Collaborative Public Audit

of the
November 2006 General Election

pursuant to the charge from the
Cuyahoga County Board of Elections

Final Report – Submitted on April 18, 2007 by

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Introduction

As is true of many initial audits, whether of a for-profit company or public agency, this Audit Report relates both "good news" and "bad news." While some readers may emphasize the bad news, we believe the overarching message should be that the Cuyahoga Board of Election's authorization for the November 2006 election audit is itself crucial good news about the agency's prospects for moving forward decisively.

We – the Collaborative Audit Committee and the coordinating Center for Election Integrity – strongly affirm that independent audits provide information to a public agency that will allow it to move forward with clear knowledge of its successes, and also of problems that need to be rectified. In the election context, audits permit the identification of problems with election managerial systems or technology, such as with voting machines or tabulation equipment, and thus allow an agency such as a local election board to develop an effective action plan for improvement. An election agency's adoption of a practice of full disclosure about (1) its efforts to identify successes and problems fully and impartially, and also (2) its plan to correct the problems, is *the path* toward rebuilding the public's respect and trust in reported election results.

Proposals to audit elections may raise internal objections because problems may be discovered that otherwise might remain hidden. But the absence of election audits works to both the agency's and the public's disadvantage: problems may remain unknown and uncorrected, and questions or charges about election accuracy continue, reducing public confidence in the agency. Any staff efforts expended to conceal problems not only wastes energies and reduces public confidence, but also means that when the problems do surface eventually, sometimes in a particularly injurious manner, the agency may be shaken to its foundations. Better, we believe, to discover the areas of success and those of needed improvement, and deploy resources to improve.

With the support of major political party county organizations, the Cuyahoga Board of Elections authorized this audit, for which we believe it deserves public recognition. While the Audit participants did encounter impediments and delays to the auditing process, we believe that even these provided opportunities for learning more about the administrative, technical, or legal changes that need to occur to smooth the process for auditing elections as a routine matter.

Even though this election audit cannot provide conclusive results on e-voting device accuracy, and could not be completed in the expected time frame because of a wide range of local managerial issues, we believe it provides an important first step toward election auditing in Cuyahoga County and in Ohio. We hope that this Audit Report will assist the Ohio Secretary of State, all Ohio local Boards of Election, election reform organizations, and other election officials nationwide in seeing how an independent audit process can be created and function at the local level. Additionally, we hope the public will recognize that this Report contains the kind of information that all election administrative agencies need to better achieve the public charge for producing accurate election results and to facilitate sound improvements in election administrative practices.

Executive Summary

An independent audit of the *unofficial* count of the November 2006 election in Cuyahoga County was undertaken collaboratively through representatives[1] by both major political parties and a number of election reform organizations. Cleveland State University's Center for Election Integrity and the Northern Ohio Data Information Service coordinated the audit process and technical services, and also supplied methodological guidance and statistical analysis.

The representatives of the organizations, and the volunteers assisting, conducted two collaborative audits. They are described here along with some terminology that will be useful in understanding the audit results.

♦ A random sample of election reports from DRE touch screen voting machines was compared for consistency with the report of precinct election results from the GEMS tabulation computer.

- The DRE voting machine produces a "Long Report" after the election has closed with vote counts for each race/issue in each precinct.
- The central ballot tabulation system software is named GEMS. The GEMS tabulation reports provide election results.
- The SOVC Report is the comprehensive Statement of Votes Cast report from the GEMS server. It shows the total votes cast for each candidate and issue by precinct.

♦ A hand count of a random sample of absentee or "early voting" ballots was compared for consistency against a GEMS report of electronically tabulated election results.

- Early/absentee ballots are optical scan paper ballots with voter selections marked on the ballot by the voter.
- These ballots are read by an optical scan reader and with the voting information transmitted into the GEMS system.

This audit did not evaluate: internal controls of the CCBOE; security procedures or chain of custody for the Long Reports; or the consistency of individually cast DRE ballots with the totals recorded on the DRE unit's Long Report. Additional audit procedures would be needed to evaluate these areas and were beyond the scope of this audit.[2] For a complete explanation of all the findings, please read this entire report.

Selected Findings

A. <u>DRE Touchscreen Voting Machines: Audit of the "Long Reports"</u>

> ***Conclusion One*** There is a high probability that the DRE Long Report (precinct) results match the GEMS produced election results published on November 8, 2006.

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[1] For the list of individuals and their credentials who participated in the Audit Committee, see the cover page. For further background on the authorization of the audit, see Appendix 1.

[2] The impediments posed by Ohio state law to more complete auditing are discussed at II. B and III. B.

Recommendation: We recommend that a random, independent audit of the election results be performed before CCBOE certifies the election. (See Top Tier Recommendation #1 *below*).

Conclusion Two Expecting a complete set of DRE Long Reports with all data clearly recorded for all precincts currently is <u>not</u> realistic.

Recommendation: As part of the planned security review, the CCBOE should assess the viability of using Long Reports as part of their overall security plan, and should take into account in selecting voting systems the ability to achieve full verification of the accuracy of election results.

Conclusion Three A number of DREs had been vendor-marked with non-unique serial numbers; several pairs of DREs were identified within the sample as having serial numbers duplicated in other DREs owned by CCBOE.

Recommendation: Resolve the non-unique DRE serial number problem by taking a number of actions with Diebold and internal tracking of serial numbers.

B. Optical Scanning: Audit of "Early Absentee Ballots"

Conclusion One Election result data in the GEMS report corresponded closely to the results obtained by the audit hand count of the optical scan ballots.

Conclusion Two The sorting process for early absentee optical scan ballots into precinct batches prior to scanning was neither complete nor accurate.

Recommendation: Hand sorting into precincts and batches should be replaced by a more automated system with appropriate quality control measures.

Conclusion Three There was a very low frequency of discrepancies that appears to be caused by a scanner misreading of some of the optical scan ballots.

Recommendation: An audit similar to this, comparing electronically recorded optical scan results to those obtained by hand-counted examination of the optical scan ballots, should be performed after every election and before certification**.**

Conclusion Four **S**ome ballots were apparently scanned for the tabulation at one point but were not included in the GEMS elections results or on the SOVC, probably because the ballot batch had been deleted (because of flawed data) and then was not rescanned.

Recommendation: Deletion of ballot batches must have greater quality control to ensure re-scanning of the deck.

__Conclusion Five__   Some ballot batches were scanned twice producing a double-count of those ballots and their votes.

> *__Recommendation:__* The electronic identification of an optical scan ballot batch should be unique and constant; and greater quality control measures need to be introduced to ensure all ballot batches are counted only once.

__Conclusion Six__   The electronic identification of a ballot batch may change within the scanning process and between scanning events, reducing the ability to accurately track that the ballot batch has been counted, and counted only once.

> *__Recommendation:__*   A mechanism should be developed to record and track batches of ballots with appropriate quality control measures.

C. __Security, Accuracy, and Sufficiency of the Data Needed for Auditing__

__Conclusion One__   The CCBOE's lack of compliance with its own electronic and physical security policy is unacceptable.

> *__Recommendation.__* An independent assessment of the security policy's adequacy and its implementation within the CCBOE should occur.

__Conclusion Two__   Some indicators of *possible* database corruption were identified in an initial database integrity evaluation.

> *__Recommendation__*:   The CCBOE should initiate an independent evaluation of the GEMS tabulation database by a qualified consultant to ascertain whether database corruption occurred in the November 2006 election.

Top Tier Recommendations for Systemic Improvement

1. __Independent audits should become a routine part of the election process.__

Independent auditing is standard business practice and should be applied to our election and voting systems because of their importance. A reasonable approach might be to perform a professional or other independent audit after each major election and a collaborative internal audit after smaller local elections. The time and cost involved do not need to be exorbitant and will decrease as problems are resolved and process controls put in place. The audit should occur prior to certifying the election.

Although this audit found a relatively small number of ballot batches that had been miscounted in the unofficial optical scan count, the audit identifies problems that indicate proper procedures for tabulation accuracy were not consistently followed. Institution of routine independent audits will facilitate tabulation accuracy, and administrative and technical improvements, and thus demonstrate to the public that confidence in the election process is well founded.

2. Reconsider the feasibility and wisdom of supporting two major voting systems: optical scan and DRE touch screens.

The problems found in this audit, the Election Sciences Institute audit of the May Primary, and report from the Cuyahoga Election Review Panel (July 2006) call into question whether it is practical and cost effective for Cuyahoga County to support two voting machine systems (i.e., electronic and optical scan). Some factors to be considered include:

- Election costs for 2006 substantially exceeded the budget allocated;
- It is unclear if DRE electronic voting can support the turnout in a Presidential election;
- CCBOE staff must be hired and trained to support both systems, and have not reached high performance standards in managing either system; by focusing on one system higher performance standards can likely be met more quickly.
- The DRE devices present considerably greater hurdles to cost-effective and complete auditing than do paper optical scan ballots.

3. A comprehensive evaluation of the election database should be undertaken by qualified technical professionals who are independent of voting system vendors.

Some indicators of *possible* database corruption were identified in an initial database review but were not investigated despite the Monitor's repeated urging. In an independent evaluation of the GEMS official results database the task should be:

- to ascertain whether database corruption occurred in the November 2006 election database,
- and if so, to determine the scope and impact of any corruption for the tabulated and reported results; and
- in light of Microsoft warnings, to provide recommendations on how to avoid tabulation database corruption to the maximum extent feasible, delineating the steps to be taken to protect election data as tabulations are occurring.

Glossary of Terms Used

Absentee voter: Voters who cast their ballots before Election Day, by mail or in-person at the Board of Elections; they do not vote at a precinct polling place.

Absentee audit: An audit of the optical scan ballots used by absentee voters.

Batch: The digital representation of a scanned deck (or decks) of optical scan ballots as recorded by GEMS.

CCBOE: As commonly used, this term can confusingly designate either the *agency* that conducts elections in Cuyahoga County -- the **C**uyahoga **C**ounty **B**oard **of** **E**lections—or its four-member governing *Board*. In this Audit Report we use CCBOE to refer to the agency as a whole, which includes its staff as well as its governing Board. The Board is comprised of two Republican and two Democratic members who normally are nominated by the local major political parties and then formally appointed by the Ohio Secretary of State.

CAC: Collaborative Audit Committee—the representatives of the two major political parties and three election oversight and advocacy organizations (see cover page) who composed the policymaking arm of this Audit.

CEI: Center for Election Integrity of Cleveland State University, which was appointed to serve as the Public Monitor of Cuyahoga County election reform by both the Cuyahoga Board of County Commissioners and the Cuyahoga County Board of Elections.

CERP: Cuyahoga Election Review Panel. The Panel was appointed by the Cuyahoga County Commissioners and the Board of Elections to review the 2006 Primary Election and make recommendations for improvement. The Panel published a final report on their findings, known as the CERP Report (www.csuohio.edu/cei/).

CSV file: Comma Separated Values file; a file format used for data files that permits them to be read on a variety of computers.

Deck: The electronic representation of a batch of optical scan ballots that will be scanned together and whose votes will be reported to the GEMS database as a unit.

DESI: Diebold Election Systems, Inc. the subdivision of Diebold, Inc. that manufactures and markets election voting systems and technical consulting services. Cuyahoga County uses Diebold's

DIMS: This is the software program Diebold Election Systems markets for recording voter registrations, processing absentee ballot applications, evaluating candidate or issue petitions, and managing poll worker information (It is the acronym of Data Information Management System). The Cuyahoga CCBOE uses DIMS in all of these ways. DESI materials note it interfaces "seamlessly" with the GEMS election tabulation software but this interface has been highly problematic in our County.

DRE: a type of electronic voting machine where the machine electronically records voters' choices (Direct Recording Electronic). In Cuyahoga County, the DRE model that is used is a Diebold AccuVote TSX with VVPAT printer. This DRE is a "touchscreen" where the computer monitor shows the ballot, and the voter "touches" rectangular boxes shaped to look like buttons to simulate the pushing of a button under a ballot choice. Most of Cuyahoga County voters currently vote on DREs at the precincts on Election Day.

EAC: U.S. Election Assistance Commission. The EAC was established by the Help America Vote Act (HAVA). It disbursed federal funds to States for replacing their voting systems. Currently, the EAC's prime task is to facilitate election administration improvements. It serves as a national clearinghouse and resource for information pertaining to the administration of federal elections, including for the technical aspects of voting systems.

EDT: Election Day Technicians, a special poll worker position created by the Cuyahoga CCBOE to activate and manage the DRE touchscreen units at polling locations.

Election certification: Formal approval of the CCBOE is required to officially confirm the results of an election. The date for certification is established by Ohio statutes.

ESI: The Election Science Institute is a nonprofit, nonpartisan election management-consulting firm located in San Francisco that was retained by the Cuyahoga County Commissioners in April 2006 to evaluate the accuracy of the DRE touch-screen voting units. ESI conducted an audit of the individual printed ballots cast on DRE units in the county's May 2006 Primary election.

E-voting: refers to "electronic voting." While the term is somewhat contested as far as its scope, generally it refers to any device on which voters cast ballots, or any election system where the reading, recording or tabulation of votes cast involves computers.

Flash memory: Internal computer memory within each DRE touch-screen unit, which stores election, results until erased. Votes cast on the electronic voting machines are recorded in two places: 1) the memory cards that are inserted before the election and removed after the election for counting, and 2) in flash memory located on a computer chip which remains inside the voting machine.

Firmware: Vendor-installed operating software.

GEMS: this is an abbreviation for a computer software program (Global Election Management System) that Diebold Election Systems sells for the creation of electronic and paper ballots, and to serve as the central tabulation program for recording and counting votes. The Cuyahoga CCBOE uses GEMS in all these ways.

Long Report: From the DRE units, a paper printout of the summary election results (votes sorted into candidate and issue, presented by precinct) for all the ballots that were cast on the one DRE voting machine from which the printout was generated (from an integrated printer).

Memory card: A removable electronic disk similar to a "floppy" that records the votes cast on a DRE voting machine. In Cuyahoga County, the memory cards are inserted into the electronic voting machine before the election, removed at the end of the election, and delivered to the

CCBOE where the voting data are uploaded to GEMS to count the votes cast on the DRE machine and recorded on the memory card.

NODIS: Northern Ohio Data Information Service, the regional data center located at Cleveland State University. NODIS provided statistical and other professional support for the Collaborative Audit.

Optical scan ballot: A paper ballot, which in November 1006, was divided into three columns. The ballot lists each race or issue with ovals beside each voting choice. To cast a vote that can be accurately read by the counting machine ("scanner"), the voter colors in the oval that reflects the voter's choice.

Optical scanner: The computerized device used to read and record the votes marked on paper ballots ("optical scan ballots"). Each scanner is connected to the GEMS computer by a wired network, where the GEMS program tabulates and reports election results.

PDF file: Portable Document Format, a type of file format.

Precinct: A geographic subdivision of a county, town, city, or ward for election purposes.

SOVC Report: The comprehensive Statement of Votes Cast report from the GEMS server. It can show the total votes cast for each candidate and issue by precinct.

VVPAT: By Ohio statute, every DRE unit must be equipped with a printer that will produce for the voter's review a Voter Verified Paper Audit Trail. The VVPAT is the printout of each voter's selections. After it prints, the voter must push a button affirming that this is the VVPAT correctly presented the voter's choices in order for the ballot to be officially cast and counted. The VVPAT is the official legal ballot of voters who vote on DRE units in Ohio.

FULL REPORT

Collaborative Public Audit for Cuyahoga County

I. Background: Achieving Independent Verification of Election Results

Achieving accuracy in reported election results is a primary objective for any quality election administration.   Given the range of recent information reported nationally about possible problems with e-voting technologies, and also some of the problems the Cuyahoga County Board of Election (CCBOE) experienced in prior elections, local election reform organizations and the major political parties sought to have the county's election results independently verified as accurate reflections of the ballots cast in the November 2006 election.   In early fall, the chief initial public concerns focused on the DRE touchscreen voting devices which were to be used at polling places on election day.

After discussions with election reform organizations about their concerns, the Public Monitor of Cuyahoga Election Reform[3] introduced at a Board of Elections public meeting a proposal for a Collaborative Public Audit. The proposal pledged that the Monitor would seek the cooperative involvement of the local Democratic and Republican Parties, plus several election reform organizations to conduct the independent audit. The proposal also requested the CCBOE to send a representative to the audit-planning group.[4]   Per the reform organizations' requests, the audit was to focus on the Diebold DRE touchscreen voting machines that are primarily used in Cuyahoga County for Election Day voting at the polling locations. Later, by political party request, the audit was expanded to encompass the optical scanning operations.

