PLANIMETRIC MAPPING IN THE SOIL CONSERVATION SERVICE*

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As HAS been the case in so many other forms of endeavor, map making in the Soil Conservation Service owes its beginning to necessity. In this instance there was an urgent need for special types of maps at scales larger than those in general use and in the majority of cases covering areas where no reliable map of any kind was available.

In carrying on their physical survey operations, the soil scientists of our Service felt the need for maps either at 4″ equal 1 mile, or in certain instances at 8″ equal 1 mile, on which to surcharge the results of their field surveys pertaining to type of soil, degree of erosion, percentage of slope, and present land use.

As a base for field tabulation, and in preliminary planning, the aerial photographs themselves proved of great value. Especially was this true because sufficient time to prepare maps for this purpose was not available. However, for numerous reasons familiar to us all, the photographs were not sufficiently accurate or versatile to meet the demands of general operations or for permanent records.

In keeping with the other units which make up the Soil Conservation Service, the original mapping organization was small and had as a program a few areas averaging approximately 50 square miles each. As the Service became more completely organized and grew capable of handling a larger amount of work, expansion took place in the form of additional areas larger in size for Service operations. The mapping organization grew accordingly to meet the larger program and is now preparing maps on a schedule of from 6,000 to 8,000 square miles per year, the scale in most cases being 4″ equal 1 mile.

The methods we are using to meet this program came from numerous sources. They include the results of investigation by other agencies, tests, developments, and investigations by our own Service, and the gradual changes due to new ideas on the various small steps which make up the whole operation by employees in the course of their work.

We do not feel that the methods I am going to explain are the complete answer to the problems of mapping. We are not completely satisfied with present results, and are constantly on the lookout for anything in the way of improvements.

However, we are on a production basis and have a job to do, and although various obstacles had to be overcome, the result is a map of high quality.

In beginning operations on an area, three sets of photographs are usually required. One set is used to compile the planimetric base map; another is used by the Map Control Section in preparing the control net; and the third is used in making the physical survey of the area.

On the set of photographs to be used in compiling the base map, lines limiting that portion to be used per photograph are drawn, since the overlap causes repetition of coverage, and the drainage pattern is carefully delineated by means of stereoscopes. This work is then accurately transferred to the set of photographs to be used in the physical survey. This assists the technicians in the field in orienting themselves, especially in wooded country, gives a field check on

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our office delineation, and, as will be seen later, simplifies the work of transferring the physical survey information from the photographs to the maps.

The photographs for the physical surveys, with this information appearing on them, are sent to the field. Soil technicians record on them the physical conditions of the land. A system of symbols is used for recording this information on the photographs.

Various planimetric data are also shown on the photographs in addition to the physical survey data. When the soil technicians are covering the area they are required to designate road classifications, names and titles, buildings and structures, and all the other features required on maps of this type. This gives a rather complete edit of such items and answers a new problem which has arisen with the later mapping methods. In former methods of mapping, where the detail was obtained from plane table or sketches in the field, the surveyor was on the ground as the map was being compiled and therefore could collect all such data as he proceeded, whereas with present day methods miles and miles of area are mapped without contact with the field.

The information surcharged on these physical survey photographs will appear later on our planimetric maps.

The methods we use for control for our maps were covered by Mr. Harry T. Kelsh in a previous issue of this magazine, but for the benefit of those who were unable to read that article, I will touch on the subject briefly.

We make use of any control previously run by other agencies, adding to this additional traverse or triangulation where necessary. The slotted templet method of radial triangulation is used to extend the net and establish control points on each photograph for map compilation. The fundamental principle of this method is that on a vertical photograph there is no displacement at the center of the photograph, due to relief, and the angular relationship of two picture points anywhere on the photograph, as measured from this center, remains unchanged regardless of relief displacement.

Sheet aluminum is used for the original base sheets. This is obtained in 5 foot×10 foot sections and has a thickness of approximately 15/1,000 of an inch. Where more than one section is necessary, the sections are carefully taped or soldered together. On this material the mapping grid is laid out and the ground control points plotted, the scale being usually 4″ equal 1 mile. It is the practice of the Soil Conservation Service to locate ground control points on approximately every fifteenth photograph along the flight, and bridge between these points with slotted templet radial control.

A templet of bristolboard is substituted for the photograph and, by means of machinery, slots are cut along radial lines from the perforated center, corresponding to those radiating to picture points from the center of the photograph. Eight slots and a center hole are the usual number appearing on each templet. Considerably more would be desirable for later compilation purposes but this not only would weaken the strength of the cardboard but tends to interfere with proper operation of the method.

A small pin resembling a collar button, having a hollow shaft, is placed through the center hole and in each of the slots of the cardboard. As these pieces of cardboard are fitted together at their corresponding points by these pins they assume the same relative position to each other which was true of the photographs when taken.

By soldering the pins representing those points which were located by ground control to the base sheet, the remaining points are forced to assume their true positions on the map grid. These can then be located on the map grid by sticking a needle through the hollow centers.

We now have the center of each photograph located on our mapping grid and enough points to establish its true orientation. However, over the surface of each photograph there are displacements due to relief, the amount depending on the variation in elevation of the area concerned.

To remove these errors of displacement we continue or intensify our radial intersection work.

Our present method of accomplishing the next step in the compilation work requires that the control obtained by the slotted templet method be located on a transparent material. For this purpose we use sheets of a cellulose material called cartaloid.

The cartaloid sheets are placed over the aluminum base sheets and the control is copied along with the grid intersections.

