NIST Voting Project

Legibility of paper ballots: What makes a printed summary-style ballot easy to verify?

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Contents

Overview of this report

This is a report of a project to explore the legibility of summary ballots printed by ballot marking devices (BMDs). Any printed ballot is a challenge for blind voters and low-vision voters, who cannot read them directly. This verification, a final review before a voter casts a ballot, is an important part of ensuring that ballots are cast as voters intend.

Our goal in this work is to identify aspects of design, layout, or typography that can make a summary-style ballot easier to read and to increase the likelihood that a mistake or change will be detected. We wanted to know what would make a summary-style ballot both easy to read visually and with assistance from optical character recognition (OCR) tools.

The investigation looked at

- the visual presentation of the ballot to identify typographic elements that might make it easier to read visually
- the feasibility of using (OCR) to allow blind or low vision voters to verify that their ballot reflected their intent before casting their ballot
- whether there is a relationship between the design elements that support both visual and OCR-assisted reading.

Summary-style ballots

A **summary-style ballot** is printed by a BMD as a list of the voter's selections, and indicators when the voter did not make a possible selection, such as voting for fewer choices than allowed.

They differ from "bubble-style" optical scan ballots, in which the BMD emulates hand-marking the ballot by filling in the bubbles. Any reading of a "bubble-style" ballot requires associating the bubbles with the name of the candidate (or other selection) by either evaluating the visual relationship or having access to a map that identifies the meaning of each bubble location.

Information to read the ballot layout is programmed into the BMDs and ballot scanners, but is not available in general purpose OCR tools. OCR applications read printed documents by taking an image and identifying the characters and words, transforming the ballot into a textual record, which can then be read out loud. Several commercial applications are in common use as assistive technology (AT) and work well with standard documents. Because these general-purpose tools do not have any special programming for reading a ballot, the layout and legibility affect their accuracy and, therefore, how easy the ballot is to verify.

We considered three overlapping properties of the printed ballot:

- **Layout** is the arrangement of the ballot elements on the printed page. This includes ballot header details that identify the election and ballot style, the list of contests and selections, QR- or barcodes, the space, lines or other visual elements that create zones for different types of information on the ballot, and the arrangement of the contest (the office or question identifier plus selections and non-selection indicators).
- **Legibility** is a property of text that defines how easy it is to be read or deciphered. For example, the legibility of a font considers how well the letters are distinguishable from each other. This is different from readability, which considers the overall clarity of a text and the ease of identifying words, sentences, and paragraphs.
- **Listenability** is our word for audio legibility, or how easy it is to understand the ballot when read aloud after being transformed into text by an OCR application.

How we worked

We analyzed 7 summary-style ballots from current voting systems for legibility and for OCR accuracy. These sample ballots were collected from demonstrations by voting system vendors and election departments.

- A **legibility analysis** looked at measurable and observable characteristics: font size, leading[1]. In addition, we also considered elements like visual separators and layout details of the contest data and other information on the ballot that might affect the readability of the overall ballot.
- An **OCR analysis** used a commercial desktop and 4 phone applications to see how accurately and understandably these systems could read the ballot as an alternative to visually verifying it.

Summary of the results

We learned that elements that enhance visual reading did not interfere with OCR accuracy and vice-versa. For example, the use of bold, text size, and horizontal lines between contests helped visual readability but did not have a noticeable impact on the OCR.

[1] A typography term that refers to the space between lines of type. This is also known as "line spacing" too. Leading is measured as the distance from the baseline of type on one line to the next.

However, the overall layout and how clearly the sections of information on the ballot are placed in distinct zones did affect the accuracy of OCR. This is partly due to the nature of general-purpose OCR tools, which are optimized for reading blocks of standard text—recognizing characters and producing a stream of words—not interpreting a complex layout.

Our **legibility analysis** showed that a combination of elements enhanced legibility rather than a single element, including creating clear zones for the overall layout and separating contests successfully.

The **OCR results** were less clear. The ability to read a ballot using an OCR tool was inconsistent, especially when using a handheld device. Even small variations in the light or the position of the handheld camera relative to the ballot paper could change the results.

There were also problems that can be attributed to the design of the ballot. Some simple reading errors in interpreting the words are legibility problems, caused by poor typography or poor print quality. In many cases these errors were minor and could be easily interpreted by someone used to reading text through OCR, such as reading "Pemsylvania" for "Pennsylvania." Others, however, rendered entire words completely unreadable.

More serious errors jumbled the information when the OCR programs did not understand the layout of the ballots. These errors included mixing header and contests information or confusing contest data, when they were not able to identify the boundaries of the contests.

Overall, the results ranged from one ballot which all tools read accurately to those with a range of problems, even on ballots that were presented in a clear way for visual reading.

Conclusions and recommendations

Despite the challenges to accurately reading these samples of current ballots with OCR tools, there is reason for optimism. Many of the design challenges would be easy to correct if the ability to read a ballot through OCR was made a design priority.

We do not have detailed design recommendations, but it is clear from this analysis that there are important design elements to consider:

- **Text size**, which should meet the VVSG 2.0 requirements for printed ballots
- **Line spacing**, so that character ascenders and descenders to not overlap

- **Clear layout** of the ballot, separating header information from the contests and making it easy to find the beginning of the contest data
- **Separating contests** with typography or design elements
- **Placing candidate identifiers** (such as party or other information) after the name, not before

Achieving this goal will require both lab testing of the ballot design with OCR tools and robust usability testing with voters using their own OCR tools in typical voting settings, including those with different levels of experience or skills using these tools.

Additional research is also needed to better understand the range of personal assistive technology that voters might choose to use and how this compares with alternative ways to read the ballot. For example:

- The ability to read back a marked ballot at a voting station before casting it
- A similar feature to display a review of selections at the ballot scanner before casting
- A QR code (or other encoding) that contains selections data, which can be more accurately read through personal assistive technology.

Context and background for this project

The voting process includes marking, reviewing (on-screen in the context of this research), verifying (the ballot to be cast), and casting a ballot.

Ballot Marking Devices (BMDs) are a hybrid technology—an electronic voting interface voters use to make selections and review their choices on a screen before printing their marked ballot to be cast. BMDs provide the advantages of an electronic voting interface, including clear feedback on selections, the ability to offer multiple languages, protection from overvotes, and a chance to review a voter's selections for accuracy and notices of undervotes.

BMDs provide an accessible in-person voting experience for voters with disabilities through options to adjust the visual presentation (such as text size or high and low contrast options), tactile controls and switches for blind and low-dexterity voters, and an audio interface to the interaction, similar to general-purpose read-aloud technologies.

Like all ballots, BMD-printed ballots serve several purposes.

- Voters use them to verify their selections before casting their ballot, an important last step in the voting process. For this purpose, legibility is critical—a ballot that is easy and inviting to read encourages voters to verify their ballot.
- When a BMD-printed ballot can be read directly, tabulators scan them as part of the vote-counting process. Tabulators may scan the human-readable text or scan a QR code or barcode.
- They are used in audits and recounts.

BMD-printed ballots come in two styles:

- A **summary-style ballot**, where the printout only shows the voter selections and any possible selections not voted.
- A **"bubble-style" ballot** in which a printer fills in the ovals on the ballot based on the voter's selection.

This report looks at the design and layout of the **summary-style ballots** produced by BMDs to understand what features make them easier—or more difficult— for voters to read and use to verify their ballot before casting.

Other studies of BMD ballots

This research builds on previous work on the design of ballots, general typography information, and reports on BMDs.

Two papers were beneficial in our preparation for the analyses.

- A report by the Open Source Election Technology Institute (OSET, 2019) report, "Machine-Marked Printed Vote Records Recommended Principles and Guidelines." provides a good overview of the technical architecture of BMDs.
- A 2020 article (Kortum, Byrne, & Whitmore, 2020) concluded, "Voter Verification of BMD Ballots Is a Two-Part Question: Can They? Mostly, They Can. Do They? Mostly, They Don't." They report that of those who chose to examine their ballots, 76% were able to detect errors reliably. The two ballots they used are similar to Samples 1 and 4 in this project. They reported that although differences in the ability of voters to detect changes were not statistically significant, more were able to do so on the more legible ballot. They concluded that "It is not the case that people are intrinsically bad at [verification] and that limitations in human performance have to be overcome. Instead, this appears to be primarily a problem of motivation and education."

This project also builds on a literature review (Quesenbery, et al, 2019) and research study (Chapman et al, 2019) that Center for Civic Design conducted for NIST.

The study identified several areas where the design of the BMD and the printed ballot could do more to encourage verification:

- Adding explicit instructions on the BMD to review the ballot (as one system did) or adding a message to the top of the ballot as a reminder that the printed page is the official ballot.
- Make undervote notifications clear in both visual presentation and textual message on both the on-screen review and printed ballot.
- At the polling place, combat the natural tendency to assume an “honest” printer by using signage and instructions from poll workers to encourage voters to review their ballot before casting it. (Bernhard et al, 2020)
- Use summary-style ballots, which participants identified as being “more like how you normally read” (p35)

How we conducted this project

This report examines the summary-style BMD-printed ballots, focusing on how easy they are to understand, for both voters reading them visually or listening to an audio readout of the ballot produced by an optical character recognition (OCR) technology.

Blind and low-vision voters who cannot read the ballot directly can use OCR to read printed documents. Several commercial applications are in common use as assistive technology (AT). However, these general-purpose tools do not have any special programming for reading a ballot, so the layout and legibility affect the listenability and, therefore, how easy the ballot is to verify.

- **Layout** is the arrangement of the ballot elements on the printed page.
- **Legibility** is a property of text that defines how easy it is to be read or deciphered. For example, the legibility of a font considers how well the letters are distinguishable from each other. This is different from readability, which considers the overall clarity of a text.
- **Listenability** is our word for audio legibility, or how easy it is to understand the ballot when read aloud.

