

Colorado Risk-Limiting Audit: Conception to Application

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Agenda

- Provide an overview of what a risk-limiting audit (RLA) is
- Provide a brief history of RLAs in Colorado
- Current post-election audit vs. RLA
- Provide workload examples
- Describe the benefits and challenges of an RLA
- Describe the tools that will be used to conduct an RLA
- Describe the responsibilities of the county clerk, the county audit board, and the SOS
- Lessons learned
- Q&A

What is a risk-limiting audit?

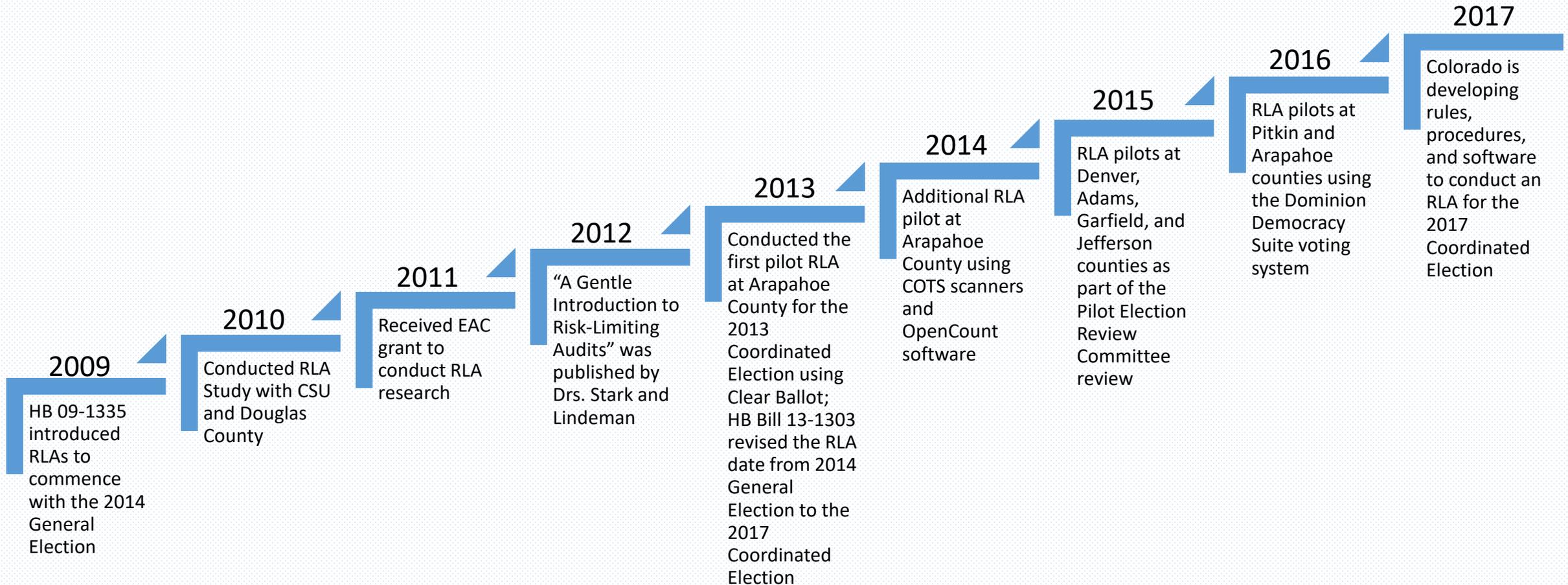
A risk-limiting audit provides strong statistical evidence that the election outcome is right, and has a high probability of correcting a wrong outcome.¹

- Risk limit: the largest chance that a wrong outcome will not be corrected
- Wrong outcome: when the reported outcome does not match the actual outcome – this can happen due to various reasons like adjudication or equipment errors.

