

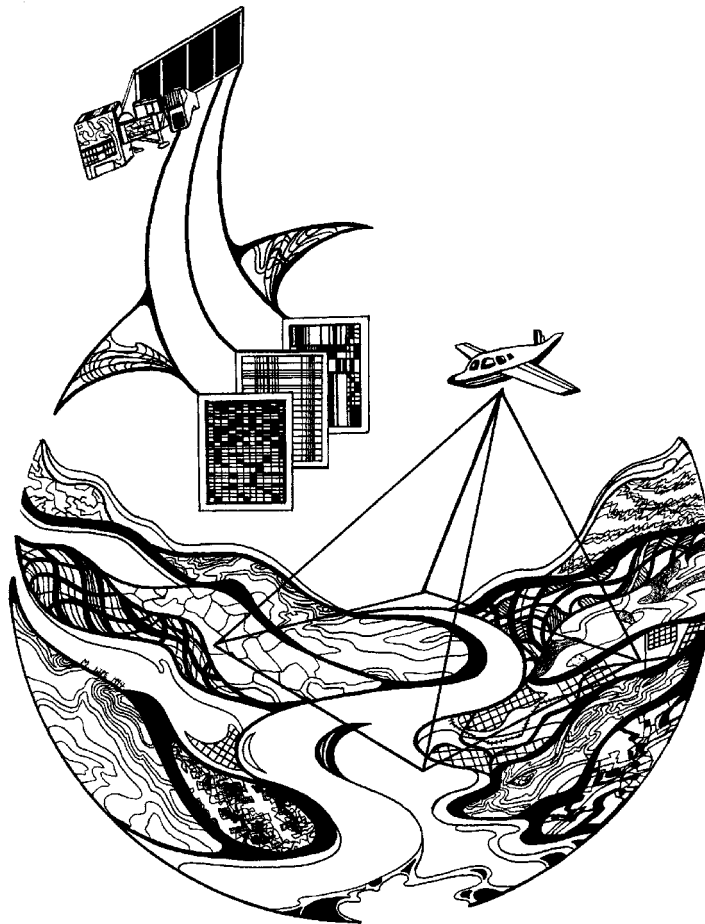


Long Term Resource Monitoring Program

Program Report

95-P008-7

Long Term Resource Monitoring Program Standard Operating Procedures: Quality Control for Cartographic Activities



May 1997

The Environmental Management Technical Center issues LTRMP Program Reports to provide Long Term Resource Monitoring Program partners with programmatic documentation, procedures manuals, and annual status reports.

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Long Term Resource Monitoring Program Standard Operating Procedures: Quality Control for Cartographic Activities

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Suggested citation:

Owens, T. W., K. Hop, L. Robinson, L. DeHaan, and T. Fancher. 1997. Long Term Resource Monitoring Program standard operating procedures: Quality control for cartographic activities. U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, May 1997. LTRMP 95-P008-7. 10 pp. + Appendixes A–F

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Figure. Example of minimum mapping unit guide 2

Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

The strategy to develop and adopt standard operating procedures is included in the LTRMP Operating Plan (USFWS 1993) as strategy 4.1.1, *Develop and Update Information Management Guidance Documents* under Objective 4.1, *Provide Direction for Automation Activities*. This report was developed with funding provided by the Long Term Resource Monitoring Program.

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Abstract

The Environmental Management Technical Center has produced a series of standard operating procedure (SOP) manuals detailing the steps in producing spatial data sets to meet quality standards. The present SOP manual is a continuation of that series detailing the quality control (QC) standards and procedures taken at each production step to ensure that the data are correct and can be passed to the next stage in the production process. Adherence to the SOPs detailed in the other manuals and to the QC procedures discussed here ensure that errors are kept to a minimum and that the data are reliable for monitoring and research.

Introduction

Quality is a "measure of how closely a good or service conforms to specified standards" (Monks 1982) and quality control efforts ensure that the standards are adhered to. In spatial data, quantifiable and nonquantifiable standards must be met. Examples of quantifiable standards include zero errors (e.g., every polygon must have a label), or an error rate less than a certain amount (e.g., a Root Mean Square error [RMSE] of less than 0.005 inches when registering quadrangles on a digitizing tablet). At this time in the technology, nonquantifiable errors include that the polygons represent their position and shape on the ground and the delineation is not overly complex. In addition, the data must be useful for scientific monitoring and research.

