

An Analysis of Long Lines in Richland County, South Carolina

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USENIX EVT/WOTE 2013, Washington DC

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“We’ve got to fix that.”

EL152 — Locked

17:59 Done

	SUP	11/06/2012 23:51:46	0001510	Vote cast by voter
153378	SUP	11/06/2012 23:51:58	0002810	Terminal - time to close voting
	SUP	11/06/2012 23:54:04	0001510	Vote cast by voter
153063	SUP	11/06/2012 23:54:23	0002810	Terminal - time to close voting
	SUP	11/06/2012 23:57:46	0001510	Vote cast by voter
	SUP	11/06/2012 23:58:00	0002810	Terminal - time to close voting
	SUP	11/07/2012 00:01:18	0001510	Vote cast by voter
153378	SUP	11/07/2012 00:01:38	0002810	Terminal - time to close voting
	SUP	11/07/2012 00:05:15	0001510	Vote cast by voter
153063	SUP	11/07/2012 00:06:00	0002810	Terminal - time to close voting
	SUP	11/07/2012 00:08:34	0001510	Vote cast by voter
153378	SUP	11/07/2012 00:08:49	0002810	Terminal - time to close voting
	SUP	11/07/2012 00:10:10	0001510	Vote cast by voter
	SUP	11/07/2012 00:11:01	0002810	Terminal - time to close voting
	SUP	11/07/2012 00:14:35	0001510	Vote cast by voter
	SUP	11/07/2012 00:14:52	0002810	Terminal - time to close voting
	SUP	11/07/2012 00:17:59	0001510	Vote cast by voter
153327	SUP	11/07/2012 00:30:47	0002810	Terminal - time to close voting

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“We’ve got to fix that.”



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Richland County

Home of Columbia, SC, the state capital, and home of the University of South Carolina

244,000 reg voters (2d largest county in SC)

121,335 votes cast in pcts on 6 Nov 2012

810 DREs in Nov 2010

~550 DREs operating at 7am on Nov 2012

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6 Nov 2012 and afterwards

All election data ordered by a judge to be counted by SC Law Enf Division (11/08/2012); data sent to SLED

Judge overruled (11/09/2012); data returned to county

State Supreme Court orders counting 11/13/2012

Results announced 11/15/2012

Legislative delegation hearing 11/26/2012

Uncounted votes discovered 11/27/2012, 11/29/2012

Conspiracy theories about a sales tax referendum

Lawsuit to throw out the entire election not settled (against) until 3/22/2013

(and yes, there's more—lots more)

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6 Nov 2012 and afterwards (2)

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Next time, voting in about an hour in Richland County?

Published: June 27, 2013

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By JOHN MONK — jmonk@thestate.com

RICHLAND COUNTY, SC — Attorney Steve Hamm on Thursday gave the Richland County Election Commission a blueprint on how to run a smooth election, saying it is crucial that the office regain public trust after November's election "disaster."

[Scroll to the bottom to read the report]

"As we now know, there was a significant failure to place a sufficient number of voting machines in precincts," Hamm said in an afternoon meeting at the county administration building.

But he also said that a former part-time staffer's decision to reduce the number of machines at precincts, even if that person's actions did not change the outcome of any race or ballot question, was serious. He said he passed what he learned along to law enforcement agents, confirming what many have suspected since an



Flanked by Herbert Sims and Allen Dowdy, the newly appointed director Howard Jackson listens to consultant Steve Hamm's recommendations.

KIM KIM FOSTER-TOBIN — kkfoster@thestate.com Buy Photo

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Disclaimer

Steve Hamm actually paid me (personally) for 36 hours worked specifically on his behalf.

I was paid at the official hourly rate of my university salary (as would be charged to NSF or other external funding).

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Long Lines and "Policy"

No evidence (none at all!) of intent, fraud, malfeasance, etc., etc., etc.

Conspiracy theories had the *affluent* voters disenfranchised (sales tax related)

"Early voting" doesn't exist in SC

Absentee voting was substantial (and largely by African-American voters?)

This was just a colossal screw-up

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Late Votes

121,000 total votes in pcts on 6 Nov 2012

14,000 votes cast after 7pm

>12% of ALL VOTES in Richland cast after 7pm

2/3 of all SC late votes in SC were in Richland

Charleston County: ~140,000 votes, ~1200 late

Greenville County: 171,000 votes, 403 late

How long did voters actually wait?

