APPENDIX A

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.
FORT ORD REMEDIAL INVESTIGATION/FEASIBILITY STUDY

PROCEDURES FOR INTEGRATION OF HISTORICAL DATA INTO A
GEOGRAPHICAL INFORMATION SYSTEM

1 PURPOSE

The purpose of this method is to ensure that the integration of historical information into the Geographical Information System (GIS) follows a uniform and acceptable set of procedures. These procedures include collection and documentation of the data and performance of quality control checks.

2 SUMMARY OF PROCEDURES

This method describes the procedures to be followed when gathering, processing and documenting data related to the ordnance and explosives program at Fort Ord. Figures 1 and 2 show flowcharts generalizing the steps needed to process the historical data. The components of the project are 1) selection of historical data to be added to the GIS, 2) ArcGIS Shapefile Conversion, 3) Database Conversion, 4) Digitizing Data Conversion, 5) Georeferencing and Mosaicing Images, 6) GPS Conversion, 7) Metadata Collection, 8) Data Quality Control and 9) Scanning Data Collection. These are in no particular order and depend solely on the type of data collected. This document outlines our current standard operating procedures. These procedures will be reviewed periodically and revised as appropriate to accommodate changes in technology in accordance with accepted industry-wide standards and practices. All data collected within this project will be backed-up daily and stored in the event data is lost or damaged.

HISTORICAL DATA SOURCE INTEGRATION FOR USE WITH GIS

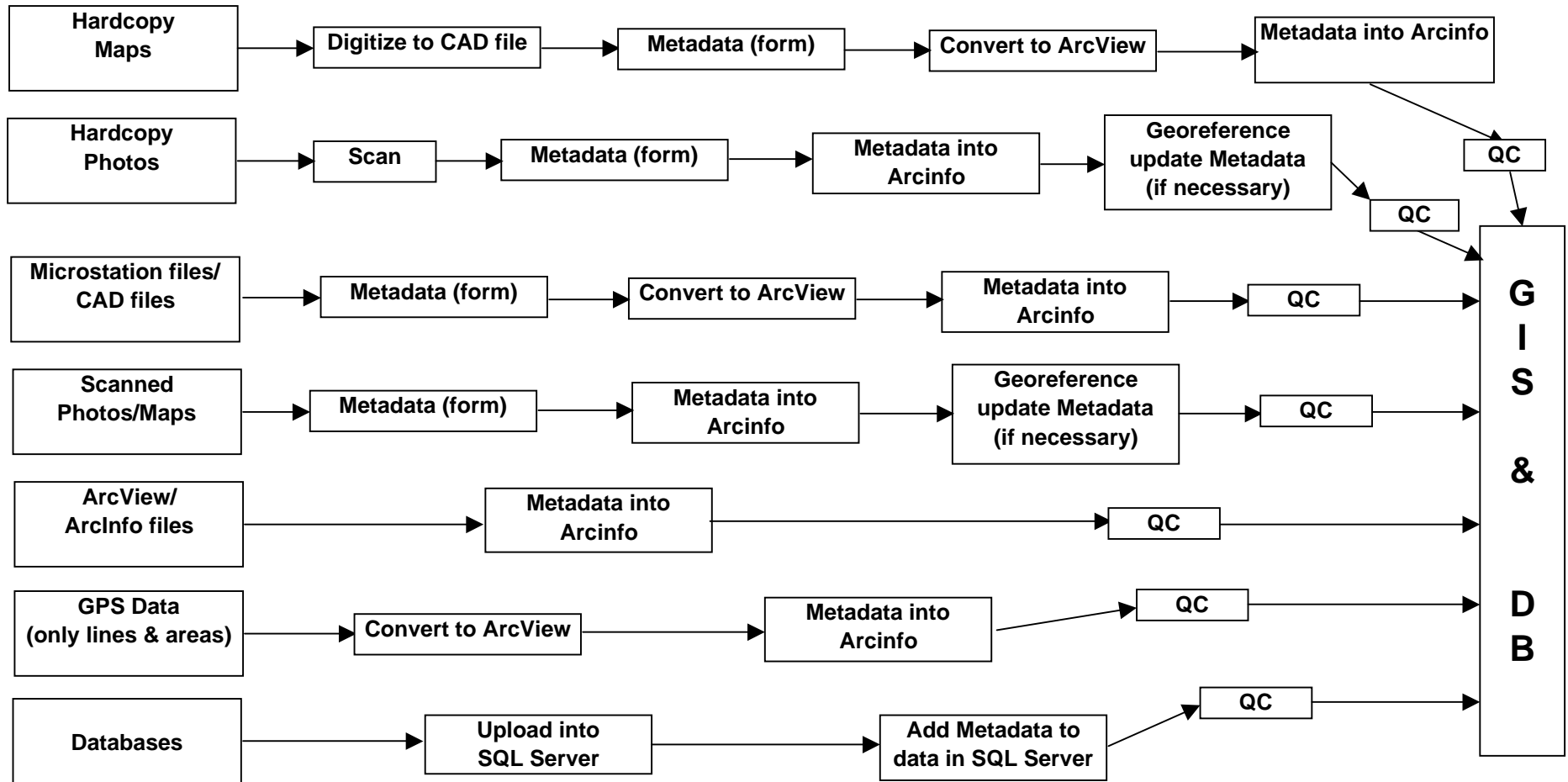**Historical Sources**   **Steps Needed**

| Hardcopy Maps | → | Digitize to CAD file | → | Metadata (form) | → | Convert to ArcView | → | Metadata into Arcinfo |

| Hardcopy Photos | → | Scan | → | Metadata (form) | → | Metadata into Arcinfo | → | Georeference update Metadata (if necessary) | QC |

QC

| Microstation files/ CAD files | → | Metadata (form) | → | Convert to ArcView | → | Metadata into Arcinfo | → | QC |

| Scanned Photos/Maps | → | Metadata (form) | → | Metadata into Arcinfo | → | Georeference update Metadata (if necessary) | → | QC |

| ArcView/ ArcInfo files | → | Metadata into Arcinfo | → | QC |

| GPS Data (only lines & areas) | → | Convert to ArcView | → | Metadata into Arcinfo | → | QC |

| Databases | → | Upload into SQL Server | → | Add Metadata to data in SQL Server | → | QC |

G I S & D B

Figure 1   8/10/2000

USES OF HISTORICAL DATA

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                                 │  └─────────────────┘
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│                 │             ├─▶│ CD DELIVERABLES  │
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│  SQL SERVER     │      │      ├─▶│     ARCIMS       │
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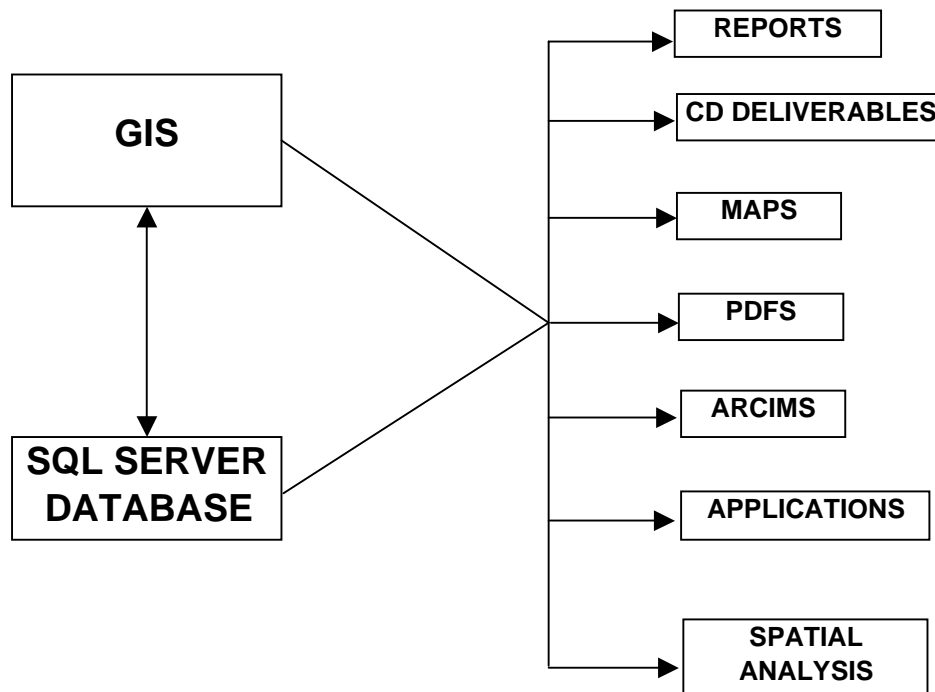
Figure 2

