

# Digital Master Images - Sample Technical Specifications for Photograph Collections

Compiled by Kit A. Peterson, Digital Conversion Specialist, June 2004

---

Prints & Photographs Division, Library of Congress, Washington, D.C. 20540-4730

## Introduction

Ideally, digital master images of photographs should be made at the highest specifications possible. Creating a rich digital master<sup>1</sup> will provide the greatest flexibility for the use and preservation of the digital image. What is acceptable and achievable quality varies depending on project needs and resources, although standardization is recommended within each institution. The table below summarizes representative choices made for digitizing photograph collections. In the absence of a widely accepted single standard, the data can provide planners with a starting point when developing their own specifications.

Many institutions use one specification for all sizes of photographs. This table shows how the resulting resolution differs according to the size of the photograph. Portions of the data in the table were derived using the mathematical formulas noted below. These resolution numbers are not necessarily obtainable from scanning equipment in the exact numbers noted. For example, you may not be able to set a scanner at 430 dpi to scan a 5x7 negative, but you may be able to specify approximately 3000 pixels on the long side of the image, which will provide the same resolution.

The table is arranged by type of photograph: 35mm, 4x5, 5x7, and 8x10. Within each type, the specifications for spatial resolution, tonal resolution (bit depth), and file format are listed from the highest to the lowest level of quality. The specifications come from nine institutions: Arkansas History Commission, Columbia University Digital Library, Cornell University Library, Lafayette Historical Society, Library of Congress, U.S. National Archives and Records Administration, Northeast Document Conservation Center, University Library University of Illinois at Urbana-Champaign, and Western States Digital Standards Group.

## Technical Specification Formulas

<p><b>1) dpi and pixel dimensions</b> a) <math>\text{dpi} = \text{pixel (Height or Width)} \div \text{original object (Height or Width)}</math> b) <math>\text{pixel (Height or Width)} = \text{original object (Height or Width)} \times \text{dpi}</math></p> <p><b>2) File size for 8-bit grayscale, 24-bit RGB, and all others:</b> a) <b>8-bit grayscale:</b> <math>(\text{pixel Height} \times \text{Pixel Width}) \div 1,000,000 = \text{approx. MB file size}</math> b) <b>24-bit RGB:</b> <math>([\text{pixel Height} \times \text{Pixel Width}] \times 3) \div 1,000,000 = \text{approx. MB file size}</math> (Reminder: RGB is 8-bits for each of three channels – Red, Green &amp; Blue) c) <b>Any digital file (height &amp; width of original object):</b> <math>(\text{height} \times \text{width} \times \text{bit depth} \times \text{dpi}^2) / 8 = \text{bytes file size}</math></p>	<p>1 Kilobyte (Kb) = approximately 1,000 bytes 1 Megabyte (MB) = approximately 1,000,000 bytes <i>Example:</i> 20,000,000 bytes = approximately 20 MB</p> <p>For tools to calculate file size estimates, see the TASI (Technical Advisory Service for Images, UK ) toolbox for a “File Size Calculator” (Excel spreadsheet), or its JavaScript counterpart “Storage Requirements Estimator”: <a href="http://www.tasi.ac.uk/resources/toolbox.html">http://www.tasi.ac.uk/resources/toolbox.html</a>.</p> <p>For more information on calculating the file size of digital images see <i>Moving Theory into Practice Digital Imaging Tutorial</i>: <a href="http://www.library.cornell.edu/preservation/tutorial/intro/intro-06.html">http://www.library.cornell.edu/preservation/tutorial/intro/intro-06.html</a></p>
--	---