By careful study with the stereoscope of the set of photographs to be used in compilation, sufficient points are selected on or near the features which are to be shown on the finished map to insure their true location regardless of the varying scale.

We then place the photographs one at a time under the cartaloid and, after orienting them with the slotted templet control, etch with a needle point a line through the additional or auxiliary control points that have been selected. As this process is carried on from photograph to photograph the auxiliary control points are located in their true positions on the map grid by the intersections of the etched lines. This gives a very good check on the slotted templet assembly, for if triangles appear in these etched intersections some error has occurred, and the lay-down must be made over.

Compilation for the final map is carried out on sheets of high quality drafting paper mounted on sheet aluminum. The plane co-ordinate systems, as set up by the U. S. Coast & Geodetic Survey for each state, are used for the map base grid. By using a sheet size which will cover an area 15,000′ by 20,000′ at the 4″ equal 1 mile scale, we approach the maximum coverage of the multilith presses which we use in reproducing our maps. The over-all dimensions of these sheets are 14″×20″.

Since with a plane co-ordinate grid the sheet size does not vary, we are able to use one master grid for sheets anywhere in the United States and thus eliminate possible errors in grid construction. This grid appears on an accurately marked glass negative. Each sheet is prepared by sensitizing the paper and printing the grid along with other useful identification marks in nonphotographic blue.

In order to eliminate any appreciable error from the expansion or contraction of the cartaloid, each 5,000 foot grid is matched separately in transferring the control points to the metal mounted sheets. This reduces the area over which distortion may occur to a 4″×4″ section; and the error is therefore practically negligible.

We have now reached the point where transfer of detail from the photographs to the base map takes place.

To accomplish this, the vertical reflecting projector is used, the photographs being placed in the projector and the image projected to the map sheet resting on the table. The sheet is then shifted until the center of the photograph falls on its located position on the map sheet and the control points on the photograph agree radially with their plotted positions. By manipulating the levers of the instrument the scale of the projected image is changed, and as the points in each small portion of the photograph come into coincidence with their plotted positions on the map sheet this small portion is at the correct scale and can be transferred. By copying each small portion at a time, the map is gradually assembled. A pencil is used for this so that any immaterial information copied from the pictures, which may not be required later, can be erased easily. It is readily seen that with this method the accuracy of the map compilation is not affected by the variations in the scale of the photographs.

After the sheets have been projected they are passed on to the draftsman. The cultural features are then carefully inked in, using standard symbols.

When all the cultural features have been drafted in ink on the sheets covering an area, a photostat copy, with the penciled drainage showing faintly, is made of each. These photostat copies are turned over to one man, who takes the physical survey photographs, and all existing map information, outlines the location of lettering required on the sheets, and makes a list of the lettering falling on each sheet and the type size.

The float lettering method which we use is probably familiar to most of you. It consists of setting up the required names in type and printing them on a thin tissue paper, using a small hand press. After the printing is complete the paper is soaked in an adhesive solution and allowed to dry on a frame.

The photostat copy with the lettering layout is turned over to the draftsman along with the printed lettering. This he places in correct position and fixes by applying moisture. The lettering can readily be changed or removed by applying moisture again.

When the lettering has been completed, each sheet is sent to the Reproduction Section, and a glass negative is made. This negative will be used to make the black printing plate. The sheet is then returned and the drainage is inked in. Again a glass negative is made (at $1\frac{1}{2}$ to 1 scale) and a blue-line print is made on a sensitized metal mounted sheet. Another glass negative is made and the cultural features are painted out. This negative is used to make the blue printing plate.

The blue-line sheet which I have just mentioned is returned to the Projection Unit. On this occasion the physical survey photographs are placed in the projectors and the image projected to the blue-line sheet. Where, before, the radial control points were used to work out the variations in scale, the planimetric features are now used. The boundaries and symbols are carefully copied in pencil on this blue-line sheet. These are later inked in by the draftsman, using contour pens and Leroy lettering guides, the Leroy being used instead of the float lettering because setting the numerous symbols in type and locating them on the sheet proved too expensive. By using the enlarged sheet and reducing again, the Leroy lettering proves very satisfactory.

At the completion of this step a sheet of cartaloid is placed over the sheet which now contains the boundaries and symbols, and the land use is placed on the cartaloid. Again the float method is used, the symbols being printed from plates on the hand press and secured to the cartaloid. The cartaloid is then removed and a glass negative is made of both the boundary and symbol sheet and the cartaloid land use sheet. These make up the brown and green printing plates.

The map is printed in the four colors mentioned above and contains all the information necessary for conservationists in carrying on their field operations but it is not readily clear to the average farmer or layman. To make these maps more useful to the general public interested in agriculture, additional information is placed on the maps.

The scientists of the Soil Conservation Service take the soils, erosion types, and degrees of slope appearing in an area and divide their various combinations into five groups according to their land use capability. These five groups consist of:

1. Suitable for cultivation without special practices.
2. Suitable for cultivation with simple practices.
3. Suitable for cultivation with complex or intensive practices.
4. Not suitable for continuous cultivation.
5. Not suitable for cultivation.

These groups are shown on the maps by tints. The five colors, red, yellow, blue, orange, and green, are obtained by using three original plates and overprinting. These plates are obtained by placing screens on additional metal mounted sheets in a manner similar to that for obtaining land use, or by use of a halftone screen and painting the negatives.

This concludes all the information appearing on the maps at the present time; and is probably all we ever will show since additional information would tend to reduce their general usefulness.