8/10/2000

STANDARD OPERATING PROCEDURE
FORT ORD REMEDIAL INVESTIGATION/FEASIBILITY STUDY

PROCEDURES FOR SELECTION OF HISTORICAL DATA FOR PLACEMENT INTO THE GEOGRAPHICAL INFORMATION SYSTEM

1   PURPOSE

The purpose of this method is to ensure that the historical information necessary for meeting the project goals is placed into the Geographical Information System (GIS).

2   SUMMARY OF PROCEDURES

This method describes the procedures to be followed when selecting data for inclusion in the project GIS. The type of information that may be placed in the GIS includes historical aerial photographs, training areas and range fans shown on historical maps, current buildings, roads and other features.

3   EQUIPMENT

The following equipment is useful for reviewing aerial photographs. No additional equipment is necessary.

- Stereo Glasses for viewing stereo pairs
- Magnifying glass for viewing aerial photographs.

4   PROCEDURES

The procedures for selection of aerial photographs for scanning and georeferencing, selection of features for digitizing, and selection of information stored in other forms such as CAD are described below.

4.1   Selection of Aerial Photographs

Aerial photographs of Fort Ord are available from the 1940s through the 1990s. At a minimum aerial photographs from each decade, that provide the most aerial coverage of the base will be selected for scanning and georeferencing. Aerial photographs may also be selected if they show a feature of interest, such as a cleared area associated with suspected training. The resolution, coverage, and file type will also be considered when selecting the image. Resolution, coverage, and file type are discussed in more detail in the Georeferencing Images SOP.

4.2   Selection of Features for Digitizing

Review of historical maps will be conducted to identify features that should be digitized for storage in the project GIS. Features that will be considered for digitizing include historical range

fans, training areas where OE is suspected to have been used, and other information that may pertain to the evaluation.

Historical range fans are available on maps dating back to the 1940s. Each available training map will be reviewed and range fans will be digitized if there is a change in the configuration from a previous map. Fans and range designations that do not change between historical maps will not be digitized. For example, if the range fans on the 1972 training map are the same as on the 1974 map, only the range fans on the 1972 map would be digitized. The training maps associated with the range configuration will be documented in the metadata.

Training areas where OE use was suspected will also be digitized. Determination of the potential for OE use will generally be based on the information provided on the map. For example, if the map designates an area as a grenade training area, that area should be digitized. If it is unclear what the use of an area might have been, consultation will be made with an OE specialist and if possible personnel who may have been present at Fort Ord at the time the training area was in use will be consulted. For example, if an area is designated an RRTA, the OE specialist and personnel present at Fort Ord during the time the training took place would be consulted to determine the type of training that may have occurred.

Other information that may be digitized would include historical roads and buildings. The decision to digitize other features will be made on a case-by-case basis after review of the data.

4.3   CAD Drawings

CAD drawings generated by previous OE and HTRW contractors may be converted into shape files for the GIS. Files that would be considered for conversion include files showing site boundaries and grid boundaries, or information on previous sampling locations. Decisions on whether CAD files should be converted to shape files will be made on a case-by-case basis.

5.   RECORDS

Documentation of discussions with OE specialists and interview records related to selection of features for digitizing will be stored in the project files.

6.   PERSONNEL

At a minimum, the task manager, project manager, and an OE specialist will make up the project team. The OE specialist will be consulted when a determination is needed on whether an area could have been used as an OE training site.

7.   REFERENCES

USACE, 2000. Ordnance and Explosives Response, Engineer Manual EM110-1-4009. June 23.

USACE, 2000. Ordnance and Explosives Response, Engineer Pamphlet EP 1110-18. April 24.

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

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ARCGIS SHAPEFILE CONVERSION

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1   PURPOSE

The purpose of this procedure is to ensure that CAD files, and DGN files are consistently converted into ArcGIS Shapefiles.

2   SUMMARY OF PROCEDURES

It is helpful to simplify the number of software programs involved in doing spatial analysis. MACTEC has decided to use ArcGIS shapefiles as our main file format. Shapefiles are a widely used format that is compatible with ArcGIS, Arc/Info and ArcIMS. Converting CAD and DGN files into shapefiles, does not affect the accuracy or precision of these files in any way. This SOP will explain how to convert CAD files and DGN files into Shapefiles.

3   EQUIPMENT

The following equipment is required:
- One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
- Current versions of ArcGIS, Autocad, and Microstation J.

4   PROCEDURE

4.1   Converting CAD Files

AutoCAD files contain layers and a variety of map features (points, lines and polygons). ArcGIS shapefiles have no layers and can only support one map feature type. Be aware that one CAD file can create 3 shapefiles. Follow these steps in importing AutoCAD R14 files into shapefiles:

- Open an ArcGIS project and make sure that the CAD Reader extension is active
- Add the CAD file as a theme. The CAD file will become up to four themes, one each for lines, points, polygons, and annotation. Only closed polygons in CAD will be shown in the polygon theme. If some data is not showing up in anyone of the themes, make sure that all the layers in the CAD file are turn on, by checking **Theme | Properties**.
- Convert the theme into a Shapefile by hitting **Theme | Convert to Shapefile**. Save the shapefile in the project directory, under GIS/ArcGIS/shapefiles and then in a directory named after the subject of this data. Create a new directory if one does not fit the subject of the data.
- Be sure to check if the new shapefile is editable. Add it as a theme and try to **Start Editing** it, if it is not editable then it was a 3D shapefile (which is created from 3D CAD features) and needs to be converted to a 2D shapefile. Run xyz2xy.ave as a click action on a tool button. Save the shapefile in the same location as before. Delete the 3D shapefile.
- Several attributes are created once the CAD file is converted: entity, layer, elevation, color and maybe more. It is only important to leave the layer attributes to identify the features in the source CAD file at a later time.

- Annotation from CAD files is not transferable to a shapefile through ArcGIS. The annotation can be added into the attributes of each shapefile or the annotation can be converted into an Arc/Info coverage and then into a shapefile.
- Other attributes may be needed for spatial analysis at the discretion of the project manager.
- Make sure that a **Metadata Form** (figure 3)is completed after the conversion is completed.
- All shapefiles should be stored by topic in the project directory under /gis/arcgis/shapefiles.