If the risk limit is 5% and the outcome is wrong, there is at most a 5% chance that the audit will not correct the outcome, and at least a 95% chance that the audit will correct the outcome.²

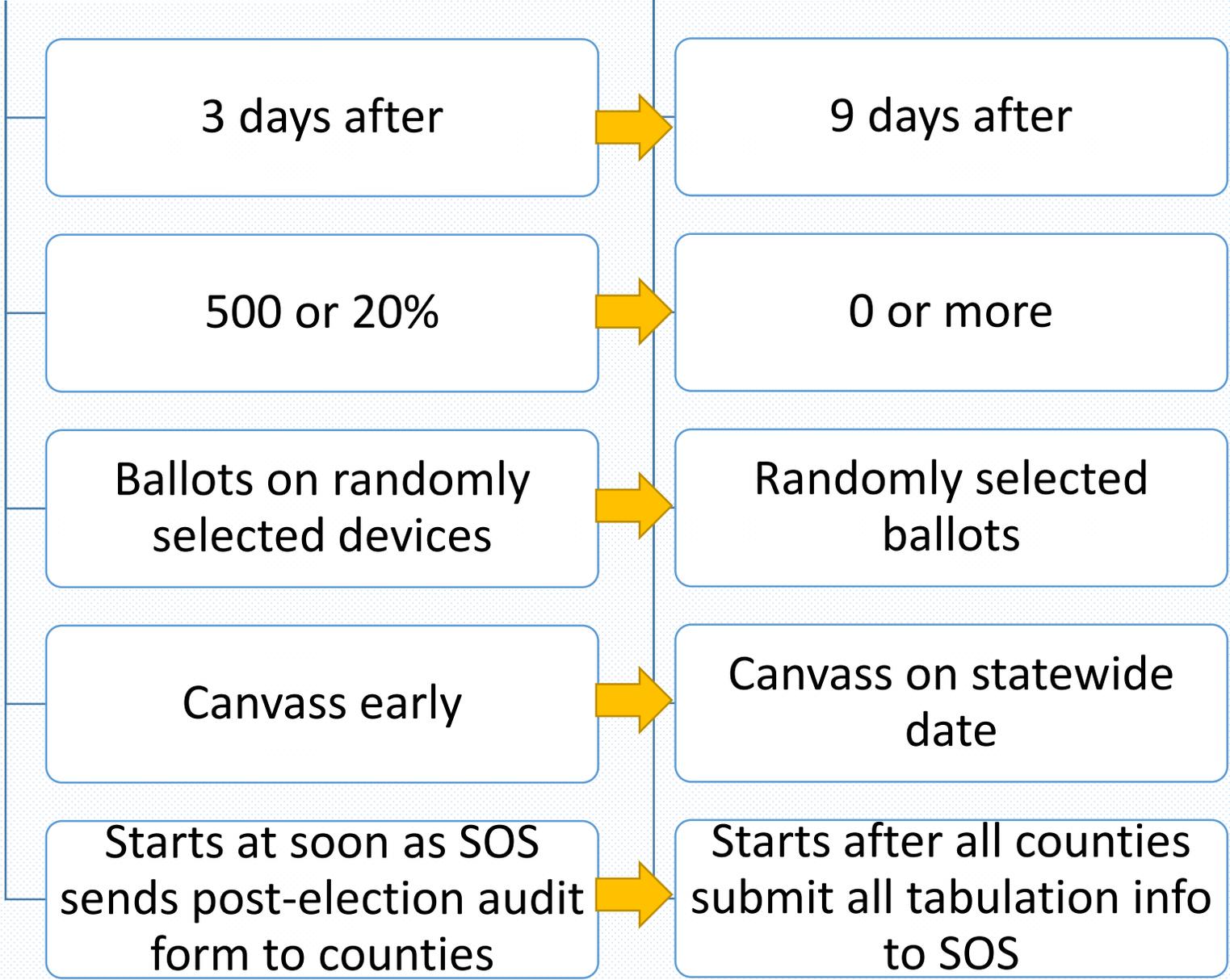
The number of ballots required to conduct an RLA will vary based on the smallest margin of the contest selected by the SOS and the risk limit. The smaller the margin, the more ballots to audit. The smaller the risk limit, the more ballots to audit.