<b>Type of original</b> rec = recommended min = minimum	<b>Spatial Resolution:</b>  <b>Dpi</b>	<b>Spatial Resolution:</b>  <b>Pixel h x w</b>	<b>Tonal Resolution / color &amp; bit depth</b>	<b>File Size (&amp; color)</b>	<b>File Format</b>	<b>Source</b>	<b>Date</b>  (of last revision to document consulted)
<b>35mm</b>							
<b>Negative or transparency</b>							
a) transparencies (rec)	a) 3300 dpi	a) 5000x3300	8-bit Gray 24-bit RGB	a) 16.5 MB Gray 49.5 MB RGB	Uncompressed a) TIFF 5 & 6	Cornell University Library <sup>2</sup>	March 2001
b) transparencies (min)	b) 2000 dpi	b) 3000x2000		b) 6 MB Gray 18 MB RGB	b) TIFF 4,5 & 6		
a) as appropriate	a) 3300 dpi	a) 5000x3300	8-bit Gray 24-bit RGB	a) 16.5 MB Gray 49.5 MB RGB	TIFF Uncompressed	Western States Digital Standards Group <sup>3</sup>	January 2003
b) min.	b) 2000 dpi	b) 3000x2000		b) 6 MB Gray 18 MB RGB			
a) rec.	a) 2800 dpi	a) 4000x2800	8-bit Gray 24-bit RGB	a) 11 MB Gray 34 MB RGB	TIFF 6.0 - Uncompressed - Intel (IBM)	U.S. National Archives and Records Administration <sup>4</sup>	June 2004
b) min.	b) 2100 dpi	b) 3000 x 2100		b) 6.3 MB Gray 19 MB RGB			
	2800 dpi	4000x2800	8-bit Gray	11 MB Gray	TIFF 6.0 Uncompressed	Arkansas History Commission <sup>5</sup>	February 2000
	2800 dpi	4000x2800	8-bit Grayscale 24-bit RGB	11 MB Gray 34 MB RGB	TIFF 6.0 Intel Uncompressed	Library of Congress <sup>6</sup>	2000
	2048 dpi	2048x3072	8-bit Gray 24-bit RGB	6 MB Gray 19 MB RGB	TIFF ---- or PHOTO CD	Columbia University Digital Library <sup>7</sup>	1997
a) Grayscale b) -- c) --  d) RGB e) -- f) --	a) 2000 dpi b) 2000 dpi c) 2000 dpi  d) 2000 dpi e) 2000 dpi f) 2000 dpi	a) 3000x2000 b) 3000x2000 c) 3000x2000  d) 3000x2000 e) 3000x2000 f) 3000x2000	a) 8-bit Gray b) 12 bit Gray c) 16 bit Gray  d) 24-bit RGB e) 36-bit RGB f) 48-bit RGB	a) 6 MB Gray b) 9 MB Gray c) 12 MB Gray  d) 18 MB RGB e) 27 MB RGB f) 36 MB RGB	----	NEDCC Handbook for Digital Projects <sup>8</sup>	2000
	600 dpi	900x600	8-bit Gray 24-bit RGB	540 KB Gray 1.6 MB RGB	Uncompressed TIFF	University Library University of Illinois at Urbana-Champaign <sup>9</sup>	December 2001