In our analysis, we looked at seven different BMD-printed ballots. The ballots were collected from demonstrations by voting system vendors and election departments. Because our sample ballots preceded our research, we did not collect samples showing the same contests and selections. In some cases, we had multiple samples for the same type of BMD-printed ballots, each with slightly different features based on the natural variety of how ballots are marked. Nevertheless, the collection was sufficient for us to see the variations in how elections officials presented the contests and voter selections.

Our analysis did not include the header areas printed at the top of the ballots, except to the degree that they were clearly identifiable as supplementary information and easy to ignore. Typically, they included details like the ballot style, precinct number, and serial number.

Visual legibility

To examine the BMDs' legibility, we analyzed the measurable and observable characteristics: font size, leading, visual separators, and layout. We also considered the overall layout—whether the ballot was inviting to read or if it looked cluttered or cramped. A cluttered or cramped appearance can dissuade people from wanting to examine a ballot more closely.

OCR audio 'listenability'

To examine the BMDs' listenability, we started with a trial run using a flat-bed scanner and a desktop OCR tool (FineReader). We wanted a baseline of OCR produced from a high-quality scan to preliminary understand how the ballots might be read.

We then analyzed the output produced by several phone-based apps capable of translating the text in an image (the ballot as viewed through the phone's camera) into text. These phone-based apps are now in common use by digitally-proficient blind or low-vision individuals as part of their everyday assistive technology. Their availability as a free or low-cost app and not requiring a specialized extra device to carry has helped make them popular.

We used personal handheld devices because this may be the only method available to a blind or low-vision voter to verify the contents of a BMD-printed ballot without assistance.

Legibility analysis

The legibility of the visual printed ballot is important because election integrity is enhanced when voters review their BMD-printed ballot before casting it.

None of the ballots were completely illegible—impossible for a person to read. For each one, it is possible to determine what selections were made for each contest. However, some were easier to read than others—requiring less effort—because of the combination of typographical elements they combined for better legibility.

For the visual analysis, we examined the BMD summary-style ballots to assemble a description of the ballots to identify elements—or combinations of elements—that make a ballot more legible and easier to read quickly for verification.

Appendix A contains an image of all of the ballots, with the typography measurements and other visual elements that can affect legibility, including:

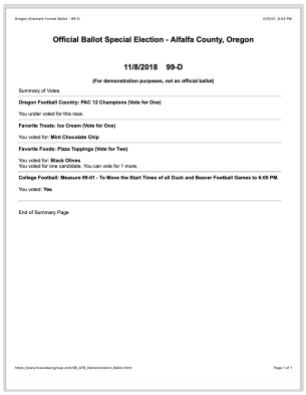
- **Text size and spacing**, the size of the text, and the line spacing—or leading—between each line.
- **White space,** the open space on a page.
- **Visual separators** between contests or other elements, such as horizontal lines.
- **Reading patterns**, especially how much horizontal movement is needed to find the beginning of each contest or the multiple selections for vote-for-N contests.
- **The placement of additional information** such as election codes or party, if they are used.

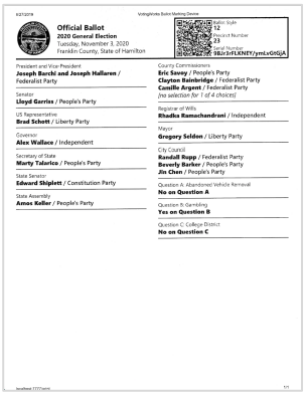
We also considered whether the ballot had an overall appearance that suggested that the ballot was intended for voters to read and verify. We used using guidelines from the design literature, including the "aesthetic-usability effect" and "wayfinding" within a document from *Universal Principles of Design* (Lidwell, Holden, Butler, 2010) and typography guidelines from *Dynamics in Document Design* (Schriver, 1997)

The elements we considered idea included font size of at least 9pt, generous leading, visual separators, vertical reading pattern rather than having to move horizontally and vertically, inobtrusive placement of election codes and other characters), as well as the arrangement of the ballot in zones for the header, contests, and other information.

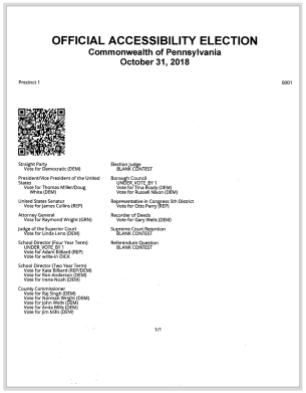
Ballot thumbnails to show overall layout

Figure 1. Ballots using letter-size paper





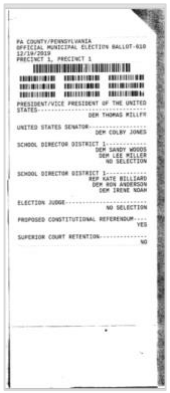
Left: Sample 2
Right: Sample 4



Left: Sample 3
Right: Sample 6

Figure 2. Ballots using custom sized paper

Sample 1
8” wide cardstock



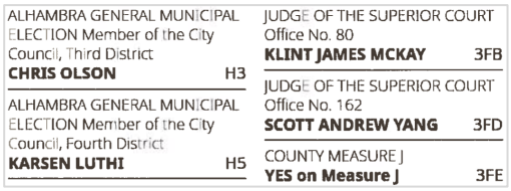
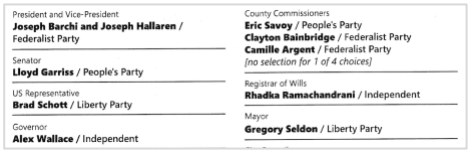
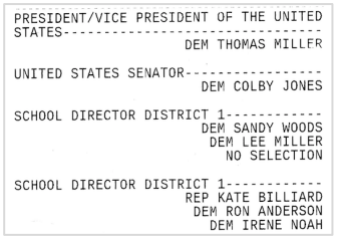
Sample 4
4.25” wide cardstock

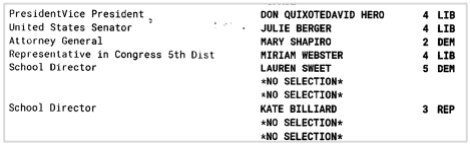
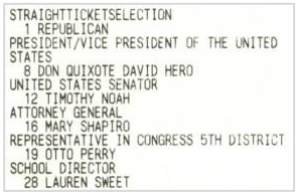
Sample 7:
3.25” wide light cardstock from a roll

This ballot 17” long. It was folded in order to show the Hollerith codes at the bottom of the ballot

Ballot legibility comparison of reading patterns

Figure 3. Contest zoning, contest chunking, and auxiliary information

No	Ballot image	Description
1		**Reading pattern:** Left-aligned within a column **Contest chunking:** White space + horizontal lines + bold **Election codes:** To the right of the candidate name **Party name:** After candidate name, spelled out
2		**Reading pattern:** Left-aligned within a column **Contest chunking:** White space + horizontal lines + bold **Election codes:** N/A **Party name:** N/A
3		**Reading pattern:** Left-aligned within a column **Contest chunking:** White space + horizontal lines + bold **Election codes:** N/A **Party name:** After candidate name, spelled out
4		**Reading pattern:** Split between right and left justification. **Contest chunking:** White space + justification **Election codes:** N/A **Party name:** Before candidate name, abbreviation

5		**Reading pattern**: Selections indented **Contest chunking**: White space (blank line) + indentation **Election codes:** N/A **Party name:** After candidate name, abbreviation
6		**Reading pattern**: Non-standard. Contest name, candidate names arranged in columns, with gaps to cross between them. **Contest chunking**: Determining the edges of a contest) requires eye movement in multiple directions. **Election codes:** In a column to the right of selections **Party name:** In a column to the right of election codes, abbreviation
7		**Reading pattern**: Selections indented **Contest chunking**: Indentation of selection(s) **Election codes:** Before the voter's selection **Party name:** N/A

How layout and visual organization affect legibility of the contests

Our primary focus is the ability to read the contests and selections on the ballot easily. Our analysis included:

- **Typographical and layout elements of legibility:** font size, leading (space between lines), alignment, and other factors that affect legibility.
- **Zoning:** the use of layout to make the area with the contests and selections visually distinct and easy to find.
- **Placement of auxiliary information:** party identifiers, election codes, or other additional information within the contest that might interfere with voters' ability to verify their selections easily.
- **Selection / no selection indicators:** how candidate selections, question answers, and undervotes are indicated.

We originally thought that font size would be the primary factor of legibility, but our analysis showed that it is the combination of factors, rather than a single factor, that enhances or reduce legibility.

We conclude that a ballot is more legible when:

- The overall typography and spacing together support legibility
- The ballot is clearly zoned
- The contests are "chunked" into clearly separate units of information
- Auxiliary information is placed unobtrusively
- "No selection" indicators are simple and clear

Text size alone is less important than typography and spacing

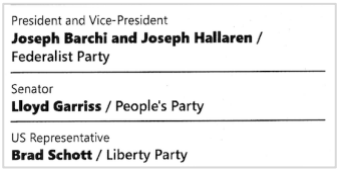
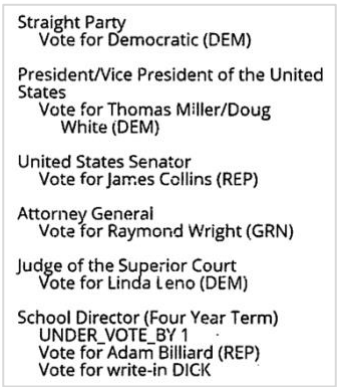
The Voluntary Voting System Guidelines (VVSG) 1.0 and 2.0 have minimum text size requirements of 9.5 and 10 points, respectively. The text size of the samples is relatively small.

Figure 4. Font size of the contests and selections

Sample	1	2	3	4	5	6	7
Font size	12pt	10pt	10pt	9pt	9pt	8pt	9pt

Multiple typographical factors beyond text size affect legibility. Including white space, use of visual separators and the space between lines of text (called leading).

