WV DOT SCANNING PROJECT

Right-of-Way (ROW) and Construction Plans

Proposal

Scanning of highway plans and associated image and file processing tasks

Prepared by WV GIS Technical Center

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Contents

1. SUMMARY

The West Virginia GIS Technical Center (WVGISTC) proposes to scan West Virginia Department of Transportation (DOT) large format highway plan sheets into digital raster images. For every highway plan book a single Adobe PDF file of all the sheets will be created along with spatially referencing the index map. This document describes the equipment and methods that will be used for the scanning, image/file processing, and for generating a web map index.

The first phase of the project will scan 50,000 highway plan sheets during a performance period of two years. If each project book or plan set averages 70 sheets, then it is estimated that 714 project plans will be scanned. The cost to perform the scanning is $2.38 per sheet and with additional image and file processing the total cost is $2.93 per sheet. The proposal includes additional expenses for a new scanner which is needed to meet the performance objectives of this project.

An online application for managing, searching, viewing, and downloading all scanned highway maps will be maintained. Both non-spatial and spatial locator tools will allow authorized users the ability to search, identify, and view the project plans online with the option to download the plans, thereby providing a fast discovery and online retrieval of the electronic highway plans. A non-spatial Highway Plan Locator Tool will be developed to allow users to search and locate all the scanned highway maps (http://157.182.4.210/dotscanning/dot_query.php) and for managing the project. In addition, the index map of every project book will be spatially referenced to allow users to locate scanned highway plans via a map search. Future work tasks will integrate the scanned highway plan sets with WV DOT's ProjectWise content management software.

To accomplish the spatial query task, the index map of each plan will be geo-referenced. Although it is more expensive (about $7.25 per plan set) to spatially reference the index map of each project book, this procedure will allow for the development of an online web map index. For the initial project phase the standard Esri ArcGIS Online viewer will be utilized for the web map index but in the future a customized application according to WV DOT requirements could be developed that allows for an improved interface and functionality.

The initial phase of the project will require interaction with WV DOT staff to ensure the work process steps, naming conventions, file folder structure, image quality, file size, etc. are suitable. It is also recommended that the priority of work regarding which plans (interstates, U.S. highways, county routes, etc.) to scan should be determined because of the large scope and costs associated with this project.

2. TECHNICAL APPROACH

Receive Project Book(s) from WV DOT: The WV DOT will determine which highway plan books are to be delivered to WV GIS Technical Center for scanning. WV DOT will attach a transmittal sheet (Appendix I) to each highway plan book with the proper *Project Key* according to WV DOT naming conventions (Appendix J).

Unbind Project Book: The DOT project plan books are bound using reusable clips, tape, or staples which must be removed before scanning. After the project plan sheets are verified that they are in the correct order sequence, using a pencil each sheet is annotated with the page number in the lower left margin. Next, the Project Tracking Database (Appendix K) is updated with all the relevant information of the particular plan set to include the *Project Key* number listed on the transmittal sheet and the total number of counted sheets. Before scanning commences, a computer file folder is created and named according to the *Project Key* number along with subfolders organized by file type: original scanned TIFFs subfolder, single highway book PDF file subfolder, geo-referenced GeoTIFF files subfolder, etc.

Sheet Scanning: The scanning process involves 85% of the work effort and includes file and image processing of each sheet.

Scanner Specifications: The WVGISTC currently uses a 10-year-old Graphtec CS600 scanner and proprietary (Graphtec) software with the following settings:

- Image type: TIFF, uncompressed
- Image resolution: 300 dpi
- Color information: 8-bit color depth (optimized)
- Image quality: High
- Scan speed: Low

Sheet Protector Sleeves: The sheet medium for the construction plans or right-of-way plans usually consists of acetate/film or waxed linen. Sheets that are torn, wrinkled, or delicate are scanned using a document protection sleeve/envelope with a clear film face and opaque white back. The color values of the scanner properties are optimized to minimize image artifacts from using the document protection sleeve.

Two-Sided Sheets: Since some sheets have information on both sides, a sheet of black paper is added when necessary to suppress reverse side information when scanning two-sided sheets. This procedure separates the front and back information into separate images, or simply enhances the front side information.

Sheet Naming Conventions: During the scanning process all the scanned images are named according to file name and page number conventions (Appendix J). Importantly, the scanning operator ensures the page number suffix of the file name corresponds to the sheet page number of the highway plan set. Following this convention allows a user to quickly reference an individual scanned sheet. If the files are named incorrectly, then a software program can be utilized to correct the file names with the correct *Project Key* number.

Image Processing: If necessary, the white space margins or borders of each plan are cropped using image processing software to remove large, unnecessary borders. In addition, image color/brightness/levels are adjusted if necessary.

File Types and File Storage: The plans are scanned initially as TIFFs at 300 dpi resolution but may later be compressed to smaller sized Zip files. Another option is to convert the files to JPEGs, a more common format for viewing raster images online.

Due to the large volume of sheets that need to be scanned, the resolution quality, file size, file type (TIFF, GeoTIFF, PDF, JPG, MrSID), viewing display performance, archival preferences, and processing time are important factors to evaluate for this project. The WV GIS Technical Center has allocated 6 TB of online storage for the initial phase of this project for temporarily storing and transferring the files to WV DOT.

See Appendices E through G for more information about the different file types and file sizes.

Re-Bind Project Book: After all the sheets of a project book are scanned they are rebound in the correct order sequence using the original clips. Both the transmittal sheet and Project Database are updated with "date scanned" and "scanned by" information. The sheets are rolled and fastened with a rubber band, the transmittal sheet placed inside the roll, and a colored paper attached to the outside of the roll to indicate that particular project book has been scanned. The Project Book is now ready to be returned to WV DOT.

Create Single PDF Document of all Project Sheets: The scanned sheets of each plan book are combined into a single Adobe PDF file and optimized for reduced size and text recognition. The PDFs are saved as "Reduced Size PDFs" according the Project Key Name and placed in the PDF subfolder. Next the PDF tool labeled "Recognized Text" is performed for OCR text recognition purposes.

Geo-Reference Index Map Sheets: The index map sheet of each project plan set is spatially referenced for creating a web map index to quickly locate and select highway project plans for viewing and download. Maps will be geo-referenced to the majority UTM Zone 17, map units in meters, file format GeoTIFF. Typically, geo-referencing a map requires between 15 to 30 minutes according to how

quickly control points can be determined. Only the project book's index map will be scanned unless instructed otherwise by WV DOT. It is recommended that all index maps be spatially referenced while maps that duplicate the same geographic space not be spatially referenced to minimize the work effort and cost. Sheets with maps that are not spatially referenced can be done later if it becomes necessary for digitizing select features or for other purposes.

Image Processing: A number of image processing steps are performed to prepare the index map for geo-referencing. Currently the sheet information surrounding the index map is not cropped, but cropping to the index map extent can be accomplished upon DOT request. Other guidelines are that the image format must in 8-bit, Indexed Color mode for compatibility with the raster mosaic in ArcGIS. Also, it is necessary to customize the color index of the image. First, there must be no perfectly black pixels in the image (RGB value of 0, 0, 0), which can be guaranteed by brightening the image very slightly. This is because all perfectly black pixels will be made transparent upon geo-referencing. Secondly, the color value assigned to the '0' position in the color index must be set to perfect black. This is done by temporarily converting the image to RGB mode, then back to Indexed Color mode, at which point the color index may be customized. These steps can by automated in Adobe Photoshop using batch processing.

Projections: The highway map sheets are spatially referenced to WV DOT's operational projection of UTM 17 Zone North, NAD 1983 Datum. For the web index application, the digital map sheets are converted to Web Mercator Auxiliary Projection to improve display performance and compatible with commercial web map services.

Geo-Referencing Tracking Sheet: Tracking information of each map sheet geo-referenced is added to the GeoReferencing Sheet of the Project Database. The following information is recorded: scan order number, page number, time amount to geo-reference, RMS error, technician's initials, date geo-referenced, and additional notes.

MrSID Compression: The geo-referenced TIFFs may be compressed with Lizard Tech MrSid compression software to 1/14th of the original file size. This requires an additional image processing step to ensure compatibility with the raster mosaic before georeferencing. Refer to Appendix G for more information about the MrSID conversion process and considerations.

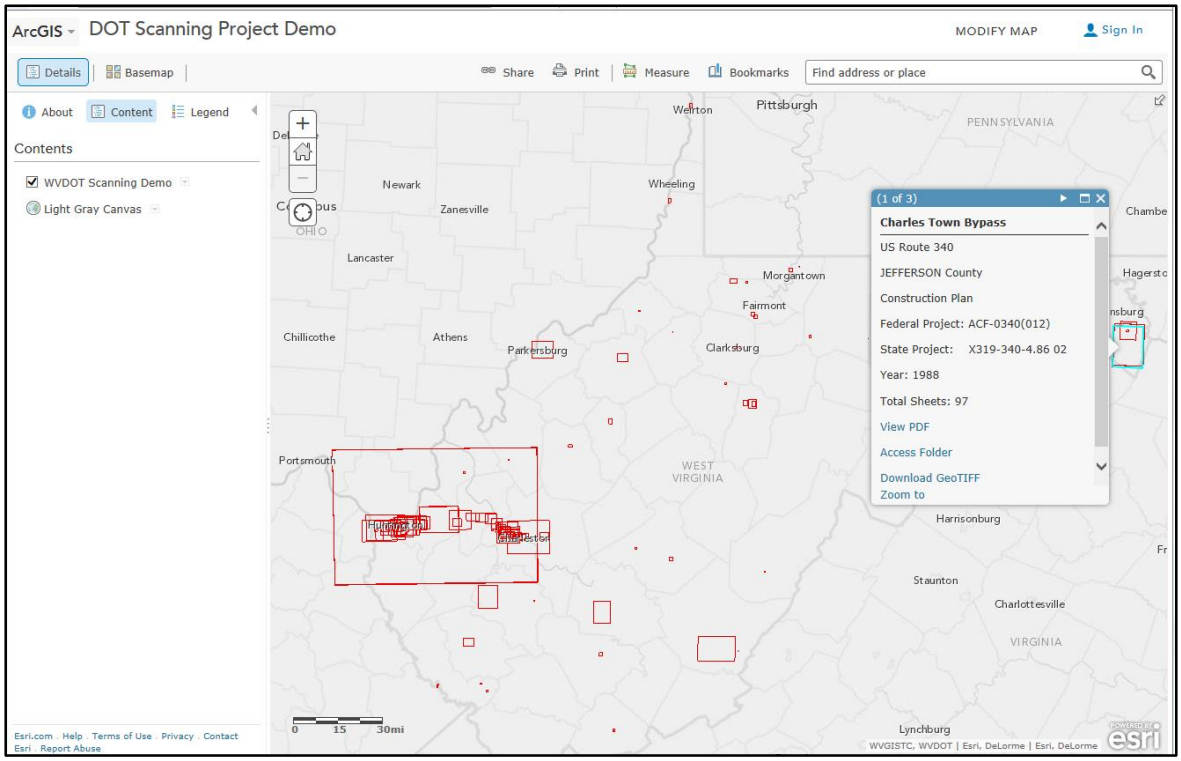
Digitization (optional task): Features such as road centerlines, structure footprints, and other planning or right-of-way features can be digitized into shapefiles in accordance with specifications set forth by WV DOT staff. Digitization accuracy is dependent upon the (1) source map quality and (2) source imagery utilized for spatial referencing. The map projection of the reference imagery does not appear to affect the digitization accuracy as long as the *data frame* in ArcGIS desktop software utilizes the UTM map projection, the preferred projection with less distortion in shape, area, direction, and/or

distances than Web Mercator projection. More coordination is necessary if WV DOT requires this work task.

