California Underground Facilities Safe Excavation Board

November 9, 2021

Agenda Item No. 7 (Information Item) – Staff Report

Measuring Ticket Volatility and Estimating Locator Workload

PRESENTER

Tony Marino, Executive Officer

SUMMARY

The Board recently created a committee of Members Bianchini and Charland to seek improvements in the state's ticketing and locating processes. To examine how notification (ticket) submission volatility affects locator workload, staff used ticket data from DigAlert, USA North 811, and Calaveras County Water District to simulate locator workload. Simulations demonstrated that even a relatively small percentage of excavators requesting a start date later than the legal minimum can dramatically reduce workload volatility at a system-wide level. Volatility may not so easily be overcome for small operators, however, and large excavators such as Pacific Gas and Electric and its contractors should work with the one-call centers to inform one-call center members of large planned excavation projects. A better understanding of why excavators choose to make notifications when they do and why they choose to request the start dates they do would be required to propose changes to reduce notification volatility.

STRATEGIC PLAN

2020 Strategic Plan Objective: Improve Accessibility of Buried Infrastructure Location knowledge and Understanding

Strategic Activity: Looking Ahead: Locator Requirements and Best Practices

BACKGROUND

Government Code Section 4216.3 (a)(1)(A) requires operators to respond to an excavator notice (aka "ticket") within two working days, not counting the date of notification. That response may be through locate and field marking, provision of facility location information, or notification that no facilities are in the area. On average, an excavator notification will require seven to eight operators to respond.

During the Board's May 2021 meeting, USA North 811 Executive Director James

Wingate relayed his concerns that excavators are losing faith in the one-call system due to their requests for locate and mark not being fulfilled in a timely manner.[1] This concern is echoed by the Common Ground Alliance's "Next Practices Initiative Report."[2] Issues associated with locate and mark were discussed more broadly during the Board's July meeting, including that locate and mark work is skilled work requiring weeks of training and difficult to retain part time. The Board chose to develop a "Ticket" Committee to review how the one-call ticket system is working and if there are opportunities for improvement and assigned Members Bianchini and Charland to that committee. Members Bianchini and Charland met with staff and articulates its mission as promoting high-quality, safely-performed locates that get done on time and the time spent performing locates provides value to and improves the safety of excavators and improves communication between the two.

DISCUSSION

The challenge for operators associated with ticket volumes can be attributed broken up into two factors: 1) average ticket volume and 2) volatility. If there were no volatility, and every day presented an operator with the average number of tickets to locate, all the operator would need to do is appropriately staff. We are not concerned about volume absent volatility, as it is the operator's responsibility to respond to all tickets. Were the Board concerned about overall ticket volume, that would undermine its efforts to promote use of the one-call system.

Volatility, however, can make an operator's locate and mark program difficult to staff, as locators require specialized training, and Board discussion has indicated that it may be difficult to keep locators employed if they are not provided steady work. It its in the Board's interest to understand how ticket volatility may impact locating workload, as doing so may assist the Board in understanding the difference between locating challenges posed by volatility and locating challenges due to a failure to appropriately staff.

Members Bianchini and Charland and staff decided that they needed more information, and staff requested ticket data from USA North 811 and DigAlert. The following analysis is based on the data they provided.[3]

[1] Accompanying letter: https://dig.fire.ca.gov/media/dqujiyes/locate-and-mark-response-from-usa-north-811.pdf

[2] https://commongroundalliance.com/Publications-Media/Next-Practices-Initiative

[3] Note that the analysis does not consider that some tickets may be more difficult to locate than others; rather, it assumes that challenging tickets are evenly spread among the thousands of tickets issued in any particular day. Except when stated, geography is not considered, though it may be expected that geographical volatility is larger than the overall system volatility. This is especially true for small operators. The absolute numbers of tickets are not relevant, as tickets are not broken down by type, which could introduce errors if the ratio of new and renewal tickets (the most common types) is systematically different (for instance if Mondays have a high

The first aspect of volatility is the number of tickets issued for any one day of the week. As can be seen in **Figure 1**, dramatically more tickets are called in during weekdays than weekends. Additionally, Mondays are consistently the heaviest ticket days.

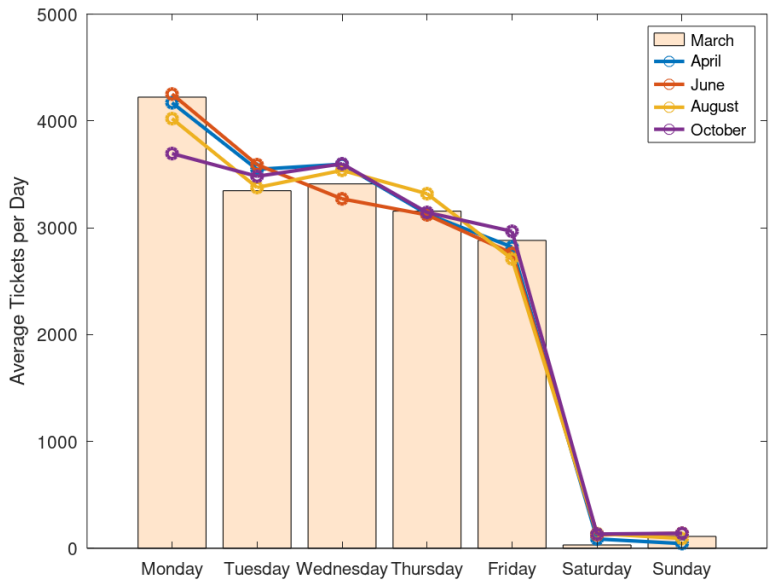


Figure 1: Graph of average ticket volatility by weekday in 2019. Months chosen are those without holidays. From DigAlert ticket data.

More relevant than when the ticket is created is when the ticket is due. We do not have data on ticket due dates but have been told that most tickets are due on the minimum legal start date. **Figure 2** shows when tickets are due, assuming the minimum legal start date of two working days, not including the date of notification.

proportion of new tickets, while Friday has a large proportion of renewals). Additionally, the one-call centers have no information about whether a ticket needed on-site locating by any member, or if it could be cleared from the office; this is assumed to be independent of volatility and not expected to influence the results.

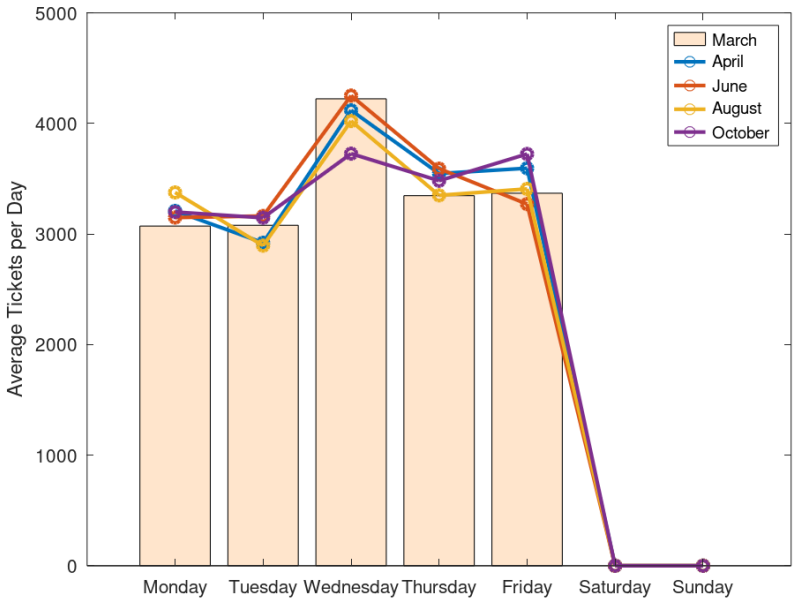


Figure 2: Graph of average due date volatility by weekday in 2019, assuming the minimum start date of two days, not including the date of notification. Months chosen are those without holidays. From DigAlert ticket data.

In viewing DigAlert ticket volume from January 2019 through August 2021, we see dips and spikes clearly associated with holiday weekends (Figure 2). Notable, however, is the consistency of tickets per month submitted to DigAlert. Many parts of the country have winter weather much less amenable to excavation work.

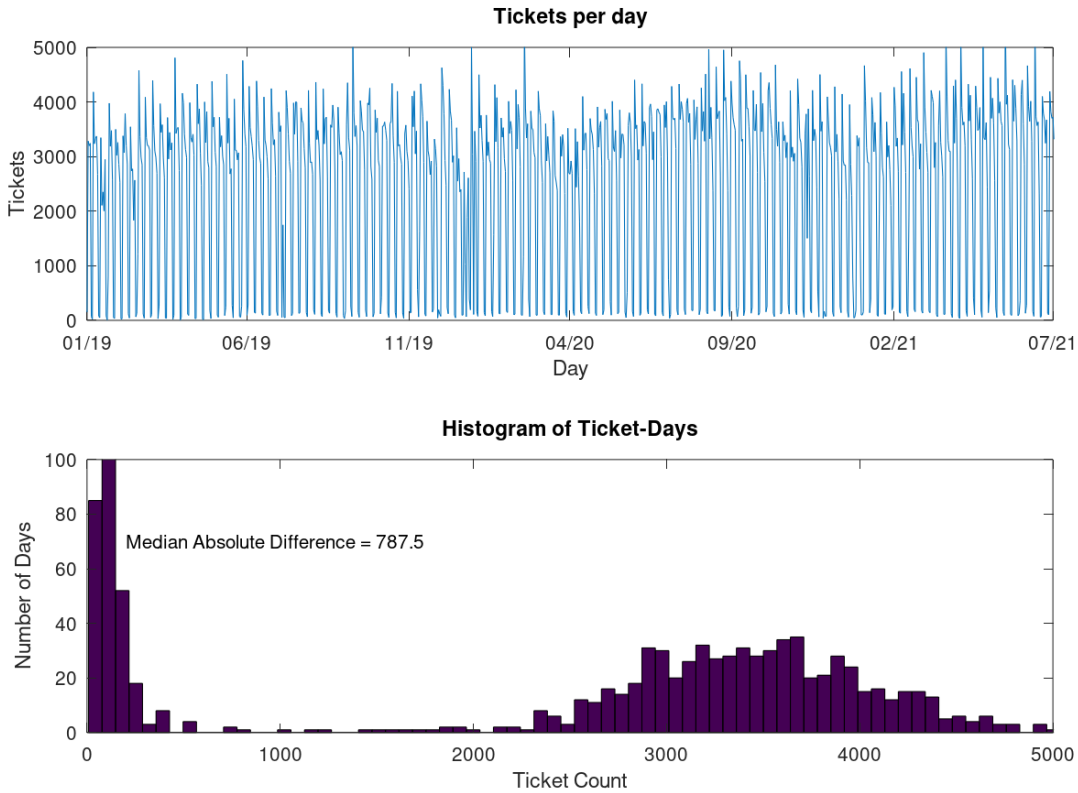


Figure 3: Ticket volume in DigAlert territory from January 2019 through August 2021.

Ticket volatility is not, however, a direct indication of locating workload, as operators do not have to locate for tickets on the day they are issued; rather, they have until the legal start date and time, which is a minimum of two working days, not counting the date of notification.[4] This can be as many as five days under certain circumstances. For instance, when an excavator makes a notification on a Thursday before a holiday weekend, the ticket is not valid until the next Tuesday at 5:01 pm.

Realistically, operators spread their locates across the days allotted to them. To better understand how they would spread out ticket workload, we simulated locator workload for a number of different excavator-requested start dates. In these simulations, we assumed that operators would not have an opportunity to locate on the day the ticket was requested, that locators would work on weekends (which is probably reasonable) and holidays (which is probably not).[5] The simulations also assume that operators know how many tickets they are going to get in upcoming days. Given the regularity of the Monday to Friday ticket cycle, this is more reasonable than an assumption that operators have no

[4] Government Code Section 4216 (l) & 4216.3 (a)(1)(A).
[5] As only 10 holidays were recognized in a year, they are not expected to greatly influence the results.

idea how many tickets will come on future days.

To benefit from a larger sample size, we reviewed DigAlert tickets starting January 2019 and ending August 2021. In the case where all excavators request tickets for the legal minimum start date (two working days, not counting the date of notification), significant variability can be seen (**Figure 4**). If, on the other hand, all excavators requested a legal start date in three days, the variability drops dramatically (**Figure 5**). In both, the largest dips in ticket volume are associated with holidays, especially Fourth of July, Thanksgiving, and Christmas.

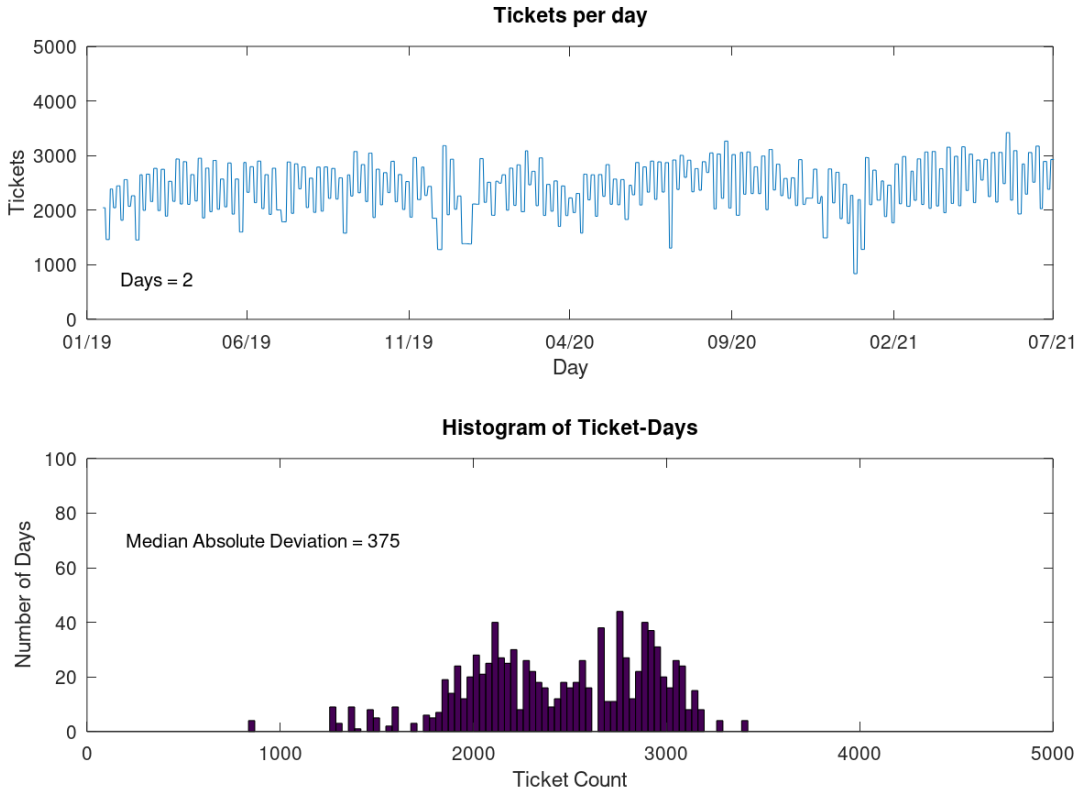


Figure 4: Workload graph of ticket volatility and distribution if all excavators requested a legal start date two days after notification (legal minimum). From DigAlert ticket data January 2019 to August 2021.

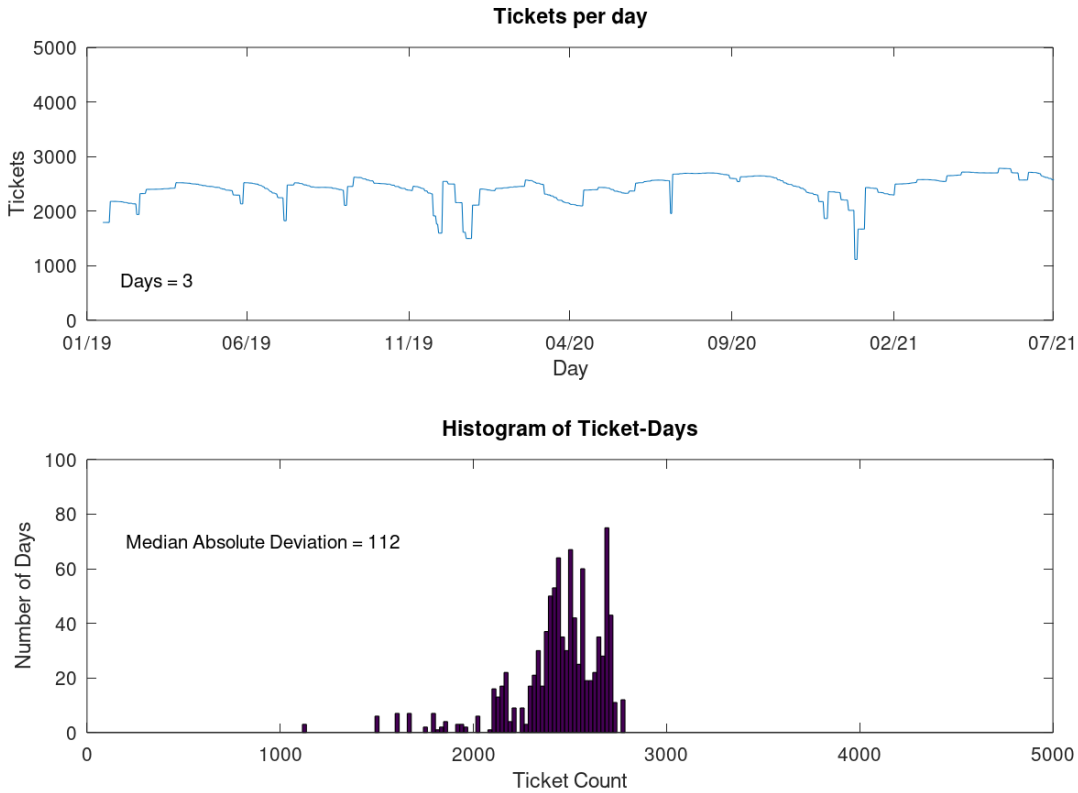


Figure 5: Workload graph of ticket volatility and distribution if all excavators requested a legal start date three days after notification. From DigAlert ticket data January 2019 to August 2021.

Note that these improvements are not based on a new requirement that the excavator need wait three working days (not counting the date of notification); rather it is a three-day request. If the excavator requested a ticket on Wednesday to be completed in three days, the operators would need to respond by Saturday, not the next Monday. Conversely, a three-day request made on Thursday would not have a legal start date until Monday evening, just as in the two working day request. Simulation details, plots, data, and code may be found in **Attachments A-E**.

Excavators do not, however, need to all wait another day for operators to see a workload benefit. If 80% of excavators requested a two-day ticket, 15% requested a three-day ticket, and 5% requested a four-day ticket, operators would still be able to achieve a considerable drop in workload variability (**Figure 6**).

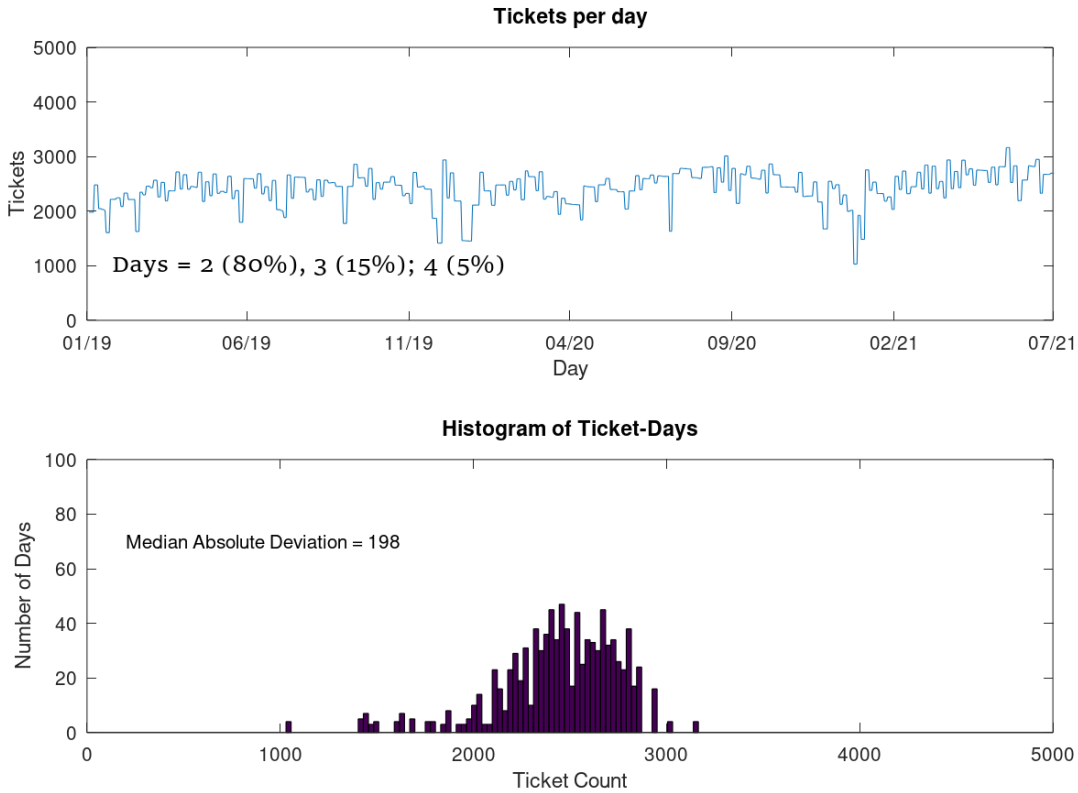


Figure 6: Workload graph of ticket volatility and distribution if 80% of excavators requested a legal start date two days after notification (legal minimum), 15% of excavators requested 3 days, and 5% requested 4 days.

Figure 7 shows the median absolute deviation—a measure of the difference in workload from day to day—for excavator request scenarios. There is a precipitous drop in variability going from two to three days, but the gains from extending further the number of days available diminishes considerably after the four-day window. Several scenarios of variable ticket request days—all of which have the largest component of legal minimum of two working days—also show significant benefits. The benefits of taking the percentage of tickets below 75% do not show significant benefits.

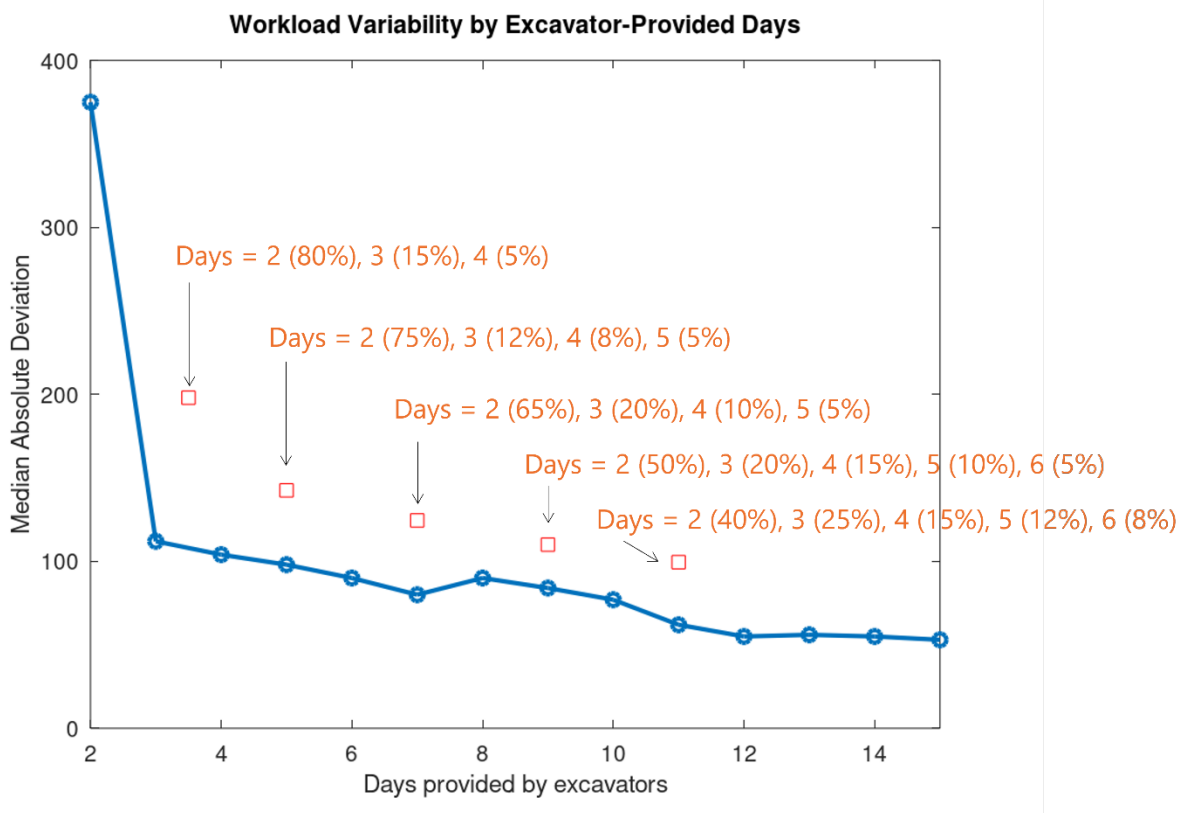


Figure 7: Mean absolute deviations of excavator request scenarios for DigAlert tickets. The blue line represents scenarios in which all excavators allowed operators the number of days listed on the x-axis to respond. The red squares represent mean absolute deviations of mixed request scenarios, and are labeled. Locations of red squares on x-axis spaced for visual comparison.

What is true for the system as a whole may not be true for an individual operator—especially if that operator has a small geographic footprint. Representatives from Calaveras County Water District (CCWD) provided information to the Board regarding a surge of tickets they've received from Osmose Utility Services (Osmose), who has been contracted by Pacific Gas and Electric Company (PG&E) to conduct power pole inspections. Over the last two years, Osmose's tickets have made up approximately 20% of all tickets received by USA North 811. CCWD's boundaries encompass 640,000 acres.[6] CCWD indicated that they'd received more than 700 new tickets in one day, followed up by subsequent renewal tickets. **Figure 8** shows the increase in total ticket numbers CCWD received in a one-year period.