<b>Type of original</b> rec = recommended min = minimum	<b>Spatial Resolution:</b>  <b>Dpi</b>	<b>Spatial Resolution:</b>  <b>Pixel h x w</b>	<b>Tonal Resolution / color &amp; bit depth</b>	<b>File Size (&amp; color)</b>	<b>File Format</b>	<b>Source</b>	<b>Date</b>  (of last revision to document consulted)
<b>4x5 Print, Negative or Transparency</b>							
a) Grayscale b) -- c) --  d) RGB e) -- f) --	a) 2000 dpi b) 2000 dpi c) 2000 dpi  d) 2000 dpi e) 2000 dpi f) 2000 dpi	a) 8000x10000 b) 8000x10000 c) 8000x10000  d) 8000x10000 e) 8000x10000 f) 8000x10000	a) 16 bit Gray b) 12 bit Gray c) 8-bit Gray  d) 48-bit RGB e) 36-bit RGB f) 24-bit RGB	a) 160 MB Gray b) 120 MB Gray c) 80 MB Gray  d) 480 MB RGB e) 360 MB RGB f) 240 MB RGB	N/A	NEDCC Handbook for Digital Projects	2000
a) As of 2004: used for only three collections. <sup>10</sup>  b) Normal scanning specification.	a) 2000 dpi  b) 1000 dpi	a) 8000x10000  b) 4000x5000	a) 16 bit Gray  b) 8-bit Gray 24-bit RGB	a) 60 MB Gray 240 MB RGB  b) 20 MB Gray 60 MB RGB	TIFF 6.0 Intel Uncompressed	Library of Congress	a) 1997 (See RFP)  b) 2000
	1228 dpi	6144x4900	8-bit Gray 24-bit RGB	30 MB Gray 90 MB RGB	TIFF ---- or PHOTO CD	Columbia University Digital Library	1997
a) negatives & transparencies (rec) b) negatives & transparencies (min)  c) prints (rec) d) prints (min)	a) 1200 dpi b) 600 dpi  c) 800 dpi d) 600 dpi	a) 4800x6000 b) 2400x3000  c) 3200x4000 d) 2400x3000	8-bit Gray 24-bit RGB	a) 29 MB Gray 86 MB RGB b) 7 MB Gray 22 MB RGB  c) 13 MB Gray 38 MB RGB d) 7 MB Gray 22 MB RGB	TIFF 6.0 - Uncompressed - Intel (IBM)	U.S. National Archives and Records Administration	June 2004
a) transparencies (rec) b) transparencies (min)  c) prints (rec) d) prints (min)	a) 1000 dpi b) 600 dpi  c) 400 dpi d) 300 dpi	a) 5000x4000 b) 3000x2400  c) 1600x2000 d) 1200x1500	8-bit Gray 24-bit RGB	a) 20 MB Gray 60 MB RGB b) 6 MB Gray 18 MB RGB  c) 3.2 MB Gray 9.6 MB RGB d) 1.8 MB Gray 5.4 MB RGB	a) TIFF 5 & 6 b) TIFF 4,5 & 6  c) TIFF 5 or 6 Uncompressed d) TIFF 4,5 & 6	Cornell University Library	March 2001

<b>Type of original</b> rec = recommended min = minimum	<b>Spatial Resolution: Dpi</b>	<b>Spatial Resolution: Pixel h x w</b>	<b>Tonal Resolution / color &amp; bit depth</b>	<b>File Size (&amp; color)</b>	<b>File Format</b>	<b>Source</b>	<b>Date</b>  (of last revision to document consulted)
<b>4x5 Print, Negative or Transparency (cont'd)</b>							
a) as appropriate  b) min.	a) 1000 dpi  b) 600 dpi	a) 4000x5000  b) 2400x3000	8-bit Gray 24-bit RGB	a) 20 MB Gray 60 MB RGB  b) 7 MB Gray 21 MB RGB	TIFF Uncompressed	Western States Digital Standards Group	January 2003
	800 dpi	4000x3200	8-bit Gray	12.8 MB Gray	TIFF 6. Uncompressed	Arkansas History Commission	February 2000
	600 dpi	2400x3000	8-bit Gray 24-bit RGB	6 MB Gray 18 MB RGB	Uncompressed TIFF	University Library University of Illinois at Urbana-Champaign	December 2001
	200 dpi	1000x800	8-bit Gray	800 KB	TIFF ----	Lafayette, CO Historical Photo Project Handbook <sup>11</sup>	November 2000
<b>5x7 Print, negative or transparency</b>							
a) As of 2004: used for only three collections. <sup>12</sup> b) Normal scanning specification.	a) 1400 dpi  b) 800 dpi	a) 7100x10000  b) 4000x5600	a) 16 bit Gray  b) 8-bit Gray 24-bit RGB	a) 54 MB Gray  b) 18 MB Gray 71 MB RGB	TIFF 6.0 Intel Uncompressed	Library of Congress	a) 2000  b) 2003
	877 dpi	6144x4388	8-bit Gray 24-bit RGB	27 MB Gray 81 MB RGB	TIFF ---- or PHOTO CD	Columbia University Digital Library	1997
a) negatives & transparencies (rec) b) negatives & transparencies (min)  c) prints (rec) d) prints (min)	a) 860 dpi  b) 430 dpi  c) 570 dpi  d) 430 dpi	a) 4300x6000  b) 2150x3000  c) 2850x4000  d) 2150x3000	8-bit Gray 24-bit RGB	a) 26 MB Gray 78 MB RGB b) 7 MB Gray 21 MB RGB  c) 12 MB Gray 36 MB RGB d) 7 MB Gray 21 MB RGB	TIFF 6.0 - Uncompressed - Intel (IBM)	U.S. National Archives and Records Administration	June 2004

