In addition to these many advantages, there are certain minor disadvantages that are now being eliminated as well as possible. As stated earlier, it has been the practice to color the condemnation area of a property to indicate property lines, as the plan itself obviously overlaps several properties. This method in some instances tends to obscure some of the detail on a photo-type print that could allow something to be overlooked. The suggestion that the lines be shaded or merely outlined is in the process of being adopted. As far as toning, the photo line process gives more weight control to precise lines and this is supplemented presently by outlining the buildings in the drafting rooms, but photogrammetric engineers are doing research on this problem and should eventually eliminate the need of any human doctoring, thereby reducing the possibility of error, which is always true with conventional plans.

Therefore, it is felt that the advantages of the photogrammetric-type of plan for use in right-of-way functions in Pennsylvania are inherent, and their continued use in the Right-of-Way Department is favorably anticipated.

Use of Aerial Enlargement Transparencies
In Right-of-Way Acquisition

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This paper discusses the problems arising from the colonial background, method of land division, and customs of conveyancing in relation to the requirements of Bureau of Public Roads Memorandums and those of the State's new Land Damage Board Law. Use and characteristics of a relatively new photographic plastic from which prints can be made in any reproduction machine, at any process stage, for use in mapping, appraisal, timber cruising, negotiation, court presentation, location and economic studies, and for public hearing plans, all with a reasonable expenditure of time and expense, are also discussed. Samples of the material and prints are included.

*IN MAINE, the Engineering Section of the Right-of-Way Division prepares all maps and plans required for the right-of-way function. These consist of the regular taking maps at scales of 1 in. equals 30, 50, or 100 ft; the 50-ft scale predominating; and such other plans necessary for land-use studies, appraisal and negotiation use, and case presentation before the Land Damage Board and in Superior Court.

The requirements of Policy and Procedure Memorandum 40-3.1 and Maine's recent Land Damage Board Law make it necessary to determine accurately the lines of ownership of the entire perimeter of every property, even if the property contains hundreds of acres and the take is only a narrow strip for widening purposes. Policy and Procedure Memorandum 40-3.1 requires the ties to intersection of new right-of-way with property lines, and the specification of total, remainder, and severance areas. The new Land Damage Board Law requires that the owner be furnished with a statement of determined damages including before-and-after land use and value. Formerly entire ownership boundaries were determined only for urban projects, entire takings, the Interstate, and in some cases on cutoffs involving severance.

This is a serious problem in Maine because of its history and character. The State dates back to early colonial times, the first semi-permanent settlement being Fort St. George in 1607. It is predominantly rural with relatively low land values. There are only six urban areas of more than 10,000 population and only fourteen more over 5,000. The customs of land division and conveyancing are very inaccurate and indefinite. The
percentage of properties for which accurate plans can be found is only about 1 to 2 percent. At least 95 percent of the conveyances contain vague, general descriptions; reference to an old lot plan (at a scale of 40 to 100 rods to the inch); bounds in rods which are found to be generally unreliable; or are bounded by owners A, B, C, and the road. In these cases, which involve such a great majority of all those encountered, the only solution is determination of physical occupancy on the ground with the assistance of the owners.

One solution would be to make an engineering survey of every property. As damage payments run mostly to only three figures, some to four figures, a few to five figures, and occasionally to six figures, the expense of a survey, especially of properties involving hundreds of acres, cannot be justified as it would most often be many times the appraised damages.

Some means of solving this problem by a reasonably simple, quickly performed, and economical routine is an absolute necessity. During the last few years several methods have been tried, none of which was satisfactory from the aspect of results, cost, and time.

About a year ago the Highway Commission found that new mediums had been developed, one by DuPont under the trade name of Cronaflex, a second by Kodak under the name Kodalith Ortho Matte Film. The Commission is using Cronaflex. These are essentially a matte-surface mylar plastic with a photographic emulsion on the underside. They are extremely stable, tough, nearly fireproof, waterproof, and with proper workmanship will produce transparencies that can be run through black and white, blueprint, or

Figure 1. Cronaflex enlargement (22-by-30-in.) at scale of 1 in. equals 300 ft on Route 4 in the City of Auburn—Cronaflex on left and black and white print made from the Cronaflex on right. Shows material as received from aerial photo contractor; original contacts at 1 in. equals 1,000 ft.
ozalid machines to reproduce as many prints as may be desired. Good black and white prints are being obtained on a Copyflex machine at speeds of 12 to 17 ft per min using Bruning No. 10 standard paper at a cost of about $0.30 per sheet, speed depends of course on photographic density. The top surface takes ink or pencil lines and lettering perfectly without any special preparation, also self-adhesive tapes have been found to be very satisfactory. They stick well, are stable through the reproduction machines, but can be easily removed for purposes of making changes or corrections. Pencil erasability is perfect without any effect on the matte surface and ink is easily removed with a water-dampened swab.