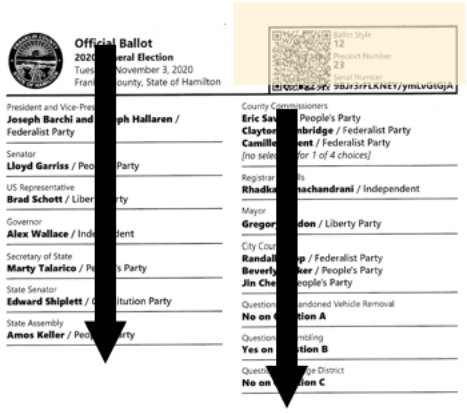
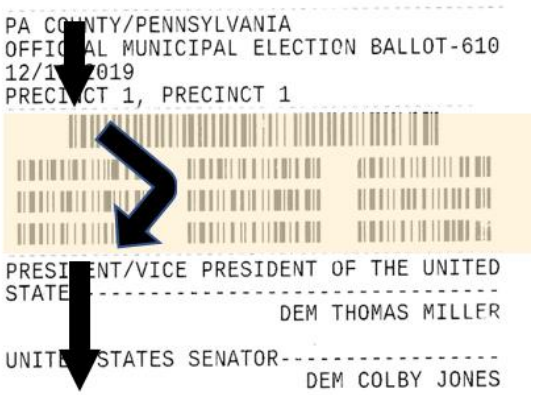
Figure 5. Comparison of two ballot samples

Visual image	Description
	**Sample 3** has 10pt font size and uses white space and visual separators to separate the contests, making it more inviting to read.
	In contrast, **Sample 5** has a 9pt font size but also has so little leading that letters with descenders (g, q, y, p, j) touch the top of the letters in the next line. This makes the ballot less inviting to read because the lines are crammed together.

Clearly zoned ballots make it easier to identify ballot selections

Zoning is a design element that creates a clear visual distinction between the voter's selections and other ballot text (header, instructions, QR and bar-codes). Good zoning makes it easier for the voter to know where to focus their attention rather than looking around to find the right point to start reading.

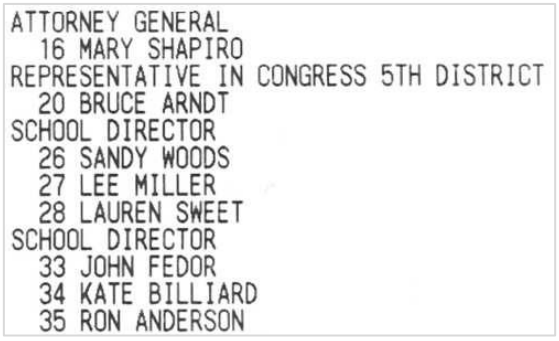
Figure 6. Reading path around codes on the ballot

Metadata outside normal reading order	Metadata interrupts the reading order
Auxiliary information (QR codes, ballot style, and other data) placed in the top right corner is easier to ignore.	Bar codes between the ballot header and the contest disrupt the reading order, requiring voters to jump over them.
	

Contests displayed in distinct chunks are easier to read

"Chunked" text is a design element where information is grouped together and visually separated from other groups. Each contest is a chunked unit - a collection of information (e.g., contest name and selected candidate(s)) the voter needs to process together to verify that contest. Ballots that were easier to read made each contest distinct using typography elements: white space, bold-face font, or horizontal lines. These elements were equally or perhaps more important than the font size. Several ballots with better legibility used a 10pt font (the minimum for the VVSG 2.0), but the combination of sufficient white space, bold-face, and horizontal lines chunking the contests made those ballots inviting and more legible.

Figure 7. Visual impact of chunking

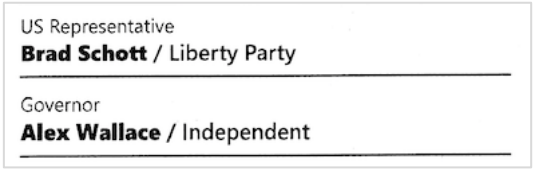
Strongly chunked contests	Poorly chunked contests
This ballot uses both white space and horizontal lines to separate contests.	The only indentation of the selections visually separates contests
	

Unobtrusive placement of auxiliary information helps legibility

The final part of the legibility analysis looked at the placement of extra words, party affiliation, and other alphanumeric codes.

Two of the samples added words to make the ballot read in a full sentence. This adds clarity to the summary ballot and places the candidate's name in the middle of a sentence. Typographical devices can be used to overcome this issue.

Figure 8. Use of highlighting

Highlight on a candidate name	No highlight on a candidate name
Highlighting the candidate name in bold helps make it stand out	Without highlighting, the candidate name is harder to find.
	

Seeing the party affiliation can help the voter in their verification process, but it is typically secondary to the candidates' names. Some of the ballots spelled out party names, usually after the candidate names. Others used short abbreviations, which may

not be meaningful to voters. They were placed both before and after the candidate name.

Figure 9. Placement of party identifiers

Less obtrusive party identifiers	More obtrusive party identifiers
Putting the party name after the candidate name places it in a secondary position.	Putting the party first requires the reader to read it before getting to the candidate name.
School Director (Two Year Term) Vote for Kate Billiard (REP/DEM) Vote for Ron Anderson (DEM) Vote for Irene Noah (DEM)	SCHOOL DIRECTOR DISTRICT 1---------- REP KATE BILLIARD DEM RON ANDERSON DEM IRENE NOAH

Another example of auxiliary information is an alphanumeric election code. Placing these codes in an unobtrusive place increases readability because they are easier to ignore. In general, these codes are not imperative for voters to understand. The code exists to assist elections offices process ballots.

Figure 10. Placement of candidate identifier codes

Less obtrusive code placement	More obtrusive code placement
A code ("3EB") is placed after candidates' name and party, making it easier for a person reading the ballot to ignore it.	A code ("33") is placed before the candidate name, requiring voters to read it before the candidate name.
SAN GABRIEL COUNTY WATER DISTRICT Member, Board of Directors **DARRELL BURNS** 3EB **LARRY TAYLOR** 3EC	SCHOOL DIRECTOR 33 JOHN FEDOR 34 KATE BILLIARD 35 RON ANDERSON COUNTY COMMISSIONER 45 RAJ SINGH 46 NORMAN WRIGHT 47 JOHN WELLS 48 ANITA WILLS 49 JIM MILLS

Under-vote indicators

The sample ballots used different methods of signaling when a contest was skipped or under-voted. The design of these warnings is (for voter verification) a delicate balance

between alerting the voter and making it seem like the voter must choose more candidates.

These samples use one of two approaches:

- A general undervote indicator for each undervote, such as "no selection", which draws attention to the missed opportunity to make a selection.
- A more explicit descriptive phrase describing the number selections made or left blank, such as "No selection for N of M choices" which draws attention, but does not reserve a space for each undervote.

In addition to the general approach, the ballots show a wide variety of phrasings and typographical presentations.

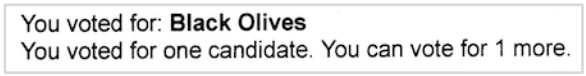
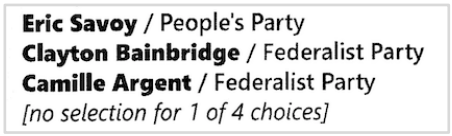
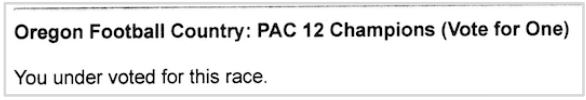
Figure 11. Undervote and skipped contest indicators

No.	Indicator for a blank vote-for-1 contest	Indicates for an undervote in a multi-selection contest
1	No Selection	No Selection (for each undervote)
2	You under-voted for this race	You voted for X candidates. You can vote for Y more.
3	*<no sample>*	[No selection for N of M choices]
4	NO SELECTION	*<no sample>*
5	BLANK CONTEST	UNDER_VOTE_BY N
6	*NO SELECTION*	*NO SELECTION* (for each undervote)
7	NO SELECTION	*<no sample>*

Figure 12. Indicators for each under-voted opportunity

Visual sample	Description
	These examples of undervotes in a multi-selection contest have a variety of typographical styles to draw attention
	Instead of an "under-vote," this example uses BLANK CONTEST in a vote-for-1 contest.

Figure 13. Undervote notices as an informative phrase

Visual sample	Description
	The most direct under-vote message tells the voter both how many selections they have made and how many are left.
	This under-vote message indicates the number of additional selections possible, but it isn't as directive as the first example.
	In this example, the message comes before the selection. Voters may not know the technical term, especially when written as "UNDER_VOTE_BY"
	This notice for a blank vote-for-one contest is written in a full sentence but relies on the term "under voted"

OCR Analysis

In the second half of this research, we explored how accurately the sample ballots can be read using an OCR tool.

Our goal was to see whether it is practically possible for blind and low vision (BLV) voters to use their personal handheld technology to verify their ballots without assistance.

We started by using a flat-bed scanner and desktop OCR application, Fine Reader. This gave us a sense of the issues we might encounter with a handheld device and a baseline for how good the OCR might be using basic consumer tools.

We also assumed that it would produce better results than phone applications. However, two of the four tools we used (Google Lens, SeeingAI) use the cloud for computational power, so they have become quite good at interpreting English text. This is, however, potentially a privacy issue.