<b>Type of original</b> rec = recommended min = minimum	<b>Spatial Resolution: Dpi</b>	<b>Spatial Resolution: Pixel h x w</b>	<b>Tonal Resolution / color &amp; bit depth</b>	<b>File Size (&amp; color)</b>	<b>File Format</b>	<b>Source</b>	<b>Date</b>  (of last revision to document consulted)
<b>5x7 Print, Negative or Transparency (cont'd)</b>							
a) transparencies (rec)	a) 715 dpi	a) 5000x3575	8-bit Gray 24-bit RGB	a) 18 MB Gray 71 MB RGB	a) TIFF 5 & 6	Cornell University Library	March 2001
b) transparencies (min)	b) 430 dpi	b) 3000x2150		b) 6.5 MB Gray 19.5 MB RGB	b) TIFF 4,5 & 6		
c) prints (rec)	c) 400 dpi	c) 2000x2800		c) 5.6 MB Gray 16.8 MB RGB	c) TIFF 5 or 6		
d) prints (min)	d) 300 dpi	d) 1500x2100		d) 3 MB Gray 9 MB RGB	d) TIFF 4,5 & 6		
a) as appropriate	a) 715 dpi	a) 3575x5000	8-bit Gray 24-bit RGB	a) 18 MB Gray 71 MB RGB	TIFF Uncompressed	Western States Digital Standards Group	January 2003
b) min.	b) 430 dpi	b) 2150x3000		b) 6.5 MB Gray 19.5 MB RGB			
	600 dpi	3000x4200	8-bit Gray 24-bit RGB	13 MB Gray or 39 MB RGB	Uncompressed TIFF	University Library University of Illinois at Urbana-Champaign	December 2001
	570 dpi	4000x2850	8-bit Gray	11.4 MB Gray	TIFF 6. Uncompressed	Arkansas History Commission	February 2000
	150 dpi	1000x700	8-bit Gray	700 KB	TIFF ----	Lafayette, CO Historical Photo Project Handbook	November 2000