[6] https://ccwd.org/about-us/about/

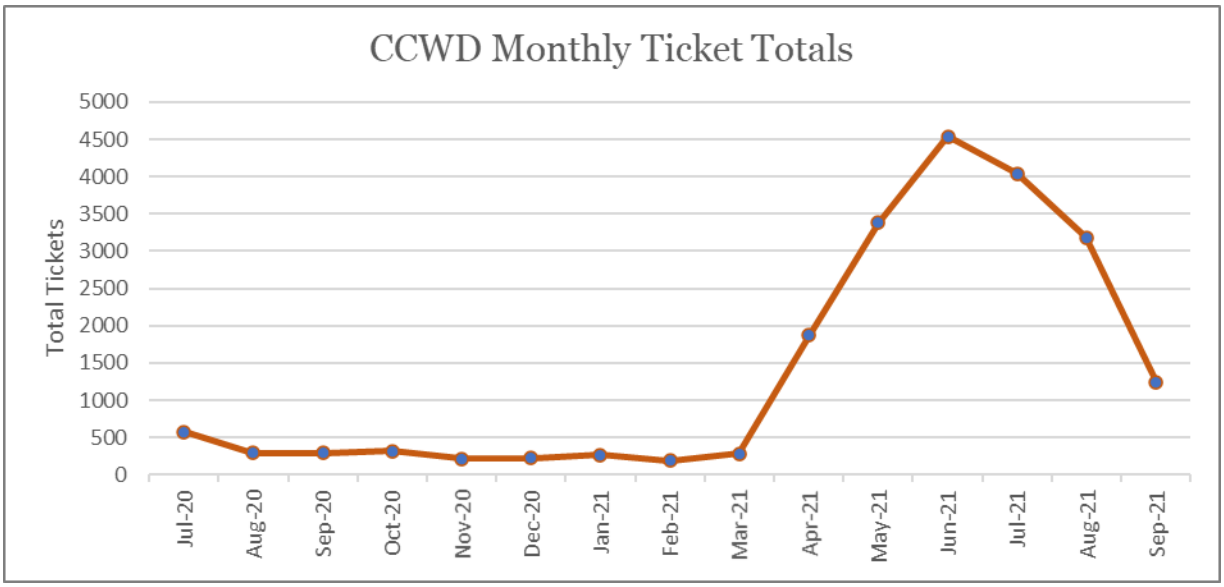


Figure 8: Monthly tickets totals (all types) provided to Calaveras County Water District from July 2020 to September 2021.

In June of 2021, Osmose made 47,302 notifications to USA North 811. Of the excavators that created 30 or more tickets, Osmose is responsible for 41%. Approximately 10% of Osmose tickets were in CCWD territory.[7]

Not only were there an uncharacteristically large number of tickets requested in CCWD territory in June 2021, the volatility of those tickets was significant (**Figure 9**).

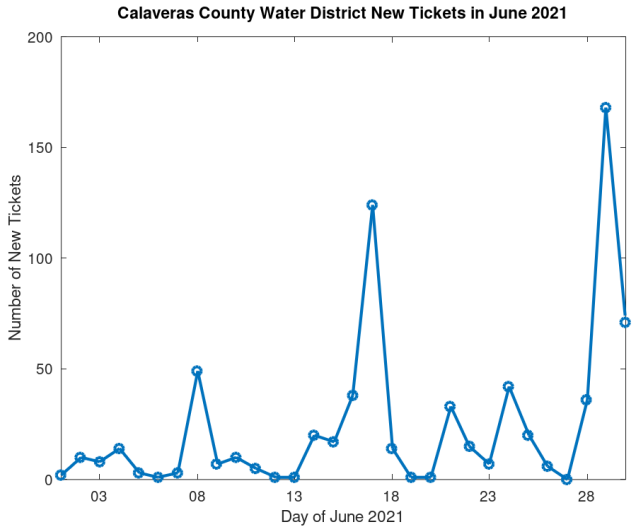


Figure 9: Calaveras County Water District new tickets, June 2021.

Performing applying the workload variability simulation to the June 2021 CCWD data, we see that a significantly greater number of days need to be allowed for

[7] USA North 811 excavator data for June 2021 available in Attachment D.

the operator to complete the locate and mark work in order to make the workload steady. Whereas the DigAlert system data indicates a steady workload with three days allotted, CCWD would need 6 days to locate and mark these tickets to achieve a steady workload (**Figure 10**). Note that this calculation ignores a challenge that CCWD employees cannot—the steep ticket month-over-month ticket increase from March through June 2021.

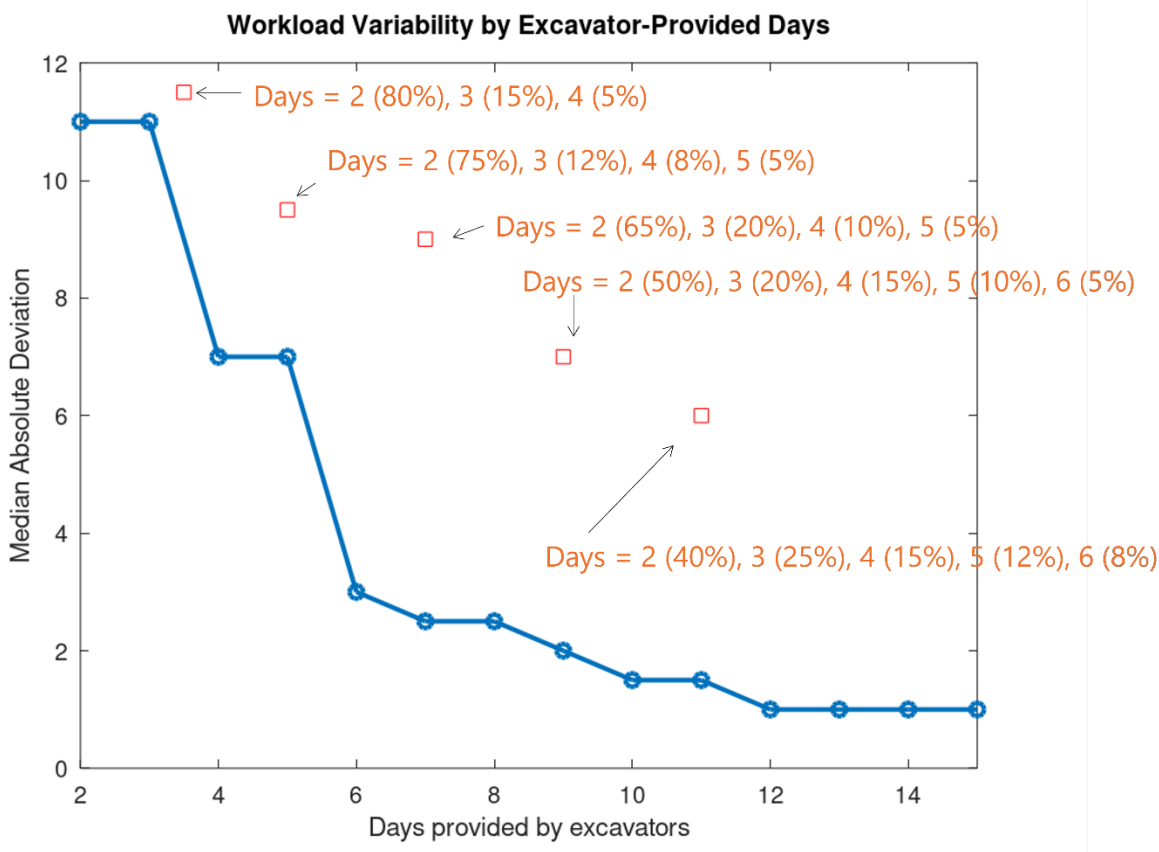


Figure 10: Mean absolute deviations of excavator request scenarios for Calaveras County Water District using June 2021 new ticket data. The blue line represents scenarios in which all excavators allowed operators the number of days listed on the x-axis to respond. The red squares represent mean absolute deviations of mixed request scenarios, and are labeled. Locations of red squares on x-axis spaced for visual comparison.

CCWD eventually was able to negotiate smaller batches with Osmose at the tail end of the project in CCWD's service territory. The CCWD representative, when speaking to Board staff, indicated that a locate-and-mark version of a pre-construction meeting or discussion with local utilities could allow large-ticket excavators and utilities to work out a ticketing process.

There does not currently exist a process to create these discussions, nor is it clear how such a process might work, as an excavator cannot determine what utilities are in the excavation area without using a notification or design ticket. The one-call center systems are not designed to take tickets covering tens of square miles or more. In this case, however, it is not clear that such a system is needed,

as Osmose is making these thousands of notifications on behalf of PG&E, and PG&E is a charter member of the Board of Directors of USA North 811, so PG&E could facilitate communication between its contractor and the small operators in the path of PG&E's planned work.

Conclusion

Excavators requesting start dates that are one to two days beyond the minimum legal start date can greatly even out locate and mark workload. Excavators would have to have confidence that all operators on his or her ticket (an average of 7 or 8) would mark in time, otherwise the excavator would be doing him- or herself a disservice. The further ahead an excavator's work can be planned, the more able he or she would be able to provide operators more time to locate and not get burned by late locates. Excavators with massive amounts of tickets for planned excavation—such as PG&E's contractor Osmose—would likely be able to have a significant and immediate positive impact on locating workload.

The reasons why excavators request start dates at the legal minimum are currently unquantified, so it is unclear what interventions may entice them to make notifications further in advance of their start date. Some possibilities are:

1. It may be that much excavation cannot be planned to the precision of a delineated area, and so they cannot make notifications further in advance.
2. It may be that a large number of excavators expect late locates, and so they provide themselves a buffer day or two. If seven operators are on time but one is late, the excavator must wait. If excavators are providing themselves a buffer day or two, then operators are being harmed by other operators, not by excavators.
3. It may be that excavators make notifications two days in advance of work because that is what they are told to do. The overwhelming majority of "Call 811" advertising focuses on getting people to request tickets. To the extent this messaging provides a timeframe, it usually tells people to make the request 2 days in advance. It may be that a significant portion of excavators make notifications two days in advance because they understand that to be the responsible course of action.
4. By requiring tickets to be renewed 28 days from the *issuance* of a ticket,[8] rather than 28 days from the legal start date, statute may be providing excavators incentive to wait to make their notification. An excavator that notifies the one-call center two weeks in advance of the start date would only have two weeks of work until he or she would need to renew the

[8] Government Code section 4216.2 (e): "A ticket shall be valid for 28 days from the date of issuance."

ticket.

To make further conclusions, staff would need to analyze one-call center electronic positive response data to determine if there is a correlation between late locates and ticket volatility, and if so, whether that correlation is general or restricted to specific operators.

RECOMMENDATION

What is unclear is how this volatility affects locate and mark compliance. Staff recommends that it obtain electronic positive response data so that it can correlate high and low workload days to electronic positive response codes. Staff also recommends that it explore options, such as project tickets, to improve communication between excavators with large, long-lasting planned work and operators.

ATTACHMENTS

A) Simulation Methodology
B) DigAlert Workload Simulation Plots
C) Calaveras County Water District Workload Simulation Plots
D) Data
E) Simulation Code

ATTACHMENT A: SIMULATION METHODOLOGY

Simulations were performed using GNU Octave 6.3.0 for Microsoft Windows. GNU Octave is a high-level scripting program primarily intended for numerical computation. GNU Octave is free open source (FOSS) software. Go to **https://www.gnu.org/software/octave/** for more information or to download a copy.

Simulations were used to spread tickets over the days they could be completed by an operator in a way that minimized workload volatility. To accomplish this, the Octave script created bins for every day that could be worked prior to every due date for every day a ticket was submitted. For instance, if 4,000 tickets were submitted on 8/26/19 (Monday), and 80% requested 2 days, 15% requested 3 days, and 5% requested 4 days, three binned arrays would be created: one for the 3,600 due in 2 days (Wednesday), one for the 300 due in 3 days (Thursday), and one for the 100 due in 4 days (Friday). To initialize the simulation, the tickets were spread evenly across the available days. The first array would have 1,800 tickets completed on the first day (Tuesday) and 1,800 tickets completed on the second (Wednesday). The second array would split the 300 tickets evenly across three bins (100 on Tuesday, 100 on Wednesday, 100 on Thursday). The third array would split the tickets evenly across four bins (25 on Tuesday, 25 on Wednesday, 25 on Thursday, and 25 on Friday). In building the workload graph, all three of these arrays would be added to determine the number of tickets completed per day: 1925 on Tuesday, 1925 on Wednesday, 125 on Thursday, and 25 on Friday.

To simulate optimization of the workload graph, the tickets in each bin were redistributed to make the overall ticket workload as even as possible by subtracting the tickets in that bin from the overall workload graph and filling it back up, deepest well first. Each bin was selected at random until all bins were redistributed. This process was repeated until the workload graph stopped changing; until the spectrum converged.

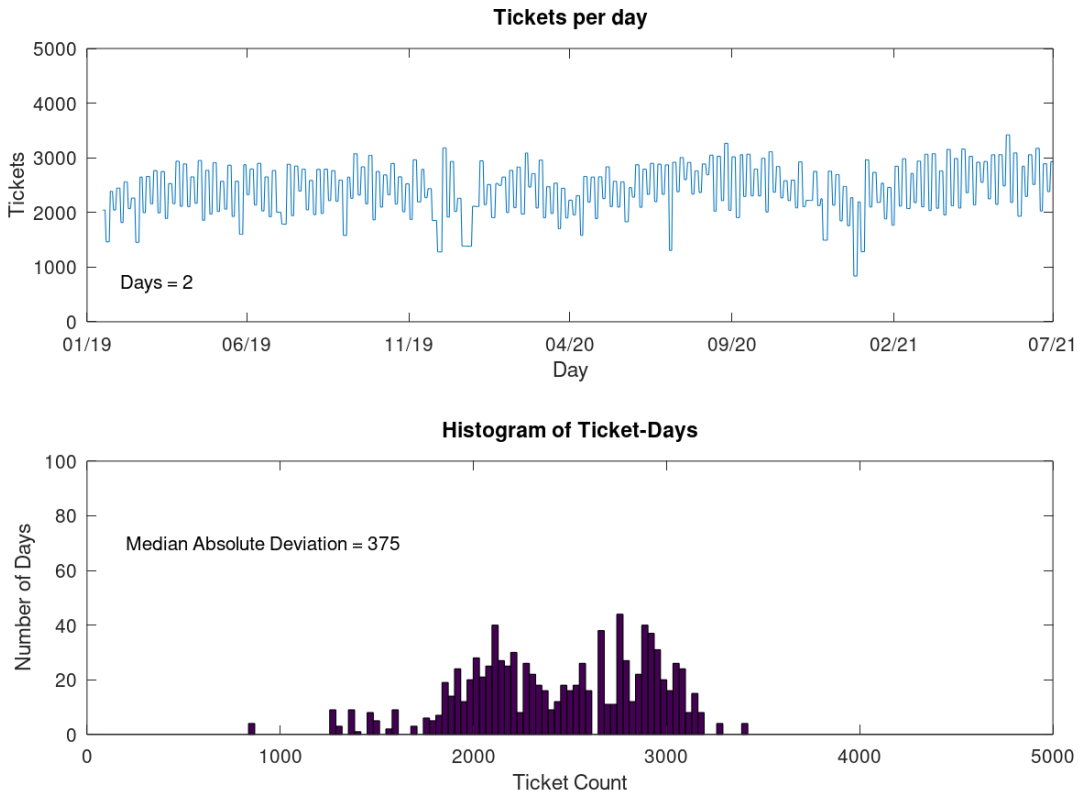
To determine convergence, the mean error between simulation runs was tested. If the mean error was below the convergence threshold for 5 consecutive runs, the workload graph was deemed to have converged. For DigAlert data, a convergence threshold of 3 was used. For CCWD data, a convergence threshold of 0.3 was used.

To quantify volatility, we used median absolute deviation as the statistical test. Median absolute deviation was chosen over standard deviation, as standard deviation is better suited for Gaussian (normal) distributions and places greater emphasis on outliers than the mean absolute deviation. Median absolute deviation was chosen over mean absolute deviation as a focus on the most common workload days is more indicative of workload stability than average.

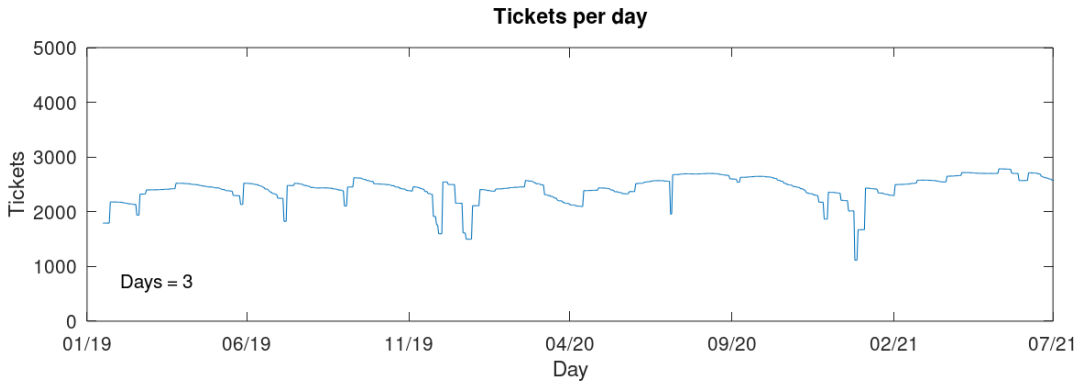
For DigAlert data, statistical measures excluded the first 15 days of the modeled time period (January 1-15, 2019), as they had an artificially low ticket workload; there is no previous month's notification data to create additional work in those first 15 days. For CCWD data, statistical measures excluded the first two days.

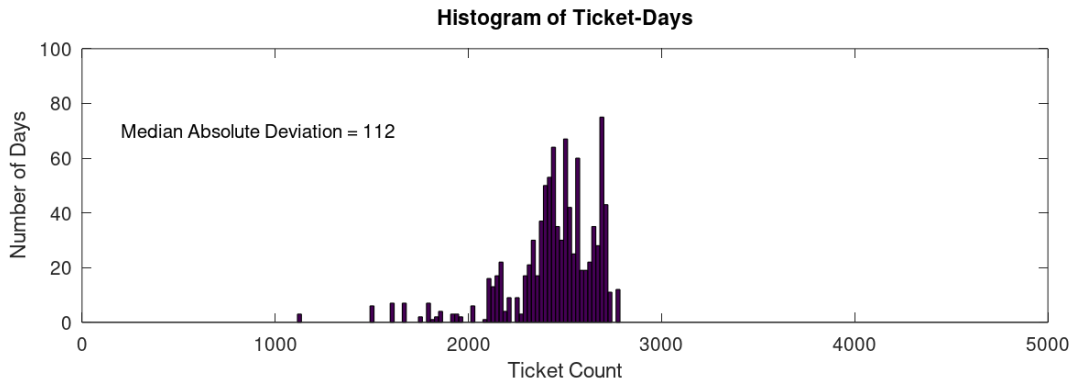
Holidays used in the simulation were New Year's Day, Martin Luther King, Jr. Day, President's Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Black Friday, Christmas. These holidays had ticket volumes that looked more like weekend days than like weekdays. Other holidays, such as Caesar Chavez Day, had ticket volumes that looked more like weekdays than weekend days.

ATTACHMENT B: DIGALERT WORKLOAD SIMULATION PLOTS

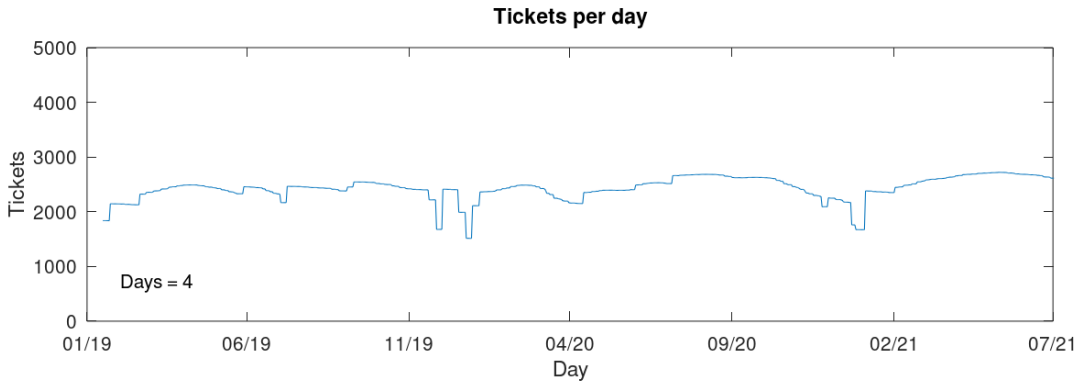


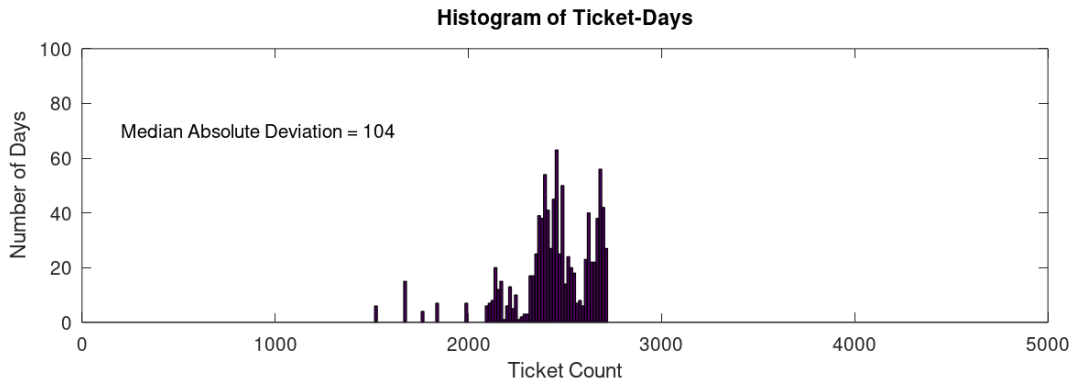
Workload graph of ticket volatility and distribution if all excavators requested a legal start date two days after notification (legal minimum). From DigAlert ticket data January 2019 to August 2021. Median absolute deviation is 375.



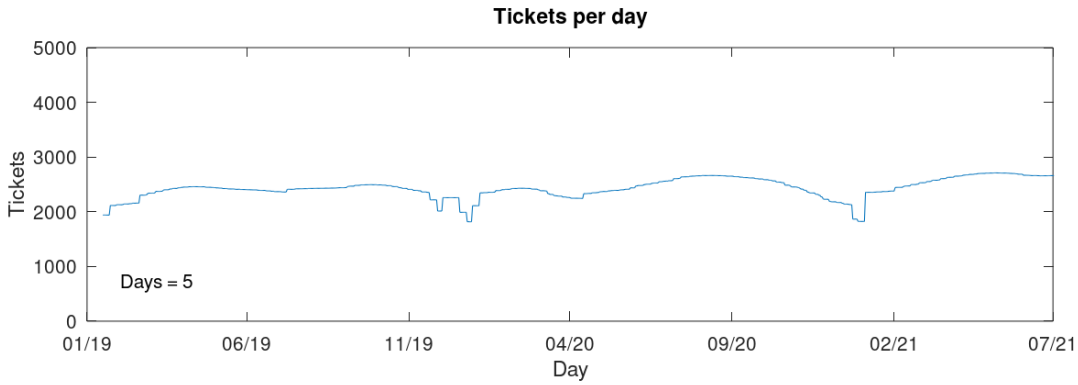


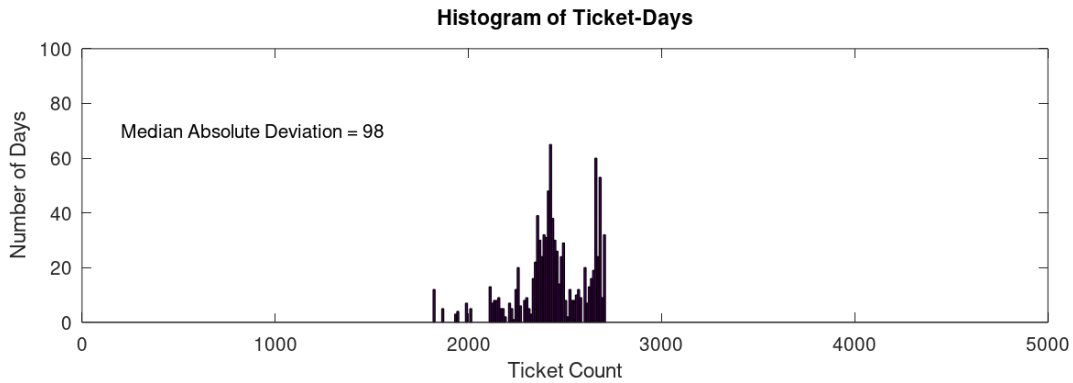
Workload graph of ticket volatility and distribution if all excavators requested a legal start date three days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 112.





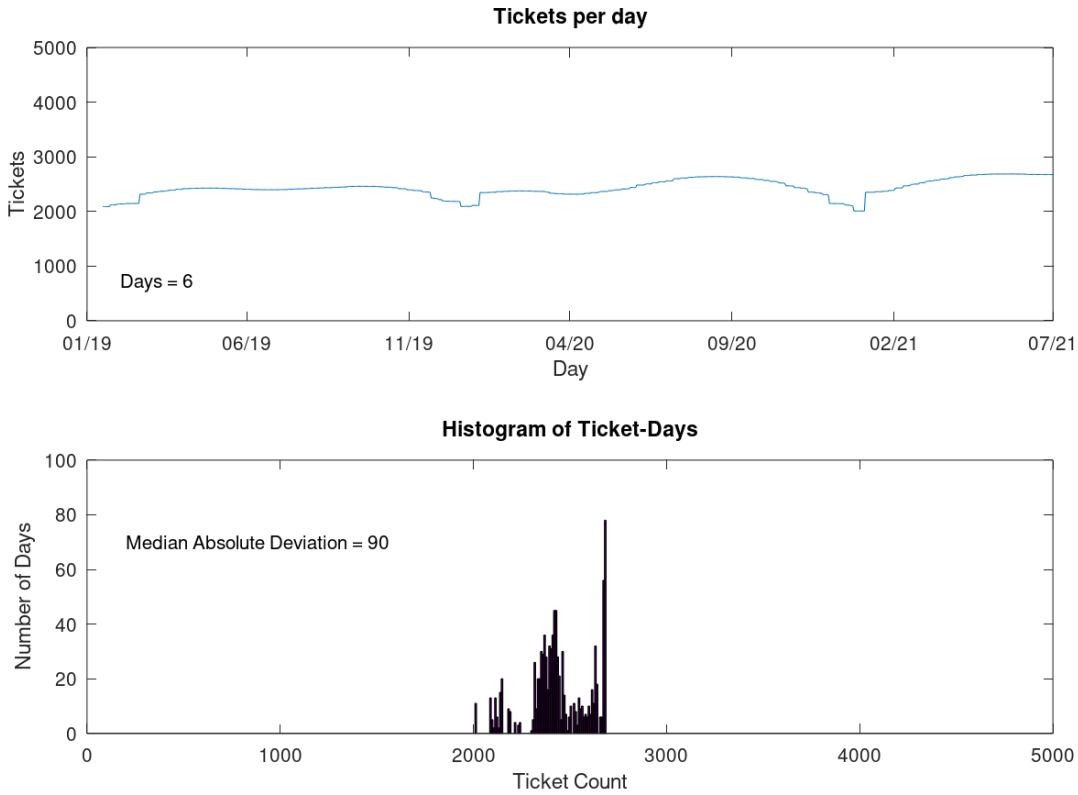
Workload graph of ticket volatility and distribution if all excavators requested a legal start date four days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 104.