The Environmental Management Technical Center (EMTC) has produced a series of standard operating procedure (SOP) manuals detailing the steps in producing spatial data sets to meet these standards (Arndt and Olsen 1995; Owens and Hop 1995a, 1995b; Robinson 1995; Owens and Robinson 1997). The present SOP manual is a continuation of that series, detailing the quality control (QC) procedures taken at each production step to ensure that the data are correct and can be passed to the next stage in the production process. Adherence to the SOPs detailed in the other manuals and to the QC procedures discussed here ensures that errors are kept to a minimum and that the data are reliable for monitoring and research.

Photointerpretation

Quality Standards

- Photo date, flight line number, and pool number should be written on the overlay and the fiducials must be carefully marked.
- All delineations and labels must be neat and legible, clear and concise.
- All delineations must follow ground features based on photographic signatures, but delineations must be drawn simply and not appear overly complex.
- All polygons and linears must be labeled.
- Each polygon must be closed, avoiding dangling segments.
- Each polygon may not have more than one attribute (although there may be multiple labels of the same attribute in large polygons).

- Adjacent polygons must have a different attribute.
- Edge ties must match in all delineations and labels to adjacent interpreted photos.
- Interpretive decisions should be consistent throughout the work and based on visual clues of similar photographic signatures and field notes.

Work on Long Term Resource Monitoring Program (LTRMP) projects is done by different photointerpreters. No two persons will interpret aerial photographs exactly the same way and an individual interpreter will not interpret aerial photographs exactly the same way over time. This creates the need for QC.

The following materials are needed for photointerpretation:

- Aerial photographs with interpreted overlays
- Photointerpretation Production Log (Appendix A)
- Field notes from photo verification (Appendix B)
- Mirror stereoscope with light table
- Loupe (magnify $\times 8$)
- Rapidograph drafting pen (4×0)
- Minimum mapping unit guide (Figure)
- Classification list (Appendix C)
- Wooden skewers (for erasing ink)
- Paper (clean white sheet, no lines)

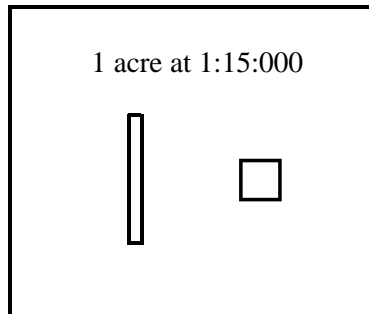


Figure. Example of a minimum mapping unit guide.

The QC reviewer shall be an experienced photointerpreter familiar with the project. Check interpreted work against photointerpretation standards as specified in the Standard Operating Procedures for Field Station Photointerpretation (Owens and Hop 1995a). Make sure that the version of classification used during the review process is the same as that used for the initial interpretation. Review groundtruth notes to become familiar with the vegetation photo signatures (Appendix B). Follow the photointerpreter's comments on the Photointerpretation Production Logs; this will assist with any special problems that the interpreter may have encountered. Make any necessary changes in delineations or labeling by erasing the ink with a wooden skewer and redrawing or labeling with a 4×0 Rapidograph pen using black india ink. Take notes of any consistent errors found during these QC procedures and pass them on to the photointerpreter. This will eliminate future errors of the same nature.

Correctness of Interpretation

Use a mirror stereoscope to review the interpretation of the aerial photograph. Review two components at this stage: (1) correctness in delineations and attributes and (2) consistency in identifying class types, both by delineation and by attributes.

The first component pertains to the correctness of the individual delineation or group of delineations, apart from other delineations. Consider, for example, an island within open water, represented by either one polygon or several integrated polygons: Do the lines follow ground features based on photographic signatures? Should the lines be drawn differently to better represent the area? Is the island labeled correctly according to the photo signature or a specific field note?

The second component compares delineations, attributes, and photo signatures to other interpreted areas, particularly areas that have been groundtruthed. For example, when comparing the interpretation of an island to other interpreted islands in similar situations with similar photographic signatures, are the delineation practices consistent with other areas? Are attributes labeled consistently compared with other areas that have similar photographic signatures and are in a similar situation?

