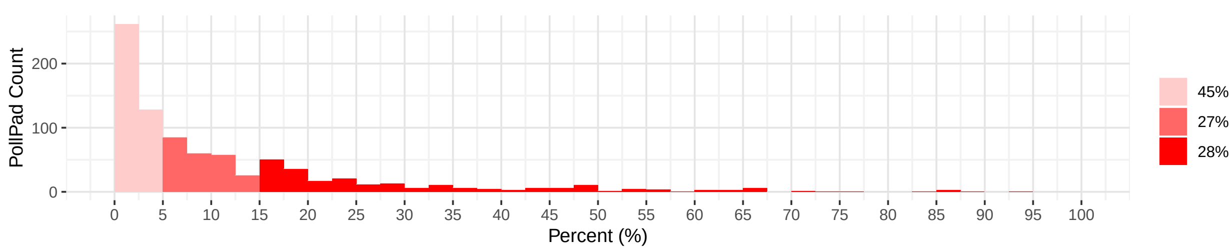
The distribution of PollPads by percentage of provisionals can be seen in Figure 25(a). Based on this distribution, we will label PollPads where 5% to 15% of ballots are provisional as "poor" and PollPads where more than 15% of ballots are provisional as "extremely poor." We can see that that 80% of PollPads are deemed good under this characterization, with the median at 1.5%.



(a) All PollPads



(b) Restricted to PollPads at Locations Where at Least One PollPad is "Poor"



(c) Restricted to PollPads at Locations Where at Least One PollPad is "Extremely Poor"

Figure 7: Distribution of PollPads by Provisional Ballot Shares

These poor and extremely poor PollPads are present at 362 (37%) and 124 (13%) of the vote center locations respectively. As we look at locations with at least one poor (Figure 25(b)) or extremely poor (Figure 25(c)) PollPad, the median provisional percentage remains below 7%.

If provisional ballots were only given to voters who needed them, there would not be a statistically significant difference in the percentage of provisional ballots each PollPad created within locations. Assuming that voters at each location were randomly directed to go to different PollPads, we would expect the provisional ballot shares to be similar for all of the devices. However, in Figure 25(b) it can be seen that around half of the PollPads at locations with at least one PollPad producing 5%-15% provisionals were still producing fewer than 5%. This supports our focus on individual PollPads, because the distribution of provisional votes within a vote center is statistically different from what we would expect if all PollPads had all been functioning equally well.

While some locations with higher levels of provisional voters could be a consequence of location and heterogeneous demographics (e.g., locations with large student population are more likely to use provisionals), it is clear that there were some unnecessary provisional ballots resulting from malfunctioning PollPads which may have exacerbated lines. We thus think it is acceptable to use higher percentages of provisional ballots as an indicator of malfunctioning PollPads and a proxy for longer wait times.

4.3 Geographical Distribution

Whether greater numbers of provisional ballots at vote centers are due to individual PollPads or not, the geographical distribution of high provisional voting locations is important for finding bottlenecks in the voting system. There are several reasons to vote provisionally, but we assume that large numbers of provisional votes may be indicative of PollPad issues.[16] Each time a person has to vote provisionally, their check-in and overall voter experience takes longer, causes a line and increases wait times. If one vote center experiences significant wait times, this may spill over to nearby vote centers.

By adding 5% to our previous thresholds to account for the 5% of total in-person voters who were added voters and therefore had to vote provisionally, we now look at *all provisional ballots* at the location level. Using this threshold of 10% and 20% provisional ballots, 77% of locations as performing well, 18% as "poor," and 5% as "extremely poor." These percentages are maintained if we look at total number of provisional votes at each location and create cutoffs at 100 and 200. Plots of these distributions can be seen in Appendix C.3. When the number of provisionals is plotted against the provisional ballot shares, as is done in Figure 8, it is clear that the locations deemed poor and extremely poor are different in the two schemes.

In Figure 9, the geographic locations of vote centers can be seen on a map of the county.[17] First, we see that the locations with disproportionately more provisional votes are not distributed randomly across the county, rather they are clustered. It is interesting to note the differences when we compare the *number* of provisional votes at a vote center versus *percentage* of provisional votes at a vote center. Focusing on the percentages, the vote centers with higher rates of provisional ballots cast are generally clustered in downtown Los Angeles and further south. In contrast, if we instead use the number of provisional votes, the vote centers with larger numbers of provisionals

[16] As shown in Table 1, we know that 60.9% of all provisional voters were conditional registrants.

[17] This includes provisional voters who were registered afterwards, because we think the total number of provisional votes by vote center is the best proxy for actual wait times.

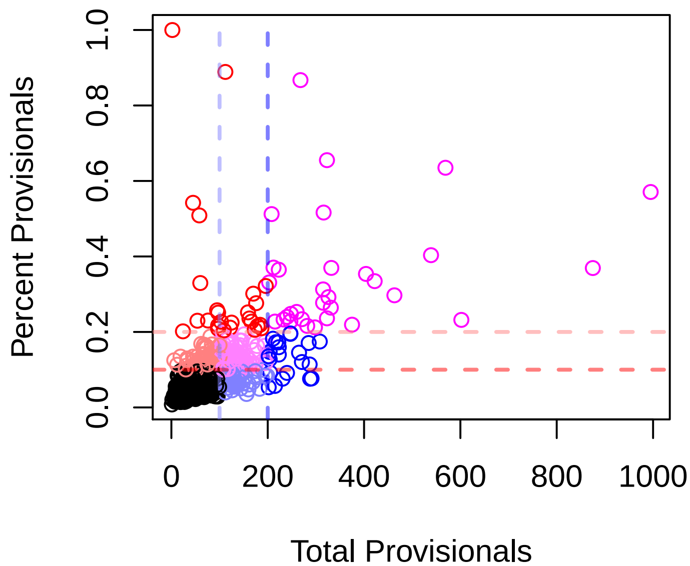
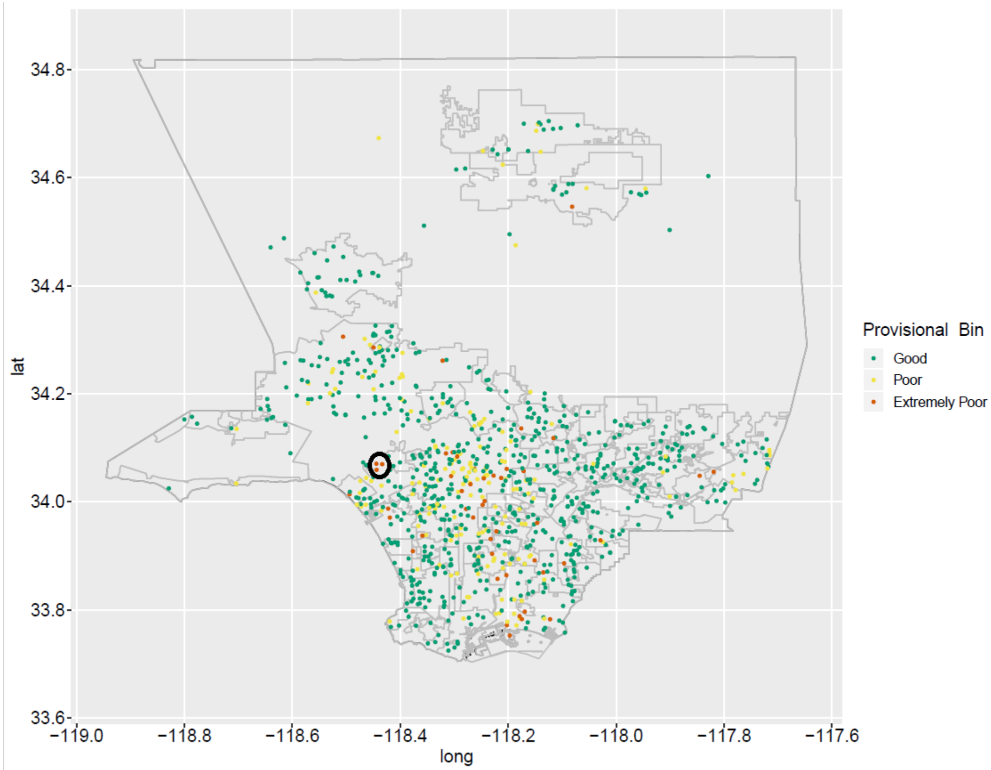
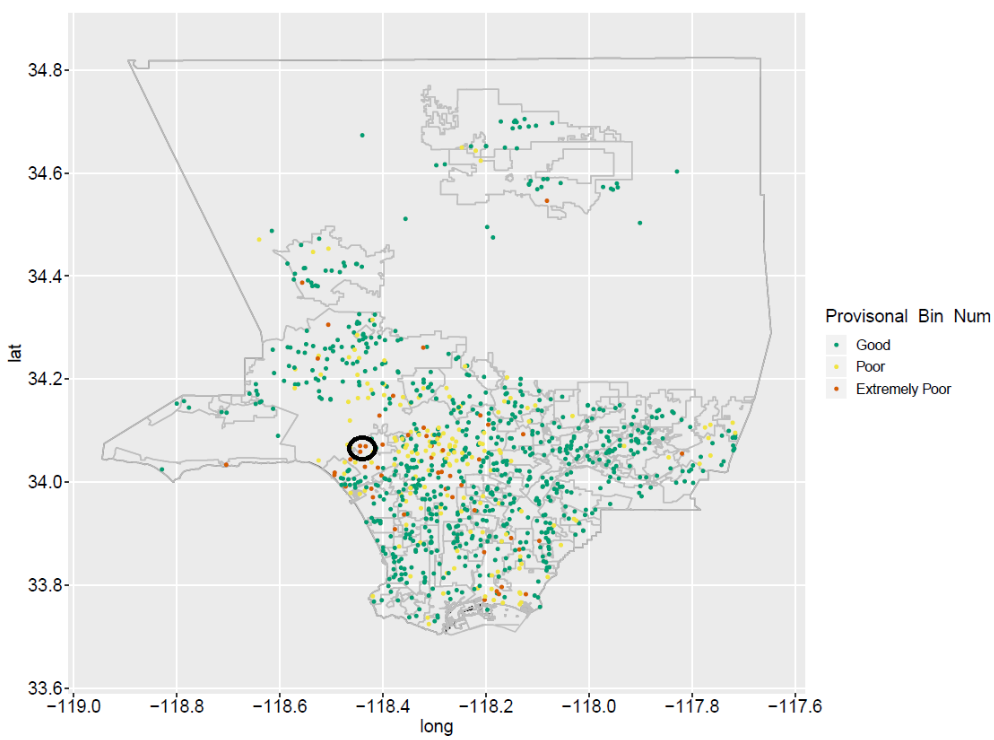


Figure 8: Total Number of Provisionals Compared to Percentage of Provisionals
Red lines show the cutoff for "poor" and "extremely poor" based on percentages while blue lines show cutoffs based on number. Purple points are locations that would be captured under either metric.

are clustered further west in Hollywood and Beverly Hills. We also note that in both maps, we see that the clusters are at UCLA and the two vote centers near UCLA.



(a) Percentage of Provisionals



(b) Total Number of Provisionals

Figure 9: Vote Center Classification Based on Percentage and Total Number of Provisional Votes. Circled in Black are the UCLA and Adjacent Vote Centers.

