★ planning advisory service

AMERICAN SOCIETY OF PLANNING OFFICIALS

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Information Report No. 29 August, 1951

URBAN MAPPING, AERIAL PHOTOGRAPHY AND DUPLICATING: SOME BASIC ELEMENTS*

Maps are essential tools of city planning. Not only is mapping one of the primary means whereby the planner can summarize the spatial characteristics of his community, but it is often the only way in which a sustained overall view of the community can be obtained. Maps naturally have their limitations. They do not show the spirit and life of the community. Since the amount of data which can be shown on a map without confusion is limited, the planner is continually faced with the problems of (1) deciding which data are amenable to map presentation, (2) in what form and by what symbols the data are to be presented on the map, and (3) to what uses the maps may be put. This latter point is extremely important. The grasping of relationships in the urban pattern is one of the prerequisites for planning and an adequate form of map presentation may permit and even foster a clear statement and understanding of these relationships.

One of the basic datum of planning is land use. And the best means for portraying existing land-use patterns in a community is through mapping. Not until the land-use pattern as it exists at present has been carefully recorded in map form, can the essential processes of evolving a comprehensive land-use plan for the community and developing a zoning ordinance which is clearly related to the comprehensive plan for land use be carried on. Other essential data which lend themselves to map and graphic presentation are traffic circulation, economic data such as assessment and land values, housing quality, population distribution and density, among others.

The city planner is not the only one who uses maps. Other municipal departments such as the park department, the city engineer's office, the finance and taxing agencies, to mention but a few, also require maps for the operation of their respective departments. Map-making and the collection of the basic data to be presented on the maps may therefore be a joint effort which eliminates wasteful duplication, while obtaining for the community a fairly complete graphic record of the facts necessary for urban government.

BASE MAPS

In some communities it will be necessary to construct new base maps whereas other communities may find that existing base maps drawn originally for other purposes may be adapted for the recording of planning data. In the case of the former, specifications must be drawn; in the case of the latter, decisions similar to those required for setting up specifications will have to be made for evaluating the existing base maps.

Coverage

First, a decision must be made as to coverage. Although for some municipal purposes a base map which ends at the city limits may be adequate, a map of the community's land-use pattern required for planning purposes must go beyond the city limits. A city may have almost no industry within the city boundaries, for example, but may have heavy concentrations of industries just beyond the limits. The economic well-being of this community and the plan for land use cannot be studied without including these peripheral areas. In addition, some cities have been given extra-territorial rights and may zone for land use several miles beyond the city limits. Certain states permit cities to exercise control over subdivisions beyond their corporate limits.

How large an area the base map should cover will depend upon the characteristics of the community and upon the uses to which the base map will be put. For example, if the base map is to be used for recording and analyzing transportation systems, a region-wide base map may be necessary. A map of a more circumscribe area will be sufficient for presenting and analyzing tax data.

Scale

A second decision which will have to be made concerning the base maps is the scale. In most communities, at least two sets of base maps will be indispensable for planning. A small-scale map (showing a large area in little detail) will be necessary for presenting generalized data on community-wide and even regional levels; a large-scale map (showing a small area in greater detail) will be indispensable for the analysis of individual parcels and lots and for neighborhood planning.

The particular scale chosen for both the large-scale map for detail analysis and the small-scale map for overall analysis (wall map) will depend upon the size of the community, both population-wise and area-wise, and the workability of the final size of the map.

In Local Planning Administration, it is suggested that for towns under 10,000 population, a scale of 1" = 500 to 600' (1:6,000 to 1:7,200) should be used for the regional wall map. In communities between 25,000 and 100,000 population, they suggest a scale of 1" = 800 to 1,000' (1"9,600 to 1:12,000) for the regional map. A

scale of 1" = 1,000 to 1,500' (1:12,000 to 1:18,000) is suggested for a wall map of communities between 100,000 and 250,000 population, whereas a scale of 1" = 1,500 to 2,640' (1:18,000 to 1:31,680) is suggested for communities with over a quarter of a million population. Communities of all sizes will require a map in sections at a scale of 1" = 200' or 1:2,400. In addition, property maps suitable for presenting details as to lot size and shape, structure and use, ownership and assessment, etc., may also be needed at a scale of 1" = 50'.