RLA History in Colorado



Random

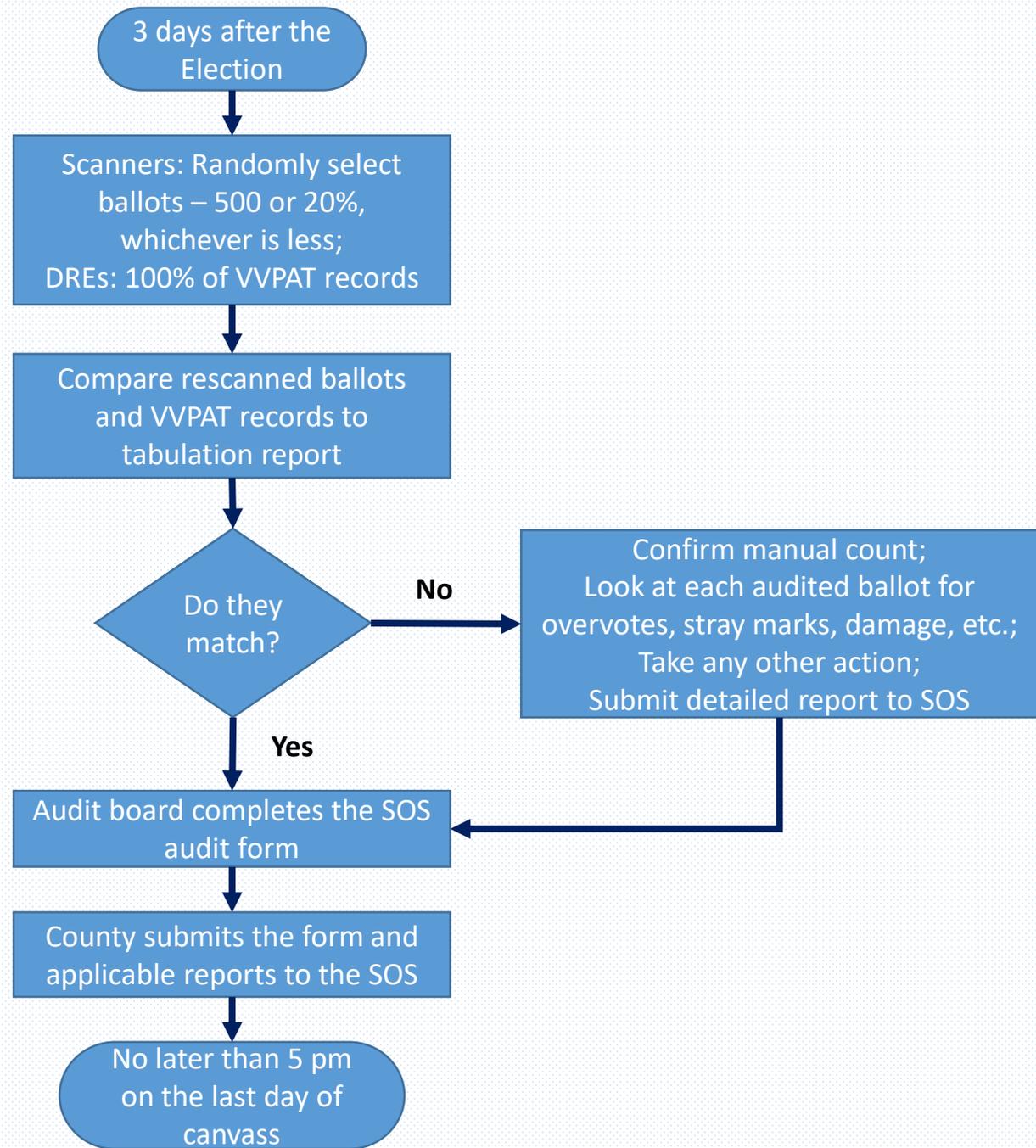
RLA



Random Audit

Pre-Audit:

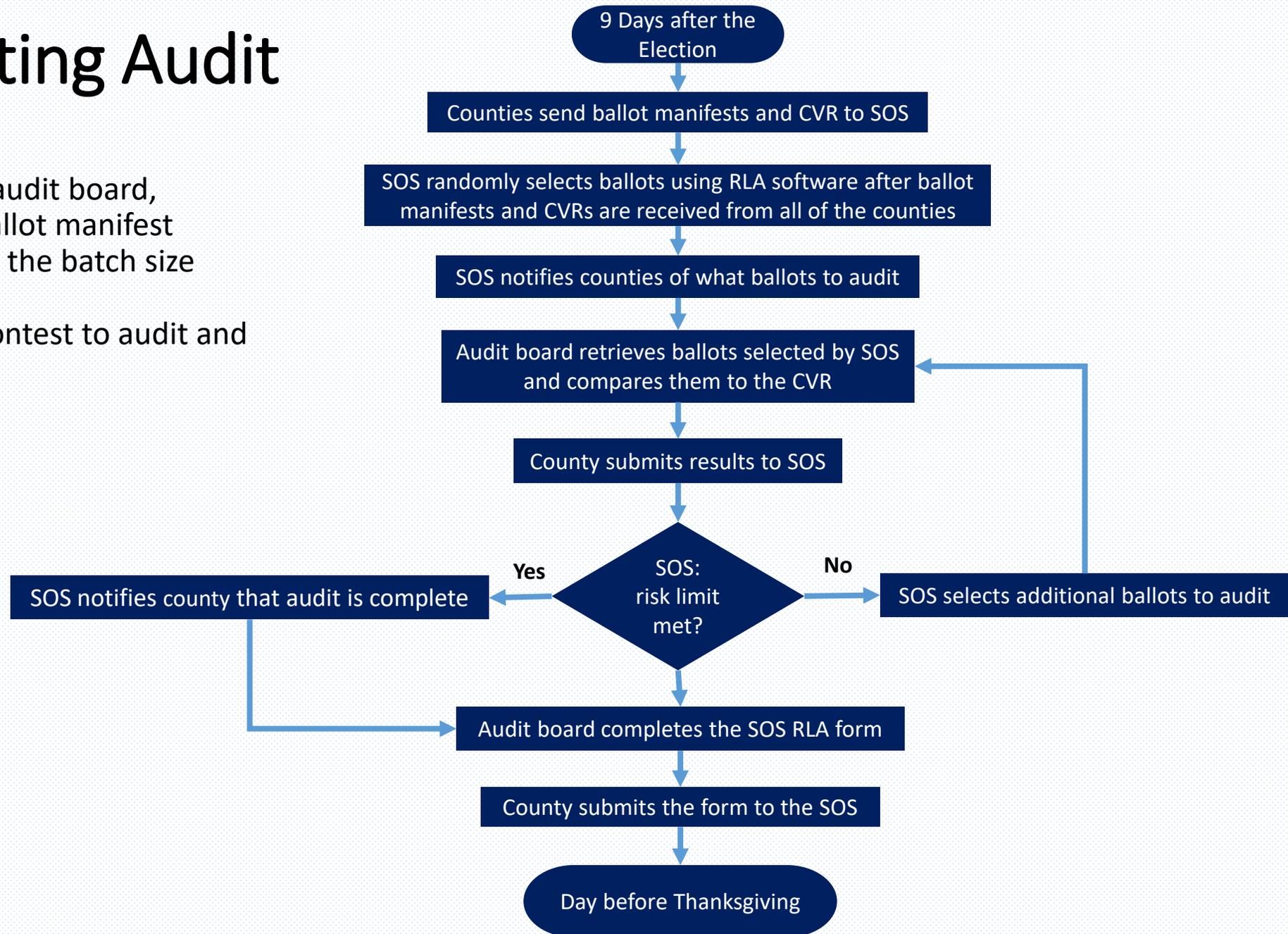
- County sends voting equipment inventory to the SOS and appoints an audit board
- SOS randomly selects equipment within 2 days after election night