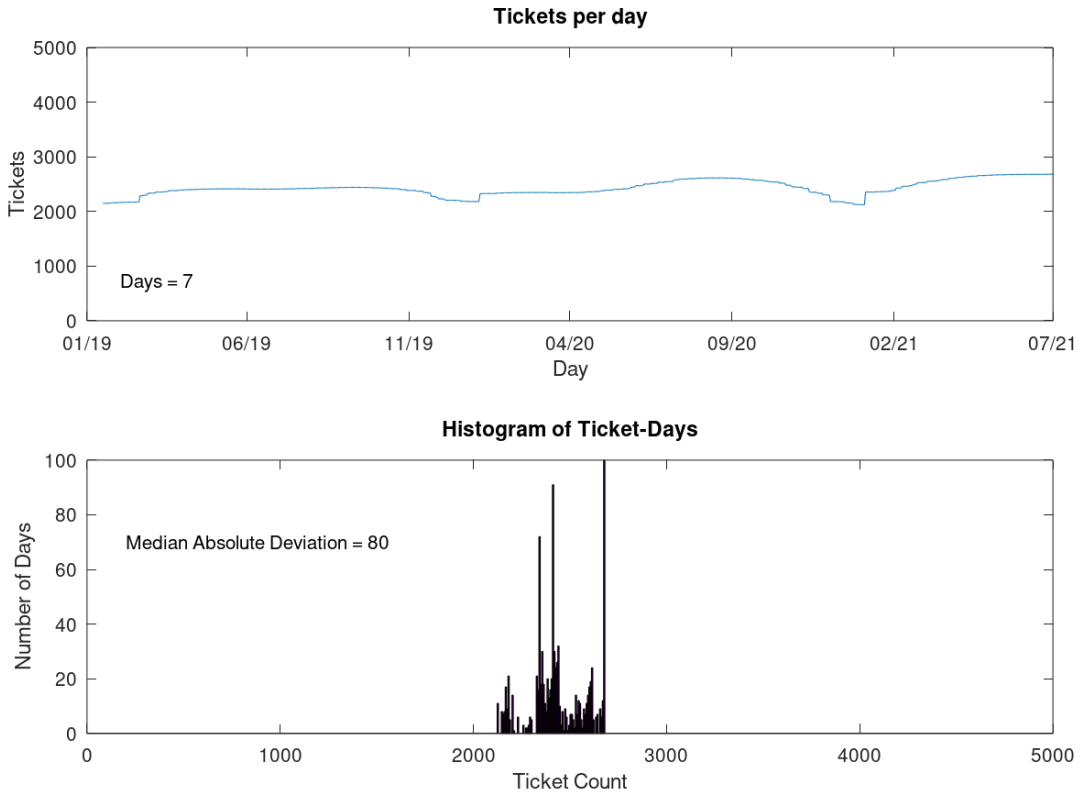
Workload graph of ticket volatility and distribution if all excavators requested a legal start date five days after notification. From DigAlert ticket data January

2019 to August 2021. The median absolute deviation is 96.



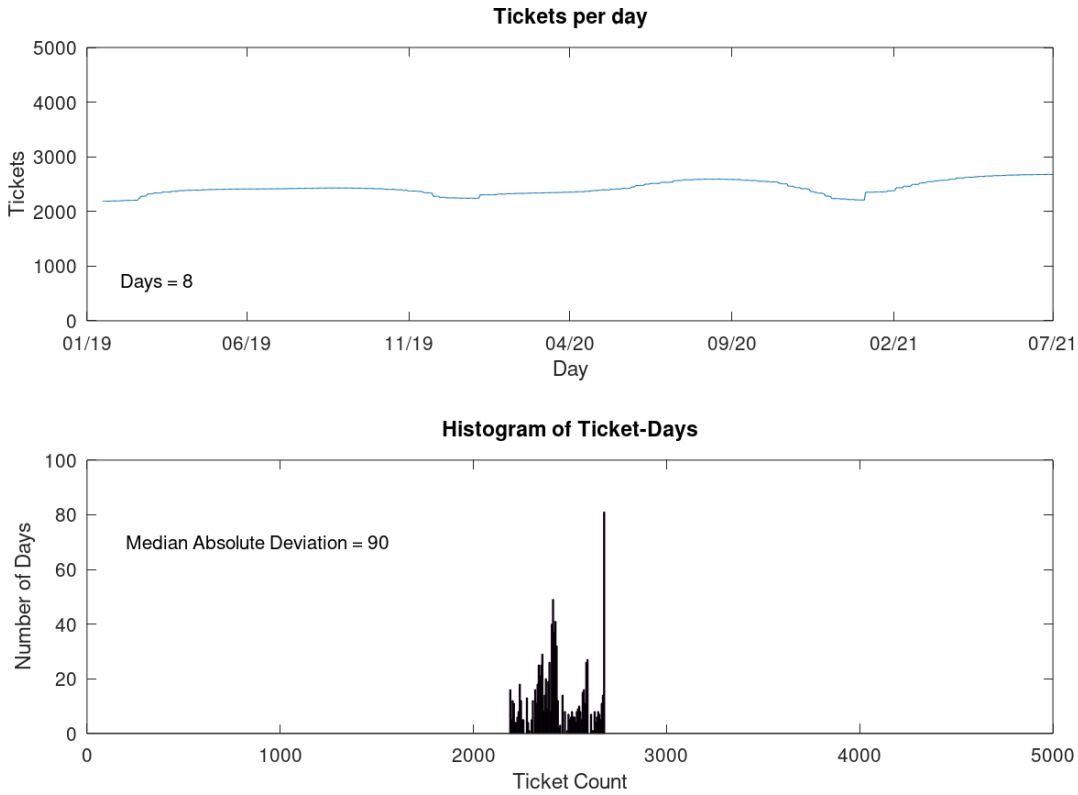
Workload graph of ticket volatility and distribution if all excavators requested a legal start date six days after notification. From DigAlert ticket data January 2019

to August 2021. The median absolute deviation is 90.



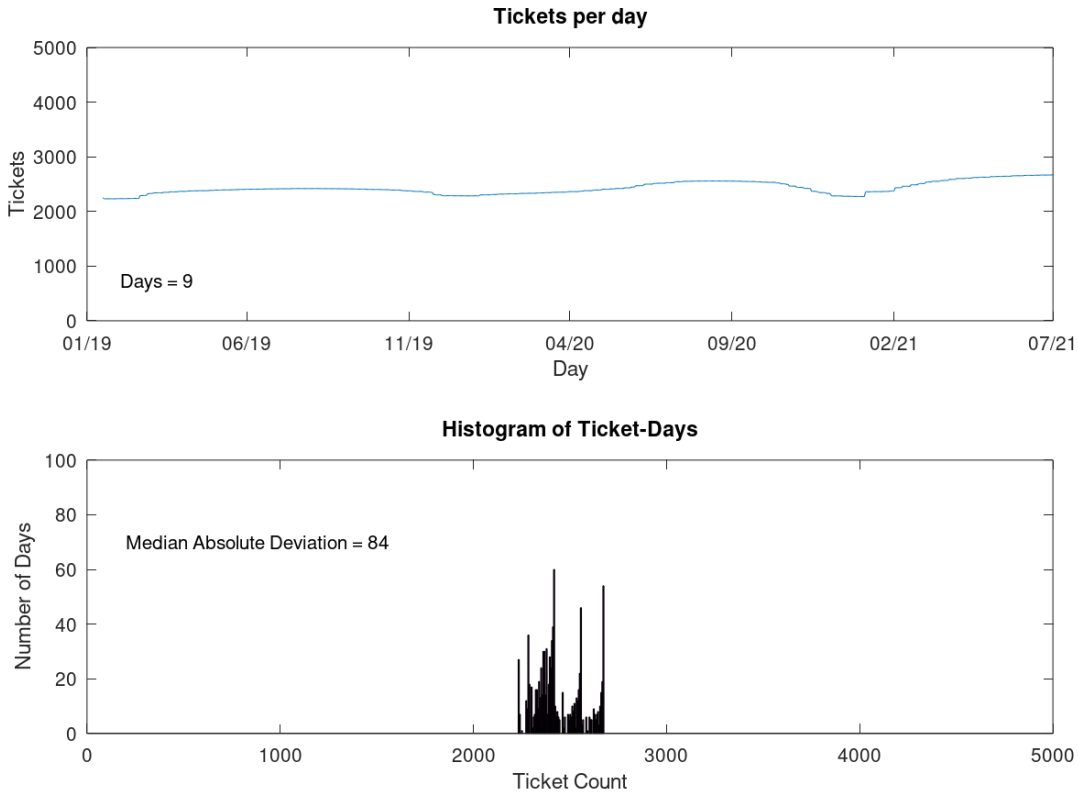
Workload graph of ticket volatility and distribution if all excavators requested a legal start date seven days after notification. From DigAlert ticket data January

2019 to August 2021. The median absolute deviation is 80.



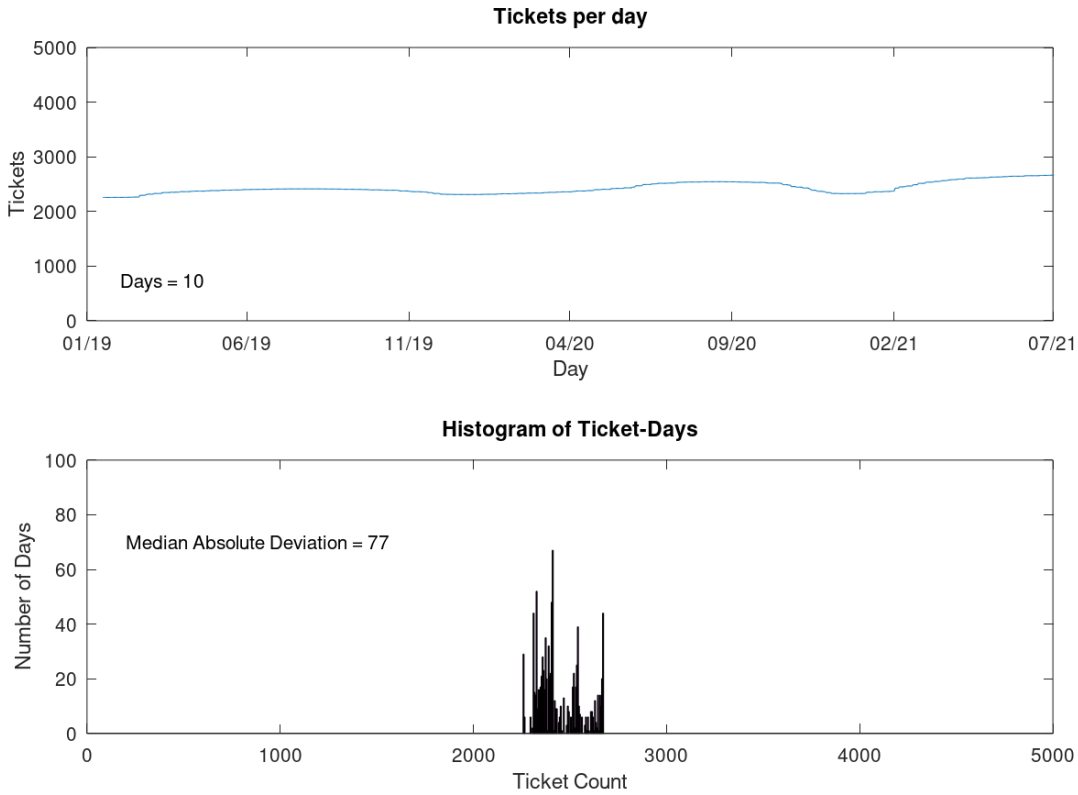
Workload graph of ticket volatility and distribution if all excavators requested a legal start date eight days after notification. From DigAlert ticket data January

2019 to August 2021. The median absolute deviation is 90.



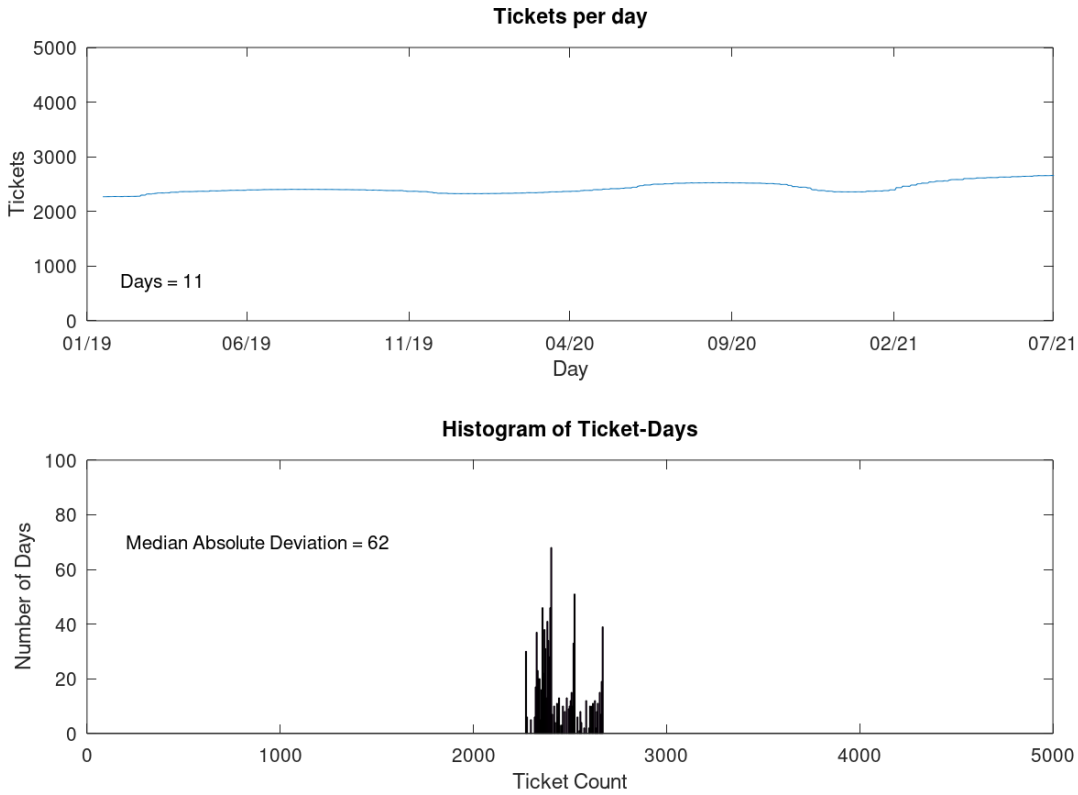
Workload graph of ticket volatility and distribution if all excavators requested a legal start date nine days after notification. From DigAlert ticket data January

2019 to August 2021. The median absolute deviation is 84.



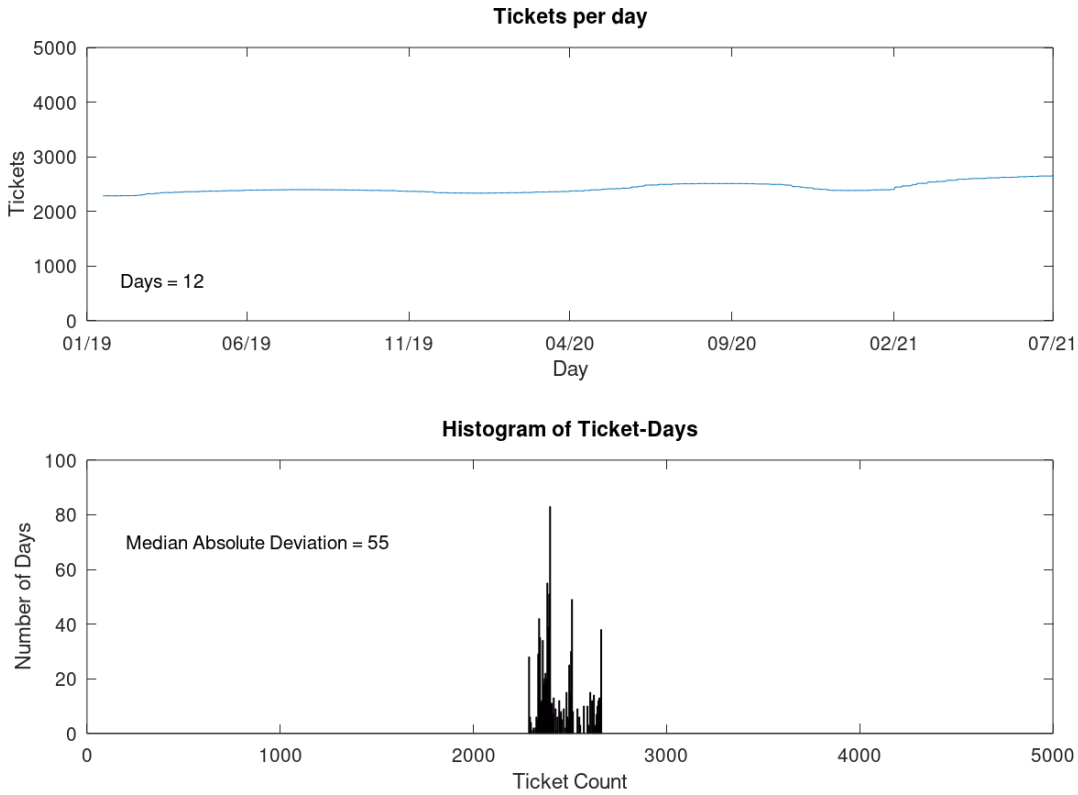
Workload graph of ticket volatility and distribution if all excavators requested a legal start date ten days after notification. From DigAlert ticket data January

2019 to August 2021. The median absolute deviation is 77.

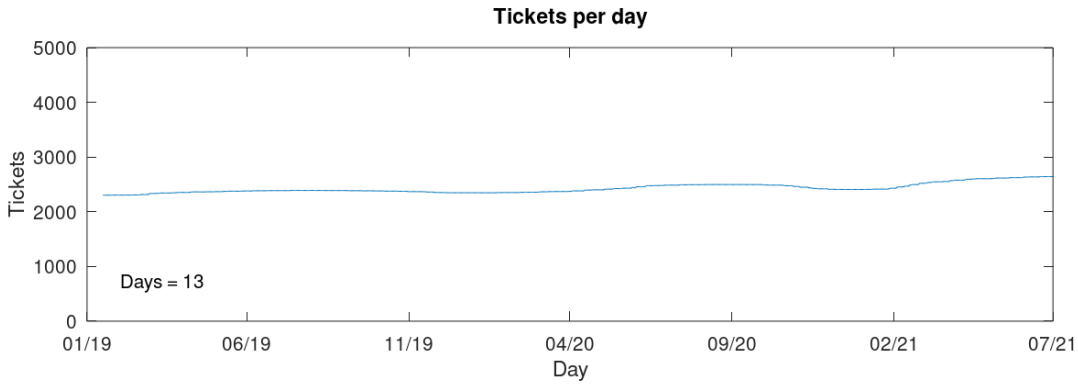


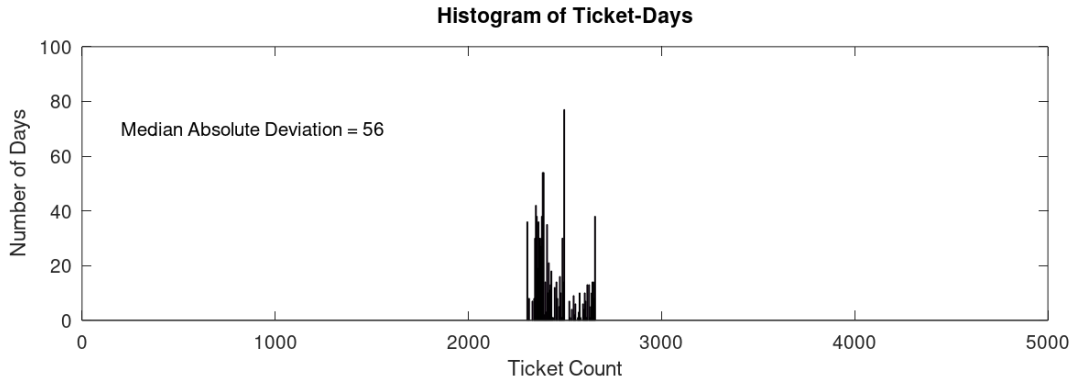
Workload graph of ticket volatility and distribution if all excavators requested a legal start date eleven days after notification. From DigAlert ticket data January

2019 to August 2021. The median absolute deviation is 62.

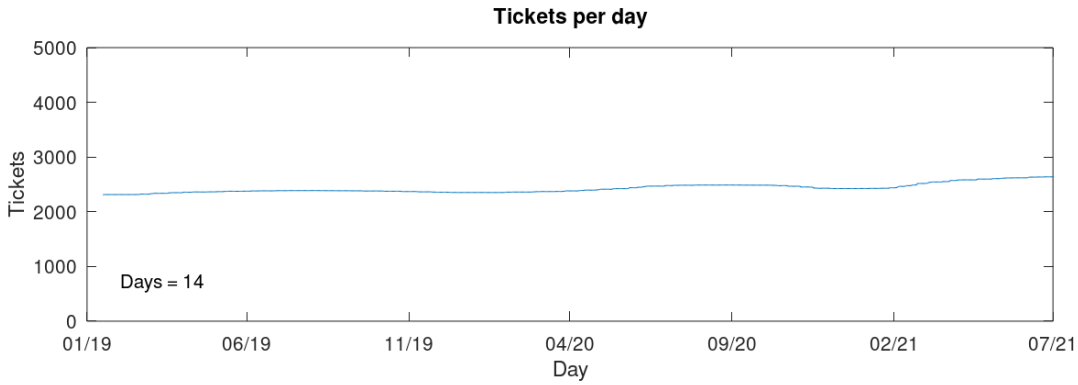


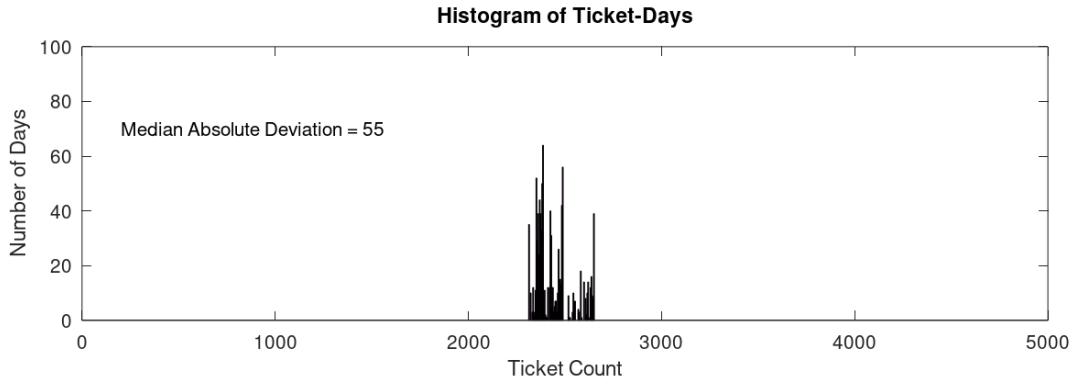
Workload graph of ticket volatility and distribution if all excavators requested a legal start date twelve days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 55.



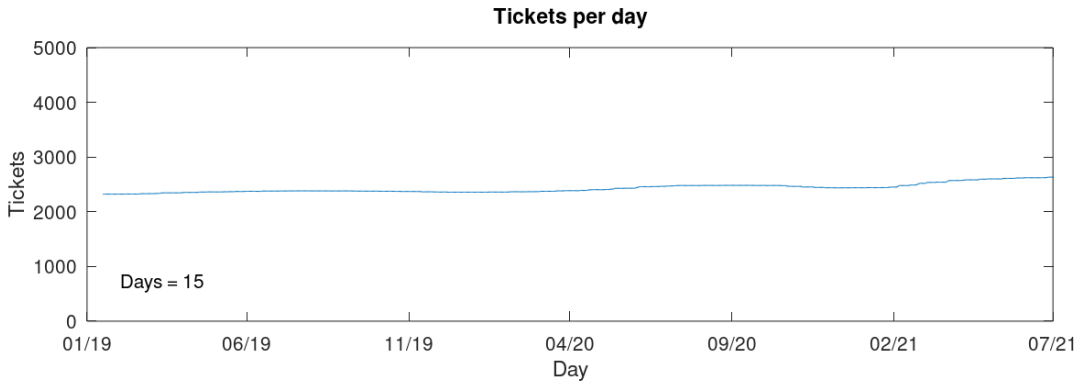


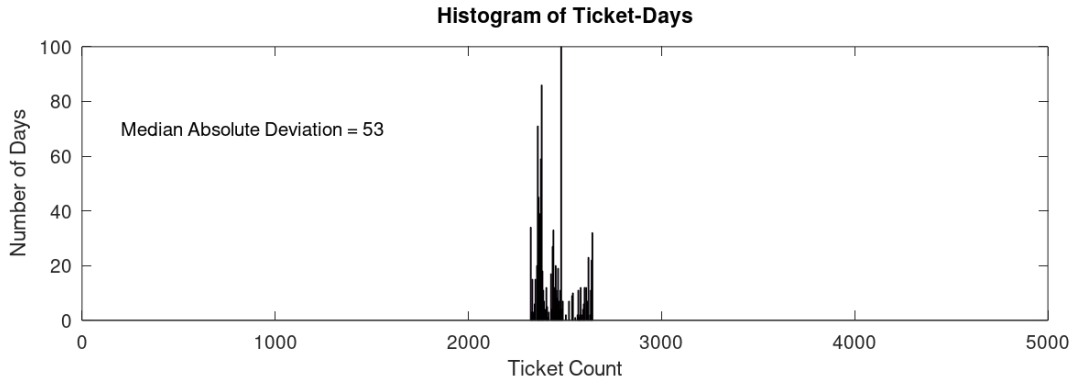
Workload graph of ticket volatility and distribution if all excavators requested a legal start date thirteen days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 56.