A present contract with James W. Sewall Company, Old Town, Maine, provides for three parallel flights, the center flight being on the specified location line. Contact prints of all three flights are furnished at a scale of 1 in. equals 800 ft with a 60 percent overlap for stereo study of location and soils interpretation work. The contractor also furnishes to the Right-of-Way Division one set of transparency enlargements at a scale of 1 in. equals 200 ft of all photos in the central strip on sheets 22 by 30 in. This gives about 4 to 6 in. of overlap along the flight line and a lateral coverage of 3,000 ft on either side. Whenever found necessary, the enlargements for either or both side flights can be quickly obtained.

Older photography is being supplied on transparencies at scales of 1 in. equals 300 ft and 1 in. equals 400 ft depending on the scale and quality of original photography. Detail on these is not as good as the photography under the present contract but is still considered to be the best medium available for the uses desired. On the enlargements

![Figure 2. Enlargement (200 ft to 1 in.) on US 1 in Town of Cyr. Cronaflex on left; black and white print on right; match lines for adjoining sheets shown, original contacts at scale of 1 in. equals 800 ft.](image)
of 1 in. equals 200 ft, detail is so good that individual telephone or power poles, plowed furrows, and potato barrels placed in the fields for the picking job, can be identified.

Cost as compared with former aerial photography is as follows: The former contracts called for contacts of 1 in. equals 1,000 ft and enlargements of 1 in. equals 500 ft for every other photo. Prices for special single flights were $60 per mi within 50 mi of Bangor, $70 per mi from 50 to 100 mi from Bangor, and $75 per mi over 100 mi from Bangor, with a minimum charge of $250 for any project. Prices under the present contract calling for contacts of 1 in. equals 800 ft and enlargements of 22 by 30 in. for every photo for special single flights are $80 per mi within 50 mi of Bangor, $90 per mi from 50 to 100 mi from Bangor, and $95 per mi over 100 mi from Bangor, with a minimum charge of $340 for any project. Enlargements of 4x on 22- by 30-in. Cronaflex are furnished from any desired portions of the side flights at $15 each or about $25 per mi. Enlargements from the older photography at 300- or 400-ft scale averages about $25 per mi per flight required.

In October 1960 an agreement was made under present contract specifications for photography on 147.2 mi on fourteen projects for a total cost of $10,659.76 or $72.42 per mi. Six projects were more than 100 mi from Bangor, four projects over 50 mi from Bangor, and four within 50 mi. This is approximately the same cost as the older contracts.

Figure 3. Completed Cronaflex for secondary Federal-aid project in Limestone. Match lines and Leroy lettering in ink; remaining lettering in pencil; property and right-of-way lines done with plastic tape; identification of westerly boundaries of properties simplified; land use readily identifiable; overlap showing very slight mismatch as evidenced by screen dots showing.
The procedure is as follows:

1. The transparencies are delivered labeled with flight and photo number (Fig. 1). They are indexed, matched on a lighttable, match lines drawn and titled in ink, survey centerline put on with plastic tape (Chartpak) and stationing indicated with pencil, every fifth station being identified (Fig. 2). Prints are then made and delivered to personnel of the preliminary information section. They locate and show on the prints the property lines as claimed by the owners, make out property owner report, also show location of property lines (within limits of the sheet) on prints of plan and profile sheets for exact station ties.

2. Prints of plan and profile and aerial enlargements are then given to the legal section for title work for use as a master working plan.

3. On completion of titles they are reviewed, any conflicts between field information and record documentation brought to light and means of settling worked out. This may involve further field and/or registry work.

4. Plans and title summary are returned to the Engineering Section and property lines for the project checked and plotted. Area of take is calculated from a right-of-way map. Areas of remainder, severance if any, and land use areas, divided into wooded and other use, calculated from transparency prints and put onto transparencies. Old and new right-of-way lines, and property lines are done with plastic tape. Name, parcel numbers, areas, etc., in HB pencil (Fig. 3).