→ *Further background information on the process for obtaining authority to conduct the audits, and the participants and governing structure, can be found in Appendix 1.*

The Collaborative Audit participants believe the public deeply desires independent verification that the election results that the e-voting technology has generated are accurate. We additionally suggest that both the election administrative staff and the public at large need to know whether the voting machines' programming maintained its integrity after the machines passed the pre-election testing and were deployed to the polling locations for Election Day.   Reliable information on these and other questions are crucial so that sound decisions can be made as to the voting and database technologies we used and so that any corrections in administrative or other systems that are needed can be identified.

We believe that yet another reason led to broad support for election auditing in our county. Our local and statewide election reform organizations (and perhaps also the county political parties) supported the initiation of election auditing to increase incentives for the administrative staff effort to reach higher standards of tabulation and reporting accuracy, and to deter the prospect of

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[3] The Center for Election Integrity of Cleveland State University per a proposal and testimony prepared by its Director, Candice Hoke.

[4] After numerous requests for a representative or liaison who would serve as a non-voting member of the Audit committee, the CCBOE Director declined to authorize a representative.

tampering.   The thought was that CCBOE managers would desire the independent audit "report card" to be a positive report regarding the accuracy and management of the election.

A national Election Audit Workgroup teaming the Brennan Center with the Samuelson Law, Technology & Public Policy Clinic at Boalt Hall School of Law (UC Berkeley), as well as several election officials and leading academics has been working to evaluate current audit laws and procedures, and to provide critical analysis to public officials as they begin to adopt audit schemes and procedures. The Workgroup has thus far identified five core goals that should motivate the design of election auditing: increasing public confidence in the results of an election; deterring fraud against the voting system; detecting large-scale systemic errors; providing feedback that will allow jurisdictions to improve elections and machinery in future years, and confirming to a high level of confidence that a 100% manual recount would not change the outcome of the race.

We agree strongly with this statement of election auditing design goals but would add a sixth: providing additional incentives for the staff to reach higher standards of accuracy.   In order to achieve these six and other auditing goals, we have concluded, as has the Election Audit Workgroup, that the independence of the auditing entity is essential.[5]

Largely because of the unexpected impediments to election auditing that the Cuyahoga effort encountered, this audit might best be considered a pilot program for identifying the necessary procedural or informational components that must be in place in order to conduct an effective audit of two different types of voting systems. Some of these components can be achieved by local Board of Election policy and procedural changes but others will likely require the Secretary of State's action. Still other impediments exist because of State statutory law but this audit may assist in identifying the legislative action that would be warranted.

While the audits that were conducted are limited rather than comprehensive and conclusive on the questions of accurate tabulation of election results in November's election, the information acquired should be useful for achieving the other election performance and auditing goals identified above.

The Collaborative Audit Committee would like to thank the over forty volunteers that gave their time over numerous days to help conduct this audit. Without this huge volunteer effort, this audit would not have been possible. We also commend the Cuyahoga Board of Election for taking an Ohio leadership role in initiating election auditing and thus creating an independent mechanism for verifying the announced election results.

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[5] Lawrence D. Norden, Statement to the U.S. House of Representatives, Committee on House Administration, Subcommittee on Elections, March 20, 2007 at 2; Candice Hoke, Statement to the U.S. House of Representatives, Committee on House Administration, Subcommittee on Elections, March 20, 2007 at 2 (this testimony to the Subcommittee on Elections that held hearings on Federal Election Auditing can be found at http://www.verifiedvotingfoundation.org/article.php?id=6445).

II. DRE Touchscreen Voting Machines: Audit of the "Long Reports" as Compared to the GEMS Tabulation Computer

A. Background

On Election Days, most Cuyahoga County voters now cast their ballots on an electronic voting device called a "DRE touchscreen." This device allows voters to read their ballot on the computer screen and push buttons on the screen to register their voting choices. At the end of choosing their voting choices, the DRE produces a summary page on screen to allow the voter to check to see whether the machine has recorded the individual's votes correctly. The voter can choose to return to earlier pages and change a vote. (Technically, a DRE voting device is a "direct recording electronic" voting machine that maintains an internal computer chip memory of ballots cast as well as records the same data on a removable memory card.) Cuyahoga County owns approximately 6,000 Diebold DRE voting devices.[6]

How and why "Long Reports" are produced. Ohio statutory law requires that all DRE units produce a "voter verified paper audit trail" or VVPAT. When a citizen uses a DRE touchscreen to vote, the unit prints for the voter's review a list of the ballot choices the voter made so that the voter can verify his or her vote before pressing a button that essentially means "yes, the printout of my voting choices is correct; count this ballot as is." The paper on which this statement of voting choices is printed is called the VVPAT.

Cuyahoga County has administratively organized its elections so that all the DRE units in a voting location (for instance, a school gym) can be used by voters from any precincts assigned to that location. The poll workers are trained to encode the "voter access card" so that the machine will bring up on screen the correct ballot for the precinct in which the voter is registered.

At the end of the night after the polls have closed and the DRE touch screens are being closed out, the poll workers command each DRE machine to print its "Long Report." The Long Report is of varying length but a constant three inches wide (in rough dimensions). The quality of the paper is similar to a cash register receipt. The print font is smaller than many register receipts.   (See Appendix 5 for a Long Report example).

The DRE "Long Report" summarizes in print (on the register-receipt paper) the election results for the ballots that were cast on that particular DRE unit. Each unit's Long Report reflects the internal DRE unit's computer sorting of all ballots and results voted on that DRE unit, providing results by precinct for every race and issue that is present on the ballots that were voted in that location. The Long Report does <u>not</u> reproduce the individual voter's ballot choices; these records are sealed on election night and not opened unless needed for a recount.

In voting locations that are assigned many precincts, the Long Reports can extend well over 20 feet since the results of each precinct must be separately stated on the Long Report. For instance, a voting location with eight precincts but with virtually identical ballots for each

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[6] Cuyahoga County uses the Diebold AccuVote TSX with VVPAT printer.

precinct will produce Long Reports that will state the results for U.S. Senate, for Governor, for Attorney General, etc., eight separate times to reflect each precinct's election results. The audit volunteers had to examine closely the Long Report for every DRE unit in a location (which could number as many as 40 units) to locate and record the results for the particular precinct that was randomly selected for the audit.

B. Objectives and Limitations of the Audit

Objectives. The objective of the DRE-GEMS portion of the audit was to determine whether the votes cast in the precincts as represented in the Long Reports are accurately recorded in the CCBOE's GEMS (central computer election tabulation) results report for the *unofficial count*[7] of the election (meaning the election results that were generated on November 8, 2007 not including provisional votes or absentee votes). This audit would thus check to see whether the DRE memory cards' recording of votes that were transferred ("uploaded") into the GEMS computer matched the Long Report results that were printed at the precinct on election night before the memory cards were pulled out and sent to the CCBOE offices[8].

Unexplained discrepancies could mean:

- The voting data on the DRE memory cards became corrupted, lost or altered at some point after the Long Reports were printed from the memory cards at the polls to the point at which the GEMS unofficial report was printed, or

- The GEMS database lost/failed to receive data from the DRE memory cards.

The audit analysis consists of two parts:

(1) A comparison of precinct-level counts between GEMS-produced data provided by the CCBOE (in "csv format") with Long Report data collected by volunteers from a sample of precincts; and,

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[7] Unofficial results count most but not all ballots. The unofficial results are typically announced late Tuesday night or early Wednesday. In Cuyahoga County, the unofficial count excludes, for instance, provisional ballots, some late arriving absentee ballots, and optical scan ballots cast at the polling places by curbside voters.

[8] It may appear at first blush that the DRE memory cards' arrival in the CCBOE offices for "uploading" is an easy task to achieve. Actually, the process has numerous junctures where an error can lead to an inability to produce complete and prompt election results. A few of the steps are:

- Poll workers must understand the sequencing of closing steps so that they eject the memory cards at the correct time
- All DRE units must be checked to ensure that all memory cards have been collected
- All memory cards in a polling location (which in our county can number high as 40) must be counted and packed into the appropriate bag and sealed.
- The driver/transportation for memory cards must arrive on time and transport the cards quickly to the CCBOE offices

As we have observed locally, the opportunity for mistakes and potential threats to the integrity of the memory cards inhere in the DRE voting system.

(2) An analysis of the "auditability" (ability to be used for an effective audit) of the Long Reports, which concerns their illegibility or unavailability (e.g., due to paper tears, printing jams, or absence from the appropriate envelopes).

Limitations. This DRE-GEMS audit was limited because of (1) Ohio election law and (2) resources. When we obtained authorization for the DRE audit, we presented an ambitious plan for conducting it right after Election Day but before the certified count occurred. This timing was designed so that if any discrepancies were found, they could be investigated and corrected before the legal certified count occurred.[9]

Conducting this audit before the certification meant that the VVPATs of individual voters' ballot choices were off-limits to witnesses and CCBOE staff. State law compelled the VVPATs to remain under seal until the recounts occurred, to protect the integrity of the ballots. (Ohio law explicitly makes the VVPAT record the official ballot and not the electronic ballot when a recount occurs.) Recounts are permitted only after certification. Hence, we could not obtain access to the individual ballots to check whether the Long Reports added the votes correctly.

Even after the optical scanning audit was added to the audit and we knew that we had to wait until after the recounts to conduct that portion of the audit, we did not request to conduct a more exact audit of the DREs' individual ballots to determine whether the Long Reports accurately reported these votes. Our reasons included:

- We knew that we could not produce the number of volunteers necessary for such an audit in mid-late December;
- We believed that we had a significant auditing project already and this was sufficient as a first step in local election auditing;
- We explicitly stated at the time the audit was proposed that it was not the broadest, most optimal election audit that could be run, but we believed it to be a strong initial step toward independent verification of election results;
- Finally, given that the CCBOE Board had planned to initiate a professional audit, any auditing beyond our Collaborative Public Audit effort could be left to the professional auditors.

Our DRE audit also cannot check the accuracy of the GEMS results as compared with individual DRE unit Long Reports. The lowest level of GEMS tabulation results available to us was the results for the precincts – not for individual DRE units. Thus we could not audit a selection of DRE units' reports against the GEMS reported results but could only audit down to the precinct level. This limitation was thus a function of the software design (as represented to us by CCBOE Ballot managers) rather than our auditing policy choice.[10]

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[9] Many unanticipated impediments and delays occurred which, with new management and logistical planning at the CCBOE, should not occur in future audits.

[10] Further investigation of whether the GEMS software product has the ability to produce election data by DRE unit should occur; this question was beyond the scope of this audit.

C. Methodology

Overview.   Rather than audit 100% of the precincts, audit methodology and statistical science have shown that auditing a random selection of precincts can predict what the error rates would be if all the precincts were audited. The number of precincts to be audited to achieve a 99% confidence level in the predictive capacity of the sample will differ according to the closeness of the results. Closer elections require auditing a higher percentage of precincts.[11]

The Collaborative Audit participants met prior to the election to plan the audit tasks and procedures. Within 48 hours after the unofficial election results reporting, the Audit Committee met to select the races to be auditing. The Committee's selection process resulted in the choice to audit the following three races in the DRE-GEMS audit:[12]

- Ohio Auditor General race between Barbara Sykes and Mary Taylor
- Cuyahoga County judicial race between Hollie Gallagher and Jeff Hastings
- Ohio Supreme Court contest between Terrence O'Donnell and William O'Neill

To ensure that all three races audited in the DRE-GEMS analysis would have a very high level of predictive reliability, the Collaborative Audit Committee (CAC) chose to use the closest race (among those selected for auditing) as the determinant of how many precincts would be audited.

To determine which of these races had been the closest electoral contest, the CAC relied on the unofficial election results reports. These reports included the votes recorded at the polling places on DRE units and also the early absentee optically scanned ballots. If the race was a statewide race, then two results reports were used to determine the electoral margin between the candidates: (a) the state unofficial results and (b) our county's unofficial results. This statistical analysis determined the need for a random sample of 132 precincts to produce a 99 percent confidence level. (See Appendix 1 for complete description of the sampling methodology.)

Dr. Mark Salling and his NODIS team generated a random selection of 132 precincts.   The selected precincts were not known to anyone in the CCBOE or in the CAC prior to the audit team's arrival in the CCBOE offices for the audit when Dr. Salling provided the list so that the selected precinct envelopes could be pulled from the sealed bins.[13]

Volunteers and professional staff conducted the DRE-GEMS audit of the Long Reports on November 9 and 14, and December 1, 2006. NODIS professionals created a paper form for audit data to be recorded from the Long Reports.   (See Appendix 2 for a sample form). Volunteers were trained on site on where to find the correct data and how to record it on the form.   The requested data included:

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[11] Norden testimony to Elections Subcommittee, see note 3 above,
[12] The CAC selected county or statewide races, with each political party selecting a race and the civic groups selecting the third race.
[13] We recommend that public viewing of the random selection of precincts occur, or that the process be videotaped with the original tape provided as a public record per the Brennan Center report.

- total votes recorded for each candidate in the selected precinct in each of the three electoral contests;
- total ballots cast for the selected precinct;
- DRE serial number;
- audit materials integrity information concerning whether the Long Report was torn, incomplete, or reflected printing problems;
- whether the report was signed at the bottom, as required by Ohio law, by at least four persons (pollworkers); and
- identification of the audit team recording the data.

After the volunteers recorded the Long Report data on the paper forms at the CCBOE offices, copies of these raw data forms were made and held for distribution to each participating organization if requested. The raw data was subsequently entered into a computer at Cleveland State University for further processing and reporting. Center staff then provided copies of the electronic data spreadsheet recording the raw data and copies of the paper raw data forms that were filled out by the volunteers to each participating organization so that they could check the data entry themselves. Special procedures were designed to prevent errors in volunteers' data collection, to verify the data in an ongoing manner, and to provide a traceable path that could be checked and permit correction of errors in case any were discovered.

Detail of Chain of Custody and On-site Audit Activities. The first on-site step in the audit process was locating the envelopes for the selected precincts. The Long Reports, as mentioned above, are long cashier tape paper rolls printed from each DRE within a given voting location. On Election Day evening, as the polling place materials arrived in the administrative offices for tabulating the vote, CCBOE staff removed (in front of trained witnesses) the extraneous materials from Long Envelopes (that had been sealed at the polling places) and then replaced the Long Reports in the correct precinct envelope with a new seal.[14] The staff then placed all the Long Envelopes (that were labeled with a polling location name and that had been stuffed with the Long Reports) into bins that were sealed with recorded seal numbers. The staff did not file the Long Envelopes in any particular order, thus the volunteer auditors had to check each bin seal to ensure the unbroken chain of custody. They then searched through approximately 40 large bins to find the polling place Long Envelopes that would contain the randomly selected precincts' Long Reports.

Working in teams of two and seated at tables in the same room where the polling place materials had been processed on Election Day, the volunteers examined each Long Report from a given polling place to locate the precinct results for the three races to be audited. Because voters from all precincts assigned to the location could use any DRE within their polling place, every DRE Long Report used in a particular polling place had to be examined for whether any of the chosen precinct's voters had cast ballots on that machine. Unrolling and re-rolling the narrow and relatively fragile Long Reports (which could easily stretch over

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[14] Midway through the night, the CCBOE staff ceased resealing the envelopes because of time pressures and chose to rely on the storage bins being sealed.

20 feet long) was a very time-consuming and tedious process.[15] Selected precincts that were located in a polling place having few DRE units were much quicker to audit since fewer Long Reports had to be analyzed.

For each precinct analyzed, the volunteers took an audit data form and recorded at the top their names, the time they started, and the time they finished. For each Long Report, they recorded the DRE serial number printed at the top of the Long Report, the total number of ballots cast from that precinct, and the number of votes recorded for each candidate in the three audited races. They also noted and recorded information and characteristics about the report (e.g. if it was torn and how many poll workers signed at the bottom). The name of the polling place stated on the Long Report was always verified.

By working in pairs, each data step was double-checked by at least one person. One person read the results off the Long Reports while the other recorded the data. Periodically, they were then required to confirm each other's work.

Evaluating the Audit Data   The data that volunteers recorded at the CCBOE was entered into a computer. Then this Long Report data was compared by precinct to GEMS-produced data (on electronic files), with careful notes as to which results did not match in all races and total votes cast. Professional staff looked for and corrected any computer data entry errors that resulted in any of the unmatched results and then examined the data recording sheets for factors that would account for unmatched counts. When there were discrepancies that could not be explained, volunteers returned to the CCBOE to pull the appropriate Long Reports and double check their auditing work. By following this approach, we were able to ensure that no discrepancies occurred because of auditor data-recording errors.

The Center's professional staff also calculated the frequency of discrepancies that occurred as well as all Long Report materials problems (e.g., torn, incomplete, or unsigned).

D. Findings

Comparison of Counts and Accuracy of the Tabulation.   Among the 132 precincts for which we recorded Long Reports data, 95 precincts' election results data for the three races and total ballots cast perfectly matched the GEMS computer data for all three races and total ballots cast. While it is possible that the Long Reports data match the GEMS data only because of balancing errors in both, the probability of that occurring is extremely small. Thus we conclude that since the data in the DRE Long Reports correctly matched the GEMS counts for those precincts and within the limitations discussed above, both sources of data correctly presented the votes for those precincts and election races.