4.2   Converting DGN files

DGN can be converted into shapefiles just like CAD files. DGN files have different map features (like cells and complex shapes) and uses levels instead of layers, but ArcView imports them in the same fashion. Follow the same steps as mentioned above. Arc/Info can also convert DGN files into coverages for topology editing and then into ArcGIS shapefiles. Another option is to use Microstation J to convert the DGN into a .dxf file and then import in into ArcGIS and convert it to a shapefile. Here are a couple things to reiterate before finalizing the conversion process:

- Save the shapefile in the project directory, under GIS/ArcGIS and then in a directory named after the subject of this data. Create a new directory if one does not fit the subject of the data.
- Other attributes may be needed for spatial analysis at the discretion of the project manager.
- Make sure that a **Metadata Form** (figure 3) is completed after the conversion is completed.
- All shapefiles should be stored by topic in the project directory under /gis/arcgis/shapefiles.

5   RECORDS

All files should be stored in the project directory.

6   PERSONNEL

Several staff members are needed to work on the conversion process. They will have experience with the current versions of ArcGIS, Autocad, and Microstation J.

7   REFERENCES

ArcGIS help files.

8   ATTACHMENTS

Figure 3 – Metadata form

MACTEC - Data Collection & Metadata Form

Date:_____
Collector Name:_____

Explain the Data you are collecting:

Data Source: Paper map__   Photo__   CAD__
                Other (specific)_____
Date of Source:_____
Source Title:_____
Source Scale:_____
Company that provided Source Data:_____

Collection Method: Digitized__GIS(AV or AI)__Image Tracing__Scanning__

Destination File Name(include path):_____

PHOTO ONLY
1) Was photo scanned from photo prints?
2) Was photo provided orthorectified and in digital format?
3) Did MACTEC Georeference scanned photo?   If so explain procedure:

4) Source Resolution:_____ dpi
5) Estimate error +/- _____ units _____

DIGITIZED ONLY
1) Specify the data and file you are using to register Source Data:
    Date:_____
    Source:_____
    Company that provided registering data:_____
2) Explain method of registering Source Data:

3) Collection Accuracy (average error in feet):

CAD/DGN ONLY
1) Specify the CAD Layer or DGN Level the Source Data originated:
2) File name of CAD/DGN drawing:

QC
1) Date of form QC:_____
2) Person performing QC:_____   Signature:_____

Figure 3

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

DATABASE CONVERSION TO SQL SERVER

1 PURPOSE

The purpose of this procedure is to ensure that tabular data and GPS point data are consistently converted into the SQL Server database.

2 SUMMARY OF PROCEDURES

All tabular data not connected to ArcGIS shapefiles and GPS point data will be collected, and organized with metadata into the project SQL Server database. MEC data from a wide variety of sources for Fort Ord that are critical to the Remedial Investigation/Feasibility Study must be combined into one database system. This SOP will explain how these sources are imported into the project database.

3 EQUIPMENT

The following equipment is required:
- One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
- Current version of SQL Server.

4 PROCEDURE

4.1 Importing Data

Tabular data for Fort Ord exists in a variety of file types, including Excel files (.xls), dbase files (.dbf), ACSII files (.txt) and Access databases (.mdb). SQL Server has excellent tools to easily import these formats without losing any data. The SQL Server database must be able to handle multiple formats to work with GIS software requirements. The following are guidelines when importing files:

- Identify the data fields (columns used in excel files, dbf files and access databases and tabs, commas or other delimiters are used in ACSII files) of each file to determine the format (number, string, date, etc.) and the number of characters in length.
- If no title is provided for the data field, the Project Manager will identify the theme of the data and a column title will be created.
- With the assistance of a SQL Server Database Specialist, setup the project database on SQL Server with the columns needed to handle each column of data in the files.
- Point feature data (MEC, targets, wells, etc.) should include x, y coordinates.
- SQL Server Database Specialist will import the data into the project database and work with the GIS Specialist to ensure that data was successfully imported and functional.

GPS point data conversion into the SQL Server will be documented in the GPS DATA CONVERSION SOP. FGDC (Federal Geographic Data Committee) compliant metadata fields will be used as needed to describe metadata within the database.

5   RECORDS

All types of data will be stored in the SQL Server project database.

6   PERSONNEL

At a minimum, the project manager, a GIS Specialist and a SQL Server Database Specialist will make up the project team to work out any issues importing data, overall project needs and GIS software requirements. Database personnel should have experience with the current version of SQL Server.

7   REFERENCES

8   ATTACHMENTS

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

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DIGITIZING DATA COLLECTION

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1   PURPOSE

The purpose of this procedure is to ensure that digital data is properly and consistently collected using a digitizer.

2   SUMMARY OF PROCEDURES

Digitizing is a process of transferring features from a hardcopy into digital form such as a CAD (Computer Aided Design) file. This method describes the procedures to be followed for digitizing features from hardcopy sources such as mylar maps, paper maps, and photographs. There are 3 steps in the digitizing process 1) Setup of the hardcopy source 2) choosing a proper digital file for collecting the hardcopy features, and 3) digitizing. Procedures for each of these steps are described in this SOP.

3   EQUIPMENT

The following equipment is required:
* One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
* Current version of AutoCAD software and a digitizer (preferably an E-sized sheet digitizer).

4   PROCEDURE

4.1   Setup of the Hardcopy Source onto the Digitizer

Proper registering of the hardcopy onto the digitizer is important to get the best accuracy and precision. Any imperfections in the source medium can translate into errors in your digitizing. The source should be free of folds, rips or wrinkles. Follow these steps to ensure a proper base to digitize from:
* Try to find the map original to digitize from. Mylar is a more stable medium than paper, because it keeps its shape and doesn't rip or fold easily
* Lessen the effect of imperfections by flattening creases or taping rips
* Tape the map flat and tight on the digitizing board

4.2   Choosing a Proper CAD file for Collecting Hardcopy Features

Digitizing is done through the current version of AutoCAD. Digitizing will digitally transfer the hardcopy features to a CAD file. The CAD file sets the coordinate system (ex. State Plane Nad83), units (ex. feet) and helps to control the level of accuracy with which you can digitize. The CAD file should have these characteristics:
* Occupy the same area that the hardcopy shows
* Share at least 7-10 common features with the hardcopy. Try to use common features that are well defined and clearly shown on both the CAD file and map. Examples of common features are:
    * Defined Line intersections
    * Landmarks (buildings, parcel boundaries, etc.)
    * Base Boundary corners
    * Coordinate Tic marks
    * Unique points that are clearly defined

- Must have the coordinate system and units corresponding to the desired output file. Fort Ord geographic data should be referenced to 1983 North American Datum (NAD 83), California State Plane Coordinate System, Zone IV, Feet.

In digitizing Fort Ord historical data, it is good to use the current version of the base boundary, which was provided by Jones & Stokes (1994). Most of the older maps have the base boundaries on them and provide plenty of common features to register the map to the current base boundary.

4.3 Digitizing

Follow these steps to digitize the hardcopy:

- Type the AutoCAD command **tablet** and then **cal**
- Using the 7-10 common points identified in step 4.2, register the hardcopy map to the CAD file. Do this by choosing one of the points on the hardcopy and then picking the same point of the CAD file. Use the snapping tools within AutoCAD to accurately pinpoint features. Repeat until all common points are used and then hit the **return** key.
- This will bring up a window to finalize the registration and to transform the digitizing tablet to match the CAD files characteristics. Choose the Transformation Type that has an **Outcome of Fit** that is exact or a success and has the lowest **Root Mean Squared (RMS) Error**. Choosing the Projective Transformation generally creates the lowest **RMS Error**.
- It is important to get the lowest **RMS Error** possible and you might need to re-register the hardcopy map to lower the error. **RMS Error** usually stems from human error, poor choice of common points, not enough common points, and imperfections or inaccuracy of the hardcopy source. If **RMS Error** is high (>100), try to calibrate the digitizer several times to get a lower **RMS Error**. The lowest **RMS Error** might be >100. If that is the case, it is usually due to hardcopy inaccuracies, so a **RMS Error** >100 are acceptable.
- After obtaining the lowest **RMS,** choose the type of transformation needed. Projective transformation is recommended for digitizing.
- Digitize the map features you want. Make sure to close all polygons.
- Once you are finished with the digitizing, save the file with a name that specifics the data within it. If the data is on a specific year, include the year within the filename. Try to have one CAD file per hardcopy document. Save the file within the project directory where the CAD files are stored.
- Fill out **Metadata Form** (figure 3).
- All CAD files will be placed within the project directory under /cad/digitizing/.

