

PHOTOGRAMMETRY IN HIGHWAY ENGINEERING

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PHOTOGRAMMETRY does and will in the future play an important part in highway location and design. A great field of usefulness has been found for air photos. To the Highway Engineer, a new instrument is provided which may be used for:

(1) Reconnaissance studies of the whole area between controls or termini of a proposed road, the selection of a preliminary line or lines, and comparative studies of alternate lines;

(2) Determination of soil types, the location of possible gravel pits, quarries and material sources;

(3) Preparation of contour maps upon which the detail location may be projected and the plans for the project drawn.

I do not mean that air photos will entirely take the place of methods previously used for carrying out these duties. I mean that in some cases they will take that place, and that in many other cases, air photos will be used to supplement information obtained by the older conventional methods.

The use of air photos in the preparation of contour maps has been developed by the Geological Survey. A number of highway departments have used the aerial survey in the preparation of contour maps to the 100 foot scale, on which the road is located and planned. I will not discuss these uses at any length here except to say that the decision as to the adoption of the air methods, rather than the ground method of producing such maps, should be based upon the probable relative costs of the two methods and the time available in which to obtain the required information. Ground methods may often be cheaper and more satisfactory for the road location use. In other cases, air methods will be quicker and cheaper considering the additional information over a wider spread of country that they will provide.

In our work, I have found air photos of great value in the reconnaissance examinations of the country between termini of a proposed road, and in the comparison of two or more preliminary lines. I have found that an amazing amount of information can be obtained from air photos that have already been made of much of the country, that these photos may be used to excellent advantage, at small cost to us, and that not only may considerable savings be made, but that a much sounder line for the highway may be selected.

Air photos are particularly useful in the selection of preliminary lines in the vicinity of population centers. Here, because of the great investment in buildings the selection of an economic location for a project such as the Washington-Baltimore Parkway is more affected by real estate developments and land costs than by the contours of the land itself. On the air photos, routes may be laid out, and study made of the effect of these routes upon existing land values, and existing highways. Adjustment of lines may readily be made to reduce land costs. On these photos, we see at a glance whether the land is wooded, pasture or tilled, where the buildings are, and where the present roads are.

In all locations, swamps may be spotted, landslide areas noted, and the expert may even identify soils, thus avoiding locations where subsoil conditions would be bad.

Another type of highway study in which air photos are particularly valuable, is in the layout and examination of preliminary highway lines in important highly developed park areas, such as Rock Creek Park. In such an area, we find

a combination of rugged terrain, water courses, playing fields, wooded areas, and traffic arteries. The selection of a highway line must consider all of these and in addition must be made in such a way as to avoid destruction or extensive injury to the natural features of the terrain, the preservation of which is one of the principal purposes in establishing the park.

The Department of Agriculture has aerial photographs of a great deal of the country, which may be purchased at reasonable prices. These are on scales of 660 feet to the inch and 400 feet to the inch. We have used these air photos in a number of cases for examination and study of alternate highway routes.

As an example of the use of the above mentioned 660-foot photographs, there is shown in Figure 1 a section of the proposed Natchez Trace Parkway a few miles south of Nashville, Tennessee. Here on the air photos we have plotted two alternate lines to be considered for a 6 mile section of the parkway. Going on the ground, a careful reconnaissance estimate of construction cost was made of each line, and also an estimate of the right-of-way cost.

Two lines were considered. Both are equally good from the standpoint of our limiting standards of alignment or curvature. The country is relatively flat so the gradients are equally good. However, one line has two bridges, not found on the other, and the line with two bridges would badly split fertile farm lands, with resultant high severance damage and high cost for underpasses to ameliorate the damage.

The cost exclusive of right-of-way was estimated at about \$1,340,000 for the upper line and \$1,080,000 for the lower line.

The photographs show clearly what local roads will need to be adjusted, the severance of properties and consequent need for service roads. A goodly amount of wooded or semi-wooded area is desirable for a parkway location and the photos show the extent of these areas.

Figure 2 is a photo of a map, on a 200-foot scale, of a portion of the Washington-Baltimore Parkway about two miles long.