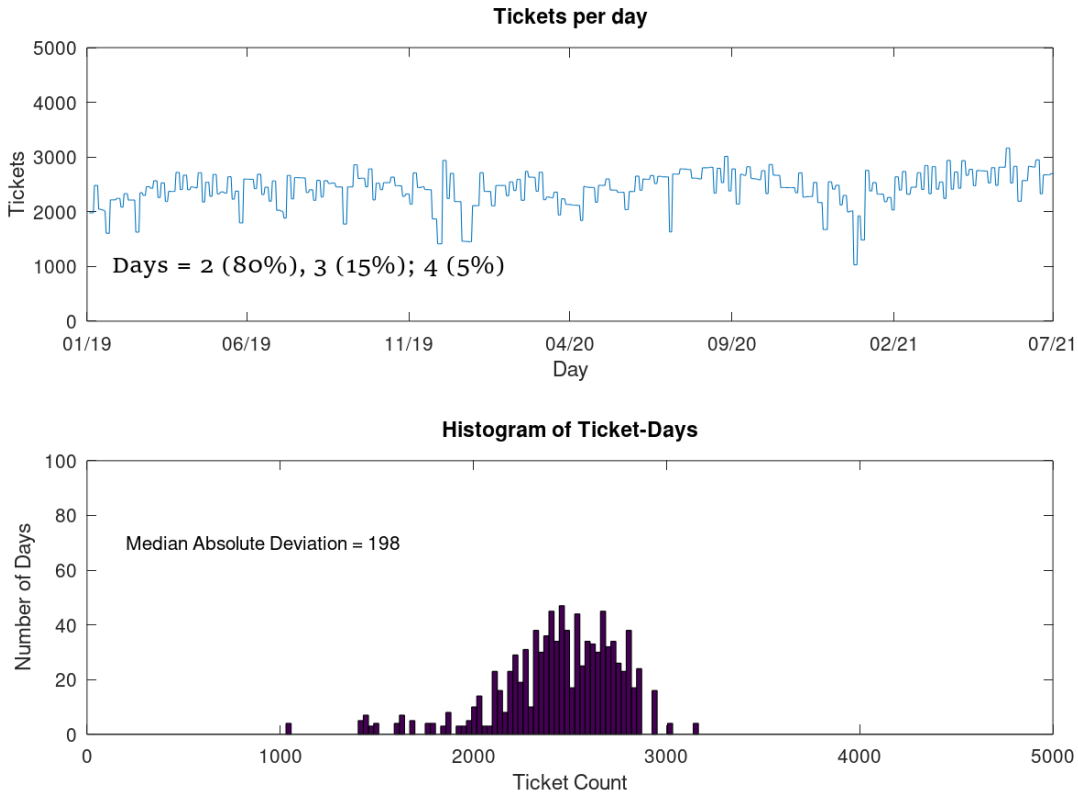


Workload graph of ticket volatility and distribution if all excavators requested a legal start date fourteen days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 55.

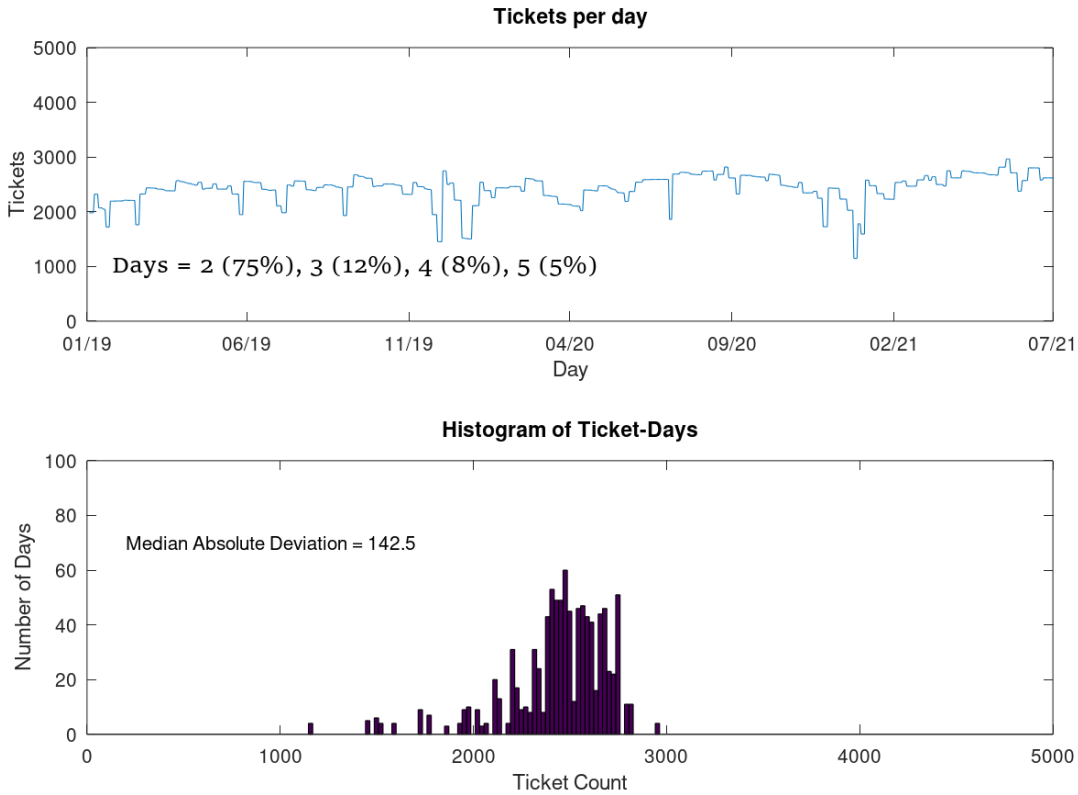




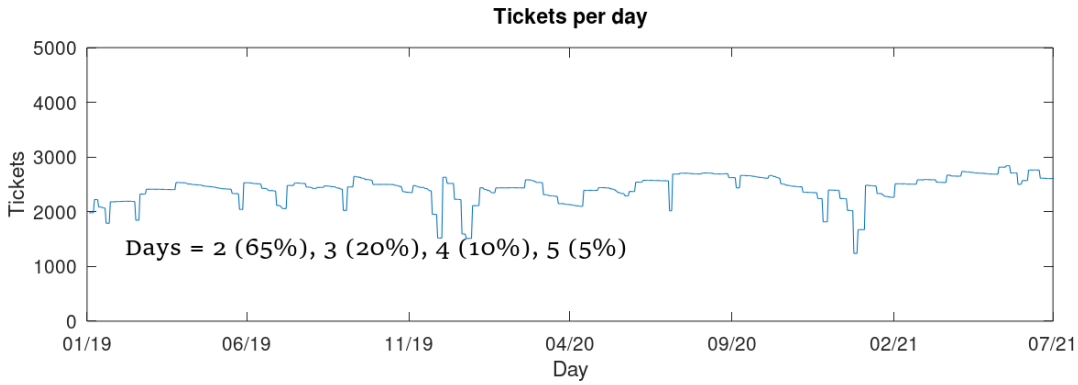
Workload graph of ticket volatility and distribution if all excavators requested a legal start date fifteen days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 53.

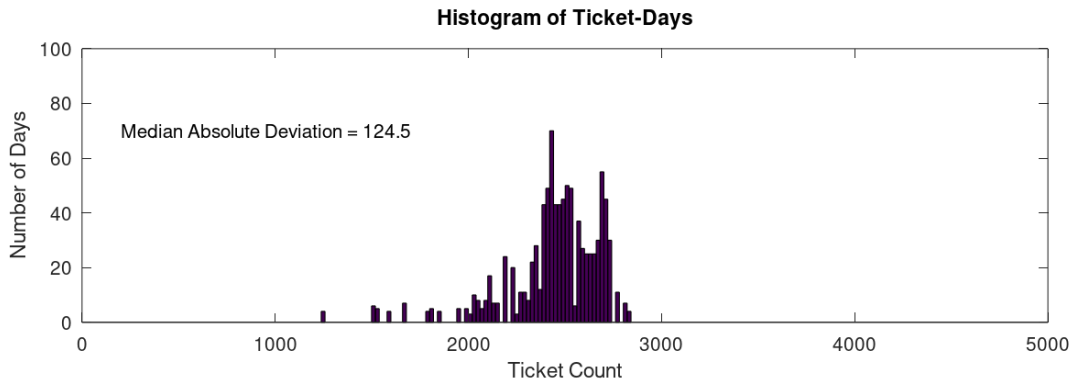


Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (80%), 3 (15%), and 4 (5%) days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 198.

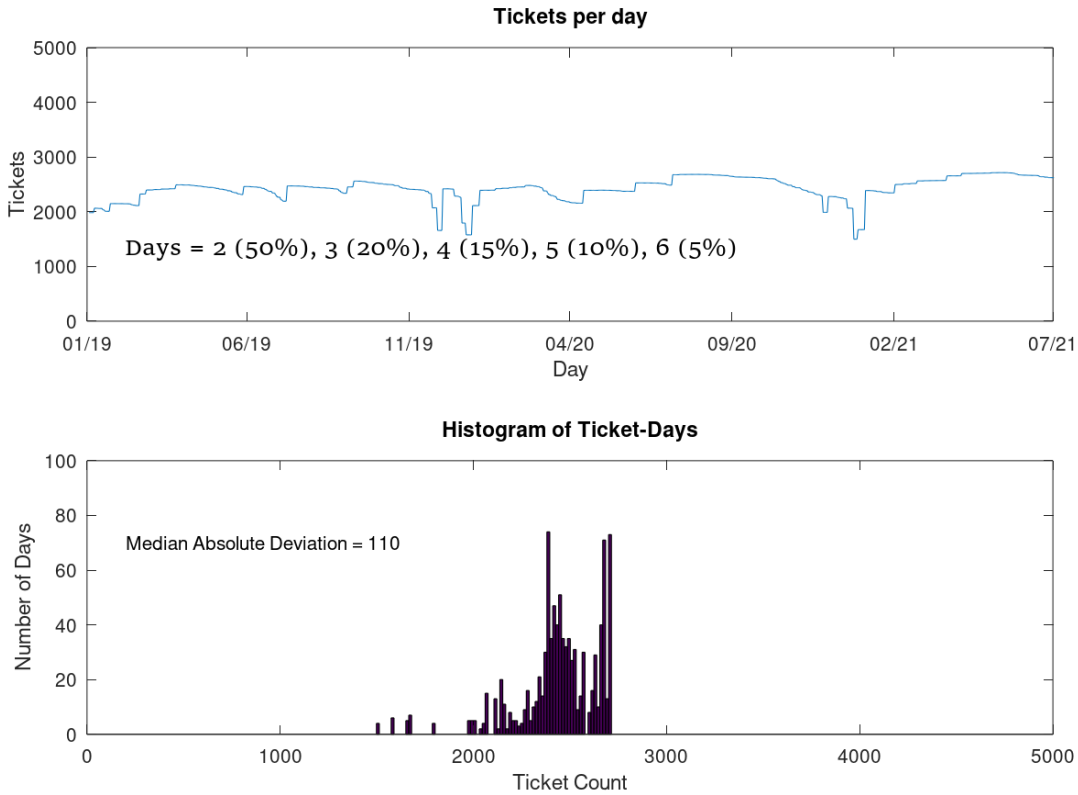


Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (75%), 3 (12%), 4 (8%), and 5 (5%) days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 142.5.

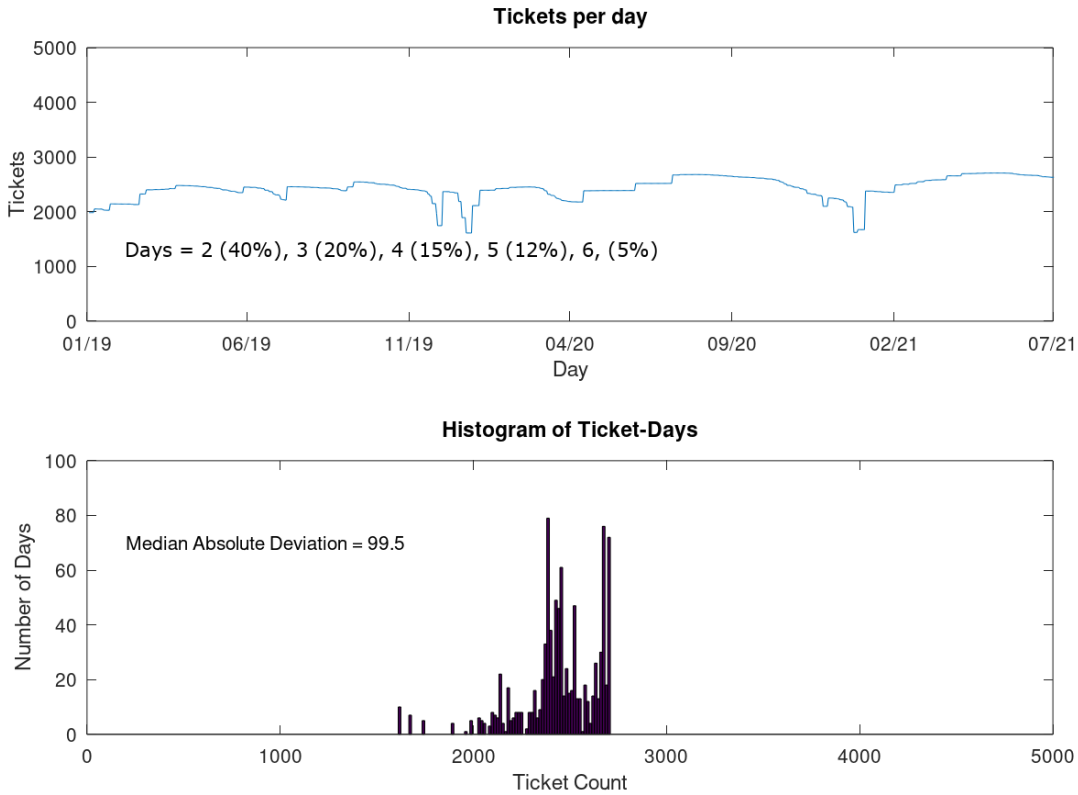




Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (65%), 3 (20%), 4 (10%), and 5 (5%) days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 124.5.

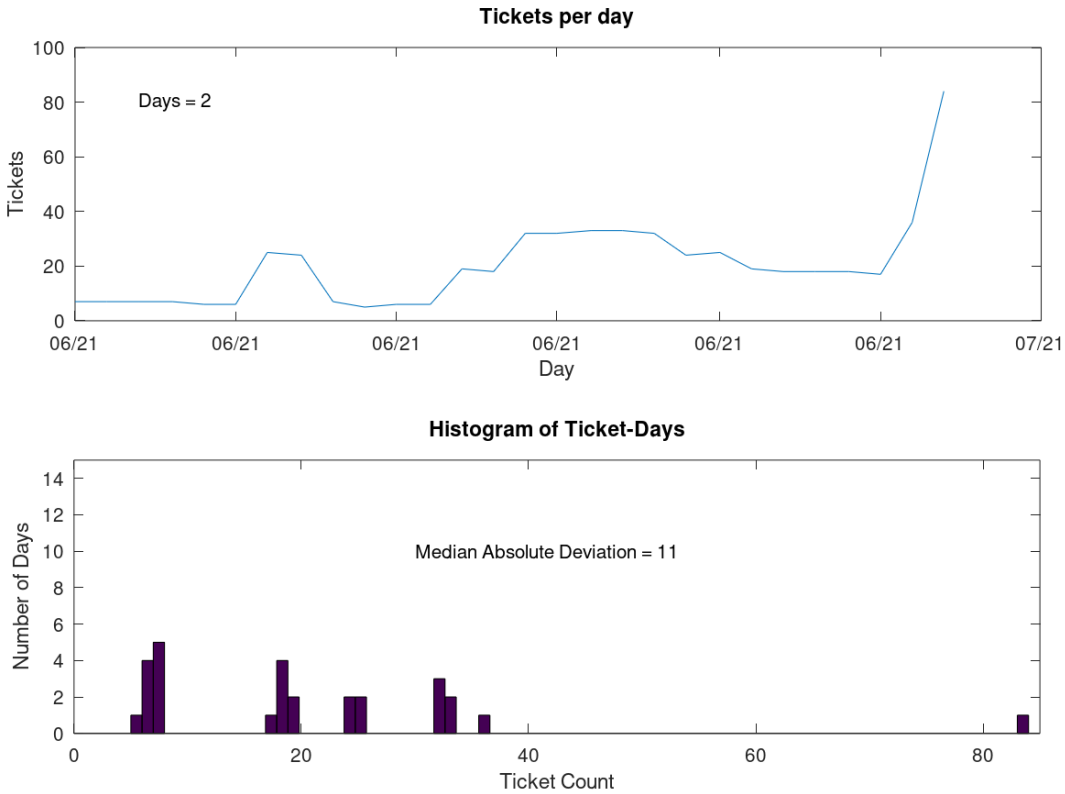


Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (50%), 3 (20%), 4 (15%), 5 (10%), and 6 (5%) days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 110.

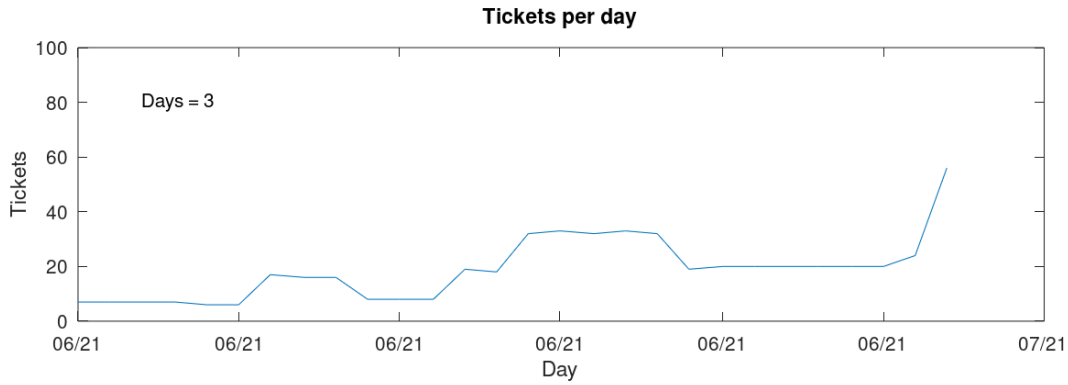


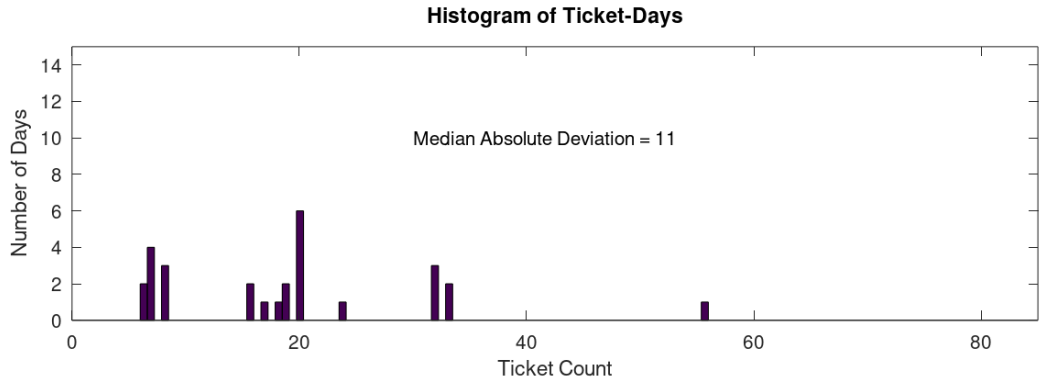
Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (40%), 3 (20%), 4 (15%), 5 (12%), and 6 (5%) days after notification. From DigAlert ticket data January 2019 to August 2021. The median absolute deviation is 99.5.

ATTACHMENT C: CALAVERAS COUNTY WATER DISTRICT WORKLOAD SIMULATION PLOTS

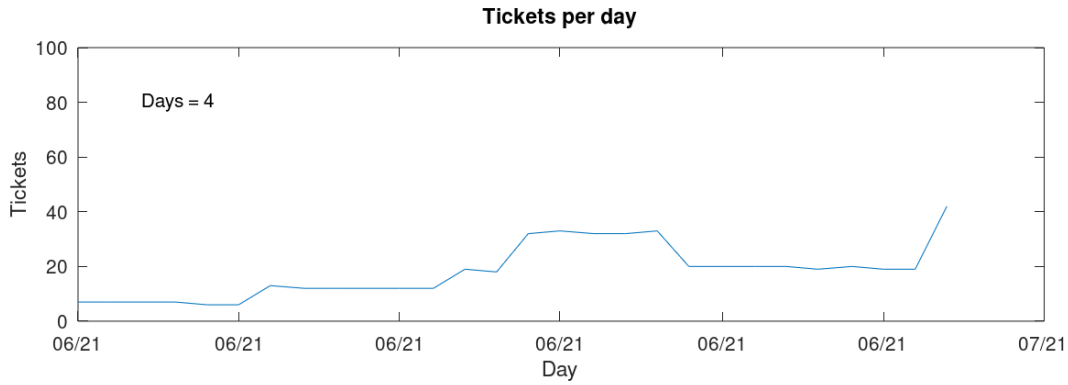


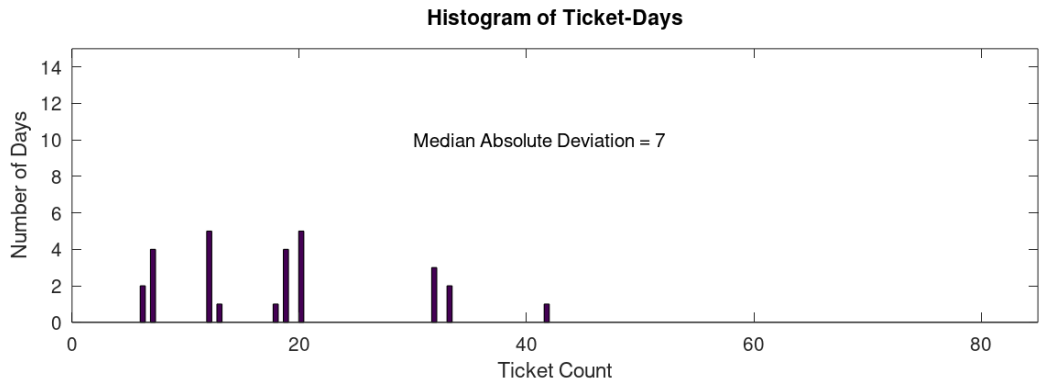
Workload graph of ticket volatility and distribution if all excavators requested a legal start date two days after notification (legal minimum). From Calaveras County Water District data for new tickets for June 2021. Median absolute deviation is 11.



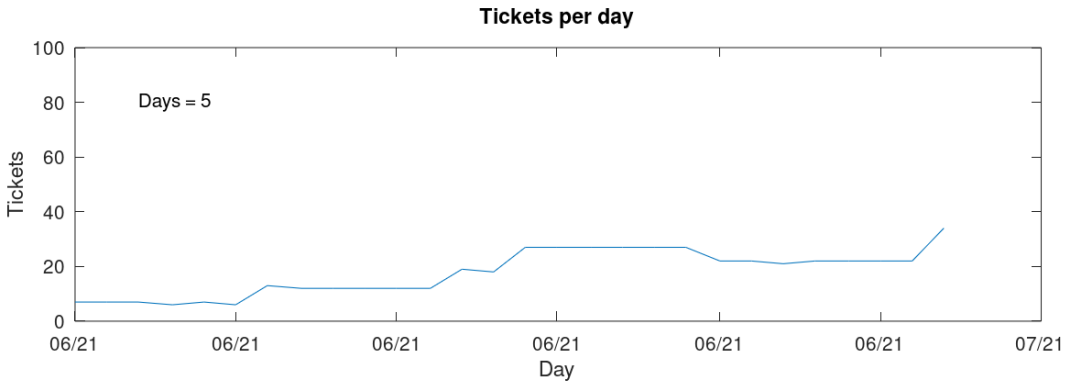


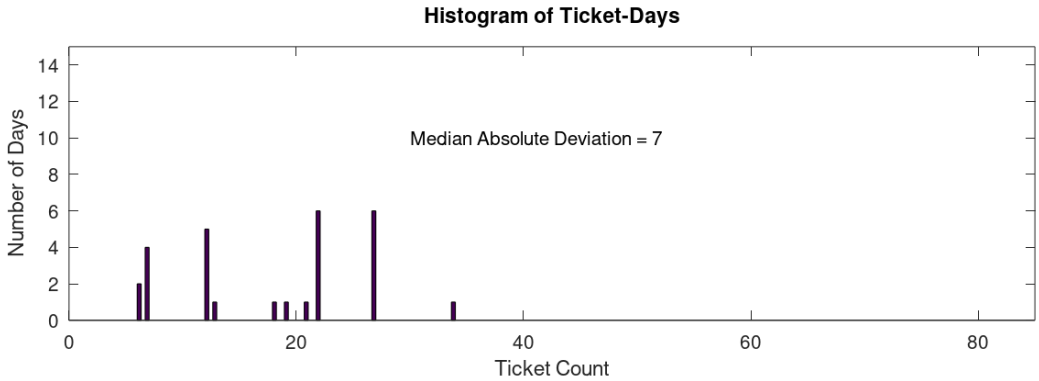
Workload graph of ticket volatility and distribution if all excavators requested a legal start date three days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 11.



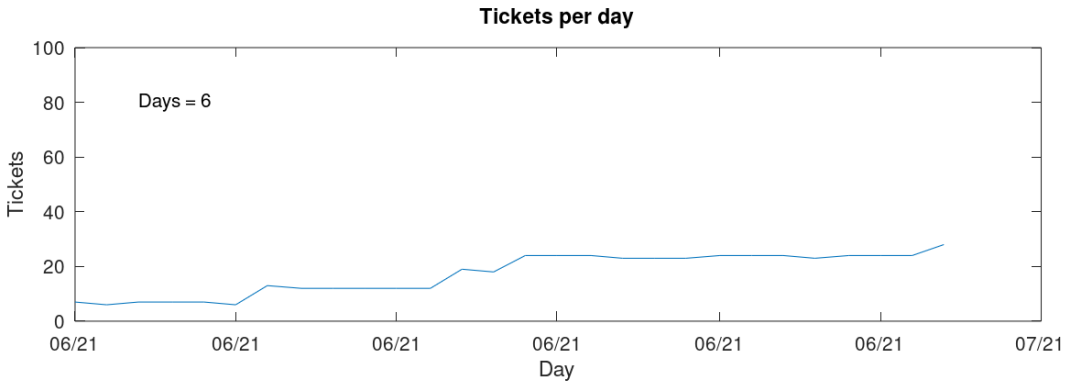


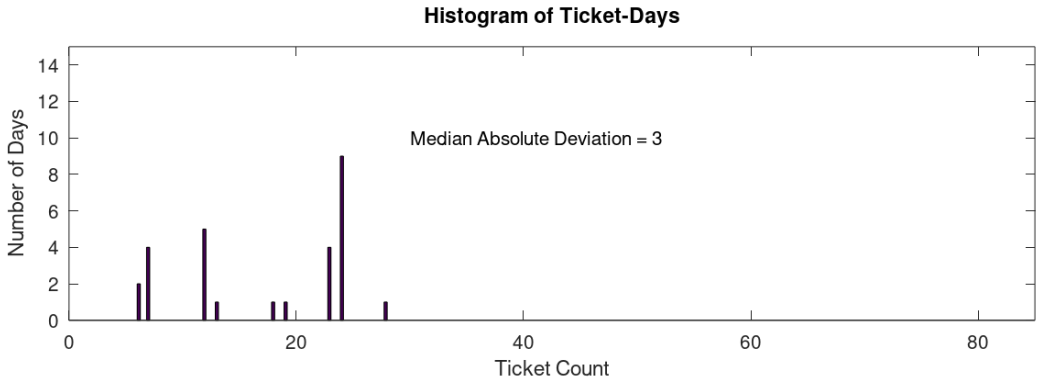
Workload graph of ticket volatility and distribution if all excavators requested a legal start date four days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 7.