5 PollPads and Ballot Marking Devices

We have so far investigated provisional votes, a second-best metric of voting experiences, in lieu of reliable voter wait time data. We believe that the total number and percentage of provisional votes is also an indicator of vote center wait times, as they align with what we observed in-person. In addition, PollPad connectivity issues seem to be a driving factor in provisional voting, which is also consistent with what we observed in-person. Therefore in this section, we investigate the PollPad data, and how they may have contributed to the voters' experience at vote centers.

Note that in the available data from ePulse, there was no diagnostic information on BMDs, and if they malfunctioned, why. So while this is also an important step in assessing the voting experience, we cannot speak to how they may have contributed to wait time.

5.1 Time Series of PollPad Statuses

The ePulse summary page classified PollPads into the following types: *optimal*, *acceptable*, and *critical*. By the type of specific problems, these are further classified into the following per our interpretation of the ePulse page:[18]

- ✓ Printer, Internet connection, battery, and power are all optimal (marked **green**).[19]
- ✓ Internet connection is acceptable (marked **yellow**).
- ✓ Battery is acceptable (marked **yellow**).
- – Printer is out of order (critical; marked **red**).
- – Internet is disconnected (critical; marked **red**).
- – There is no battery (critical; marked **red**).
- – PollPad is unplugged (critical; marked **red**).

Figure 10, shows how many of the PollPads belong to each status during the entire voting period. While the gaps are associated with the monitor not up and running, the trends show important information about the PollPad utilization rates. First of all, among 6,670 or more PollPads, only around 3,000 PollPads were deemed optimal at any point during the election process. Second, connectivity problems seem to be the most frequent problem experienced by PollPads, followed by printer problems, power problems, and battery problems.

What the data shows aligns with what we observed in-person: the PollPad malfunctions were mostly due to connectivity issues, which likely contributed to long lines and the need for additional provisional voting. What the reasons are for these connectivity issues is unclear to us. Was it that the PollPad was not turned on intentionally, due to staffing shortages? Was it that the

[18]Using the information available from the source code, we interpret the printer icon to be about the printer, the cloud icon to be about the Internet connection, the battery icon to be about the battery, and the plug icon to be about power outlets.

[19]While there are separate icons for printer, internet connection, battery, and power, the numbers are the same every time—i.e., all conditions have to be optimal for a PollPad to be deemed "optimal."

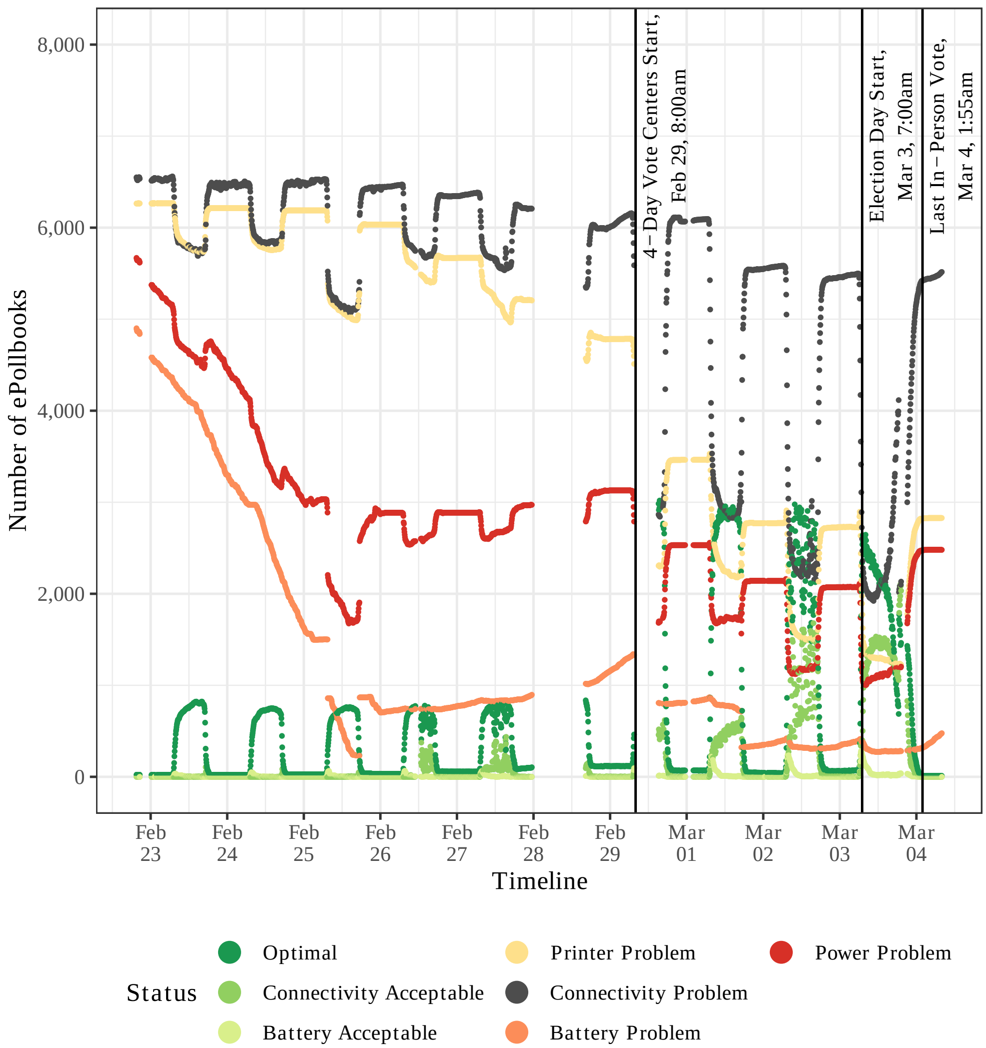


Figure 10: PollPads by Status

device was malfunctioning so that it was not communicating via the Internet? Was the router malfunctioning so that the device connection to the LACRR/CC server was hampered? Was the general Internet connection in the area poor, so that while the device and router were both working, the device failed to sync in time? This is not something we can answer with the given data and hope to see a future probe into the matter.

Although printer issues also seem pronounced in Figure 10, we did not observe any printing issues in-person, and few battery/power issues.

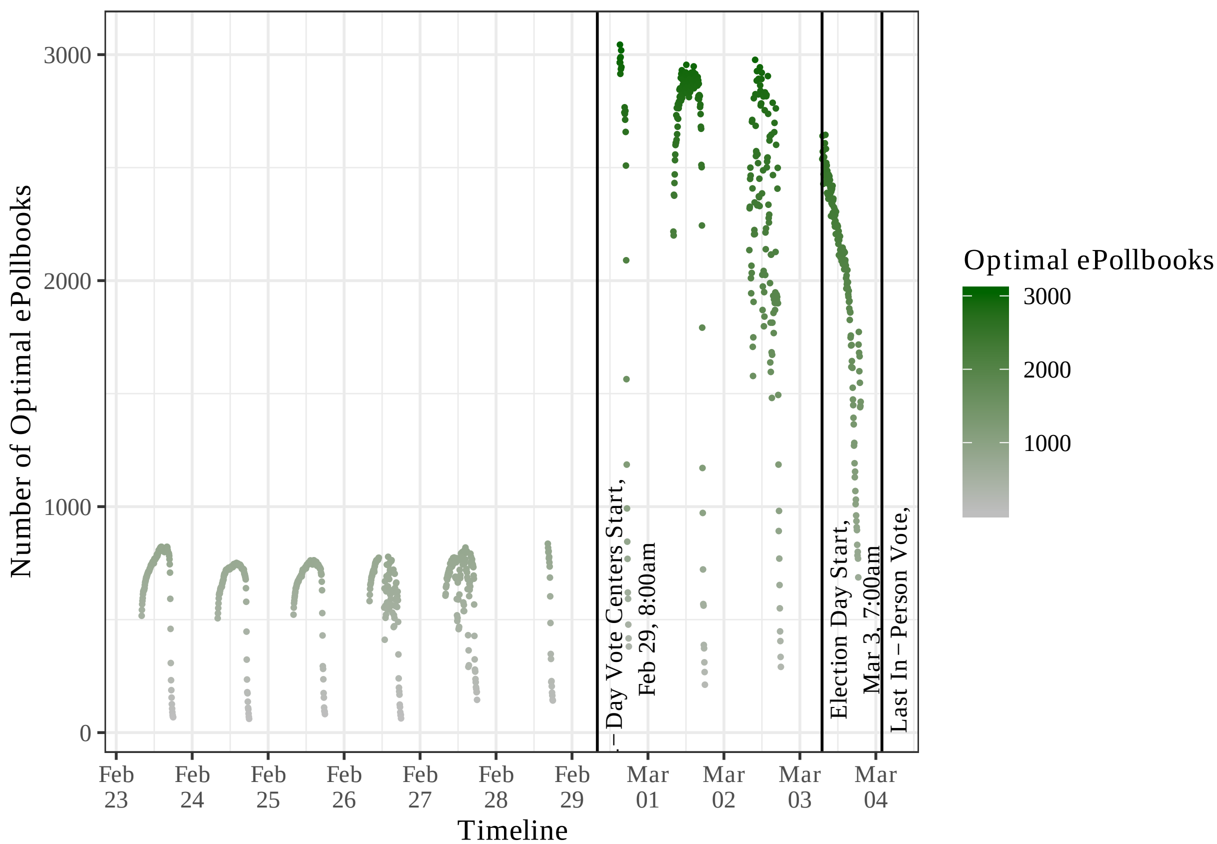


Figure 11: Number of Optimal PollPads over Time

To delve deeper into how many of the PollPads were optimal during the vote center open hours,[20] Figure 11 focuses on the number of optimal PollPads. The following are some notable trends in this figure. First, not many PollPads were powered up before the 4-day voting period. However, this is to be expected given that more vote centers opened during the 4-day period. Second, there is substantial variation during the day. Many PollPads seem to be being powered off as the closure of polls nears, which may be due to the fact that poll workers are closing down parts of the vote center in locations where there was no line. Third and most importantly, the maximum number of optimal PollPads on Election Day (2,645) was much less than the maximum number

[20]February 22–March 2: 8am–5pm; Election Day, March 3: 7am–8pm.

of optimal PollPads during the three days before Election Day (3,044).

Why was there such a large dip in the number of optimal PollPads at the start of Election Day, compared to previous days? Why did this number, on average, continue decreasing throughout the day? Answering these two questions would be vital to solving the check-in bottleneck experienced in this election. We suspect that this will be related to the number of support tickets. That is, as more voters voted, the number of incidents and support tickets increased, and could not be streamlined through the existing resolution system. The reports on trouble tickets—presumably what is called "Issue Tracking Details" had no records, and records such as calls for assistance, messages to the LACRR/CC, or visits by technical support staff are invisible to us, so we cannot verify this.