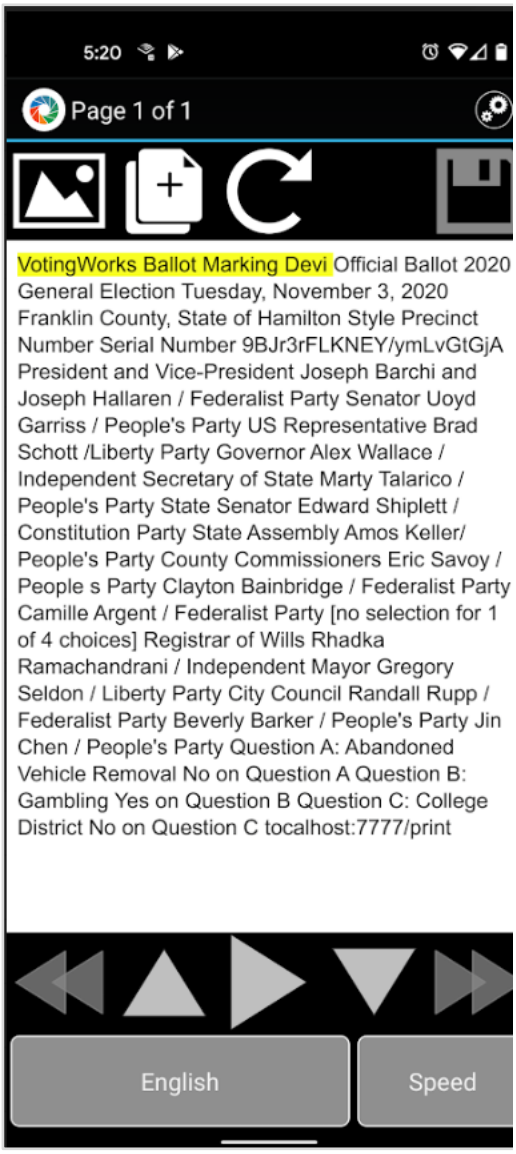
The first three tools we chose are widely used and recommended by blind voters we met in other voting system research. The last is a recently released tool for Android. These four apps provided a range of approaches to reading text from an image and included tools on both major mobile platforms, iOS, and Android.

- **The KNFB Reader**: a personal AT tool from the National Federation of the Blind (NFB) using OCR technology from Kurzweil.
- **SeeingAI:** a free iOS AT app from Microsoft.
- **Voice DreamReader:** one application in a suite of iOS general-purpose text applications recommended to us by several BLV voters.
- **GoogleLens**: a tool embedded in a recent version of Android to read text in images.

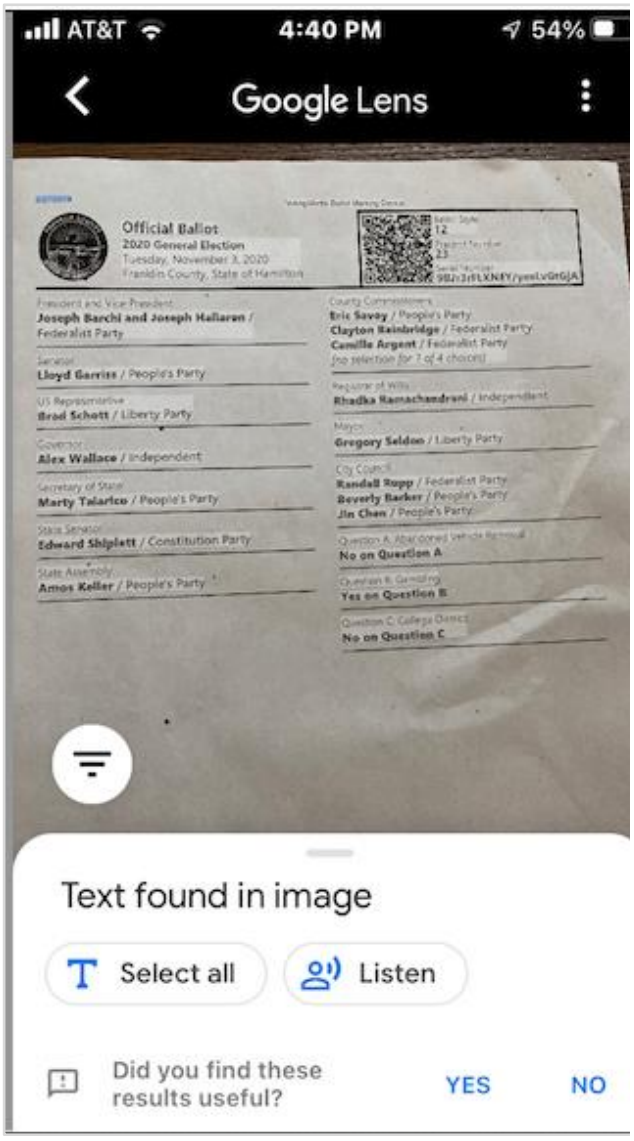
The KNFB Reader and SeeingAI are designed specifically as assistive technology for the blind. They have features that help users position their mobile device, ensure that the entire paper is in view, and align the camera to the paper. They also have an output that is optimized for listening rather than a more visual presentation.

Figure 14. Output formatted for visual reading or listening

Screenshot from KNFB



Screenshot from Google Lens



Factors that affect the use of a handheld device

Overall, the general OCR was generally effective, but several factors affect how effectively a handheld mobile device can capture and read a ballot.

Quality of the printed ballot

Not surprisingly, the OCR was most accurate when working with printouts with clean, crisp letters and numbers. For a visual reader, or even an OCR application reading

narrative text, the context of surrounding text can help read even blurry text accurately. But ballots have very little text.

Ballots with letters and numbers that were less crisp did not OCR as well. For a reader, less crisp letters are not as much of an obstacle because a reader has the context of the surrounding letters.

Identifying the layout

Many of the errors we found were caused by the OCR being unable to determine the layout of the ballot. One of the tools (KNFB Reader) had a mode for reading multi-column text, but the others used white space, lines, and indentation to determine the reading order. When they were able to infer the layout, they did better at producing an accurate reading of the ballot selections.

Lighting

The lighting proved to be a significant factor. When the ballot was poorly lit or partly shadowed (from the phone above it, for example), the OCR accuracy went down. This is an important consideration because a blind voter would have no means of assessing how well-lit the ballot is or how strong the shadows are.

Size of the ballot

Another factor that influenced the OCR accuracy was the size of the ballot, especially the length of the paper. Some of the ballots print on long skinny paper with blank space between the printed selections and the bottom of the paper.

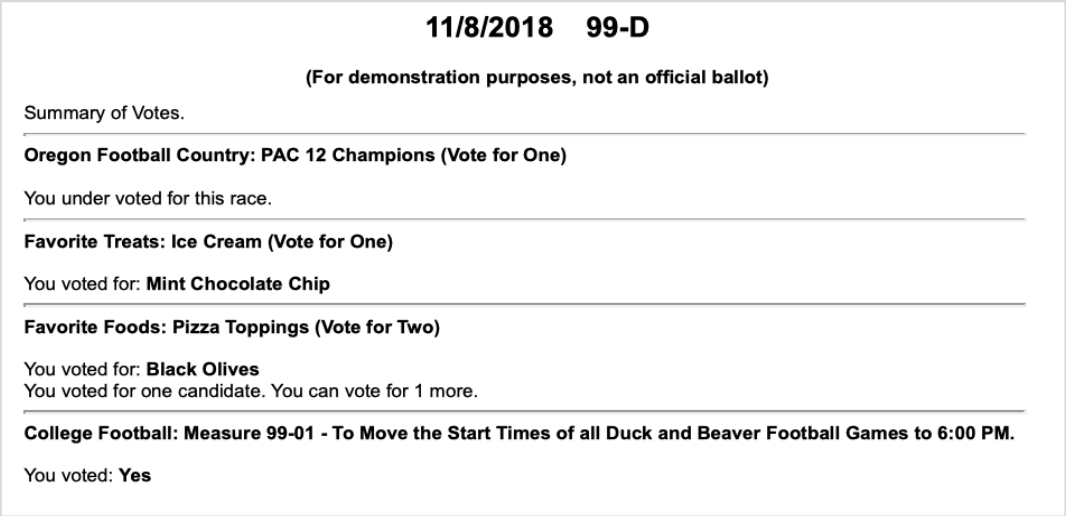
Sample 7 was a particular problem. OCR was possible when the phone was close enough to focus on just the selections, but a BLV voter would not be able to make this determination, and the apps are only able to communicate whether the edges of the paper are in view. When the phone was far enough away to see the entire ballot paper, the ballot image was too small to OCR.

OCR results

Although all of the apps were able to read much of the ballots, each OCR application had different strengths and weaknesses in this task. No application successfully produced text that accurately reflected all of the ballots.

Sample ballot 2 stood out as the only ballot that all of the applications could read accurately. It has the simplest layout, with a single column of text, so the visual presentation is most like the narrative text the OCR tools are most familiar with. However, it is the least like the presentation of a typical ballot and will often not fit on a single page.

Sample 2 image and text order as read



11/8/2018 99-D

(For demonstration purposes, not an official ballot)

Summary of Votes.

Oregon Football Country: PAC 12 Champions (Vote for One)

You under voted for this race.

Favorite Treats: Ice Cream (Vote for One)

You voted for: **Mint Chocolate Chip**

Favorite Foods: Pizza Toppings (Vote for Two)

You voted for: **Black Olives**
You voted for one candidate. You can vote for 1 more.

College Football: Measure 99-01 - To Move the Start Times of all Duck and Beaver Football Games to 6:00 PM.

You voted: **Yes**

Text as read

11/8/2018 99-D (For demonstration purposes, not an official ballot) Summary of Votes. Oregon Football Country: PAC 12 Champions (Vote for One) You under voted for this race. Favorite Treats: Ice Cream (Vote for One) You voted for: Mint Chocolate Chip Favorite Foods: Pizza Toppings (Vote for Two) You voted for: Black Olives You voted for one candidate. You can vote for 1 more. College Football: Measure 99-01 - To Move the Start Times of all Duck and Beaver Football Games to 6:00 PM. You voted: Yes

The results on the rest of the sample ballots varied depending on whether the OCR applications were able to understand the layout or not.