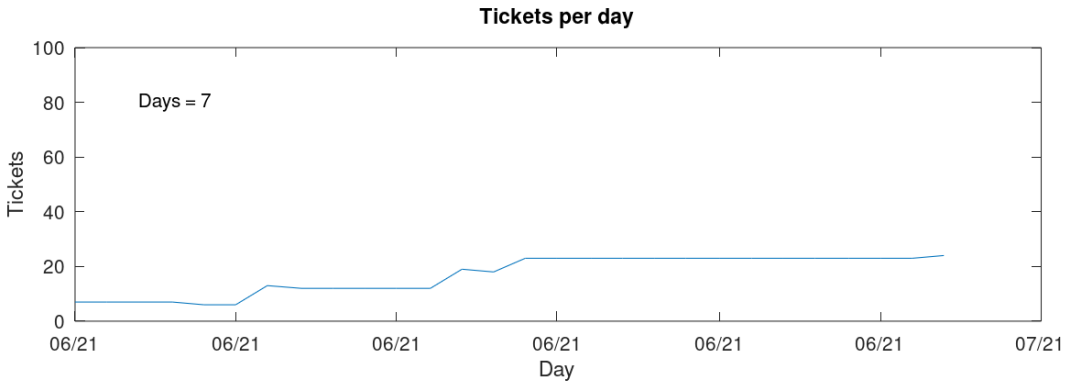


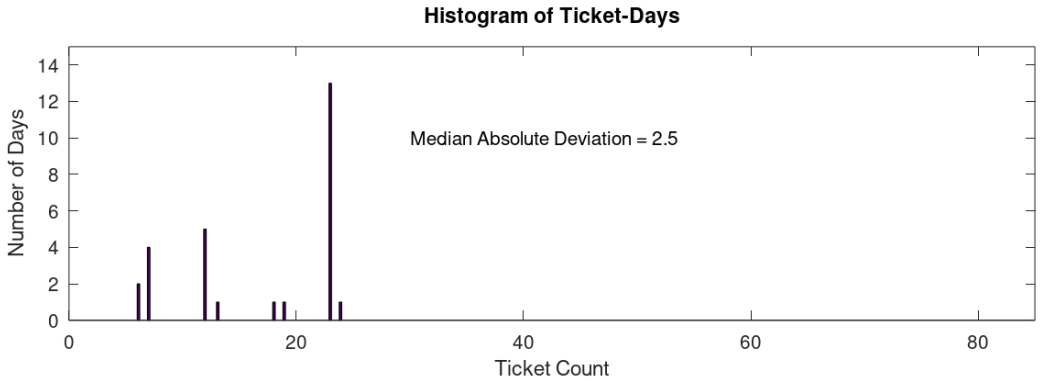
Workload graph of ticket volatility and distribution if all excavators requested a legal start date five days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 7.



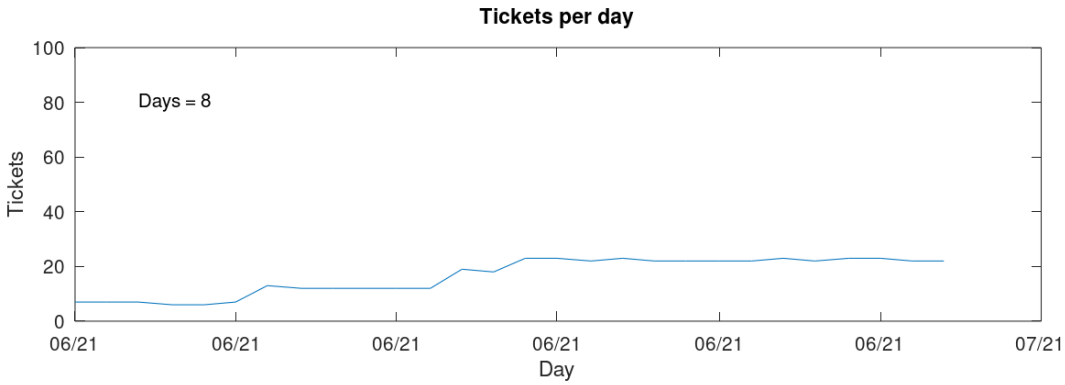


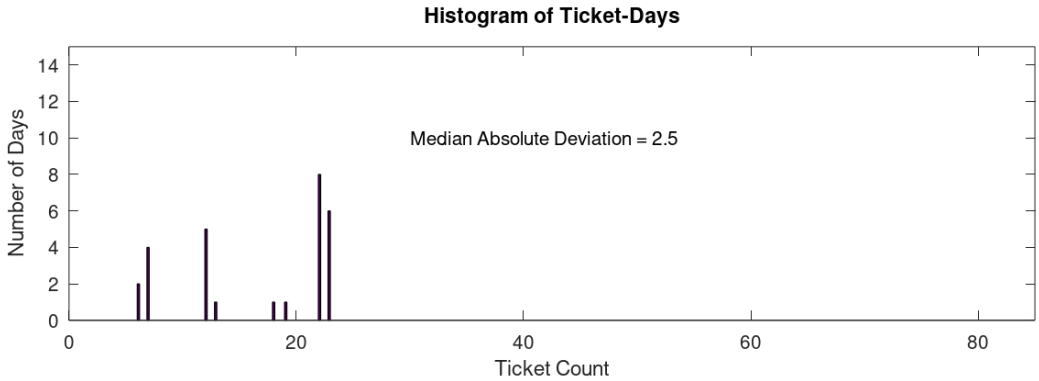
Workload graph of ticket volatility and distribution if all excavators requested a legal start date six days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 3.



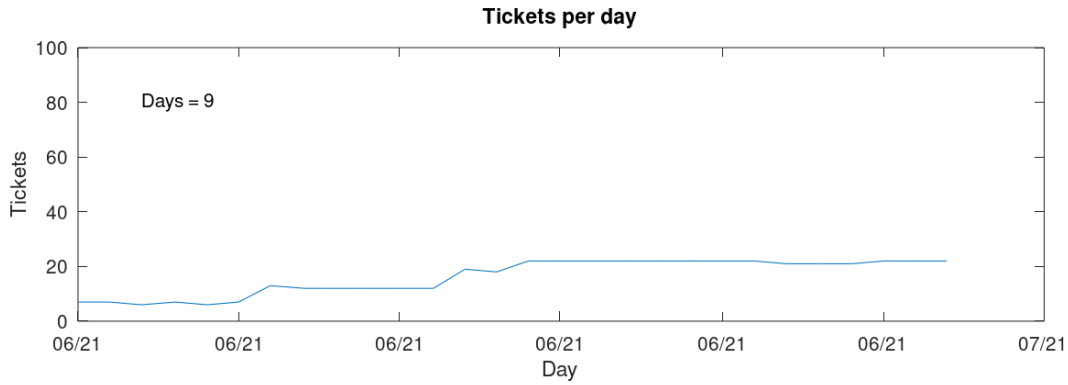


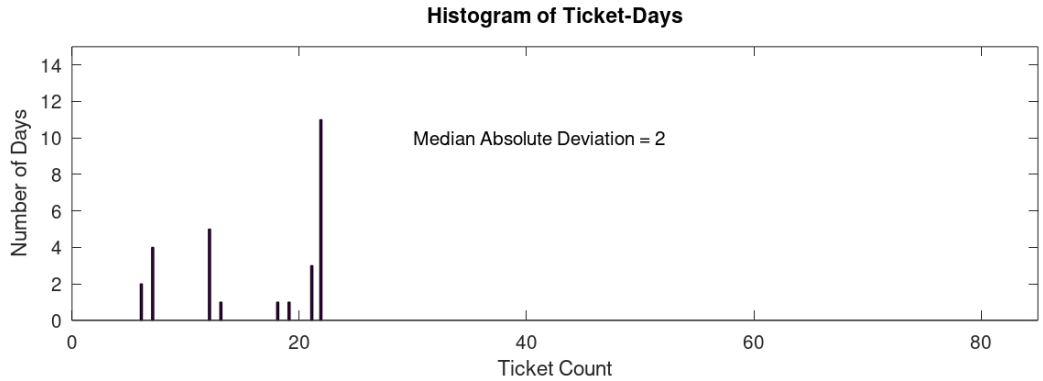
Workload graph of ticket volatility and distribution if all excavators requested a legal start date seven days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 2.5.
Workload graph of ticket volatility and distribution if all excavators requested a legal start date eight days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 2.5.



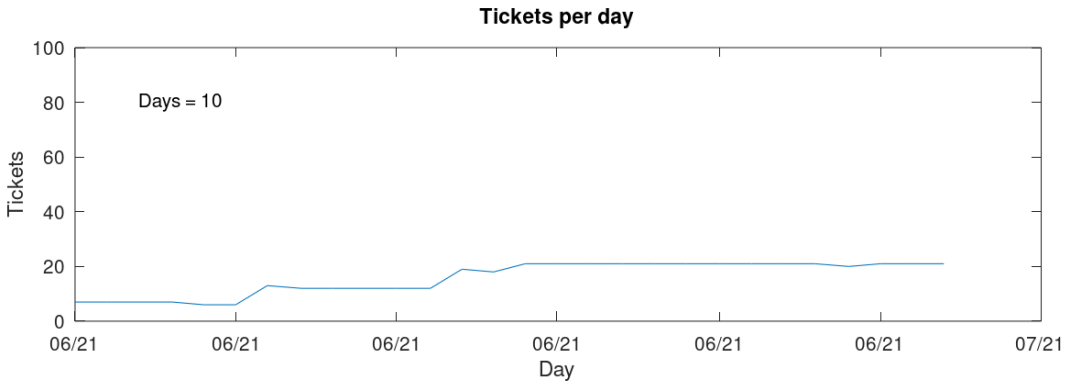


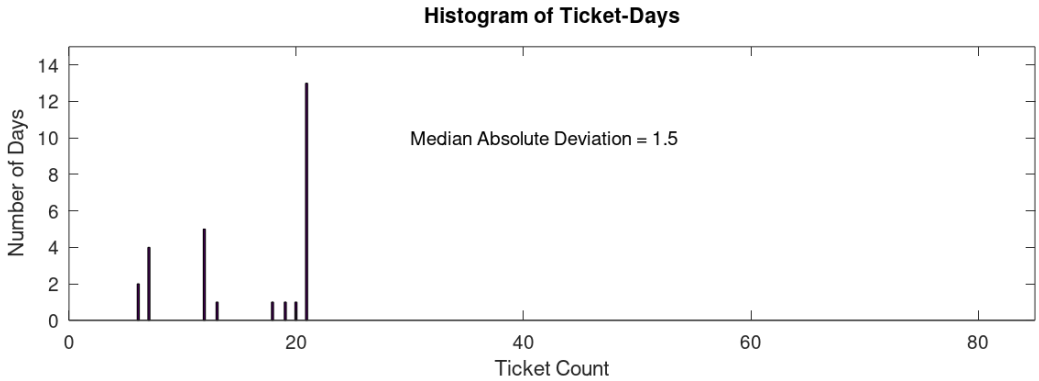
Workload graph of ticket volatility and distribution if all excavators requested a legal start date eight days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 2.5.



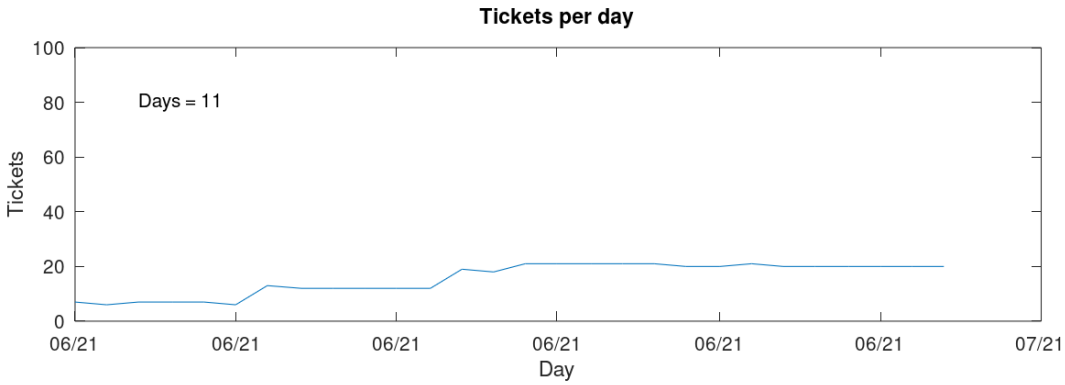


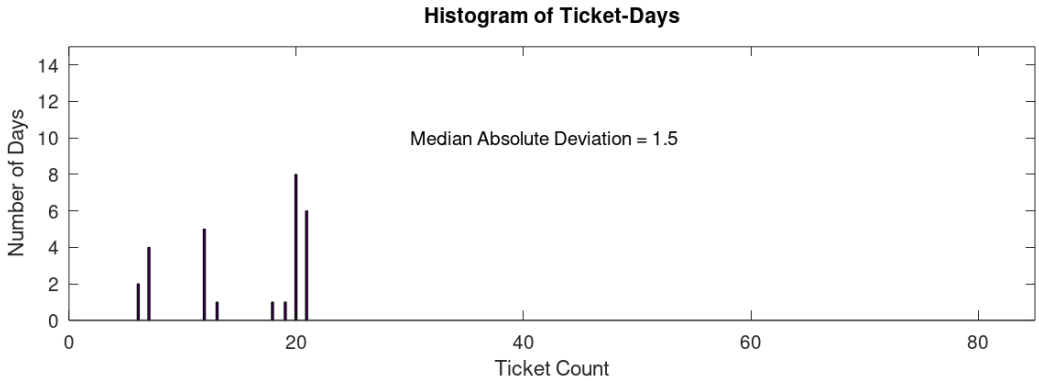
Workload graph of ticket volatility and distribution if all excavators requested a legal start date nine days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 2.



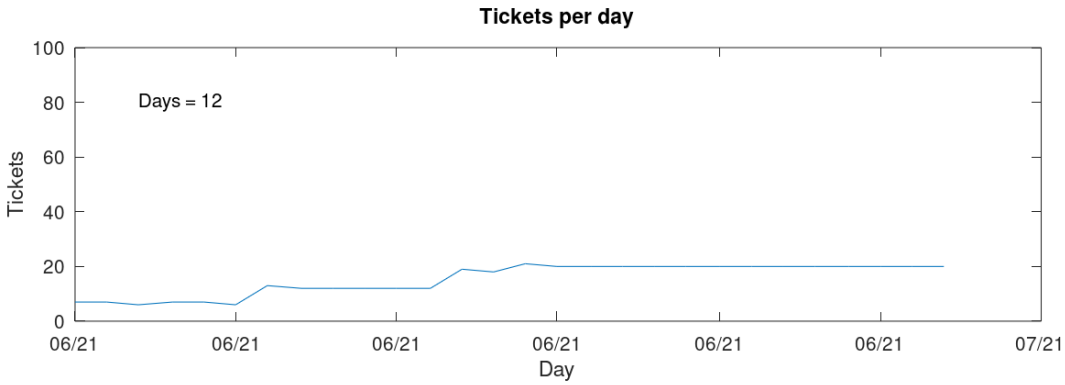


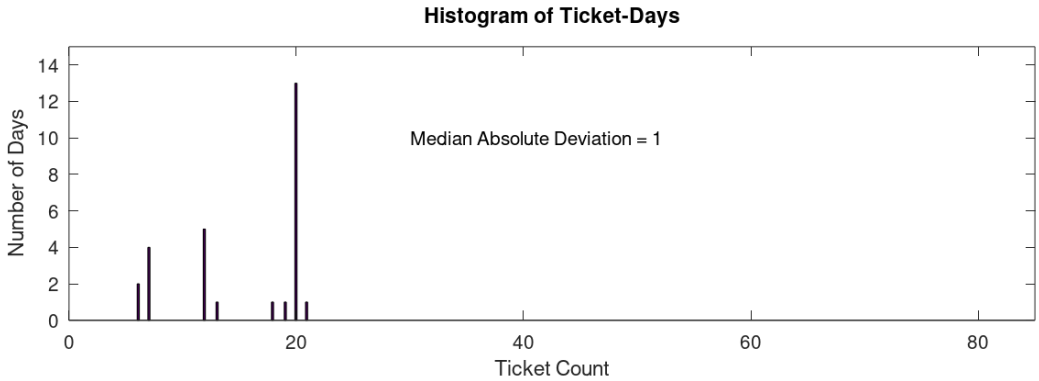
Workload graph of ticket volatility and distribution if all excavators requested a legal start date ten days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 1.5.



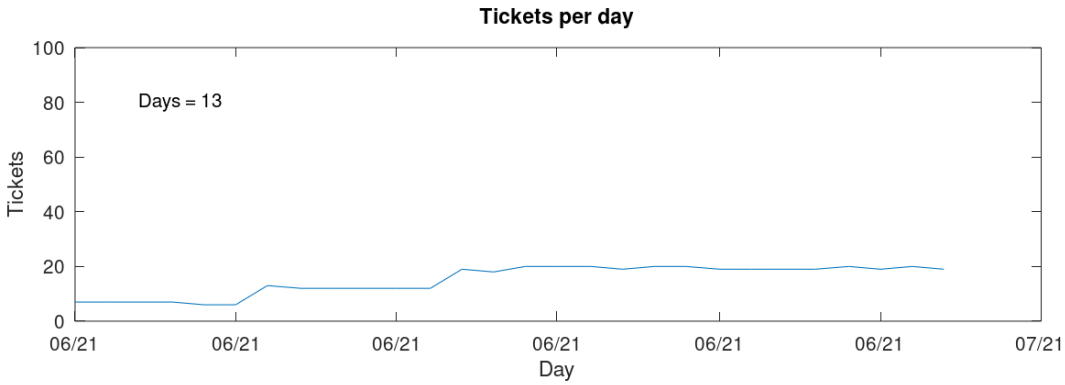


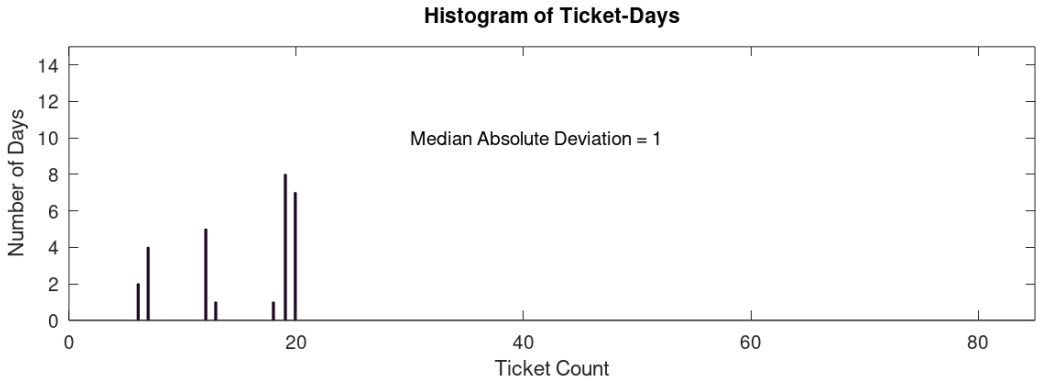
Workload graph of ticket volatility and distribution if all excavators requested a legal start date eleven days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 1.5.



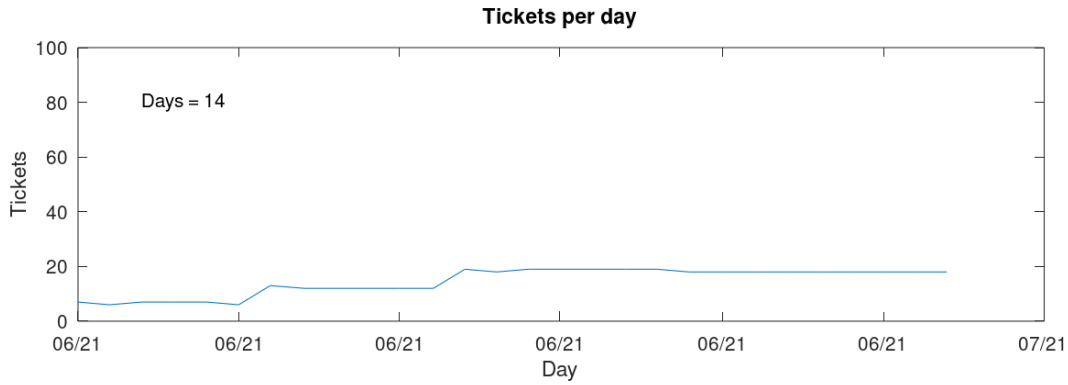


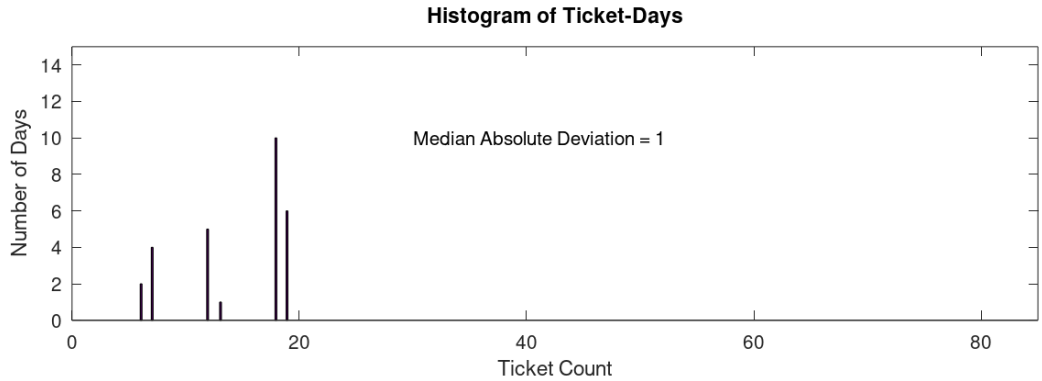
Workload graph of ticket volatility and distribution if all excavators requested a legal start date twelve days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 1.



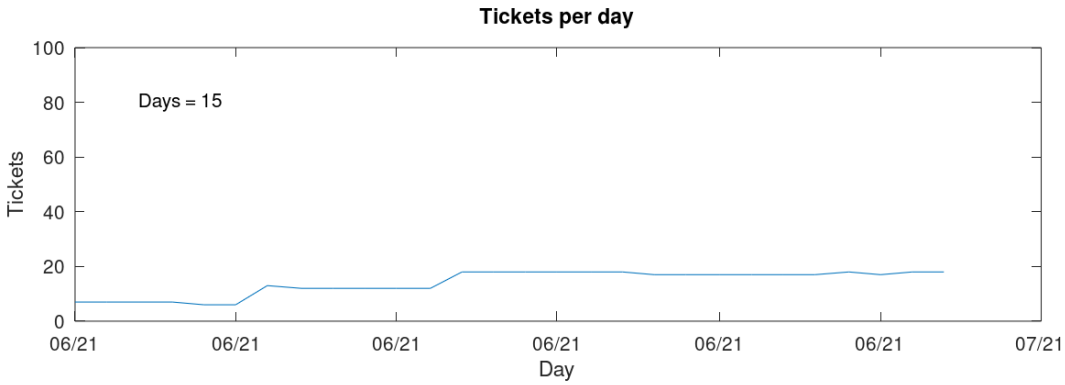


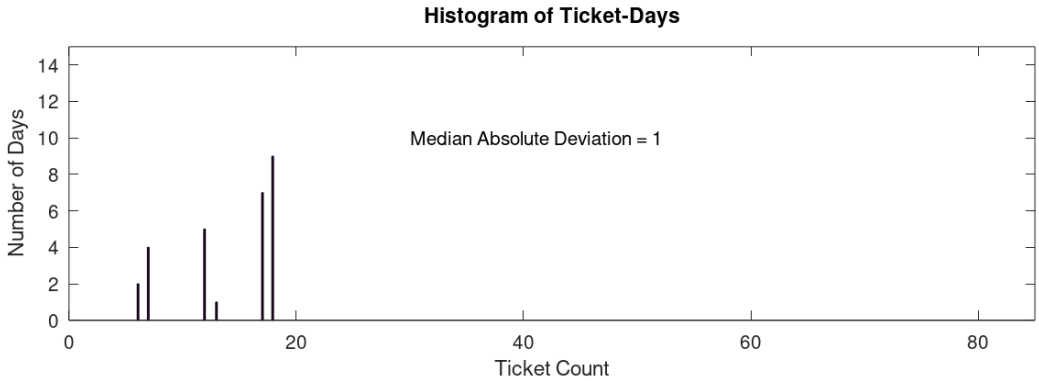
Workload graph of ticket volatility and distribution if all excavators requested a legal start date thirteen days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 1.



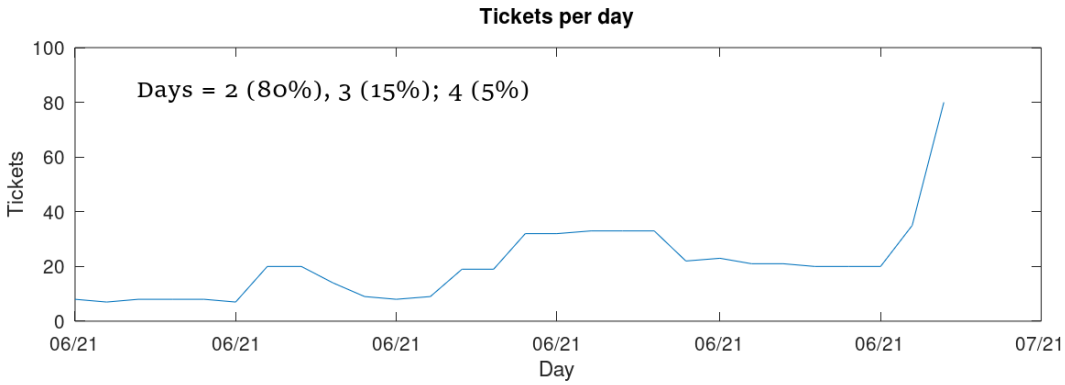


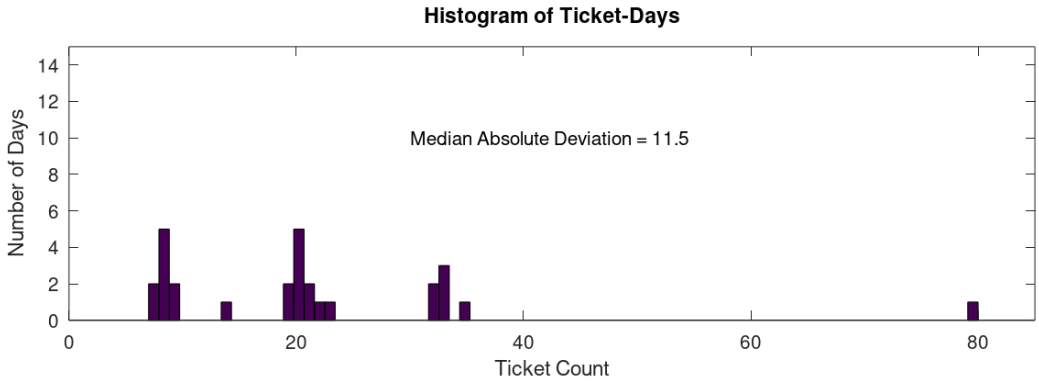
Workload graph of ticket volatility and distribution if all excavators requested a legal start date fourteen days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 1.