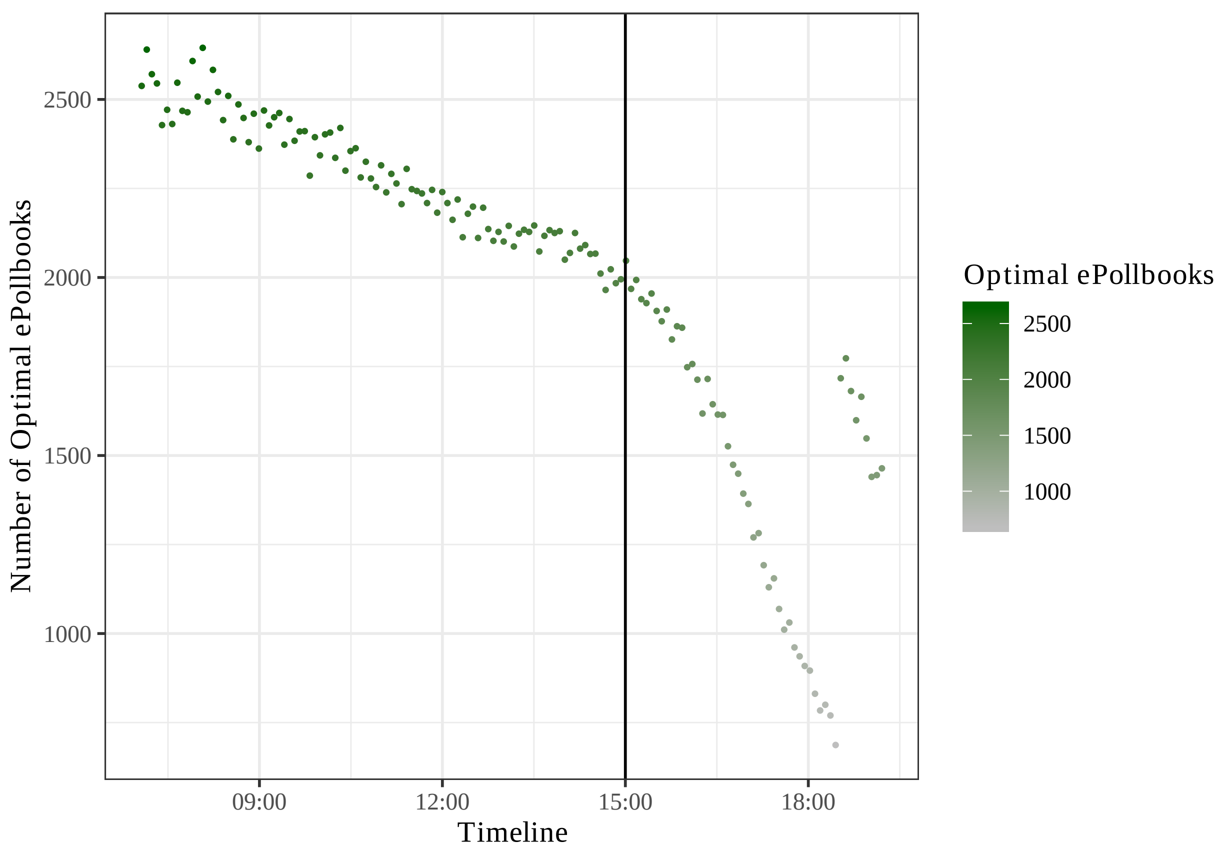


Figure 12: Number of Optimal PollPads over Time, Election Day

Figure 12 shows the number of optimal PollPads over time on Election Day. There seems to be a sharp decline in the number of optimal PollPads starting around 3:00pm on Election Day. Note also that the number of optimal PollPads jumps sharply in the evening—more precisely, between 6:27pm and 6:32pm. Analyzing the issues around those two time periods may also be a key to an improved voting experience in November.

5.2 Utilization Rates

Of the 7,002 PollPads distributed during the election cycle, 2,108 (30.1%) did not process a single voter. From a vote center perspective, the data indicate that at least one PollPad at 354 of the 995 locations (35.6%) did not register a single voter. Based on the available data, we cannot determine if this was because they malfunctioned, or because they were never used during the entire primary election period.

5.3 Vote Center Equipment Allocations

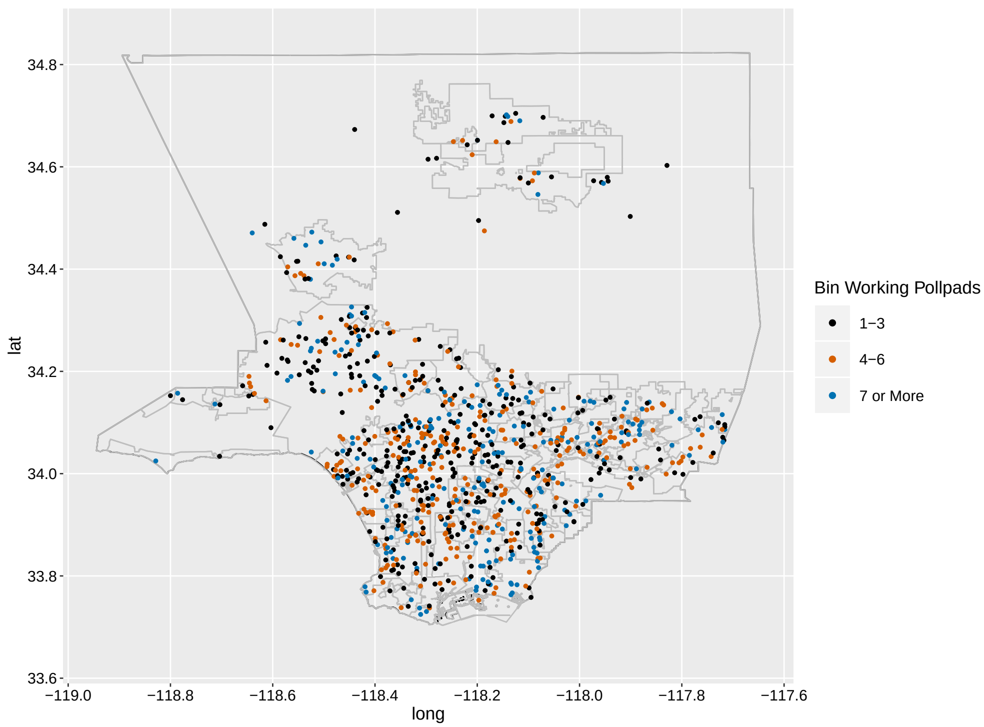


Figure 13: Number of Working PollPads by Vote Center

The median vote center had twenty Ballot Marking Devices and five PollPads, with every vote center getting approximately four BMDs per PollPad. However, there was high variance in equipment allocations. Of course, there are size constraints on the maximum number of voting machines that can be deployed to a particular location; based on our in-person observations, we conclude that in some locations the physical layout of the vote center space placed a limit in the number of BMDs and PollPads. In Figure 13, the number of working PollPads (as measured by recording at least one vote) by location are plotted.

We do not fully know how equipment was allocated to vote centers, but one guiding principle should be that vote centers with higher turnout get more equipment. Turnout by location was difficult to forecast for the first election held under this regime, but we note that there is only a weak correlation (approximately 0.16) between the amount of allocated equipment and the number of votes cast at a location. We also do not have data on the number of votes cast at each BMD, which would allow us to see how many of those malfunctioned in a similar manner as for the PollPads.

While more than half of the vote centers used all of their PollPads to check in voters, more than a quarter of locations had PollPads that were either never working or just never used. We also observe in the data that five vote centers only had one working PollPad, which each saw more than five times the average of 160 votes for all PollPads. Somewhat surprisingly, only one of those would classify as "poor" based on provisional shares described above; the rest were performing well.

Our recommendation is that in future elections LACRR should be prepared to quickly deploy PollPads to sites that experience malfunctioning PollPads or long lines.

5.4 Connectivity Problems

To give voters the ability to vote at any location, each vote center needs a continuous Internet connection to the central database. This allows it to identify the voter, give them the correct ballot, and mark them as having cast a ballot. However, this was difficult to maintain for thousands of PollPads across all of LA County, as we have observed in-person. Again, as mentioned in Section 5.1, we are uncertain as to what exactly are the reasons behind connectivity issues, as there could be as many as four different reasons.

What may help is to see the temporal distribution of reasons for provisional ballots to see how the connectivity issues have manifested over time. In Figures 14 and 15, we plot stacked histograms of the provisional vote reason hourly on Election Day and hourly for all early voting period. There were provisional ballots cast all throughout the voting period because PollPads were "offline." As described in our companion report, vote center staff were sometimes able fix the problem by restarting or syncing the PollPads, but as can be seen, connectivity was a constant problem overall.

While the number of reasons that PollPads were offline were more constant in the early voting period overall, on Election Day, there is a marked increase of provisionals citing "PollPad Offline." There was some improvement from 4 to 5pm, before returning to this increasing trend. The number drops sharply after polls close.

Note also that the time trends in provisional votes due to offline PollPads do not quite line up with the time trends in total votes cast (Figure 3 in Section 2.2). This leads us to believe that there are connection issues to be resolved beyond the sheer amounts of ballots cast at the time. We believe these PollPad connection issues were responsible for a significant fraction of the long lines experienced on Election Day—understanding why they manifested would be an important step in achieving a better voting experience.

