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Mapping for the Trans-Alaska Pipeline

THE DISCOVERY OF OIL on the north slope of Alaska is a major factor in the opening of one of the last frontiers of modern times. An important part of this process is the proposed construction of an 800-mile pipeline by the Trans-Alaska Pipeline System, known as TAPS, from Prudhoe Bay in the north to the warm-water port of Valdez in the south. TAPS' staff of engineers, scientists and experts in all imaginable fields are working to provide a sound plan for the construction of the pipeline.

Adequate maps of the pipeline route were one of the first requirements of the project. Existing mapping consisted mainly of U S. Geological Survey topographic quad sheets. These maps varied in scale from 1:63,360 to 1:250,000 and showed contours of 50 to 200-foot intervals. Although these maps were of value in general route selection. they were unsuitable for pipeline location and design. Teledyne Geotronics of Long Beach, California, was selected as the prime contractor on the mapping project, with Tobin Research, Inc. of San Antonio, Texas, as subcontractor. Due to the extremely tight delivery schedules, it was considered that the combined resources of both companies would be required to complete the work within the time required.

ABSTRACT: *Analytical aerotriangulation provided the key for establishing control for the mapping of the proposed Trans-Alaska Pipeline route. Tight delivery schedules, difficult terrain, and unreliable weather emphasized the value of the analytical aerotriangulation approach.*

The mapping was divided into two sections; the southern area from Valdez to the Yukon River and the northern area from the Yukon River to Prudhoe Bay.

Considering snow conditions and the critical time requirement, it was decided to map the southern part of the pipeline route using existing photography and control even though the flight scale and direction, and the control locations and distribution were not desirable. Aerial photographs. photo identified control, and diapositives were obtained from U.S. Geological Survey in Denver. Analytical aerotriangulation using these materials began at once. The Geotronics Analytical Aerotriangulation system was the ideal method to provide mapping control within the time limits of the contract.

The division of work between Geotronics and Tobin was as follows: Geotronics provided the project management, accomplished the aerial photography, established the field control, extended analytical aerotriangulation and compiled the majority of the maps. Tobin's main contribution was in map compilation, digitizing the proposed pipeline location, compiling mosaics, and construction of the final sheets.

Mobilization of the flying and field effort began with the arrival in Alaska of Geotronics' Field Coordinator in May. The proposed route was to be photographed using multi-spectral color film at 1:60,000 and 1:24,000, and also with infrared color at a scale of 1:24,000. Problems with weather, snow, and smoke from forest fires almost doomed this portion of the project to failure. Geotronics' DC-3 spent most of the summer waiting for the snow to melt and for a few days of clear weather during which smoke conditions would permit photography. As a result. a second aircraft was mobilized to expedite photography on the rare days suitable for photography. One aircraft was located at Fairbanks and the other at Bettles. Finally, by October the photo coverage of all probable routes was obtained, part in color, part in black-and-white, and some with snow;

FIG. 1. George Brennan, Geotronics' Chief Surveyor on the TAPS Project, operates MRA-3 Tellurometer on Alaskan mountain top. Note leg of control panel across center of picture.

however, the photographs were adequate for mapping. The infrared coverage flown simultaneously with the black-and-white 1:24,000 photographs were of outstanding quality.

The field survey crews faced many of the same problems as the photography teams. Equipped with two Geotronics helicopters, theodolites and electronic distance mesuring instruments, the surveyors had all of the mobility and technical capabilities required (Figure 1). The basic control for the mapping north of the Yukon River was paneled and established early in the season (Figure 2). Photo control was added as needed to fulfill analytical aerotriangulation requirements. The delay in obtaining the photography caused much added pressure and many additional problems for the field survey crews. Some paneled control was covered by snow and added points were required. Smoke from the forest fires caused visibility problems, and wind, snow, and ice made work impossible at times. In spite of these problems, the survey control was completed for the mapping north of the Yukon River by mid-September.

The mapping of the southern portion of the pipeline route from Valdez to the Yukon River, a distance of about 430 miles, was initiated in May. The completed maps were delivered to TAPS in early August. These final maps in plan and profile foremat, at a scale of 1000 feet per inch, were prepared for pipeline design and planning. The maps also included property ownership data.

The analytical aerotriangulation work on the north end of the route began in mid-July after completing the triangulation of the Valdez to Yukon River area. This portion of the mapping was controlled by using two

FIG. 2. A typical control panel used on the 1:60,000 photography in the Brooks Range. Each leg of the panel is approximately 24 feet long and 4½ feet wide.

sets of photographs. Initially high-altitude control photography, flown at a scale of 1:60,000 with a super-wide-angle camera, was bridged. Control for bridging was transferred to the 1:24,000 mapping photographs, which in turn was bridged and adjusted using an analytical block solution. This provided a means of controlling a large number of photographs rapidly with minimum field control to produce the required mapping, and maintain the extremely demanding schedules imposed by the client.

All stereo-compilation manuscripts used in the project were plotted with Geotronics' automatic Gerber Plotter, thus eliminating problems of misplotted control and pass points. The maps were compiled at a scale of 400 feet per inch or 700 feet per inch with a 10-foot contour interval.

Upon completion of the compilation phase of the work, TAPS pipeline engineers located the proposed pipeline alignment on the compilation manuscripts. The stereo models were reset and prominent photo-identifiable tie points were located near all intersection points (P.I's) on the compilation manuscripts. Bearings and distances were determined from such features to the theoretical location of the P.I.'s in order that the P.I.'s could later be located on the ground. The pipeline was then digitized, a profile plotted, and the final plan-profile sheets constructed.

Once the flying and field work were completed, the analytical aerotriangulation and mapping portions of the project moved rapidly, and final sheets were delivered in early January. This included the mapping for the proposed road to the north slope and approximately 140 miles of changes in pipeline route alignment which were added after the work was begun.

Without the use of the analytical aerotriangulation system to provide supplemental mapping control, the mapping of the pipeline route could not have been accomplished without the required time schedules.

In addition to the mapping of the proposed pipeline route, Geotronics mapped several proposed sites for pumping stations.

Geotronics is proud to have been a part of the first step of this vast and important project.