Among the remaining 37 precincts (see Appendix 6 "All Unmatched Precincts"), for some precincts the data collection was harmed owing to torn or illegible Long Reports that affected only a portion of the three races to be audited. Wherever we had a complete set of results for a chosen race, we compared those races even if one or both of the other races' data could not

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[15] By chance, the largest polling location in Cuyahoga County, Brook Park -- having 40 DRE units – was in our random sample. So we had to analyze all 40 Long Reports in order to record the one selected precinct's data.

be analyzed because the Long Report was torn or quit printing in precisely the location where that needed data was located. We found that Long Reports from six more precincts had sufficient data that at least some of the three races were auditable. For each race that could be audited, the Long Report data matched the GEMS computer data exactly.

The other 31 precincts, however, were not auditable because, owing to one or more materials problems with the Long Reports (including missing reports, reports that were torn, reports reflecting printing problems due to printer jams), some essential data was not available for each of the three races we were auditing. The Long Reports deficiencies for these 31 precincts were noted by volunteers when they were attempting to record all the requisite election data needed.

Missing or defective Long Reports led to an inability to audit a sample size as large as originally planned. The sample design attempted to take into account a limited number of such problems by adding another 20 percent to the sample size. Clearly the problems of missing or damaged reports exceeded reasonable expectations.

Points Raising Concerns

<u>Duplicate DRE Serial Numbers.</u> We found several Long Reports with the same DRE serial number but that recorded different election results (see Appendices 4 and 5).

In one case, two sets of two DRE Long Reports (each pair having the same DRE serial number) presented different vote counts. Rather surprisingly, each of these two pairs of DRE machines was assigned to a common polling location. In each of these cases, the votes reflected in each of the four Long Reports appear to have been included within the GEMS totals; when we included all four DREs' votes for comparison with GEMS, the GEMS totals matched the Long Reports perfectly.

In another case of duplicate Long Reports, we found a pair of reports from DRE units having the same DRE serial number, but these DREs were assigned to different polling locations.

When asked about these duplicate serial numbers, a representative of the CCBOE stated the following in an email:

> It appears as though Diebold transposed serial numbers when it loaded firmware [vendor-installed operating software] into these machines. The serial numbers on the machines themselves are sequential (hardware). This is problematic because the linkage to the memory card is off the serial number presented by the screen….

If indeed the serial numbers were entered by Diebold, including some mistaken duplicate numbers, and then shipped to the CCBOE, the chances of two machines with duplicate serial numbers ending up at the same polling location within our sample is extremely unlikely. Given that we found this situation twice in our sample, this explanation merits further exploration. We have not been provided any further explanation from Diebold or from the CCBOE.

<u>No DRE Serial Number.</u> The audit found 19 instances where the DRE serial number was missing from the Long Report or otherwise unavailable. This problem relates to the issue of torn and printing problems noted above.

<u>Five-digit DRE Serial Numbers.</u>   Of unknown implication and importance we note here that we found two instances where the recorded DRE serial numbers were five digits in length. This is at variance from the six-digit length that we found for all the other serial numbers that were recorded. While this might be a data entry error in the audit process, it also may reflect an error in the manufacturer's creation of the serial numbers. We did not make an extra check to ascertain whether it arose from a data entry error.

<u>Other Problems with the Long Reports</u>

Legally Required Poll Worker Signatures: Among the 1,168 DRE Long Reports that the auditing teams examined, 354 or 30 percent lacked the legally specified four signatures. Among these 181 (16 percent of the total) had three signatures, 63 had only two signatures and two Long Reports had only one. 108 Long Reports weren't signed at all (9%).

Defective Long Reports: Volunteers recorded information showing that 95 reports (8%) were torn, incomplete, or had apparently jammed in printing and that they either lost or may have lost Long Report data that was to be printed. These figures exclude instances where we found a second Long Report from the same DRE unit, evidently printed to replace a report with such problems. Given that we found and used for the audit a number of what appear to be replacement Long Reports, the 8% figure for the rate of defective Long Reports is a lower rate than actually occurred.

<u>Lack of Agreement between Unofficial PDF Versus Sum of Three CSV Files.</u> The PDF file of unofficial results that the CCBOE posted on its website presents totals that differ by very small amounts from the sum of the three unofficial CSV files (DRE polling place, early absentee on optical scan ballots, and "walk-in" absentee ballots on DREs at the CCBOE) we obtained from the Ballot Department to use in our audit.

The accumulation of vote totals in the CSV files and the election results as presented in the published PDF file should reflect the exact same totals for the unofficial results, but 128 precincts out of the 1,434 in the county do not match. They generally only differ by one or two votes. We do not have an explanation for this discrepancy (see Appendix 7 for complete list of precinct discrepancies). For fuller exploration of data reliability issues, see Section IV.

E. Conclusions

<u>Conclusion 1</u>
There is a high probability that the DRE Long Report results match the GEMS produced data for the election on November 7, 2006.

This conclusion is important and reassuring. For all of the randomly selected precincts for which the Long Reports were legible and available, the Long Reports vote totals for candidates matched the GEMS election results exactly. More precisely, of the 132 precincts randomly selected for the audit, 95 matched the GEMS totals exactly. The balance of the precincts could not be evaluated because of missing or incomplete Long Reports.[16]

Conclusion 1, however, assumes that the Long Reports accurately reflect the ballots cast. As explained above in the report, the accuracy of the Long Reports was not evaluated by this audit. To be clear, for an election audit to be able to assess the likelihood that voters' ballots cast on DRE units are accurately reflected in the reported election results, we would need audits (using scientific sampling) of at least three separate phases of the election vote-recording and tabulation process:

      a. an audit of the individual voters' ballots cast on DRE units to determine if the Long Report (a summary of all ballots and votes cast on that unit) accurately reflected the votes; *plus*

      b. an audit checking the correspondence of the DRE Long Reports to the GEMS tabulation data; *plus,*

      c. an audit of the GEMS tabulation data to determine whether the results reported in the Totals lines accurately reflect the votes in the selected columns.

Additionally, for utmost confidence in reported election results, an audit covering all three phases is needed at both the pre-certification and after the official canvass or certified count stages of election reporting.

<u>Conclusion 2</u>
Expecting a complete set of DRE Long Reports with all data clearly recorded for all precincts currently is *not* realistic.

This conclusion is based on the problems we encountered with Long Reports (e.g., torn, missing, printing problems) in 37 of the 132 precincts in our sample. The 132 precincts within the sample included 1,414 DRE machines so that would mean that 1,414 Long Reports were analyzed.   Of this number, 181 (13%) were not auditable.   Since, as noted above, voters could lawfully vote on any DRE in the polling place, some of these Long

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[16] We determined whether there were "missing" Long Reports based upon an electronic file we received from the CCBOE listing the number of DREs at each polling place. We expected to find a Long Report for each DRE. It should be noted, however, that the CCBOE apparently had another list with a slightly different DRE count per polling place. As we had no way of knowing which was more accurate, we used the file sent to us via official CCBOE channels.

Reports recorded results for more than one precinct in our sample. In those cases, the damaged Long Report could cause the exclusion of two randomly selected precincts from the audit.

These results are consistent with the ESI report's finding that 9.66 percent of the VVPAT ballots were defective or compromised in some fashion in the May 2006 primary.[17]

Some of the Long Reports that CCBOE workers could not find for us may exist but could have been misfiled within the CCBOE on Election Night because precinct materials were flooding into the building and the staff was focused on retaining and uploading memory cards.

Producing legible and complete Long Reports is difficult for a number of reasons:

- Printer jams are common;
- With the addition of electronic voting and voter ID requirements, poll worker duties have become more complicated;
- Changing and reloading TSx printer paper is a complicated process, with a number of possible errors that can cause printer failure or marred Long Reports
- In this county, nearly 6,000 Long Reports will need to be produced by poll workers who have had four to eight hours of training (often occurring weeks before the election); and
- At the closing of the polls when the Long Reports need to be printed, poll workers are tired and the focus is on hurrying to obtain the memory cards so they can be sent for tabulation.

Neither this recommendation nor its attempt to outline the causes of defective Long Reports should be taken to suggest that the CCBOE should relax or eliminate the effort to achieve proper printing of the Long Reports at the polling places. Improvements in poll worker training should help to reduce the number of problematic Long Reports, and this should be an objective when planning improvements for poll worker training.

Yet we must also point out that a voting system that leaves 8-13% of the precincts unauditable is highly problematic and will likely have serious consequences for voter confidence.

Conclusion 3
Some DREs have serial numbers that are non-unique and duplicate those found on other DRE units owned by the CCBOE.

Our audit discovered some Long Reports having duplicate serial numbers, apparently printed by separate DREs that have been manufacturer-marked with the same serial number. Given that we found this problem in a random sample of Long Reports having predictive capacity, it is likely that other Cuyahoga County DREs have duplicate serial numbers. The Board of Elections believes that this duplication occurred due to Diebold transposing serial numbers

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[17] "DRE Analysis for May 2006 Primary Cuyahoga County, Ohio," Election Science Institute (August 2006), 102-124.

when it loaded firmware into the DREs, thus resulting in two machines having the same serial number.

Duplicate serial numbers raise at least three *potentially* harmful outcomes for the accuracy of vote counts, dependent upon whether certain safeguards are embedded in the GEMS software; this professional assessment of GEMS protections is beyond the scope of the audit. First, if GEMS is allowing data associated with the same serial number to be uploaded twice, votes from the same DRE could potentially be counted twice. Conversely, if two DREs have the same serial numbers, there is a risk of GEMS not allowing the votes from both voting units to be uploaded and overwriting the votes of one machine, thus losing votes. Third, correct and unique serial numbers are also essential for being able to pull the correct vote records from DRE flash memory when a memory card is missing or unusable.

Additionally, at least three *possible* logistical and administrative problems are raised by the duplicate serial number problem. First, duplicate serial numbers make it impossible to audit machine performance across multiple elections. Second, the serial numbers may also need to be unique for warranty purposes. Third and last, the duplicate numbers may impede correct internal tracking of the machine's physical location in CCBOE records.

F. Recommendations for CCBOE Action

<u>Recommendation 1</u>

Develop an Independent Random Audit Policy and Practice for Validating E-Voting Election Results.

We recommend that an independent random audit of the election results be performed before CCBOE certification of the election. Ideally, however, to verify the official count and its reported results, an audit would be performed after the official count but before those results were presented to the CCBOE Board for a certification vote. This timing would be optimal, because it is the point at which all ballots have been counted and the CCBOE believes it is ready to certify the results.   Thus, any discrepancies can be corrected before certification. Given, however, that the Ohio General Assembly recently shortened the time frame for certification by almost a week, this optimal timing of the audit may not be feasible. But with advance logistical planning and better procedures and staffing within the CCBOE, it might still be possible to achieve this objective.

The largest problem currently, however, is the lack of any CCBOE procedures to undertake an independent verification of the election results generated by the GEMS software results before certification.   Quoting the Brennan Center landmark report "*The Machinery of Democracy: Voting System Security, Accessibility, Usability, and Cost*:"

Systems with voter-verified paper records provide little, if any, security benefit over systems without such records, unless there are regular audits and/or recounts of the paper records.[18]

The Collaborative Audit Committee is willing to work with the CCBOE to develop a plan and procedures under which expedited random auditing of every election and to help identify the time frame within which the auditing can occur. This Audit Report can provide a template of the explanatory information the public needs to understand the process. Overview material about the voting systems can be simply restated with each election audit so that the audit report could be issued very quickly.

While undoubtedly the best source for verification of the results is to use the voter-verified paper audit trail (VVPAT), by State law the VVPAT cannot be unsealed until the recounts occur (after certification). Statutory law further bars auditing activities that might piggyback on the recount process. Given these state law impediments to random auditing of the VVPAT before certification and also during the recounts, it may be that auditing the Long Reports as against the GEMS results is acceptable until state law changes can be achieved.

Because eight to ten percent of the Long Reports are likely to be damaged and unusable in verification procedures, their value for verification audits is compromised. But it appears that use of the Long Reports is the only mechanism for auditing DRE units at present. Thus, neither this recommendation nor its attempt to outline the causes of defective Long Reports should be taken to suggest that the CCBOE should relax or eliminate the effort to achieve proper printing of the Long Reports at the polling places so long as the DREs are being used. Improvements in poll worker training should help to reduce the number of problematic Long Reports, and this should be an objective when planning improvements for poll worker training.

Yet we must also point out that a voting system that leaves 8-13% of the precincts unauditable cannot command the voters' trust. This high proportion of unauditable precincts means that in many races, the margin of victory is substantially closer. We understand that the vendor is planning to introduce a new printer model that may have fewer problems. But we believe (given the issues identified in bullet points immediately above) that the human elements and the fact that virtually no mechanical device is 100 percent perfect will mean that the printers will continue to produce a proportion of problematic VVPATS and Long Reports.

These facts about the rates of precinct unauditability owing to printer difficulties should be taken into account when assessing the long-term viability of using the DREs in Cuyahoga County.

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[18] "The Machinery of Democracy: Protecting Elections in an Electronic World," Brennan Center Task Force on Voting System Security, Brennan Center for Justice at NYU School of Law, 2006.

<u>**Recommendation 2**</u>

As part of the planned security review, the CCBOE should assess the viability of using Long Reports as part of its overall security and accountability plan.

Our audit calls into question the feasibility of expecting to use Long Reports as part of any oversight or audit process because of the frequent problems encountered in printing them. The technology and human factors involved in producing the Long Reports should be evaluated to determine if the process can be improved or replaced by other security methods.

<u>**Recommendation 3**</u>

Resolve the non-unique DRE serial number problem by taking a number of actions.

The occurrence of duplicate DRE serial numbers raises the possibility that the vote totals from one DRE unit may overwrite votes from another unit or be counted twice. Duplicate DRE serial numbers may also lead to CCBOE inability to identify correctly a DRE unit whose internal (flash) memory needs to be used for the re-creation of voting results (normally when a memory card is missing or damaged), and other problems discussed above. These potential problems present sufficient cause to warrant further investigation by qualified independent professionals (not manufacturer employees or contractors) and a public report on findings and corrective actions taken.

We believe the following steps are needed:

- Determine all the purposes for which DRE serial numbers are used within the CCBOE;
- Investigate the extent of the problem of duplicate serial numbers on DREs by checking both the number located on the external casing of every DRE unit and also the serial number that has been loaded into the firmware and publish the results of the inquiry;
- Fully investigate and analyze why duplicate serial numbers were found on Long Reports and what the consequences are for vote tabulation (e.g., whether votes can be uploaded twice or overwritten because of this problem);
- Require the vendor (Diebold Election Systems, Inc.) to correct the non-unique serial number problem and also pay for the investigation of the extent of the problem; and
- Create and maintain a database of all DREs to track serial numbers, testing results, polling place location, malfunctions and service history, lifetime vote totals, and warranty information.

III. <u>Optical Scanning: Audit of "Early Absentee Ballots"</u>

A. Background

"Optical scan ballots" are paper ballots that list each race or issue and provide ovals beside each voting choice. The voter is directed to color in the oval beside the candidate or issue answer that reflects the voter's choice. Cuyahoga County's optical scan ballots are printed on both sides. The optical scanner is a device that reads and records the ballot choices the

voter made if his/her marks were made correctly. Underlining a candidate's name or placing an X in the oval, for instance, are not valid marks that the scanner can read.

While some election jurisdictions use scanners at the polling place to scan ballots and tabulate voting results for each precinct (a "precinct-count" system), Cuyahoga County and other jurisdictions scan all optical scan ballots at a central location (a "central-count" system). Numerous scanners are used simultaneously to scan the ballots. Scanners are linked together in a network with the GEMS computer, which receives and records the scanned voting data and tabulates the election results.

In Cuyahoga County, optical scan ballots are provided to a number of different types of voters. All mailed absentee ballots are paper optical scan ballots, whether mailed to homes in Cuyahoga County or to overseas absentee voters. But paper optical scan ballots are also provided at the polling places for provisional ballot voters and for "curbside" voters who are disabled and cannot enter the polling place to vote. Additionally, backup paper ballots are provided to each precinct in case there were problems with the DRE touch screen units or excessive wait times for voters.

in November 2006, Cuyahoga County's policy was to scan, tabulate, and announce in its "unofficial results" only those absentee ballots that were received in the CCBOE offices by Friday, November 3rd, at 5:00 p.m. These are often called "*early absentee ballots*." As these voted ballots arrived during the weeks preceding Election Day, the CCBOE staff sorted the absentee ballots (still in their sealed envelopes) into precincts. Then, beginning on Saturday, November 4th, CCBOE staff opened, unfolded, and stacked the paper ballots so that they could be compressed flat. This flattening process was designed so that the ballots would be more easily fed into the scanners and the scanners would be more likely to read the votes correctly.