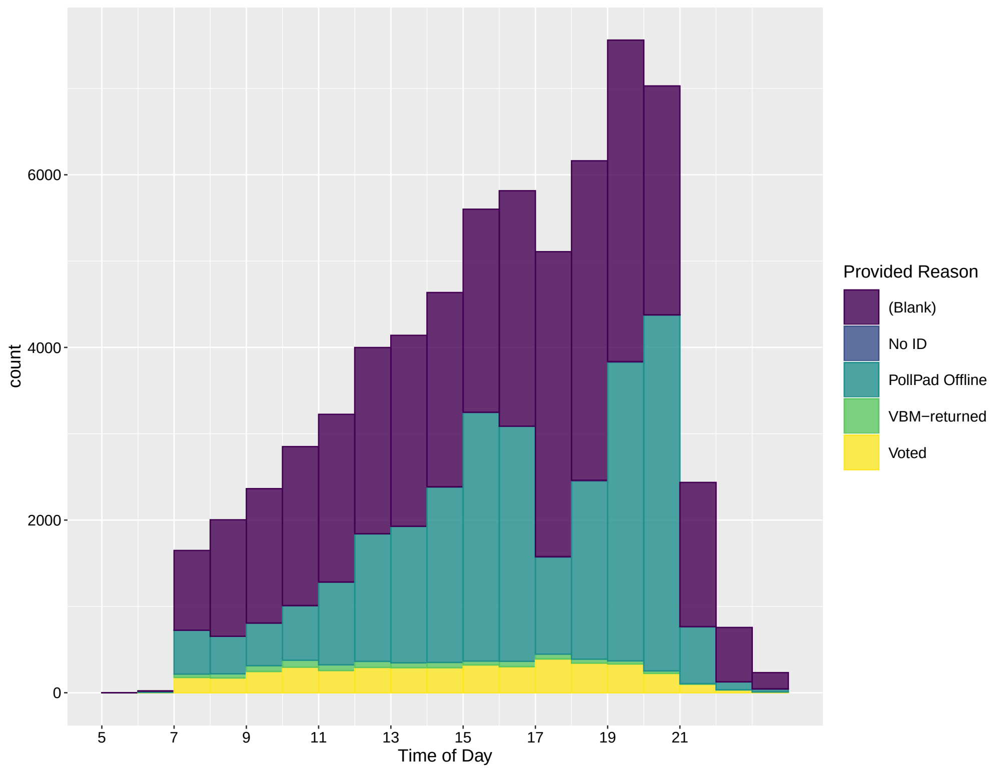


Figure 14: Provisional Votes on Election Day

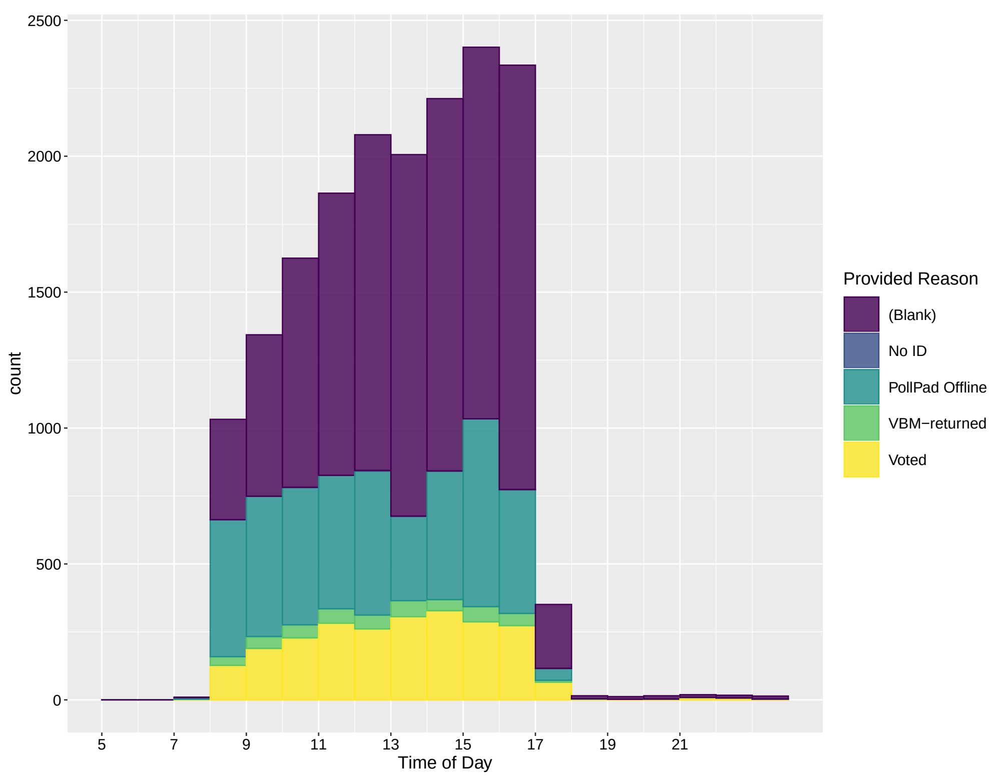


Figure 15: Provisional Votes Before Election Day

5.5 Ballot Marking Devices

Before concluding, we note that LACRR/CC has recently provided us with some data regarding the performance of the Ballot Marking Devices (BMDs) that were used in the March primary. Our initial analysis of the provided data, combined with our in-person observations as well as our participation in the LACRR/CC mock election (September 28–29, 2019), all indicated to us that the BMD devices could suffer from various problems, including printer/scanner jams.

The provided data showed that approximately 2.5% of ballots cast experienced some form of a paper jam due to misinsertion. We believe that the bottleneck at check-in helped prevent these malfunctions from becoming a crucial issue in vote centers in the March primary. From our observations, even at places with large lines, BMDs were not being used at full capacity in the March primary. As a result, if there was a paper jam or other issue a voter could quickly be moved to a new BMD and the one facing problems could be addressed or taken out of commission without much effect. However, we note that when the check-in bottleneck is remedied, BMD printer/scanner issues could create other lines in vote centers; if there are no available BMDs in a vote center when they occur, they may lead to new bottlenecks. This would be especially concerning in vote centers with fewer BMDs or with large numbers of voters. While we acknowledge that with the data we have there is no way to easily determine how BMD issues might affect vote center performance if there is little or no voter check-in waits, we suggest that LACRR/CC continue to study how to alleviate BMD printer/scanner issues. Our group will also conduct more research using the data we have to assist LACRR/CC.

What's more, the sight of malfunctioning machines or fixing the machines may not instill confidence in the voters who witness this as they stand in line or are waiting for the BMD to be fixed in order to vote. Therefore, we recommend the following:

- Provide clear, visible guidelines to the voter on how to correctly insert the ballot into the BMD at every BMD to reduce the paper jam rates.
- Train the vote center lead to quickly fix a malfunctioning BMD.
- Have a technical help backup team ready, especially late on Election Day.

We plan to take a deeper dive into the BMD performance data in the near future.

6 Conclusions and Recommendations

This March 2020 primary report was written to be of service to the voters of Los Angeles County and to LACRR/CC, to help create a better voting experience in the November general election. Our aim was to analyze what contributed to long lines and voting wait time, and to suggest ways forward in resolving these issues.

We want to again emphasize the "law of available data"—that we have only been able to conclude the data available from the sources cited, and this may result in overlooking some of the other important obstructions in the voting experience. For instance, the health and functionality of the ballot marking devices is something we have not been able to observe or analyze in depth.

Based on the available data, we conclude as follows:

1. Section 3 shows that the quality of the voter wait time data is poor, likely due to not having been prioritized, and makes it difficult to audit what went wrong in terms of voter wait time. Therefore, we turn to how many voters voted provisionally, a second-best metric to gauge the wait time.
2. Section 4 shows that many provisionals cited the reason they were used was "PollPad Offline." In addition, there were vote centers and PollPads that were creating significantly more provisional ballots than the norm, which likely resulted in longer vote wait times. We conclude that malfunctioning PollPads were contributing to provisional voting, which is also what we observed in-person.
3. Section 5 shows that overall and particularly in some vote centers, the number of operational PollPads was low and decreased over time, especially due to connectivity issues. This potentially led to high numbers of provisional votes and consequently longer lines and wait times.

Based on these conclusions, we have the following recommendations to complement the recommendations provided in our complementary, in-person observation report:

1. We recommend that LACRR/CC strengthen and emphasize the process where **real-time wait times data is collected for each vote center**, and have them **made available to voters and vote center staff in real-time**.
   - The **collection of wait time data must be improved** in the November 2020 general election, which is both important for analysis purposes and information dissemination purposes.
   - In terms of analysis, accurate wait time data is crucial for **diagnosing the events of the voting process** and improving the overall voting experience for future elections.
   - In terms of information dissemination, publishing real-time wait data to voters and vote center staff will **help voters find locations with shorter wait times**.

- To achieve better data collection, there should be a **strong emphasis of the importance of their collection** to vote center leads and staff, and although they have many responsibilities, collecting the wait times data should be given much higher priority in the 2020 November general election.
- Better methods for the entry of the wait times data are necessary to make it easier for vote center staff to enter accurate data, for example, on the same unit and within a sensible range. In addition, from the LACRR/CC, there should be frequent checks during the election period to guarantee the collection and quality of these important data.

2. We recommend that **additional independent evaluation of PollPad malfunctions be undertaken**, especially with regard to the **Internet connectivity and syncing of PollPads**.
   - From our preliminary analysis, this failing seems to be the major cause of the prolonged wait times, especially on Election Day.
   - This assessment needs to produce **a set of safeguards** so that these problems do not arise in November 2020.
   - We applaud the recent *VSAP Board Report*, which undertook an analysis parallel to ours, but we recommend continued and more intensive study of the PollPads and their deployment for the November general election.[21]
3. We recommend that **several datasets not analyzed in this report be made available** to better assess the issues that arose in the March primary. These include the following:
   - Geographical data used for the Vote Center Placement Project (VCPP) and full decision criteria for equipment and vote center staff allocation, which will help to optimize allocation and ultimately lower the wait time for the November general election.
   - Detailed data from the support team, such as call logs to LACRR/CC, as well as the issuance/resolution of trouble tickets, which will help diagnose the most urgent problems at the vote center.
   - A survey of vote center staff that collects post-primary feedback, which will be helpful to confirm/complement this report. Although we have provided a comprehensive, data-driven analysis, feedback from vote center staff is critical and will be very useful to optimize future experiences.
4. We recommend that LACRR/CC **continue to study the functionality of BMDs in the March primary.** Our research group will also continue to study the available data on BMD performance in the March primary. For the November 2020 elections, we suggest the following as preventative measures:

[21] The *VSAP Board Report* is available online at https://lavote.net/docs/rrcc/board-correspondence/VSAP-Board-Report.pdf?v=2.

- Provide clear, visible guidelines to the voter on how to correctly insert the ballot into the BMD at every BMD to reduce the paper jam rates.
- Train the vote center lead to quickly fix a malfunctioning BMD.
- Have a technical help backup team ready, especially late on Election Day.

Without accurate and reliable wait time data, analyzing what contributed to a less-than-optimal voting experience is extremely difficult. We recommend that significant resources be allocated to estimating and disseminating the wait time data in future elections. Indeed, the issue of managing and minimizing voter wait times may be even more important with the onset of COVID-19, as there is a significant concern that the pandemic may put significant constraints on in-person voting services in the November general election. There is a significant risk that it might be necessary to mitigate voter wait times and long lines, to ensure the safety of both voters and vote center staff.

As we discussed in the Executive Summary, the March 2020 primary took place before COVID-19 was declared a pandemic by the WHO and the Los Angeles County went into a lockdown. The bulk of this report was also written before COVID-19 became prevalent in California. The November election will be held in a very different context than the primary, per the Governor's actions that designates that the general election will be conducted as an all-mail ballot election with some in-person voting options. All registered voters in the county—and in the entire state of California—will receive a vote-by-mail ballot. However, as in-person voting will still be available, our conclusions still hold for the early and Election Day in-person voting experiences.

Appendices

A Election Overview

A.1 Total Check-ins over Time

As of March 17, 2020, at 2:35pm, the total reported check-in is 916,383 out of a total of 7,136,990 registered voters, a 12.84% turnout. Note that this is a different turnout percentage than reported via LACRR/CC's Third Ballot Counting Update for the March 3 Presidential Primary Election news release on March 6, 2020. This seems to be a result of the ePulse system using the number of active and inactive voters, while the news release relies on the number of "eligible Los Angeles County voters," i.e., active voters.

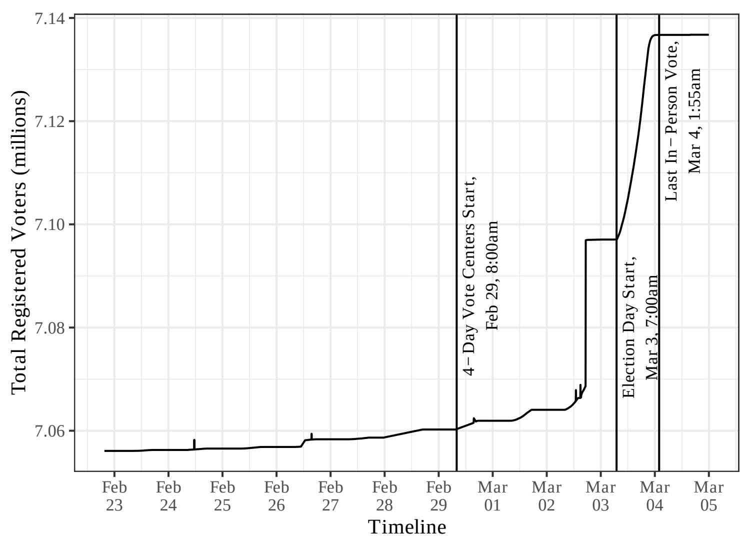


Figure 16: Registration Changes over Time

Figure 16 suggests that the increase of registered voters during this period was about 80,000.[22] This number is at odds with the total number of "added" voters (conditional voter registrations), which is about 50,000 as shown in Figure 2. The cause of this disparity is unclear and beyond the scope of this report but seems worth investigating.