Build Web Map Index Application: A web map index application (http://bit.ly/TnFASu) is maintained for the online viewing and downloading of the PDF project book and other files. The purpose of the map index is to allow WV Division of Highway personnel quick and easy access to the highway scans via the Internet. The web application also serves as a tool for managing and reporting progress of the project.

A raster mosaic dataset is created of all the geo-referenced index maps and then published to Esri's ArcGIS Online Viewing application. As additional highway maps are scanned, the new images are added to the mosaic dataset and attributes updated.

In addition to viewing the highway project plans online, the web map index allows users to change base map views, share map view links with other users, print online maps, perform measurements, query project book attributes, and access all the files processed (TIFF, GeoTIFF, PDF, etc.). In the future, since the ArcGIS Online application is limited in its viewing capabilities, search functions and map tools, the DOT may want to develop a customized application with more functionality (See Appendix H).



Quality Control Procedures: Proper quality control and management procedures are implemented to ensure work tasks are done in an efficient and satisfactory manner. Quality control procedures include:

- Verify accuracy/completion of Project Database entries
- Verify file name accuracy
- Verify completion of image processing
- Verify completion/accuracy of PDF
- Verify completion/accuracy of GeoTIFF
- Update Tracking Database's QC Checklist sheet
- Back-up all files onto project server FTP drive

Refer to Appendix D for an outline of the scanning methodology. A Procedural Manual with more detailed information can also be made available.

3. DELIVERABLES

Highway Map Scans

- *Tagged Image File Format (TIFF) image files* for all sheets scanned, with separate image files for each side of reverse printed sheets. Files can be compressed to ZIP files or JPEGs to reduce file sizes and provide a more universal image format for online viewing.
- A *PDF Book* of all multi-page documents combined into a single portable document format (.pdf) for each plan set.
- *Geo-referenced TIFF* images of the index map of each project book. These images can be further compressed to MrSID image files.

Project Tracking Database

- A *Project Tracking Sheet* that includes relevant information of all projects books scanned. Database entries like County and Highway Number will be standardized to allow search queries via the Highway Plan Locator Tool. Missing information like project title will be added to the project database if such information is printed on the project plan sheets.
- A *Geo-referenced Sheet* of the Project Database to record all spatially referenced map sheets.

Online Scanned Highway Plan Locator (non-spatial locator)

- An online locator tool allows users to search and view highway plan sets. Highway plan sets can be queried by county, sign system, route number, mile marker, fiscal year, project title, federal project, state project, bridge ID, and scan ID. The locator tool allows users to view the plan books via a PDF reader and download highway maps of interest. It also allows users to link to at web map location of each highway plan. See Appendix L for more information and prototype link: http://157.182.4.210/dotscanning/dot_query.php
- Future development will allow the viewer to save the query parameters in the URL or to a specific plan set record number. Future customization will also look at integrating the scanned highway maps with WV

DOT's ProjectWise system, a project collaboration and information software developed explicitly for the design and construction of architecture, engineering, construction, and operations (AECO) of infrastructure projects.

Web Map Index (spatial locator)

- An online *Web Map Index* viewable in a GIS environment to display the geographic locations of the geo-referenced sheets along with links to all the digital highway maps for download. Importantly, all scanned highway plans at a specific map location can be viewed and downloaded. View prototype link: http://bit.ly/TnFASu
- A customized online map application with more functionality and search capabilities can later be created according to WV DOT specifications.

Digitized Map Features (optional)

- Select features can be digitized from the geo-referenced scanned maps as determined by WV DOT.

Progress Reports

- *Progress Reports* submitted periodically about objectives and milestones accomplished.

4. PROJECT SCOPE

The first phase of the project will scan 50,000 highway plan sheets. If each project book or plan set averages 70 sheets, then it is estimated that 714 project plans will be scanned. In addition to the individual scans, a single Adobe PDF file will be created for each project book. For each highway plan book the index map will also be geo-referenced to create a web index map tool for spatially referencing and showing progress of the highway scanning project. An online application for managing, searching, viewing, and downloading all scanned highway maps will also be maintained.

The initial phase of the project will require interaction with WV DOT staff to ensure the work process steps, naming conventions, file folder structure, image quality, file size, etc. are suitable. WV DOT may also want to prioritize which project books should be scanned (e.g., first scan all interstate plans, U.S. highways, etc.).

5. PERFORMANCE PERIOD

The performance period shall be 24 months.

6. BUDGET

The budget proposed for the initial phase is $219,083 to scan 50,000 sheets (or an estimated 714 plan sets), and to create PDF books and spatial index map of each project book. Others costs are project management expenses, project tool development, hardware costs which include a new scanner, related travel expenses, and indirect costs.

SCANNING, PDF BOOK, GEO-REFERENCING COSTS: About 85% of the paper to digital conversion involves scanning process at $2.38 per sheet or $166.57 per book for a typical plan set of 70 sheets. Additional per book costs are as follows: $7.52 to create a single PDF file of each plan set, $7.25 to geo-reference each index map, and $13.03 for other tasks such as file management and quality control for each plan set. The total cost for the scanning, PDF book creation, geo-referencing, and associated tasks is $194.38 per book or a $2.93 per sheet cost. A student labor rate of $14.75/hour plus graduate student fringe rate of 9.2% totals to $16.12 per hour. *Total scanning and file/image processing costs are $138,835.15.*

PROJECT MANAGEMENT COSTS: The project management costs are subdivided into three categories: project specifications, project supervision, and project tools. Project Specifications Tasks ($10,491) include determining the scanning and file type specifications, file naming conventions, new scanner specifications, and other research costs regarding project specifications. Project Supervisory Tasks ($9,106) include system administrative services of hardware and software programs, hiring and scheduling of personnel, progress reports, monitoring performance objectives, and other associated management costs. Project Tool Tasks ($10,658) involve the programming of spatial and non-spatial web tools for querying, viewing, and downloading project plans via the Internet. Other tool tasks include writing geo-processing scripts for file processing, such as renaming all the scanned files to a different naming convention. All labor rates for students and full-time personnel will be confirmed by the WVU Office of Sponsored Programs. A student labor rate (Research Assistant I.357, PG 15) at $14.75/hour plus graduate student fringe rate of 9.2% totals to $16.12 per hour. The hourly wages of benefit eligible full-time personnel are determined from annual salaries divided by 1,950 hours per year. *Total project managements costs are $30,254.55.*

HARDWARE/SUPPLY COSTS: This project requires constant use of a large-format scanner which periodically requires operator maintenance and repairs of the scanner. A new scanner is required to increase production during the summer when we have a larger volume of workers. In addition, our current scanner is nearly 10 years old and because of its age the maintenance costs are more frequent and repair costs higher. Besides the scanner costs, a computer is required for each scanner and protective cover supplies for scanning plan sheets that are torn, folded, or delicate. Lastly, six terabytes of online FTP storage are required for temporary storage of all the scanned files, along with

another six terabytes of external storage for offsite storage and transferring files to WV DOT. *The total cost for hardware and supplies is $26,491.00.*

TRAVEL: Travel costs associated with transporting plan books between Charleston and Morgantown are $3,585.96. The amount covers 18 trips from Morgantown to Charleston and back; four of the trips include overnight stays. Standard mileage ($0.47 per mile), per diem ($51 per day), and lodging rates ($105 per day) apply. *Total travel costs are $3,585.96.*

FACILITIES & ADMINISTRATION COSTS: An indirect costs of 10% would apply to the project at a cost of $19,917.67.

No costs for digitizing were included in the budget, but if costs were to be calculated, a rate of $14.75 per hour cost would apply. See Appendices A and B for tables and graphs associated with the Phase I budget.

7. CONTACTS

For all matters related to the activities described in this document, please contact the following individuals in the WVGISTC:

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APPENDIX A – Phase I Budget

Estimates	
Sheets per plan book	70
Cost per sheet	$2.93
Cost per plan book	$194.38
Total Books Completed	714

Total Costs, Scans, Time Period	
Total Cost	$219,083
Total Sheets Scanned	50,000
Maps Geo-Referenced	1 per book
Performance Period	2 years

Phase I Budget

Item	Unit Price	Unit Type	Quantity	Extended Price
** SCAN, PDF BOOK, GEO-REF **				**138,835.15**
Sheet Scanning	$2.38	per Sheet	50,000	118,980.95
PDF Book / Geo-Reference Index Map / Other Tasks	$27.81	per Book	714	19,854.20
** PROJECT MANAGEMENT **				**30,254.55**
Project Specifications Tasks				10,490.76
Project Supervisory Tasks				9,105.56
Project Tool Development Tasks				10,658.23
** HARDWARE/SUPPLIES **				**26,491.00**
Scanner #1 Colortrac SG44C 44-inch Wide Format Scanner				16,911.00
Scanner #2 Maintenance & Repairs	$2,500		2	5,000.00
2 computers	$1,200		2	2,400.00
6 TB External Storage Devices	$250		6	1,500.00
Scanner Carrier Sheets "D" Size	$85		8	680.00
TRAVEL				**3,585.96**
Total Direct Costs				199,166.67
Facilities & Administration (10%)				**19,916.67**
Total Costs				**$ 219,083.33**

APPENDIX B – Phase I Costs Breakdown

Scan, PDF Book, & Geo-Reference Costs Breakdown

Major Task	Sub Tasks	Unit	Average Time (Minutes)	Avg. Sheets per Project	Total Minutes	Total Hours	Hourly Rate	Est. Per Sheet Cost	Est. Cost Per Project
Scan $2.38 per sheet or $166.57 per book	Map book disassembly/assembly, assign page numbers	Project Book	20		20	0.3	$ 16.12	$ 0.08	$ 5.37
	Scan (standard or reverse sides)	Sheet	4.5	x 70	315	5.3	$ 16.12	$ 1.21	$ 84.63
	Crop/Image Processing	Sheet	4	x 70	280	4.7	$ 16.12	$ 1.07	$ 75.23
	Update Project Tracking Database	Project Book	5		5	0.1	$ 16.12	$ 0.02	$ 1.34
	total		33.5		620	10.33	$ 16.12	**$ 2.38**	**$ 166.57**
Adobe PDF $7.52 per book	Create Adobe PDF Book of all map sheets	Project Book	28		28	0.47	$ 16.12	**$ 0.15**	**$ 7.52**
Geo-Reference $7.25 per book	Geo-reference	Sheet	25	x 1	25	0.42	$ 16.12	$ 6.72	$ 6.72
	Update GeoRef Sheet Database	Project Book	2		2	0.03	$ 16.12	$ 0.54	$ 0.54
	total		27		**27**	0.45	$ 16.12	**$ 0.15**	**$ 7.25**
Other Tasks $13.03 per book	Add index map to raster mosaic	Project Book	3		3	0.05	$ 16.12	$ 0.02	$ 0.81
	Copy all files to folder structure and copy to server and external drive	Project Book	0.5	x 71	35.5	0.59	$ 16.12	$ 0.19	$ 9.54
	Quality Control - Check PDF, GeoTIFF, file names	Project Book	10		10	0.17	$ 16.12	$ 0.05	$ 2.69
	total		13.5		**48.50**	**0.81**	$ 16.12	**$ 0.26**	**$ 13.03**
	grand total				**723.50**	**12.06**	$ 16.12	**$ 2.93**	**$ 194.38**

Project Management Costs Breakdown

Personnel Costs

Item	Hourly Wage	# Hours	Base Salary	Fringe (%)	Total Salary
(1) GIS Manager (Kurt Donaldson)	$34.28	230	$7,884	25.0	$9,856
(2) System Administration / Programmer (Frank LaFone)	$32.24	70	$2,266	25.0	$2,832
(3) GIS Project Leader (Eric Hopkins)	$27.56	120	$3,307	25.0	$4,134
(4) Student GIS Programmer (Jim Schindling)	$14.75	400	$5,900	9.2	$6,443
(5) Student GIS Programmer (Tommy Brown)	$14.75	434	$6,401	9.2	$6,990
Total			$25,759		**$30,255**