Risk-Limiting Audit

Pre-Audit:

- County appoints audit board, downloads the ballot manifest form, and defines the batch size
- SOS selects the contest to audit and sets the risk limit



RLA Workload Examples

2016 Presidential Contest	
Total Ballots Cast = 2,859,216; Risk Limit = 5%	
Clinton	1,338,870
Trump	1,202,484
Smallest Margin = 136,386 Diluted Margin = smallest margin/total ballots cast = 4.77%	
Using Dr. Stark's comparison RLA algorithm, the number of ballots to audit is 142 for the whole state. (In our current audit, all counties are probably required to audit at least 32,000 ballots)	

RLA Workload Examples continued

City and County of Denver Referred Question 2A

Total Ballots Cast = 341,987; Risk Limit = 5%

Yes/For

235,595

No/Against

75,598

Smallest Margin = 159,997

Diluted Margin = smallest margin/total ballots cast = 46.8%

Using Dr. Stark's comparison RLA algorithm, the number of ballots to audit is **15** for the county.

(In our current audit, Denver is probably required to audit at least **500** ballots)

Benefits	Challenges
Should examine significantly fewer ballots than are required in the current audit	Potentially audit more ballots than are currently required, and if the outcome is incorrect, could evolve into a full hand count
Statistically based - the county manually inspects a number of ballots based on a statistical algorithm	Retrieving specific ballots can be more difficult than simply selecting ballots haphazardly
Check how the voting system interpreted each ballot	Requires maintaining counted ballots in the exact order they are scanned, or imprinting numbers on the ballots, in order to accurately compare a CVR to the ballot it represents
Should require fewer resources to conduct the audit	Will not be able to canvass early

RLA Tool Kit – what is required to conduct an RLA

- Ballot manifest – a document that describes how ballots are organized and stored
- CVR – an export of data from the voting system showing how the voting system interpreted markings on every ballot
- Hash utility – will create a hash value (digital fingerprint) for a county's CVR export
- RLA software³ – used to calculate the number of ballots to audit, randomly select the ballots, provide a ballot lookup table, and notify the user when the audit can stop.

Sample Ballot Manifest

- Batch size – the smaller the batch size, the easier to retrieve ballots
- Label all ballot storage bins for easy location and retrieval
- Maintain documented chain-of-custody for all ballot storage bins

County	Scanner ID	Batch #	# of Ballots Scanned
Fremont	Scanner1	4	49
Fremont	Scanner2	1	50
Fremont	Scanner3	3	51