Use a magnifying loupe to identify submergent areas not apparent on the photograph under conventional stereoscopic viewing. Review aquatic areas using the loupe to verify these delineations.

Technical Review

Use a blank piece of white paper to clearly review an interpreted overlay for correctness in delineation and attributing. Place the sheet of paper between the interpreted overlay and the photograph. The line work and labels will show up on the white background of the paper. The following is a brief overview of what to review and correct if needed:

Delineations and labels must be neatly written, legible, clear, and concise. Line work should be of uniform width, as well as consistent (no breaks within the lines). Linears should be represented with an evenly spaced dashed line.

Delineations must be simply drawn, but with enough detail to accurately reflect the ground features. Overly complex detail in delineations is not acceptable.

Polygons must be closed and labels should be placed within the polygon if space allows. If the polygon is so small that the label touches the polygon delineations, the label should be placed outside the polygon with a lead-line into the polygon. Linears must be identified with an arrow from the attribute.

Each polygon may not have more than one attribute assigned to it. Although more than one label may be assigned to large polygons and long linears, the labels must be the same attribute. Each adjacent polygon must have different attributes assigned to it.

Each segment of linears must have a label.

When review of a photo is complete and all corrections and changes have been made, write your initials and date on the interpreted overlay below the photointerpreter's signature (for example, QC-KH, 4/29/96). If the photointerpreter did not sign and date the interpreted overlay, have the interpreter do so. If this is not

possible, then write the interpreter's name on the top right corner of the photo and date it according to the Photointerpretation Production Log. Initial the log to record that the QC is complete for that particular photograph.

When QC is complete for each interpreted photograph, check all edge ties to ensure that delineations match and attributes are the same. To eliminate duplication of effort make the appropriate changes if errors are found; record to assure that all edge ties have been checked. This can be as simple as placing a check mark in the margin of the overlay.

Relay any consistent errors to the photointerpreter to eliminate ongoing errors.

Organize the photographs, making sure that all interpreted overlays are covered with a photo jacket. The interpreted photographs are now ready for transfer. Notify the Senior Photointerpreter that the project is complete. Complete the necessary paperwork and pass the project folder to the Senior Cartographer for transfer.

Zoom Transfer Scope Quality Control

Quality Standards

- Drafted tics must be neat and accurate.
- Complete project information must be listed in the lower right corner of the overlay (quad name and state, project name and year, and other relevant information).
- Line work and attributes must be neat, legible, and properly oriented.
- Each polygon and linear must be uniquely and clearly labeled.
- All edges with data must be precisely tied to the adjacent quad.
- All photos numbers must be labeled on the overlay in red at the approximate center.
- Each quad should be initialed and dated upon completion of QC.

These procedures assume the use of multiple quads for a project's completion. If a project is confined to one quad, some steps will not be necessary. Careful adherence to these procedures will result in a smoother, more efficient flow of cartographic products to the data automation group.

Check that tic marks are present and aligned properly. If necessary, add or redraft tics. Paper topographic maps are susceptible to shrinking and expanding with changes in humidity and temperature. These changes may be small but can make quad registration difficult for the digitizer.

Check for proper labeling of the quad and project name. If unsure of the project name, ask the Senior Cartographer or the geographic information system (GIS) Project Coordinator. The more project information included on the overlay, the easier identification will be if the overlay gets misfiled or separated from the project in the future.

Acquire associated photos with overlays and zoom transfer scope (ZTS) production logs (Appendix D). Compare interpretation line work and labeling with the transferred line work and labeling. If any line work discrepancies are found, note them on the transferred map overlay with red pencil or yellow Post-it Notes. Mislabeled polygons should be changed immediately. If the photo number is not on the quad, write it in red pencil at the photo's approximate center. Once QC is complete for that photo area, put a small red check mark next to the photo number and date the ZTS production log.

After completion of line work and labeling QC, check that all edge ties carried over to adjacent quads are properly labeled. Any discrepancies in edge ties should be brought to the immediate attention of the ZTS operator or Senior Cartographer.

Write initials and date near the quad name and project information in the overlay's lower right corner (for example, QC-LR, 3/3/96).