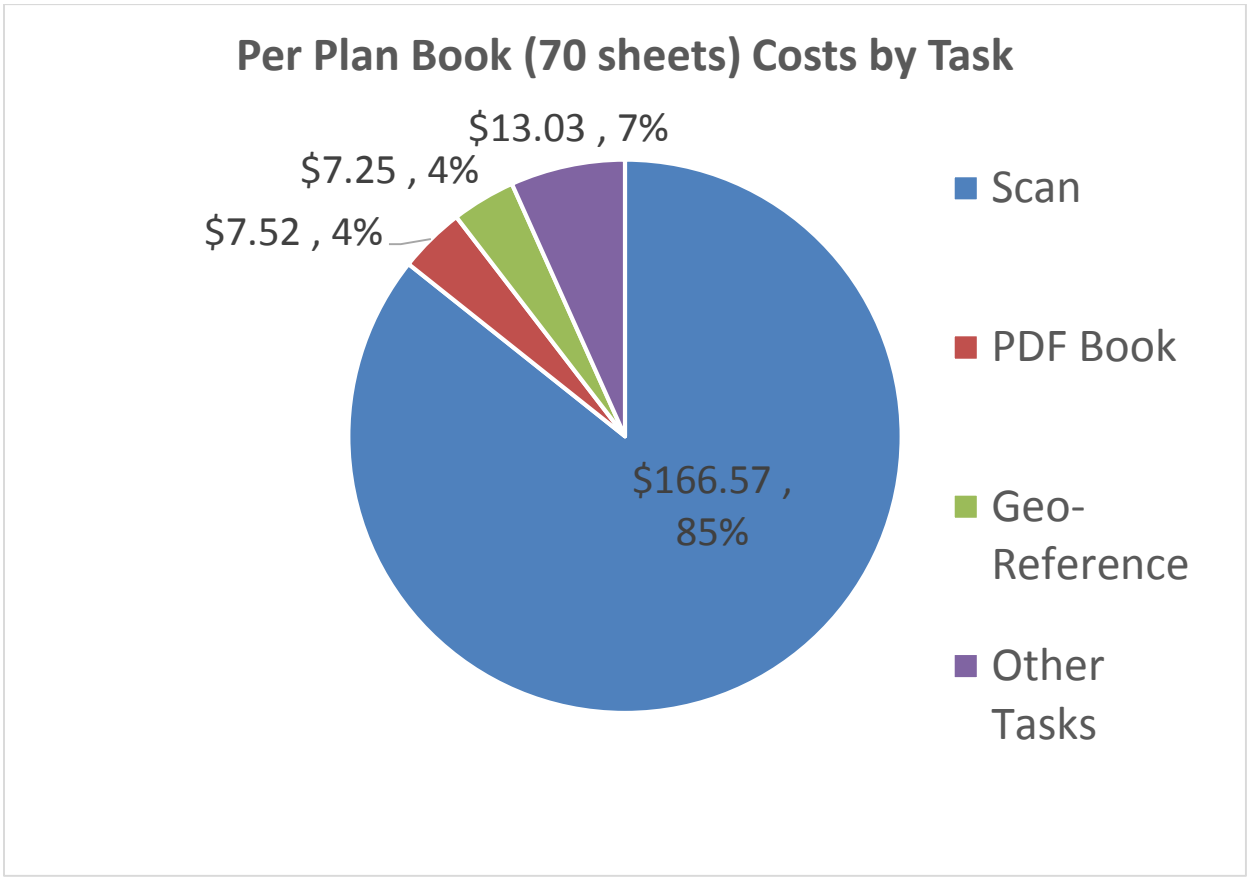
Percent Effort by Task

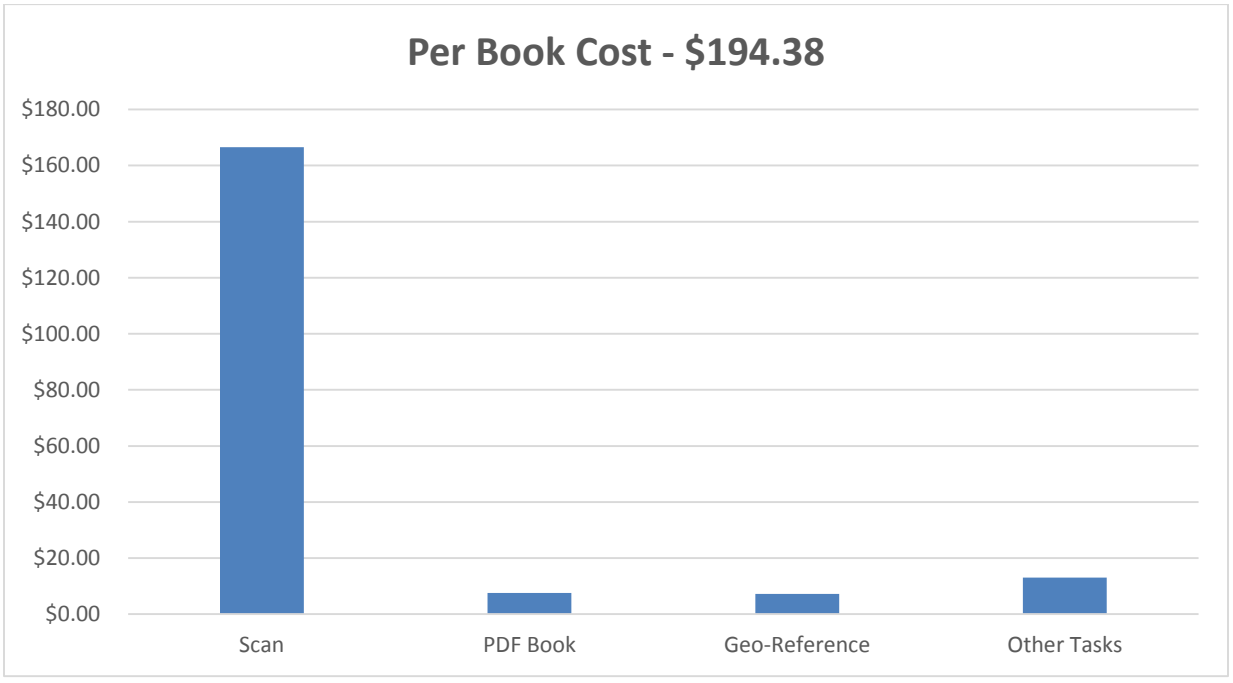
(1) Specs % Effort	(2) Superv. % Effort	(3) Tools % Effort	Total Cost & Effort
5,913	2,957	986	9,856
60%	30%	10%	100%
	1,699	1,133	2,832
	60%	40%	100%
2,480	1,654		4,134
60%	40%		100%
		6,443	6,443
		100%	100%
2,097	2,796	2,097	6,990
30%	40%	30%	100%
10,491	9,106	10,658	**$30,255**

Travel Costs Breakdown

Travel Item	Unit		Qty	Cost
Lodging	$ 105.00	per day	4	$420
Per Diem Meals	$ 51.00	per day	8	$408
Total Mileage (.47 per mile x 326 miles) from Morgantown to Charleston and return trip	$ 153.22	per mile	18	$2,758
sum				$3,586

Travel: 18 trips from Morgantown to Charleston and back; four of those trips include overnight stays


Per Plan Book (70 sheets) Costs by Task
$13.03 , 7%
$7.25 , 4%
$7.52 , 4%
$166.57 , 85%
Scan
PDF Book
Geo-Reference
Other Tasks


Per Book Cost - $194.38
$180.00
$160.00
$140.00
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$0.00
Scan
PDF Book
Geo-Reference
Other Tasks

APPENDIX C – Scanning Project Work Estimates

Total Plan Sheets

9,163	Number of project books in WV DOT database
18,326	70% estimated not in the WV DOT Database
27,489	Total number of estimated project books
70	Estimated sheets per project book (from Project Tracking Database)
1,924,230	Estimated number of plan sheets

Scanning Estimates for one person

70	Number of scans per day
240	Work days per year
16,800	Scans per year
336	Projects Books per year

GeoReferencing Estimates for one person

26	Number of geo-referenced files per day [2]
240	Work days per year
6,240	Geo-Referenced index maps per year

Notes:

[1] It is assumed that each project plan book or set averages 70 sheets.

[2] Only index map sheet per book geo-referenced; the geo-referencing time ranges from 15 to 30 minutes depending on source imagery accuracy and available control points.

APPENDIX D – Procedures Outline

1) **Receive Project Book(s) from WVDOT**
   a) Transmittal sheet provided WV DOT
   b) Project Key provided by WVDOT
   c) Scan ID designated by WVGISTC

2) **Unbind Project Book**
   a) Remove clips/tape/staples from sheets
   b) Rearrange pages in proper sequence if necessary.
   c) Number pages sequentially with pencil in lower-left corner
   d) Review page number suffixes
   e) Enter Project Book information into Project Tracking Database
      i) Information found on Project Book cover sheet
      ii) Project Key found on transmittal sheet
   f) Create project folder to contain scanned images:
      i) Name project folder with Project Key provided by WVDOT
      ii) Subfolders:
         (1) TIFF
         (2) PDF
         (3) GeoTIFF

3) **Sheet Scanning**
   a) Configure scanner with Project Key, page number, and output location
      i) Files are named by the established naming convention
         (1) *ProjectKey_PageNumber.TIF*
         (2) Verify page number accuracy
         (3) Save scans in Project folder > TIFF
   b) Scan sheets
      i) Scanner Settings:
         (1) Image type: TIFF, uncompressed
         (2) Image resolution: 300 dpi
         (3) Color information: 8-bit color depth (optimized)
         (4) Image quality: High
         (5) Scan speed: Low
   c) Image processing
      i) Crop images when necessary to eliminate white space using image processing software
      ii) Adjust image color/brightness/levels with image processing software when necessary

4) **Re-Bind Project Book**
   a) Re-bind all sheets as it was received
   b) Update transmittal sheet:
      i) Date Scanned

ii) Scanned By

c) Roll sheets and fasten with rubber band
   i) Place transmittal sheet inside roll
   ii) Add colored paper with scan order number to outside of roll

d) Update Tracking Database:
   i) Number of sheets Scanned
   ii) Date of Scan
   iii) Initials of person who performed scan
   iv) Additional Comments

e) Project Book is now ready to return to WVDOT

5) **Create Single PDF Document of all Project Sheets**

a) Specifications:
   i) Save as Reduced Size PDF
      (1) Save in projectFolder/PDF
      (2) Naming Convention: *ProjectKey_PageNumber.pdf*
   ii) Run Text Recognition tool

b) Check PDF for rotation errors resulting from Text Recognition tool and make necessary corrections

6) **Georeference Index Map Sheets**

a) Estimate 1 map sheet per project book (cover sheet)

b) Prepare TIFF for georeferencing
   i) Crop out all whitespace/margin (optional)
   ii) Adjust image format for Web Map Index compatibility
      (1) Must be in 8-bit, Indexed Color mode
      (2) Brighten TIFF if necessary (no pixels below RGB='10,10,10')
      (3) Create custom color index with index value '0' set to black (RGB='0,0,0')
   iii) If converting to MrSID format:
      (1) Adjust color levels to add minor color data to TIFF if necessary

c) Georerefence TIFF
   i) When rectifying, set NoData as '0' to set background transparency

d) Name georeferenced images according to DOT naming conventions
   i) Naming conventions: *ProjectKey_PageNumber_UTM17N83.tif*
   ii) Save in: projectFolder/GeoTIFF

e) Update Tracking Database's Georeferencing sheet
   i) Scan_order number
   ii) Page number
   iii) Amount of time to georeference
   iv) RMS error
   v) Technician initials
   vi) Date
   vii) Additional notes

7) **Build Web Map Index**

a) Create Mosaic Dataset
b) Add rasters to Mosaic Dataset
c) Attributes
    i) Esri GIS attributes automatically created
    ii) User-defined attributes added to raster footprint
        (1) Link to PDF booklet
        (2) Link to Project folder for access to all related files
        (3) Link to zipped GeoTIFF
        (4) Option to join Project Database Table to Raster Mosaic Footprints Table
d) Build Map Application
    i) Publish raster mosaic to ArcGIS server
    ii) Customize application
    iii) Develop automated routines

8) **Quality Control Procedures for each Project Book**
    a) Accuracy/completion of Project Database entry.
    b) File-name accuracy
    c) Completion of image processing
    d) Completion/accuracy of PDF
    e) Completion/accuracy of GeoTIFF
    f) Update Tracking Database's QC Checklist sheet
    g) Back-up all files onto project server FTP drive

More detailed information is provided in the Procedural Manual.