All absentee ballots that arrived after the Friday cut-off time and all precinct-cast optical scan ballots were segregated from the early absentee ballots and locked up until after Election Day and the unofficial results were reported. These later-arriving absentee and precinct-cast paper ballots were counted and presented only as part of the *official, certified* election result totals.

B. Objectives and Limitations of the Audit

Objectives. The objective of this portion of the audit was to ascertain whether the early absentee ballot votes were accurately reflected in the GEMS reports of the unofficial electoral results. A hand count of randomly selected precincts' early absentee ballots by teams of volunteers was compared with the GEMS totals to check for any discrepancies. Unexplained discrepancies could indicate any of a number of different types of problems. Unlike the DRE audit, which only audited summary data by precinct from Long Reports, this audit of optical scan ballots compared actual voted ballots with the GEMs tabulation.

Limitations. As with the DRE audit, this audit of early absentee ballot scanning was of a limited nature because of (1) Ohio election law and (2) resources. When the major political parties requested the extension of the collaborative audit to encompass optical scan absentee ballots, we checked with the CCBOE on when the audit's necessary hand count could occur.

The Ballot Department managers said that, as with the VVPAT, the paper ballots would need to be locked, sealed, and unavailable for auditing until after certification and all recounts, per the Ohio recount statute. This meant that the absentee ballot hand count could not occur until mid- to late-December.

Conducting this scanning audit after certification and the recounts meant that we were in the midst of the university exam and December holiday season. We knew that it would be difficult to assemble sufficient volunteers to conduct a hand count of three races so the CAC chose to audit only one race, that of the State Auditor (Sykes-Taylor). We also knew that since the CCBOE Board had announced a plan to undertake a professional audit, any optical scan auditing beyond our Collaborative Public Audit effort could be left to the professional auditors.

Given that we only hand-counted one race and compared these results to the GEMS totals produced in the unofficial count, the audit conclusions are limited. We know that sometimes, depending on the ballot location of a race and how close its placement is to the vertical column lines, the scanners may prove differentially accurate in reading votes.[19] Our audit of only one race could not take account of such factors and identify resulting discrepancies. The Logic and Accuracy testing of the scanners is supposed to identify any problematic scanners so that the CCBOE deploys only those scanners having a perfect accuracy in reading paper ballots are used.

C. Methodology

Overview. At the request of the Audit Committee, Dr. Mark Salling and Ellen Cyran of NODIS at CSU generated a random selection of precincts different from that used for the DRE audit. The 72 precincts selected provided a 99% confidence standard. The Audit Committee selected the State Auditor's race for the Audit.

Detail of Chain of Custody and On-site Audit Activities As noted above, the CCBOE staff sorted the absentee ballots (sealed in their envelopes) into precincts. They were then taken to locked rooms to be preserved until time for opening and scanning. On Saturday, November 4, the early absentee ballots were removed from the locked rooms and brought to the "pink room" for opening. The ballots were placed flat in stacked bins. The bins were placed in locked rooms until the time for the early scanning. The CCBOE staff then sorted the ballots into pre-marked envelopes so that each precinct's ballots could become a "deck" unless the precinct had a particularly large number of ballots cast. Then the precinct's ballots were divided into two or three separate decks. The CCBOE purchased a machine that counted the number of ballots that were in each envelope, and staff recorded the number on the envelope's label.

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[19] *See, e.g*., the CERP Final Report concerning the scanning problem in May 2006, in which only particular races were not read accurately and correlated highly to ballot placement and formatting issues.   Also see the Systest Labs Report concerning the optical scanning problem that is found in CERP Appendix.

The early absentee ballot envelopes were brought down to the basement scanning area that had been specially constructed for this early absentee scanning. Up to 100,000 absentee ballots were expected to have arrived in time for the early count—many times more than in any previous election.[20] After the early absentee scanning on November 6, the ballots were locked again.

The on-site hand count audit activities occurred on December 6, 8 and 29, 2006. A team of volunteers returned on February 16, 2007 to double-check discrepancies. At the outset of each day of the audit, approximately 20-30 precinct files (the number the auditors felt they could complete in the day) were pulled by CCBOE staff from the third floor vault where all early absentee ballots were stored. Members of the audit team observed the unlocking of the ballot vault and the transporting of the optical scan ballots to the "pink room." At no time during the audit activities did the auditors leave the ballots unattended or unsecured.

The CCBOE managers represented that even though the audit occurred after all recounts, only CCBOE staff could legally touch the ballots.[21] This rule meant that scheduling the hand count of the optical scan ballots was dependent upon the availability of CCBOE staff.

Each hand count team of auditing volunteers was composed of four people: one "reader" of the ballot/race, one "observer/confirmer" that the reading was correct, and two "recorders" who recorded separately.[22] Because only CCBOE staff can touch a ballot, one CCBOE staffer handled and turned each ballot as the vote was being read and recorded by volunteers. The CCBOE assigned two of their staffers (one Democrat, one Republican) to be present at all time per the managers' representation of the law governing the handling of voted ballots.

The audit recorders first recorded in ink on the audit forms (see Appendix 8 for sample form) all location and batch information from the label on the front of the precinct envelope. The CCBOE staff (with close monitoring by the four auditor volunteers) then separated out the pages that contained the State Auditor race. This segregation of the needed ballot pages generated a faster auditing process. Upon realizing that some decks included some ballots from other precincts mixed within the selected precinct ("misfilings"), the reader and confirmer (and CCBOE staffer) checked the name and number of the precinct on the bottom of each page to make sure it was from the correct precinct.

All votes were to be classified in one of four ways by the reader who called out the vote: "Taylor" or "Sykes" or "no vote" or "unable to determine." The confirming volunteer watched carefully to ensure the accuracy of the reader's call. Periodically volunteers switched roles to keep everyone fresh.

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[20] Reasons for the sharp increase in absentee ballots included (1) the 2006 Ohio statutory change to permit "no-excuse absentee ballots" (allowing virtually any voter who wanted to vote by absentee to do so), and (2) the Cuyahoga County Commissioners' public campaign to encourage voting by absentee ballot.

[21] We are not sure that this representation as to the legal constraints on touching the ballots is correct. In the summer 2006 ESI audit of the VVPAT, it appeared that ESI employees were touching the DRE ballot as a part of their audit activities.

[22] State law hand count "best practices" collected in the study that the U.S. Election Assistance Commission funded provide for at least these four positions in a hand count team to ensure accuracy. (Study by Prof. Thad Hall of the University of Utah is not yet available via the EAC website.)

Two volunteers independently recorded the vote on the audit reporting form. They ensured that every ballot page on which the selected race was presented was reflected by a record in one of the four categories listed on the audit report form. After approximately every 20 ballot pages, the recording process paused so the two recorders could compare their tallies. By proceeding in this manner, if tallies did not match, the team only had to review the last 20 ballots to find the recording discrepancy rather than a full deck of ballots. Once all the votes in the race were recorded for all ballots for the precinct, the recorders independently tallied the results on each form. They then placed the results at the bottom of the form and compared them to each other to ensure that the grand total for each candidate in that precinct matched across the sheets.

This hand count data was later entered into a CSU computer database and then the computer data was checked for data entry mistakes. The hand count results were then compared to electronic files provided by the CCBOE.[23] These files are discussed in more detail below.

D.   Findings

We were able to audit (via our procedures for hand counting) all 72 precincts in our random sample of early absentee ballots. The ballots from two of the precincts (Cleveland 13-O and 17-K) could not be located during our first round of audits (December 6 – 8, but Ballot Department employees were able to track them down for our follow-up visit on December 29. Upon investigation, it turned out that these missing ballots had not been filed in the correct envelopes but by looking at batch numbers, the Ballot Department was able to figure out with which precinct they had been scanned and accidentally misfiled. This misfiling would not have affected the GEMS tally because each ballot page is computer-coded with the precinct's identifier.

After the original on-site audit activities and the first follow-up, a comparison of the hand count audit data with the GEMS tabulation report showed the hand count results were consistent with the GEMS precinct counts for 43 of the 79 precincts. Most of the 29 tallies inconsistent with the GEMS report differed by only plus or minus one vote. One precinct showed one more vote for Taylor and one less for Sykes than the GEMS report. One precinct, however, contained 60 ballots in its folder while the GEMS report showed zero ballots had been tabulated for that precinct. These differences are documented in four groups in Appendix 9.

Discrepancy Evaluation: Off by One or Two Votes   Possible explanations or causes of the discrepancies of a few ballots include (1) errors in counting by audit volunteers during the hand count; and (2) incomplete or inaccurate sorting of ballots prior to scanning resulting in ballots from another precinct being present in the folder that was audited and/or ballots from the audited precinct being misfiled in a different precinct folder.

> *Regarding Possible Explanation 1*
> During the original audit, each team had two observers who examined the ballot pages before calling out the voter's choice, and their observations were independently recorded by two other volunteers who then reconciled their results at several interim steps as

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[23] For the purpose of the optical scan audit a file labeled *"GEMS SOVC REPORT Unofficial AVOS Only.pdf"* was used based on guidance from the Ballot Department managers (see Appendix 13 and Part IV of this Audit Report).

described in the procedure section above. Additionally, at a subsequent return visit to the CCBOE, 11 of these 29 discrepant precincts were re-counted. No errors in the hand count were detected.

Regarding Possible Explanation 2
The central count tabulation report for the unofficial count was made available by the Ballot Department. This report shows each group or "batch" of optical scan ballots and shows the number of ballot "cards" (pages) in each batch and to which precinct each ballot "card" was assigned. Close examination of this report showed that the ballot pages of 307 precincts were filed in more than one batch, and that 201 batches contained ballot pages from more than only one precinct. It was also noted that in the Central Count Report, 12 precincts showed no ballots had been counted and no votes had been recorded.

Auditors returned to examine these discrepancies on February 16 (see Appendix 10 for complete description). Eleven of the precincts with fewer ballots in the hand count than reported by GEMS were found to have misfiled ballot pages, scanned in with a different precinct. Five of the precincts with fewer hand counted ballots could not be explained by misfiling. Of the 11 precincts in our sample with a higher hand-count than the GEMS report, three were found to be filing errors in which another precinct's ballots were included in the wrong precinct deck and the auditors mistakenly included them in their hand count.

The remaining eight discrepancies could not be explained by filing or hand-count errors. The hand count for the precinct with one higher vote and one lower vote for the two candidates was rechecked and found to be accurate. No explanation for the discrepancy with the GEMS report could be found for this precinct.

Discrepancy Evaluation: Precincts with No Votes Recorded in the GEMS Report
The finding of greatest concern was the precinct, North Olmsted 2-F, which was found to have ballots in the precinct folder but no results reflected in the GEMS election results. This precinct was also one of the 12 that did not show any ballots counted in the Central Count Scanning Report. Auditors returned to examine all 12 of these precincts (expanding beyond the original sample) to see how common this problem was.

The CCBOE apparently received no early absentee ballots for eight of these 12 precincts that recorded no ballots counted. Four precincts were found, however, where it appears likely that all or nearly all of their early absentee ballots were not included in the unofficial SOVC Report[24] (see Appendix 11 for a complete description).

Auditors were able to physically examine the ballots and envelopes of three of these four precincts where the GEMS election results showed no early absentee ballots had been tallied. In our view, it appears that these precincts' ballots were scanned but then deleted from the GEMS tally (see Appendix 12 for the CCBOE's explanation of the omission). The precinct folders the auditors examined contained ballots in numbers corresponding to the number of

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[24] The SOVC Report is the comprehensive Statement of Votes Cast Report from GEMS. It can show, precinct by precinct, the total votes cast for every candidate and ballot issue and thus is quite lengthy unless a selected portion is requested for printing.

early absentee ballots that the CCBOE staff in the Candidate and Voter Services Department had recorded as returned in time for early scanning.

The CCBOE procedure during the early scanning for the unofficial count required verification by the ballot tabulation staff that the number of ballot pages GEMS reported as having been scanned was within a certain margin of error of the number of pages reported by the scanner. If not within that predetermined margin of error, the tabulation staff was supposed to delete the precinct batch result from the GEMS tabulation. They were then to send word to the scanning room with 60 teams of scanning personnel that the deleted deck was to be rescanned. In these cases, it is possible that after deleting the precinct batch from GEMS, the ballots were not rescanned but simply refiled in the envelope. Two precincts each showed one vote in GEMS because there was a single ballot card for each of those precincts present in a deck that consisted of only the single card.

Discrepancy Evaluation: Ballot Decks Scanned Multiple Times   While comparing the SOVC electronic file with the reported numbers of absentee ballots returned, it was also noted that for at least two precincts (not originally included in our sample) it appeared that there were significantly more votes recorded than were absentee ballots. Specifically:

North Royalton 3C	*770 voters*	*52 abs returned*	*118 SOVC*
Euclid -02-J	*896 voters*	*73 abs returned*	*142 SOVC*

Examination of the Central Count GEMS report for these precincts shows each to have had 2 batches of identical or near identical size with sequential or near-sequential numbers. When we examined these precincts' folders, there were ballots present in the folders in numbers consistent with the number of absentee ballots reported returned. These observations are all consistent with an explanation that the ballots in these two precincts' folder were scanned twice and that the votes on each ballot had been included in the SOVC election results twice.

E. Conclusions

From the limited scope of this audit, which examined the results of one race as recorded on early absentee optical scan ballots that were part of the unofficial count, we may conclude the following:

Conclusion 1

Election result data in the GEMS report corresponded closely to the results obtained by the audit hand count of the optical scan ballots

Audit results either matched exactly or were discrepant in a manner and degree consistent with the number of ballot pages misfiled for 57 of the 72 precincts included in the audit. Fourteen of the 15 precincts that did not exactly match were discrepant by plus or minus one vote with an aggregate of one more vote for Sykes and three more for Taylor found by the audit. This is a low net error rate out of a total of 3628 votes. The one other discrepant precinct was not reported in the unofficial SOVC at all and represents an apparent scanning procedural error.

Conclusion 2

The sorting process for early absentee optical scan ballots into precinct batches prior to scanning was neither complete nor accurate.

A total of 1,768 "decks"[25] were created in which the early absentee ballots from the 1,434 precincts in Cuyahoga County were placed. Of these 1,768 decks, 201 contained ballots from more than one precinct. The election reports also show some ballot pages of 307 precincts were separated (possibly misfiled) into more than one folder.

Prior to commencing the scanning of the early absentee ballots, the CCBOE staff hand sorted a total of 66,228 absentee ballots into precinct decks. We were able to identify patterns of misfiling: often the ballots were misfiled into precincts where extremely similar precincts codes to the correct code were used. These codes often differed by only one character. This pre-sorting was necessitated by concerns about the GEMS database's limitations and its stability over the period of uploading optically scanned ballots. Although the sorting was imperfect, without it we would not have been able to conduct this audit and compression of the GEMS database—and its consequent risks -- would have had to occur much more often.

Conclusion 3

Some discrepancies that occur at a very low frequency appear to be caused by a scanner misreading of some of the optical scan ballots.

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[25] A "deck" is the electronic representation of a batch of ballots that were to be scanned together. The scanner sends the accumulated results of the ballot up to the GEMS computer as one deck tally. This deck approach is in lieu of scanning 55 ballots separately and sending 55 separate vote tallies up to GEMS. By using sizable decks, the GEMS database does not grow as fast as having more decks with fewer ballots in each.

In several of the discrepant precincts, the correct number of ballots was identified in the initial audit and in a subsequent follow-up visit. However, the GEMS reported results differed in a pattern suggesting that one or more ballots that the auditors considered to have been clearly marked in either blue or black ink had not been accurately read or recorded by the scanners/GEMS. In these cases, one fewer vote would be reported in the GEMS data file.

Conclusion 4

Some ballots were apparently scanned at some point but were not included in the GEMS results or on the SOVC election results report.

At least four precincts for which early absentee ballots had been returned showed no votes recorded in the unofficial election result tabulations. In at least three cases, it appeared from the ballot folder documentation that ballots had been scanned and must have been deleted but not rescanned.

Conclusion 5

Some ballot batches were scanned twice with their votes double-counted when the GEMS unofficial results and the SOVC election results report is analyzed.

The ballots in at least two precinct folders appear to have been scanned twice. The numbers of optical scan ballots present in the folder was consistent with the number of absentees returned while the results reported in the election result tabulation for these precincts were approximately doubled.

Conclusion 6

Batch/deck numbers identifying specific groups of ballots may change within the scanning process and between scanning events.

The deck/batch identification is arbitrarily assigned by the "header card" that is placed at the front of a stack of optical scan ballots prior to their being scanned. As reflected above, a batch can be rescanned with a different header card. Similarly, some of these ballot batches were given different digital batch identities when they were re-scanned for the official count. The change in ballot batch identifiers greatly impeded the accurate tracking of batches so that they could be confirmed as having been counted, and counted only once in the election tabulation.