5 RECORDS

All CAD files will be placed within the project directory under /cad/digitizing/.

6 PERSONNEL

A staff member with previous digitizing and AutoCAD experience will perform digitizing.

7 REFERENCES

AutoCAD R14 online help.
Jones & Stokes Associates printout (dated 3/25/98) of previous web site titled "GIS at the former Fort Ord"

8 ATTACHMENTS

Figure 3 – Metadata form.

MACTEC - Data Collection & Metadata Form

Date:_____
Collector Name:_____

Explain the Data you are collecting:

Data Source: Paper map___   Photo___   CAD___
                Other (specific)_____
Date of Source:_____
Source Title:_____
Source Scale:_____
Company that provided Source Data:_____

Collection Method: Digitized___GIS(AV or AI)___Image Tracing___Scanning___

Destination File Name(include path):_____

PHOTO ONLY
1) Was photo scanned from photo prints?
2) Was photo provided orthorectified and in digital format?
3) Did MACTEC Georeference scanned photo?   If so explain procedure:

4) Source Resolution:_____ dpi
5) Estimate error +/- _____ units _____

DIGITIZED ONLY
1) Specify the data and file you are using to register Source Data:
    Date:_____
    Source:_____
    Company that provided registering data:_____
2) Explain method of registering Source Data:

3) Collection Accuracy (average error in feet):

CAD/DGN ONLY
1) Specify the CAD Layer or DGN Level the Source Data originated:
2) File name of CAD/DGN drawing:

QC
1) Date of form QC:_____
2) Person performing QC:_____   Signature:_____

Figure 3

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

<u>**GEOREFERENCING & MOSAICING IMAGES**</u>

1   PURPOSE

The purpose of this procedure is to ensure images are properly and consistently geo-referenced to the coordinate system used for the project.

2   SUMMARY OF PROCEDURES

Georeferencing is a process of assigning map coordinates to an image without geographic or real-world coordinates, so that it can be overlaid with GIS data. This process can also be used to convert images from one coordinate system to another. This SOP is specifically designed for georeferencing and mosaicing aerial photos. Historical aerial photos generally provide the best sources of historical data. The image will be referenced to a digital file that contains the same features and geographic coordinates, as the image. Common features will help lock the image within the same coordinate system as the digital file. There are 3 steps of the georeferencing process 1) selecting the image 2) choosing the digital file to georeference the image and 3) georeferencing the image. Procedures for each of these steps are described in this SOP.

3   EQUIPMENT

The following equipment is required:

- One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
- Current version of ArcGIS (7.1 or greater) or ERDAS Imagine software (current version).

4   PROCEDURE

4.1   Selecting the Image

Image resolution, image coverage (the area that the image shows), and image file type may affect the georeferencing process. The following characteristics should be considered when selecting an image:

- The image resolution should be greater than or equal to 600 DPI (dots per inch).
- Try to use an image that covers a large geographic area (preferably > 1:1200 scale), to maximize the number of features used for georeferencing.
- Images created as a JPEG (an image file format) file will be smaller and easier to manage, but TIFF (an image file format) files can usually capture details better than JPEG files.
- A clean image with clearly defined features improves the georeferencing accuracy.
- True color and grayscale images show higher definition, this helps in identifying features.
- If there are two or more images that cover the area needed, it is best to mosaic the images into one image. This function is available in ERDAS.
- Use the most current image of the area available.

4.2   Choosing the Digital File to Reference the Image

It is very important to find a coverage (Arc/Info file) or high quality orthophoto that shows the current representation of the image being georeferenced. For example, an aerial photograph of Fort Ord in the 1950's may show buildings, firing ranges, and other features that no longer exist. The photograph is often the best available source to identify the locations of these features, and should be georeferenced to a file that accurately represents current conditions at the base. In addition:

- Geographic data created in the last decade is more accurate and precise.
- Using up-to-date digital data allows the project team to analyze present conditions with respect to historical activities within the same area.

Before the georeferencing process can begin it helps to study the image and coverage to identify common features. Those common features will be used to snap the image into the reference file coordinate system. Discuss and choose common points to use with an experienced member of the project team who can point out the related features. Try to use these features for registering:

- Roads
- Buildings
- Unique land forms (excavations, military structures, etc)
- Benchmarks
- Coordinate Tic Marks

All past georeferenced photos were registered to an Arc/Info coverage provided by Jones & Stokes in 1998. The coverage was called rds_100b and was created off of 1994 aerial photographs at a scale of 1": 100' created by Hammon, Jensen, and Wallen Associates. The roads coverage will be used to georeference images not georeferenced to date.

4.3   Georeferencing

Georeferencing can be done with either Arc/Info, ArcMap, or ERDAS software. Guidelines for using each software package are listed below. Use a coverage or high-quality orthophoto to assign map coordinates to the aerial photo image by connecting common features. First pick a common feature on the image and the digital file. This will transfer the coordinates of the selected point the digital file to the image, which is called a link or ground control point (GCP).

A variety of factors can introduce error into the georeferencing process. These include:

- Older technology and equipment used to create older photos.
- Incomplete records kept about photo. Examples of information to record include scale, camera angle used, lens distortion, and atmospheric refraction information, which can affect the photo quality and help in determining the level of accuracy obtainable. Current technology may be able to compensate for some of these factors. This information should be stored in metadata.
- Paper photos degrade over time, creating distortion of scale and pixel quality. Try to scan the original diapositives to get highest quality images.
- Misidentifying common points, not using enough links or GCPs, and not proportionally spacing the links or GCPs throughout the image can cause error.

No procedure will consistently create the same amount of error nor is there a defined amount of acceptable error. Georeferenced images are only as good as the coverage or image used to transfer coordinates. The National Map Accuracy Standards (NMAS), published by the USGS, states "maps scales larger than 1:20,000, not more than 10 percent of the points tested shall not be in error no more than 1/30 inch and maps scales smaller that 1:20,000, 1/50 inch". This level of effort will be difficult to match when georeferencing older photos, but can be used as a guideline. Aerial photo images should be georeferenced several times to find the best match. The final georeferenced image should be clearly identified with a unique filename and all information about it (RMS error, # links, camera angle, scale, etc.) should be stored on the **Metadata Form** and within Arc/Info.