5. Complete sets of prints of plans including construction plan and cross-sections, right-of-way maps, and aerial enlargements are delivered to the appraisal section.

6. Following appraisal and condemnation the same sets of plans are furnished the negotiator. Procedure from this point is regular routine (Fig. 4).

Figure 4. Portion of strip map as furnished appraiser and negotiator for major relocation of Route 100 in Auburn in vicinity of interchange with Maine Turnpike. Four previous minor relocations shown; map solved problem on property near center; deed described original tract, excepting and reserving lands previously conveyed; outsales readily identified; relocation is controlled access.
At present all enlargements are made by screen process without correction for tip or tilt. Even without correction the accuracy of scale is remarkably good. Scaling along the flight line is regularly within 5 ft per mi with an occasional sheet that will approach an error of 10 ft per mi. The lateral error increases to 10 or 15 ft with occasional excessive tilt showing greater error. The 22-by 30-in. enlargements cover only 60 percent of the contact along the flight line and about 85 percent laterally. As there is an overlap on all sheets of 3 to 4 in., the used portion along survey line is under 50 percent. If side flights are required for extended lateral coverage, the overlap reduces the lateral use to 50 percent of the center flight and to about 65 percent of the side flight. This reduces both matching and scaling errors. Relief errors of course cannot be eliminated. From the checking that has been done to date, it is believed the areas calculated from the prints of these enlargements average in the vicinity of 1 percent error.

These transparencies and the prints made from them are the best solution found so far to solve quickly, easily, and economically the following right-of-way acquisition problems:

1. Field location of the lines of ownership is simplified because the lines or boundaries as shown by the owners as their use and occupancy are in most cases readily identifiable, less than 10 percent having to be measured on the ground.

Figure 5. Portion of Public Hearing Plan—relocation of Cold Brook Road in Hampden. Cold Brook Interchange on Interstate 95 is about 0.9 mi westerly of photo. US 1A is vertical band at right of photo. US 202 from Augusta intersecting at Hampden Upper Corner in lower right-hand corner; present Cold Brook Road (lower black band) runs below high knoll at intersection with US 1A which at that point has 7 percent grade. Proposed relocation shown by upper black band. On original, dark bands are different colored plastic tapes, channelized intersection with islands and passing lane on US 1A being indicated; building and other identifications are typed stickers; ground survey made from plan line.
2. As a master plan for title search, the scale is large enough to permit plotting the one or more deed descriptions covering the ownership. Determination of deed and occupancy conflicts, spotting the probability of unrecorded deeds, and other title problems are readily apparent and can be worked out without difficulty by standard procedures.

3. Determination of total area, areas of remainders, and approximate areas of land usage become routine calculation.

4. They are very useful as a typing map for timber cruises.

5. For use by the appraiser for land use, comparative market, and neighborhood influence studies, and as a means of studying relationship of take to improvements and remainders.

6. For use by the negotiator as a "selling" tool. A firm offer is now made to the owner with the notification of taking and the negotiator must "sell" this offer to the owner. The owner can be shown the over-all picture of his property and the manner in which the highway will affect it. He also gets a clearer idea of the detail and amount of work, study, and thought that has gone into the appraisal on which the offer is based. Reaction from appraisers, negotiators, and owners to date has been very favorable.

7. As an exhibit before the Land Damage Board and in Superior Court as a means of illustrating of the State's case. This has been done in the past by drawing up a special plan for each property at scales varying from 1 in. equals 10 ft to 1 in. equals 400 ft to obtain a plan of the entire property of a size easily readable by a board or jury, with the various features color outlined or shaded to depict the various factors to be discussed. In complicated cases one or more mylar overlays have been used to show certain specific features. This has been time consuming as it required mechanical enlargement; also only the more significant features could be shown. The prints themselves are now being used, where the scale is satisfactory, and color outlined and shaded. Where enlargement is necessary photostating produces a faded and blurred base that can be traced to show all of the more important features of the photo with reasonable expenditure of time.