APPENDIX E – Estimated Sizes of Scanned Products

File type preferences are based on preferences of image quality, file size, and display performances.

Files Size Estimates for Each File Format

Product	DPI	Unit	Est. Size	X 100,000	Notes
ORIGINAL SCANS					
(1) Original TIFF 8-bit indexed color; not gray-scale because files need to be homogeneous (all color or gray-scale) for web raster mosaic.	300	Sheet	75 MB Zip Compressed 37.5 MB	7.5 TB 3.75 TB	Best format for archival purposes and image quality. Zip compression results in 2 to 1 compression ratio or file size reduction by 50%.
PDF PLAN BOOK					
(2) PDF Sheet Saved as "Reduced Sized PDF"	300	Sheet	1 MB 55 MB avg. project book size	0.1 TB	75 to 1 compression ratio or about 1 MB per page; allows for OCR recognition. Combines all pages of plan into single file. Some image quality lost due to compression but readable.
GEO-REFERENCED					
(3) GeoRef TIFFs 8-bit indexed color (UTM projection)	300	Sheet	70 MB Zip 25 MB	7 TB 2.5 TB	Varies by crop size. Assume only index map needs to be geo-referenced. Zip compression typically 3 to 1 compression ratio.

Product	DPI	Unit	Est. Size	X 100,000	Notes
COMPRESSED					
(4) ZIP Lossless Compression of TIFFs or GeoTIFFs	300	Sheet	37.5 MB (TIFFS) 25 MB (GeoTIFFs)	3.75 TB 2.5 TB	2 to 1 compression of **TIFFs** 3 to 1 compression of **GeoTIFFs**
(5) JPG Lossy Compression of TIFFs 24-bit RGB color	300	Sheet	37.5 MB	3.75 TB	2 to 1 compression of **TIFFs** and a more common format for viewing online with web browsers
(6) MrSIDs Lossy Compression of GeoTIFFS 8-bit RGB color	300	Sheet	10 MB 5 MB	1 TB 500 GB	20: 1 MrSID compression setting results in a 7 to 1 to compression of **GeoTIFFs** 40: 1 MrSID compression setting results in a 14 to 1 to compression of **GeoTIFFs**
WEB RASTER MOSAIC (for web index application)					
(7) Raster Mosaic for Web Map Index (Web Mercator Projection; GeoTIFF or MrSID format)	300	Mosaic	Files stored on server	500 GB to 7 TB	MrSID significantly reduced file sizes but slower drawing performance. An extra processing step using Photoshp is also required to remove color value artifacts (Appendix G)

Yellow Highlight: File types at a minimum that must be created for project.

Total Estimates for 100,000 Scanned Images

File Type	X 100,000 scans
TIFFs/GeoTIFFS	7.5 TB
Zipped TIFFs/GeoTIFFS	3.8 TB
JPEGs	3.8 TB
PDF Individual Sheets	0.1 TB
GeoRef MrSIDS (40:1 setting)	.25 TB

Zip File Compression Ratios of Different File Types

File Name	File Type	.zip compression ratio	Original Size (KB)	.zip Size (KB)
00003_1	TIFF	1.9 to 1	71,744	37,089
00003_2	TIFF	2 to 1	75,493	38,255
00003_3	TIFF	2.1 to 1	71,357	34,155
00003_1_wmA84.tif	GeoTIFF	2.8 to 1	17,019	6,085
00003_4_wmA84.tif	GeoTIFF	2.8 to 1	17,966	6,394
00003_1	JPG	1 to 1	27,922	27,702
00003_2	JPG	1 to 1	28,419	27,158
00003.pdf	PDF	1.1 to 1	16,156	15,139
00003_1_wmA84.sid	MrSID	1 to 1	9,638	9,574

MrSID compression ratios from GeoTIFF to MrSID

File Name	GeoTIFF size (KB)	MrSID size (20 to 1)	Ratio to one	MrSID size (40 to 1)	Ratio to one
00001_1_wmA84	67,179	14,035	4.79	7,023	9.57
00006_1_wmA84	65,353	7,937	8.23	3,972	16.45
00007_1_wmA84	68,215	8,757	7.79	4,383	15.56
00008_1_wmA84	77,747	9,477	8.20	4,743	16.39
00009_1_wmA84	65,952	8,348	7.90	4,179	15.78
00011_1_wmA84	72,682	9,371	7.76	4,689	15.50
average	*69,521*	*9,654*	*7.45*	*4,832*	*14.88*

File Type Recommendations

- Sheets will be originally scanned at 300 dpi as TIFFs and compressed to Zip files. Sheets that are geo-referenced will be in a GeoTIFF format, zip compressed, and in a UTM 17N map projection.
- The PDF book format is recommended because it combines all map sheets of a particular construction plan set into a highly compressed single file for viewing purposes.
- The JPG and MrSID compression formats are optional and can be implemented any time later during the project using batch processes. MrSID is only recommended if a large number of sheets are being geo-referenced.
- The raster mosaic of spatially referenced sheets is required for the web map index application and will reference either GeoTIFF or MrSID compression formats in a Web Mercator Auxiliary projection.

APPENDIX F – Advantages and Disadvantages of File Types

TIFF

TIFF (Tagged Image File Format) is recognized by the extensions .tif or .tiff. It is recommended especially for text and black and white images. Though it is not widely supported by web browsers, it remains the standard format for printing, scanned documents and Optical Character Recognition, since it doesn't have any of the JPG artifacts.

Purpose: Best format for original scans.

GeoTIFF

GeoTIFF is a public domain metadata standard which allows georeferencing information to be embedded within a TIFF file. The potential additional information includes map projection, coordinate systems, ellipsoids, datums, and everything else necessary to establish the exact spatial reference for the file. The GeoTIFF format is fully compliant with TIFF 6.0, so software incapable of reading and interpreting the specialized metadata will still be able to open a GeoTIFF format file.

Purpose: Best format for spatially referenced maps using Esri GIS software.

Adobe PDF

Invented by Adobe Systems and perfected over 20 years, Portable Document Format (PDF) is now an open standard for electronic document exchange maintained by the International Organization for Standardization (ISO). Scanned text can be converted using optical character recognition (OCR) technology to make text searchable. Files are read using free Adobe Reader software.

Purpose: Best format for viewing an entire set of project sheets at a very high reduced file size or compression ratio.

Compressed files are worth evaluating because of the significant file size reduction; however, the image quality of the original images may be affected.

JPG compressed

JPEG is probably the most commonly used image format. Its name derives from the name of the people who developed the JPEG compression technique: the Joint Photographic Experts Group. Common file extensions associated with this format are .jpg, .jpeg. Jpeg is a good format for photographs because it offers a reasonable compromise between picture size and picture quality. However, images can lose their quality when repeatedly edited and saved in this format. It is not recommended for scanned documents or text that's going to be used with OCR software because of the digital artifacts (unpleasant visual defects in an image).

Purpose: Best format for viewing compressed TIFF scans.

Zip compressed

ZIP is an archive file format that supports lossless data compression. A ZIP file may contain one or more files or folders that may have been compressed. Lossless data compression is a class of data compression algorithms that allows the original data to be perfectly reconstructed from the compressed data.

Purpose: A suitable compression format to compress TIFFs and GeoTIFFs as well as to combine multiple files like geo-referenced TIFFs (TIFF & TIFW) into a single file name which allows for easier download.

Mr SID compressed

MrSID (pronounced Mister Sid) is an acronym that stands for multiresolution seamless image database. It is a file format (filename extension .sid) developed and patented by LizardTech for encoding of georeferenced raster graphics, such as orthophotos. MrSID technology uses lossless wavelet compression to create an initial image.

LizardTech offers a software package called GeoExpress to read and write MrSID files. They also provide a free web browser plug-in for the Microsoft Windows operating system. Most commercial GIS software packages can read MrSID files including those from GE Smallworld, ESRI, Intergraph, Bentley Systems, MapInfo, Safe Software, Autodesk, with ERDAS IMAGINE being able to both read and write MrSID files.

Display Viewing Performance

Raster layers that do not use wavelet compression result in improved drawing performance because the data does not have to be uncompressed at display time.

Wavelet compression, used by raster formats such as MrSID, JPEG 2000, and ER Mapper's ECW, takes time to decompress before drawing. These formats are good at storage efficiency but result in slower drawing because of the amount of computation required to unpack the wavelet-compressed data prior to display. Other compression options often require more storage but can uncompress and draw faster in ArcGIS.

Esri recommends that you use a compression other than wavelet to get better drawing performance. For example, formats such as TIFF and JPEG provide much better drawing performance, but they typically require more storage space than wavelet-based compression.

Caching could improve display performance but would increase file storage required.

Purpose: For compressing spatially referenced GeoTIFFs, the format is good for storage efficiency but results in slower drawing because of the amount of computation required to unpack the wavelet-compressed data prior to display. More processing steps using Photoshop are also required before creating GeoTIFFs to to remove color value artifacts during the MrSID conversion process (See Appendix G). Lastly, there is a conversion cost involved with MrSID software. It is recommended that MrSID only be considered if there are a large number of files being geo-referenced.

APPENDIX G – MrSID Conversion Process

MrSID Conversion Process Summary

In order to successfully convert GeoTIFFs into MrSID format while maintaining compatibility with the raster mosaic and the ArcGIS online utility, some image processing steps must be performed.

When GeoTIFFs are converted to compressed MrSIDs, the background "No Data" pixels of the GeoTIFF are forced into have a color value as part of the compression process, which causes those pixels to be opaque. It is possible to set a single color value in a MrSID image to be transparent in ArcGIS, but the MrSID compression process causes speckling in those background pixels which results in a "halo" of discoloration around the image border. Additionally, images must contain some color information to avoid be converted to Grayscale mode by the MrSID conversion process.

The above issues can be avoided by following the steps outlined below before and during georeferencing. These steps only need to be performed on the TIFFs that will be georeferenced, and all steps performed in Adobe Photoshop can be automated and run as a batch process.

Steps for MrSID conversion

In Photoshop (all steps here can be automated in a batch process):

- Brighten the image (raise Output Levels by 10)
- Convert to RGB mode
- Convert back to Indexed Color Mode, creating a custom Color index where swatch 0 is the color R:0 G:0 B:0 (pure black)
- Adjust Color Levels to add color data to the TIFF if there is not any

In ArcGIS:

- Georeference the image
- Rectify, set "No Data" to 0

In GeoExpress 9:

- Run the Despeckle tool
- Convert to MrSID

Conversion Procedure

In Adobe Photoshop, a newly scanned image is brightened slightly to ensure that there are no visible pixels in the image with an RGB value lower than R:10 G:10 B:10. This is done by raising the Output Levels in the levels adjuster by 10. By this process, darker pixels are brightened more than lighter pixels (black pixels will be brightened by 10, whereas nearly white pixels might be raised by 2 or 3), which minimizes the brightening of the image, resulting in little noticeable change from the original.