In this case air photos were used to select an alternate location that would fit into the land use of the whole area better than the original location.

Note that the original location would cut in two the projected landing strip of a privately-owned local airport, which was partially developed. The new alternate location cuts a piece off of one end of the airport, instead of out of the middle of it. We saved a considerable sum in land damages by adopting the alternate location.

Figure 3 illustrates the use of the 100-foot scale photographs.

About 10 years ago, we had to make a study of the Alexandria water front to investigate the possibility of relocating the Mount Vernon Highway on an overhead structure along that water front. Using the old ground methods, such a study would have meant a party of men engaged for several months in the coordination of existing maps, the preparation of new maps, and the taking of ground photographs to illustrate the conditions. Here was a highly developed area, waterfront buildings, wharves, a railroad, commercial establishments and even residences. Obviously, such a study would cost quite a sum of money. We found that a commercial photographer had air pictures of the area on a scale of 100 feet to the inch. For about \$100 we purchased a set of them, and in about a month an experienced engineer, with a draftsman to help him, made a complete projection and a reasonably good estimate of the cost of several possible lines. Not only that, but the air photos told the whole story in the way of the character and condition of the buildings, and the land areas in a way that the old style maps never would.

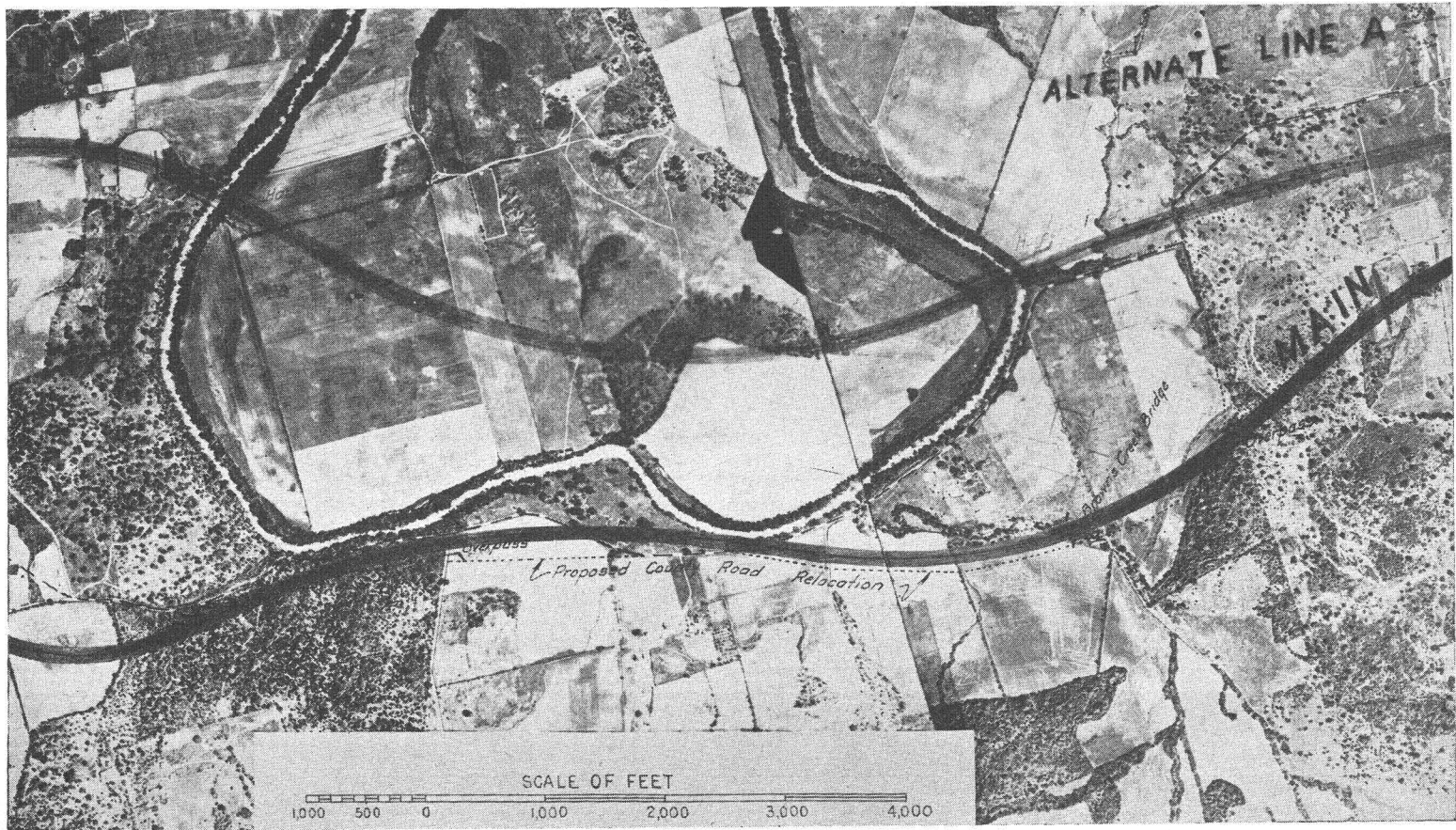


FIG. 1. Comparison of two alternate lines for a portion of the Natchez Trace Parkway near Nashville, Tennessee. Original on scale of 1 inch equals 660 feet.