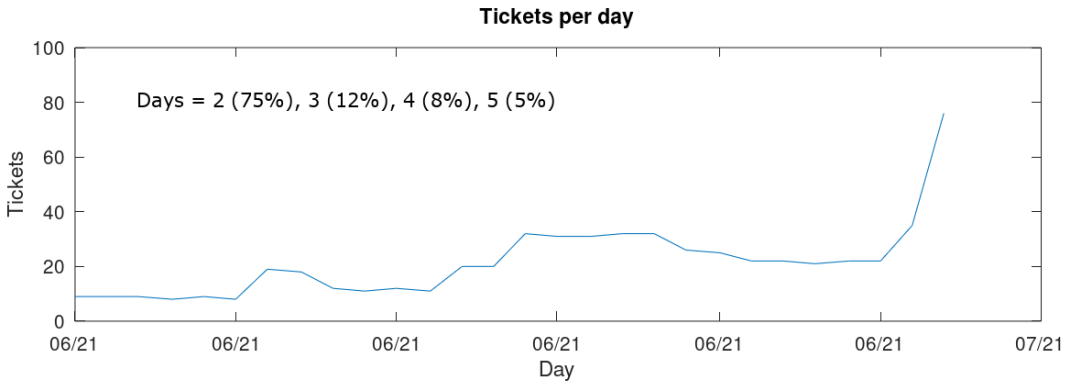


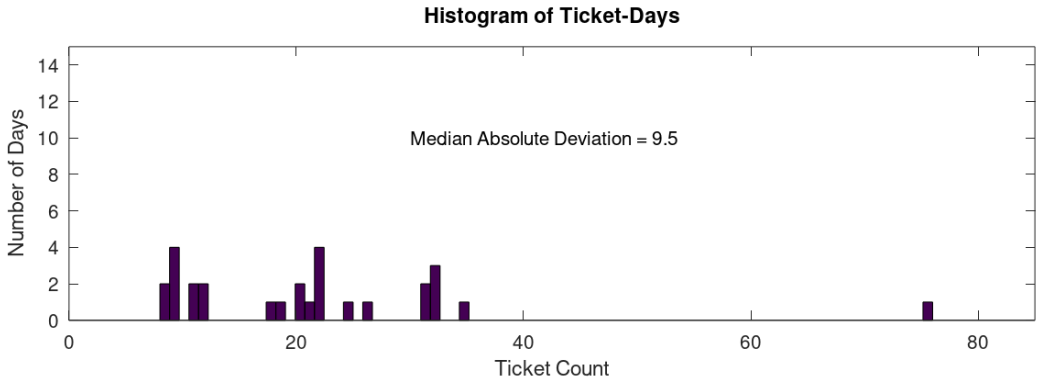
Workload graph of ticket volatility and distribution if all excavators requested a legal start date fifteen days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 1.



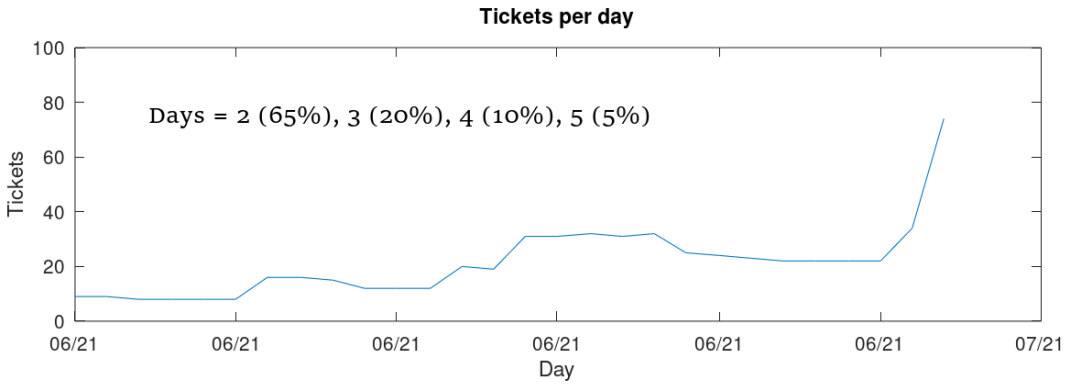


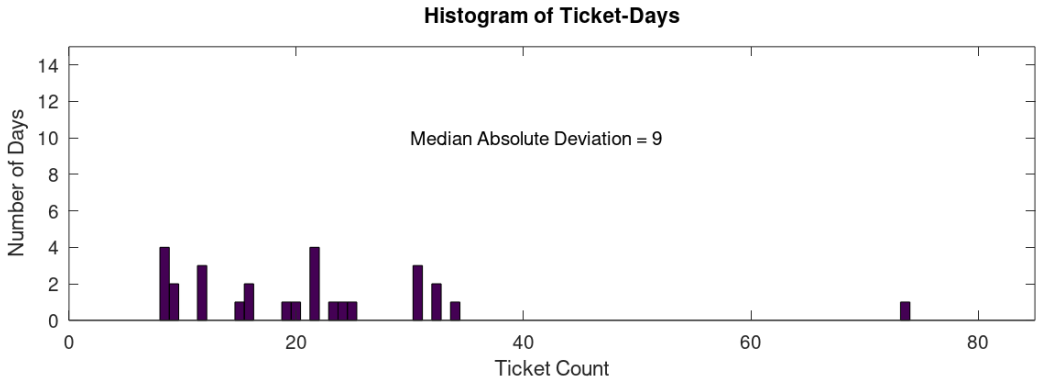
Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (80%), 3 (15%), and 4 (5%) days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 11.5.



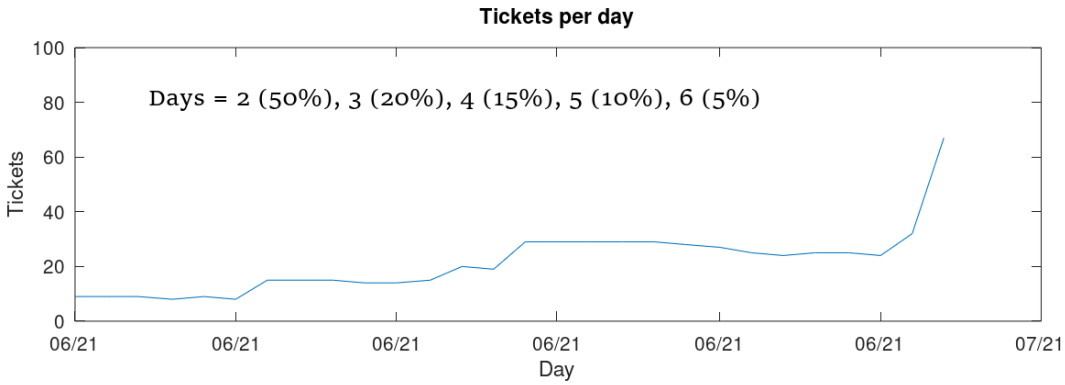


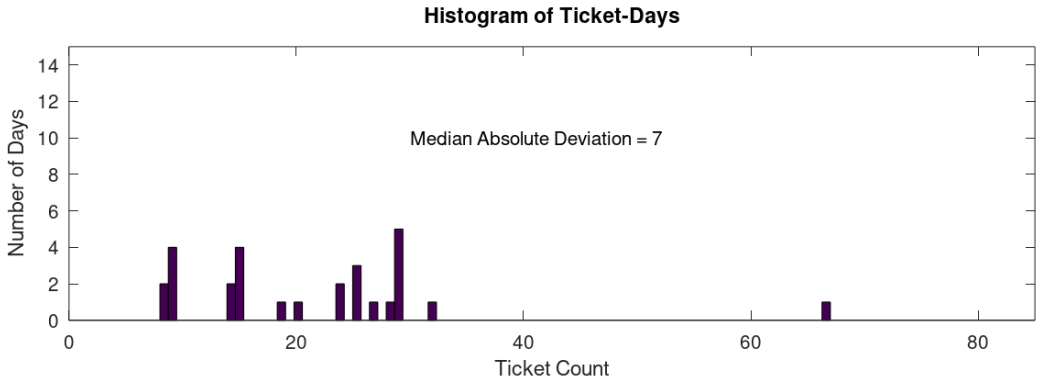
Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (75%), 3 (12%), 4 (8%), and 5 (5%) days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 9.5.



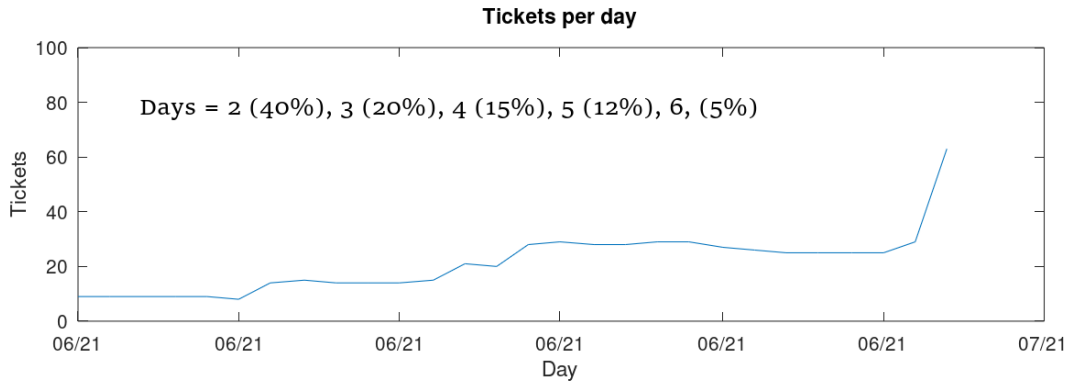


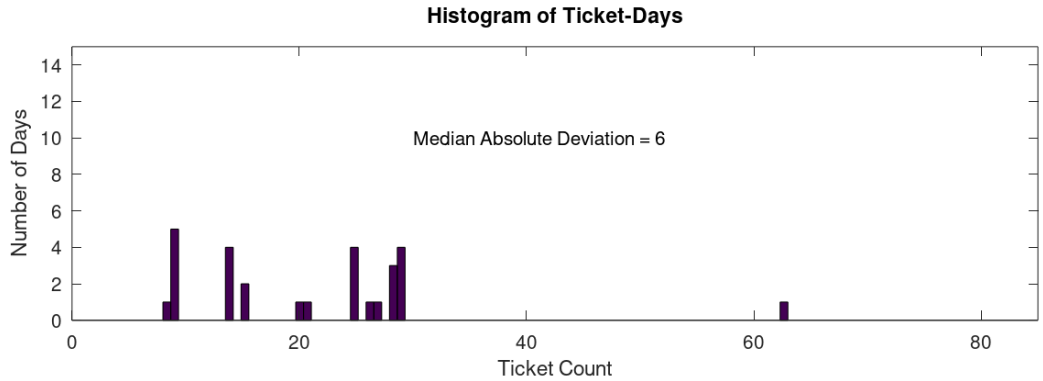
Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (65%), 3 (20%), 4 (10%), and 5 (5%) days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 9.





Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (50%), 3 (20%), 4 (15%), 5 (10%), and 6 (5%) days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 7.





Workload graph of ticket volatility and distribution if all excavators requested a legal start date 2 (40%), 3 (20%), 4 (15%), 5 (12%), and 6 (5%) days after notification. From Calaveras County Water District data for new tickets for June 2021. The median absolute deviation is 6.

Calaveras County Water District
June 2021 New Tickets

Date	Octave Date	New Tickets
6/1/2021	738308	2
6/2/2021	738309	10
6/3/2021	738310	8
6/4/2021	738311	14
6/5/2021	738312	3
6/6/2021	738313	1
6/7/2021	738314	3
6/8/2021	738315	49
6/9/2021	738316	7
6/10/2021	738317	10
6/11/2021	738318	5
6/12/2021	738319	1
6/13/2021	738320	1
6/14/2021	738321	20
6/15/2021	738322	17
6/16/2021	738323	38
6/17/2021	738324	124
6/18/2021	738325	14
6/19/2021	738326	1
6/20/2021	738327	1
6/21/2021	738328	33
6/22/2021	738329	15
6/23/2021	738330	7
6/24/2021	738331	42
6/25/2021	738332	20
6/26/2021	738333	6
6/27/2021	738334	
6/28/2021	738335	36
6/29/2021	738336	168
6/30/2021	738337	71

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2019 Tickets

Date	Octave Date	Tickets
1-Jan-19	737426	149
2-Jan-19	737426	3285
3-Jan-19	737426	3198
4-Jan-19	737426	3243
5-Jan-19	737426	69
6-Jan-19	737426	22
7-Jan-19	737426	4183
8-Jan-19	737426	3235
9-Jan-19	737426	3331
10-Jan-19	737426	3374
11-Jan-19	737426	2678
12-Jan-19	737426	77
13-Jan-19	737426	50
14-Jan-19	737426	3346
15-Jan-19	737426	2106
16-Jan-19	737426	2352
17-Jan-19	737426	2004
18-Jan-19	737426	2947
19-Jan-19	737426	84
20-Jan-19	737426	8
21-Jan-19	737426	805
22-Jan-19	737426	3977
23-Jan-19	737426	3187
24-Jan-19	737426	3477
25-Jan-19	737426	2569
26-Jan-19	737426	51
27-Jan-19	737426	37
28-Jan-19	737426	3499
29-Jan-19	737426	3022
30-Jan-19	737426	3259
31-Jan-19	737426	2862
1-Feb-19	737426	2530
2-Feb-19	737426	27
3-Feb-19	737426	28
4-Feb-19	737426	3379
5-Feb-19	737426	3070
6-Feb-19	737426	3787
7-Feb-19	737426	3198
8-Feb-19	737426	2853
9-Feb-19	737426	120
10-Feb-19	737426	42
11-Feb-19	737426	3545
12-Feb-19	737426	2738
13-Feb-19	737426	2774
14-Feb-19	737426	1832
15-Feb-19	737426	2568
16-Feb-19	737426	64
17-Feb-19	737426	131
18-Feb-19	737426	1219
19-Feb-19	737426	4578
20-Feb-19	737426	3367
21-Feb-19	737426	2985
22-Feb-19	737426	2849
23-Feb-19	737426	116
24-Feb-19	737426	39
25-Feb-19	737426	4088
26-Feb-19	737426	3346
27-Feb-19	737426	3203
28-Feb-19	737426	3195
1-Mar-19	737426	3120
2-Mar-19	737426	54
3-Mar-19	737426	104
4-Mar-19	737426	4396
5-Mar-19	737426	3566
6-Mar-19	737426	3102
7-Mar-19	737426	2985
8-Mar-19	737426	2694
9-Mar-19	737426	31
10-Mar-19	737426	266
11-Mar-19	737426	3969
12-Mar-19	737426	3443
13-Mar-19	737426	3583
14-Mar-19	737426	2985
15-Mar-19	737426	2604
16-Mar-19	737426	43
17-Mar-19	737426	38

DigAlert
2020 Tickets

Date	Octave Date	Tickets
1-Jan-20	737791	108
2-Jan-20	737791	3465
3-Jan-20	737791	2914
4-Jan-20	737791	162
5-Jan-20	737791	75
6-Jan-20	737791	4500
7-Jan-20	737791	3523
8-Jan-20	737791	3756
9-Jan-20	737791	3298
10-Jan-20	737791	2909
11-Jan-20	737791	139
12-Jan-20	737791	83
13-Jan-20	737791	3760
14-Jan-20	737791	3017
15-Jan-20	737791	3267
16-Jan-20	737791	2947
17-Jan-20	737791	2881
18-Jan-20	737791	158
19-Jan-20	737791	70
20-Jan-20	737791	1566
21-Jan-20	737791	4318
22-Jan-20	737791	3272
23-Jan-20	737791	4081
24-Jan-20	737791	3156
25-Jan-20	737791	125
26-Jan-20	737791	119
27-Jan-20	737791	3708
28-Jan-20	737791	3355
29-Jan-20	737791	3530
30-Jan-20	737791	2961
31-Jan-20	737791	2723
1-Feb-20	737791	171
2-Feb-20	737791	144
3-Feb-20	737791	4013
4-Feb-20	737791	3422
5-Feb-20	737791	3645
6-Feb-20	737791	3480
7-Feb-20	737791	2565
8-Feb-20	737791	102
9-Feb-20	737791	115
10-Feb-20	737791	4224
11-Feb-20	737791	3140
12-Feb-20	737791	3955
13-Feb-20	737791	3711
14-Feb-20	737791	2811
15-Feb-20	737791	102
16-Feb-20	737791	92
17-Feb-20	737791	1171
18-Feb-20	737791	5371
19-Feb-20	737791	3892
20-Feb-20	737791	3341
21-Feb-20	737791	3601
22-Feb-20	737791	385
23-Feb-20	737791	67
24-Feb-20	737791	3834
25-Feb-20	737791	3517
26-Feb-20	737791	3496
27-Feb-20	737791	3075
28-Feb-20	737791	2980
29-Feb-20	737791	97
1-Mar-20	737791	94
2-Mar-20	737791	4198
3-Mar-20	737791	3878
4-Mar-20	737791	3755
5-Mar-20	737791	2921
6-Mar-20	737791	2522
7-Mar-20	737791	162
8-Mar-20	737791	104
9-Mar-20	737791	3602
10-Mar-20	737791	2920
11-Mar-20	737791	3368
12-Mar-20	737791	3027
13-Mar-20	737791	2703
14-Mar-20	737791	108
15-Mar-20	737791	104
16-Mar-20	737791	3841

DigAlert
2021 Tickets

Date	Octave Date	Tickets
1-Jan-21	738157	99
2-Jan-21	738157	100
3-Jan-21	738157	155
4-Jan-21	738157	4667
5-Jan-21	738157	4019
6-Jan-21	738157	3167
7-Jan-21	738157	2892
8-Jan-21	738157	2887
9-Jan-21	738157	139
10-Jan-21	738157	384
11-Jan-21	738157	4082
12-Jan-21	738157	3762
13-Jan-21	738157	3089
14-Jan-21	738157	3626
15-Jan-21	738157	3005
16-Jan-21	738157	100
17-Jan-21	738157	75
18-Jan-21	738157	1930
19-Jan-21	738157	4175
20-Jan-21	738157	3431
21-Jan-21	738157	2799
22-Jan-21	738157	2622
23-Jan-21	738157	118
24-Jan-21	738157	110
25-Jan-21	738157	3636
26-Jan-21	738157	2993
27-Jan-21	738157	3204
28-Jan-21	738157	2759
29-Jan-21	738157	2104
30-Jan-21	738157	192
31-Jan-21	738157	247
1-Feb-21	738157	4270
2-Feb-21	738157	3928
3-Feb-21	738157	3187
4-Feb-21	738157	3340
5-Feb-21	738157	2731
6-Feb-21	738157	151
7-Feb-21	738157	131
8-Feb-21	738157	4558
9-Feb-21	738157	3213
10-Feb-21	738157	4160
11-Feb-21	738157	3451
12-Feb-21	738157	2709
13-Feb-21	738157	161
14-Feb-21	738157	68
15-Feb-21	738157	1895
16-Feb-21	738157	4614
17-Feb-21	738157	3530
18-Feb-21	738157	3188
19-Feb-21	738157	2996
20-Feb-21	738157	200
21-Feb-21	738157	158
22-Feb-21	738157	4453
23-Feb-21	738157	3686
24-Feb-21	738157	3619
25-Feb-21	738157	2768
26-Feb-21	738157	3234
27-Feb-21	738157	178
28-Feb-21	738157	133
1-Mar-21	738157	4905
2-Mar-21	738157	3908
3-Mar-21	738157	3449
4-Mar-21	738157	3078
5-Mar-21	738157	2714
6-Mar-21	738157	170
7-Mar-21	738157	140
8-Mar-21	738157	4213
9-Mar-21	738157	4105
10-Mar-21	738157	3983
11-Mar-21	738157	2798
12-Mar-21	738157	3259
13-Mar-21	738157	108
14-Mar-21	738157	66
15-Mar-21	738157	3572
16-Mar-21	738157	4204
17-Mar-21	738157	3263

USA North 811
Excavators with 30 or more tickets, June 2021

Rank	Name	Total Tickets
1	OSMOSE UTILITIES SERVICES INC.	8,093
2	OSMOSE UTILITIES SERVICES INC.	4,590
3	OSMOSE UTILITIES SERVICES INC.	4,572
4	OSMOSE UTILITIES SERVICES INC.	4,306
5	OSMOSE UTILITIES SERVICES INC.	3,915
6	OSMOSE UTILITIES SERVICES INC.	3,424
7	OSMOSE UTILITIES SERVICES INC.	2,866
8	OSMOSE UTILITIES SERVICES INC.	1,940
9	OSMOSE UTILITIES SERVICES INC.	1,669
10	OSMOSE UTILITIES SERVICES INC.	1,580
11	DAVEY SURGERY CO.	1,326
12	VULCAN CONSTRUCTION MPP	1,313
13	OSMOSE UTILITIES SERVICES INC.	1,300
14	OSMOSE UTILITIES SERVICES INC.	1,240
15	OSMOSE UTILITIES SERVICES INC.	1,190
16	EDT TEC	1,164
17	PSP	996
18	OSMOSE UTILITIES SERVICES INC.	927
19	VPI CHARGE	864
20	KS INDUSTRIES, LP	809
21	FERREIRA POWER WEST	804
22	WESTERN STATES CONTRACTING	798
23	OSMOSE UTILITIES SERVICES INC.	798
24	OSMOSE UTILITIES SERVICES INC.	779
25	OSMOSE UTILITIES SERVICES INC.	768
26	OSMOSE UTILITIES SERVICES INC.	714
27	HOTLINE CONSTRUCTION INC	706
28	ERGEON	663
29	OSMOSE UTILITIES SERVICES INC.	663
30	OUTSOURCE UTILITY CONTRACTOR CORP	640
31	DAVEY TREE SURGERY CO.	614
32	ROKSTAD POWER	583
33	OSMOSE UTILITIES SERVICES INC.	582
34	FARWEST SAFETY	568
35	PRESTON PIPELINES	529
36	INTREN	509
37	OSMOSE UTILITIES SERVICES INC.	502
38	ITG	502
39	LASAR UNDERGROUND	489
40	OSMOSE UTILITIES SERVICES INC.	478
41	BROWNING CONTRACTORS INC	470
42	GTO	464
43	RANCHO TREE SERVICE	445
44	DAVEY RESOURCE GROUP	430
45	ARCADIS	415
46	KROEKER INC	410
47	OSMOSE UTILITIES SERVICES INC.	406
48	ROKSTAD POWER	404
49	INTREN	381
50	ALPHA LANDSCAPES, LLC	373
51	ROKSTAD POWER	354
52	MGE UNDERGROUND	344
53	OUTBACK CONTRACTORS INC	338
54	INTREN	334
55	ARROW CONSTRUCTION	332
56	BADGER DAYLIGHTING	330
57	OSMOSE UTILITIES SERVICES INC.	328
58	SUNRUN	324
59	FERREIRA POWER WEST	320
60	REMEDIAL TRANSPORTATION SERVICES	316
61	ARCADIS	313
62	WEST VALLEY CONSTRUCTION COMPANY	298
63	AMERICAN UNDERGROUND CONTRACTOR	278
64	BRAVO UNDERGROUND, INC.	273
65	ANVIL BUILDERS INC	271
66	PG&E	268
67	HIRSCHI MASONRY	267
68	MGE UNDERGROUND	266
69	LAS VEGAS PAVING CORPORATION	263
70	NORTHERN PIPELINE	255
71	SUMMIT LINE CONSTRUCTION	252
72	LEWIS & TIBBITTS	249
73	LAS VEGAS VALLEY WATER DISTRICT	241
74	ENERGY DELIVERY PARTNERS INC.	240
75	VANGUARD CONSTRUCTION	240
76	ACCURATE SAWCUTTING	237

Calaveras County Water District
Total USA North 811 Tickets by month, July 2020 to September 2021

Month	Total Tickets
Jul-20	574
Aug-20	296
Sep-20	289
Oct-20	319
Nov-20	216
Dec-20	223
Jan-21	266
Feb-21	186
Mar-21	283
Apr-21	1873
May-21	3379
Jun-21	4536
Jul-21	4041
Aug-21	3183
Sep-21	1243

18-Mar-19	737426	3715
19-Mar-19	737426	2956
20-Mar-19	737426	3443
21-Mar-19	737426	3121
22-Mar-19	737426	3252
23-Mar-19	737426	17
24-Mar-19	737426	94
25-Mar-19	737426	4810
26-Mar-19	737426	3423
27-Mar-19	737426	3515
28-Mar-19	737426	3533
29-Mar-19	737426	2742
30-Mar-19	737426	8
31-Mar-19	737426	55
1-Apr-19	737426	4161
2-Apr-19	737426	3982
3-Apr-19	737426	3410
4-Apr-19	737426	3132
5-Apr-19	737426	2982
6-Apr-19	737426	114
7-Apr-19	737426	91
8-Apr-19	737426	3988
9-Apr-19	737426	3351
10-Apr-19	737426	3267
11-Apr-19	737426	3409
12-Apr-19	737426	3028
13-Apr-19	737426	31
14-Apr-19	737426	38
15-Apr-19	737426	4327
16-Apr-19	737426	3601
17-Apr-19	737426	3876
18-Apr-19	737426	3067
19-Apr-19	737426	2471
20-Apr-19	737426	22
21-Apr-19	737426	14
22-Apr-19	737426	4001
23-Apr-19	737426	3255
24-Apr-19	737426	3825
25-Apr-19	737426	2906
26-Apr-19	737426	2799
27-Apr-19	737426	180
28-Apr-19	737426	32
29-Apr-19	737426	4379
30-Apr-19	737426	3546
1-May-19	737426	3719
2-May-19	737426	3082
3-May-19	737426	2816
4-May-19	737426	96
5-May-19	737426	58
6-May-19	737426	3720
7-May-19	737426	3178
8-May-19	737426	3383
9-May-19	737426	3001
10-May-19	737426	2853
11-May-19	737426	88
12-May-19	737426	241
13-May-19	737426	4509
14-May-19	737426	3248
15-May-19	737426	3701
16-May-19	737426	2682
17-May-19	737426	2777
18-May-19	737426	277
19-May-19	737426	46
20-May-19	737426	4054
21-May-19	737426	3119
22-May-19	737426	3108
23-May-19	737426	2939
24-May-19	737426	3071
25-May-19	737426	71
26-May-19	737426	58
27-May-19	737426	262
28-May-19	737426	4760
29-May-19	737426	3863
30-May-19	737426	3420
31-May-19	737426	3182
1-Jun-19	737426	94
2-Jun-19	737426	283
3-Jun-19	737426	4287
4-Jun-19	737426	3535
5-Jun-19	737426	3363