A.2 Adds, Cancels, and Provisionals on Election Day

To better show trends with smaller scales from Figure 2, and to see if there are any rapid increases in provisionals or cancelled check-ins, Figure 17 shows adds, cancels, and provisionals on Election Day. It seems that overall, on Election Day, there were no particular instances of spikes in provisional voting, added voters, or cancelled check-ins. Note that this does not mean that all individual vote centers had a steady increase in provisionals.

[22]Data collection only began on Feb 22, 2020, at 7:33pm.

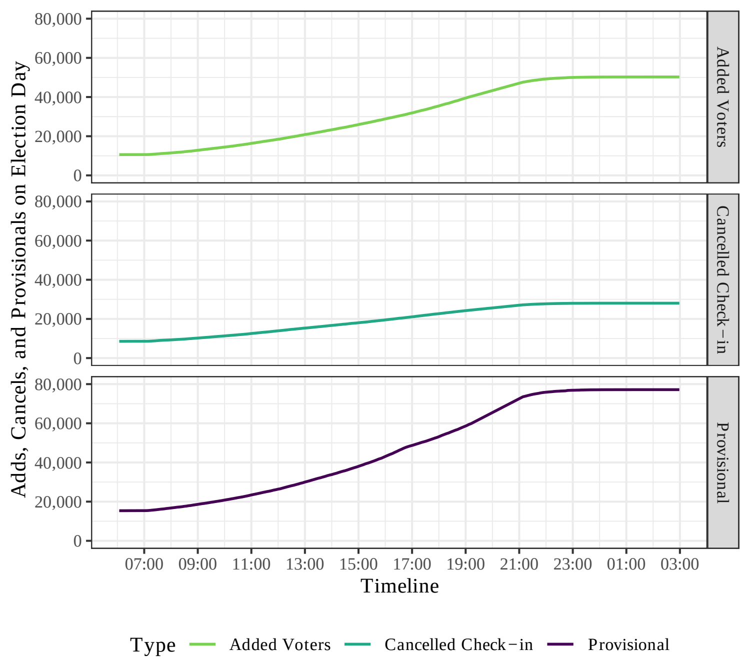


Figure 17: Adds, Cancels, and Provisionals on Election Day

B Further Wait Time Analysis

B.1 Wait Time Tracking Document

Figure 18 shows the wait time tracking documented that was designated to be given to all vote center leads.

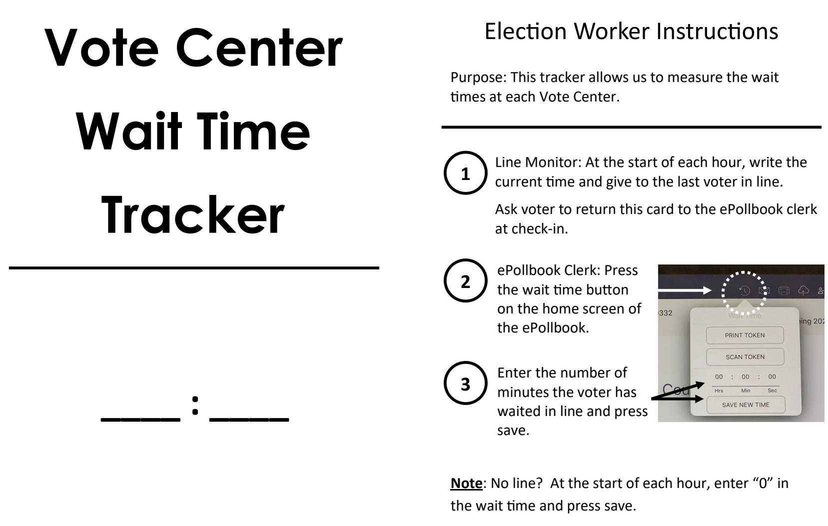


Figure 18: Wait Time Tracking Document

B.2 Percentage of Open Locations with at Least n Records on Each Day of Voting

This table presents the raw data displayed in Figure 4.

Day of Voting	Percent of Locations by Minimum Number of Wait Time Observations							
	1	2	3	4	5	10	15	20
1	12	8	6	6	5	0	0	0
2	14	12	11	10	9	4	2	1
3	14	12	10	9	8	3	2	2
4	18	15	13	13	11	5	2	1
5	22	21	19	18	16	7	3	1
6	27	21	20	18	17	8	4	2
7	45	41	36	34	30	16	7	3
8	28	22	19	17	15	8	5	2
9	28	24	21	19	18	9	5	3
10	39	30	26	23	20	11	6	4
11	42	37	33	30	27	17	10	6

Table 2: Wait Time Observations by Day

B.3 Wait Time Quality

Table 3 are the reports from Cal State University Los Angeles, which reported eight times on Election Day at various times. While this is an encouraging sign and hints at the high quality of the data, the numbers do not make much sense if the wait time data unit is milliseconds.

	Location	Wait Time (Minutes)	Wait Time (Raw)	Timestamp
1	Cal State University Los Angeles - Library Palmer Wing 4049	0.003	180	2020-03-03 08:18:23
2	Cal State University Los Angeles - Library Palmer Wing 4049	0.011	660	2020-03-03 10:48:02
3	Cal State University Los Angeles - Library Palmer Wing 4049	0.040	2400	2020-03-03 12:57:18
4	Cal State University Los Angeles - Library Palmer Wing 4049	0.009	540	2020-03-03 13:02:19
5	Cal State University Los Angeles - Library Palmer Wing 4049	0.016	960	2020-03-03 13:13:00
6	Cal State University Los Angeles - Library Palmer Wing 4049	0.032	1920	2020-03-03 13:24:05
7	Cal State University Los Angeles - Library Palmer Wing 4049	0.050	3000	2020-03-03 14:36:07
8	Cal State University Los Angeles - Library Palmer Wing 4049	0.025	1500	2020-03-03 15:22:20

Table 3: Reports at Cal State University Los Angeles, if unit is milliseconds

This contradicts the evidence given on social media by an LA Times reporter, who reported on Twitter that there was a decent line at Cal State University Los Angeles at 1:06pm on Election Day. Her anecdotal evidence was about 40 minutes.

If the unit is seconds instead of milliseconds for Cal State University Los Angeles, it makes slightly more sense, as that would bring the reported wait time at 1:02pm to 9 minutes, and at 1:13pm to 16 minutes, but this is still far from the 40 minutes reported at around the same time.

If the "At a Glance" page showed valid wait time on Election Day (ranging from 10-30 minutes on average), it may be the case that units in data entry or generated report are mixed up between seconds and milliseconds.

B.4 Summary of Wait Time Data

Keeping the discussed limitations in mind, we will look at the data we do have, maintaining the assumption the recorded units are milliseconds, and see if there are any clear trends. Figure 19 shows the histogram of mean wait time by vote center, regardless of the reported period.

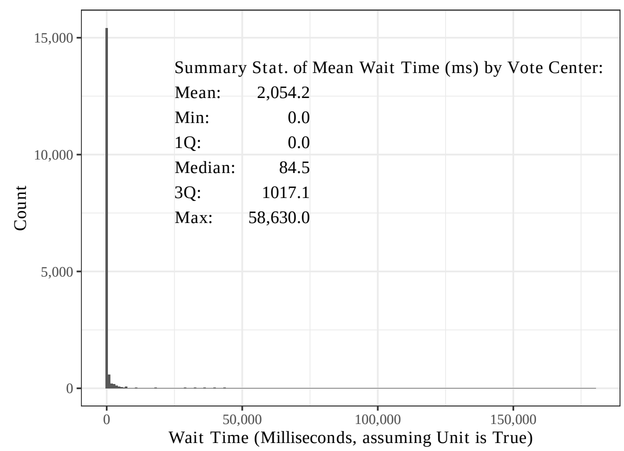


Figure 19: Histogram of Reported Average Voter Wait Time (if unit is milliseconds)

From the wait time data available, the worst wait time encountered during the primary was 3 minutes at Centinela Bible Church. The list of the 10 locations with the worst max wait time can be seen in Table 4, while the 10 locations with the worst mean wait time can be seen in Table 5. These results, with a worst wait time of 3 minutes and worst average wait time of .997 minutes, suggest that that the voting process in Los Angeles County was not subject to serious wait times, which is contradictory to the qualitative in person observations made.

	Location	Max Wait Times (Minutes)	Timestamp
1	Centinela Bible Church - Fellowship Hall	3.000	2020-03-03 17:04:20
2	New Life Church Of The Nazarene	1.260	2020-03-01 10:47:32
3	Westminster Presbyterian Church - Morrison Hall	1.200	2020-03-03 16:28:44
4	Palmdale Masonic Lodge - Dining Room	1.180	2020-03-03 20:41:50
5	Union Station East - Metro Headquarters Lobby	0.984	2020-02-29 16:24:59
6	Cabrillo High School - North Gymnasium	0.960	2020-03-01 16:51:03
7	Newcomb Academy - Gymnasium	0.949	2020-03-02 15:49:38
8	Hollywood Hotel - Ballroom	0.943	2020-03-03 16:08:45
9	New Philadelphia Ame Church - Butler Hall	0.915	2020-03-03 13:31:47
10	Stoner Recreation Center - Classroom	0.912	2020-03-01 15:13:04

Table 4: Worst Max Wait Times by Vote Center

	Location	Max Wait Times (Minutes)
1	Palmdale Masonic Lodge - Dining Room	0.977
2	Wilshire Park Elementary - Multi-purpose Room	0.718
3	Pasadena City College - Circadian Room	0.698
4	Cerritos College - Conference Center	0.510
5	Union Station East - Metro Headquarters Lobby	0.492
6	New Hope Home - Dining Room / Rec Room	0.446
7	Castaic Sports Complex - Community Room 2	0.421
8	Westminster Presbyterian Church - Morrison Hall	0.420
9	Brand Library & Art Center - Recital Hall	0.401
10	Ward Villas For Seniors - Lobby	0.394

Table 5: Worst Mean Wait Times by Vote Center

B.5 Geographical Distribution

We also geolocated the polling places and below have mapped them onto a map of LA County (minus the islands) for different days and different times of day. As mentioned earlier, it is not clear what conversion factor would make these numbers translate into comparable times so the raw numbers are preserved. Not shown are the vote centers that did not have a wait time recorded during that timeframe, as well as approximately 330 vote centers that never logged a waiting time over the entire period.