Bundle and label QC'd quads with the project name and give to the Digitizing Supervisor. Return project quads and photos to their designated storage locations. Notify the Senior Cartographer that the project is complete. Complete the necessary paperwork and pass the project folder to the GIS Project Manager for transfer.

Data Automation

The GIS software used for automation is ARC/INFO and all commands are ARC commands. Digitizing is done using EMTC's Production ARCEDIT (PAE) program, which uses a graphic user interface to guide digitizers through the process (Arndt and Olsen 1995).

Command Explanation

The following ARC commands are used for quality control of data. Refer to ARC documentation for exact usage of these commands. The commands are italicized.

1. *Nodeerrors* with the dangle option

Nodeerrors lists the nodes that are not connected to another feature such as an arc or another node. When the *nodeerrors* command is run with the dangle option, the result should be *Total number of dangling nodes: 0*.

2. *Labelerrors*

Labelerrors lists the polygons that have either zero labels or more than one label. The result of a *labelerrors* should be *Polygon 1 has 0 label points*. Polygon 1 is the outer polygon and should never have a label.

3. *Joinitem*

Joinitem joins two info files on the basis of a common item that exists between the two info files.

4. *Describe*

Describe provides descriptive information on a coverage, such as the number of polygons, the number of labels, the status of topology, the minimum and maximum bounding coordinates, and projection information.

5. *Dissolve*

Dissolve combines adjacent polygons that have the same value or description for a specified item. This command is useful for determining if adjacent polygons have the same attribute.

6. *Statistics*

Generates an INFO data file that lists the unique code occurrences and their statistics. This command is useful for verifying attributes in a coverage.

7. *Frequency*

Generates an INFO data file that lists the unique code occurrences and their statistics. This command is useful for verifying attributes in a coverage.

Quality Standards

- Root Mean Square error must be less than 0.005 inches after quad setup.
- Line work must be smooth, complete, and accurate.
- Every polygon must be closed without any dangles.
- Every polygon must contain one and only one label (except the outer polygon, that contains zero label points).
- Every data feature (point, line, or polygon) must have an acceptable attribute.
- All coverages must have topology and a defined projection.
- Adjacent maps should be tied across map edges.
- After mapjoining, arcs and attributes should match across map edges.

Checking Line Work (by Another Digitizer or GIS Coordinator)

Run a *nodeerrors* on the coverage.

Lay check plots over original digitizing media and compare line work.

Check the plot for missing, inaccurate, or incomplete data. If any white areas show between the digitized arcs and the original arcs, redigitize the arcs.

If the data layer has coincident lines with an existing coverage, compare the two coverages to ensure that coincident lines have been maintained. Visually check each arc in ARCEDIT by bringing the less detailed of the two coverages in as an edit coverage and the other in as a background coverage. For data layers such as a study area boundary coincident with land cover/use, using ARC commands such as *union* will sometimes show where arcs are NOT coincident.

After line work corrections and QC are complete, run another *nodeerrors* on the coverage, and date and initial the Map Information Sheet (Appendix E).

Checking Attributes (by Another Digitizer or GIS Coordinator)

Run a *labelerrors* on the coverage.

Create an area report consisting of a list of the attributes, the frequency, and the area in acres. Check the area report for any attributes that are misspelled, missing, or do not conform to the classification scheme.

A second check plot is created with the attributes displayed. For extremely detailed data where plotting the attributes may not be practical, use the *rplot.aml* that allows you to plot selected attributes (3–5 attributes at a time) in different colors. This also makes it easier to keep track of attribute frequencies. Also check for "empty" attributes, which are labels that have no attributes assigned to them.

Verify the attributes on the check plot with the attributes on the original digitizing media. If there are any discrepancies on the original media, refer to the photos.

As you check the attributes between the two media types, use a third checkoff method with the area reports. As you check attributes on the plot, also check them off on the area report to ensure that the frequency of each attribute is accurate.

Do a *joinitem* with a master lookup table (if necessary) and then go into INFO to again check for any "empty" attributes. If blanks are found, refer to the source media to attribute the feature. After all features are assumed to be attributed, drop the items that were brought over from the first *joinitem* and run the *joinitem* again with the master lookup table. Repeat the process until attributes are complete.