<b>Type of original</b> rec = recommended min = minimum	<b>Spatial Resolution:  Dpi</b>	<b>Spatial Resolution:  Pixel h x w</b>	<b>Tonal Resolution / color &amp; bit depth</b>	<b>File Size  (&amp; color)</b>	<b>File Format</b>	<b>Source</b>	<b>Date</b>  (of last revision to document consulted)
<b>8x10 Print, negative or transparency</b>							
a) Grayscale b) -- c) --  d) RGB e) -- f) --	a) 2000 dpi b) 2000 dpi c) 2000 dpi  d) 2000 dpi e) 2000 dpi f) 2000 dpi	a) 16000x20000 b) 16000x20000 c) 16000x20000  d) 16000x20000 e) 16000x20000 f) 16000x20000	a) 8-bit Gray b) 12 bit Gray c) 16 bit Gray  d) 24-bit RGB e) 36-bit RGB f) 48-bit RGB	a) 320 MB Gray b) 480 MB Gray c) 640 MB Gray  d) 960 MB RGB e) 1.44 GB RGB f) 1.92 GB RGB	N/A	NEDCC Handbook for Digital Projects	2000
a) transparencies (rec) b) transparencies (min) c) prints (rec) d) prints (min)	a) 1000 dpi b) 600 dpi c) 400 dpi d) 300 dpi	a) 5000x4000 b) 3000x2400 c) 1600x2000 d) 1200x1500	8-bit Gray 24-bit RGB	a) 20 MB Gray 60 MB RGB b) 6 MB Gray 18 MB RGB c) 3.2 MB Gray 9.6 MB RGB d) 1.8 MB Gray 5.4 MB RGB	a) TIFF 5 & 6 b)TIFF 4,5 & 6 c) TIFF 5 or 6 d) TIFF 4,5 &6	Cornell University Library	March 2001
a) As of 2004: used for only three collections. <sup>13</sup> b) Normal scanning specification.	a) 1000 dpi b) 500 dpi	a) 8000x10000 b) 4000x5000	a) 16 bit Gray b) 8-bit Gray 24-bit RGB	a) 80 MB Gray b) 20 MB Gray 60 MB RGB	TIFF 6.0 Intel Uncompressed	Library of Congress	a) 1997 b) 2000
a) negatives & transparencies (rec) b) negatives & transparencies (min)  c) prints (rec) d) prints (min)	a) 800 dpi b) 300 dpi  c) 400 dpi d) 300 dpi	a) 6400x8000 b) 2400x3000  c) 3200x4000 d) 2400x3000	8-bit Gray 24-bit RGB	a) 51MB Gray 153 MB RGB b) 7 MB Gray 21 MB RGB  c) 13 MB Gray 36 MB RGB d) 7 MB Gray 21 MB RGB	TIFF 6.0 - Uncompressed - Intel (IBM)	U.S. National Archives and Records Administration	June 2004
	614 dpi	6144x4900	8-bit Gray 24-bit RGB	30 MB Gray 90 MB RGB	TIFF ---- or PHOTO CD	Columbia University Digital Library	1997

<b>Type of original</b> rec = recommended min = minimum	<b>Spatial Resolution:</b>  <b>Dpi</b>	<b>Spatial Resolution:</b>  <b>Pixel h x w</b>	<b>Tonal Resolution / color &amp; bit depth</b>	<b>File Size (&amp; color)</b>	<b>File Format</b>	<b>Source</b>	<b>Date</b>  (of last revision to document consulted)
<b>8x10 Print, negative or transparency (cont'd)</b>							
	600 dpi	2400x3000	8-bit Gray 24-bit RGB	6 MB Gray 18 MB RGB	Uncompressed 54 TIFF	University Library University of Illinois at Urbana-Champaign	December 2001
a) as appropriate  b) min.	a) 500 dpi  b) 300 dpi	a) 4000x5000  b) 2400x3000	8-bit Gray 24-bit RGB	a) 20 MB Gray 60 MB RGB  b) 7 MB Gray 19.5 MB RGB	TIFF Uncompressed	Western States Digital Standards Group	January 2003
	200 dpi	1000x800	8-bit Gray	800 KB	TIFF ----	Lafayette, CO Historical Photo Project Handbook	November 2000

<sup>1</sup> The phrase “rich digital master” refers to a digital image of sufficiently high quality to capture the essential physical and subjective visual elements of an original photograph. Such digital masters may be used for high resolution electronic or print reproduction and for creation of derivative files that aid reference and access. Rich digital masters also facilitate preservation of the digital images as electronic surrogates of the original photographs.

<sup>2</sup> 1) prints: pixel dimensions and file size derived from data provided in the document; 2) transparencies: dpi, portions of the pixel dimensions and file size derived from data provided in the document. Cornell University Library, “Report of the Digital Preservation Policy Working Group on Establishing a Central Depository for Preserving Digital Image Collections – Part 1: Responsibilities of Transferee”, Version 1.0, March 2001, <http://www.library.cornell.edu/imls/image%20deposit%20guidelines.pdf>.