The problems reading the ballots fell into 3 categories:

- **Intermingled contests:** information from one or more contests were jumbled together.
- **OCR stumbles**: characters were not accurately identified.
- Errors due to camera position: edge alignment, height.
- Handling QR and bar codes.

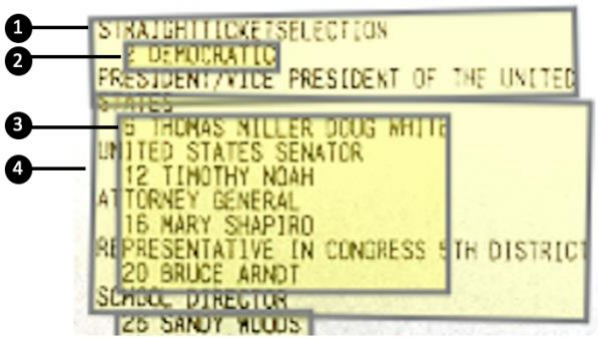
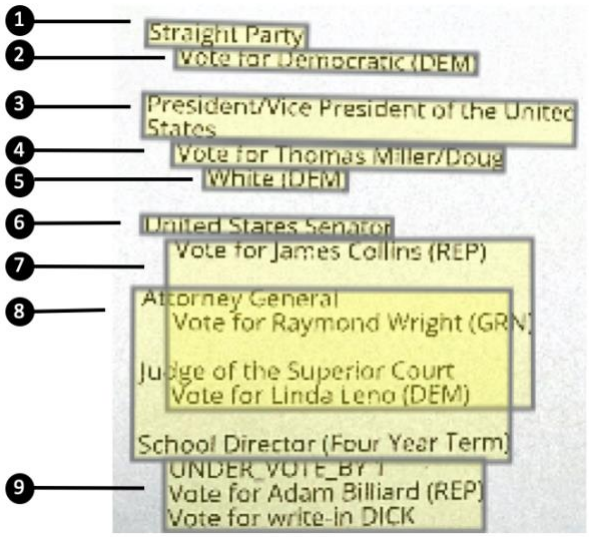
Intermingled contests (order issues)

Intermingled contests are the most severe issue because the OCR output (text) becomes unintelligible, mixing up information from different contests or reading

contests differently from the visual presentation. For example, it might read a contest name followed by one or more candidate names from other contests, thus making it impossible for a listener to understand what was on the printed ballot.

Contests are intermingled when the OCR applications cannot accurately identify the layout of the ballots. Ballot layouts are not just two-column text, but unique arrangements of the information for each system. A person looking at a ballot can sort out the reading order by context, but OCR applications don't have the background and experience they need to interpret the contents consistently.

Figure 15. Examples of how contests can become intermingled

Visual sample		Text order as read
	1. 2. 3. 4.	STRAIGHTTICKETSELETION PRESIDENT/VICE PRESIDENT OF THE UNITED 2 DEMOCRATIC 6 THOMAS MILLER DOUG WHITE 12 TIMOTHY NOAH 16 MARY SHAPIRO 20 BRUCE ARDNT STATES UNITED STATES SENTATOR ATTORNEY GENERAL REPRESENTATIVE IN CONGRESS 5TH DISTRICT SCHOOL DIRECTOR
	1. 2. 3. 4. 7. 5. 6. 8. 9.	Straight Party Vote for Democratic (DEM) President/Nice President of the United States Vote for Thomas Miller/Doug Vote for James Collins (REP) Vote for Raymond Wright (GRN) Vote for Linda Leno (DEM) White (DEM) United States Senator Attorney General Judge of the Superior Court School Director (Four Year Term) UNDER _VOTE_BY 1 Vote for Adam Billiard (REP) Vote for write-in DICK

OCR errors

OCR stumbled over every ballot we tested on. The mistakes ran the gamut from a single character being misrecognized to errors that would make it difficult to understand the text:

- "PENMSYLVANIA" instead of "PENNSYLVANIA"
- "Vote for Otto Per^'TREP" instead of "Vote for Otto Perry (REP)"

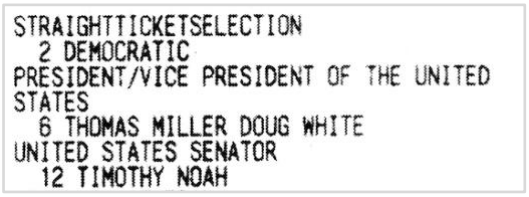
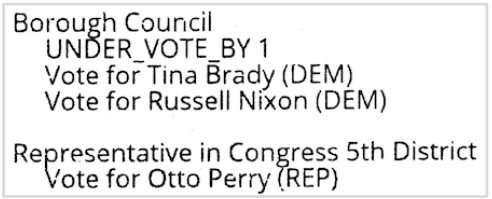
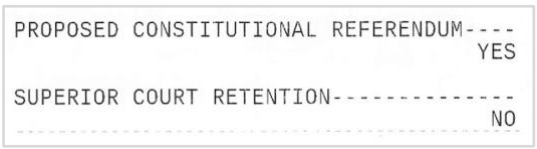
There were also errors we cannot explain in which words or phrases were simply omitted from the OCR.

Errors due to camera position

Some of the most severe mistakes were caused by misalignment of the phone relative to the ballot, the phone's height above the ballot, or poor lighting.

In many cases (see below), the results were completely unreadable, making it obvious that the OCR had failed. However, a voter using only OCR to read the ballot might not notice if part of the ballot was omitted. This was a particularly large problem on ballots on non-standard paper, especially Sample 7, which uses a 5" wide paper roll.

Figure 16. Examples of severe OCR errors

Visual sample	OCR errors
	STRAIGHTTICKETSELECTION 2 KNORATIC PRESIDENT/VICE PRESIDEhiT OF THE UNITED STATES 6 THOMAS MILLER DOU6 HhITE UNITED~$STATES~$ENAf6R~ 12 TIMOTHY NOAH
	Borough Council UNDER VOTE BY 1 Vote foFTina Brac Vote for Russell Nixon (OEN) Representative Congress 5th District Vote for Otto Per^'TREP)
	PROPOSED CONSTITUTIONAL REFERENDUM---SUPERIOR COURT RETENTION

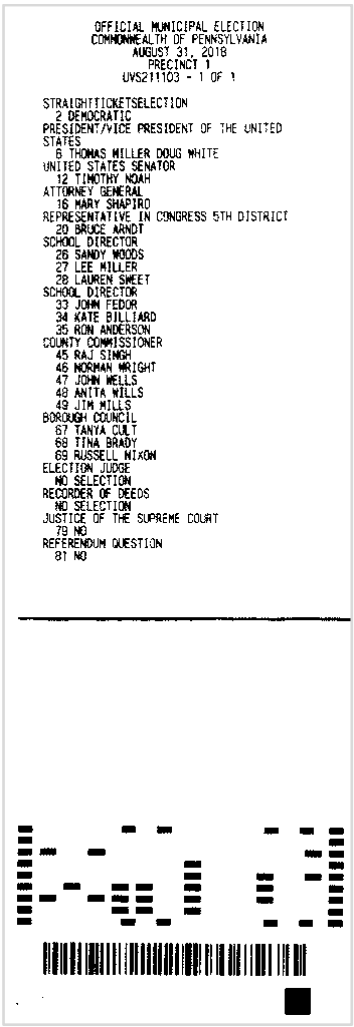
QR codes and barcodes

A sighted person reading a ballot will easily skip over a QR code or barcode, recognizing it as something on the paper that is not intended to be read by a person.

The tools we worked with also skipped the QR-codes, though one read the barcodes on sample 4 as a string of numbers, or repeated “1” in an attempt to read it.

Figure 17. Examples of code placement

Barcode at the bottom of the ballot



QR code in the ballot header

Conclusion

The results of our legibility and OCR analysis suggests that the verification for blind and low-vision voters could be improved if summary-style BMD ballots were designed to consider both visual and OCR-mediated verification.

Although the success of reading current ballots with OCR tools is mixed, we believe there is reason for optimism. There is little research experience with the design of summary-style ballots, and it is unlikely that the ability to read these ballots using OCR was an important part of the design process.

The legibility analysis is helpful in identifying design elements that can be used to make ballots easier to read visually. It is not clear, however, how important this is in visual verification. Sample 4 has a difficult visual layout, but one of the few research studies (Kortum, Byrne, & Whitmore, 2020) which used ballots similar to Samples 1 and 4 did not show significant differences in the ability of participants who actively verified their printed ballot to find mistakes.

We have general recommendations in the next section, rather than detailed specific guidance for design elements. This is in part because the OCR data was challenging to collect: the ability to read a ballot using an OCR tool was inconsistent, producing different results on each try. This was especially true when using a handheld device, a problem that would be even more severe when we think about many different individuals in difficult environments.

None of the phone applications we tried successfully read all of our sample ballots. This was caused by a combination of the ballot design and environmental factors. It is difficult to position a handheld device over the ballot in perfect alignment for optimal interpretation of the contents. We also found that even small changes in lighting and the clarity of the printing affected OCR quality.

Even acknowledging the additional challenges that voters will face trying to read their ballots with OCR in a polling place, there were two main causes of problems:

- The OCR applications had difficulty understanding the layout of the ballots, including how to identify the boundaries of the contests, “chunking” the layout accurately. This produced inaccurate reading of the ballot content that mixed text from different contests or even different zones of the page.
- OCR errors ranged from severe difficulty in listenability to minor stumbles over single letters. Minor issues occurred within words, but allowed for the meaning to be extrapolated, such as reading “Pemsylvania” for “Pennsylvania.” More severe errors rendered words as a jumble of letters.

One of the counter-intuitive findings in the analysis was that Sample 1, a ballot carefully designed for visual verification, was difficult to read with OCR tools while the ballot presented in simple HTML (Sample 2) was the easiest to read with OCR tools. These two ballots represent very different design and accessibility goals.