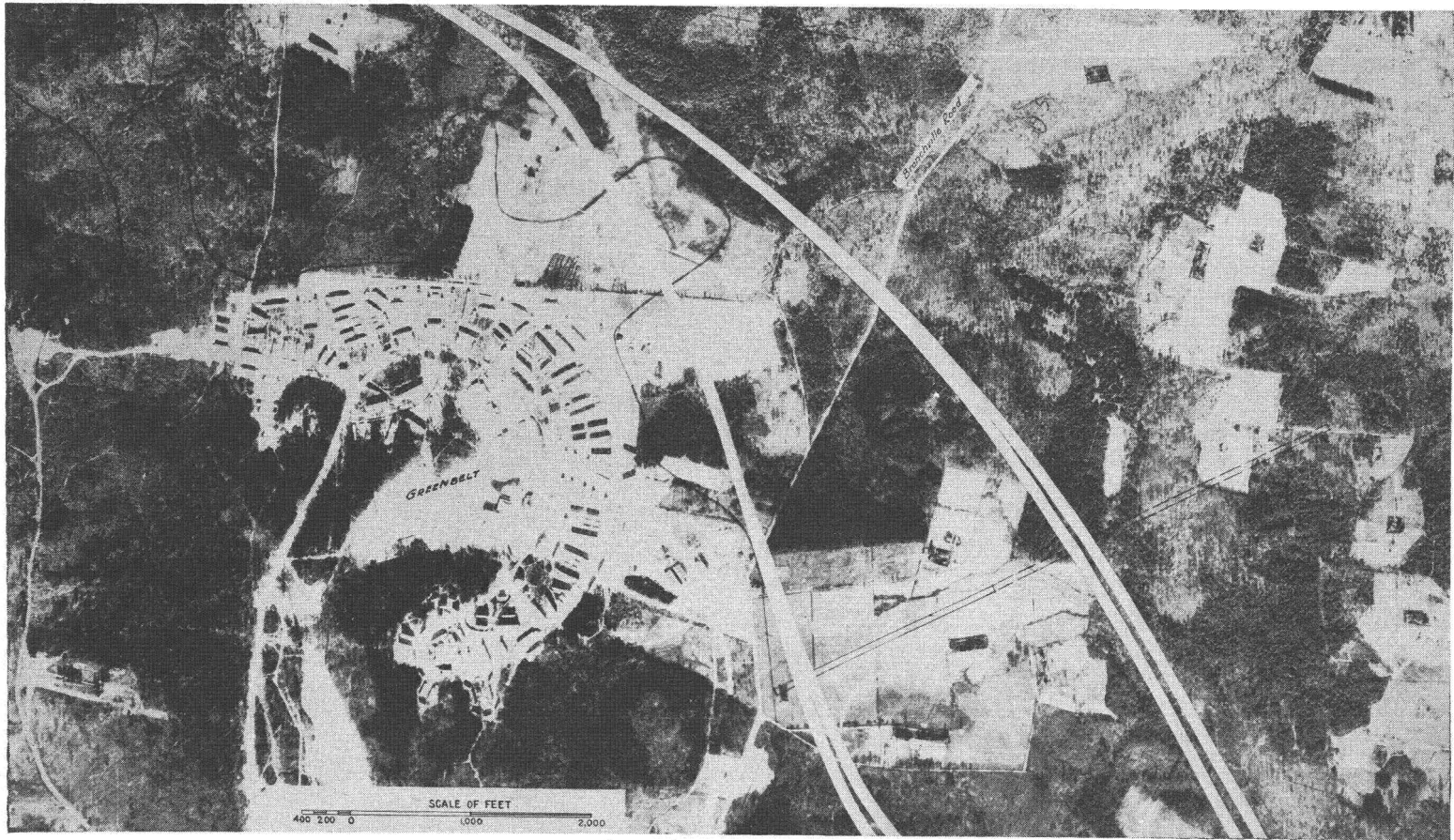


FIG. 2. Comparison of two alternate locations for a portion of the Washington-Baltimore Parkway. Work done on original scale of 1 inch equals 200 feet.