In Urban Mapping, published by the Central Mortgage and Housing Corporation of Ottawa, Canada, in 1950, it is suggested that urban maps be drawn at a scale of 1" = 800', and that regional maps be drawn at a scale of 1" = a mile.

The Town and Country Planning Textbook contains an appendix on the preparation of planning maps by Jack Whittle which gives the British recommendations for survey maps and scales. For the presentation of material on land use, age of buildings, net accommodation density, and road and rail traffic, maps at scales of 1" to 208" and of 6" to a mile are suggested for urban areas, whereas a scale of 1" to 1 mile is suggested for rural areas. A scale of 1" to 208' is suggested for water supply and sewerage maps, for gas and electricity maps, and for floor-space index maps. Presentation of net population density and communications data is suggested at a scale of 6" to the mile.

Maps of three different scales are advocated in the "Outline of Procedure for the Institution of City Planning Studies in the Smaller Cities and Villages of the State of Minnesota." For the base map of the city, a scale of 1" = 500' is suggested. This map scale is easily adapted for use as an ordinance map for zoning and is good for local studies of streets, public buildings, parks, etc., over fairly extensive areas. A general map at a scale of 1" = 1,000' is suggested for diagrammatic studies and for showing summaries of findings. A detail-of-design map is also suggested at scales of from 50' to 200' to the inch.

The Connecticut Development Commission, Research and Planning Division, has published a manual entitled, Land Use Map-Making Procedure, in which it is stated that a base map should be drawn at a scale not much greater than 1" = 200' or smaller than 1" = 1,000'.

Obviously, no rule-of-thumb is wholly satisfactory. The scale chosen for base maps for a community which is sparsely settled and which covers many square miles will be very different from that chosen for a community with the same population but with a small and densely-developed area.

A map may be enlarged or reduced in overall size for presentation by means of photography. If such change in size is contemplated, it will be necessary to change the scale notation. An automatic means whereby the scale notation may be changed with a change in overall size of the map is through the use of a graphic scale, that is, a bar, the length of which is equal to a particular linear distance. When the map is enlarged, this bar is enlarged proportionately; when the map is

reduced in size, the bar shrinks in proportion to the total map size.

SOURCE OF BASE MAPS

There are a number of potential sources of base maps. Some of these are city departments, such as public works, city engineer, water, sewerage and taxation, which may have base maps already prepared. Property-recording maps, utility-company maps, maps prepared by commercial firms for sale, title-insurance maps, etc., should also be investigated for possible use as base maps. Frequently, state, federal or other political units (districts, authorities, etc.) may be fruitful sources of maps which may be adapted for use in city planning. The Sanborn Insurance Maps at a scale of 1" = 50' often prove very useful.

Aerial Photography

Where no adequate base map exists, a community will find it necessary to prepare one. Maps may be produced through the tedious process of piecing together original plats of the community and correcting for discrepancies. It is also possible to construct a base map from field surveying alone. A method which is being used more and more, however, is mapping from aerial photographs. Base maps may be prepared from both vertical and oblique aerial photographs. The process is simplest where vertical photographs (giving a plan-view) are available, but by the use of the Canadian Grid System, it is possible to construct a base map from an oblique photograph.

The advantages which have been claimed for mapping from aerial photographs as opposed to mapping from ground survey alone are comparatively low cost and rapidity of execution. For example, aerial coverage of the Jackson planning region (roughly 80 square miles) was obtained at a scale of 1" = 400' from the Production and Marketing Administration of the Department of Agriculture. The cost was only $72.00. By far, however, the greatest saving is to be obtained in time. Estimates of this saving vary from one-half the time to as much as one-fiftieth the time required for a ground survey.