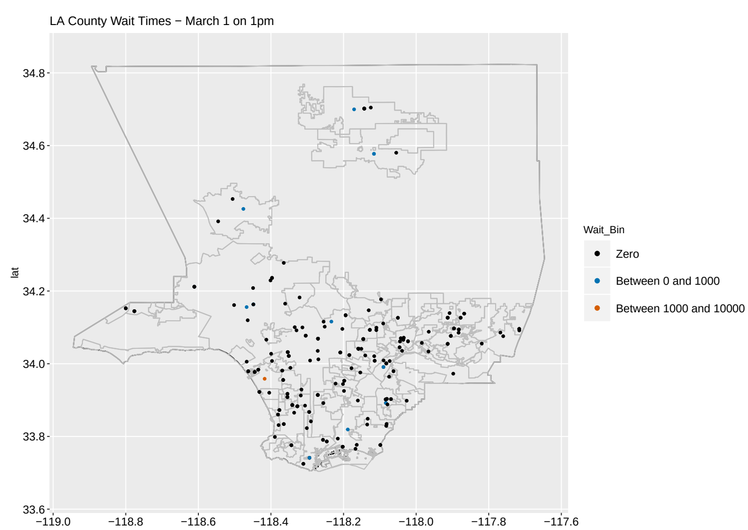


Figure 20: Reported Average Voter Wait Time

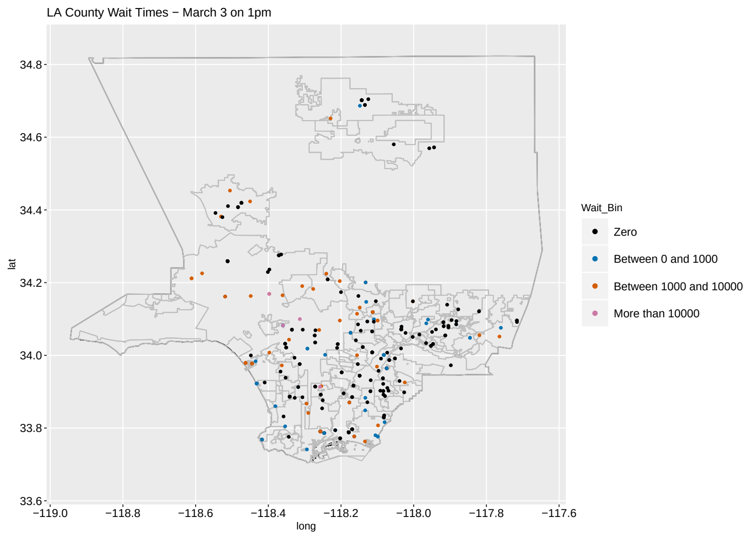


Figure 21: Reported Average Voter Wait Time

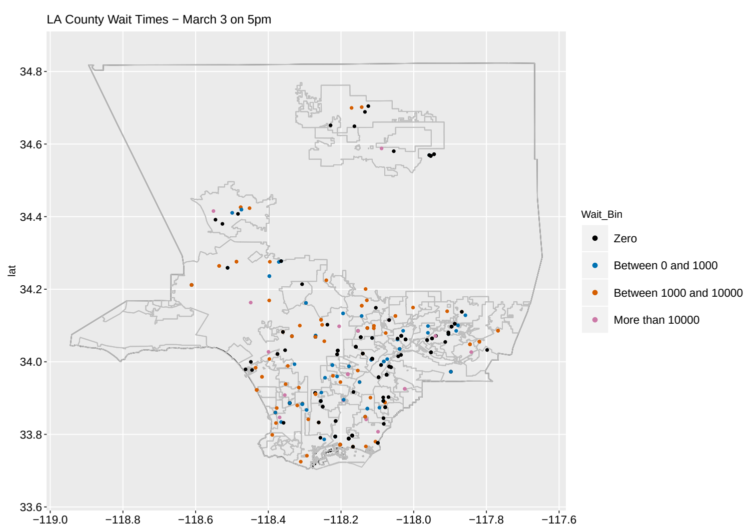


Figure 22: Reported Average Voter Wait Time

C Provisional Ballots

C.1 Data Quality

Through the ePulse interface, we were able to obtain three separate records of provisional voting:

1. each **PollPad** recorded the number of check-ins and provisional ballots it processed;
2. each **vote center** reported the total number of regular, provisional, cancelled, and spoiled ballots that went through the center each hour; and
3. each time a provisional ballot was distributed, an **individual entry** specifying the voter, vote center, and PollPad was recorded.

If we compare the number of provisional ballots from the PollPad (1) record and the individual (3) record, it appears as though, in general, the PollPads are over-reporting the number of provisional ballots. This comparison can be seen in Figure 23. Of the 4,894 PollPads that recorded at least one ballot either regular or provisional, 50% matched the individual records exactly (black), 49% underestimated them (red) and <1% overestimated them (blue).

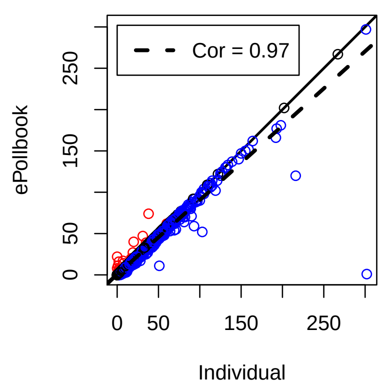
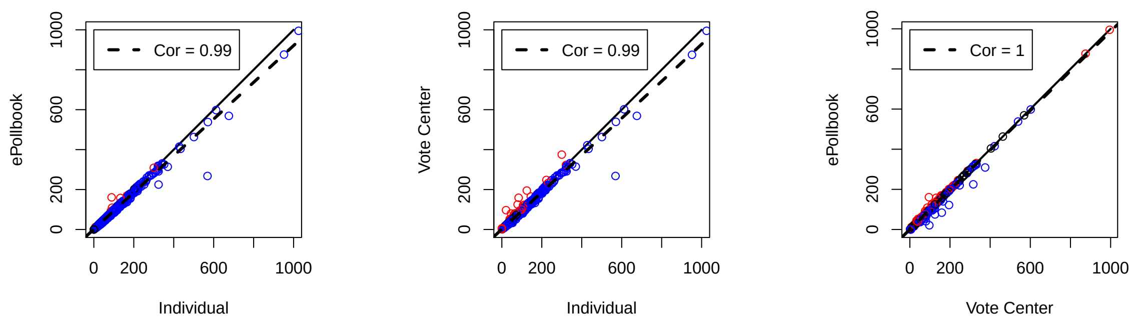


Figure 23: Analysis of Provisional Reporting Quality at the PollPad Level
Compares PollPad and Individually Reported records. Color coded to show if points are above (red, 11%), on (black, 31%), or below (blue, 58%) the one-to-one line.

When this data is aggregated at the vote center level rather than the PollPad level, the results are slightly more consistent. Similar plots, this time also including the vote center results can be seen in Figure 24. The improved correlation at the vote center level could be a result of vote center workers trying a voter on multiple PollPads and attributing the final provisional vote to a different PollPad than the technology assumes. Alternatively, in some of the individual reports the reason says Voted, which could mean the voter began the provisional process but ended up voting normally. More transparency in what the reasons for provisional voting mean and more consistency in filling out the reason could help uncover the discrepancies we see. Regardless of these inconsistencies, we will take the PollPad reported provisionals as ground truth, as we can link them to location and individual PollPads for further analysis.



(a) 89%, 1%, 10% (b) 85%, 5%, 10% (c) 23%, 15%, 62%

Figure 24: Analysis of Provisional Reporting Quality at the Location Level
Compares PollPad, Individually Reported and Vote Center records. Color coded to show if points are above (red), on (black), or below (blue)the one-to-one line.

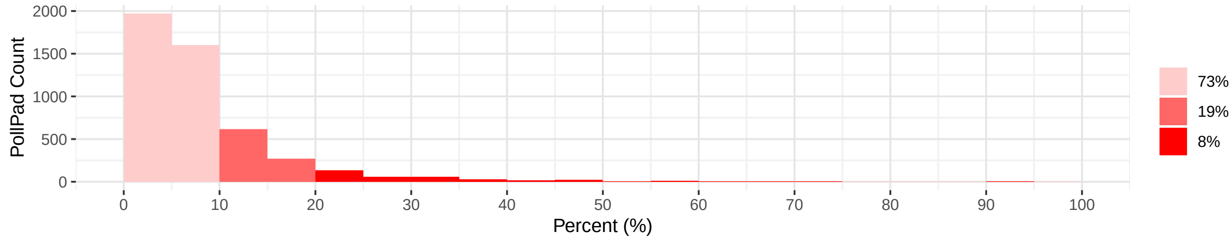
It is worth noting that even when comparing the Vote Center and PollPad reports, while the correlation is 1, of the 992 locations there were still 53 locations where they claimed a difference of 5 or more provisional ballots and 20 locations where they were off by 15 or more. The ten locations with the largest discrepancies between Vote Center and PollPad reported provisionals can be seen in Table 6.

	Location	Location Name	Vote Center	PollPad	Report
1	451355	Pop-Up Vote Center 2	316	225	316
2	450437	Dominguez Hills Estates - Club House	97	21	16
3	450981	Dollarhide Health Center - Multi-Purpose Room	159	84	65
4	451096	Sherman Oaks Galleria - Community Room	195	122	65
5	451100	Sunland Senior Citizen Center - Senior Club Room	375	309	254
6	451119	Assistance League Of Pasadena - Meeting Room	95	161	77
7	451062	Montecito Heights Senior Citizen Center - Foyer / Lobby	125	75	62
8	451132	West Los Angeles College	80	41	38
9	450483	Santa Monica Blvd Comm School Auditorium	248	220	137
10	451026	La County Registrar-Recorder / County Clerk - Room 3201	131	158	95

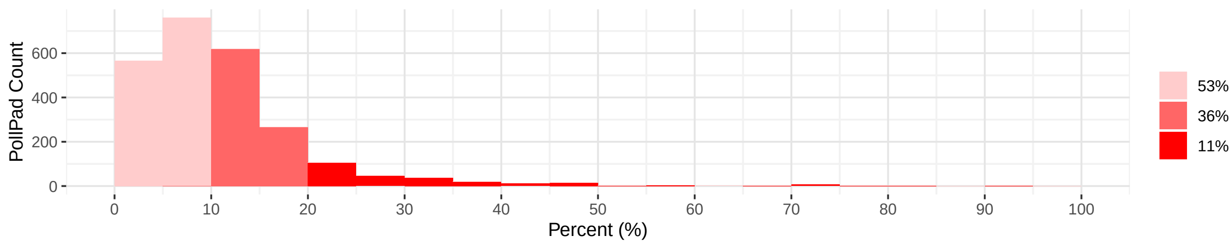
Table 6: Locations with Largest Provisional Discrepancies

C.2 Relationship to PollPad Malfunctions

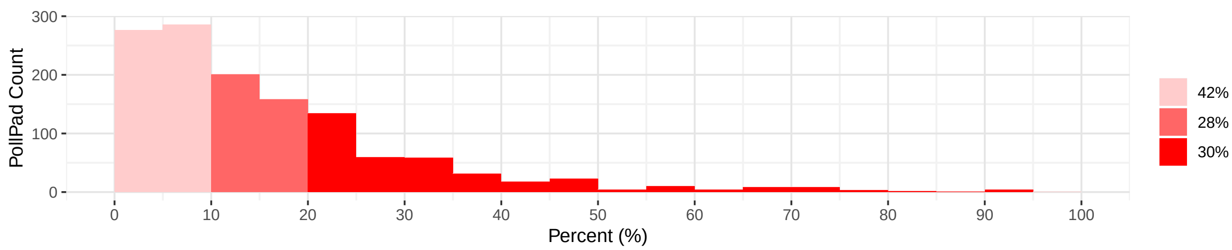
In order to look at the relationship between provisional ballots and PollPad malfunctions, we will first look at the distribution of provisional ballot shares per PollPad. We will exclude the PollPads that did not have a single ballot printed—the existence of never-used PollPads will be discussed in Section 5.



(a) All PollPads



(b) Restricted to PollPads at Locations Where at Least One PollPad is "Poor"



(c) Restricted to PollPads at Locations Where at Least One PollPad is "Extremely Poor"

Figure 25: Distribution of PollPads by Provisional Ballot Shares

Based on this distribution, we will label PollPads where 10% to 20% of ballots are provisional as "poor" and PollPads where more than 20% of ballots are provisional as "extremely poor." Figure 25(a) shows that about 75% of PollPads are deemed good enough under this characterization, with the median at 6%.