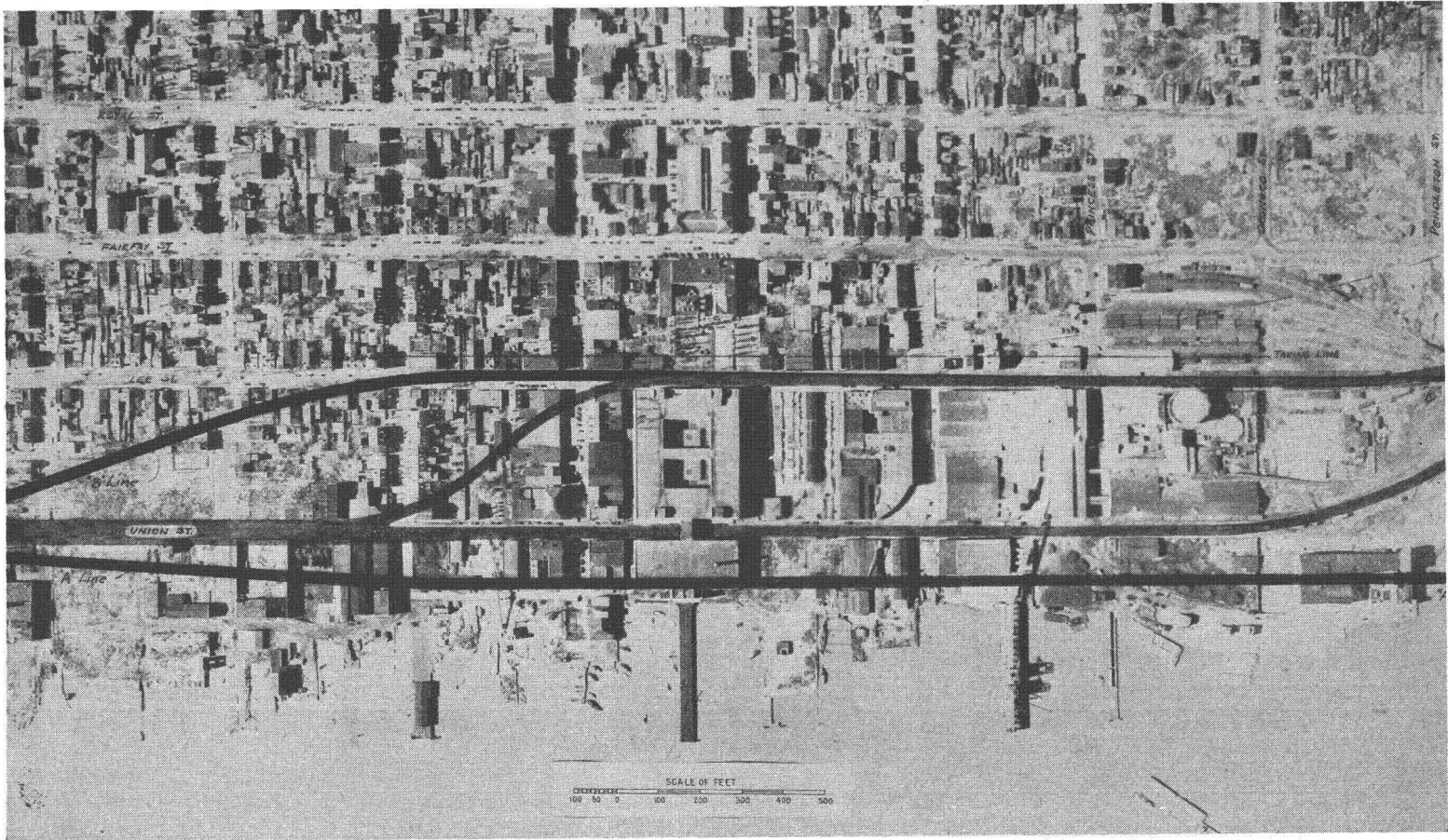


FIG. 3. Location studies for a possible high-level roadway along Alexandria waterfront. Original on scale of 1 inch equals 100 feet.

One hundred scale air photos were used in studying road location in a nearby section of Rock Creek Park. A section of the Park extending from the Shoreham Hotel north to about Blagden Avenue was covered. On the photos, we have shown to scale a great variety of possible routes for an extension northerly through the Zoo and Park of the present Rock Creek Parkway. These studies were made prior to the war, and are quite preliminary in character. No final determination has yet been made as to the desirable location; and a considerable further study of the whole problem is expected. Air photos are very useful in the study of such an area.

In my exhibits, I have dealt with the use of air photos made for some other use, and how we have adopted them to our needs and found them of great value. We are now undertaking obtaining air photographs specifically for a proposed alternate location about two miles long in extremely rough topography in the mountains near Waynesville, North Carolina. We have arranged with the Tennessee Valley Authority to prepare for us, by photogrammetric methods, a contour map on a scale of $1"=100'$ for this proposed alternate location. Controls for the work will be the line earlier established, by ground methods, which lies at all points within 2,000 feet of the proposed relocation.

This proposed location lies between 5,000 and 6,000 feet above sea level, in an inaccessible place. In dry weather a light truck can get within $3\frac{1}{2}$ miles of one end of it. To do the job by ground methods would require seven to eight miles daily of walking over very rough terrain by the party. We have a rough estimate that the maps can be prepared by photogrammetric methods for about \$1,000, whereas we estimate the cost by ground methods at about \$2,000.