Use these guidelines to georeference an image using Arc/Info:

- Use the **Register** command to pick the links between the image and the coverage. Using the links as control points, **Register** calculates the amount of scaling, rotating and translating required to align the image to map coordinates.
- Pick links of common features that are easily recognized on both the image and coverage.
- If using roads as common features, try to pick the center of the road on the image and the coverage.
- It is important to pick common points that are consistently spread throughout the image. This allows better control and uniformly links the image to the map coordinates. Areas with a high density of links will offer better control in that area only.
- Choose at least 3 common features. There is no general rule as to the number of links that will be required to register an image. Some images will require more links than others; each image will have to be handled on a case-by-case basis. Try to use at least 10-15 links to cover the whole image.
- Test for errors by either locking the image, which will temporarily position the image over the coverage, or performing a registering test. These two methods will give you the best view of the error incurred. Locking the image will let you visually see the error or distance between the image and the coverage. The registering test (**Edit | Register** in the window with the image in it) will bring up a window that shows the x, y coordinates for the links. The distance between the true coordinates (the x, y location on the coverage) and the calculated coordinates (the x, y location calculated from the registration). The difference between the two coordinates should be minimized. **Register** calculates the links x, y based upon the assumption that all links are of equal quality. If a link has a large offset distance, it might be a high-quality link and if deleted will not guarantee a better registration. Use a combination of locking and registering to lower the error.
- Once you have chosen the number of links and the image matches well, save the transformation and run the **Rectify** command. Arc/Info will create a world file (.tfw for TIFF files or .jgw for JPEG files), that stores the map coordinates of the image.

Use these guidelines to geo-reference an image using ERDAS:

- ERDAS IMAGINE provides tools for simple linear corrections as well as for image-to-image registration or image-to-map rectification using ground control points. For georeferencing choose the following:

    - Display the image in viewer.
    - Select **Raster** | **Geometric Correction.**
    - Select **Polynomial** (as the Geometric Model).

- Select the **Set Projection**, **Add/Change Projection** and select the categories as "US State Plane - Nad83" and the projection as "California IV". Map units should be set to feet. Hit the **Apply** button.
- Finally select your reference source as a "vector coverage" or "image", then select the file.
- Start choosing the GCPs.
- Resample image using Nearest Neighbor and save the file as another name. Save in the project directory under /graphics/scanned/georeferenced/ which are organized by year. Save the file in these formats: JPEG, TIFF, or IMG. These all work with ArcView and Arc/Info.

- Pick GCPs of common features that are easily recognized on both the image and coverage.
- It is important to pick common points that are consistently spread throughout the image. This allows better control and uniformly links the image to the map coordinates. Areas with a high density of GCPs will offer better control in that area only.
- Choose at least 3 common features. There is no general rule as to the number of links that will be required to register an image. Some images will require more links than others will; thus, each image will have to handled on a case-by-case basis. Try to use at least 10-15 links to cover the whole image.
- It is important to pick common points that are consistently spread throughout the image. This allows better control and uniformly links the image to the map coordinates. Areas with a high density of GCPs will offer better control in that area only.

Use these guidelines to georeference an image using ArcMap:

- Open an ArcMap session, Navigate to **View, Toolbars** and check **Georeferencing.**
- To successfully georeference a scanned aerial photo, you will need an existing base map or other vector data (i.e., roads, buildings, etc.) already created in the desired coordinate system. These data will be used as a guide to create reference points for the new aerial photo.
- Turn on all layers and zoom to existing projected data (i.e., roads or other vector type data). If you are familiar with the area your photo will cover, zoom to that area in the view. Next from the Georeferencing dropdown menu, choose **Fit to Display**. Your scanned photo will appear in the view with your already projected data.
- Click the **Control Points** icon on the Georeferencing toolbar.
- Looking at the aerial photo, we need to match our projected data to the raster image. For example, a road intersection on the photo to the same known projected data location.
- Once you have identified a match click the spot on the aerial photo (a crosshair appears). Move your cursor to the position that occupies the same space in the projected data and click again. We have successfully linked our projected data to the photo. Continue to add control points until your projected data accurately overlays the aerial image.

   NOTE: The more control points created, the more accurately ArcMap can calculate the space shared between the projected data (through control points) and the image.

- Track your RMS error by clicking the link table (last button on the georeferencing toolbar) a lower RMS is desirable and personally have found an affine transformation (1st order polynomial) to work best. You may choose to save the link table once you have created all your control points. This table (once saved) can be reloaded at anytime if the photo ever needs to be georeferenced again.
- Next, from the Georeferencing drop down menu, choose **Rectify.** A **Save As** box appears. Resample

Type is **Nearest Neighbor** (for **discrete data**). The final step is to create a path to the directory you want the output raster (new aerial photo) to go. Once finished, click **OK**.

- Repeat steps 1 thru 9 for entire tile set of photos then continue to the Mosaicing procedure explained below.

4.4   Mosaicing

Use these guidelines to mosaic an image using ERDAS:

- Click the **Viewer** button opening a view. Click the open directory button (icon under file) and open a single tile that will be part of your mosaic.
- Click the **Show information icon** below the word view. This window provides all the information about your image. All these information aspects about the image must be complete in order to mosaic. If any information is missing:
  - Click **Edit** and choose **Compute Pyramid Layers** (note that if you are computing a color photo, you actually may be manipulating three bands of color. Be patient).
  - Click **Edit** again. Choose **Compute Statistics**. Again, if you are computing statistics for a color photo it will run through all three bands.
  - Next we will change the projection. Click **Edit** and choose **Change Map Mode**. Here is where you set the projection. Choose your units and projection.
  - Next, click **Edit** again and choose **Add/Change Projection**. Click the **Standard** tab to choose a normal. Now we must clip the images to remove access borders.

- Click **View, Scale** and choose **Image to window**. This will bring your whole image into view. Click the **dataPrep** button and choose **Subset Image**. Click the Inquiry Box button. Shift and manipulate the box until surrounds the image you would like to keep. Choose a new name and directory for your subset image. Check the **Ignore Zero in Output Stats** box. Click **OK.** Close windows and Viewer, and open a new viewer to view your recently created subset image.
- Click the **dataprep** button and choose **Mosaic Images**.
- Once the Mosaic Tool screen appears, choose **Edit**, and **add images**. Highlight and add to your subset images. You will notice all the images listed in the **Add Images for Mosaic** display. From this display, double click each image you wish to include in the mosaic.

  NOTE: If your image outlines do not line up or your pattern looks off in the mosaic tool screen for any reason, first check that the statistics have been calculated and the projection defined for each subset image.

- Once you have added all your images into the Masaic tool, click **process**, and choose **run mosaic**. Navigate to the directory you want to save your mosaic in, name the file, and save (be sure to save as an .img file. This will guarantee better results). Check the Output a Common Look Up Table box and click the **OK** button. The Mosaic process may take a very long time; i.e., 15 to 30 minutes depending on the size of your subset images, and will use all your computer's RAM. Be prepared.
- Once the Mosaic has run, close the Mosaic tool window, and open the new Mosaic in a viewer window. Open the file, click **view**, click **scale** and select **image to window**. Your Mosaic is now complete. For problem-free use in Archview, be sure to visit the ESRI website for current patches pertaining to .img files.

5   RECORDS

All image files must be stored under the project directory, under graphics/scanned/georeferenced/ and then organized by year.

6   PERSONNEL

It is desirable to have a staff member that is knowledgeable of the project area and is experienced in ERDAS and Arc/Info georeferencing procedures.

7   REFERENCES

Geospatial Positioning Accuracy Standards - Part 3: National Standard for Spatial Data Accuracy, FGDCSTD-007.3-1998.

United States National Map Accuracy Standards – USGS Mapping Information
http://rockyweb.cr.usgs.gov/nmpsts/nmas647.html.

Photogrammetric Engineering & Remote Sensing Magazine April 200 Issue – Article on "Accuracy Assessment of Wetland Boundary Delineation Using Aerial Photography and Digital Orthophotography" By Jeffrey Barrette, Peter August and Francis Golet.