F. Recommendations for CCBOE Action

Recommendation 1

Hand sorting into precinct batches should be replaced by an automated system.

If the CCBOE has a continuing need to sort received absentee ballots into precinct-based groups, this process should be automated. All of the absentee ballots originate with the

CCBOE and are machine addressed. Automated sorting of the returned ballots could be done by a commercial mail handler using a barcode placed by the CCBOE at the time of addressing the mail to the voter.

Recommendation 2

The labeling or identity of a batch (and its electronic representation as a "deck") should be unique and constant.

Each deck of ballots should have a unique and immutable identity code, and ballots should not float between decks. If the CCBOE continues to sort by precinct, this could be a precinct-based code. Such a system would enable tracking and accounting for all ballots received. It would also facilitate an audit of the performance of the optical scanning system.

Recommendation 3

A mechanism should be developed to record and track specific batches of ballots.

Each uniquely identified deck of ballots should be scanned and included in the election results one time and only one time. Possible approaches to such a system include a precinct-based system that counts and reports the number of absentee ballots received by the CCBOE as the precinct bar code is read on the intake sort. A system that uniquely identifies ballot decks, prevents the double counting of ballot decks, and has the ability to flag missing decks would be a major improvement over the uncontrolled situation that now exists.

Recommendation 4

The process of deleting ballot batches must have greater quality control to ensure re-scanning of the deck.

Deletion of ballot batches means a large number of ballots are not recorded in the tabulation unless rescanned. The CCBOE did not use the paper and ink log to record events such as this, and there was deficient quality control and procedural verification over whether deleted batches were re-scanned. Improving the quality control over the scanning procedure is the best solution. However, an easy *interim* step is to perform a reasonableness test to determine whether all optical scan ballots in a precinct were scanned and scanned only once. This test would compare the number of returned absentee ballots multiplied by the average number of sheets per ballot to the total number of scanned sheets. While these totals will not match exactly because of variation in the number of sheets per ballot, a large discrepancy would indicate either deleted or double-counted decks of ballots.

Recommendation 5

An audit similar to this, comparing electronically recorded optical scan results to those obtained by hand counted examination of the optical scan ballots, should be performed after every election and before certification.

In general, the results of the counts corresponded closely in this audit. There was, however, a very low frequency of lower votes recorded by the electronic system. There is no reason to expect this to bias a race vote count but it does suggest that further verification of the accuracy and completeness of the optical scanning system under real world conditions is needed.

IV. Security, Accuracy, and Sufficiency of the Data Needed for Auditing

When the Collaborative Audit Committee began its work, the presumption was that the tabulation data from the central tabulation computer (GEMS server) would be easily identifiable and readily made available to the Audit committee or Center for Election Integrity/Monitor staff engaged in audit work. This proved not to be the case.

A. GEMS Election Results: Tabulation Files and Reports

To conduct the audit, the Center's professional staff specified certain files in generic terms in writing. We received confirmation that the ballot department would be providing the files needed for the DRE audit immediately upon the closing of the unofficial tabulation on November 8. Although the Center went out of its way to have staff present throughout the 36 hour Election Day and Night to take possession of the GEMS reports needed and was present when the election closed early Wednesday afternoon, November 8, the data that the ballot department supplied did not satisfy the specifications and did not permit the audit to proceed.

The Center staff then undertook a series of conversations with CCBOE Director Michael Vu and with Diebold's technician Chris Bellis about how GEMS produces data and the types of files and reports that are possible after the election has closed. We then drew up a new list of the data files that were needed for the audit. If the information that we were given is correct, no single GEMS report is available that has exactly what is needed for both audits (absentee ballots and DREs).   We discovered that a series of analytic steps using several types of election reports was required in order to obtain the data necessary to complete the audit.

Based on the information that we were able to obtain from the ballot department and the Diebold representative, we list in the accompanying footnote the data we required to complete the audit.[26] Despite our effort to pin down the exact data required and to ensure

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[26] The electronic files or reports we apparently needed for this audit:
 a. GEMS Statement of Votes Cast (SOVC) Report run on the database backup after absentee ballots were tabulated, but *BEFORE* DRE memory cards were uploaded.
 b. Database file after absentee ballots were uploaded, but before GEMS tabulation was performed.
 c. GEMS data export after absentee ballots were uploaded, but before GEMS tabulation was performed.
 d. Database file after DRE uploading was complete.
 e. GEMS data export after DRE uploading was complete.
 f. GEMS SOVC Report after all absentee ballots performed on DREs.
 g. Need the database file after all absentee ballots performed on DREs were uploaded.
 h. GEMS data export after all absentee ballots performed on DREs were uploaded.

that we obtained the requisite files immediately after the election's unofficial count closed, we were unable to do so. The Ballot Department manager advised that the files turned over on November 8 included all that we had requested and needed, even though they did not.

B. Reliability and Accuracy of the Data from the GEMS Computer

Inconsistent absentee ballot results files. For the absentee ballot audit, the ballot department provided several different electronic files that should have had the same data but actually reported different election results. It is unclear to us, and apparently to the CCBOE as well, why these election results files differ (see Appendix 13). We have no independent knowledge of which results file should be used or why GEMS generates a variety of files with varying election totals. What is clear to us, however, is that it is critical for the ballot department to have accurate information on which file contains the actual total election results. It is also essential information for determining the degree of fidelity the audit hand-count has to the electronically produced election results.

Raw election data and database review. The Monitor software engineers sought to review the raw election data to compare it with the GEMS-reported results to determine if there were any errors in the GEMS tabulation.[27] Additionally, certain tabulation events (i.e., server crashing during scanning operations; freezing of the database during a backup and compression operation) occurred during the unofficial count that raised the possibility of database corruption.

The CCBOE Director initially would not permit the raw election data to be provided to the Audit committee or to the Monitor. He said Diebold Election Systems, Inc. (DESI) would assert trade secret or other protection of this data as proprietary. We challenged the legal basis for any such claim.[28] Eventually, a limited database review was conducted by Monitor software engineers with a DESI representative present and several CCBOE ballot and information services managers. Focusing on only three of the November races, the lead engineer showed the observers that for each of the three, GEMS maintained two separate election results tables that held values that were inconsistent with one another. The results differed between the two tables by over 100 votes for each of the three races checked.

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[27] Joe Hall of the UC Berkeley School of Information provided significant consultation as the Monitor prepared for this database review and served as a sounding board for other technical questions.

[28] We find that the decision in *Assessment Technologies v. Wiredata*, 350 F. 3d 640 (2003) (Posner, J.) (concerning real estate tax assessment data) persuasively demonstrates that the election voting data would be beyond propriety control if urged to be protected by copyright law. We thank Professor Mike Madison of the University of Pittsburgh Law School for bringing this case to our attention. For a discussion of trade secret claims asserted by voting system vendors and possible challenges to those claims, see: Aaron Burstein, Stephen Dang, Galen Hancock and Jack Lerner, "Legal Issues Facing Election Officials in an Electronic-Voting World", Samuelson Law, Technology and Public Policy Clinic at the University of California at Berkeley School of Law (Boalt Hall), available at: http://www.law.berkeley.edu/clinics/samuelson/projects_papers/Legal_Issues_Elections_Officials_FINAL.pdf

We filed a written query with DESI, and received a response that we find raises more questions (see Appendix 14). In brief, the GEMS software engineer said that the tables are updated at different points and that this does not matter to the final results. This explanation did little to alleviate our concerns. Additionally, we have no clarity on which table contains the final accurate results.

The Monitor's software engineers conducting the review also found other strong indicators of possible database corruption, including blank fields. (See Appendix 16 for a memo on other database corruption indicators). Microsoft's JET engine, which DESI used to communicate with the vote tally database, is documented to have a problem with unpreventable database corruption.[29] (See Appendix 17 for excerpts from a Microsoft publication concerning security and corruption issues in the JET platform.)

→*An in-depth Monitor's Report on technical and database issues is forthcoming.*

C. Hardware and Software Design Impediments to Auditing

Hardware design issues: The current generation of major brand optical scanners, including those used in Cuyahoga County, do not count *ballots* but only ballot *pages*. In Cuyahoga's General Election in November 2006, among the 59 separate jurisdictions, optical scan ballots could vary in length by several pages. Also, voters did not always return every page of the ballot when they sent it in. Thus, even if we know the total number of optical scan ballots that the CCBOE received for tabulation, we have no easy way to determine whether all the ballots were part of the tabulation. To determine whether all the ballots had been counted, the CCBOE executives simply averaged the number of ballot pages and *estimated* that all the optical scan ballots had been counted.

This design problem also impedes the ability to produce accurate undervote rates (in specific races or ballot issues).

By contrast, with punch cards the CCBOE was able to determine with complete accuracy whether all the ballots that had been received had been counted. The current generation optical scan hardware (and firmware) design, however, does not include features that are essential to determining whether all ballots are counted. As a result of new, apparently HAVA-compliant[30] equipment, we have reduced rather than increased the accuracy and reliability of our elections results. This reduction in reliability is apparently due to an engineering design omission, one that must be redressed either by a hardware change or expensive auditing procedures.

Software Design Issues   The GEMS system currently does not report election data at the DRE unit level of specificity. The lowest level of reporting is for the precinct. This means that the accuracy of particular DRE machines cannot be determined via an audit.

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[29] *How to Troubleshoot and to Repair a Damaged Access 2002 or Later Database*, (Rev. 6.1 2006) *at* http://support.microsoft.com/default.aspx?scid=kb;en-us;283849.
[30] The Help America Vote Act, 42 USC SS 15301-15545.

D. Security: Logging and Data Systems in the CCBOE

As stated in the *Monitor's Report on Possible Legal Noncompliance* (January 8, 2007),[31] the Ballot and Information Services Departments have failed to implement crucial Security Policy provisions that are designed to protect the tabulation server and the integrity of the election results. The paper and ink logs that were to be used to record deleted ballot batches and server events were largely unutilized, in violation of the Security Policy, and probably one of the key reasons for the inability to track deleted batches to assure their re-scanning.

E. Recommendations for CCBOE Action

1. Obtain independent guidance (to supplement and compare that from DESI) on what electronic files should be used for each type of election auditing, and how the files differ from one another.
2. To permit accurate election audits to be conducted, the Secretary of State should specify the data that must be kept and for what period of time.

3. The CCBOE Board should authorize the Monitor to ascertain whether the security policy has been fully implemented and to provide recommendations for how to achieve full compliance before the next election.

4. A citizen's advisory board of up to five qualified individuals should be created to focus on technical and security issues. Its first task, in conjunction with the Monitor, should be to review, rewrite, and improve the CCBOE Security Policy.

5. The CCBOE should request an independent evaluation of the GEMS database from a qualified consultant. The task should be to ascertain whether database corruption occurred in the November 2006 election. Secondly, the consultant should make recommendations on how to avoid database corruption to the maximum extent feasible and what steps should be taken to protect election data as tabulations are occurring.

V. TOP TIER RECOMMENDATIONS for SYSTEMIC IMPROVEMENT

This report covers many audit findings in great detail but it is by necessity limited in scope. Budget, timing, and legal and administrative impediments narrowed the scope of the two audits to such a degree that they do not provide a comprehensive view of how Cuyahoga County's overall election system is functioning. While we believe our findings are extremely important and merit strong consideration by the CCBOE, they are not a stopping point. They are a first step in providing public oversight of the electoral system.

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[31] The *Public Monitor Report on Possible Legal Noncompliance* (dated Jan. 8, 2007) can be found at www.csuohio.edu/cei/.

1. **<u>Independent random audits should be a routine part of the election process</u>**.

Auditing is standard business practice and should be applied to our voting systems because of their importance. There is clear evidence that problems exist:

- This Collaborative Public Audit has discovered problems with DRE Long Reports and the Optical Scan counting process;
- As reported in the Cleveland *Plain Dealer* in November 2006, thousands of people voted without having signed in at the polling place;
- Two CCBOE employees were convicted for performing illegal actions during the 2004 recount; and
- The ESI audit and Cuyahoga Election Review Panel assessments after the May 2006 election found numerous problems (e.g., 9.6% of paper audit trails, including the legal ballots, were defective or compromised the audit).

A reasonable approach might be to perform an independent audit after each major election and a collaborative internal audit after smaller local elections. The time and cost involved do not need to be exorbitant and will decrease as problems are resolved and process controls are put in place. A periodic professional independent audit could help identify needed improvements and restore voter confidence in the system. Future election audits should include evaluations of the following issues so that internal administrative and technical systems may be improved where needed:

- Electronic voting & legal ballots (e.g., do the paper ballots/VVPATs match the electronic counts?)
- Chain of custody of election materials (e.g., were security procedures followed?)
- Provisional ballot procedures (e.g., Did the right people cast these ballots? How many voters lost their vote because they were at right polling location, but were not directed to the correct precinct?)
- Optical Scan/Absentee ballots (e.g., were all the ballots counted? Were they counted accurately? Were any ballots counted more than once?)
- Security Plan (e.g., was the plan complete? Was the plan implemented?)
- Internal Controls (e.g., were important internal processes documented? Were those procedures followed?)

In addition to implementing a routine comprehensive professional audit, the Collaborative Audit Committee believes the current system, which relies upon two voting systems, should be seriously reviewed.

2. **Reconsider the feasibility and wisdom of supporting two major voting systems –Optical Scan and DREs.**

The problems found in this audit, the ESI audit, and report from the Cuyahoga Election Review Panel[32] call into question whether it is practical and cost effective for Cuyahoga County to support two voting machine systems (i.e., electronic and optical scan). Some factors to be considered include:

- **Election Costs for 2006 went well beyond the budget.** Some costs were one time costs, but a significant amount of the overrun was for enhanced training to help prepare poll workers and Election Day Technicians (EDTs) for an increasingly complicated job. These costs probably will not go away because we cannot assume that these workers will return and remember the complex instructions that they were taught a year ago.

- **It is unclear if DRE electronic voting can support the turnout in a Presidential election.** Despite a large increase in absentee voting for November 2006, a federal judge ordered 16 polling places to be kept open after the normal closing time of 7:30 PM because of reported wait times exceeding one hour.   The voting turnout in a presidential year is substantially higher than a mid-term election. What planning has occurred to avoid problems with lines in 2008? Have options other than purchasing more DRE units been considered for dealing with the expected spike in turnout?

- **CCBOE staff must be hired and trained to support both systems**. Hardware needs to be set up, poll worker manuals need to be provided, poll worker and professional staff training must be planned and executed, and different types of ballots and pre-election and post-election testing must be prepared and executed. All of this needs to be done for two systems instead of one. Does the CCBOE have the resources (including managerial and financial) to achieve success with two systems?

- **The DREs present considerably more hurdles to complete auditing than do optical scanning systems.** The problems with the DRE printers causing damaged Long Reports, and the difficulties in locating data printed in a miniscule typeface on a narrow register-receipt that can be over 20 feet long, are only two impediments to DRE auditing.

If the CCBOE claims that continuing to use two voting systems is the best solution, the burden of proof should on the CCBOE to show:

- That they will resolve the problems reported in the CERP report, the ESI audit, and January 8, 2007 Monitor memo from the Center For Election Integrity;
- That they have or will hire the managers and staff necessary to resolve the problems caused by staff shortages; and

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[32] The Cuyahoga Election Review Panel's Final Report can be found at www.csuohio.edu/cei/ (dated July 20, 2006). This webpage provides the option of reading or downloading the panel report in separate chapters rather than in its entirety of 400 pages (including appendices).

- The difference between maintaining two voting systems (including poll worker training, vendor support costs, and CCBOE staff headcount and expenses) and a single optical scan voting system is a defensible cost.

3. Undertake a GEMS election results Database Integrity and Reliability Evaluation

The Diebold Corporation used a Microsoft database "engine" (JET) as the foundation for its GEMS software. Microsoft has posted warnings that database corruption cannot be completely prevented in this "engine." Microsoft also warned that JET was inappropriate for use where there were high needs for data accuracy and security. (See Appendix 17) The risk factors for GEMS data integrity can be identified. The CCBOE should examine, using a qualified expert, the integrity of the November 2006 GEMS database and solicit recommendations for minimizing the risks to the accuracy and integrity of election tabulations.