These poor and extremely poor PollPads are present at 438 (44%) and 195 (20%) of the vote center locations respectively. As we look at locations with at least one poor (Figure 25(b)) or extremely poor (Figure 25(c)) PollPad, the median provisional percentage remains below 15%.

If provisional ballots were only given to voters who needed them, there would not be a statistically significant difference in the percentage of provisional ballots each PollPad created within locations. Assuming that voters at each location were randomly directed to go to different PollPads, we would expect the provisional ballot shares to be similar for all of the devices. However, in Figure 25(b) it can be seen that over half of the PollPads at locations with at least one PollPad producing 10%-20% provisionals were still producing fewer than 10%. This supports our focus on individual PollPads, because the distribution of provisional votes within a vote center is statistically different from what we would expect if all PollPads had all been functioning equally well.

While some locations with higher levels of provisional voters could be a consequence of location and heterogeneous demographics (e.g., locations with student population are more likely to use provisionals), it is clear that there were some unnecessary provisional ballots resulting from malfunctioning PollPads which may have exacerbated lines. We thus think it is acceptable to use higher percentages of provisional ballots as an indicator of malfunctioning PollPads and a proxy for longer wait times.

C.3 Provisional Locations

In Figure 26, the density of percent provisionals by location can be seen. Interestingly, this looks very similar to the density based on PollPads (Figure 25(a)). Using the same threshold of 10% and 20%, this labels 77% of locations as performing well, 18% as "poor," and 5% as "extremely poor."

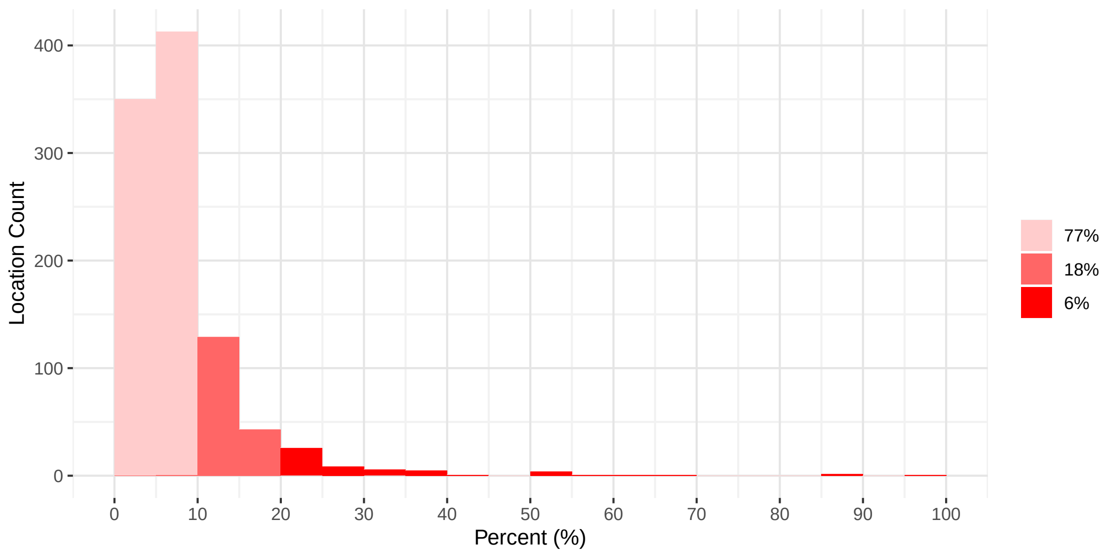


Figure 26: Density of Percent Provisionals by Location

We also plot the density of number of provisionals by location in Figure 27. This distribution looks extremely similar to the density of the percentages. If we section the locations at 100 provisional votes and 200 provisional votes, we maintain 77% acceptable, 18% poor, and 5% extremely poor locations.

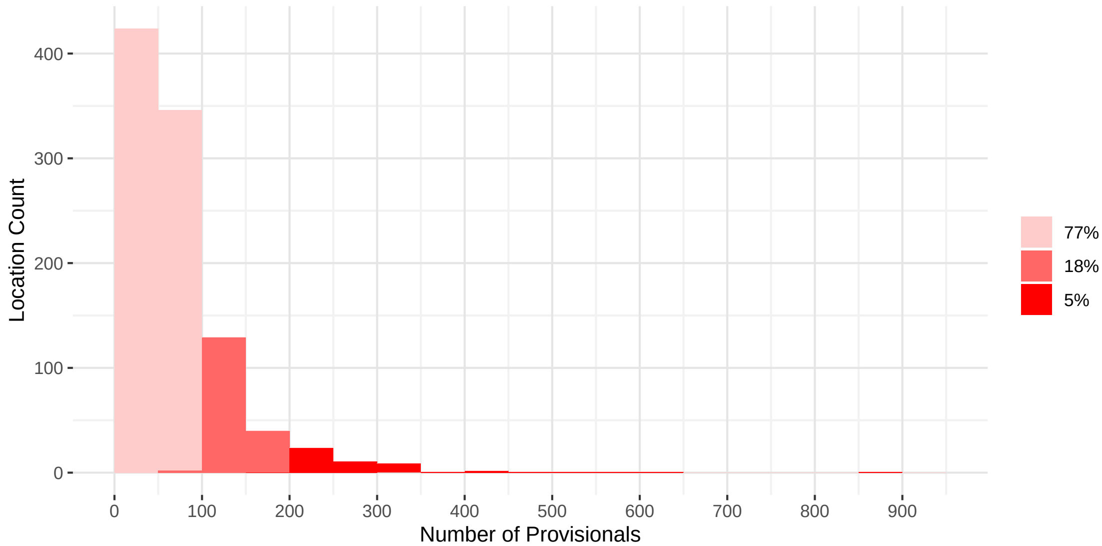


Figure 27: Density of Provisionals by Location

C.4 Provisional Relationship to Turnout

We now look at whether there is a relationship between malfunctioning PollPads and the overall traffic in the location. Malfunctioning PollPads are any that fit the poor or extremely poor criteria from the main report section (4.2). This leaves us with 1,291 (27%) malfunctioning PollPads out of the 4,840 that processed at least one ballot.

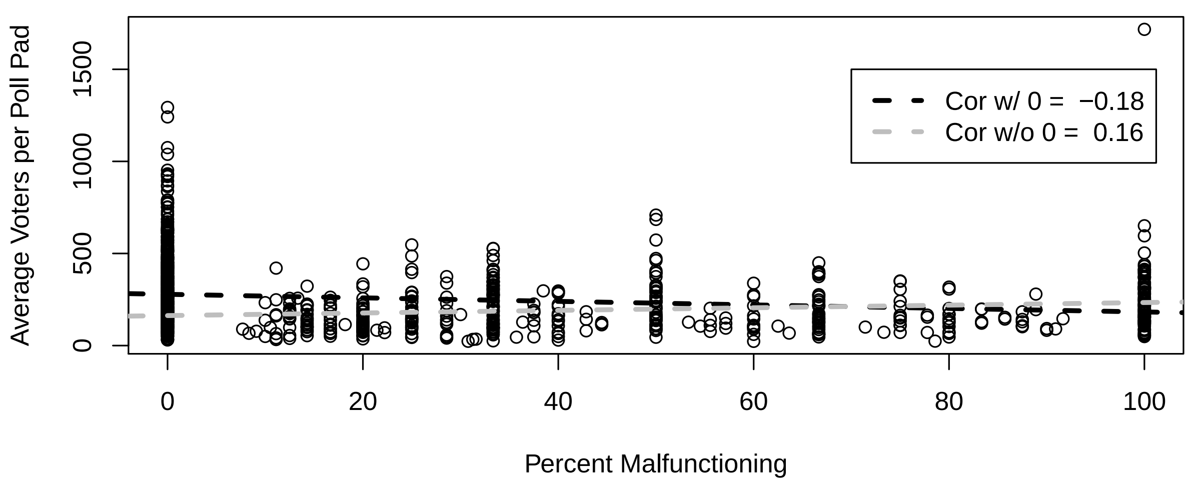


Figure 28: Percent of Poor PollPads Compared to Average Number of Voters at PollPads in Location

From Figure 28, there does not seem to be a clear relationship between the percent of PollPads

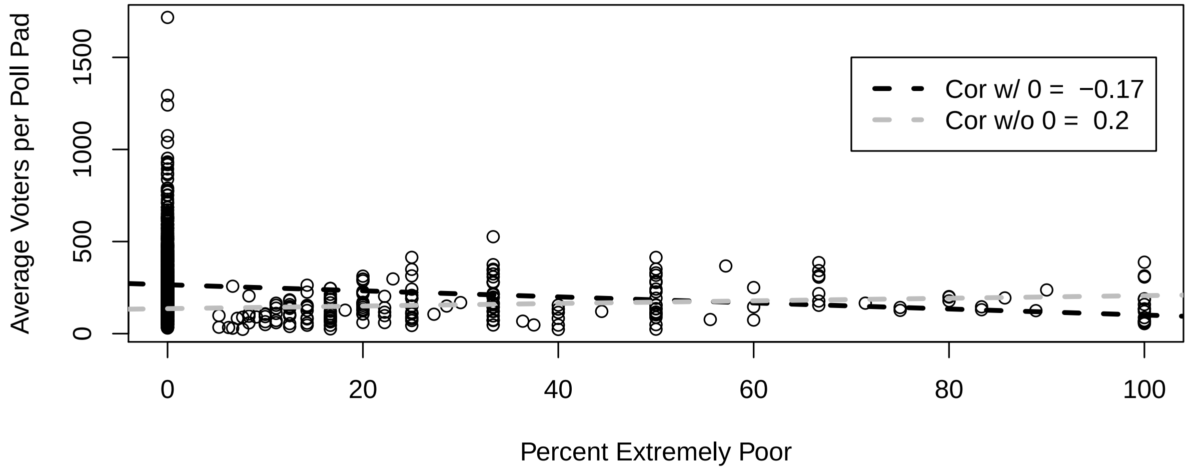


Figure 29: Percent of Extremely Poor PollPads Compared to Average Number of Voters at PollPads in Location

that malfunction and the amount of traffic through the location, per the low Pearson correlation coefficients. The correlation is slightly negative at -0.18. This correlation becomes slightly positive (0.16) when locations with no malfunction PollPads are omitted. This same pattern can be seen for percentage of extremely poor PollPads (-0.17, 0.2). Overall, however, there does not seem to be a clear trend between turnout and PollPad malfunctioning. This reinforces the designation of these PollPads as malfunctioning or over-assigning provisional ballots.