Again in Adobe Photoshop, the image is converted to RGB Color mode, then back to Indexed Color mode. This step optimizes and rearranges the color index and allows for a custom color index to be generated.

During the conversion back to Indexed Color mode, the new custom color index will be configured to contain the color R:0 G:0 B:0 (pure black), and this color will be assigned to the index value 0.

If there are no color pixels in the image (all pixels are some shade of gray), a small amount of color must be added, which can be easily done by adjusting the color levels. This is because the MrSID conversion process will detect if all the pixels are gray and then automatically convert the image to Grayscale mode, rendering it incompatible with the raster mosaic. This step prevents that.

The image can now be georeferenced. When rectifying the georeferenced image, the "No Data" value is set to the image's color index value 0, which is pure black.

The image is then compressed into MrSID format, which forces the image out of Indexed Color mode and into RGB mode as part of the compression process. During this process, the despeckling tool is utilized to avoid any discoloration created in the black background. This tool works by causing all pixels below a specified brightness threshold, in this case R:10 G:10 B:10, to be set to R:0 G:0 B:0. This should be only those pixels that comprise the black background. The resulting image can be added to a map in ArcGIS, and all pixels with the RGB value R:0 G:0 B:0 can be set to transparent, which will remove only the black background.

GeoTIFF versus MrSID Web Display Performance Comparison

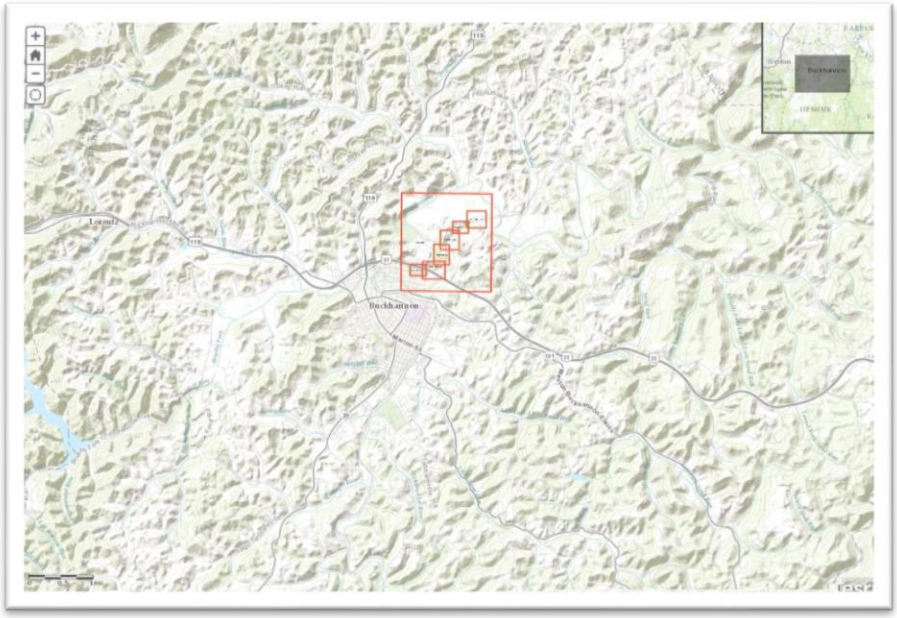
Below is a link to an ArcGIS Online demo containing a TIFF and two SIDs at different compression settings. The demo compares the performance quality of the different image formats but in the same map projection.

http://bit.ly/1kFfhSR

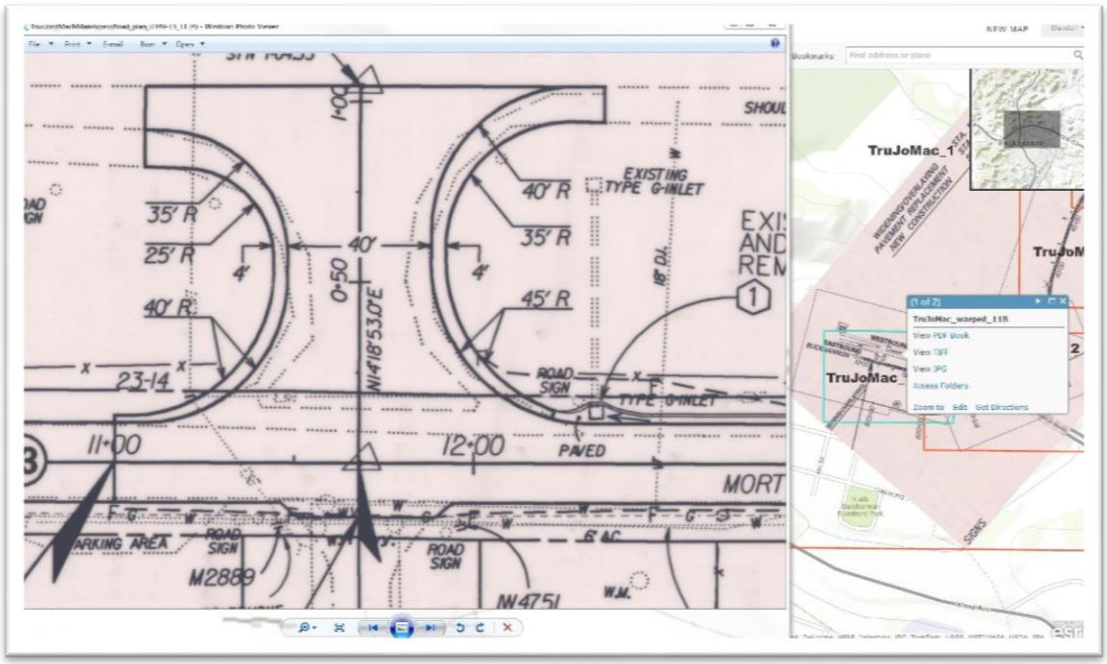
From viewing the online web demo, first, the SIDs have a speckled black halo around them which may be difficult to remove. Secondly, the viewing display time of the MrSIDs (zoom in on GeoTIFF and MrSID formats at larger scales) is faster for the GeoTIFFs than the MrSID files. The same applies to when displaying both formats in the same projection using ArcGIS desktop software.

APPENDIX H – Web Map Index Application

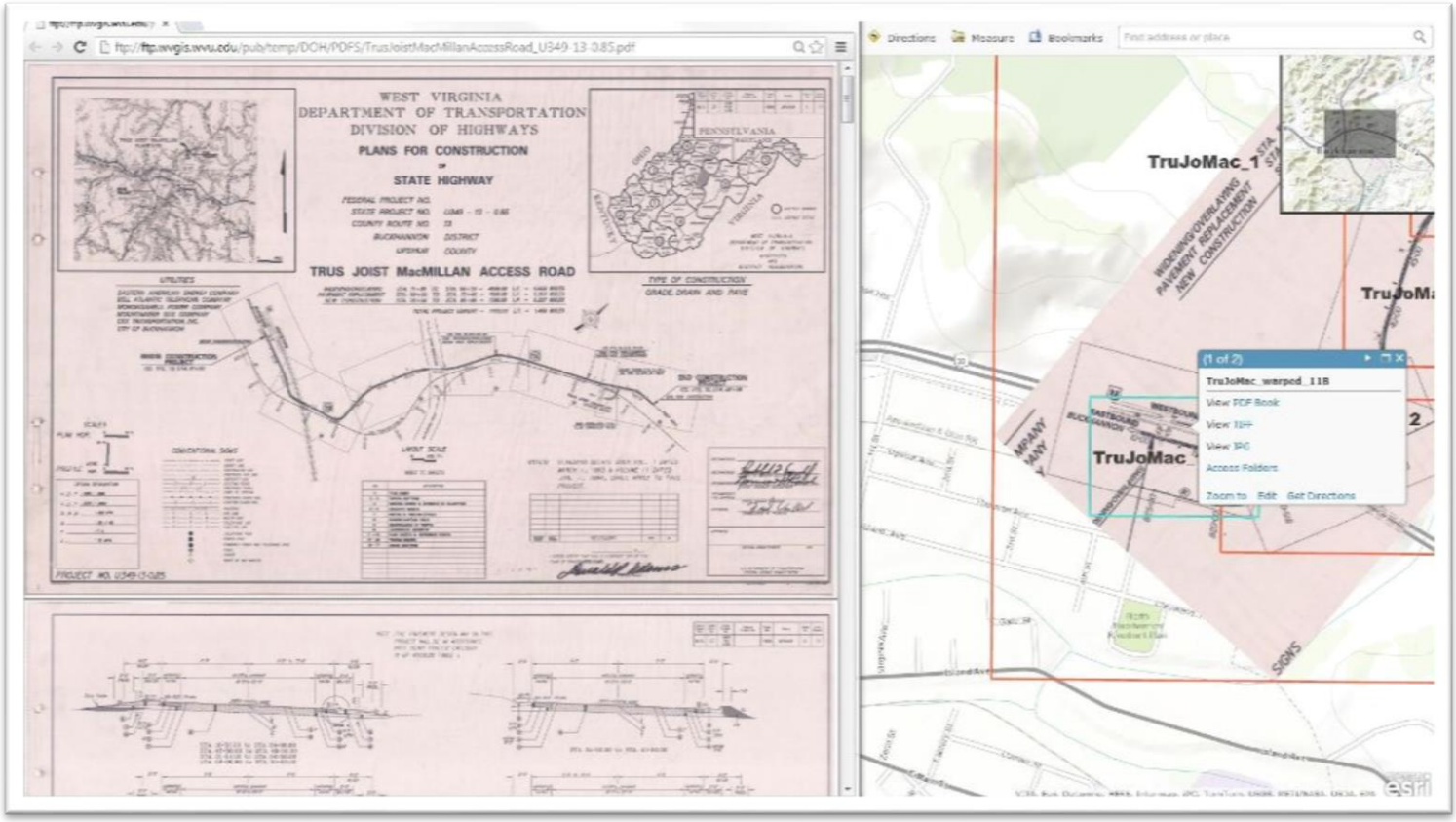
Example screen shots of web map index, a geographic locator for viewing and downloading project plans.
Online link: http://bit.ly/TnFASu



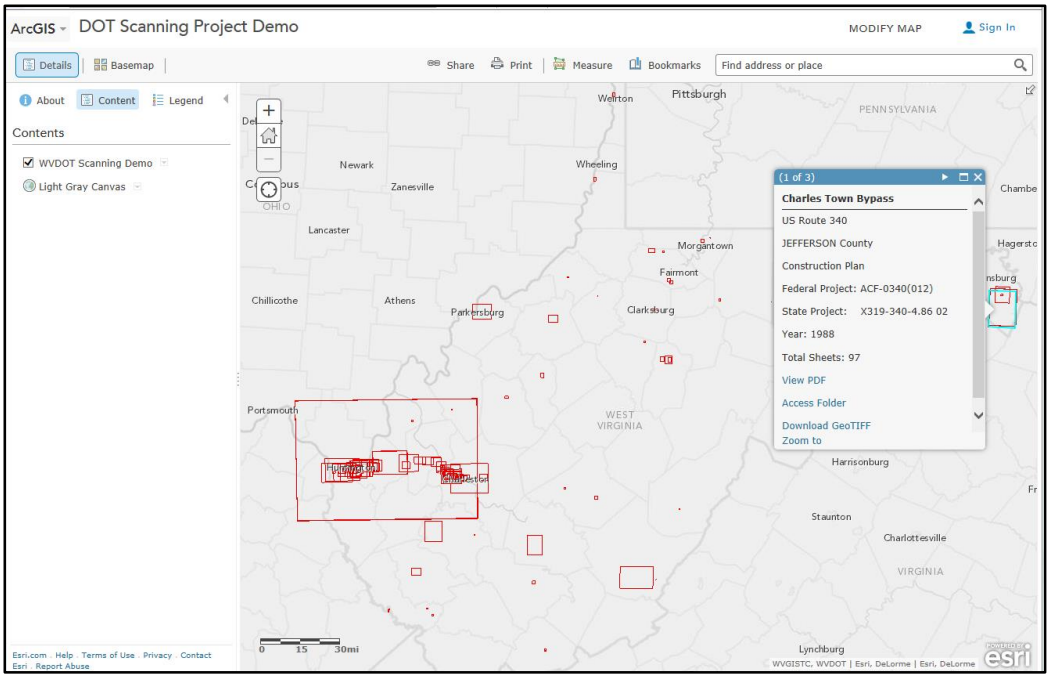
Sheet map boundaries (red boxes) of Project Plan