4. Evaluate the Voter Registration Software System

While analyzing the feasibility of supporting two voting systems, we also recommend an assessment of the DIMS voter registration system. While not part of this audit, DIMS was repeatedly mentioned by both internal CCBOE staff and external observers as a weak link within the electoral system. Both the January 8, 2007 *Public Monitor Report on Possible Legal Noncompliance* and the December 7, 2006 memo from Tom Hayes of the LNE group (serving as the CCBOE's Program Manager) to the Cuyahoga County Commissioners[33] describe a number of problems with DIMS including: lost voter records due to overwriting, corrupted poll worker applicant information, inconsistencies in the voter history record, and lost productivity due to the need to reboot the system several times each day. The CERP Final Report[34] devoted almost an entire chapter to the DIMS voter registration database problems but reportedly no investigation has ever been conducted. The range of problems has increased. A technical evaluation to identify the design and operational problems, and any "glitches," is warranted so that the problems can be fixed or the system replaced. Maintaining an arguably defective voter registration database may present legal liability for the CCBOE as well.

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This Collaborative Audit Committee appreciates the authorization to conduct this audit and would look forward to working with the CCBOE's new managerial and Board Member team to improve election verification and other internal controls.

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[33] Memo from Tom Hayes, LNE Group to the Cuyahoga County Board of County Commissioners (December 7, 2006), p 1.
[34] CERP Final Report, see www.csuohio.edu/cei/ at chapter 1-2.

Appendices

Background on the Cuyahoga Collaborative Public Audit:

Creation, Purposes, Authority, and Participants in the
Collaborative Public Audit

I. The Need to Achieve Independent Verification of Election Results

Achieving accuracy in reported election results is the primary objective for any quality election administration. Given the range of recent information reported nationally about possible problems with e-voting technologies, and also some of the problems the Cuyahoga County Board of Election (BOE) experienced in prior elections, election reform organizations and the major political parties sought to have the local election results independently verified as accurate reflections of the ballots cast in the November 2006 election. In early fall, the chief initial public concerns focused on the DRE touchscreen voting devices which were to be used at polling places on election day.

After discussions with election reform organizations about their concerns, the Public Monitor of Cuyahoga Election Reform[1] introduced at a public Board meeting a proposal for a Collaborative Public Audit. The proposal pledged that the Monitor would seek the cooperative involvement of the local Democratic and Republican Parties, plus several election reform organizations to conduct the independent audit. The audit, per the reform organizations' requests, was to focus on the Diebold DRE touchscreen voting machines. The DRE units are the primary technology used in Cuyahoga County for Election Day voting at the polling locations. The DRE units are also used in "walk-in" absentee voting.[2]

The BOE Board Members unanimously approved the DRE audit proposal (and one other presented in the same verification proposa) on October 2, 2006, noting that some flexibility might be needed and that the Board's attorney needed to approve its legality. Thereafter, the county political parties' chairmen (Republican and Democratic) requested that the audit be extended to include optically scanned absentee ballots. The Audit Committee, which had been formed and begun working, agreed to this extension. The CCBOE Board Members unanimously approved the extension as well.

The Collaborative Audit participants believe the public wants independent verification that the election results that the e-voting technology has generated are accurate. Additionally, they believe both the election administrative staff and the public at large need to know whether the voting machines' programming maintained its integrity after the machines passed the pre-election testing and were deployed to the polling locations for Election Day. Reliable information on these and other questions are crucial so that sound decisions can be

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[1] The Center for Election Integrity of Cleveland State University per a proposal and testimony prepared by its Director, Candice Hoke.

[2] Functionally, "walk-in" absentee voting is a form of early voting.

made as to the voting and database technologies we used and so that any corrections in administrative or other systems that are needed can be identified.   While the audits that were conducted are limited rather than comprehensive and conclusive on these points, the information acquired is useful on these and other issues.

A national Election Audit Workgroup teaming the Brennan Center with with the Samuelson Law, Technology & Public Policy Clinic at Boalt Hall School of Law (UC Berkeley), as well as several election officials and leading academics as been working to evaluate current audit laws and procedures and provide critical analysis to public officials as they begin to adopt audit schemes and procedures. The workgroup has thus far identified five core goals that should motivate the design of election auditing: increasing public confidence in the results of an election; deterring fraud against the voting system; detecting large-scale systemic errors; providing feedback that will allow jurisdictions to improve elections and machinery in future years, and confirming to a high level of confidence that a 100% manual recount would not change the outcome of the race.

We agree strongly with this statement of election auditing design goals but would add a sixth: providing additional incentives for the staff to reach higher standards of accuracy.   In order to achieve these six and other auditing goals, we have concluded, as has the Election Audit Workgroup, that the independence of the auditing entity is essential.[3]

The Collaborative Audit Committee commends the Cuyahoga Board of Election for taking this Ohio leadership role in initiating election auditing and thus creating an independent mechanism for verifying the announced election results. We would also like to thank the over forty volunteers that gave their time over numerous days to help conduct this audit. Without this huge volunteer effort, this audit would not have been possible.

Policy Formation, Structure, and Participating Entities

The participating organizations that exercised policymaking powers over the audit and solicited volunteers were:

- Democratic Party of Cuyahoga County
- Republican Party of Cuyahoga County
- League of Women Voters
- CASE-Ohio (Citizens' Alliance for Secure Elections)
- Greater Cleveland Voter Coalition

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[3] Lawrence D. Norden, Statement to the U.S. House of Representatives, Committee on House Administration, Subcommittee on Elections, March 20, 2007 at 2; Candice Hoke, Statement to the U.S. House of Representatives, Committee on House Administration, Subcommittee on Elections, March 20, 2007 at 2 (this testimony to the Subcommittee on Elections that held hearings on Federal Election Auditing can be found at http://www.verifiedvotingfoundation.org/article.php?id=6445).

The Center for Election Integrity at CSU, in its role as Public Monitor for Cuyahoga County Board of Elections, served as the coordinator of the audit process. Center staff undertook a great deal of auditing duties but proposed the audit structure so that it acted as a neutral facilitator rather than a policymaker with a vote in Collaborative Audit group decisions. The Center for Election Integrity supplied professional staff services. Assistant Director Abigail Horn led the Center's audit work.

The policy decisions governing the audit, including which races to audit, were made by the representatives of the participating policymaking organizations. Each participating organization was limited to a maximum of two representatives on the planning and policymaking Audit Committee. The political parties sent experienced professional auditors and lawyers. The election reform organizations supplied individuals with a wide range of election expertise, including software engineers with technical voting technology expertise and poll workers or election observers. Virtually all decisions were made by consensus.

CSU's Northern Ohio Data Information Service (NODIS)[4] directed by Dr. Mark Salling designed the sample and audit methodology and provided analysis of the results.

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[4] http://nodisnet1.csuohio.edu/nodis/index.shtml

Appendix 2

Methodology and Procedures to Select Sample for Cuyahoga County Election Audit of DRE Long Reports versus GEMS Tabulations

Prepared by
Ellen Cyran and Mark Salling
Northern Ohio Data and Information Service
Maxine Goodman Levin College of Urban Affairs
Cleveland State University

December 28, 2006

This report describes the methodology used to select the sample of precincts used in the audit of the printed long reports produced from the electronic voting machines (DRE) immediately after the polls close on Election Day.[5] This audit is to verify the accuracy of the long reports against the published output of GEMS tabulation system that is produced after loading data from each of the memory cards used by the DREs.[6]

To insure that any discrepancy found is unlikely to affect the outcome of an election, the sample size is based on the closest race among those selected for inclusion by the collaborative audit group. The audit group selected county or statewide races with each political party selecting a race and civic groups selecting the third race. The unofficial election results, which included electronic voting machines (DRE) at the polling locations and early absentee optical scanned ballots, were used to determine the closest race. If the race was a statewide race, then the margin between the candidates at the state level was used in addition to the county level to determine the closeness of the race.

The steps involved in determining the sample size are as follows.

1. Calculate the percentage vote margin between the top two candidates of the closest race. In this case, the three selected races had only two candidates each.
2. Since the closest race was a statewide race and the statewide percent winning margin was less than the county-wide margin, the statewide margin percentage was used. The resulting margin was 2.1 percent of the votes cast for that race (state auditor).
3. Apply the state percentage vote margin (2.1%) to the votes in the county for the selected race, divide by two, and add one to obtain the votes needed to change the winner of the race. This provides the number of votes in the county that need to be switched in order to change the outcome of the race, assuming that the percentage margin is applied uniformly statewide.
4. Assume a maximum vote shift of 15 percent between the leading candidate and all other candidates in any precinct. (The Brennan Center recommends 7.5 percent for polling

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[5] Multiple DREs may be (are often) used at each polling place to collect votes on one or more precincts.
[6] This audit is performed since the long reports are available for audit soon after the election. The voter-verified paper audit trail (VVPAT) is not available for the audit because Ohio state law bars access to it.

location sampling and 15 percent for voting unit sampling. [7] This value represents the estimated maximum proportion of votes per polling location, precinct, or voting machine that needs to be switched for a candidate in order to change the outcome of the race.)

5. Sort precincts by descending order of votes cast in the closest race using the unofficial results reported from the Cuyahoga County Board of Elections tabulation server (based on voting from the DREs at the polls and the early absentee results).

6. Calculate the vote shift per precinct:
   a. Sort the precincts in descending order by votes cast in the closest race.
   b. Apply the 15 percent vote shift rate to each precinct, rounding up to the nearest vote. The 15 percent vote shift rate is from one candidate to another or 30 percent vote shift margin.
   c. If the winning candidate did not receive 15 percent of the votes in any given precinct, then assign a zero vote shift for the precinct.

   This would total to the necessary votes to change the election result (if applied uniformly across the state).

7. Sum the vote shift amount among the precincts until reaching (or just exceeding) the number calculated in step three; i.e., the number of votes necessary to change the outcome. The count is the minimum number of corrupt votes to alter the election with a 2.1 percent margin difference. The number of precincts, which were required to obtain the minimum number of corrupt votes, is the minimum number of corrupt precincts required to alter the election.

8. Use a hypergeometric distribution to determine the probability P of selecting at least one corrupt precinct in a sample of s precincts selected from a population of N precincts containing b corrupt precincts. The formula is:

$$P = 1 - \frac{\binom{N-b}{s}}{\binom{N}{s}}$$

   This formula must be solved for s with a computer program[8] or by estimation. A computer program was used since it gives the most accurate result. The formula was solved to determine the number of precincts that must be audited to insure 95 percent and 99 percent confidence interval levels.
   a. The 99 percent confidence intervals requires 110 precincts
   b. The 95 percent confidence intervals requires 72 precincts;

9. Add 20 percent to the sample size to account for "long reports" that may not be available or useable. Since the 99 percent confidence level was preferred, 22 secondary or "back-up" precincts were added to the primary 110 precincts to be drawn in the sample. Thus,

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[7] The Brennan Center Task Force on Voting System Security, Lawrence Norden, Chair, *The Machinery of Democracy: Protecting Elections in an Electronic World*, pg 22, http://www.Brennancenter.org/dynamic/subpages/download_file_39288.pdf.

[8] A Matlab program was converted to SAS to calculate the sample size, based on the minimum corrupt votes and the number of corrupt precincts from step 7. The Matlab program is available from Dopp, Kathy and Stenger, Frank: "The Election Integrity Audit," National Election Data Archive Project, September 25, 2006, http://electionarchive.org/ucvAnalysis/US/paper-audits/ElectionIntegrityAudit.pdf.

110 precincts are needed to achieve the objectives, though a total of 132 precincts are to be drawn.

The following steps were then used to select the sample precincts.

10. Select a sampling seed. Single-digit numbers submitted by each member of the audit collaborative were used to construct the seed.
11. Obtain the overall sample ($s_{overall}=132$) with 'proc surveyselect' in SAS®[9] from the population of $N = 1,434$ precincts.
12. Using the same seed as was used in the overall sample selection, obtain the primary sample ($s_{primary} = 110$) with 'proc surveyselect' in SAS® from the overall sample of useable forms ($s_{useable}$), where $s_{useable}$ is expected to be between 110 and 132.
13. Sort the 110 primary sample precincts and the 22 secondary sample precincts separately in descending order by votes cast in the largest precinct and polling location. This kept selected precincts at the same polling place together in the listing to facilitate data collection from the long reports. It also insured that the largest precincts were examined first and included in the sample in the event that a complete sample could not be implemented.

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[9] SAS®, http://www.sas.com.

Appendix 3
Example of the Form for Recording DRE "Long Report" Data

Recorder: _____   Reviewer: _____   Start Date: _____   Time: _____   End Time: _____

#	Polling Place Name	Precinct Name	DRE Serial Number	Report OK - not torn, missing, incomplete (Yes, No)	Precinct Name matches Report (Yes, No)	Report signed (Yes, No)	Total Votes Cast	Judicial		Auditor		Supreme Court		Reviewed?	Comment
								Gallagher	Hastings	Sykes	Taylor	O'Neill	O'Donnell		
1	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
2	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
3	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
4	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
5	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
6	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
7	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
8	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
9	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
10	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
11	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
12	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
13	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
14	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
15	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													
16	1410-ST. SAVA CHURCH HALL	BROADVIEW HEIGHTS -03-B													

Appendix 4
Basic Statistics on DRE Long Report entries

General:
1. The complete sample contained 1,414 unique long reports. The BOE had 5,834 DREs to use on Election Day (although it is unclear if they used them all). If all the available DREs were used, our sample represented 24.2 percent of all long reports.
2. The complete sample contained 132 precincts in 121 polling locations. This represents 9.2 percent of all precincts in the county.
3. The precincts in the complete sample contained 32,062 total votes cast. This represents 8.9 percent of the total votes cast in the county (361,025).
4. In the long report sample, 246 unique long reports (some containing data for more than one precinct in our sample) were not audited at all because those precincts/polling locations were missing some long reports. Without a complete set of long reports for a given precinct, we were unable to audit the existing long reports.
5. This leaves 1,168 unique long reports audited and used in the frequency counts. Some of these long reports contained data for more than one precinct in our sample.

Race and total vote matches:
1. 95 precincts matched the GEMS Server for total votes casts and the six candidate total in the three races.
2. Six precincts partially matched the GEMS Server data since the long reports were missing for some of the races audited. The two listed below matched at least one complete race. The other four precincts matched at least one candidate, but not a complete race.

   - Lakewood 3-E, polling location 5650-Westerly Apts. (Barton Ctr) matched in total, state auditor and Supreme Court races. DRE SN 295434 had a tape jam so the results for judicial race were missing for that DRE.

   - East Cleveland 3-D, 4810-Martin Luther King Civic Center matched only the judicial race. DRE SN 254353 was blank for the other races.

3. 31 precincts did not match because of problems with long reports in those polling location.

Appendix 5
Duplicate DRE Serial Numbers

1. Two duplicate DREs with different vote counts were found within polling locations.

   DRE SN 278596 – Garfield Heights 1D, Polling location 8027-St. Timothy Manor

   DRE SN 254886 – Middleburg Heights 4D Polling location 6100-Baptist Mid-Missions

   None of the above duplicates were deleted from any reporting. The votes in both duplicate long reports appears to have been loaded into the GEMS server since both are needed for the totals to match the audit totals.