After attribute corrections and QC are complete, generate a final area report and attach it to the back of the Map Information Sheet (Appendix E) as a record of what was done.

Final Quality Control (by GIS Project Coordinator)

Run the *labelerror* and *nodeerror* commands on the coverage.

Do a *describe* on the coverage to check topology and to ensure that the projection has been defined.

Do a *dissolve* on the coverage (if polygonal) as a final check for adjacent polygons with like attributes. If any polygons are dissolved out, refer to the source media. If a problem also exists on the source media, refer to the photos. Make sure that any changes are reflected on the original source media and photos.

If there is more than one coverage, *append* or *mapjoin* the adjacent coverages.

Do a *labelerrors* and a *nodeerrors* on the mapjoined coverage.

Dissolve the mapjoined coverage mainly to check attributes across map edges and check for data that have not been edge-matched properly.

Visually check against another data set in the same location to check the geographic location.

Stereo Zoom Transfer Scope Quality Control

Quality Standards

- Should have five or more control points for every stereo pair.
- Residual error should be less than 5 m except with setups occurring in open water.
- Digitize sufficient vertices for smooth and accurate arcs.
- Line work must be smooth and accurate.
- Every polygon must be closed without any dangles.
- Every polygon must contain one and only one label.
- Every label must contain an acceptable attribute.
- All coverages must have topology and a defined projection.
- Adjacent maps should be tied across map edges.
- After mapjoining, arcs and labels should match across map edges.

Digitizing and Background Coverage Editing

In most instances, Stereo Zoom Transfer quality control (SZTS QC) will be performed by the SZTS Technician upon completion of a stereo pair (and before setup is compromised), after completion of the entire study area, and after completion of the final edit.

Acquire photos with interpreted overlays and compare interpretation to the computer display. Note any digitizing discrepancies and either add, delete, or redigitize as necessary.

After the digitizing and editing of the background coverage are complete, check that the coverage has been properly edge-tied between photos and that each arc is unique. If an arc has been digitized multiple times, determine which line is most accurate and delete all others (it may be necessary to zoom in to determine if there is more than one arc).

Final Coverage Editing

After completion of final editing and labeling by a GIS Technician, obtain a plot of the line work at the same scale as the photography and compare it directly with the interpreted photos. If any changes were made to the line work during digitizing, update the interpretation overlay at this time. Initial and date the additional QC on the overlay.

Once line work is complete, obtain the plot with the labels and compare with the labels on interpreted overlays. If there is a label discrepancy or a change in cover type, height, or density, determine which is correct and update where appropriate. If interpretation is changed, initial and date additional QC on the overlay.

Once all corrections have been made, obtain a summary report and final plot of the line work with labels. Attach both to the SZTS Info Sheet (Appendix F) and file. Return photos to their designated storage location.

Aquatic Areas Quality Control

Quality Standards

- Study area boundary (SAB) and land–water lines must match exactly with the parent land cover/use (LCU) coverage.
- No wing dams or other structures can be in the Main Navigation Channel.
- Line work must be smooth and accurate.
- Every polygon must be closed without any dangles.
- Every polygon must contain only one label.
- Every label must contain an acceptable attribute.
- All coverages must have topology and a defined projection.
- Adjacent maps should be tied across map edges.
- After mapjoining, arcs and labels should match across map edges.

Do a *labelerrors* and a *nodeerrors* on the poolwide coverage.

Do a *describe* on the coverage to check topology and to ensure that the projection has been defined.

Do a *statistics* or *frequency* on the coverage's attribute table to ensure all attributes are legal.

Do a *dissolve* on the coverage as a final check on the attributes. If any polygons are dissolved out, refer to the source coverage. Make sure that any changes are reflected on the original source coverage.

Overlay the aquatic area coverage on top of the parent LCU coverage on-screen in ARCPLOT. Carefully inspect the SAB to make sure that the lines are coincident. Shade the LCU coverage into two colors on the basis of the land–water attribute and overlay the aquatic areas coverage to ensure that all land–water breaks were correctly classified.

Visually check against another data set in the same location to verify the geographic location.