Why are Richland and Greenville so different?

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Late Votes

Table I. Late Votes by Hour, Richland County SC

			Nov 2010	Nov 2012
7pm	-	8pm	1888	6297
8pm	-	9pm	43	4544
9pm	-	10pm	0	2520
10pm	-	11pm	0	1145
11pm	-	12pm	0	255
12pm	-	1am	0	29

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Doing the Analysis

SC votes entirely on ES&S iVotronic DREs

One advantage of the DREs is that there is actual data

And the data is public record

We can work the data to find out how bad it really was

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Lots of Issues with the Data

EL155 cast vote record

EL152 event log

EL30A, EL45A results files

Timestamps are not always correct

Event messages not always precise or complete

We don't get an "I am a dead computer" message

We don't get actual time-to-vote (endtime-starttime)



Nonetheless, …

We compute "time between 'cast vote' messages

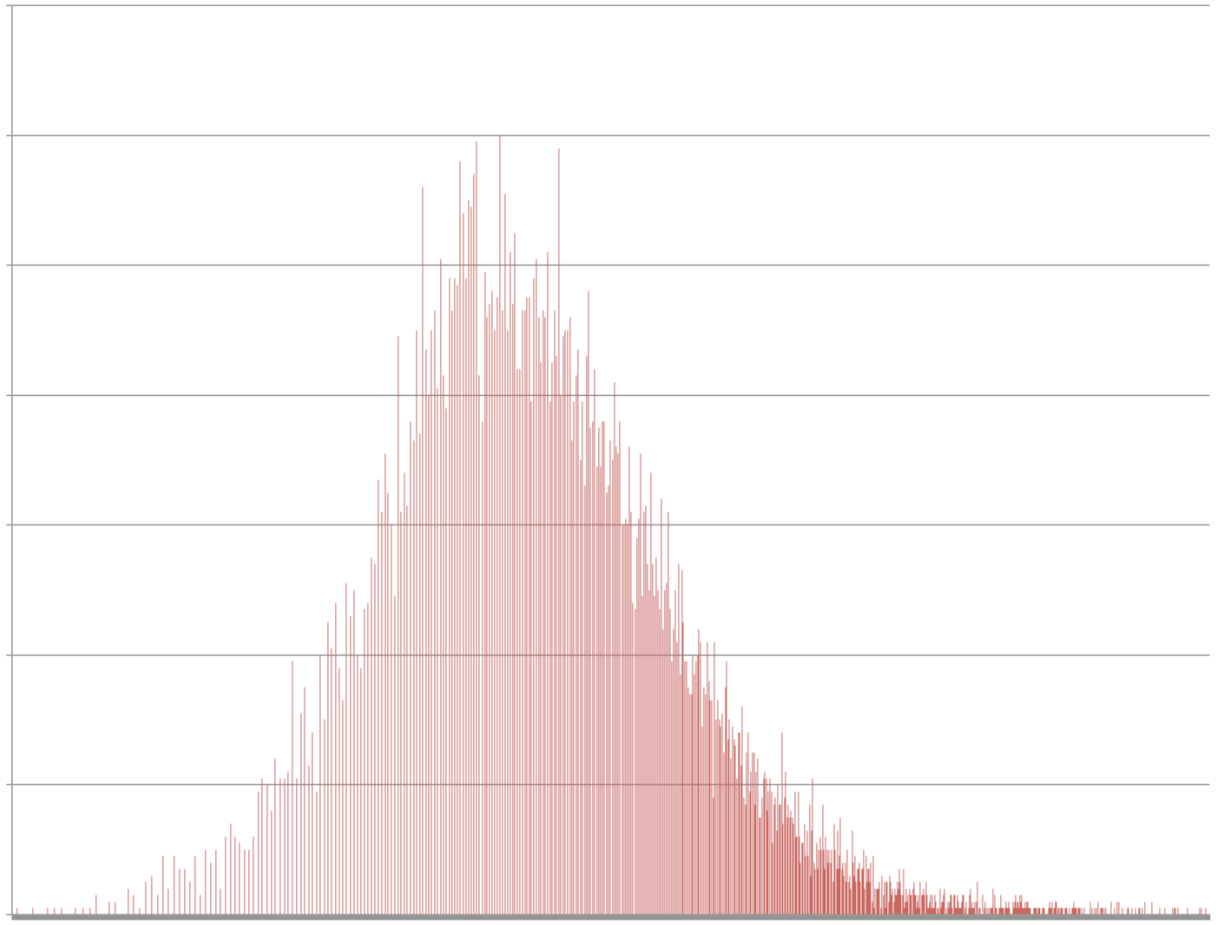
(looks log normal)