2. One duplicate DRE across polling locations was found.

   DRE SN 260368 - Brook Park 1E, Polling location 1460-Brook Park Recreation Center
      Cleveland 3Q, Polling location 2261-Church Of God Of Cleveland

Appendix 6
2 DREs from the Same Precinct with the Same Serial Number:
Photocopies of Excerpts of 2 Long Reports
[note right column portion, "*MACHINE SERIAL*")

```
NO                    38
************************


*************************
** PRECINCT:   7685 **
   GARFIELD HEIGHTS -01-D
*************************
BALLOTS CAST
BALLOT        QUANTITY
  323             62


BALLOTS CAST SUMMARY
  BLANK VOTED        0
  UNDERVOTED         0
  WRITE-IN           0
*************************
Governor and Lieutenant Governor
RACE #  10
# RUNNING           4
# TO VOTE FOR       1


# TIMES COUNTED      62
# TIMES BLANK VOTED   0
BLACKWELL/RAGA       10
FITRAKIS/RIOS         1
PEIRCE/NOBLE          0
STRICKLAND/FISHER    51
WRITE-IN 1            0
# WRITE-INS           0
*************************
Attorney General
RACE #  20
# RUNNING            2
# TO VOTE FOR        1


# TIMES COUNTED      62
# TIMES BLANK VOTED  13
MARC DANN            41
BETTY MONTGOMERY      8
*************************
Auditor of State
RACE #  30
# RUNNING            2
# TO VOTE FOR        1


# TIMES COUNTED      62
# TIMES BLANK VOTED   9
BARBARA SYKES        50
MARY TAYLOR           3
*************************
Secretary of State
RACE #  40
# RUNNING            4
# TO VOTE FOR        1


# TIMES COUNTED      62
# TIMES BLANK VOTED   8
JENNIFER L. BRUNNER  46
JOHN A. EASTMAN
```

```
*************************
ELECTION RESULTS REPORT
*************************
CUYAHOGA COUNTY


NOVEMBER 7, 2006


           GENERAL ELECTION
DATE: Nov-07-2006
POLL CTR:      4955D00
       ST. TIMOTHY MANOR
MACHINE ID:          3
VERSION: 2    COPY: 0
COUNT:    0  SIZE: 32M
ACCU-VOTE RELEASE: 4.6.4
REPORT:       US 1.15


TIME: 19:01  11/06/2006
MACHINE SERIAL:  278596
PUBLIC COUNTER:      64
SYSTEM COUNTER:      94


*************************
*** SUMMARY TOTALS
*************************


BALLOTS CAST BY PRECINCT
PRECINCT 7685
BALLOT        QUANTITY
  323             62
PRECINCT 7695
BALLOT        QUANTITY
  324              2


BALLOTS CAST SUMMARY
  BLANK VOTED        0
  UNDERVOTED         0
  WRITE-IN           0
  TOTAL BALLOTS     64


*************************
Governor and Lieutenant Governor
RACE #  10
# RUNNING           4
# TO VOTE FOR       1


# TIMES COUNTED      64
# TIMES BLANK VOTED   0
BLACKWELL/RAGA       10
FITRAKIS/RIOS         1
PEIRCE/NOBLE          0
STRICKLAND/FISHER    53
WRITE-IN 1            0
# WRITE-INS           0
```

NO   21
****

****
** PRECINCT: 7685 **
    GARFIELD HEIGHTS -01-D
****
BALLOTS CAST
BALLOT   QUANTITY
  323   57

BALLOTS CAST SUMMARY
  BLANK VOTED   0
  UNDERVOTED   0
  WRITE-IN   0
****
Governor and Lieutenant Governor
RACE # 10   4
  # RUNNING   1
  # TO VOTE FOR

  # TIMES COUNTED   57
  # TIMES BLANK VOTED   0
  BLACKWELL/RAGA   2
  FITRAKIS/RIOS   2
  PEIRCE/NOBLE   0
  STRICKLAND/FISHER   53
  WRITE-IN 1   0
  # WRITE-INS
****
Attorney General
RACE # 20   2
  # RUNNING   1
  # TO VOTE FOR

  # TIMES COUNTED   57
  # TIMES BLANK VOTED   10
  MARC DANN   42
  BETTY MONTGOMERY   5
****
Auditor of State
RACE # 30   2
  # RUNNING   1
  # TO VOTE FOR

  # TIMES COUNTED   57
  # TIMES BLANK VOTED   6
  BARBARA SYKES   47
  MARY TAYLOR   4
****
Secretary of State
RACE # 40   4
  # RUNNING   1
  # TO VOTE FOR

  # TIMES COUNTED   57
  # TIMES BLANK VOTED   4
  ... BLANK VOTED

****
ELECTION RESULTS REPORT
****
      CUYAHOGA COUNTY

      NOVEMBER 7, 2006

        GENERAL ELECTION
DATE: Nov-07-2006
POLL CTR: 4955C00
      ST, TIMOTHY MANOR
MACHINE ID: 2
VERSION: 2   COPY: 0
COUNT: 0   SIZE: 32M
ACCU-VOTE RELEASE: 4, 6, 4
REPORT: US 1, 15

TIME: 18:46 11/06/2006
MACHINE SERIAL: 278596
PUBLIC COUNTER: 58
SYSTEM COUNTER: 94

****
*** SUMMARY TOTALS
****

BALLOTS CAST BY PRECINCT
PRECINCT 7685
BALLOT   QUANTITY
  323   57
PRECINCT 7695
BALLOT   QUANTITY
  324   1

BALLOTS CAST SUMMARY
  BLANK VOTED
  UNDERVOTED   0
  WRITE-IN   0
  TOTAL BALLOTS   58
****

Appendix 7. All Unmatched Precincts

Id	First Line	Polling_Place_Name	Precinct_Name	Difference (Audit minus GEMS)							Partial Matches	Comments
				Votes Cast	Gallagher	Hastings	Sykes	Taylor	O_Neill	O_Donnell		
1	31	360-BROOK PARK RECREATION CENTER	BROOK PARK -01-E	-81	-34	-20	-49	-30	-28	-37	no	Missing parts of long reports
2	157	3980-CLEVELAND KOREAN PRESB. CHURCH	CLEVELAND -16-P								no	Missing several long reports
3	158	3980-CLEVELAND KOREAN PRESB. CHURCH	CLEVELAND -16-Q								no	Missing several long reports
4	189	5400-GATES MILLS COMMUNITY HOUSE	GATES MILLS -00-B								no	All long reports missing for this precinct
5	201	7220-ST. MARGARET MARY CHURCH HALL	SOUTH EUCLID -01-C	-17	-9	-2	-8	-7	-8	-7	no	Missing several long reports
6	225	1120-BEACHWOOD HIGH SCHOOL	BEACHWOOD -00-F								no	Missing several long reports
7	295	6700-JOHN MUIR ELEMENTARY SCHOOL	PARMA -04-A	-3	0	-3	-2	-1	0	-2	Partial, but not the same race	Missing one long reports
8	308	1170-COLUMBUS INTERMEDIATE SCHOOL	BEDFORD HEIGHTS -03-C								no	Missing several long reports
9	458	6090-MIDDLEBURG HTS. CHURCH OF GOD	MIDDLEBURG HEIGHTS -04-A	-277	-74	-100	-94	-137	-70	-128	no	Missing several long reports
10	464	7830-ST. JUDE PARISH HALL	WARRENSVILLE HTS -07-B								no	Missing several long reports
11	516	7580-HIGH POINT RECREATION CENTER	STRONGSVILLE -02-I	-1	-11	-24	0	-1	0	-1	Partial, but not the same race	Torn long reports
12	571	4990-OUR LADY OF LOURDES SHRINE	EUCLID -04-B								no	Missing several long reports
13	698	3012-ZION CHAPEL(MISS BAPT ANNEX)	CLEVELAND -01-U	-24	-12	-1	-17	-2	-8	-9	no	Missing several long reports
14	718	6130-ST. WENCESLAS SCHOOL	MAPLE HEIGHTS -04-C								no	Missing several long reports
15	719	6130-ST. WENCESLAS SCHOOL	MAPLE HEIGHTS -04-D								no	Missing several long reports
16	773	3040-CUDELL RECREATION CENTER	CLEVELAND -18-I								no	Missing several long reports
17	796	5650-WESTERLY APTS. (BARTON CTR)	LAKEWOOD -03-E	0	-5	-2	0	0	0	0	Partial	Printer jam couldn't read two races
18	842	8024-FIFTH CHRISTIAN CHURCH	CLEVELAND -01-B	-2	0	-1	-2	0	0	-1	Partial, but not the same race	precinct missing on long report
19	916	2440-ST. MARTIN DEPORRES CENTER	CLEVELAND -09-K								no	Missing several long reports
20	936	5710-LINCOLN ELEMENTARY SCHOOL	LAKEWOOD -02-H	-190	-58	-74	-101	-72	-79	-79	no	Missing several long reports
21	937	5710-LINCOLN ELEMENTARY SCHOOL	LAKEWOOD -02-I	-6	-2	-1	-6	0	-3	-3	Partial, but not the same race	Missing several long reports
22	980	4220-GLENVILLE HIGH SCHOOL	CLEVELAND -09-E	-189	-71	-47	-162	-8	-79	-71	no	Missing 1 long reports
23	985	4860-TERRACE TOWERS	EAST CLEVELAND -04-E								no	Missing several long reports
24	990	2265-BOYS & GIRLS CLUB OF CLEVELAND	CLEVELAND -03-L								no	Missing several long reports
25	1013	2420-CAPTAIN ARTHUR ROTH SCHOOL	CLEVELAND -09-F								no	Missing several long reports
26	1027	6535-SENIOR CITIZENS CENTER BLDG-G	OAKWOOD -05-A	-83	-36	-12	-61	-14	-32	-23	no	printer problems
27	1097	4500-SIMPSON UN'D METHODIST CHURCH	CLEVELAND -18-R								no	Missing all long reports
28	1107	4280-IMMACULATE HEART OF MARY	CLEVELAND -12-D	-37	-14	-17	-24	-9	-13	-19	no	Missing 1 long report
29	1153	6710-RIDGEBROOK ELEMENTARY SCHOOL	PARMA -01-G								no	Missing several long reports
30	1194	2360-EVERLASTING BAPTIST CHURCH	CLEVELAND -10-J								no	Missing 1/2 of a long report
31	1206	4810-MARTIN LUTHER KING CIVIC CENTER	EAST CLEVELAND -03-D	-17	0	0	-12	-2	-11	-3	Partial	Blank tape for auditor and supreme court
32	1328	6580-ORANGE VILLAGE HALL	ORANGE -00-C	-11	-4	-13	-5	-4	-5	-5	no	Missing 1 long report
33	1380	8018-PEARLBROOK CHURCH OF GOD	CLEVELAND -16-S								no	Missing all long reports
34	1419	2300-ALEXANDER G. BELL ELEM. SCHOOL	CLEVELAND -06-G	-58	-28	-12	-50	-3	-43	-35	no	Missing 1 long report
35	1527	2080-GREATER ABYSSINIA TOWERS	CLEVELAND -08-O								no	Missing several long reports
36	1546	4290-WESTSIDE SACHSENHEIM HALL	CLEVELAND -16-A								no	Missing several long reports
37	1547	4290-WESTSIDE SACHSENHEIM HALL	CLEVELAND -16-C								no	Missing several long reports

Note: Those precincts with blanks (no differences recorded) did not have completed audits because long report problems were identified at the beginning and auditors knew they would not have sufficient information to do a comparison with GEMS data.

Appendix 8
Discrepancies between PDF and sum of CSV files for unofficial results
(128 precincts)

Precinct	Cards Cast	Sykes	Taylor	Gallagher	Hastings	O'Donnell	O'Neill
	Difference - Unofficial PDF results minus combined CSV results						
BEACHWOOD -00-D	1	0	0	0	1	0	1
BEACHWOOD -00-H	1	1	0	0	1	1	0
BEACHWOOD -00-K	1	1	0	1	0	0	1
BEDFORD -01-A	1	1	0	0	0	1	0
BEDFORD -03-A	3	2	1	2	0	0	1
BEREA -02-A	1	0	1	0	1	1	0
BRECKSVILLE -00-E	2	0	1	0	2	2	0
BRECKSVILLE -00-L	1	0	0	0	0	0	0
BROOKLYN -00-A	1	0	1	0	1	0	1
BROOKLYN -00-C	2	1	0	1	0	1	1
BROOKLYN -00-F	1	1	0	1	0	0	1
BROOKLYN -00-G	2	2	0	1	1	1	1
BROOK PARK -01-A	1	1	0	1	0	0	1
BROOK PARK -01-B	1	0	1	0	1	1	0
BROOK PARK -01-C	1	1	0	0	0	0	0
BROOK PARK -02-A	1	0	1	0	1	0	1
BROOK PARK -02-C	1	0	1	0	1	1	0
BROOK PARK -04-A	1	0	1	0	1	1	0
CLEVELAND -01-D	1	1	0	0	1	0	1
CLEVELAND -01-F	1	1	0	1	0	0	1
CLEVELAND -01-N	1	1	0	1	0	0	1
CLEVELAND -01-P	1	1	0	0	0	0	1
CLEVELAND -02-A	1	1	0	0	0	1	0
CLEVELAND -02-I	1	1	0	0	0	0	1
CLEVELAND -02-S	5	5	0	0	1	0	2
CLEVELAND -03-B	1	1	0	0	1	1	0
CLEVELAND -03-R	1	0	0	0	0	0	0
CLEVELAND -05-J	1	0	1	1	0	1	0
CLEVELAND -05-L	1	1	0	1	0	0	1
CLEVELAND -05-M	1	1	0	0	0	1	0
CLEVELAND -05-N	1	1	0	0	0	0	0
CLEVELAND -05-R	1	1	0	1	0	0	1
CLEVELAND -08-E	1	1	0	1	0	0	1
CLEVELAND -08-R	1	0	0	0	1	1	0
CLEVELAND -09-F	1	1	0	1	0	1	0
CLEVELAND -09-G	1	1	0	1	0	0	1
CLEVELAND -09-J	1	1	0	0	0	1	0
CLEVELAND -09-K	1	1	0	0	0	0	1

CLEVELAND -10-M	1	1	0	1	0	0	0
CLEVELAND -10-Q	1	1	0	1	0	1	0
CLEVELAND -11-J	2	1	0	1	0	1	0
CLEVELAND -13-E	1	1	0	1	0	1	0
CLEVELAND -13-X	1	1	0	0	0	0	0
CLEVELAND -15-E	1	1	0	0	1	1	0
CLEVELAND -16-D	1	1	0	1	0	1	0
CLEVELAND -16-Q	1	0	1	0	0	0	0
CLEVELAND -16-R	1	1	0	0	0	0	1
CLEVELAND -17-G	1	0	1	0	1	0	1
CLEVELAND -18-D	1	1	0	1	0	1	0
CLEVELAND -19-C	1	1	0	0	0	0	1
CLEVELAND -19-D	2	2	0	0	0	0	2
CLEVELAND -20-A	1	0	0	0	0	0	0
CLEVELAND -20-N	1	0	0	0	0	0	0
CLEVELAND -21-A	1	0	1	1	0	1	0
CLEVELAND -21-G	1	0	1	1	0	1	0
CLEVELAND -21-P	2	2	0	0	2	0	2
CLEVELAND HEIGHTS -01-J	2	1	1	0	1	0	1
CLEVELAND HEIGHTS -04-D	1	1	0	1	0	0	1
EAST CLEVELAND -03-G	1	0	1	0	1	0	1
EUCLID -01-D	2	0	2	0	2	1	1
EUCLID -01-M	1	1	0	1	0	0	1
EUCLID -03-K	1	0	0	0	1	0	0
EUCLID -04-D	1	0	1	1	0	0	1
EUCLID -04-I	1	1	0	1	0	0	1
GARFIELD HEIGHTS -01-E	1	1	0	1	0	1	0
GARFIELD HEIGHTS -02-C	1	1	0	1	0	0	1
GARFIELD HEIGHTS -05-C	1	0	0	0	0	0	0
INDEPENDENCE -00-A	1	1	0	1	0	0	1
INDEPENDENCE -00-G	1	0	1	0	1	0	1
INDEPENDENCE -00-H	1	1	0	0	0	0	0
LAKEWOOD -01-A	2	0	2	0	0	0	1
LAKEWOOD -01-L	1	1	0	1	0	0	1
LAKEWOOD -02-K	1	1	0	0	1	1	0
LAKEWOOD -04-D	1	1	0	1	0	1	0
LYNDHURST -02-D	1	1	0	1	0	0	1
LYNDHURST -03-A	1	1	0	0	1	1	0
LYNDHURST -04-E	1	0	1	0	1	1	0
MAPLE HEIGHTS -03-D	1	0	1	1	0	0	1
MAPLE HEIGHTS -04-A	1	1	0	1	0	0	1
MAPLE HEIGHTS -04-C	1	1	0	1	0	0	0
MAPLE HEIGHTS -07-C	2	1	1	2	0	1	1
MAYFIELD HEIGHTS -00-B	1	0	1	0	1	0	1

MAYFIELD HEIGHTS -00-F	2	1	0	1	0	0	1
MAYFIELD HEIGHTS -00-M	1	1	0	1	0	0	1
MAYFIELD VILLAGE -01-A	1	0	1	0	1	1	0
MAYFIELD VILLAGE -03-A	1	0	1	0	1	1	0
MIDDLEBURG HEIGHTS -04-C	1	1	0	0	1	0	1
NEWBURGH HEIGHTS -00-A	1	0	0	1	0	0	0
NORTH OLMSTED -01-B	1	0	1	0	1	1	0
NORTH OLMSTED -02-D	1	1	0	1	0	0	1
NORTH OLMSTED -04-A	2	1	1	2	0	1	1
NORTH OLMSTED -04-G	1	1	0	0	0	1	0
NORTH OLMSTED -04-H	1	1	0	0	1	0	1
NORTH ROYALTON -03-A	1	0	1	0	1	1	0
NORTH ROYALTON -03-E	2	0	1	0	2	1	0
NORTH ROYALTON -05-C	1	0	1	0	0	1	0
OLMSTED TOWNSHIP -00-B	2	1	1	0	1	0	1
PARMA -01-C	1	1	0	0	0	0	0
PARMA -01-E	1	1	0	1	0	0	1
PARMA -02-A	1	1	0	0	0	0	0
PARMA -03-A	1	1	0	1	0	0	1
PARMA -03-J	1	1	0	1	0	0	1
PARMA -04-C	1	1	0	1	0	0	1
PARMA -05-D	1	1	0	1	0	0	1
PARMA -06-D	1	0	1	0	1	1	0
PARMA -07-G	1	0	1	0	0	0	1
PARMA -08-E	1	0	1	0	1	1	0
PARMA -09-E	1	1	0	1	0	0	1
PEPPER PIKE -00-B	1	1	0	0	1	0	1
PEPPER PIKE -00-D	1	0	1	0	1	0	1
PEPPER PIKE -00-F	3	2	1	1	2	0	3
ROCKY RIVER -02-F	2	1	1	1	1	1	1
ROCKY RIVER -03-B	1	0	0	0	1	1	0
SEVEN HILLS -01-C	1	1	0	1	0	0	1
SEVEN HILLS -03-C	1	1	0	1	0	0	1
SHAKER HEIGHTS -00-JJ	1	0	0	0	1	1	0
SOLON -01-C	1	0	1	0	1	0	1
SOLON -02-B	1	1	0	0	0	0	1
SOLON -03-C	1	1	0	0	0	0	0
SOUTH EUCLID -02-G	1	0	0	0	0	0	0
STRONGSVILLE -04-C	1	0	0	0	0	0	0
UNIVERSITY HEIGHTS -00-F	1	1	0	1	0	1	0
UNIVERSITY HEIGHTS -00-M	2	2	0	1	1	0	2
WESTLAKE -02-C	1	0	0	0	0	0	0
WESTLAKE -02-D	1	1	0	1	0	1	0

WESTLAKE -04-B	1	1	0	0	1	0	1
WESTLAKE -05-E	1	0	1	1	0	1	0
WESTLAKE -05-F	1	0	1	0	0	0	0
Total	152	91	42	58	50	48	72
Maximum difference	5	5	2	2	2	2	3
Minimum difference	1	0	0	0	0	0	0

Page 1 of 1

City_precinct | Batch Count 143 | GEMS Count 143 | Recorder: Jane Doe | Date 13-Dec | Ending Time 2:30pm

Scanned 143 | Rejected 0 | ✓ = vote

If you mistakenly check a cell **circle** it. Then make such a cell **solid filled if re-**used.