<sup>3</sup> Dpi, portions of the pixel dimensions and file size derived from data provided in the document. Western States Digital Standards Group, “Digital Imaging Best Practices Version 1.0”, Western States Digital Standards Group - Digital Imaging Working Group, January 2003 (Last modified 2003-03-05), [http://www.cdpheritage.org/resource/scanning/documents/WSDIBP\\_v1\\_2003-01-13.pdf](http://www.cdpheritage.org/resource/scanning/documents/WSDIBP_v1_2003-01-13.pdf).

<sup>4</sup> Portions of the pixel dimensions and file size derived from data provided in the document. Steven Puglia, Jeffrey Reed, and Erin Rhodes, “Technical Guidelines for Digitizing Archival Materials for Electronic Access: Creation of Production Master Files – Raster Images”, U.S. National Archives and Records Administration, June 2004, available soon at [http://www.archives.gov/research\\_room/arc/arc\\_info/guidelines\\_for\\_digitizing\\_archival\\_materials.html](http://www.archives.gov/research_room/arc/arc_info/guidelines_for_digitizing_archival_materials.html).

<sup>5</sup> Dpi, portions of the pixel dimension and file size derived from data provided in the document. Arkansas History Commission, Stage One Digitization Project, “State of Arkansas Department of Finance and Administration Request for Proposals RFP-00-0796 ‘Scanning of Photographic Materials’”, February 2000, <http://www.arkives.com/photo/images/pdf/P000796.PDF>; and “Answers to Questions Submitted on RFP-00-0796 by Scanning Vendors February 23, 2000”, <http://www.arkives.com/photo/images/pdf/ScanQA2.pdf>.

---

<sup>6</sup> Dpi, portions of the pixel dimension and file size derived from data provided in the document. Library of Congress, “Library of Congress RFP97-9: ‘Conversion of Pictorial Materials to Digital Images’”, <http://memory.loc.gov/ammem/prpsal9/rfp9.pdf>.

<sup>7</sup> Dpi, portions of pixel dimension, and file size derived from data provided in the document. Columbia University Digital Library: “Technical Recommendations for Digital Imaging Projects”, Image Quality Working Group of ArchivesCom, a joint Libraries/AcIS committee, April 1997, <http://www.columbia.edu/acis/dl/imagespec.html>.

<sup>8</sup> Dpi, portions of the pixel dimension derived from data provided in table: “Est. File Sizes for Preservation Quality Scans of Photographs – Negatives or Transparencies”. Steven Puglia, “Technical Primer”, *Handbook for Digital Projects: A Management Tool for Preservation and Access*, ed. Maxine K. Sitts, 83-102 (Andover, MA: Northeast Document Conservation Center, 2000), 88. Also available online at <http://www.nedcc.org/digital/dman.pdf>.

<sup>9</sup> Pixel dimensions and file size derived from data provided in the document. University Library University of Illinois at Urbana-Champaign, Digital Imaging and Media Technology Initiative, “Draft Version #3: Guidelines for Digital Imaging Projects”, December 2001, <http://images.library.uiuc.edu/resources/digitalguidev3.pdf>.

<sup>10</sup> The three collections scanned at this resolution are: *Ansel Adams's Photographs Of Japanese-American Internment At Manzanar* (negatives and original prints), *Prokudin-Gorskii Collection* (glass plate negatives), and the original negatives from the *Wright Brothers Negatives* collection (glass plate negatives, including “First Flight”). All three collections are available in the Prints & Photographs online catalog (<http://www.loc.gov/rr/print/catalog.html>).

<sup>11</sup> Dpi, portion of pixel dimensions and file size derived from data provided in document. Kathy Mitchell, “Lafayette Historical Photo Project Handbook”, Lafayette, CO, November 2000, p. 22, <http://www.cdpheritage.org/heritage/documents/lafayette.pdf>.

<sup>12</sup> See note 10.

<sup>13</sup> See note 10.