- Sample 1 is optimized to fit even a very large ballot on a single sheet, with good typography but little blank space between zones of the ballot to help the OCR application group chunks of text accurately. This resulted in many layout errors.
- Sample 2 is optimized to print accurately from virtually any browser and printer, without concern for the number of pages. It is also the most similar to written documents, with every line left-aligned and then proceeding horizontally across the page. It even presents the results for each contest as a sentence, complete with punctuation ("For Contest Name, you voted for Selection Name."). This was the only ballot that all 4 of the OCR applications consistently read correctly

Of the other ballot samples:

- Samples 6 and 7 were the most difficult to read visually, and were also the most difficult for the OCR to read.
- In between, Samples 3, 4, and 5 were generally easy to read visually, but had some OCR layout and reading errors.

Recommendations

Based on this analysis, there are several possible design guidelines that would improve voters' ability to verify printed summary-style ballots, whether reading them visually or through a personal OCR tool.

Design recommendations

Recommendations for improving the ballot design are based on both the OCR and legibility analysis.

Use typography to improve legibility for both visual and OCR reading

These recommendations are not specific design guidelines but aspects of the overall design that can be used in many ways to create a successful ballot.

- **Make the text large enough to read easily** Ideally, candidate names should meet the VVSG 2.0 requirements for printed ballots of 3.5mm (10 points), however a range of 9-12 points may be acceptable depending on the layout.
- **Separate lines of text with sufficient spacing**, so that character ascenders and descenders to not overlap.

Design the overall ballot layout to make it easier for OCR tools to read the ballot

- **Create clear zones for different types of** information on the ballot and placement of auxiliary information or other codes.
- **Make it easy** to **find contest and selections data** by creating clear zones for auxiliary information and codes by using space or other design elements to separate header information from the contests.

Design contests as distinct chunks of information

- **Separate contests** with typography or design elements**.** This applies to both contests in a column and to separate columns on a multi-column layout. Successful strategies include:
  - Bold font for candidate names, so they stand out
  - Extra space or thin lines between contests
  - Starting all lines of text within a contest on the left margin, with no indentation

    - Avoiding long line lengths that require tracking contest data across blank spaces
- Place **candidate identifiers after the name, not before**. This includes party designations, alphanumeric codes, or other information about the candidate.

Test ballot designs with voters

The best way to improve the ability to verify a summary-style ballot design using OCR tools, is for vendors to include useability testing with these tools as part of their design process. This includes both

- Lab testing with variety of OCR tools to optimize the design, especially the overall ballot layout.
- Usability testing with blind and low-vision voters using their own personal assistive technology in a test setting that resembles a typical polling place or vote center.

Although small-scale usability testing is useful in the early stages of design, the variations in environmental conditions in a polling place, the OCR tools used, and the skill voters have in using the tools require either large-scale testing or robust pilots.

Technology and voting system recommendations

There are also ways to improve the voting experience to support better verification outside of the design of the ballot itself, by optimizing assistive technology to read ballots.

- Voting system vendors can work with OCR and assistive technology vendors to understand how the OCR works and optimize the ballot design to be read by this technology.
- Assistive technology vendors can also optimize their technology to either read ballots more effectively as part of the core product or by adding a “ballot reading” mode.

There are also alternative ways to verify the printed ballot, already in use in some voting systems. For example:

- The ability to read back a marked ballot at any voting station
- A similar feature to display a review of selections at the ballot scanner before casting
- A QR code (or other encoding) that contains selections data, which can be more accurately read through personal assistive technology.

Future research

There are several recommendations for future research:

- Investigation of OCR capabilities to provide recommendations for how to design a summary-style ballot that these tools are most likely to read accurately.
- Research with blind voters to understand how they use personal OCR tools both within elections and in other aspects of their lives, and which features of those systems are helpful in reading ballot formats.
- Usability testing and observation with a range of voters in a typical voting setting to learn more about their processes for verification and what design elements on a summary-style ballot can help them efficiently and effectively verify that the printed ballot matches their intent.
- Comparison of verification on summary-style and bubble-style ballots, especially with voters with lower levels of civic and reading literary, who are more likely to misunderstand ballot marking rules.

Appendix A: BMD-printed ballots and analysis summary

Definitions

Ballot size – Physical size of the ballot

Layout - Physical positioning of contest and selections on the printed ballot

Reading pattern - Vertical and horizontal eye movement required to read one contest and first selection

Capitalization - Use of ALL CAPS

Font size – Measured in points

Vertical space – leading between contest name & selection, between multiple selections, and between contests

Visual separators - Additional visual separators between contests

Visual elements - Within the contest and selections that might interfere with human reading

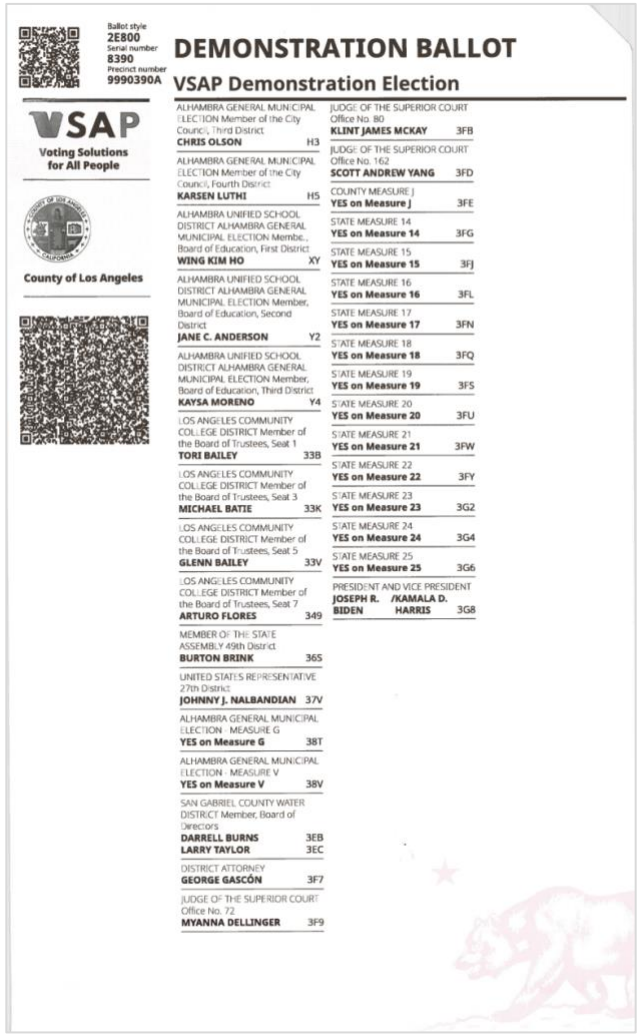
OCR text results – Quantity or type of OCR errors: None, Minor, Many (multiple small errors), Major

OCR layout results – Errors in reading the text in the correct order (None, Minor, Severe

Verification options – If the ballot be read back to the screen for verification by the system

This work is performed as part of NIST Contract #1333ND20FNB770277 - Task 4: research on the legibility of summary-style ballots for usable and accessible voter verification

Sample 1



Ballot style 2E800
Serial number 8390
Precinct number 9990390A

DEMONSTRATION BALLOT

VSAP Demonstration Election

VSAP
Voting Solutions for All People

County of Los Angeles

ALHAMBRA GENERAL MUNICIPAL ELECTION Member of the City Council, Third District
CHRIS OLSON H3

ALHAMBRA GENERAL MUNICIPAL ELECTION Member of the City Council, Fourth District
KARSEN LUTHI H5

ALHAMBRA UNIFIED SCHOOL DISTRICT ALHAMBRA GENERAL MUNICIPAL ELECTION Membe., Board of Education, First District
WING KIM HO XY

ALHAMBRA UNIFIED SCHOOL DISTRICT ALHAMBRA GENERAL MUNICIPAL ELECTION Member, Board of Education, Second District
JANE C. ANDERSON Y2

ALHAMBRA UNIFIED SCHOOL DISTRICT ALHAMBRA GENERAL MUNICIPAL ELECTION Member, Board of Education, Third District
KAYSA MORENO Y4

LOS ANGELES COMMUNITY COLLEGE DISTRICT Member of the Board of Trustees, Seat 1
TORI BAILEY 33B

LOS ANGELES COMMUNITY COLLEGE DISTRICT Member of the Board of Trustees, Seat 3
MICHAEL BATIE 33K

LOS ANGELES COMMUNITY COLLEGE DISTRICT Member of the Board of Trustees, Seat 5
GLENN BAILEY 33V

LOS ANGELES COMMUNITY COLLEGE DISTRICT Member of the Board of Trustees, Seat 7
ARTURO FLORES 349

MEMBER OF THE STATE ASSEMBLY 49th District
BURTON BRINK 365

UNITED STATES REPRESENTATIVE 27th District
JOHNNY J. NALBANDIAN 37V

ALHAMBRA GENERAL MUNICIPAL ELECTION - MEASURE G
YES on Measure G 38T

ALHAMBRA GENERAL MUNICIPAL ELECTION - MEASURE V
YES on Measure V 38V

SAN GABRIEL COUNTY WATER DISTRICT Member, Board of Directors
DARRELL BURNS 3EB
LARRY TAYLOR 3EC