We can histogram votes collected

If a pct is collecting votes, but a terminal is not, AND the terminal has thrown error messages, then maybe it's not being used

Time-to-Vote (logs of)

Of late votes, after excluding some (dubious) times



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We Simulate the Election

Percents of total voters/pct in each hour
(10, 10, 10, 5, 5, 5, 10, 10, 5, 5, 5, 10 10)

Poisson interarrivals in each hour

Log normal time-to-vote

(we have stats before closing, county-wide, and stats after closing for pcts with many late votes)

Choose 14 “worst” pcts in Richland, random 14 “best”, and all of Greenville County

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Basic Capacity

- SC “permits” three minutes for voting
- 12 hours * 60 mins / 3 (mins/vote) =240 votes/DRE
- Queueing theory says don’t go over ½ this capacity (i.e., 120 votes/DRE)
- Richland had 192/DRE, Greenville had 200



Estimated "Effective" Terminal Count

Look at open times and close times, and prorate hours

Look at histograms of votes collected

Look at EL152 for "anomalies", "errors", etc.

Use first hand information (pcts 340, 378)

There were reports of broken terminals all over the county. Some of this can be substantiated and quantified by manual examination of the data.

Manual, subjective, … yes, we admit that

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Validating the Simulation

- Simulate with various numbers of terminals to include actual count and estimated effective count
- Simulate with before 7pm and after 7pm time-to-vote
- Match up the number of late votes (simulated vs. real) to get a terminal count as per the simulation
- We consider the simulation and model validated, because the terminal count as per the simulation is very close to the independently estimated effective terminal count
- We can then look at the wait times from simulation



Results, Richland Late Votes

10 of 14 pcts match up with before or after times

2 match up with before, but not after

1 matches up with after, but not before

Only 1 is truly anomalous

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Results, Richland Late Votes

Pct	Real T	Sim T	Mean Time	Dev Time	Sim Late Mean	Sim Late Dev	Act Late	Mean Queue Time	Max Queue Time	Capacity Quotient
324	3/2	2	2.944	1.207	450.400	7.908	309	364.830	661.051	1.930
(before)		3			203.550	9.271		132.781	197.380	1.286
		4			3.150	5.247		29.500	86.790	0.965
324	3/2	2	2.797	0.965	425.300	5.469	309	332.051	595.119	1.834
(after)		3			171.850	7.485		114.283	161.924	1.223
		4			3.350	4.704		23.281	80.151	0.917
340	6/4	5	3.363	1.592	138.950	16.539	138	80.418	123.559	1.141
(before)		6			5.850	8.278		26.493	83.061	0.951
340	6/4	5	3.382	1.208	157.100	8.843	138	86.854	126.736	1.148
(after)		6			2.950	5.287		27.777	84.503	0.957
380	7/4	4	2.962	1.107	469.150	11.778	459	209.004	348.499	1.487
(before)		5			222.050	11.800		100.099	137.291	1.190
		6			6.500	6.667		35.470	93.388	0.992
		7			4.750	5.735		18.206	66.704	0.850
380	7/4	4	3.080	1.059	505.400	10.027	459	229.753	388.958	1.546
(after)		5			270.800	11.830		117.924	166.222	1.237
		6			32.550	9.785		44.483	102.000	1.031
		7			4.800	6.882		20.139	72.559	0.884

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Results, Richland Late Votes