Example of online viewing and download of individual TIFF digital image



Example of online viewing and download of PDF plan book



Statewide view of all project books scanned

Customized Web Map Application

A customized web map index could be similar to the online Pennsylvania Mine Map Atlas application (http://www.minemaps.psu.edu/) hosted by the Pennsylvania Spatial Data Access (PASDA). The map index application can customized to user requirements set forth by the WV Division of Highways. Map functions could include:

- Customized user interface
- View spatially referenced scans (GeoTiffs or compressed MrSIDs)
- Map Results Box which could include Download, Highlight, View Map, and Zoom to Map functions. Could have viewable and downloadable links for (1) individual sheets as TIFFs or compressed JPGs, (2) PDF booklet of all sheets, and access to (3) project plan file folders that contains all files (TIFF, JPG, PDF, GeoTIFF, MrSID) as well as project notes.
- Zoom to County, Street Address, Geographic Coordinates
- Search by Highway Number, Project Name, or Project Key
- Base map and other reference overlay layers with no map scale zoom-in limitations
- Other functions: Transparency Slider for highway maps, print map, measure tool, Link to FTP folder of all scanned and processed files

Project Book Links

Users can share online links to specific Project Books. Some examples are listed below:

(1) Keith Bridge: http://bit.ly/1hTr0cc
(2) Trus Joist MacMillan Access Road: http://bit.ly/1hTrdfn
(3) Elk Two Mile Watershed: http://bit.ly/Mm0fCI
(4) St Albans Nitro Bridge: http://bit.ly/LftZQO
(5&6) McMechen Slide Corrections 1 & 2: http://bit.ly/1hTsbZ6 (two projects overlap)
(7) Grantsville Bridge: http://bit.ly/1hTskvI
(8) Guyandot and Gideon District: http://bit.ly/1hTt2ck
(9) Washington and Scott Districts and Danville Corporation: http://bit.ly/1hTtnfa
(10) Logan Relocation: http://bit.ly/1hTtJT3
(11) Oak Hill Expressway Contract No. 6: http://bit.ly/1hTtY0b

Full Extent: http://bit.ly/TnFASu

Automatically Update Web Index

Another objective of the web application could be the ability to automatically generate a new web map index and corresponding file links when additional map scans are ready to be viewed online. Where possible, automatic programming scripts could be developed to expedite updating functions in the application which will decrease costs and minimize human errors during the file updating procedures.

APPNDIX I – Transmittal Sheet

Project Key	Project Title

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22	23
_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_		S	_	_	_	_	_
Type	County ID	Sign System	Route Number					Sub Route		Begin Milepost			Fiscal Year					*Scan Order Number (To be completed by scan tech.)*					

Supplemental Information

1	2	3	4	5	6	7	8	9						
_	_	_	_	_	_	_	_	_	_	_	_	_	.	_
District #	Direction		Special ID		Status ID	Supplemental Code		Bridge #						

Transmittal Information

Date Scanned	Scanned by:
Notes:	

APPENDIX J – WV DOT File Name Conventions

WV DOT Scanning File Name Convention

The following table illustrates the file naming convention, an alpha-numeric name of 29 digits that describes the project being named. The first 13 digits follow the WV DOT County Route ID naming convention. Folder structures and scanned files will adopt this convention for file organization. All the files will be complete to include leading zeroes and null values so that all Project Key Numbers have the same fixed length format. Fields are separated by underscores within the file name for readability.

PRIMARY FIELDS: Plan Type, County Code, Sign System Code, Route, Sub-Route, Begin Mile Marker, Scan Order Number, Fiscal Year

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	S	_	_	_	_	_	_	_	_	_	_	_
Type	County ID		Sign System	Route Number				Sub Route		Begin Milepost			Fiscal Year				Unique Scan ID						Sheet Number				Suffix	

PROJECT KEY NUMBER: The unique ID number generated for each project book. The first 8 fields are concatenated and separated with underscores to create this Project Key Number which is also the file folder name. The last two fields are for the sheet names of the individual scanned TIFF files; total file name characters of Project Key Number (23 characters) and Sheet Number and Suffix (6 characters) sums to 29 possible characters.

EXAMPLE FILE NAMES: Boldfaced text represents Project Key Number; regular text represents sheet number and suffix.

1 2 3 4 5 6
12345678901234567890123456789012345678901234567890123456789012

B_06_1_0064_00_011_2012_S00149	*(folder name)*
B_02_3_0081_08_000_2008_S00150.pdf	*(PDF highway plan set)*
B_52_4_0036_00_002_2010_S00151_0010A1.tif	*(TIF file of individual scanned sheet)*
P_47_2_0048_00_073_2005_S00152_0002.tif	*(TIF file of individual scanned sheet)*
B_23_3_0010_00_013_2012_S00153_0157B.tif	*(TIF file of individual scanned sheet)*
R_17_1_0079_00_132_1971_S00156_0001_UTM17N83.tif.zip	*(Compressed Geo-Referenced Tiff sheet)*

PRIMARY FIELDS: Data elements that are part of Scanned File Name

Type: Must be a letter. Currently permitted values: R = Right of Way, P = Construction Plan, B = Bridge, S = Shop Drawings

County Code: Denotes a numeric code associated with each county. This reflects the county of origin of the project. This code is the numeric equivalent of the alphabetized county name list.

Sign System: Denotes sign system. Code specified by WV DOT. Example: 1 = Interstate, 2 = US Route, 3 = State, 4 = County

Route Number: Denotes the project primary route number.

Sub Route Number: Denotes the primary sub-route number.

Begin Milepost: Denotes the project's beginning milepost, as stated on the project cover/index sheet. If the beginning milepost is unknown, the value 000 shall be entered.

Fiscal Year: Denotes the fiscal year, as stated on the project cover/index sheet.

Scan ID: Unique scan order number.

Sheet Number: Denotes the sheet number as stated on the page/sheet scanned. This field may contain 0000(verify length), or a coded value for additional or un-marked pages. Folder names shall not include these characters.

Suffix: Multi-use, alpha-numerical characters. Can denote: alpha-characters that appear after the page number as seen on the scanned sheet, as in page 5**A**, 5**B**, etc…; the reverse side of a sheet; sheets that have no page number; deleted sheets. Additional uses added as discovered. Folder names shall not include these characters. Can be left blank.

SUPPLEMENTARY FIELDS: Data elements that can be added to the Project Tracking Database and subsequently displayed or queried using the Highway Plan Locator tool.

Direction: Denotes the directional heading of the roads depicted on the map. NB, SB, EB, WB for dual geometry; 00 for bidirectional, single geometry road systems.

Supplemental Code: Denotes a supplementary code identifier which refers to a key provided by WVDOT. (See WVDOT table for all values)

Status ID: Denotes Project book Status ID. Code to be specified by WV DOT: 1 = initial design, 2 = preliminary design, 3 = final design

Special ID: Denotes a special code. This code is intended to differentiate between multiple contracts or projects that fall within the same route and milepost. Code to be specified by WV DOT. Example: 01 = contract 1, AA = archived set. . (See WVDOT table for all values)

Bridge Design Number: If there are multiple bridge identifiers, then use the lowest number and list the other bridge identifiers in the notes field of project database.

DOMAIN AND NULL/DEFAULT VALUES FOR FIELDS:

FIELD NAME	WIDTH	DOMAIN VALUES	NULL OR DEFAULT VALUES
Plan Type	1	R = Right of Way, P = Construction Plan, B = Bridge, S = Shop Drawings	Required
County Code	2	County Number 01 (Barbour) through 55 (Wyoming); 99 for statewide continuous features	Required
Sign System	1	Sign system of route: 1 = Interstate, 2 = US Route, 3 = State, 4 = County (See WVDOT table for all values)	Required
Route Number	4	Project Route Number	Required
Sub Route	2	Sub-Route Number	00
Begin Milepost	3	Starting Milepost Number	000
Fiscal Year	4	Project fiscal year as it appears on the cover sheet	Required
Scan ID	5	Letter “S” plus unique 5-digit scan order number	Required
Sheet Number	4	Sheet Number	Blank
Suffix	2	Sheet Number Suffix	Blank

APPENDIX K – Project Tracking Database

Excerpt of Project Database as of 12/30/2014

#	Project Title	Federal Project Number	State Project Number	Total Sheets	Date Scanned
1	Grantsville Bridge and Approaches	S-119(6)		43	1/1/2014
2	Trus Joist MacMillan Access Road		U349-13-0.85	20	1/1/2014
3	Keith Bridge	BRO_0310(009)E	S303-3/10-0.02	26	1/1/2014
4	Elk Two Mile Watershed Dam Site #4		U320-SCS/14-1	12	1/1/2014
5	McMechen Slide Correction 1		E426-MECH-1, C-2	28	1/1/2014
6	McMechen Slide Correction 2		426-MECH-1, C-3	17	1/1/2014
7	Washington & Scott Districts & Danville Corporation	APD-323(22)		30	1/1/2014
8	Logan Relocation	U-296(5)		21	1/1/2014
9	Oak Hill Expressway Contract No. 6	F-173(28)		26	1/1/2014
10	St. Albans-Nitro Bridge Modification		320-SP25-0.00	2	1/1/2014
11	Guyandot & Gideon District	I-64-1(12)10		40	1/1/2014
12	Neds Branch Bridge		S330-52/4-0.01	26	2/21/2014
13	Jesse Run Girder	TBCG-0084(047)E	S321-8/4-0.00	18	2/21/2014
14	Given Bridge (Rock Castle)	BR-0015(033)E	S318-15-5.64	23	2/21/2014
15	Glico Access Bridge and Approaches		X324-52/32-0.00	22	2/24/2014
16	Poverty Run Arch Bridge	NFA-0005-(0.56)	S309-5-5.34	17	2/24/2014
17	Moorefield Middle School		U316-55/7-0.00	16	2/24/2014
18	Lost River Dam Site#4		S316-SCS/4-1.00	42	2/24/2014
19	Upper Buffalo Creek Dam Site 33A		S325-ScS/33-1.00	30	2/25/2014
20	Browning Fork Bridge	BR-0052(115)	S330-52-50.34	59	2/25/2014
21	WV 55 to Clifford Hollow Bridge	APD-0484 (123)C	X316-H-101.92 04	109	2/26/2014
22	Kanawha County Building Demolition	NFA-0642(126)	U320-64-49.73 (12)	10	3/6/2014
23	Spring Valley I-64 Connector		X250-7/47-0.00	59	3/7/2014
24	Culloden Interchange		X306-64-31.65 00	140	3/7/2014
25	Dunbar I/C to Westmoreland Bridge	NH-0642 (116)	U320-64-49.73 (03)	144	3/8/2014
26	Davis Creek Bridge	NH-0642 (114)	U320-64-49.73 (04)	238	3/11/2014
27	Institute I/C to Dunbar I/C	NH-0642 (110)	U320-64-49.73 (05)	163	3/12/2014
28	Institute I/C to Dunbar I/C	NH-0642 (110)	U320-64-49.73 (05)	178	3/13/2014
29	I-64, Darnell Road Overpass	IM-0641 (253)	S306-64-14.12	214	3/14/2014
30	Interstate 64 Bridge Over Edgewood Drive	IM-0641 (116)	S350-64-5.20	123	3/15/2014
31	Interstate 64	IR-64-2 (43) 53	S320-64-53.27	14	3/17/2014
32	Dunbar I/C to Westmoreland Bridge	NH-0642 (116)	U320-64-49.73 (03)	186	3/18/2014
33	Kanawha River Bridge West Abutment and Wall	NH-0642 (115)	U320-64-49.73 (06)	132	3/19/2014
34	Interstate Highway 64	I-64-1 (32)10		58	3/21/2014
35	Interstate Highway 64	I-64-1 (32)10, C-2		18	3/21/2014
36	Interstate Highway 64	I-64-1 (32)10, C-3	F-57 (5)	26	3/21/2014
37	Interstate Highway 64	I-64-1 (32)10, C-3	F-57 (5)	20	3/22/2014
38	Huntington Mall Road	NH-0641 (245)	U306-64-19.72 00	40	3/23/2014
39	ALT. D, Parallel Road (Huntington Mall Road)	NH-0641 (245)	U306-64-19.72 00	4	3/23/2014
40	Interstate 64 Over Big Sandy River	IM-0641(164)	S350-64-0.02	3	3/27/2014