DISTRICT ATTORNEY
GEORGE GASCÓN 3F7

JUDGE OF THE SUPERIOR COURT Office No. 72
MYANNA DELLINGER 3F9

JUDGE OF THE SUPERIOR COURT Office No. 80
KLINT JAMES MCKAY 3FB

JUDGE OF THE SUPERIOR COURT Office No. 162
SCOTT ANDREW YANG 3FD

COUNTY MEASURE J
YES on Measure J 3FE

STATE MEASURE 14
YES on Measure 14 3FG

STATE MEASURE 15
YES on Measure 15 3FJ

STATE MEASURE 16
YES on Measure 16 3FL

STATE MEASURE 17
YES on Measure 17 3FN

STATE MEASURE 18
YES on Measure 18 3FQ

STATE MEASURE 19
YES on Measure 19 3FS

STATE MEASURE 20
YES on Measure 20 3FU

STATE MEASURE 21
YES on Measure 21 3FW

STATE MEASURE 22
YES on Measure 22 3FY

STATE MEASURE 23
YES on Measure 23 3G2

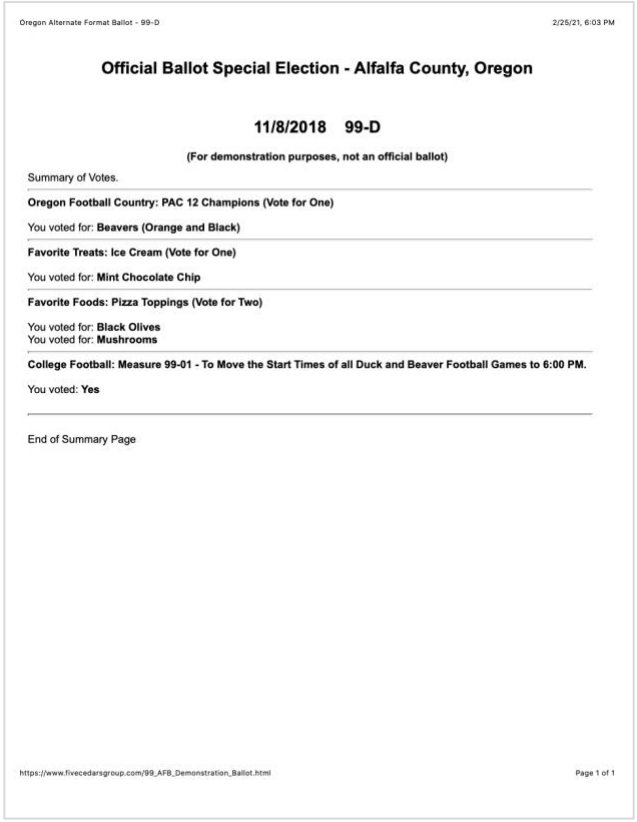
STATE MEASURE 24
YES on Measure 24 3G4

STATE MEASURE 25
YES on Measure 25 3G6

PRESIDENT AND VICE PRESIDENT
JOSEPH R. BIDEN /KAMALA D. HARRIS 3G8

Ballot size	8" wide variable length cardstock
Layout for ballot contents	Up to 2 newspaper-style columns
Reading pattern	Everything left-aligned
Capitalization	CANDIDATE NAMES YES/NO for questions
Font size	12pt
Vertical space between contests and selection	16pt between contest name and selection 16pt between selections 22pt between last selection and next contest
Visual separators	Thin horizontal line centered in the space between contests
Visual elements	1-3-char code on the right margin of the line for each selection
OCR results	Major errors with all OCR tools, especially separating the contest area from the top and left side header
Verification options	The ballot can be read by any system, using the QR code

Sample 2



Oregon Alternate Format Ballot - 99-D 2/25/21, 6:03 PM

Official Ballot Special Election - Alfalfa County, Oregon

11/8/2018 99-D

(For demonstration purposes, not an official ballot)

Summary of Votes.

Oregon Football Country: PAC 12 Champions (Vote for One)

You voted for: **Beavers (Orange and Black)**

Favorite Treats: Ice Cream (Vote for One)

You voted for: **Mint Chocolate Chip**

Favorite Foods: Pizza Toppings (Vote for Two)

You voted for: **Black Olives**
You voted for: **Mushrooms**

College Football: Measure 99-01 - To Move the Start Times of all Duck and Beaver Football Games to 6:00 PM.

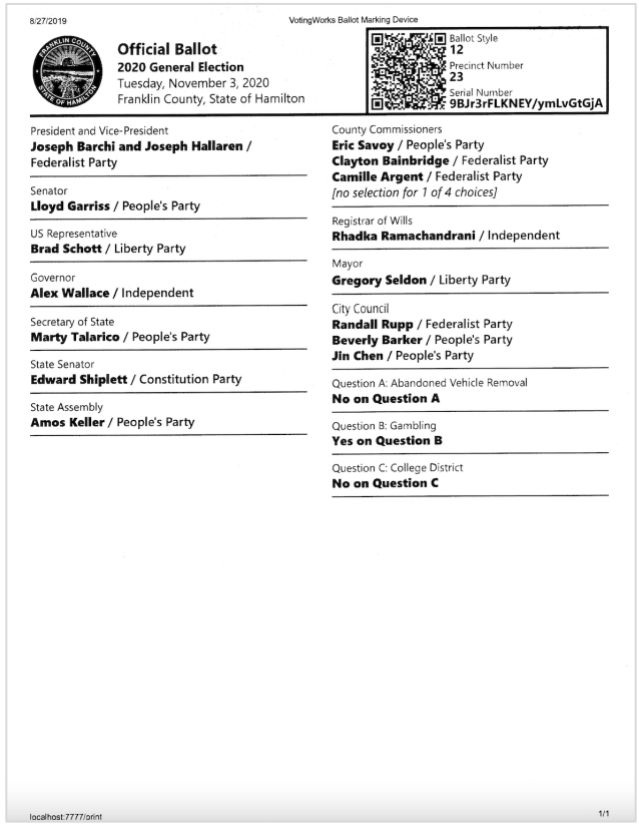
You voted: **Yes**

End of Summary Page

https://www.fivecedarsgroup.com/99_AFB_Demonstration_Ballot.html Page 1 of 1

Ballot size	Letter paper
Layout for ballot contents	One column, header centered
Reading pattern	Vertical Everything left-aligned
Capitalization	None
Font size	10pt
Vertical space between contests and selection	22pt between contest name and selection 11pt between selections 22pt between last selection and next contest
Visual separators	Thin horizontal line centered in the space
Visual elements	None
OCR results	Read correctly with all tools
Verification options	No read-back capabilities

Sample 3



8/27/2019 VotingWorks Ballot Marking Device

Official Ballot
2020 General Election
Tuesday, November 3, 2020
Franklin County, State of Hamilton

Ballot Style 12
Precinct Number 23
Serial Number 9BJr3rFLKNEY/ymLvGtGjA

President and Vice-President
Joseph Barchi and Joseph Hallaren / Federalist Party

Senator
Lloyd Garriss / People's Party

US Representative
Brad Schott / Liberty Party

Governor
Alex Wallace / Independent

Secretary of State
Marty Talarico / People's Party

State Senator
Edward Shiplett / Constitution Party

State Assembly
Amos Keller / People's Party

County Commissioners
Eric Savoy / People's Party
Clayton Bainbridge / Federalist Party
Camille Argent / Federalist Party
[no selection for 1 of 4 choices]

Registrar of Wills
Rhadka Ramachandrani / Independent

Mayor
Gregory Seldon / Liberty Party

City Council
Randall Rupp / Federalist Party
Beverly Barker / People's Party
Jin Chen / People's Party

Question A: Abandoned Vehicle Removal
No on Question A

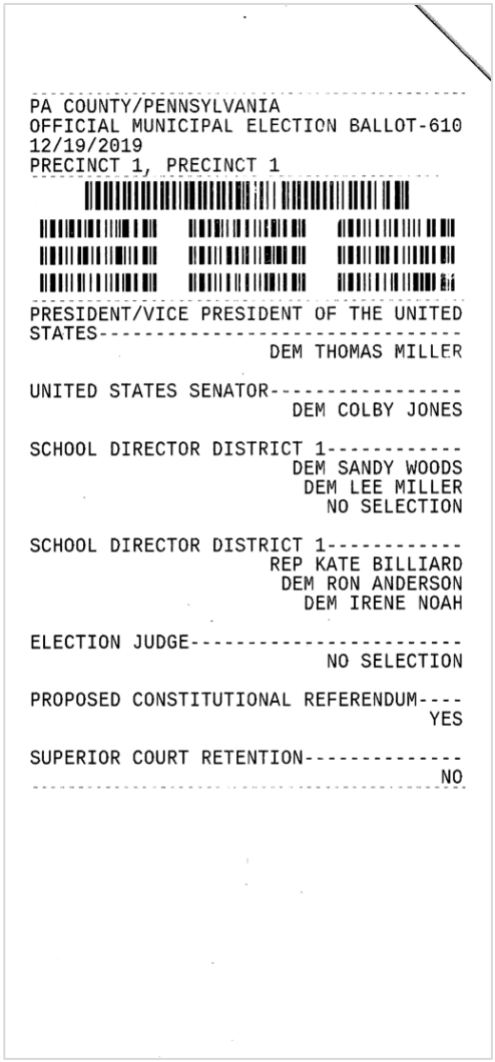
Question B: Gambling
Yes on Question B

Question C: College District
No on Question C

localhost:7777/print 1/1

Ballot size	Letter paper
Layout for ballot contents	Up to 2 newspaper-style columns
Reading pattern	Everything left aligned
Capitalization	None
Font size	10pt
Vertical space between contests and selection	14pt between contest name and selection 14pt between selections 24pt between last selection and next contest
Visual separators	Thin horizontal line centered between each contest
Visual elements	None
OCR results	Mixed results with different OCR attempts
Verification options	No read-back capabilities