Sykes — TOTAL: 54

Taylor — TOTAL: 78

No Vote (blank) — TOTAL: 8

Cannot Be Determined — 3

Reason
✓ torn off portion with vote
✓ unclear mark
✓ Coffee stained

ALL: 143

58

Appendix 10
Discrepancies in Optical Scan Hand Count from GEMS report

Group A. The audit hand count results were **lower** than the GEMS reported count in these 16 precincts:

Beachwood 0-E	*-1 Sykes*	
Berea 4-C		*-1 Taylor*
Brook Park 1C	*-1 Sykes*	
Brook Park 2A		*-1 Taylor*
Cleveland 14-J	*-1 Sykes*	
Cleveland 17-B	*-1 Sykes*	
East Cleveland 4-H	*-3 Sykes*	
Mayfield Heights 0-I	*-1 Sykes*	
North Olmstead 1-A	*-1 Sykes*	
North Olmstead 4G	*-1 Sykes*	
Olmsted Falls 3-A	*-2 Sykes*	*-2 Taylor*
Richmond Heights 3-C		*-1 Taylor*
Shaker Heights 0-Q	*-1 Sykes*	
South Euclid 2-A	*-1 Sykes*	
University Heights 0-E	*-1 Sykes*	
Westlake 2-B	*-1 Sykes*	

Group B. The audit hand count results were higher than the GEMS reported count in these 11 precincts:

Broadview Heights 1-D	*+1 Sykes*	*+1 Taylor*
Broadview Heights 2-C	*+1 Sykes*	
Cleveland 3-K	*+1 Sykes*	
Cleveland 6-D	*+1 Sykes*	
Cleveland 7-T	*+1 Sykes*	
Cleveland 11-D	*+1 Sykes*	
Highland Hills 0-A	*+1 Sykes*	*+1 Taylor*
Lyndhurst 4-C	*+1 Sykes*	
Maple Heights 4-D		*+1 Taylor*
Rocky River 3-B	*+1 Sykes*	
Seven Hills 4-B		*+1 Taylor*

Group C. The audit hand count results were both higher and lower for the candidates compared to the GEMS reported count in precinct Lyndhurst 1-B with –1 Sykes vote and +1 Taylor vote.

Group D. The GEMS reported count was zero ballots counted and zero votes in precinct North Olmsted 2-F. The folder for OS ballots for this precinct contained ballots (36 for Sykes, 21 for Taylor, and 3 blank).

Appendix 11
Investigation of Discrepancies in Optical Scan Audit

Discrepancy Evaluation – Group A
Examination of the Central Count report for information about the 16 precincts with discrepancies of a lower count (Group A) showed that 11 of the precincts had ballot cards filed in an additional location. Such ballot cards would have been included in the GEMS count but because they were not present in the folder at the time of the audit, they would not have been included in the audit tabulation. There appear to be two subgroups in this category. One group has additional ballot cards misfiled as a minor component of another deck in numbers consistent with the numbers of votes missing, i.e., three ballot cards per vote.

Specifically

Beachwood 0-E	*1 missing vote*	*3 ballot cards wrong deck*
Cleveland 14-J	*1 missing vote*	*3 ballot cards wrong deck*
East Cleveland 4-H	*3 missing votes*	*9 ballot cards wrong deck*
Mayfield Heights 0-I	*1 missing vote*	*3 ballot cards wrong deck*
North Olmstead 1-A	*1 missing vote*	*3 ballot cards wrong deck*
Olmsted Falls 3-A	*4 missing votes*	*12 ballot cards wrong deck*
Richmond Heights 3-C	*1 missing vote*	*3* ballot *cards wrong deck*
Shaker Heights 0-Q	*1 missing vote*	*3 ballot cards wrong deck*

The second group has single ballot cards scanned in a deck that consisted of only that single card. The origin of these single card decks is not known.

Specifically

Brook Park 1C	*1 missing vote 1 ballot card solo deck*
Brook Park 2A	*1 missing vote 1 ballot card solo deck*
North Olmstead 4G	*1 missing vote 1 ballot card solo deck*

These ballot cards were not recovered from their locations nor examined to determine votes marked. The number of ballot cards in all cases was sufficient to account for the number of votes that were missing from the respective precincts.

The discrepancies in the other five precincts in Group A could not be explained by this means since there was no evidence found of ballot cards filed in locations other than the folder examined by the audit.

Discrepancy Evaluation – Group B
Examination of the Central Count report for information about the 11 precincts with discrepancies of a higher count (Group B) showed that six of the precincts had additional ballot cards from other precincts included. These would not have been included in the GEMS count but could possibly have been included in the audit tabulation if they were not recognized and excluded.

Specifically:

Broadview Heights 1-D	*2 extra votes*	*4 cards other precincts*
Broadview Heights 2-C	*1 extra votes*	*3 cards other precincts*
Cleveland 6-D	*1 extra votes*	*3 cards other precincts*
Highland Hills 0-A	*2 extra votes*	*6 cards other precincts*
Lyndhurst 4-C	*1 extra votes*	*3 cards other precincts*
Rocky River 3-B	*1 extra votes*	*3 cards other precincts*

During a second follow-up visit to the BOE, these precinct folders were re-examined specifically to determine if the ballot cards from other precincts shown by the Central Count to be present were in fact present and to determine if these ballots had been included in the audit count. In all six of these precinct folders, ballot cards from other precincts were indeed present. In three folders, the original audit count had apparently included the misfiled ballot cards and the discrepancy was resolved when these were excluded. In the other three precincts, the misfiled ballots had apparently been excluded at the time of the original audit (the misfiled ballots were all placed first in each folder) and the re-count results excluding these were the same as those found in the original audit.

The discrepancies in the other five precincts in Group B could not be explained by this means.

Group C - Other Discrepancy Evaluation
The one precinct (Group C; Lyndhurst 1-B) in which the audit count was one vote high for one candidate and one vote low for the other was also recounted and the results were found to be the same as the original audit count.

NOTE: During this follow-up visit, five other precincts with discrepant results that were not apparently explained or reconcilable by misfiled ballots were examined and re-counted. In all cases the counts were the same as those from the initial audit.

Appendix 12
Precincts with All or Most Optical Scan Ballots Missing from GEMS

Because we had by chance selected a precinct (North Olmsted 2F) that had OS ballots returned but not recorded in the Central Count Report or on the SOVC report we were aware that this was a possible explanation for no results and no ballots counted. An alternate explanation for zero results would be if there were, in fact, no absentee ballots returned for these precincts. In an attempt to determine if that was the case we determined the number of absentee ballots reported returned for each of these precincts by November 3, 2006, the cutoff time for inclusion in the early absentee scanning. This file was obtained from the BOE (absentee voters for November 2006.csv). Nine of the 11 precincts did not have any absentee ballots returned, but two others did.

As a follow-up, the report of absentee ballots returned was compared to the number of ballots reported in the GEMS report and ballots counted in the Central Count report for all precincts.

Within the limitations of the data and possible errors in the absentee information it appears likely that all or nearly all of the ballots for at least several precincts were not included in the unofficial SOVC. Specifically:

> *Chagrin Falls Twp A   126 voters 11 abs returned   0 SOVC*
> *Cleveland 2I   940 voters 30 abs returned   1 SOVC*
> *Cleveland 13X   920 voters 12 abs returned   1 SOVC*
> *North Olmsted 2F   759 voters 63 abs returned   0 SOVC*

We asked to examine these four decks and were able to examine three of them. One was not able to be found and was not present on the log showing storage location. The documentation on the folders for the three decks examined indicated that these ballots had been scanned during the unofficial count. One of these had a notation "Reject delete" that had been erased but was still readable. It appears that these precincts were deleted from the GEMS tally for some reason. The precinct folders examined contained ballots in numbers corresponding to the number of absentee ballots reported returned.

The procedure during scanning for the unofficial count required verification by the tabulation staff that the number of pages reported on GEMS was within a certain margin of error of the number of pages reported by the scanner. If not within that margin of error the tabulation staff was to delete the batch result from GEMS and the deck was to be rescanned. In these cases, it is possible that after deleting the digital batch from GEMS, the ballots were not rescanned but simply put back in the file. Two precincts each showed one vote in GEMS because there was a single ballot card for each of those precincts present in a deck that consisted of only the single card.

Appendix 13
BOE Email on Missing Batch in the Unofficial Count

-------- Original Message --------
Subject: Missing Batch in the Unofficial Count
   Date: Fri, 29 Dec 2006 13:28:30 -0800 (PST)
  From: Frank James Hlad <fjhlad@yahoo.com>
     To: Abigail Horn <abigail@urban.csuohio.edu>

We have no evidence of that missing batch in the unofficial count. As we said, it looks as if the batch was scanned, deleted from GEMS, and never re-scanned. Austin had that printout that Kurt was talking about, and the precinct showed no votes cast.

We have been unable to find transaction log information on that day. I am not certain if that's because Matt and Brian don't know where to look or if the log doesn't exist. We did locate a transaction log from the official count, but there was no way to sort or find data within it. It is massive, as you might imagine.

I guess I don't know what to tell you about all this. Your point about dropping a batch in the official count is well taken. Because we can't output data in any usable form from GEMS, we really have no mechanism (except eyeballs) to catch a problem like that.   F

Appendix 14
Differences between files provided by the BOE for Optical Scan Audit

run date	Title in PDF	Name of File	Received by Audit	Cards Cast	Sykes	Taylor
11/13/2006 (12:48 PM)	Post Absentee/Pre DRE	gems sovc report post avos - pre tsx.pdf	11/13/2006	201,290	40,194	21,059
11/13/2006		post avos- pre tsx data.csv	11/13/2006	201,290	40,194	21,059
11/27/2006 (7:52 AM)	filename Official, but data is unofficial, inside the document only titled ABS	GEMS SOVC REPORT official AVOS only 11-06.pdf	1/31/2007	201,595	40,321	21,068
1/31/2007 (10:54 AM)	ABS, Unofficial Results	GEMS SOVC REPORT Unofficial AVOS Only.pdf	1/31/2007(?)	201,473	40,307	21,109

Appendix 15
Email Exchange between the Monitor and DESI about GEMS Database

-------- Original Message --------
Subject: Database Question posed by the Monitor
   Date: Fri, 17 Nov 2006 16:28:21 -0500
  From: Bellis, Chris <BellisC@diebold.com>
    To: Michael Vu <bempv@cuyahogacounty.us>, Lou Irizarry <belmi@cuyahogacounty.us>,
       Matthew Jaffe <bemij@cuyahogacounty.us>, Hiner, Jessica
       <jessicah@dieboldes.com>, Candice Hoke <shoke@law.csuohio.edu>,
       tryan@law.csuohio.edu
   CC: Gwen Dillingham <begdx@cuyahogacounty.us>, Green, Pat <GreenP@diebold.com>

Earlier today as a result of the Monitor's Investigation of a GEMS Database [a Monitor software engineer] ran the following SQL statement on a mdb file off of a CD:

SELECT SUM(Vote Totals) from candidatecounter WHERE CANDVGROUPID = 1433

The resulting value was 186,205.
Then he ran the following statement on the same .mdb file

        SELECT SUM(Vote Totals) from sumcandidatecounter WHERE CANDVGROUPID = 1433 AND VCENTERID <> -1

The resulting value was 186, 027.

Two questions emerged:
      1.   Why is the value different?
      2.   Why do we store candidate totals in two different tables?

ANSWER:

Chris,
        The SumCandidateCounter table is used to store the totals by precinct rather than by counter batch; this was done for performance reasons. The SumCandidateCounter table is updated from the CandidateCounter table when a report is printed whereas the CandidateCounter table is updated when the when the results are posted. Therefore if results had been posted since the last report was printed the totals would not match.
        Hope this helps.

Tab

Talbot Iredale, P.Eng,
Software Development Manager
Diebold Election Systems

Appendix 16
Indicators that MAY Show Database Corruption
(Discovered in the Monitor's Review of CCBOE *Unofficial* Results Database on 11/17/06)[10]

1. Table element entries were missing date/time stamps of when the information was entered.

2. Table element entries had date/time stamps of January 1, 1970, which is the epoch (zero-point) of UNIX time.

3. In an email dated November 3rd, 2006, from DESI's Talbot Iredale, he claimed

> "Accounting for transaction overhead, I do not expect the database to grow by more than 100 MB during absentee processing. However this will vary dependent on what other other activities (printing, reports, etc.) occur during the processing."

The database grew to a size greater than 100 MB for absentee processing and a size above 1000 MB for the full election. What happened? Why were the estimations wrong? Precision is very important, especially when dealing with votes. Where else were DESI calculations imprecise?

4. Vote totals in two separate database tables held different values. DESI has provided a response, but as of yet, this response has not been tested or verified.

5. In an email from Chris Bellis dated Monday, November 20, 2006, Mr. Bellis summarized the "large amount of concurrent activity" that was occurring on the GEMS server on election night. This included DRE uploads, the JResults server running, the AVServer running, and Digital Guardian running, all interacting with the database in varying functions. In a subsequent email from Jessica Hiner, dated Sunday, November 26, 2006, Ms. Hiner stated "In the context of an online system with many users, Jet would not be an appropriate choice, but that is not how we use it."

❑ It appears in DESI's own words, Hiner acknowledges that when there is a large amount of concurrent activity, Jet database corruption can occur. Chris Bellis has said that on election night, there was a lot of concurrent activity on the server. Taking these two statements together, it would seem very possible that corruption may have occurred.

Microsoft's own documentation has stated that database corruption within JET is unavoidable. This statement is without qualifiers. Normal operation of the Jet database includes corruption.

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[10] *From a Monitor staff software engineer with substantial database expertise who conducted an initial review of the unofficial election results database with representatives of DESI and the BOE present; the Monitor's review was limited to just over one hour. T resulting information was provided to Project Director Candice Hoke, who then hand-delivered it to the Board Members at the November 2006 certification Board meeting.*

Excerpt from Microsoft Documentation on JET-Access Databases
(emphasis added)

Security

Although Access databases (using the Jet engine) can be password protected and encrypted, ***these databases do not have the same level of security*** as SQL Server or mainframe database systems. ***If data security is critical***, a SQL Server solution is the better choice....   SQL Server allows distributed data in a controlled and highly secure manner.

Data Integrity

Similarly, ***data integrity and recovery is not as robust on file-based databases using Jet....***

File server ***databases using Jet may become corrupt*** and require regular maintenance to maintain optimal results. ***Even with maintenance, the chance of failure is much higher*** than with SQL Server.   ....

Transaction Logs and Rollbacks

If you need to know who modified what data, and undo changes, SQL Server's built-in features and triggers support this *[but not Access using JET—ed.]*

An Access application can try to replicate the tracking of changes by managing user interaction with the data. However, it would require programming and could not be managed at the core data level. ***Mistakes in the application or other applications in contact with the Access data could cause data changes that are not documented***. There are ***also no rollbacks*** *[opportunities to "undo" the operation—ed.]* ***in Access after a transaction is committed***.

The above paragraphs can be found in *Microsoft Access or SQL Server: What's Right in Your Organization?* at
 http://www.microsoft.com/sql/solutions/migration/access/compare-access.mspx