The Construction Divisions are making two uses of the prints:

1. For location studies and surveys. If a 2- or 3-mi section of a route of 20 mi or more between important terminuses is to be reconstructed, the location to be surveyed can be planned to fit the most desirable over-all location. Economic effect is more easily determined; cutoffs can be more intelligently planned; and survey control points can be chosen. The Commission has been told by the location engineers that the prints are proving of excellent value for these purposes; also that surveys run on the ground from lines laid out on the prints have only required minor adjustment to make them fit the chosen terminuses and control points. It is expected this use will become regular procedure even though on the more important projects the 1620 computer and planimetric maps will be used for location studies.

2. They are also an excellent exhibit for use at public hearings on proposed projects (Fig. 5). Prints are mounted on plywood panels, the alignment shown with colored plastic tape, connections and interchanges shown (alternate designs being taped on mylar for superimposition). All roads shown on the prints, all important topographic features, buildings that will be affected, and other items of interest are labeled. The explanation of the purposes and effects of the proposed project is more easily made, and most important, is more clearly understood by the citizens at the hearing. They can identify buildings, road intersections, streams, ponds, and other things with which they are familiar and arrive at a reasonably clear understanding of the relationship of the proposed location with these knowns.

The public reaction has been very favorable to this use, and there appears to be less opposition now to proposals, which is believed due to the better understanding of the proposal.

A public hearing was recently held on about 25 mi of Interstate location. The prints covered five 4- by 8-ft panels of plywood. The cost for the prints was about $30.00. Two men matched, mounted, taped, and labeled them in less than three days. The strip
covered varied in width between 2 and 3½ mi over the 25-mi length. These were enlargements of 1 in. equals 300 ft made from photography of 1 in. equals 1,000 ft.

There are now enlargements for immediate and future use, for nearly 300 mi of highway locations for all presently planned Interstate, Primary and Secondary Federal-Aid, and State Projects (except spot hazard removal work).

Both time and money are being saved by using this medium. Also, better information is being obtained, providing the appraisers with means of making better and more realistic appraisals, and have an additional and better means of presenting the case to the owner and when necessary before the Board and in Court.

The Legal Section has stated they believe about $10 per title or $150 to $200 per mi is being saved. Drafting time saved per project is running $50 to $100 per mi. Appraisal cost has been reduced about $10 per appraisal or about $150 to $200 per mi. The other possible savings have not been estimated. Time-saving and better results are the most important things that use of this procedure has accomplished. The Commission is now current with the construction divisions and is expected to remain so even though it is furnishing appraisal and negotiation sections with material that was previously not possible.

Use of Aerial Mosaics and Photogrammetry
In Right-of-Way Acquisitions

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- THE Michigan State Highway Department executed its first contract for an aerial survey on September 22, 1925. An excerpt from the contract states "we will desire to do enough work in the neighborhood to find out the value of this 'sort' of mapping to us in hilly country." As a result of this contract, made with Talbert Abrams, the Department was furnished with an uncontrolled mosaic of photographs taken at a scale of approximately 800 ft per in. The aerial mosaic was subsequently used to establish the alignment for a particularly scenic section of US 31 near Beulah. The photographs were taken with a World War I Eastman camera from a standard J-1 90-hp World War I training plane.

Apparently the highway officials at that time recognized the value of this "sort" of mapping immediately, because the Department has had contracts with Abrams Aerial Survey Corporation for aerial mapping every year since.

Immediately after World War I, the people of Michigan demanded a system of weatherproof roads to get them out of the mud. By the middle of the 1950's their children and grandchildren were demanding a road system that would free them from the strangling python of traffic that had grown up to choke the very life of the State.

The national government being aware of highway needs of the entire nation, provided a great boost with legislation authorizing a national system of interstate highways to be completed in 1975. The Michigan legislature, heedful of the demands of the populace, authorized the Highway Department to borrow money through the sale of bonds to speed the construction of the Interstate System, and a system of arterial freeways and farm-to-market State roads. Michigan expects to complete this system by 1967, and at a cost of $2 billion.

Confronted by a program of this scope, the State administration is using every advanced engineering tool available in order to meet the program deadlines. One of these valuable tools is photogrammetry. Photogrammetric methods are used in all phases of work prior to contract letting. One of these phases includes the use of aerial mosaics and photogrammetry in the acquisition of rights-of-way for the projects. It has been found that aerial mosaics can be used to a great advantage in land evaluation work during the study of alternate project alignments, and that the same mosaic can be used to