Pct	Real T	Sim T	Mean Time	Dev Time	Sim Late Mean	Sim Late Dev	Act Late	Mean Queue Time	Max Queue Time	Capacity Quotient
336	6/5	5	5.009	2.962	500.100	9.914	434	288.396	511.124	1.688
(before)		6			360.600	11.749		187.181	306.554	1.406
		7			212.750	13.386		112.026	157.530	1.206
		8			72.350	13.890		57.675	112.472	1.055
		9			6.250	8.318		27.010	85.130	0.938
336	6/5	5	4.394	2.122	386.350	13.774	434	204.354	336.055	1.480
(after)		6			221.200	15.949		115.166	163.512	1.234
		7			52.900	12.837		51.473	107.404	1.057
		8			2.900	4.471		23.236	80.432	0.925
353	12/9	9	4.530	1.976	963.250	16.658	714	275.482	482.744	1.683
(before)		10			801.800	14.918		215.149	360.490	1.515
		11			647.750	13.145		167.779	263.675	1.377
		12			487.250	16.807		126.828	180.872	1.262
		13			328.550	13.098		91.410	130.277	1.165
353	12/9	9	3.794	1.304	694.200	13.113	714	181.212	294.264	1.410
(after)		10			506.150	14.051		131.217	193.239	1.269
		11			311.650	15.743		89.334	130.911	1.153
		12			118.550	18.710		54.001	108.290	1.057
		13			8.150	9.645		33.771	91.432	0.976

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Results, Richland No Late Votes

Table III. Results for Precincts with No Late Votes, Richland County SC

Pct	Real T	Simu T	Mean Time	Dev Time	Sim Late Mean	Sim Late Dev	Act Late	Mean Queue Time	Max Queue Time	Capacity Quotient
101	4/4	4	3.901	1.748	1.650	2.903	1	22.568	79.589	0.893
103	4/3.4	3	2.875	1.024	83.650	8.788	5	73.335	118.566	1.119
		4	2.875	1.024	2.650	4.028	5	16.032	61.227	0.840
116	3/3	3	2.671	1.280	0.500	1.118	1	24.807	81.076	0.944
130	3/3	3	4.585	2.606	2.100	3.727	1	14.956	63.371	0.819
133	3/3	3	4.010	1.851	2.050	4.489	0	30.554	92.210	0.958
307	6/6	6	3.895	1.763	1.400	3.056	0	26.057	84.105	0.956
309	8/8	8	4.049	1.544	5.100	8.426	0	23.012	79.254	0.918
310	6/6	6	4.383	2.077	2.400	3.625	0	29.120	89.250	0.951
321	3/3	3	3.086	1.249	1.950	2.783	0	28.736	86.602	0.971
343	3/3	3	4.230	1.913	1.900	3.419	0	25.170	84.766	0.950
351	3/3	3	3.619	1.444	2.700	3.703	0	33.666	94.436	0.990
362	4/3.8	3	4.333	2.188	58.650	9.707	1	74.846	120.870	1.127
		4	4.333	2.188	1.750	3.562	1	16.355	64.693	0.846
368	10/10	10	3.231	1.223	2.300	5.367	1	33.071	91.662	0.981
370	3/3	3	3.258	4.443	3.300	4.196	0	31.842	92.809	0.884

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Results, Greenville County

171,146 total votes, 403 late votes, 202 in only 3 pcts

Simulation shows <10 late votes in all pcts (except 2 of the 3 above)

95% confidence level:

$Mean_{sim} - 1.96*Dev_{sim} < actual < Mean_{sim} + 1.96*Dev_{sim}$

Even with few late votes, still 36,000 voters in line for more than one hour

But simulation has no wait times more than two hours

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Wait Times, Richland County

Conservatively:

>53,000 voters (44%) more than one hour

>20,000 voters (17%) more than two hours

Even in sampled "good" pcts, ¼ of voters >one hour

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Ballot Complexity

Table IV. Mean Number of Ballot Choices, Richland and Greenville Counties SC

	Richland	Greenville
Contested	6.53	4.04
Uncontested	6.50	7.32
Combined	13.02	11.36

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Capacity Redux

Richland:

121,206 votes * 190 secs = 533 DREs for 12 hours

121,206 votes * 217 secs = 608 DREs for 12 hours

Only 555 open by 8:00am

Never more than 578 collecting votes

Greenville:

171,146 votes * 190 secs = 752 DREs for 12 hours

171,146 votes * 198 secs = 784 DREs for 12 hours

>810 operating for all but 90 minutes

Table II (if nothing else) shows the sharp sensitivity

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The End

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