17-Mar-20	737791	3648
18-Mar-20	737791	2654
19-Mar-20	737791	2533
20-Mar-20	737791	2379
21-Mar-20	737791	99
22-Mar-20	737791	95
23-Mar-20	737791	3365
24-Mar-20	737791	3006
25-Mar-20	737791	3403
26-Mar-20	737791	3189
27-Mar-20	737791	2325
28-Mar-20	737791	126
29-Mar-20	737791	61
30-Mar-20	737791	3519
31-Mar-20	737791	2700
1-Apr-20	737791	2679
2-Apr-20	737791	2920
3-Apr-20	737791	2696
4-Apr-20	737791	157
5-Apr-20	737791	92
6-Apr-20	737791	3512
7-Apr-20	737791	2439
8-Apr-20	737791	3274
9-Apr-20	737791	2647
10-Apr-20	737791	1810
11-Apr-20	737791	162
12-Apr-20	737791	122
13-Apr-20	737791	4101
14-Apr-20	737791	3118
15-Apr-20	737791	3417
16-Apr-20	737791	3429
17-Apr-20	737791	2758
18-Apr-20	737791	257
19-Apr-20	737791	123
20-Apr-20	737791	3697
21-Apr-20	737791	3488
22-Apr-20	737791	3406
23-Apr-20	737791	3127
24-Apr-20	737791	2317
25-Apr-20	737791	130
26-Apr-20	737791	89
27-Apr-20	737791	3910
28-Apr-20	737791	3172
29-Apr-20	737791	3529
30-Apr-20	737791	3644
1-May-20	737791	2823
2-May-20	737791	104
3-May-20	737791	189
4-May-20	737791	3867
5-May-20	737791	3682
6-May-20	737791	3789
7-May-20	737791	2959
8-May-20	737791	2929
9-May-20	737791	340
10-May-20	737791	96
11-May-20	737791	4013
12-May-20	737791	3171
13-May-20	737791	3094
14-May-20	737791	3477
15-May-20	737791	2552
16-May-20	737791	122
17-May-20	737791	146
18-May-20	737791	3854
19-May-20	737791	2975
20-May-20	737791	3412
21-May-20	737791	3404
22-May-20	737791	3209
23-May-20	737791	149
24-May-20	737791	50
25-May-20	737791	506
26-May-20	737791	3569
27-May-20	737791	3802
28-May-20	737791	3622
29-May-20	737791	2987
30-May-20	737791	164
31-May-20	737791	70
1-Jun-20	737791	4404
2-Jun-20	737791	3511
3-Jun-20	737791	3577
4-Jun-20	737791	2935

18-Mar-21	738157	3017
19-Mar-21	738157	2624
20-Mar-21	738157	109
21-Mar-21	738157	111
22-Mar-21	738157	5224
23-Mar-21	738157	4095
24-Mar-21	738157	3293
25-Mar-21	738157	3098
26-Mar-21	738157	3097
27-Mar-21	738157	120
28-Mar-21	738157	53
29-Mar-21	738157	4296
30-Mar-21	738157	3247
31-Mar-21	738157	4404
1-Apr-21	738157	3704
2-Apr-21	738157	2433
3-Apr-21	738157	69
4-Apr-21	738157	36
5-Apr-21	738157	5163
6-Apr-21	738157	3901
7-Apr-21	738157	3579
8-Apr-21	738157	3633
9-Apr-21	738157	3199
10-Apr-21	738157	176
11-Apr-21	738157	73
12-Apr-21	738157	4327
13-Apr-21	738157	3654
14-Apr-21	738157	4124
15-Apr-21	738157	3308
16-Apr-21	738157	2597
17-Apr-21	738157	406
18-Apr-21	738157	102
19-Apr-21	738157	4292
20-Apr-21	738157	3905
21-Apr-21	738157	3480
22-Apr-21	738157	3512
23-Apr-21	738157	3899
24-Apr-21	738157	184
25-Apr-21	738157	57
26-Apr-21	738157	5077
27-Apr-21	738157	3341
28-Apr-21	738157	3309
29-Apr-21	738157	3624
30-Apr-21	738157	2446
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2-May-21	738157	537
3-May-21	738157	4453
4-May-21	738157	3700
5-May-21	738157	4070
6-May-21	738157	3610
7-May-21	738157	2562
8-May-21	738157	221
9-May-21	738157	52
10-May-21	738157	4434
11-May-21	738157	3797
12-May-21	738157	4002
13-May-21	738157	3646
14-May-21	738157	3567
15-May-21	738157	157
16-May-21	738157	90
17-May-21	738157	5597
18-May-21	738157	3957
19-May-21	738157	4126
20-May-21	738157	3221
21-May-21	738157	3131
22-May-21	738157	108
23-May-21	738157	92
24-May-21	738157	4407
25-May-21	738157	3649
26-May-21	738157	4305
27-May-21	738157	3879
28-May-21	738157	3288
29-May-21	738157	87
30-May-21	738157	113
31-May-21	738157	355
1-Jun-21	738157	4138
2-Jun-21	738157	4400
3-Jun-21	738157	3602
4-Jun-21	738157	2865
5-Jun-21	738157	130

77	UNIFIED FIELD SERVICES CORP	236
78	Q&D CONSTRUCTION	235
79	MISSION CONSTRUCTORS	234
80	CABLECOM	233
81	OSMOSE UTILITIES SERVICES INC.	231
82	DISCOVERY HYDROVAC LLC	224
83	SIERRA NEVADA CONSTRUCTION	223
84	CEDAR CREEK CORPORATION	221
85	WEST VALLEY CONSTRUCTION COMPANY	221
86	R P WEDDELL & SONS CO	219
87	SPENCON	218
88	WEST VALLEY CONSTRUCTION COMPANY	210
89	DESILVA GATES CONSTRUCTION	206
90	LIFESCAPING OUTDOORS	202
91	OSMOSE UTILITIES SERVICES INC.	200
92	DISCOVERY HYDROVAC	199
93	CONCRETE DEMO WORKS	198
94	JERRY'S TRENCHING	195
95	UTILITY CONSTRUCTION SERVICES	194
96	MILLER PIPELINE	193
97	IRISH CONSTRUCTION	191
98	NORCAL PIPELINE SERVICES	190
99	LEO TIDWELL EXCAVATING	190
100	PHOENIX ELECTRIC COMPANY	185
101	MGE UNDERGROUND	184
102	ACCURATE TRENCHING	184
103	ARROW CONSTRUCTION	184
104	INTREN	184
105	HARDIMAN CONSTRUCTION	183
106	CITY OF PALO ALTO	183
107	TAK COMMUNICATION	182
108	EAST BAY MUNICIPAL UTILITIES DISTRICT	182
109	WEST VALLEY CONSTRUCTION COMPANY	181
110	HOT LINE CONSTRUCTION INC	181
111	JJR CONSTRUCTION, INC.	178
112	WEST VALLEY CONSTRUCTION COMPANY	178
113	MCGUIRE AND HESTER	177
114	PACIFIC EXCAVATION INC	177
115	MEZAS FENCE	176
116	BRAVO UNDERGROUND, INC.	174
117	MAMMOTH UNDERGROUND, LLC	171
118	SILVER LAKE COSTRUCTION	171
119	ARIZONA PIPELINE	170
120	MICHELS PACIFIC ENERGY	165
121	DESERT CONCRETE	164
122	MCK SERVICES	163
123	PRECISION DIRECTIONAL BORING	162
124	WEST VALLEY CONSTRUCTION COMPANY	161
125	CRATUS INC	154
126	MGE UNDERGROUND	154
127	MGE UNDERGROUND	153
128	SUPERIOR FENCE	152
129	ARGONAUT CONSTRUCTORS	152
130	FORO ENERGY	151
131	ROKSTAD POWER	151
132	OSMOSE UTILITIES SERVICES	150
133	EAST BAY MUNICIPAL UTILITIES DISTRICT	149
134	WEST VALLEY CONSTRUCTION COMPANY	149
135	PG&E	148
136	A AND J FENCING	147
137	CHRISP COMPANY	147
138	UNDERGROUND ELECTRIC CONSTRUCTION COMPAN	146
139	OSMOSE UTILITIES SERVICES INC.	145
140	W.K. MCLELLAN	145
141	SECURITY PAVING	143
142	MGE UNDERGROUND	141
143	SAN JOSE WATER COMPANY	141
144	MGE UNDERGROUND	140
145	WEST VALLEY CONSTRUCTION COMPANY	140
146	CAL WEST CONCRETE CUTTING INCORPORATED	138
147	GOLDEN BAY CONSTRUCTION	138
148	GOLDEN STATE UTILITY CO.	137
149	ARCADIS	136
150	NOR CAL PIPELINE SERVICES	136
151	WK MCLELLAN	135
152	PLANNED ENVIRONMENTS INC	135
153	PG&E	134
154	SJL CONSTRUCTION INC.	134
155	MOON VALLEY NURSERY	133
156	INTREN	133

6-Jun-19	737426	3192
7-Jun-19	737426	2943
8-Jun-19	737426	146
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12-Jun-19	737426	3298
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17-Jun-19	737426	4092
18-Jun-19	737426	3303
19-Jun-19	737426	3207
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21-Jun-19	737426	2587
22-Jun-19	737426	87
23-Jun-19	737426	99
24-Jun-19	737426	4246
25-Jun-19	737426	3612
26-Jun-19	737426	3216
27-Jun-19	737426	3310
28-Jun-19	737426	2641
29-Jun-19	737426	168
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1-Jul-19	737426	3814
2-Jul-19	737426	3457
3-Jul-19	737426	3563
4-Jul-19	737426	55
5-Jul-19	737426	1748
6-Jul-19	737426	60
7-Jul-19	737426	48
8-Jul-19	737426	4209
9-Jul-19	737426	3904
10-Jul-19	737426	3415
11-Jul-19	737426	2915
12-Jul-19	737426	2697
13-Jul-19	737426	87
14-Jul-19	737426	126
15-Jul-19	737426	3983
16-Jul-19	737426	3409
17-Jul-19	737426	4003
18-Jul-19	737426	3995
19-Jul-19	737426	2907
20-Jul-19	737426	128
21-Jul-19	737426	141
22-Jul-19	737426	3892
23-Jul-19	737426	3663
24-Jul-19	737426	3613
25-Jul-19	737426	3148
26-Jul-19	737426	2788
27-Jul-19	737426	143
28-Jul-19	737426	65
29-Jul-19	737426	4213
30-Jul-19	737426	3243
31-Jul-19	737426	2888
1-Aug-19	737426	2903
2-Aug-19	737426	2679
3-Aug-19	737426	187
4-Aug-19	737426	109
5-Aug-19	737426	4363
6-Aug-19	737426	3313
7-Aug-19	737426	3479
8-Aug-19	737426	3204
9-Aug-19	737426	2567
10-Aug-19	737426	106
11-Aug-19	737426	70
12-Aug-19	737426	4241
13-Aug-19	737426	3233
14-Aug-19	737426	3693
15-Aug-19	737426	3721
16-Aug-19	737426	2618
17-Aug-19	737426	177
18-Aug-19	737426	131
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20-Aug-19	737426	3534
21-Aug-19	737426	3944
22-Aug-19	737426	3674
23-Aug-19	737426	2751
24-Aug-19	737426	127

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12-Jun-20	737791	3067
13-Jun-20	737791	192
14-Jun-20	737791	117
15-Jun-20	737791	3895
16-Jun-20	737791	3963
17-Jun-20	737791	3736
18-Jun-20	737791	2943
19-Jun-20	737791	3453
20-Jun-20	737791	113
21-Jun-20	737791	84
22-Jun-20	737791	3854
23-Jun-20	737791	3874
24-Jun-20	737791	3811
25-Jun-20	737791	3770
26-Jun-20	737791	2996
27-Jun-20	737791	146
28-Jun-20	737791	82
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6-Jul-20	737791	4286
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8-Jul-20	737791	3674
9-Jul-20	737791	3704
10-Jul-20	737791	3147
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13-Jul-20	737791	4329
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15-Jul-20	737791	4007
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18-Jul-20	737791	202
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21-Jul-20	737791	4066
22-Jul-20	737791	3624
23-Jul-20	737791	3791
24-Jul-20	737791	2858
25-Jul-20	737791	182
26-Jul-20	737791	179
27-Jul-20	737791	4039
28-Jul-20	737791	3315
29-Jul-20	737791	3689
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31-Jul-20	737791	2881
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3-Aug-20	737791	4258
4-Aug-20	737791	3469
5-Aug-20	737791	3825
6-Aug-20	737791	3282
7-Aug-20	737791	4512
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9-Aug-20	737791	119
10-Aug-20	737791	4967
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12-Aug-20	737791	3902
13-Aug-20	737791	3343
14-Aug-20	737791	2371
15-Aug-20	737791	184
16-Aug-20	737791	172
17-Aug-20	737791	4645
18-Aug-20	737791	3692
19-Aug-20	737791	3777
20-Aug-20	737791	3834
21-Aug-20	737791	2650
22-Aug-20	737791	73
23-Aug-20	737791	93

6-Jun-21	738157	281
7-Jun-21	738157	4666
8-Jun-21	738157	3913
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16-Jun-21	738157	3567
17-Jun-21	738157	3633
18-Jun-21	738157	2316
19-Jun-21	738157	60
20-Jun-21	738157	71
21-Jun-21	738157	4102
22-Jun-21	738157	3791
23-Jun-21	738157	3676
24-Jun-21	738157	3245
25-Jun-21	738157	3673
26-Jun-21	738157	125
27-Jun-21	738157	102
28-Jun-21	738157	4195
29-Jun-21	738157	3816
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2-Jul-21	738157	3260
3-Jul-21	738157	82
4-Jul-21	738157	30
5-Jul-21	738157	366
6-Jul-21	738157	5118
7-Jul-21	738157	4325
8-Jul-21	738157	3593
9-Jul-21	738157	3595
10-Jul-21	738157	247
11-Jul-21	738157	80
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13-Jul-21	738157	3689
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17-Jul-21	738157	116
18-Jul-21	738157	125
19-Jul-21	738157	4782
20-Jul-21	738157	3924
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22-Jul-21	738157	3843
23-Jul-21	738157	2881
24-Jul-21	738157	146
25-Jul-21	738157	375
26-Jul-21	738157	4398
27-Jul-21	738157	4083
28-Jul-21	738157	3976
29-Jul-21	738157	3408
30-Jul-21	738157	3014
31-Jul-21	738157	75
1-Aug-21	738157	49
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3-Aug-21	738157	3502
4-Aug-21	738157	4175
5-Aug-21	738157	3826
6-Aug-21	738157	2951
7-Aug-21	738157	184
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11-Aug-21	738157	3972
12-Aug-21	738157	3185
13-Aug-21	738157	2965
14-Aug-21	738157	161
15-Aug-21	738157	99
16-Aug-21	738157	4178
17-Aug-21	738157	3752
18-Aug-21	738157	4596
19-Aug-21	738157	3824
20-Aug-21	738157	2782
21-Aug-21	738157	375
22-Aug-21	738157	67
23-Aug-21	738157	4663
24-Aug-21	738157	3600

157	MGE UNDERGROUND INC	133
158	TEICHERT ENERGY & UTILITIES GROUP, INC.	133
159	STATEWIDE TRAFFIC SAFETY & SIGNS	131
160	TAK COMMUNICATION	128
161	WILSON CONSTRUCTION	127
162	KLEVEN CONSTRUCTION	126
163	ACCURATE CORROSION CONTROL INC.	126
164	LTEC	125
165	FLOREZ PAVING	124
166	INTREN	124
167	MCH ELECTRIC	123
168	OILFIELD SAFETY ANCHOR SERVICE	122
169	BRAUN ELECTRIC	121
170	SUMMIT LINE CONSTRUCTION	121
171	CONCRETE VALUE COMPANY	121
172	J & M INCORPORATED	120
173	TODD COMPANIES	119
174	MCE CORPORATION	118
175	WELCO UNDERGROUND CONSTRUCTION, INC.	118
176	WEST VALLEY CONSTRUCTION COMPANY	118
177	BADGER DAYLIGHTING	118
178	PG&E	118
179	ARIZONA PIPELINE	117
180	ALB INC.	117
181	BESS TESTLAB	117
182	OGRADY PAVING	116
183	HENKELS & MCCOY, INC.	116
184	HARD DIG LLC	115
185	GRANITE CONSTRUCTION	115
186	CAL VALLEY CONSTRUCTION	114
187	JOHNSON CONSTRUCTION COMPANY	114
188	A1 ADVANTAGE ASPHALT	114
189	POMEGRANATE UNDERGROUND & CONSTRUCTION C	113
190	RESOURCE ENVIRONMENTAL INC	111
191	TEICHERT	110
192	CC UTILITY INC	110
193	MISSION CONSTRUCTORS	108
194	TEAM FISHEL	108
195	GHILOTTI CONSTRUCTION COMPANY	108
196	SUNSTATE COMPANIES	108
197	THE PAVER COMPANY	108
198	MOON VALLEY NURSERY EASTERN	108
199	CITY OF SAN JOSE	107
200	VPI CHARGE	106
201	DISCOUNT PLUMBING ROOTER, INC	106
202	UNDERGROUND ELECTRIC CONSTRUCTION	105
203	TEICHERT PIPELINES	104
204	JOHNSON ENGINEERING	104
205	SILLER CONSTRUCTION	104
206	LINDCO INC	103
207	PG&E	102
208	ARGONAUT CONSTRUCTORS	102
209	VERSAGRADE INC.	102
210	BRADLEY TANKS	101
211	PARMETER GENERAL ENGINEERS	101
212	HANFORD ARC	101
213	MOON VALLEY NURSERY	101
214	MUSE CONCRETE	100
215	GHILOTTI CONSTRUCTION COMPANY	100
216	WEST VALLEY CONSTRUCTION COMPANY	100
217	GOLDEN STATE UTILITY CO.	99
218	TEICHERT PIPELINES	99
219	DA GROUP	99
220	UNDERGROUND EXPRESS	99
221	TEICHERT CONSTRUCTION	98
222	CITY OF MODESTO	97
223	J. FLORES CONSTRUCTION COMPANY	97
224	SIERRA LUMBER & FENCE	96
225	BEYOND BROAD BANDS	96
226	HARC	96
227	INTEGRATED HOME SOLUTIONS	96
228	J. MORAGA CONSTRUCTION	96
229	ALBANESE CONCRETE CONSTRUCTION	96
230	GEORGE REED INC.	95
231	GTO	95
232	MP NEXLEVEL	94
233	PG&E	94
234	WILSON CONSTRUCTION	94
235	AGILITECH	93
236	VETERAN POWER INFRASTRUCTURE	93

25-Aug-19	737426	59
26-Aug-19	737426	3905
27-Aug-19	737426	3427
28-Aug-19	737426	3036
29-Aug-19	737426	3091
30-Aug-19	737426	2930
31-Aug-19	737426	90
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3-Sep-19	737426	3588
4-Sep-19	737426	4352
5-Sep-19	737426	3340
6-Sep-19	737426	3119
7-Sep-19	737426	249
8-Sep-19	737426	70
9-Sep-19	737426	5129
10-Sep-19	737426	3803
11-Sep-19	737426	3367
12-Sep-19	737426	3567
13-Sep-19	737426	3188
14-Sep-19	737426	145
15-Sep-19	737426	57
16-Sep-19	737426	4026
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20-Sep-19	737426	2766
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23-Sep-19	737426	3980
24-Sep-19	737426	3946
25-Sep-19	737426	4255
26-Sep-19	737426	2818
27-Sep-19	737426	2584
28-Sep-19	737426	64
29-Sep-19	737426	129
30-Sep-19	737426	3855
1-Oct-19	737426	3442
2-Oct-19	737426	3704
3-Oct-19	737426	2933
4-Oct-19	737426	2816
5-Oct-19	737426	119
6-Oct-19	737426	425
7-Oct-19	737426	3558
8-Oct-19	737426	3558
9-Oct-19	737426	3634
10-Oct-19	737426	3484
11-Oct-19	737426	3296
12-Oct-19	737426	132
13-Oct-19	737426	53
14-Oct-19	737426	3601
15-Oct-19	737426	3640
16-Oct-19	737426	4340
17-Oct-19	737426	3375
18-Oct-19	737426	2895
19-Oct-19	737426	146
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22-Oct-19	737426	3195
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24-Oct-19	737426	3005
25-Oct-19	737426	2861
26-Oct-19	737426	134
27-Oct-19	737426	37
28-Oct-19	737426	3422
29-Oct-19	737426	3576
30-Oct-19	737426	3099
31-Oct-19	737426	2923
1-Nov-19	737426	2408
2-Nov-19	737426	138
3-Nov-19	737426	143
4-Nov-19	737426	4109
5-Nov-19	737426	3546
6-Nov-19	737426	4200
7-Nov-19	737426	3050
8-Nov-19	737426	3468
9-Nov-19	737426	561
10-Nov-19	737426	64
11-Nov-19	737426	1633
12-Nov-19	737426	4333

24-Aug-20	737791	4954
25-Aug-20	737791	4023
26-Aug-20	737791	4084
27-Aug-20	737791	3421
28-Aug-20	737791	2376
29-Aug-20	737791	245
30-Aug-20	737791	73
31-Aug-20	737791	4383
1-Sep-20	737791	3977
2-Sep-20	737791	3712
3-Sep-20	737791	3585
4-Sep-20	737791	3485
5-Sep-20	737791	223
6-Sep-20	737791	69
7-Sep-20	737791	261
8-Sep-20	737791	4755
9-Sep-20	737791	4418
10-Sep-20	737791	3283
11-Sep-20	737791	3322
12-Sep-20	737791	84
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19-Sep-20	737791	130
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22-Sep-20	737791	3493
23-Sep-20	737791	3472
24-Sep-20	737791	3959
25-Sep-20	737791	2713
26-Sep-20	737791	97
27-Sep-20	737791	140
28-Sep-20	737791	4540
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11-Oct-20	737791	69
12-Oct-20	737791	4680
13-Oct-20	737791	3498
14-Oct-20	737791	3190
15-Oct-20	737791	3637
16-Oct-20	737791	2891
17-Oct-20	737791	115
18-Oct-20	737791	156
19-Oct-20	737791	3638
20-Oct-20	737791	3292
21-Oct-20	737791	3391
22-Oct-20	737791	2979
23-Oct-20	737791	3260
24-Oct-20	737791	297
25-Oct-20	737791	114
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27-Oct-20	737791	2986
28-Oct-20	737791	3174
29-Oct-20	737791	2914
30-Oct-20	737791	3060
31-Oct-20	737791	176
1-Nov-20	737791	102
2-Nov-20	737791	4422
3-Nov-20	737791	3947
4-Nov-20	737791	3335
5-Nov-20	737791	3260
6-Nov-20	737791	2814
7-Nov-20	737791	185
8-Nov-20	737791	55
9-Nov-20	737791	3421
10-Nov-20	737791	3780
11-Nov-20	737791	1503

25-Aug-21	738157	3706
26-Aug-21	738157	3142
27-Aug-21	738157	2810
28-Aug-21	738157	125
29-Aug-21	738157	73
30-Aug-21	738157	4755
31-Aug-21	738157	3653

237	ESQUIVEL GRADING & PAVING, INC.	93
238	FONTENOY ENGINEERING	92
239	XL LANDSCAPE DEVELOPMENT	92
240	GALT DEVELOPMENT	91
241	SACRAMENTO AREA SEWER DISTRICT	91
242	OSMOSE UTILITIES SERVICES INC.	91
243	PREMIER POOLS AND SPAS	90
244	NAVAJO PIPELINE	90
245	LAS VEGAS VALLEY WATER DISTRICT	89
246	PRINCE TELECOM	89
247	MICHELS PACIFIC ENERGY	89
248	OSMOSE UTILITIES SERVICES INC.	89
249	WEST VALLEY CONSTRUCTION	89
250	COLVIN CONSTRUCTION	89
251	BAY AREA LIGHTWORKS	89
252	AMM FENCING	89
253	CSI ENGINEERING	89
254	PETERSON CHASE GENERAL ENGINEERING CONST	89
255	IRISH CONSTRUCTION	88
256	GOTHIC LANDSCAPE	88
257	MGE UNDERGROUND	87
258	QUALITY TELECOM CONSULTANTS, INC	87
259	MEARS	87
260	BYRD UNDERGROUND	86
261	TEICHERT UTILITIES	86
262	VALVERDE CONSTRUCTION	86
263	PRO ENERGY SAN DIEGO	86
264	LEWIS & TIBBITTS	86
265	BOCKMON & WOODY ELECTRIC CO., INC.	86
266	TEICHERT CONSTRUCTION	85
267	WEST VALLEY CONSTRUCTION	85
268	SEATEC UNDERGROUND UTILITIES	85
269	TEICHERT PIPELINES	84
270	M & M ELECTRIC	84
271	MONTEREY PENINSULA ENGINEERING	84
272	AGUILAR FENCE	84
273	PAR ELECTRIC	84
274	SIERRA NATIONAL ASPHALT	84
275	WEST VALLEY CONSTRUCTION COMPANY	84
276	TEICHERT UTILITIES	83
277	PENHALL	83
278	ACCU BORE	83
279	OSMOSE UTILITIES SERVICES INC.	83
280	SMITH DENISON CONSTRUCTION	82
281	SIERRA NEVADA CONSTRUCTION	82
282	PLATINUM PIPELINE, INC	82
283	UNDERGROUND ELECTRIC CONSTRUCTION	82
284	ATLANTIC CONCRETE, INC	81
285	JAEGER VACUUM EXCAVATION	81
286	PG&E	81
287	PHASE 3 COMMUNICATIONS	81
288	EMMETTS EXCAVATION	80
289	WEST VALLEY CONSTRUCTION COMPANY	80
290	PTM GENERAL ENGINEERING SERVICES, INC	79
291	PG&E	79
292	OUTSOURCE UTILITY CONTRACTOR CORP	78
293	TABER DRILLING	78
294	MOUNTAIN PINE CONSTRUCTION	78
295	SILVER STATE FENCE & STAIN	78
296	VPC CHARGE	78
297	HOTLINE CONSTRUCTION INC	78
298	SURFACE SOLUTIONS	78
299	MGE UNDERGROUND	77
300	SOUTHERN CALIFORNIA GAS COMPANY	77
301	ARIZONA PIPELINE	77
302	PG&E	77
303	SILLER CONSTRUCTION	77
304	GTO	77
305	PG&E	76
306	WEST VALLEY CONSTRUCTION COMPANY	76
307	ACCU BORE	76
308	BALFOUR BEATTY	76
309	COLUMBIA ELECTRIC INC.	75
310	PENECORE DRILLING, INC.	75
311	GHILOTTI BROS., INC.	75
312	PACIFIC EXCAVATION INC	74
313	CUSTOM GRADING INC	74
314	PG&E	74
315	WEST VALLEY CONSTRUCTION COMPANY	74
316	ARIZONA PIPELINE	74