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Appendix B. 1989 Pool 10 Field Verification

Personnel: Kevin Hop
Larry Robinson

Date of Field Verification: August 31, 1994
September 9, 1994

Areas Visited: Just south of L&D 9 and NE of Harper's Ferry, Prairie Du Chien, Pikes Peak Wisconsin River Area, and Guttenburg and North (French Town Lake)

Photos Verified: 49-10, 49-8, 50-6, 50-10, 50-8, on August 31, 1994
52, 10, 52-9, 52-7, 52-5, 50-12, 51-15 on September 9, 1994

Photo Duties Visited: 9-10-89 and 08-30-89

Common Vegetation Seen in Field:

Echinodorus, *Leersia*, *Polygonum*, *Sagittaria*, *Cyperus*, several other grasses and forbs, *Acer*, *Salix*, *Scirpus*, *Nymphaea*, *Nelumbo*, *Sparganium*, *Lemna*, *Anoratus*

Less Common: Cucumber vines, *Ulavis*, *Eliocharis*, *Fraxiens*, *Typha*, *Phalaris*, *Lephalantus*, submergents

Vegetation and water conditions seemed to be upper pool; many sag areas, mud flats, and sag/net/*Nymphaea* areas H₂O and regime, more so in the upper part of the pool. Ex. vegetated signatures of *Sagittaria* proved mud and H₂O in upper part of pool and *Nymphaea*, *Nelumbo* in mid-part of pool. Lower pool proved most consistent in slight variabilities in vegetation on structure. Much of mid-pool showed consistency too. 194 field showed invading spp. of grasses and forbs. *Cyperus*, etam.

Backwater pools tended to be good mixtures of emergent veg., such as spring, *Scirpus*, sag.

Suggestions: Signatures probably consistent in Pool 9. Pool 9 pl first.