Sample 4



PA COUNTY/PENNSYLVANIA
OFFICIAL MUNICIPAL ELECTION BALLOT-610
12/19/2019
PRECINCT 1, PRECINCT 1

PRESIDENT/VICE PRESIDENT OF THE UNITED STATES----------
DEM THOMAS MILLER

UNITED STATES SENATOR----------
DEM COLBY JONES

SCHOOL DIRECTOR DISTRICT 1----------
DEM SANDY WOODS
DEM LEE MILLER
NO SELECTION

SCHOOL DIRECTOR DISTRICT 1----------
REP KATE BILLIARD
DEM RON ANDERSON
DEM IRENE NOAH

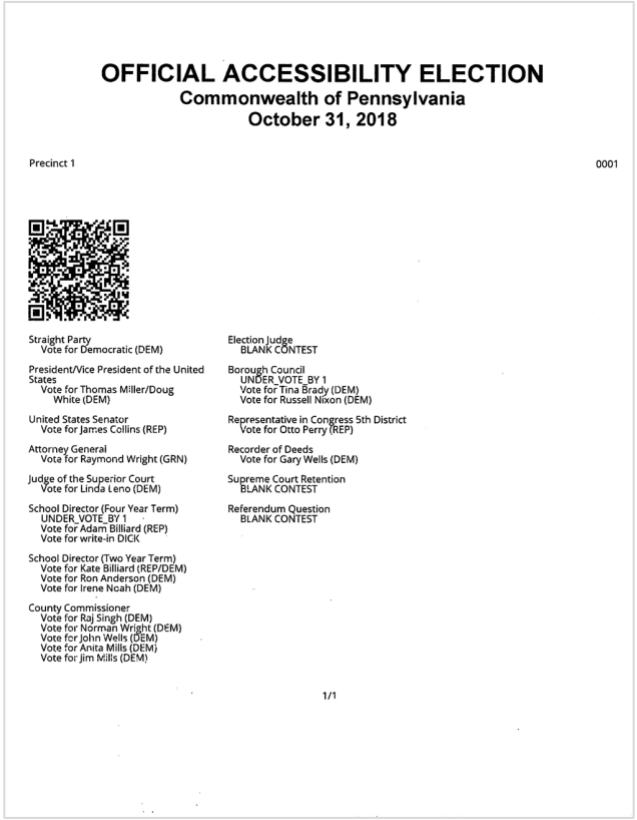
ELECTION JUDGE----------
NO SELECTION

PROPOSED CONSTITUTIONAL REFERENDUM----
YES

SUPERIOR COURT RETENTION----------
NO

Ballot size	4.25" wide card stock (variable length)
Layout for ballot contents	1 column
Reading pattern	Complex: Contest name is left-aligned - dots from the end of contest name to the right margin. Selection is on the next line, right-aligned
Capitalization	EVERYTHING
Font size	12pt
Vertical space between contests and selection	12pt between contest name and selection 12pt between selections 24pt between last selection and next contest
Visual separators	None
Visual elements	The dotted line from contest name to the right edge Write-ins have an arrow on the right margins
OCR results	Mixed results with different OCR attempts
Verification options	The ballot can be read by any system, using the bar code

Sample 5



OFFICIAL ACCESSIBILITY ELECTION
Commonwealth of Pennsylvania
October 31, 2018

Precinct 1 0001

Straight Party
Vote for Democratic (DEM)

President/Vice President of the United States
Vote for Thomas Miller/Doug White (DEM)

United States Senator
Vote for James Collins (REP)

Attorney General
Vote for Raymond Wright (GRN)

Judge of the Superior Court
Vote for Linda Leno (DEM)

School Director (Four Year Term)
UNDER_VOTE_BY 1
Vote for Adam Billiard (REP)
Vote for write-in DICK

School Director (Two Year Term)
Vote for Kate Billiard (REP/DEM)
Vote for Ron Anderson (DEM)
Vote for Irene Noah (DEM)

County Commissioner
Vote for Raj Singh (DEM)
Vote for Norman Wright (DEM)
Vote for John Wells (DEM)
Vote for Anita Mills (DEM)
Vote for Jim Mills (DEM)

Election Judge
BLANK CONTEST

Borough Council
UNDER_VOTE_BY 1
Vote for Tina Brady (DEM)
Vote for Russell Nixon (DEM)

Representative in Congress 5th District
Vote for Otto Perry (REP)

Recorder of Deeds
Vote for Gary Wells (DEM)

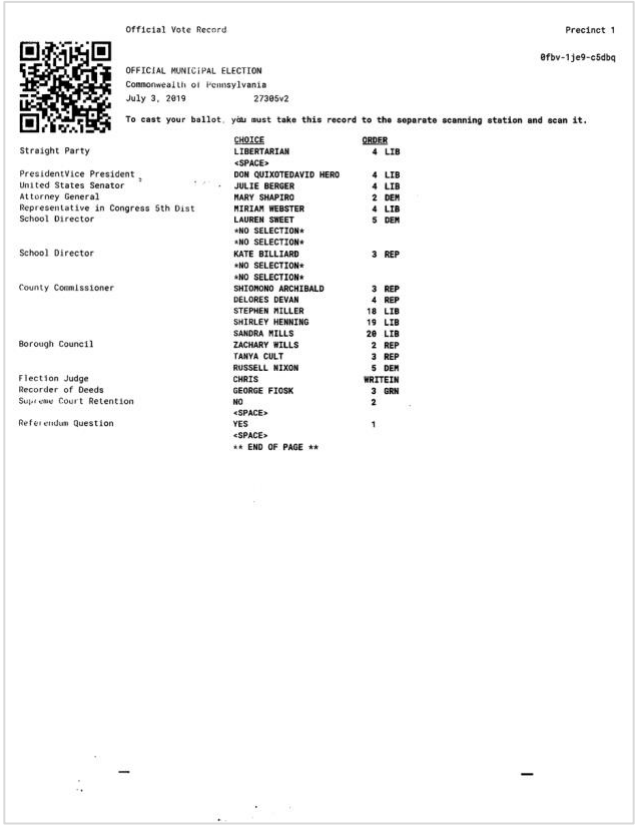
Supreme Court Retention
BLANK CONTEST

Referendum Question
BLANK CONTEST

1/1

Ballot size	Letter paper
Layout for ballot contents	Up to 3 newspaper-style columns
Reading pattern	Contest left-aligned Selections indented 2 chars
Capitalization	Only NO SELECTION
Font size	9pt
Vertical space between contests and selection	9pt between contest name and selection 9pt between selections (descenders touch the next line) 20pt between last selection and next contest
Visual separators	None
Visual elements	None
OCR results	Mixed results with different OCR attempts
Verification options	No read-back capabilities

Sample 6



Official Vote Record — Precinct 1

0fbv-1je9-c5dbq

OFFICIAL MUNICIPAL ELECTION
Commonwealth of Pennsylvania
July 3, 2019 27305v2

To cast your ballot, you must take this record to the separate scanning station and scan it.

	CHOICE	ORDER
Straight Party	LIBERTARIAN	4 LIB
	<SPACE>	
President\Vice President	DON QUIXOTE\DAVID HERO	4 LIB
United States Senator	JULIE BERGER	4 LIB
Attorney General	MARY SHAPIRO	2 DEM
Representative in Congress 5th Dist	MIRIAM WEBSTER	4 LIB
School Director	LAUREN SWEET	5 DEM
	NO SELECTION	
	NO SELECTION	
School Director	KATE BILLIARD	3 REP
	NO SELECTION	
	NO SELECTION	
County Commissioner	SHIOMONO ARCHIBALD	3 REP
	DELORES DEVAN	4 REP
	STEPHEN MILLER	18 LIB
	SHIRLEY HENNING	19 LIB
	SANDRA MILLS	20 LIB
Borough Council	ZACHARY WILLS	2 REP
	TANYA CULT	3 REP
	RUSSELL NIXON	5 DEM
Flection Judge	CHRIS	WRITEIN
Recorder of Deeds	GEORGE FIOSK	3 GRN
Supreme Court Retention	NO	2
	<SPACE>	
Referendum Question	YES	1
	<SPACE>	
	** END OF PAGE **	

Ballot size	Letter paper
Layout for ballot contents	Each contest on 1 line, up up to 4 columns of information
Reading pattern	Must read across the full width of the paper
Capitalization	Only “NO SELECTION”
Font size	8pt
Vertical space between contests and selection	11pt between contest name and selection 11pt between selections 11pt between last selection and next contest
Visual separators	None
Visual elements	Sequence numbers in 3rd column
OCR results	Mixed results with different OCR attempts
Verification options	No read-back capabilities

Sample 7

OFFICIAL MUNICIPAL ELECTION
COMMONWEALTH OF PENNSYLVANIA
AUGUST 31, 2018
PRECINCT 1
UVS211103 - 1 OF 1

STRAIGHTTICKETSELECTION
2 DEMOCRATIC
PRESIDENT/VICE PRESIDENT OF THE UNITED STATES
6 THOMAS MILLER DOUG WHITE
UNITED STATES SENATOR
12 TIMOTHY NOAH
ATTORNEY GENERAL
16 MARY SHAPIRO
REPRESENTATIVE IN CONGRESS 5TH DISTRICT
20 BRUCE ARNDT
SCHOOL DIRECTOR
26 SANDY WOODS
27 LEE MILLER
28 LAUREN SWEET
SCHOOL DIRECTOR
33 JOHN FEDOR
34 KATE BILLIARD
35 RON ANDERSON
COUNTY COMMISSIONER
45 RAJ SINGH
46 NORMAN WRIGHT
47 JOHN WELLS
48 ANITA WILLS
49 JIM MILLS
BOROUGH COUNCIL
67 TANYA CULT
68 TINA BRADY
69 RUSSELL NIXON
ELECTION JUDGE
NO SELECTION
RECORDER OF DEEDS
NO SELECTION
JUSTICE OF THE SUPREME COURT
79 NO
REFERENDUM QUESTION
81 NO

Ballot size	3.25" wide paper (variable length)
Layout for ballot contents	1 column
Reading pattern	Contest left-aligned Selections indented 2 chars
Capitalization	EVERYTHING
Font size	9pt
Vertical space between contests and selection	8pt between contest name and selection 8pt between selections 8pt between selection and next contest
Visual separators	None
Visual elements	The number before the candidate name
OCR results	Mixed results with different OCR attempts
Verification options	No read-back capabilities

Appendix B: References

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