We expect to use the contour maps so obtained to prepare the regular road plans for the proposed improvement. This work is undertaken as an experiment in the use of photogrammetric methods in extremely rough terrain. From it, we hope to be able to determine the degree of accuracy possible for such methods under such conditions.

OHIO ADAPTS AERIAL PHOTOGRAMMETRY TO HIGHWAY ENGINEERING*

Mr. Ralph J. Lehman, Geometric Design Engineer, Ohio Department of Highways.

BEFORE enlarging upon the history of Ohio's experience in the use of aerial surveying and mapping, it will be advantageous for me to present certain organizational structure and operational procedure used by the Ohio Department of Highways, in order to illustrate the relative position of the aerial surveying unit with the other bureaus and sections. Since aerial surveying is used by us primarily as an engineering tool, we will dispense with a discussion of the administrative functions and concentrate upon engineering activities, principally those which make maximum use of aerial photographic materials.

The highway engineer has numerous responsibilities, the assignment of which is divided among the several bureaus within the Department of Highways. For instance, matters of planning, location and design are assigned to the Bureau of Location and Design, while the construction, maintenance and operation, traffic and safety, and other phases of highway engineering each warrant separate bureaus.

* Due to the unavoidable absence of Mr. Lehman, this paper was read by Warren J. Cremean, Ass't to the Geometric Design Engineer.