Appendix C. LTRMP Vegetation Classification Photointerpreter's List

Version 3.12
5 January 1996

100	Open Water	708	Pontederia	923	Leersia/Phalaris
101	Lemnaceae	709	Sagittaria	924	Leersia/Phalaris/Polygonum
102	Azolla	710	Sagittaria/Lemnaceae		
		712	Sagittaria/Scirpus/Sparganium	1000*	Woody Terrestrial
200	Submergents	713	Sagittaria/Sparganium	1001	Acer
201	Lemnaceae/submergents	714	Scirpus	1002	Acer/Populus and/or Salix
202	Myriophyllum	715	Scirpus/Sagittaria	1003	Amorpha
203	Zosterella	716	Scirpus/Sparganium	1004	Betula
204	Vallisneria/Zosterella	717	Sedge meadow	1005 [†]	Brush
205	Myriophyllum/Zosterella	718	Sparganium	1006	Carya/Nyssa
206	Vallisneria/Potamogeton	719	Typha	1007	Cephalanthus
207	Myrioph/Potamoget/Vallis	720	Typha/Sagittaria	1008	Forest-mesic (moist soil sp.)
208	Potamoget/Vallis/Zost/Cerat	721	Typha/Scirpus	1009	Forest-upland (dry soil sp.)
209	Elodea	722	Typha/Scirpus/Sparganium	1010	Fraxinus
210	Azolla/submergents	723	Typha/Sparganium	1011	Plantation
250	Vallisneria/Potamoget/Heteran	724	Zizania	1012	Populus
251	Ceratophyllum	725	Equisetum	1013	Quercus
252	Lemnaceae/Ceratophyllum			1014	Salix
253	Lemna/Ceratophyll/Potamogeton	727	Scirpus/Zizania	1015	Salix and/or Populus
254	Potamogeton	728	Typha/Sagittaria/Scirpus	1016	Salix and/or Populus - grass
255	Vallisneria	729	Typha/Sagittaria/Sparganium	1017 [†]	Shrub/grass/forbs
		730	Typha/Sagittaria/Scirpus/Sparganium	1018 [†]	Shrub/Scirpus
300	Submerg-Rooted Floating Aqua	731	Typha/Lythrum	1019	Taxodium
301	Brasenia/submergents	732	Scirpus/Lythrum	1020	Taxodium/Nyssa
302	Nelumbo/Nymphaea/submerg/Lemn			1021	Ulmus
303	Nelumbo/submergents	800	Emergents-Grasses/Forbs	1022	Conifers
304	Nelumbo/submergents/Lemnaceae	801	Leersia/Carex/Polygonum	1023	Juniperus
305	Nymphaea/Nelumbo/submergents	802	Leersia/Carex/Sagit/Polygonum	1024	Populus/Acer/Ulmus/Fraxinus community
306	Nymphaea/submergents	803	Leersia/Phalar/Scirp/Lythr/Phrag	1025	Quercus/Carya community
307	Nymphaea/submergents/Lemnaceae	804	Leersia/Sagittaria	1026	Salix community
308	Nymphaea/Myriophyllum	805	Sagittaria/Phalaris	1027	Populus community
309	Nelumbo/Myriophyllum	806	Sagittaria/Polygonum	1028	Salix/Populus community
310	Nelumbo/Nymphaea/Myriophyllum	807	Sag/Sparg/Typ/Scirp/Leer/Phrag	1029	Quercus/Nyssa/Taxodium community
311	Nymph/Ceratoph/Myriophyl/Lemna	808	Scirpus/Leersia	1030	Acer/Tilia community
312	Nymphaea/Ceratophyllum/Lemna	809	Scirpus/Carex/Leersia/Polygon	1031	Upland Forest community
313	Nuphar/submergents	810	Scirpus/Phalaris	1032	Cephalanthus community
314	Nuphar/Nymphaea/submergents	811	Scirpus/Phragmites	1033 [†]	Mixed shrubs community
400	Submerg-Rooted Floating-Emerg	812	Scirpus/Polygonum	1034	Plantation community
401	Nelum/Nymph/Sag/Sparg/sub/Lemn	813	Scirpus/Phalaris		
402	Nelum/Nymph/Ponted/sub/Lemn	814	Sparganium/Leersia	1100	Agriculture
403	Scirpus/Nelumbo/submergents	815	Typha/grasses/forbs		
404	Scirpus/Nymphaea/submergents	816	Scirpus/grasses/forbs	1200	Urban/Developed
405	Zizania/Nymphaea/Nelumbo/sub	817	Sagittaria/Scirpus/Leersia	1201	Developed
406	Pontederia/Nymph/Nelumbo/sub	818	Carex/Grasses/Forbs	1202	Developed parks
407	Sagittaria/Ceratophyllum/Lemnaceae	819	Typha/Lythrum/Phragmites	1203	Industrial pond
408	Nelumbo/Sagittaria/submergents	820	Lythrum/Grasses/Forbs	1204	Urban
409	Nelumbo/Nymphaea/Sagittaria/submergents	821	Sagittaria/Leersia/Polygonum	1205	Revetted bank
410	Nymphaea/Zizania/submergents	822	Scirpus/Leersia/Polygonum		
500	Rooted Floating Aquatics	823	Scirpus/Leersia/Phalaris	1300	Sand/Mud
501	Brasenia	824	Typha/Leersia	1301	Mud
502	Jussiaea			1303	Sand
503	Nelumbo	900	Grasses/Forbs		
504	Nelumbo/Lemnaceae	901	Ambrosia	1400	No Coverage
505	Nelumbo/Nymphaea	902	Grass		
506	Nuphar	903	Hay meadow		
507	Nymphaea	904	Pasture (heavily grazed areas)		
508	Nelumbo/Nymphaea/Lemnaceae	905	Leersia		
509	Nymphaea/Lemnaceae	906	Leersia/Polygonum		
		907	Meadow		
600	Rooted Floating Aqua-Emergents	908	Mixed forbs and/or grasses		
601	Nelumbo/Nymphaea/Sagittaria	909	Nettles		
602	Nymphaea/Sagittaria	910	Phalaris	1.	0-20 Feet Tall
603	Nymphaea/Scirpus	911	Phalaris/Polygonum	2.	21-50 Feet Tall
604	Sagittaria/Nelumbo	912	Phragmites	3.	>50 Feet Tall
605	Nymphaea/Zizania	913	Phragmites/Phalaris		
700	Emergents	914	Polygonum		
701	Acoris	915	Polygonum/Nelumbo		
702	Carex	916	Rdside-levee/grass/forbs/shrub		
703	Cyperus	917	Sand-prairie		
704	Decodon	918	Spartina		
705	Echinodorus	919	Vines as dense overgrowth		
706	Eleocharis	920	Polygonum/Eupatorium		
707	Lythrum salicaria	922	Grass/forbs/shrubs		