C.5 Locations with the Most Provisional Votes

	Code	Location	Regular	Provisional	Cancelled	Spoiled	Provisional (%)
1	451127	Dana Middle School - Multi-Purpose Room	748	994	23	12	57
2	450787	UCLA Ackerman Union - Bruin Reception Room	1494	875	148	15	36
3	450713	Hammer Museum - Annenberg Terrace	1993	602	7	74	23
4	450074	Signal Hill Public Library - Community Room	327	569	3	0	63
5	450259	Progress Park Recreation Center - Auditorium	797	539	42	22	40
6	450698	Cal State University Long Beach - Pacific Sunset A & B	1095	463	89	14	29
7	450119	Santa Monica Place Shopping Center - Community Room	839	422	38	40	33
8	450706	Cal Poly Pomona - Building 35 Room 35-2135 Ursa Minor	738	404	40	25	35
9	451100	Sunland Senior Citizen Center - Senior Club Room	1335	375	7	9	21
10	450977	University Of Southern California - Ground Zero Event Space	566	332	31	14	36

Table 7: Locations with Most Provisional Votes

	Code	Location	Regular	Provisional	Cancelled	Spoiled	Provisional (%)
1	451356	Pop-Up Vote Center 3	14	112	2	1	88
2	450588	Hiram Of Tyre Grand Lodge - Assembly Hall	41	268	3	1	86
3	450586	St Mark Baptist Church - Youth Education Bldg	170	323	7	13	65
4	450074	Signal Hill Public Library - Community Room	327	569	3	0	63
5	451127	Dana Middle School - Multi-Purpose Room	748	994	23	12	57
6	451357	Pop-Up Vote Center 4	38	45	3	2	54
7	451355	Pop-Up Vote Center 2	296	316	9	3	51
8	450284	Bursch Elementary School - Library	198	208	12	13	51
9	451354	Pop-Up Vote Center 1	56	58	2	0	50
10	450259	Progress Park Recreation Center - Auditorium	797	539	42	22	40

Table 8: Locations with Highest Percentage of Provisional Votes

D Cancelled Ballots

Like with the provisional ballots, we have more than one reporting mechanism. Again, the individually reported cancellations and the cancellations reported by the locations are inconsistent. In this case, significantly worse than with the provisional ballots.

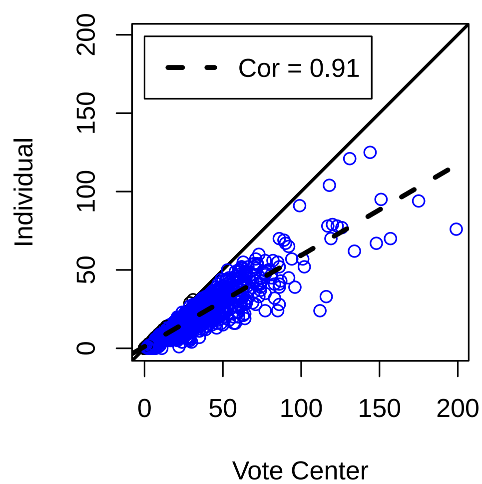


Figure 30: Quality of Cancelled Ballot Records

In this case, however, there seems to a systematic under reporting in the individual vs. precinct level data.

Compared to the provisional ballot distribution, which was skewed right, this distribution seems much more normal making it seem like less or a tool to look for irregularities.

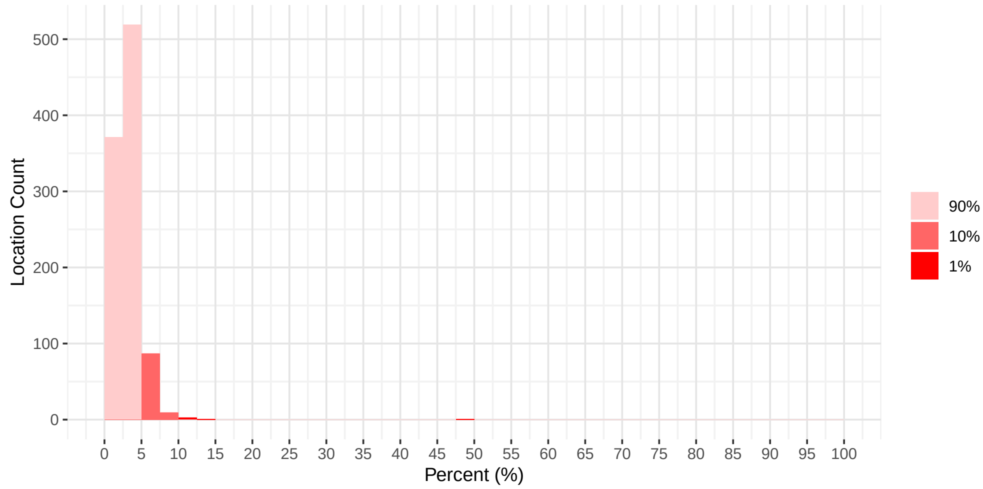


Figure 31: Density of Percent Cancelled Ballots by Location

E Spoiled Ballots

Unfortunately, the individually reported spoiled ballots have an empty field for polling location, so we do not have a method for investigating the quality of the spoiled reports. The only method of attaching spoiled ballots to locations is through the location-by-location reporting.

When looking at the density of percent spoiled, the distribution is skewed to the right, like in the provisional ballots, but the numbers are so low they seem like a less robust tool than the provisional ballots for rooting out the source of inefficiencies.

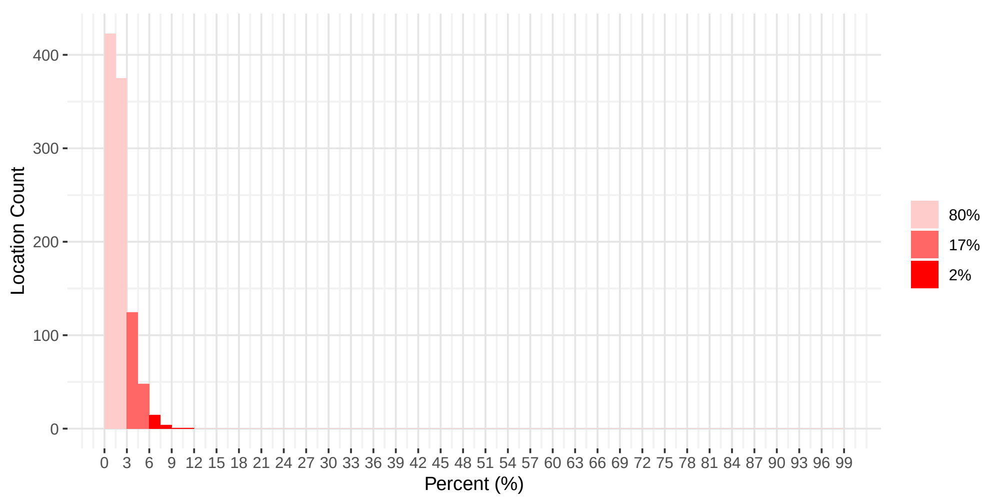


Figure 32: Density of Percent Spoiled Ballots by Location

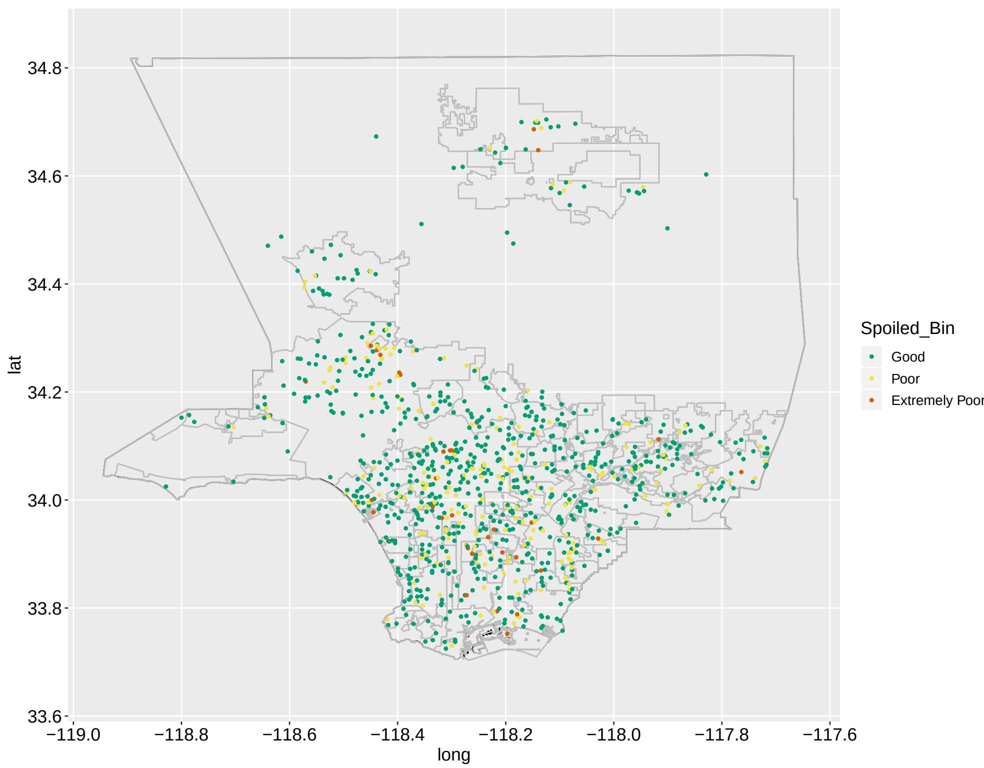


Figure 33: Vote Centers by Binned Percent Spoiled Ballots

F Polling Places Reporting

Figure 34 shows the number of polling places reporting back to the LACRR/CC. While usually almost all of the 990 to 995 vote centers[23] reported back, the number fell rapidly around 3:00 on March 3 (minimum 201), and recovered rapidly before the vote centers opened (963 at 6:59am). However, not all polling places were reported to be reporting back, and it was only around 2:00pm that 990 out of 995 places were reporting back.

[23]Some were added during the 11-day voting period.

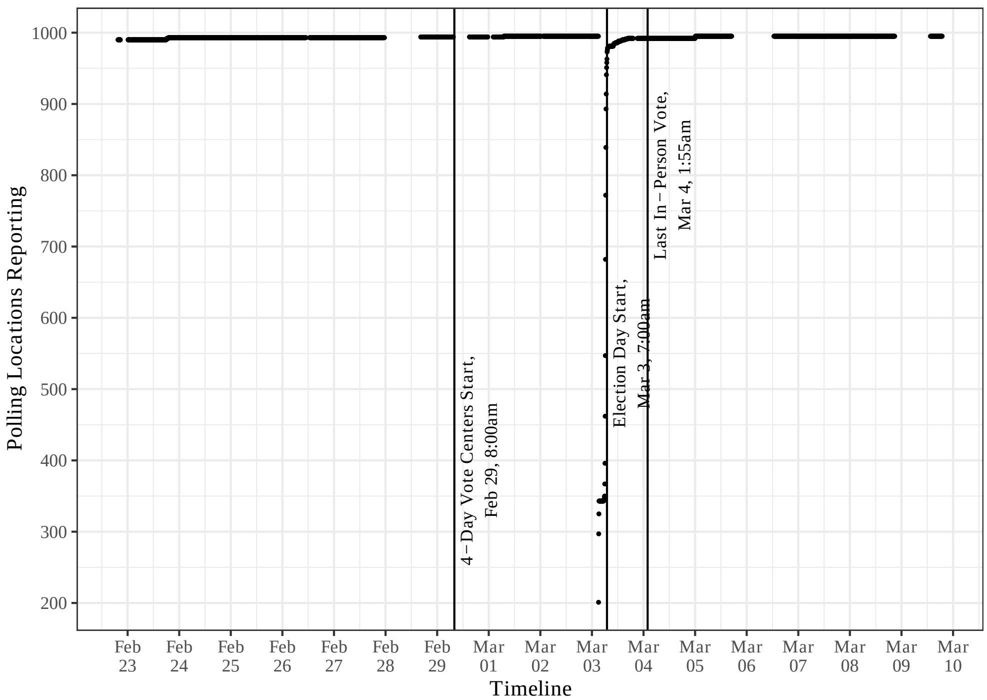


Figure 34: Polling Places Reporting