#	Project Title	Federal Project Number	State Project Number	Total Sheets	Date Scanned
41	Twelvepole Creek Bridge	BR-0641(220)	S350-64-2.02 02	15	3/28/2014
42	Crossroads Overpass Bridge	NFA 0641(279)	S306-64-11.98	2	3/28/2014
43	16th St Ent/Exit Ramp	IM-0641(339)D	S306-64-10.91 00	22	3/29/2014
44	19th Street Overpass	IM-0641(268)	S306-64-6.28 00	5	3/29/2014
45	Interstate Route NO.64 Expressway (Union District)	I-64-2(13)53, S-1		19	3/29/2014
46	Interstate 64 (Loudon Charleston District)	I-64-2-2(15)57	PM96-1-KANA-26	58	3/29/2014
47	Interstate 64 (West Charleston District)	I-64-2(16)59		43	4/2/2014
48	Interstate 64 (Union District, Slide Corrections)	I-64-2(25)47		6	4/2/2014
49	Interstate Route NO. 64 (Union District)	I-64-2(13)53, S-2		11	4/2/2014
50	Merrick Creek Connector Interchange	NH-0019(180)	U306-19-0.00 00	66	4/3/2014
51	Interstate Route NO. 64 (Pocatalico Union District)	I-64-2(3)46, S-1		52	4/3/2014
52	Interstate NO. 64 (Pocatalico District)	I-64-1(25)43	S-71(7)	29	4/3/2014
53	Interstate Route NO. 64 (Union District)	I-64-2(13)53, S-3		70	4/4/2014
54	Cross Lanes Interchange - WV Route 622	IM-0642(096)	U320-64-47.42	22	4/4/2014
55	Institute - South Charleston Road		U320-64-49.73 (00)	45	4/4/2014
56	Interstate Route NO. 64 (Union District)	I-64-2(6)51, C-2		5	4/5/2014
57	Interstate Route NO. 64 (Union District)	I-64-2(3)46, S-3		76	4/5/2014
58	Interstate 64	I-64-2(14)55		90	4/8/2014
59	Interstate 64 (Teays Valley & Scott Districts)	I-64-1(20)35		57	4/9/2014
60	I-64	I-64-1(35)19		19	4/10/2014
61	Interstate 64 (Westmoreland District)	I-34-1(31)0, PHASE 5		44	4/10/2014
62	I-64	I-64-1(14)30		9	4/15/2014
63	Interstate Route NO. 64 (Union District)	I-64-2(3)46, S-2	S-71(10)	42	4/15/2014
64	I-64 (Barboursville & Grant District)	I-64-1(7)19	S 675(1)	55	4/23/2014
65	I-64 (Kyle & Guyandot District)	I-64-1(31)0, PHASE 3		32	4/23/2014
66	I-64	I-64-1(3)13		38	4/24/2014
67	I-64 (Ceredo District)	I-64-1(31)0, PHASE 2		27	4/24/2014
68	I-64 (Barboursville & Grant Districts)	I-64-1(7)19	S-675(1)	37	4/24/2014
69	I-64	I-64-1(14)30		59	4/25/2014
70	Johnson Cemetery Reinternment	I-64-1(31)0		10	4/25/2014
71	I-64	LSI-64-1(1)0		14	4/25/2014
72	I-64	I-64-1(63)0		5	4/25/2014
73	I-64 (Slide Correction)	I-64-1(65)8		5	4/25/2014
74	I-64 (Guyandotte District)	I-64-1(63)0		6	4/25/2014
75	I-64 (Huntington District)	I-64-1(31)0 Phase 4		18	4/25/2014
76	I-64 (Pocatalico District)	I-64-1(22)41		20	4/25/2014
77	Beckley/Stratton Junior High School Access Road		X341-21/15-0.00	39	4/26/2014
78	Hough Street Bridge		S325-1/16-0.00	17	4/26/2014
79	Shinnston-Lumberport Road	STP-0020(133)EQ	S317-20-24.52	7	4/28/2014
80	Lumberport Road	STP-0018(082)EQ	S317-18-3.24	7	4/28/2014
81	East Main Street		U317-S20-0.80	7	4/28/2014
82	Town of Matewan Curb Construction		U330-49-8.66	9	4/28/2014
83	Stewartstown Road Left Turn Lane	NH-0119(099)E	U331-119-18.50	9	4/28/2014
84	Page-Deepwater Road	STP-0061(029)EQ	S310-61-19.47	43	4/29/2014
85	Shinnston-Lumberport Road	STP-0020(133)EQ	S317-20-24.52	17	4/29/2014
86	I-79 - U.S. 250 Road	STP-7373(009)EQ	U325-73/73-2.67	56	4/29/2014

#	Project Title	Federal Project Number	State Project Number	Total Sheets	Date Scanned
87	Lookout-Rainelle Road	STP-0060(138)EQ	S310-60-35.48	46	4/30/2014
88	Clarksburg Expressway	NH-0050(134)E	S317-50-15.46	37	4/30/2014
89	Bush Creek Ind. Park Access		X328-16/25-0.00	19	5/1/2014
90	Garden Street Bridge Project	BR-6079(002)E	S313-60/79-0.17	14	5/1/2014
91	Wardenville Bridge	PLH-0259(012)E	S316-259-32.64	34	5/1/2014
92	Race Track Road		U325-58-1.00	100	5/2/2014
93	Upshuer County Industrial Park Connector		X349-33/15-0.00	39	5/6/2014
94	Bush Creek Bridges		U328-SCS-1.00	17	5/7/2014
95	North Fork Hughes River (Bunnell)		U343-SCS-3.	47	5/7/2014
96	Patteson Drive Left Lane	STP-0705(001)EQ	U331-705-0.00	31	5/7/2014
97	Roane County/Spencer Business Park		X344*-33/2-0.00	23	5/8/2014
98	Fairview Concrete Girder Bridge		S325-218-11.47	45	5/9/2014
99	Evansville W-Beam Bridge No. 15721	BH-0092(012)E	S339-92-2.95 00	49	5/9/2014
100	Hutchinson Branch Bridge No. 4717	BR-0039(045)E	S334-39-19.36	34	5/9/2014
101	Swago Creek Bridge		S338-219/5-0.01	30	5/12/2014
102	McMullen Bridge	BR-0063(004)E	S348-6/3-4.70	29	5/12/2014
103	State Line T-Beam Bridge	BR-0050(133)E	S339-50-28.05	39	5/12/2014
104	Charles Town Bypass	ACF-0340(012)	X319-340-4.86 02	97	5/13/2014
105	Maintenance Headquarters Site Preparation		G049-UCM/H-1.01	32	5/14/2014
106	District 9 Headquarters		G013-HDQ-1. 00	5	5/14/2014
107	Dunlavy Ridge Bridge		S327-76-0.05	36	5/14/2014
108	Appalachian Corridor D East of CR 50/2 to Interstate 77	APD-0282(127)C	X354-D-7.00 09	139	5/14/2014
109	0.34 Miles South of CO. 8 to CO. 8 (Wiltshire Blvd.)	DPC-0042(059)C	U319-9-2.28 04	73	5/15/2014
110	Kings Creek Bridge	BR-0002(361)E	S315-2-3.04 00	171	5/15/2014
111	Clifford Hollow - Hardy Co.1	APD-0484(125)C	X316-H-101.92 06	157	5/19/2014
112	29th Street Bridge	BRST-3310(002)E	S306-60-6.11	104	5/20/2014
113	Charles Town Bypass	ACF-0009(048)	X319-340-4.86	156	5/21/2014
114	Canvas-nettie Road		U334-39-34.55	66	5/22/2014
115	Teletech Holdings LT LN		U319-8-2.77	9	5/22/2014
116	Charles Town Bypass	ACF-0009(058)	X319-340-4.86(04)	30	5/22/2014
117	Tollgate P. O. Bridge		S343-10-5.99	22	5/23/2014
118	North Fork Hughes River (Bunnell)		U343-SCS-3.	165	5/27/2014
119	CO.RT. 6 TO WV 55	HDH-0484(110)	X316-H-101.92 03	186	5/28/2014
120	Lower exchange replacement bridge		S304-19/26-8.17	16	5/30/2014
121	US 19 Bridge over Meadow River	F-0019(059)	S334-19-0.01	21	5/30/2014
122	Davisson Run Road	STP-0098(005)EQ	U317-98-0.00	6	5/30/2014
123	North Bridgeport Bypass Route 50 Connector		X317-279-0.00	20	6/2/2014
124	Broad Run Bridge	NFA-0023(002)	S309-23-4.23	15	6/2/2014
125	Walker Systems Industrial Access +1		U354-14-25.27 00	12	6/2/2014
126	University Avenue, Morgantown	F-0119(019)	U331-119-12.91-(00)	14	6/2/2014
127	Route 19 Reloc. Bridge Over Meadow River	APD-482(28)C-2		31	6/2/2014
128	Molded Acoustical Products Facility Access Roads	APL-1019(513)S	X325-73/24-0.00	14	6/2/2014
129	Left Hand Run Bridge	NFA-TIM3)003)	S344-58/2-1.70	21	6/4/2014
130	Booths Creek and Owl Creek		S331-77-1.17	23	6/4/2014
131	Enterprise Road		S317-19/2-0.00 02	29	6/4/2014
132	Fairmont Ave +1(I/s)	STP-0019(069)S	U331-19-9.16	15	6/4/2014

#	Project Title	Federal Project Number	State Project Number	Total Sheets	Date Scanned
133	King Lear Road	NFA-TIM5(003)	S319-25/5-1.74	15	6/5/2014
134	Epps Bridge	Br-2204(001)E	S312-220/4-0.99	26	6/5/2014
135	Ellenboro Bridge - Pedestrian Trail and Bridge	STP-0016(84)EQ	U343-16-22.49 00	20	6/5/2014
136	US Route 50 E.B. 8 W.B. Over Goose Creek	F-0050(058)	S309-50-5.61,00	37	6/5/2014
137	Oakvale Twin Bridges No. 2814	F 0460 (011)	S328-460-21.71	26	6/5/2014
138	Lavalette I/S Improve	CM-0152(023)E	U350-152-41.65	62	6/5/2014
139	Upper Cove Road		U316-SCS/27-1.00	71	6/6/2014
140	Fbi Access Road NO. 1		X317-13/5-1.99(01)	56	6/6/2014
141	US 52 Butler & Ceredo Districts	DPS-0011	U350-52-10.85 00	507	6/13/2014
142	Z Tower Road	STP-0046(015)S	U329-46-18.01	123	6/10/2014
143	Midway Plaza to South of Madison Branch	STP-0010(210)	S323-10-13.56 02	182	6/16/2014
…					
184	Ashford Truss Bridge	BR-0001(112)E	S303-1-8.28 00	155	9/2/2014
			average	**70**	

Estimated Total Number of Sheets per Plan

Based on the 184 project plan books sent to us WVU for scanning, it is estimated that:

- **a typical plan has 70 sheets per plan book**
- only the index map sheet will be geo-referenced; however, some project books may have more than one index map sheet
- based on Project Database status as of 12/30/2014

Original Right-of-Ways Tracking Database

The original Right-of-Way Projects Database provided by WV DOT will be utilized as a reference to track the project books. Currently the database has 9,163 records and 17 fields. Unnecessary fields may need to be deleted while additional fields to track which projects have been scanned should include:

- Project Book Scanned
- Number of Maps Scanned
- Number of Maps Georeferenced
- Date of Scan
- Initials of person who performed scan

Some records have both state and federal project numbers while certain text fields like Project Title are quite long and will result in a long file name. Not every field in the Project Database has information recorded such as the Project Title, Project Number, or Project Date. Consequently, missing information like Project Title will be added to the Project Database if it is present when the sheets are being scanned. More consultations with WV DOT are needed on this subject. No database for construction plans was provided.