Modifiers:

- A 10-33% Vegetation Cover
- B 34-67% Vegetation Cover
- C 68-90% Vegetation Cover
- D >90% Vegetation Cover

* Optional Height Modifier Per EMTC Instructions
† No Height Modifier

Appendix E. Map Information Sheet

Coverage Name: _____ Date: _____

Project Name: _____ Name: _____

Location: _____ Mapsheet scale: _____

Mapsheet name: _____ Data type: _____

Mapsheet vintage: _____ Theme name: _____

TicId#____ (lon)_____ TicId#____ (lon)_____
(lat)_____ (lat)_____

TicId#____ (lon)_____ TicId#____ (lon)_____
(lat)_____ (lat)_____

TicId#____ (lon)_____ TicId#____ (lon)_____
(lat)_____ (lat)_____

Date of QC line work_____ Initial_____

Date of QC attributes_____ Initial_____

Checked Labelerrors_____

Checked Nodeerrors_____

Fuzzy Tolerance_____

Dangle Tolerance_____

Transformation Errors(if projected)_____

Adjacent Maps for Edge-matching:

Date of Edge-match_____ Initial_____

Date of Mapjoin_____ Initial_____

Appendix F. Stereo ZTS Information Sheet

PROJECT NAME: _____

<u>DIGITIZING</u>				
DIRECTORY NAME _____		DATE _____		
SHIFT/DATA SET NAME _____		THEME _____		
LOCATION _____		DIGITIZER _____		
SHIFT X = _____	Y = _____	PAGE _____	OF _____	
<u>PHOTO RESIDUALS</u>				
PHOTO #	X	Y	Z	TOTAL
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

<u>EDITING</u>		
EDITOR _____	DATE _____	
LOCATION _____	DATA TYPE: POLY _____ LINE _____ POINT _____	
<u>TRACKING</u>		
_____	_____	
_____	_____	
_____	_____	
_____	_____	

<u>QUALITY CONTROL</u>		
TOTAL # ARCS _____	TOTAL # POLYGONS _____	TOTAL ATTRIBUTES _____
FUZZY TOLERANCE _____	NODE ERR FIXED _____	LABEL ERRORS FIXED _____
DATE MAP COMPLETED _____	LINE PLOT QC'D _____	ATTRIBUTES QC'D _____
QC SUPERVISOR _____	TOTAL HOURS TO COMPLETE _____	

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, D.C. 20503			
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE May 1997	3. REPORT TYPE AND DATES COVERED	
4. TITLE AND SUBTITLE Long Term Resource Monitoring Program standard operating procedures: Quality control for cartographic activities		5. FUNDING NUMBERS	
6. AUTHOR(S) Thomas W. Owens, ¹ Kevin Hop, ² Larry Robinson, ¹ Lynne DeHaan, ² and Tammy Fancher ³			
7. PERFORMING ORGANIZATION NAME AND ADDRESS ¹ U.S. Geological Survey, Environmental Management Technical Center, 575 Lester Avenue, Onalaska, Wisconsin 54650 ² Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987 ³ Midcontinent Ecological Science Center, 4512 McMurry Avenue, Fort Collins, Colorado 80525-3400		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Geological Survey Environmental Management Technical Center 575 Lester Avenue Onalaska, Wisconsin 54650		10. SPONSORING/MONITORING AGENCY REPORT NUMBER 95-P008-7	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Release unlimited. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (1-800-553-6847 or 703-487-4650)		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The Environmental Management Technical Center has produced a series of standard operating procedure (SOP) manuals detailing the steps in producing spatial data sets to meet quality standards. The present SOP Manual is a continuation of that series detailing the quality control (QC) standards and procedures taken at each production step to ensure that the data are correct and can be passed to the next stage in the production process. Adherence to the SOPs detailed in the other manuals and to the QC procedures discussed here ensure that errors are kept to a minimum and that the data are reliable for monitoring and research.			
14. SUBJECT TERMS Cartography, digitizing, photo interpretation, quality control, standard operation procedures, zoom transfer scope		15. NUMBER OF PAGES 10 pp. + Appendices A-F	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