Arc/Info Online Help

ERDAS Online Help and Tech-support

8   ATTACHMENTS

Figure 3 – Metadata form

MACTEC - Data Collection & Metadata Form

Date:_____
Collector Name:_____

Explain the Data you are collecting:

Data Source: Paper map__   Photo__   CAD__
                Other (specific)_____
Date of Source:_____
Source Title:_____
Source Scale:_____
Company that provided Source Data:_____

Collection Method: Digitized__GIS(AV or AI)__Image Tracing__Scanning__

Destination File Name(include path):_____

PHOTO ONLY
1) Was photo scanned from photo prints?
2) Was photo provided orthorectified and in digital format?
3) Did MACTEC Georeference scanned photo?   If so explain procedure:

4) Source Resolution:_____ dpi
5) Estimate error +/- _____ units _____

DIGITIZED ONLY
1) Specify the data and file you are using to register Source Data:
    Date:_____
    Source:_____
    Company that provided registering data:_____
2) Explain method of registering Source Data:

3) Collection Accuracy (average error in feet):

CAD/DGN ONLY
1) Specify the CAD Layer or DGN Level the Source Data originated:
2) File name of CAD/DGN drawing:

QC
1) Date of form QC:_____
2) Person performing QC:_____   Signature:_____

Figure 3

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.
GLOBAL POSITIONING SYSTEM (GPS) CONVERSION

1   PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that historical and newly-collected GPS data are consistently exported into a format usable for this project.

2   SUMMARY OF PROCEDURES

Historical GPS data in its original form needs to be stored as an ArcGIS shapefile for spatial analysis. Any new GPS data used to confirm the locations of historical Fort Ord features also needs to be exported to an ArcGIS shapefile or stored in SQL Server Database. All GPS point data will be stored within SQL Server and line and area features will be stored in shapefiles. This SOP will explain how to convert GPS data and store it in shapefiles or in SQL Server. There are 2 steps to converting GPS data: 1) Correcting data, and 2) Exporting data to either ArcGIS or an ASCII file (for subsequent import into SQL Server database).

3   EQUIPMENT

The following equipment is required:
- One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
- SQL Server (current version) connection, Pathfinder Office (current version) and ArcGIS (current version).

4   PROCEDURE

4.1   Correcting Data

Historical GPS data from other companies should already be corrected. All new GPS data needs to be corrected to maximize accuracy and precision. Pathfinder Office software can be used to correct GPS data collected using Trimble GPS equipment.

Follow these steps and recommendations to correct GPS data:

- Create a new Pathfinder Office project with the proper coordinate system (California Stateplane Nad83, Zone 4, US Survey Feet) before opening the .ssf file (Trimble rover file). This is important because the rover file will be converted to the coordinate system of the project file.
- Open rover file. All original rover files should be placed under the project directory at /gis/gps/original/date (ex. 0728).
- Choose **Utilities | Differentially Correct** to start correcting the rover file.
- Conduct an internet search to pick base files from a base provider that is closest to the GPS site.
- Select the directory /gis/gps/corrected/date (of original rover file) to store the corrected file (.cor).
- If the base files do not transfer correctly, try the next closest base provider.
- Put in the proper coordinate system again (see above) and correct the files.
- Once the correction process is complete, view the file to check the results.

4.2   Exporting GPS Data

Corrected files can only be read in Pathfinder Office software, so the data needs to be exported to either ArcGIS or ASCII format. Lines and area features are stored in ArcGIS shapefiles; point data are stored in SQL Server.

Follow these steps to export data to an ArcView shapefile:

- Choose the .cor file to be exported.
- Go to **Utilities | Export** and pick the directory /gis/gps/export/date (of original rover file) to export the shapefile.
- Choose the export setup **Sample ArcGIS shapefile Setup**. Adjust the setup setting, check the proper attribute checkboxes and then double-check the coordinate system and units. Make sure to check the following attributes for export:
  - Correction Status
  - Receiver Type
  - Date Recorded
  - Data Dictionary.
- Several Tabs within the export tool need to be configured: Data Tab, Output Tab, and the Position Filter Tab.
  - Under the Data Tab, make sure you check the box next to **Include not in Feature Positions**.
  - Under the Output Tab, select **Combine all input files and output to the project export folder**.
  - Under the Position Tab, select **Filter by GPS Position info** and then make sure all the boxes below are checked off.
- Export shapefile.
- Depending on the data dictionary used to collect the GPS features, there could be many shapefiles. Use ArcGIS to consolidate the lines or area shapefiles into one shapefile and save in /gis/arcgis/shapefile/topic (of shapefile).

Use these steps to export GPS point data to ASCII file format:

- Choose the .cor file to be exported.
- Go to **Utilities | Export** and pick the directory /gis/gps/export/date (of original rover file) to export the shapefile.
- Choose the export setup **Sample Configurable ASCII Setup**. Adjust the setup setting, check the proper attribute checkboxes and double-check the coordinate system and units. Make sure to check the following attributes for export:
  - Correction Status
  - Receiver Type
  - Date Recorded
  - Data Dictionary.
- Several Tabs within the export tool need to be configured: Data Tab, Output Tab, Configurable ASCII Tab and the Position Filter Tab.
  - Under the Data Tab, make sure you check the box next to **Include not in Feature Positions**.
  - Under the Output Tab, select **Combine all input files and output to the project export folder**.
  - Under the Configurable ASCII Tab, select **One set of Files per Feature Type**.
  - Under the Position Tab, select **Filter by GPS Position info** and then make sure all the boxes below are checked off.
- Export ASCII file.
- Work with experienced database staff to import ASCII file into SQL Server.
- Inform the database staff of the GPS data coordinate system. Example: NAD83 CA SP Zone IV – for NAD83 California Stateplane Zone 4

5   RECORDS

All data should be stored in the SQL Server database or ArcGIS shapefiles.

6   PERSONNEL

Staff experienced in Pathfinder Office and GPS related issues is imperative.

7   REFERENCES

Pathfinder Office Help Files.

8   ATTACHMENTS

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

METADATA COLLECTION

1   PURPOSE

The purpose of this procedure is to ensure that Metadata is accurately and thoroughly collected while gathering historical data on Fort Ord.

2   SUMMARY OF PROCEDURES

Metadata are vital to the project success. Metadata are "data about data", which describes the content, quality, condition, and other characteristics of data. Metadata will be collected on all historical Fort Ord data acquired. There are 2 methods for collecting Metadata 1) Filling out **Metadata Form**, and 2) Loading Metadata into Arc/Info. Procedures for each of these methods are described in this SOP.

3   EQUIPMENT

The following equipment is required:
- One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
- Arc/Info (current version).
- **Metadata Forms** used to collect metadata, which will be stored electronically.

4   PROCEDURE

4.1   Filling out Metadata form

The **Metadata Form** (figure 3) helps collect valuable initial metadata. Historical data comes from various sources that need to be kept track of during the conversion into a consistent GIS compatible format (figure 1). Figure 1 details the point in the project when the form must be filled out. The **Metadata Form** will be used for the following:

- Digitizing, Scanning, Georeferencing, and Converting CAD/DGN (Microstation files) files into ArcGIS shapefiles.
- Writing down original file names, documenting where sources originated and GIS staff involved.
- Documenting methods and procedures in accomplishing historical data conversion steps (see figure1).

