DETAIL MAPPING BY THE USE OF ENLARGED AERIAL PHOTOGRAPHS

James W. Littleton, Engineer
Mapping Section
Little Rock Engineer District

DURING the period when the volume of military construction in the southwestern part of the United States was very large, the Mapping Section of the Little Rock Engineer District was often assigned urgent mapping projects. As a larger percentage of the more experienced survey and mapping personnel were in the armed forces, some of these assignments could not have been completed on schedule had the common procedures for surveying and mapping been used.

Probably the most critical assignment of this type was that requiring the detailed mapping of five auxiliary airfields, each approximately one square mile in area, in about seven days at a time when only two topographic survey parties of four men each were immediately available to accomplish the field work. A very successful method involving the use of enlarged aerial photographs was devised to meet the situation. By using this method, the detailed maps were obtained for this assignment in about one-fourth of the time that they could have been completed by the usual plane table methods and they were found to be very accurate.

The following steps were used to accomplish the mapping:

a. A small scale aerial photograph covering the area to be mapped was enlarged to approximately the desired mapping scale.

b. The enlarged photograph was used as the plane table base sheet. Contours and critical elevations were added by plane table and alidade and other pertinent data such as crop outlines, cultural features and all obstructions to construction were surcharged onto the sheet in pencil form.

c. The contours, topographic features, and other data were inked on the sheet by a draftsman using standard conventional mapping symbols.

d. The irrelevant photographic emulsion was then bleached from the photograph to make a line map.

e. A standard border line and title block mask was added and the line map photographed.

f. The resulting film negative was opaqued and reproductions made from it to the exact scale desired.

To give a better conception of the method, a more detailed description of some of the procedure follows:

Enlarging the Aerial Photograph. The most recent aerial photograph negative on which the area to be mapped occurred was selected. On the negative this area was masked, blocking out the area that was not to be used. Preliminary scale restitution studies were made of the negative using railroad alignments, highway tangents, section lines, etc. The usuable area was then enlarged on double weight, semi-matte photographic paper (P.M.C. No. 9) to the scale required for the detailed survey. The approximate scale of the negative being known from the scale restitution studies, the amount of enlargement was figured. The photograph negatives were at a scale of approximately 1:20,000 and they were enlarged to a scale of 1:4,800 or from 1″=1667′ to 1″=400′. The enlarged photograph was then used as a plane table base sheet.

Field Surveys. The first field operation was to make a scale check of the enlarged photograph sheet. This was done by selecting two distinct points on the sheet that were at least one-half of the sheet length apart, measuring that distance on the ground and then comparing the measured distance with the scaled distance. Two or more of these scale checks were made in different portions of the sheet and a mean scale taken as the actual mapping scale. Special proportional scales for the nearest five feet of the determined scale were furnished to the topographer for plotting stadia distances. If a mean scale check of the photograph was found to be $1'' = 408'$, a scale of $1'' = 410'$ was used and the topographer made allowances for the differences in the plotting and the determined scales by using the proportional scales. It was not necessary for the topographer to locate any of the topography by instrument methods but he simply outlined in pencil the fences, section corners, houses, woods, pasture areas, and crops. He also made special notes in regard to houses, wells, power lines, road classifications and other data that might have a bearing on construction operations. The addition of the critical elevations that could not be identified in position was the only plotting or location work required since the enlarged photograph furnished the topographic data.

Drafting. When the surveys were completed, the enlarged photograph was inked with waterproof ink by a draftsman. The inked sheet was compared with a contact print of the aerial photograph to see that none of the topographic features had been omitted since the enlargement might not be as sharp as the original photograph. A title block containing a graphic scale to correspond to the determined scale and a standard size sheet mask were prepared for later use.

Bleaching. The inked photograph was converted to a line map by bleaching out the photographic emulsion. The bleaching solution was composed of one ounce of potassium ferricyanide and four ounces of sodium hyposulphite added to a quart of water. The bleach was made permanent by washing the sheet in regular photographer's hypo solution. There are other bleaches that may be used with equal success such as iodine or a mixture of potassium chlorate, sulphuric acid and water. It was not necessary to ink the sheets before bleaching, as pencil lines will remain after the bleaching process. The resulting line map was next dried and the standard sheet outline and title block taped to the map.

Reproduction. The line map was photographed and the resulting film negative opaqued to remove small flaws that may have been left on the map in the bleaching process. If the scale of the original map was not the standard scale desired, an enlargement or reduction to exact standard scale was made. Any number of copies of the positive type of reproduction could then be reproduced directly from the final film negative.

The accuracy of the maps which were made by the method described above have been thoroughly tested in that they were used in the actual construction of the auxiliary airfields and were found to meet all the requirements of a detailed map. It should be mentioned, however, that the sites were in flat areas and no notable distortions occurred in the scale of the photograph due to differences in elevation as was shown by the very even scale checks. The method naturally works better in the mapping of flat delta lands for which the ratioing of individuals photographs is not necessary.

Tests failed to show changes in scale of the paper sheet due to the bleaching process. Minor changes in the sheet length (about the same as for heavy detail paper) were noted with changes of atmospheric conditions while working with the sheet in the field. The outstanding feature of the method in regard to accuracy was the detail obtained. A topographer will not get the details on "white

sheet plane table" mapping that an aerial photograph will help to portray, no matter how careful he may be with his work.

The practice of bleaching aerial photographs is not new since it has been mentioned in Army Training Manuals, but it is believed that its application to this type of detail mapping is not practiced. This article is written with the hope that greater developments may be had by its use. This office has completed some successful survey report mapping using, instead of a single enlarged aerial photograph, a photograph of a controlled mosaic. The writer visualizes the possibility of postwar mapping of relatively flat areas for survey report studies being accomplished in the following manner:

a. Establish base horizontal control for controlled mosaic using the Army's M-1, Land, Odograph instrument.

b. Use "Precision altimetry" method as described by Professor Kissam in issue No. 1, Volume X of Photogrammetric Engineering to add contouring to the controlled mosaic.

c. Apply the principle described above to obtain a finished map.