New DOT Project Database

A new Project Database was created which incorporates fields (field names uppercase) from the original DOT database. The new Project Database has 40 fields and auto generates the *Project Key* from select data fields. The database is shared as Google Document to allow multiple user access. Some of the data fields are auto-generated from other fields. Select fields are used by the Web map index.

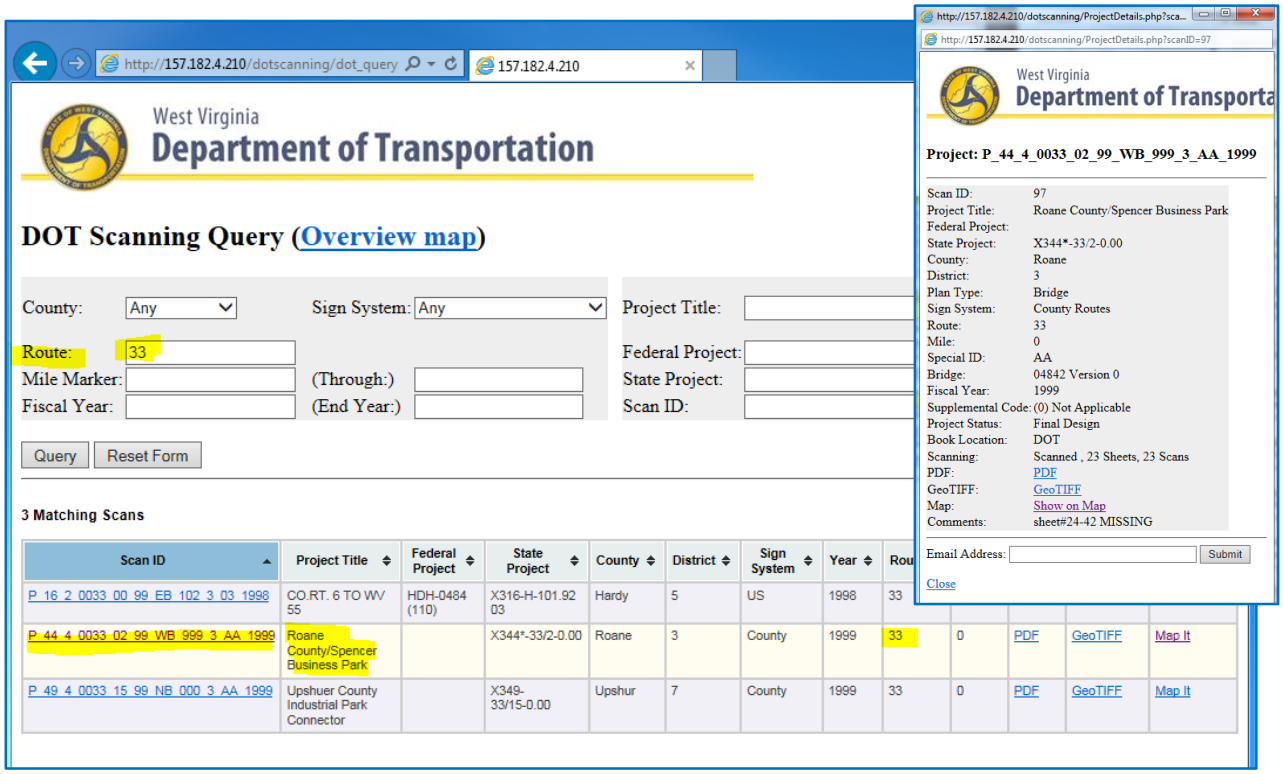
Short Name	Long Name	Auto-Generated	Web Map Index	Description
scan_order	WVGISTC scan order of books			Corresponds to the order in which the project book was scanned.
OLD_PROJKEY	Old Project Key			Corresponding key of old database
PROJTITLE	Project Title		Yes	Project title as it appears on the cover sheet.
FEDPROJ	Federal Project Number		Yes	Federal Project number as it appears on the cover sheet.
STPROJ	State Project Number		Yes	State Project number as it appears on the cover sheet
county1	County 1		Yes	County location of the project
county2	County 2			Additional county location of the project
DISTRICT	District			State district location of the project
sign_system	Sign System			The sign system of the route.
ROUTENO	Route Number			Project route number
SUBROUTE	Sub-route Number			Secondary project route number
MICROROLL	Microfilm Roll ID			ID number of the corresponding microfilm
ORIGFILE	?			Old database field, exact definition unknown
TURNPIKE	?			Old database field, exact definition unknown
FILENO	?			Old database field, exact definition unknown
MISCINFO	Miscellaneous Information			Old database field, exact definition unknown
LOCATION				Old database field, exact definition unknown

Short Name	Long Name	Auto-Generated	Web Map Index	Description
PROJLENT	Project Length			Old database field, exact definition unknown
PRINT	?			Old database field, exact definition unknown
PROJDATE	Project Date			Old database field, exact definition unknown
fiscyear	Fiscal Year		Yes	Project fiscal year as it appears on the cover sheet
sheet_total	Sheet Total		Yes	Total number of sheets/pages
scan_total	Scan Total			Total number of scans generated
type	Project Type		Yes	Indicates if the project is a Right of Way (R) or a Construction Plan (P).
scandate	Scan Date			Date the project book was scanned
book_location	Project Book Phycial Location			Current physical location of the project book (DOT or TC)
technician	Technician			Technician(s) who performed the scanning
comments	Comments			Additional comments/issues regarding the scanning process.
projectkey	Project Key	Yes		The unique ID number generated for each project book. The following 11 fields are concatenated to create this number.
type	Project Type	Yes	Yes	Indicates if the project is a Right of Way (R) or a Construction Plan (P).
countyno	County Number			Corresponding number for the county in the 'county1' field above.
sign_system	Sign System			The sign system of the route. 1 = Interstate, 2 = US Route, 3 = State Route, 4 = County Route
routeno	Route Number	Yes		Project route number
subroute	Sub-route Number	Yes		Secondary project route number
suppcode	Supplemental Code			Supplemental code provided by WV DOT
direction	Project Direction			Code representing the azimuthal orientation of the project route, provided by WV DOT
begin_mile	Beginning Milepost			Starting milepost of the project route
statusID	Status ID			Project Status ID provided by WV DOT
special_ID	Special ID			Project Special ID provided by WVDOT
fiscyear	Fiscal Year	Yes		Project fiscal year as it appears on the cover sheet

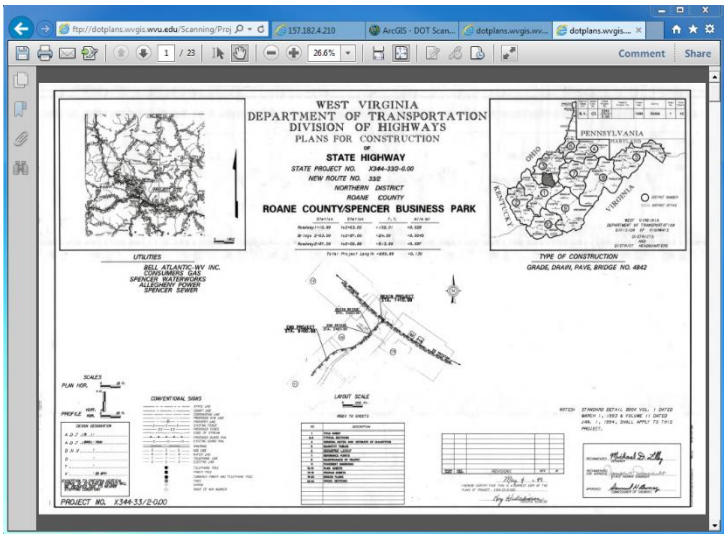
APPENDIX L: Highway Plan Locator Tool Prototype

(http://157.182.4.210/dotscanning/dot_query.php)

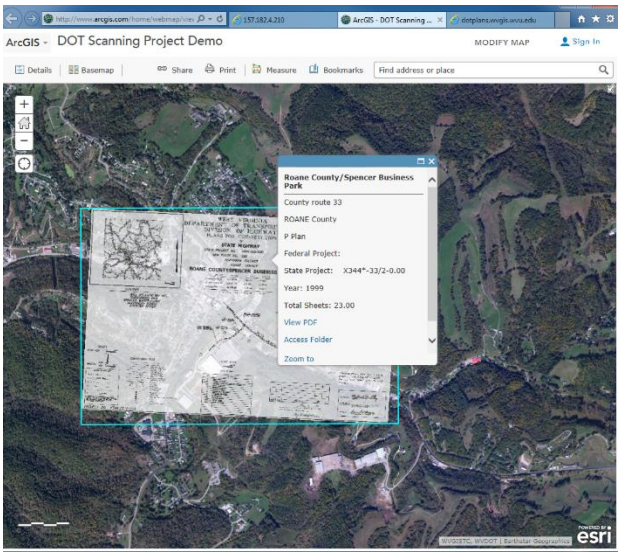
1. Locate Scanned Highway Plans



2. View Highway Plans via PDF Reader



3. View or Locate Plans via Web Map



Scan Project Database Fields

#	DATA FIELDS		PROJECT KEY #	LOCATE RECORD	BROWSE RECORD	DETAILED RECORD
	*** Highway Plan Fields *****					
1	Project Title			1	1	1
2	Federal Project #			1	1	1
3	State Project #			1	1	1
4	County Name 1			1	1	1
5	County Name 2					
6	County Code		1			
7	District #					1
8	Plan Type (Construction, Right-of-Way, Bridge)		1			1
9	Sign System Name			1	1	1
10	Sign System Code		1			1
11	Route #		1	1		1
12	SubRoute #		1			1
13	Begin Mile Marker		1	1	1	1
14	Direction					1
15	Supplemental Code					1
16	Status ID					1
17	Special ID					1
18	Bridge # (multiple numbers)			1	1	1
19	Fiscal Year		1	1	1	1
	*** Scan Info Fields *****					
20	Scan Order # (unique ID)		1	1		1
21	Sheet Total					1
22	Scan Total (# PDF Book Pages)					1
23	Scan Date					1
24	Scan Technician					
25	Scan Notes					1
26	Plan Location					1
27	Old WV DOT Database Key					
	*** Link Fields *****					
28	Scan ID # (unique ID)			1	1	1
29	FTP Folder Link					1
30	PDF Book Link				1	1
31	Map Link				1	1
32	GeoTIFF Download Link					1
33	ProjectWise Link					1
			8	11	11	29