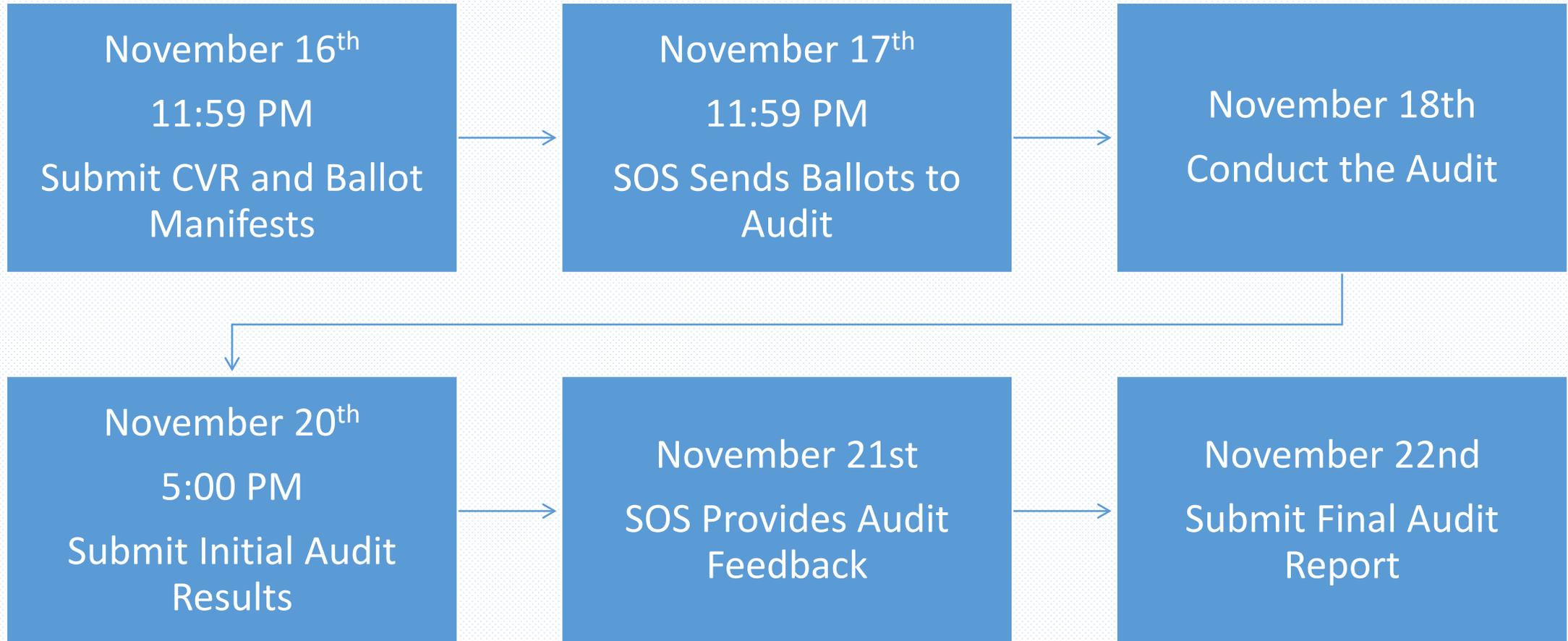
Conducting the RLA

1. County creates ballot manifest describing in detail how ballots are stored (County ID, scanner ID, batch ID, # of ballots in each batch)
2. County keeps ballots in the same order in which they are scanned or imprints ballots with identifying numbers
3. County secures and stores ballots
4. County exports CVR by 11:59 PM on the 9th day after the election and creates a hash of the CVR file
5. County sends ballot manifest and CVR to SOS by 11:59 PM on the 9th day after the election.

Conducting the RLA continued

6. SOS uses RLA software to randomly select ballots to audit and sends information to counties after ballot manifests and CVRs are received from all of the counties
7. County audit board retrieves the selected ballots and compares them to the CVR
8. County reports results of RLA to the SOS
9. SOS determines whether additional auditing is needed. If so, SOS sends county a list of additional ballots to retrieve and inspect.
10. County reports audit results and other pertinent data to SOS at the end of the audit

RLA Timeline



Lessons Learned

- Embrace the wide spectrum of opinions
- Don't get so caught up in how or why you are doing this and forget who will be doing this
- Don't lose sight of the big picture. Come to terms with the fact that there will be mistakes, but those stumbling blocks are simply opportunities to make it better.
- Be on the same page with your team – opposing philosophies can hinder progress
- Expect resistance – monumental change naturally brings resistance
- Plan, plan, plan, test, test, test, train, train, train...and then do it all over again

References

1. https://www.usenix.org/system/files/jets/issues/0301/overview/jets_0301_stark_update_9-10-15.pdf
2. <https://www.stat.berkeley.edu/~stark/Preprints/gentle12.pdf>
3. <http://www.stat.berkeley.edu/~stark/Vote/auditTools.htm#>
4. <https://www.stat.berkeley.edu/~stark/Preprints/RLAwhitepaper12.pdf>
5. <https://www.sos.state.co.us/pubs/elections/VotingSystems/riskAuditGroup.html>

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