4.2   Loading Metadata into Arc/Info

Arc/Info has excellent pre-created tools ready to collect FGDC (Federal Geographic Data Committee) compliant metadata. Aerial photo images, ArcGIS shapefiles and Arc/Info coverages will all have FGDC compliant metadata stored in Arc/Info. FGDC compliant metadata on databases will be stored in conjunction with the tabular data. Due to the large amount of metadata fields provided by the FGDC, only those fields pertinent to this specific project and the **Metadata Form** will be used. All data collected from the **Metadata Form**, will be entered into Arc/Info.

5   RECORDS

All **Metadata Forms** will be stored in the project files. Metadata collected within Arc/Info will be stored with each individual shapefile.

6   PERSONNEL

Several staff members are required to enter the large amounts of Metadata. Knowledge of Arc/Info and the creation of the metadata is helpful for more efficient work.

7   REFERENCES

Federal Geographic Data Committee's Content Standards for Digital Geospatial Metadata, Metadata Workbook – Version 2.0, FGDC-STD-001-1998, June 1998 Version

8   ATTACHMENTS

Figure 3 – Metadata form
Figure 1 – Historical Data Source Integration for use with GIS

MACTEC - Data Collection & Metadata Form

Date:_____
Collector Name:_____

Explain the Data you are collecting:

Data Source: Paper map__   Photo__   CAD__
                Other (specific)_____
Date of Source:_____
Source Title:_____
Source Scale:_____
Company that provided Source Data:_____

Collection Method: Digitized__GIS(AV or AI)__Image Tracing__Scanning__

Destination File Name(include path):_____

PHOTO ONLY
1) Was photo scanned from photo prints?
2) Was photo provided orthorectified and in digital format?
3) Did MACTEC Georeference scanned photo?   If so explain procedure:

4) Source Resolution:_____ dpi
5) Estimate error +/- _____ units _____

DIGITIZED ONLY
1) Specify the data and file you are using to register Source Data:
    Date:_____
    Source:_____
    Company that provided registering data:_____
2) Explain method of registering Source Data:

3) Collection Accuracy (average error in feet):

CAD/DGN ONLY
1) Specify the CAD Layer or DGN Level the Source Data originated:
2) File name of CAD/DGN drawing:

QC
1) Date of form QC:_____
2) Person performing QC:_____   Signature:_____

Figure 3

HISTORICAL DATA SOURCE INTEGRATION FOR USE WITH GIS

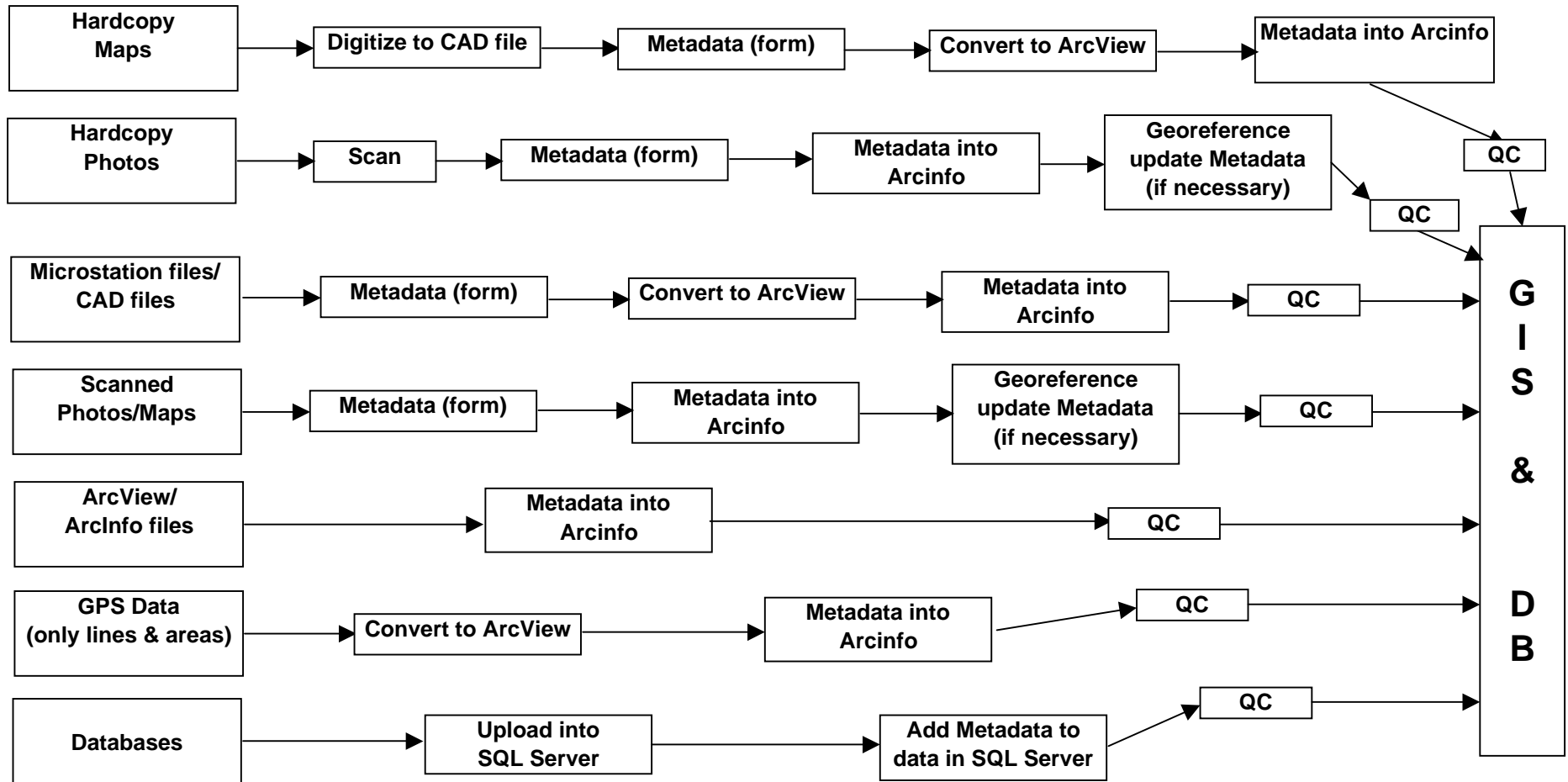**Historical Sources**   **Steps Needed**

| Hardcopy Maps | → | Digitize to CAD file | → | Metadata (form) | → | Convert to ArcView | → | Metadata into Arcinfo |

| Hardcopy Photos | → | Scan | → | Metadata (form) | → | Metadata into Arcinfo | → | Georeference update Metadata (if necessary) | → | QC |

QC

| Microstation files/ CAD files | → | Metadata (form) | → | Convert to ArcView | → | Metadata into Arcinfo | → | QC |

| Scanned Photos/Maps | → | Metadata (form) | → | Metadata into Arcinfo | → | Georeference update Metadata (if necessary) | → | QC |

| ArcView/ ArcInfo files | → | Metadata into Arcinfo | → | QC |

| GPS Data (only lines & areas) | → | Convert to ArcView | → | Metadata into Arcinfo | → | QC |

| Databases | → | Upload into SQL Server | → | Add Metadata to data in SQL Server | → | QC |

G I S & D B

Figure 1   8/10/2000

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

DATA QUALITY CONTROL

1 PURPOSE

The purpose of this procedure is to ensure that a systematic quality control (QC) procedure is used to evaluate all historical data.

2 SUMMARY OF PROCEDURES

All historical data collected and converted will go through a QC procedure to ensure that data were processed precisely and accurately. This SOP explains how data will be evaluated.

3 EQUIPMENT

The following equipment is required:
- One computer equipped with at least 512 megabytes of RAM and a microprocessor faster than 1 GHz.
- Current versions of SQL Server and, ArcGIS, and Arc/Info.