Another advantage, of course, in making the base map from an aerial photograph is that at the same time information necessary for the land-use survey is also collected. Aerial photographs can also be an invaluable source of data on drainage, soil and vegetation characteristics, some of which are indispensable for recreational planning and rural zoning.

It is possible to construct topographical maps of 5' contours with a fairly high degree of accuracy from aerial photographs. The City of New Rochelle, New York, has obtained aerial topographic maps for the entire city, showing 5' contours on a horizontal scale of 200' to the inch. The uses to which these photogrammetric maps have been put are many. They have been used by the Public Works Department in sewer and drainabe projects, in revising the routes of garbage-collection equipment, in planning for snow-removal and street-sanding; by the Bureau of Parks, Docks and Harbors in studies of waterfront improvements,

and in the planning of recreation areas; by the City Assessor; by the Department of Public Health; and, of course, by The Planning Board and the City Plan Engineer.

One of the many city planning departments making extensive use of aerial photography is the San Diego City Planning Commission, which has used aerial photography in the development of new park and recreation facilities created by land-fill in Mission Bay. Using an aerial map of the city to determine land use, Muncie, Indiana, completed a revision of its zoning regulations. In Pennsylvania, many cities and townships, including Erie, Lancaster and Mannheim, have prepared zoning ordinances based on state aerial surveys.

The decision as to whether or not aerial photography should be used to construct base maps and to obtain land-use data will depend, of course, upon how much information the city already has in map form, to what uses it is likely to put data so obtained, and, of course, comparative costs.

The mapping of a community may very well be a combination of both ground and aerial photographic surveying, in such a proportion as to yield maximum usefulness with minimum monetary outlay. Again, no rule-of-thumb can be offered in advance. Consideration should be given to the hidden costs and benefits involved in the various forms of map-making and land-use surveying. One of the hidden benefits of aerial photography as opposed to ground surveying is that data which are not thought to be significant at present (and therefore would not be collected in the initial ground survey) may prove to be essential later. If the ground-survey method was used, it would be necessary to conduct a duplicate study; if an aerial photograph is available, the additional data may be abstracted with far less expenditure of time and staff.

WHAT TO PUT ON THE BASE MAP

For planning purposes, one of the basic types of information to be transcribed onto the base map is land use. The degree of detail with which land use may be shown on the map will depend upon the scale of the base map and upon the care and precision with which land-use categories are established and symbols and notations refined.

Land-Use Classification

One of the basic problems to be solved is that of setting up a land-use classification system which will be most meaningful for future uses. Every manual on mapping land uses for planning purposes accepts the general categories currently used in zoning ordinances with greater or less refinement. These major categories of use are residential, business and commercial, industrial, public and quasi-public, agricultural, and vacant.

In Wilkens, Mapping for Planning, the following refinements are made. Residential land use is distinguished according to single-family use, two-family use,

three and four-family use, boarding and rooming houses, multiple dwellings (over four families), tourist and trailer courts, and hotels. Business and commercial uses are distinguished as to local or neighborhood business, offices and banks, general business, and intensive business such as theaters, recreation, etc. Industrial uses are further refined into light industry, railroads and public utilities, and heavy industry. Public uses are parks, public schools, public buildings, whereas quasi-public uses are distinguished as to open uses, churches, quasi-public buildings and institutions, and cemeteries. Agricultural land is divided into crop land and livestock land.

Similar categories are found in Suggested Symbols for Plans, Maps and Charts, published by the National Resources Committee, Washington, D.C., in June of 1938. Accepting the same general major categories without the refinements, Action for Cities (Public Administration Service No. 86, Chicago: 1944) suggests a system for the classification of land use and its symbolic representation in mapping. The Connecticut Development Commission, Research and Planning Division, in its Mapping for Zoning (Hartford, Connecticut: April 1950) suggests a land-use notation and symbol system which recognizes the following categories: single-family, two-family and multi-family residence, light and heavy business, light and heavy industry, agriculture of all types, public and semi-public use, forests, and vacant land.