13-Nov-19	737426	4036
14-Nov-19	737426	3727
15-Nov-19	737426	2891
16-Nov-19	737426	111
17-Nov-19	737426	80
18-Nov-19	737426	3649
19-Nov-19	737426	3106
20-Nov-19	737426	2990
21-Nov-19	737426	2670
22-Nov-19	737426	2919
23-Nov-19	737426	151
24-Nov-19	737426	203
25-Nov-19	737426	3320
26-Nov-19	737426	3142
27-Nov-19	737426	2824
28-Nov-19	737426	43
29-Nov-19	737426	193
30-Nov-19	737426	116
1-Dec-19	737426	74
2-Dec-19	737426	4629
3-Dec-19	737426	4307
4-Dec-19	737426	3788
5-Dec-19	737426	2926
6-Dec-19	737426	2470
7-Dec-19	737426	232
8-Dec-19	737426	121
9-Dec-19	737426	4232
10-Dec-19	737426	3828
11-Dec-19	737426	3671
12-Dec-19	737426	2896
13-Dec-19	737426	3014
14-Dec-19	737426	96
15-Dec-19	737426	45
16-Dec-19	737426	3528
17-Dec-19	737426	2549
18-Dec-19	737426	2962
19-Dec-19	737426	2353
20-Dec-19	737426	2397
21-Dec-19	737426	93
22-Dec-19	737426	101
23-Dec-19	737426	2718
24-Dec-19	737426	1032
25-Dec-19	737426	66
26-Dec-19	737426	1891
27-Dec-19	737426	2610
28-Dec-19	737426	384
29-Dec-19	737426	192
30-Dec-19	737426	5002
31-Dec-19	737426	3047

12-Nov-20	737791	3875
13-Nov-20	737791	2644
14-Nov-20	737791	187
15-Nov-20	737791	139
16-Nov-20	737791	4214
17-Nov-20	737791	3291
18-Nov-20	737791	3500
19-Nov-20	737791	3355
20-Nov-20	737791	2435
21-Nov-20	737791	520
22-Nov-20	737791	63
23-Nov-20	737791	4503
24-Nov-20	737791	3465
25-Nov-20	737791	3641
26-Nov-20	737791	40
27-Nov-20	737791	167
28-Nov-20	737791	75
29-Nov-20	737791	76
30-Nov-20	737791	4095
1-Dec-20	737791	3673
2-Dec-20	737791	3253
3-Dec-20	737791	3168
4-Dec-20	737791	3013
5-Dec-20	737791	146
6-Dec-20	737791	74
7-Dec-20	737791	4280
8-Dec-20	737791	3086
9-Dec-20	737791	3408
10-Dec-20	737791	2918
11-Dec-20	737791	2228
12-Dec-20	737791	250
13-Dec-20	737791	140
14-Dec-20	737791	4145
15-Dec-20	737791	2919
16-Dec-20	737791	2839
17-Dec-20	737791	2845
18-Dec-20	737791	2206
19-Dec-20	737791	166
20-Dec-20	737791	58
21-Dec-20	737791	3953
22-Dec-20	737791	2863
23-Dec-20	737791	2288
24-Dec-20	737791	770
25-Dec-20	737791	43
26-Dec-20	737791	62
27-Dec-20	737791	184
28-Dec-20	737791	3384
29-Dec-20	737791	3194
30-Dec-20	737791	3344
31-Dec-20	737791	1427

317	W.R. FORDE ASSOCIATES, INC.	73
318	MOON VALLEY NURSERY	73
319	FLATIRON	72
320	HCI	72
321	SEFNCO	72
322	ARCADIS	72
323	COASTLINE WATER RESOURCES	72
324	PG&E	72
325	PCL INDUSTRIAL SERVICES	71
326	A PLUS TREE	71
327	SACRAMENTO AREA SEWER DISTRICT	71
328	AL FRESCO LANDSCAPING, INC	71
329	LINDCO ENERGY DIVISION	70
330	TEICHERT CONSTRUCTION	70
331	JOHNSON CONSTRUCTION COMPANY	70
332	FENCEWORKS INC.	70
333	ENERGY DELIVERY PARTNERS INC.	69
334	PERRIN CONSTRUCTION INC	69
335	VPC - VETERAN PIPELINE CO.	69
336	CITY OF PALO ALTO	69
337	WEST COAST ARBORISTS, INC.	69
338	CONTRA COSTA	68
339	MGE UNDERGROUND	68
340	COMMERCIAL TREE CARE	68
341	ST. FRANCIS ELECTRIC	68
342	HENKELS & MCCOY	68
343	BRAUN ELECTRIC	67
344	LANDSCAPE CONNECTION	67
345	DACO CONSTRUCTION	67
346	PLANNED ENVIRONMENTS INC	67
347	SAN FRANCISCO WATER DEPT	67
348	PG&E	67
349	BENTANCOURT BROTHERS CONSTRUCTION	67
350	WEST VALLEY CONSTRUCTION COMPANY	67
351	KNIFE RIVER CONSTRUCTION	66
352	PRESTIGE UTILITY INC.	66
353	KS INDUSTRIES, LP	66
354	INTREN	66
355	DARCY & HARTY CONSTRUCTION, INC.	65
356	SUNRISE PAVING	65
357	CALIFORNIA WATER SERVICE	65
358	PG&E	65
359	PG&E	65
360	PG&E	65
361	GM CONSTRUCTION & DEVELOPERS, INC.	65
362	SMITH DENISON CONSTRUCTION	65
363	PATRIOT CONTRACTORS	65
364	GHILOTTI CONSTRUCTION	64
365	J.R. PIERCE PLUMBING CO.	64
366	MGE UNDERGROUND	64
367	CALIFORNIA UTILITY CO	64
368	GOTHIC LANDSCAPE	64
369	K.J.WOODS CONSTRUCTION	63
370	CALIFORNIA WATER SERVICE	63
371	STAR ROOTER & PLUMBING INC.	63
372	TRENCHFREE, INC.	63
373	ALVAH	63
374	PG&E	63
375	INTREN	63
376	MGE UNDERGROUND	62
377	MARSHALL BROTHERS ENTERPRISES INC	62
378	C.F. ARCHIBALD PAVING	62
379	ARROW CONSTRUCTION	62
380	A.C. ELECTRIC	62
381	FLATIRON WEST, INC.	62
382	MISSION CONSTRUCTORS INC.	61
383	PG&E	61
384	BAY AREA UNDER PINNING	61
385	B&B PLUMBING CONSTRUCTION	61
386	CENTURY LANDSCAPE	61
387	TEICHERT CONSTRUCTION	61
388	JCP PLUMBING INC	61
389	MEARS PIPELINE	61
390	ALW ENTERPRISES, INC.	61
391	OSMOSE UTILITIES SERVICES INC.	60
392	MGE UNDERGROUND	60
393	WEST COAST HYDROVAC INC.	60
394	PG&E	60
395	AMM FENCING	60
396	MC4 CONSTRUCTION LLC	60

397	AZTRACK CONSTRUCTION CORP	60
398	MICHELS CORPORATION	59
399	KS INDUSTRIES, LP	59
400	WIPF CONSTRUCTION	59
401	STURGEON ELECTRIC	59
402	REDWOOD RESIDENTIAL FENCE	59
403	CALTRANS	59
404	COUNTY OF SACRAMENTO	58
405	WEST COAST BACKHOE	58
406	TENNYSON ELECTRIC	58
407	TERRA CONTRACTING	58
408	WEST VALLEY CONSTRUCTION COMPANY	58
409	MIKON CONSTRUCTION CO INC	58
410	EXTENDED POWER INC	58
411	SANCO PIPELINES INC.	58
412	PG&E	58
413	PROCIDA LANDSCAPE	58
414	EDDIE AXNER CONSTRUCTION	58
415	HENKELS & MCCOY	57
416	ASSOCIATED TRAFFIC SAFETY	57
417	KW EMERSON	57
418	WEST COAST ARBORIST INC.	57
419	AMERICAN CONSTRUCTION & EXCAVATION	57
420	TEICHERT CONSTRUCTION	57
421	M CON, INC.	57
422	SIERRA TRAFFIC MARKINGS, INC.	56
423	SMART COMMUNICATION SYSTEMS, LLC	56
424	MR PAVERS	56
425	GHITA UNDERGROUND ENGINEERING INC.	56
426	TEICHERT CONSTRUCTION	56
427	MGE UNDERGROUND	56
428	INTREN	56
429	CITY OF FRESNO	56
430	INTREN	55
431	T AND S DVBE INC	55
432	CONETEC	55
433	RANDAZZO ENTERPRISES INC.	55
434	RELIANT CONSTRUCTION	55
435	HUDSON EXCAVATION	55
436	FRIENDS OF THE URBAN FOREST	55
437	POWERPLUS	55
438	ALAMEDA COUNTY WATER DISTRICT	55
439	TAB CONTRACTORS INC	55
440	SWAN POOLS	55
441	TOTAL WESTERN INC.	55
442	HP COMMUNICATIONS	55
443	CABLECOM	54
444	OSMOSE UTILITIES SERVICES INC.	54
445	PG&E	54
446	GEER EXCAVATION	54
447	PG&E	54
448	PG&E	54
449	PINNACLE POWER	54
450	PG&E	54
451	HYLAN WEST	54
452	ROSAS BROTHERS CONSTRUCTION	54
453	MGE UNDERGROUND	54
454	MIKE BROWN ELECTRIC COMPANY	54
455	SPANISH SPRINGS CONSTRUCTION INC.	53
456	FRIENDS OF THE URBAN FOREST	53
457	KCI TECHNOLOGIES	53
458	CALIFORNIA CUT & CORE, INC	53
459	TENNYSON ELECTRIC	53
460	NFB ENGINEERING	53
461	BAY CITIES PAVING & GRADING	53
462	TRI-VALLEY FENCE WORKS	52
463	PG&E	52
464	HUDSON EXCAVATION	52
465	RADIUS EARTHWORK	52
466	PERMA-GREEN HYDRO SEEDING INC	52
467	VPC CHARGE	52
468	MARQUES GENERAL ENGINEERING	52
469	ST. FRANCIS ELECTRIC	52
470	FLOCK SAFETY	52
471	OUTSOURCE UTILITY CONTRACTOR CORP	52
472	TEAM GHILOTTI	52
473	WEST VALLEY CONSTRUCTION COMPANY	52
474	TAK COMMUNICATIONS	51
475	CENTRAL VALLEY ENGINEERING & ASPHALT	51
476	JOHNSON CONSTRUCTION COMPANY	51

477	MOUNTAIN CASCADE	51
478	CARSON VALLEY WELDING	51
479	ROLL N ROCK CONSTRUCTION INC	51
480	LEWIS AND TIBBITTS	50
481	HYDROCHEMPSC	50
482	ARB, INC.	50
483	LEO TIDWELL EXCAVATING	50
484	DUDLEYS' EXCAVATING, INC	50
485	PRO ENERGY SERVICES	50
486	VANTAGE CONCEPTS	49
487	TERRACON	49
488	ALDRIDGE ELECTRIC	49
489	FREMONT FENCE	49
490	PG&E	49
491	NV ENERGY	49
492	LASAR UNDERGROUND CONSTRUCTION	49
493	KROEKER, INC.	49
494	GOLDEN STATE UTILITY CO.	49
495	NATIONAL CONSTRUCTION RENTALS	49
496	PRECISE CONCRETE SAWING INC	49
497	FRIENDS OF THE URBAN FOREST	49
498	PG&E	48
499	STRAIGHT LINE INC.	48
500	SUMMIT LINE CONSTRUCTION	48
501	J. CRAWFORD CONSTRUCTION	48
502	MCH ELECTRIC INC.	48
503	INTREN	48
504	PG&E	48
505	TEICHERT CONSTRUCTION	47
506	IRISH CONSTRUCTION	47
507	STURGEON ELECTRIC	47
508	CIVIL WERX	47
509	BAY AREA HYDROVAC LLC	47
510	BAY SIDE FENCING CO	47
511	UNDERGROUND CONSTRUCTION COMPANY	47
512	M CON, INC.	47
513	ALLISON SIERRA INC	47
514	PG&E	47
515	CONSTRUCTION AREA SIGNS	47
516	ECONOMY ROOTER AND PLUMBING	47
517	ANVIL BUILDERS	47
518	MP NEXLEVEL	47
519	MGE UNDERGROUND	47
520	PG&E	47
521	ARROW SIGN COMPANY	46
522	WESTERN ENGINEERING CONTRACTOR	46
523	DURAN CONSTRUCTION GROUP	46
524	GROVER LANDSCAPE SERVICES	46
525	MGE UNDERGROUND	46
526	MEARS PIPELINE	46
527	TEICHERT CONSTRUCTION	46
528	MORENO TRENCHING	46
529	PACIFIC UNDERGROUND CONSTRUCTION INC.	46
530	PHASE ONE CONSTRUCTION	46
531	PG&E	46
532	COASTLINE WATER RESOURCES	46
533	TEICHERT CONSTRUCTION	46
534	PG&E	45
535	INTREN	45
536	MGE UNDERGROUND	45
537	PAR ELECTRICAL CONTRACTORS	45
538	TEAM FISHEL	45
539	PACIFIC DISTRIBUTING	45
540	COLUMBIA ELECTRIC INC.	45
541	PG&E	45
542	SUNRISE CARPENTRY INC	45
543	WATTIS CONSTRUCTION COMPANY, INC.	44
544	PG&E	44
545	INDEPENDENT CONSTRUCTION	44
546	EXPRESS SEWER & DRAIN	44
547	DESILVA GATES CONSTRUCTION	44
548	G.T.O.	44
549	GOODFELLOW BROS	44
550	SANCO PIPELINES INC.	44
551	PHASE 3 COMMUNICATIONS	44

ATTACHMENT E: SIMULATION CODE

```
function out_spc = optimize_ticket_workload(ticket_data, dates_array, holidays,
convergence, skips, figure_num)
%
%

% Constants %
% NUMBER_OF_RUNS = 30;
CONVERGENCE_AT_X_RUNS = 5;
%FIGURE_NUMBER = 24;

% Initialization %
num_runs_under_convergence = 0;
iteration = 0;

% initialize binarray
binarray = build_ticket_bin_cell_array("initialize", ticket_data, dates_array, holidays,
skips);
num_bins = length(binarray);
index_array = [1:1:num_bins];
spc = build_workload_spectrum(ticket_data, binarray, skips);
spc_length = length(spc);
previous_spc = spc;
out_spc = zeros(spc_length, 2);
%plot_ticket_spc(spc, FIGURE_NUMBER)
plot_ticket_spc(spc, figure_num)
try
  plot_text_1 = ['Days = ' num2str(dates_array(:,1))];
catch
  plot_text_1 = [];
end_try_catch

% for iteration = 1:NUMBER_OF_RUNS
while num_runs_under_convergence < CONVERGENCE_AT_X_RUNS
  iteration = iteration + 1
  bin_index_array = index_array;
  for i = 1:num_bins
    bin_index = randi(num_bins + 1 - i);
    selected_bin = bin_index_array(bin_index);
    % take the previous index out of the random sample
    for j = (bin_index+1):(num_bins + 1 - i)
```

```
  bin_index_array(j-1) = bin_index_array(j);
endfor
bin_index_array(num_bins + 1 - i) = 0;

% Extract ticket data info for dates in binarray
bin_distribution = binarray{selected_bin, 3};
num_window_days = length(bin_distribution(:,1));

% Account for a bin_distribution that begins before spc
if bin_distribution(num_window_days,1) < spc(1,1)
  % skip this bin %
elseif bin_distribution(1,1) < spc(1,1)
  num_window_days = bin_distribution(num_window_days,1) - spc(1,1) + 1;
  length_bin_dist = length(bin_distribution(:,1));
  temp_distribution = zeros(num_window_days,2);
  for j = 1:num_window_days
    temp_distribution(num_window_days + 1 - j, 1) =...
     bin_distribution(length_bin_dist + 1 - j);
  endfor
  bin_distribution = temp_distribution;
  'TEST 2'
else
  % Account for a bin_distribution extending past the length of spc
  while bin_distribution(num_window_days,1) > spc(spc_length,1)
    num_window_days = num_window_days - 1;
    'TEST 1'
  endwhile
  if length(bin_distribution(:,2)) > num_window_days
    temp_distribution = zeros(num_window_days,2);
    temp_distribution(:,1) = bin_distribution([1:num_window_days],1);
    temp_distribution(:,2) = bin_distribution([1:num_window_days],2);
    bin_distribution = temp_distribution;
  endif

  spc_window = zeros(num_window_days,1);
  spc_window_indices = zeros(num_window_days,1);

  %printf('First index: %d\n', find(spc(:,1) == bin_distribution(1,1)))
  %printf('Second index: %d\n', find(spc(:,1) == bin_distribution(num_window_days),1))
  spc_window_indices = [find(spc(:,1) == bin_distribution(1,1)):...
     find(spc(:,1) == bin_distribution(num_window_days),1)];
  for k = 1:num_window_days
    spc_window(k) = spc(spc_window_indices(k),2);
    spc(spc_window_indices(k),2) = spc(spc_window_indices(k),2) -...
```

```
        bin_distribution(k,2);
    endfor

    bin_distribution(:,2) = redistribute_bin_data(...
      spc_window, bin_distribution(:,2));
    binarray{selected_bin, 3} = bin_distribution;

    % Add the new distribution back in
    for k = 1:num_window_days
      spc(spc_window_indices(k),2) = spc(spc_window_indices(k),2) +...
        bin_distribution(k,2);
    endfor
  endif
endfor

spc = build_workload_spectrum(spc, binarray);
mean_error = sum(abs(previous_spc(:,2) - spc(:,2)))/length(spc(:,1))
if mean_error < convergence
  num_runs_under_convergence = num_runs_under_convergence + 1;
else
  num_runs_under_convergence = 0;
endif
previous_spc = spc;

plot_spc(:,1) = spc([1:spc_length - skips(2)],1);
plot_spc(:,2) = spc([1:spc_length - skips(2)],2);
%plot_ticket_spc(plot_spc, FIGURE_NUMBER)
plot_text_2 = ['Median Absolute Deviation = ' num2str(mad(plot_spc(:,2),1))];
plot_ticket_spc(plot_spc, figure_num, plot_text_1, plot_text_2)
pause(1)
% endfor
endwhile

out_spc = plot_spc;
plot_text_2 = ['Median Absolute Deviation = ' num2str(mad(out_spc(:,2),1))];
% plot_ticket_spc(out_spc, FIGURE_NUMBER)
plot_ticket_spc(out_spc, figure_num, plot_text_1, plot_text_2)
endfunction

function binarray = build_ticket_bin_cell_array(flag, ticket_data, due_date_dist,
holidays, skips)
  %
  % flag = "initialize": spreads workload from each due_date_dist evenly across
  %   all dates. Used to initialize the optimization.
```

```
% flag = "due": assigns workload for each due_date_dist to the last legal day.
% flag = "optimize": performs optimization of workload across available days.

% binarray{};

num_days = length(ticket_data(:,1));
bin_index = 1;

for i = 1:(num_days - 1 - skips(2))
  % Note: don't consider the last #'s ('skips') tickets, as they will not be
  %   included in the spectrum. Even if no skips, don't consider the last day,
  %   as any tickets placed on the last day won't apply to period considered,
  %   given the assumption that no tickets are located on the day they are
  %   issued.
  due_dates = start_dates(ticket_data(i,1), due_date_dist, holidays);
  switch flag
    case "initialize"
      for j = 1:length(due_dates(:,1))
        if due_dates(j,2) > 0
          binarray{bin_index,1} = ticket_data(i,1); % start date
          binarray{bin_index,2} = due_dates(j,1);% end date
          num_window_days = due_dates(j,1) - ticket_data(i,1);
          temparray = zeros(num_window_days,2);
          for k = 1:num_window_days
            temparray(k,1) = ticket_data(i,1) + k;
            temparray(k,2) = floor((ticket_data(i,2) * (due_dates(j,2)))/num_window_days);
            % account for fractional tickets -- add leftover tickets to the beginning dates
            if mod((ticket_data(i,2) * due_dates(j,2)), num_window_days) - k + 1 > 0
              temparray(k,2) = temparray(k,2) + 1;
            endif
          endfor
          binarray{bin_index,3} = temparray;
          bin_index = bin_index + 1;
        endif
      endfor
    case "due" % spectrum w/ due dates
      for j = 1:length(due_dates(:,1))
        if due_dates(j,2) > 0
          binarray{bin_index,1} = ticket_data(i,1); % start date
          binarray{bin_index,2} = due_dates(j,1);% end date
          temparray = zeros(1,2);
          temparray(1,1) = due_dates(j,1);
          temparray(1,2) = round(ticket_data(i,2) * due_dates(j,2));
          binarray{bin_index,3} = temparray;
```

```
          bin_index = bin_index + 1;
        endif
      endfor
    endswitch
  endfor
endfunction

function day_list = start_dates(ticket_date, days_array, holidays)
  %% Function returns an array of legal start dates based on how many days are
  %%  supplied to respond. Function factors in weekends and holidays in
  %%  determining the initial legal start date and time.
  %%
  %% 'days_array' is a 2-column array with the first column being the due days
  %% and the second column being the fractions of tickets due that day.

  % Constant %
  LEGAL_MIN_NUMBER = 2;
  TRUE = 1;
  FALSE = 0;

  % Array Initialization %
  days_array(:,1) = days_array(:,1) + ticket_date;
  %legal_min = ticket_date + LEGAL_MIN_NUMBER;

  % Determine Legal Start Date %
  %test_date = min(days_array(:,1)) - 1;
  test_date = ticket_date;
  workday_counter = 0;
  while workday_counter < LEGAL_MIN_NUMBER
    test_date = test_date + 1;
    workday = check_workday(test_date, holidays);
    if workday == TRUE
      workday_counter = workday_counter + 1;
    endif
  endwhile
  legal_start = test_date;

  % determine length of array be ensuring that it extends to at least
  %  first legal start date.
  if (max(days_array(:,1))) < legal_start
    length_daylist = legal_start - ticket_date;
  else
    length_daylist = max(days_array(:,1)) - ticket_date;
  endif
```

```
  day_list = zeros(length_daylist, 2);
  for i = 1:length_daylist
    day_list(i,1) = ticket_date + i;
  endfor

  % Assign ticket fractions to due dates $
  [b legal_start_index] = ismember(legal_start, day_list(:,1));
  [member_bool member_index] = ismember(days_array(:,1), day_list(:,1));

  for i = 1:length(days_array(:,1))
    if days_array(i,1) < legal_start
      day_list(legal_start_index,2) = day_list(legal_start_index,2) + days_array(i,2);
    else
      day_list(member_index(i),2) = day_list(member_index(i),2) + days_array(i,2);
    endif
  endfor
endfunction

function workday = check_workday(inputdate, holidays)
  % Returns TRUE if a workday, FALSE if Saturday, Sunday, or Holiday %
  % Note that function "weekday" starts with 1 = Sun. and ends with 7 = Sat.

  % Constants %
  TRUE = 1;
  FALSE = 0;

  % initialize "workday"
  workday = TRUE;
  if (weekday(inputdate) == 1) || (weekday(inputdate) == 7)
    workday = FALSE;
  else
    for i = 1:length(holidays)
      if holidays(i,1) == inputdate
        workday = FALSE;
      endif
    endfor
  endif
endfunction

function output_spectrum = build_workload_spectrum(input_spectrum, binarray,
varargin)
  %
  %
```

```
  switch nargin
    case 2
      skips = [0, 0];
    case 3
      skips = varargin{1};
  endswitch

  length_spectrum = length(input_spectrum(:,1)) - skips(1);
  num_binarrays = length(binarray);
  output_spectrum = zeros(length_spectrum, 2);
  output_spectrum(:,1) = input_spectrum([skips(1)+1:length_spectrum + skips(1)],1);
  date_index = 0;
  temparray = [];

  for i = 1:num_binarrays
    temparray = binarray{i,3};
    for j = 1:length(temparray(:,1))
      date_index = find(output_spectrum(:,1) == temparray(j,1));
      if date_index % check to ensure not empty
        output_spectrum(date_index, 2) =...
        output_spectrum(date_index, 2) + temparray(j,2);
      endif
    endfor
  endfor
endfunction

function plot_ticket_spc(input_spectrum, varargin)
  %
  %

  switch nargin
    case 1
      % do nothing
    case 2
      figure(varargin{1}, 'position', [100, 100, 740, 520])
      runtext_1 = [];
      runtext_2 = [];
    case 3
      figure(varargin{1}, 'position', [100, 100, 740, 520])
      runtext_1 = varargin{2};
      runtext_2 = [];
    case 4
      figure(varargin{1}, 'position', [100, 100, 740, 520])
      runtext_1 = varargin{2};
```

```
    runtext_2 = varargin{3};
  endswitch

  subplot(2,1,1)
  plot(input_spectrum(:,1), input_spectrum(:,2))
  %axis([input_spectrum(1,1) input_spectrum(length(input_spectrum(:,1))) 0 5000]) % DA
data
  axis([input_spectrum(1,1) input_spectrum(length(input_spectrum(:,1))) 0 100]) % CCWD
  if ~isempty(runtext_1)
    %text(737457, 700, runtext_1) % DA data
    text(738312, 80, runtext_1) % CCWD
  endif
  xlabel ("Day")
  ylabel ("Tickets")
  title ("Tickets per day")
  datetick ('x', "%m/%y")
  %datetick ('x', "%m/%d")

  subplot(2,1,2)
  hist(input_spectrum(:,2), 80)
  axis([0 85 0 15]) % CCWD
  %axis([0 5000 0 100]) % DA data
  if ~isempty(runtext_2)
    %text(200, 70, runtext_2) % DA Data
    text(30, 10, runtext_2) % CCWD
  endif
  xlabel ("Ticket Count")
  ylabel ("Number of Days")
  title ("Histogram of Ticket-Days")
  if ~isempty(runtext_1)
    print_name = ['plot_' runtext_1 '.png']
    print(print_name)
  endif
endfunction
```