4 PROCEDURE

4.1 Metadata Form

A QC section is included with the **Metadata Form** (figure3). Every time the **Metadata Form** is filled out the project manager or other designated personnel will check the information on the form for completeness and accuracy. Upon completion the QC reviewer will sign and date the form. This form is then used to enter metadata to Arc/Info.

4.2 Final QC

The final QC review of all data should be performed after all metadata is loaded into Arc/Info. Data entered into the project SQL Server database should be QC reviewed using QC reports. Specific QC reports should be created with the support of the project team if none exist. Arc/Info and ArcGIS will be used to check geographic data for the following:

- Correct coordinate system.
- All the data needed for report has been collected?
- Completeness and accuracy of all points, line and areas. Are the map features appropriately represented in the GIS
- Discuss the error and accuracy of the data. This should already be very well documented in the metadata.
- Completeness and accuracy of metadata.

5 RECORDS

NA

6   PERSONNEL

The project manager will designate the appropriate personnel for the performance of QC. An experienced technician who created the data files should be available to discuss the QC review and make corrections as appropriate.

7   REFERENCES

8   ATTACHMENTS

Figure 3 – Metadata Form

MACTEC - Data Collection & Metadata Form

Date:_____
Collector Name:_____

Explain the Data you are collecting:

Data Source: Paper map___   Photo___   CAD___
                Other (specific)_____
Date of Source:_____
Source Title:_____
Source Scale:_____
Company that provided Source Data:_____

Collection Method: Digitized__GIS(AV or AI)__Image Tracing__Scanning__

Destination File Name(include path):_____

PHOTO ONLY
1) Was photo scanned from photo prints?
2) Was photo provided orthorectified and in digital format?
3) Did MACTEC Georeference scanned photo?   If so explain procedure:

4) Source Resolution:_____ dpi
5) Estimate error +/- _____ units _____

DIGITIZED ONLY
1) Specify the data and file you are using to register Source Data:
    Date:_____
    Source:_____
    Company that provided registering data:_____
2) Explain method of registering Source Data:

3) Collection Accuracy (average error in feet):

CAD/DGN ONLY
1) Specify the CAD Layer or DGN Level the Source Data originated:
2) File name of CAD/DGN drawing:

QC
1) Date of form QC:_____
2) Person performing QC:_____   Signature:_____

Figure 3

STANDARD OPERATING PROCEDURE
MACTEC Engineering and Consulting, Inc.

<div align="center">

SCANNING DATA COLLECTION

</div>

1   PURPOSE

The purpose of this procedure is to ensure that hardcopy maps and photos are properly and consistently scanned into a digital form.

2   SUMMARY OF PROCEDURES

Scanning creates a digital duplicate of a hardcopy document. There are many different types of documents that could be scanned including maps, photos or reports. These procedures are intended to cover scanning maps and photos only. Once scanned the digital copy can be saved into a variety of image files. Scanning is mainly a hardware and software process. There are 3 steps of the scanning process 1) selecting the scanner 2) scanning the document 3) choosing software to edit and convert images. Procedures for each of these steps are described in this SOP.

3   EQUIPMENT

The following equipment is required:
- One computer equipped with at least 512 megabytes of RAM and a microprocessor 1 GHz or faster.
- Adobe PhotoShop (version 5 or greater) and Scanning software (usually comes with scanner).
- A scanner capable of scanning 11"x17" documents.

4   PROCEDURE

4.1   Selecting the Scanner

A scanner converts the document into a digital image file. It is very important to pick a quality scanner, because the quality and usability of your image are directly affected by it. Use these guidelines in choosing a scanner:
- The scanner should be able to scan in True color, Grayscale or black & white
- The most important scanner specification is its optical resolution, which is typically quoted in dots per inch (DPI). A scanner's resolution refers to the level of detail that the scanner is capable of capturing and converting into digital form. The higher the resolution, the better. (The drawbacks of higher resolutions are that the images take up a lot more hard drive space and take much longer to scan.)
- Choose a scanner that can create images greater than 600 DPI (min to make good quality images).
- A scanner that scans 11x17 inch documents will allow you to do a good portion of the scanning in-house and will help keep costs down

4.2   Scanning the Document

The quality of the document and the scanner setting can also effect the scanning process. Follow these instructions and recommendations when scanning documents:

- Choose a document that is clear of wrinkles, rips, and folds.
- Documents with clean and crisp text will reproduce the best.

- Place the document flat on the scanner.
- Try to use a photo that covers a large geographic area (preferably > 1:1200 scale).
- Set the amount of DPI at which you are going to scan the document. Please scan at a minimum of 600 DPI. It is important to scan at the highest DPI as is efficient (the higher the DPI the longer the scanning time and file size), the DPI can always be lowered to save disk space, but never increased.
- Scan by True Color if you want to scan color documents or Grayscale if you want to scan aerial photos. Grayscale will allow you to clearly see small details in aerial photos. Black & white scanning is for the text in reports.
- Pick the type of image that you want the scanner to create. Jpg files create smaller file sizes, and .tif files can capture details better than .jpg files, but have large file sizes and longer scanning times.
- Scan the document.
- Fill out the **Metadata Form** (figure 3).
- All images need to be stored within the project directory under the /graphics/scanned/ directory and organized by year.

In the case where the document is larger than 11"x17", the document can be sent to a company that has a large scanner. The same instructions stated above should be applied when out-sourcing the scanning.

4.3   Choosing Software to Edit and Convert Images

Images can be used for various purposes including posting in web pages (where image type and size are important) and georeferencing images (where high image resolution is important). It is important to have the right software to handle these different scenarios. Choose software that can do the following:
- Cut, trim, or shrink the size of the image
- Adjust the dpi of the image to lower the image file size
- Convert the image into many formats (especially .pdf, .tiff, .jpeg and .bmp formats)
- Merge two or more images together into one image
- Edited images need to be saved and stored within the project directory under the /graphics/scanned/ directory and organized by year.

All these tasks can be handled by many different software. Image manipulations and editing are best accomplished with Adobe Photoshop 5.5.

5   RECORDS

All images should be stored within the project directory under the /graphics/scanned/ directory and organized by year.

6   PERSONNEL

It is desirable to have a staff member that is experienced scanning procedures and modifying images.

7   REFERENCES

8   ATTACHMENTS

Figure 3 – Metadata form

MACTEC - Data Collection & Metadata Form

Date:_____
Collector Name:_____

Explain the Data you are collecting:

Data Source: Paper map__   Photo__   CAD__
                Other (specific)_____
Date of Source:_____
Source Title:_____
Source Scale:_____
Company that provided Source Data:_____

Collection Method: Digitized__GIS(AV or AI)__Image Tracing__Scanning__

Destination File Name(include path):_____

PHOTO ONLY
1) Was photo scanned from photo prints?
2) Was photo provided orthorectified and in digital format?
3) Did MACTEC Georeference scanned photo?   If so explain procedure:

4) Source Resolution:_____ dpi
5) Estimate error +/- _____ units _____

DIGITIZED ONLY
1) Specify the data and file you are using to register Source Data:
      Date:_____
      Source:_____
      Company that provided registering data:_____
2) Explain method of registering Source Data:

3) Collection Accuracy (average error in feet):

CAD/DGN ONLY
1) Specify the CAD Layer or DGN Level the Source Data originated:
2) File name of CAD/DGN drawing:

QC
1) Date of form QC:_____
2) Person performing QC:_____   Signature:_____

Figure 3