By means of colors and symbols, the following land uses were distinguished on a land-use map prepared by the City-County Planning and Zoning Commission of Lexington, Kentucky, in 1948:

"Residential Uses

One-family detached
One-family semi-detached
Two-family
Dormitories
Three or four families
Five or more families
Boarding or rooming houses
Tourist homes

Commercial Uses

Retail stores, offices, tourist courts, etc.
Wholesale stores and warehouses
Commercial garages
Gasoline filling stations
Billboards
Parking and used-car sales lots
Non-structural or open-air commercial uses

Industrial Uses

Light and unobjectionable industries
Semi-objectionable industries
Objectionable industries
Non-structural or open-air industrial uses (large lumber or coal yards, gravel pits or dumps)

Mixed or Other Uses

Professional offices in residence
Home occupations
Commercial and residential (detached)
Commercial and residential (attached)
Industrial and residential
Commercial and industrial

Institutional Uses

Churches
Parochial schools and convents
Private hospitals, clinics, convalescent homes, etc.
Public hospitals
Children's homes, homes for the aged, etc.
Cemeteries
Clubs
State and other universities

Public and Public-Utility Uses

Public utilities
Railroad rights-of-way
Truck and bus terminals
Parks
Playgrounds and playfields
Public schools
Fire stations
Libraries
Other public buildings

Private Recreation

Golf courses
Trotting track

Agriculture

Agricultural Experiment Station

Vacant"

Clearly, the land-use classification system adopted must relate to the categories foreseen eventually in the zoning ordinance. However, there have been recent trends in zoning practices which may well require a revision and a rethinking of land-use classification. For example, the distinction between heavy and light industry is one which is made in almost every conventional zoning ordinance. There is even considerable consensus as to which industries are to be characterized as light and which heavy. The criterion for this distinction has been ostensibly the degree of nuisance-creation. Unfortunately, much of this classification has not taken into account recent technological advances and practices in plant design which, if properly utilized, can control in a large measure the nuisances created by individual plants. Some of the so-called "heavy" industries are characterized as such because of the smoke, ash and cinders given off in the operations. There is certainly adequate proof that, with sufficient investment, this nuisance may, in large measure, be removed. Again, an industry classified as "heavy" because of noise, may have its plant so constructed and so located and screened to eliminate to a large extent the noise which is audible from outside. The classification of business uses is also being re-examined by planners. New practices in the construction of outlying shopping centers with their landscaping, screening, setbacks and arcades, off-street parking and the like make it unrealistic for many planning purposes to place them in the same category with the conventional four-corner or ribbon local shopping centers. There are many other examples.

The need is, therefore, for a re-classification of land use prior to the land-use survey, so that the results of this survey may aid in preparing a better kind of zoning ordinance. This is not to say that the long struggle for a standard notation system or legend for land-use mapping is to be abandoned. However, stand-

ard notation should be modified and revised where such modification will lead to better zoning.

Stimulus in the re-thinking of land-use classification is to be found in the proposed zoning ordinance for New York City, which utilizes a classification system which bears little resemblance to typical zoning ordinances or land-use classifications. The ordinance would establish some thirty-seven districts. Although no small community will require so many, the assumptions and the thinking which have led to the establishment of these classifications are worthy of attention.

Legend and Symbols

In addition to establishing definitions and categories, another step preliminary to the obtaining and recording of land-use data is the selection of symbols and colors to be used for representing various uses. A number of the references cited in the bibliography to this report publish lists of colors and symbols appropriate to various categories. Colors are definitely preferable in the work-map stage. They are more easily read than are black and white symbols and greater variations within general categories are possible without a loss of distinction between the broad categories.

An example of a color legend is that used in the land-use survey of New York City, conducted by Harrison, Ballard and Allen. The uses and color symbols used are reproduced here in table form:

USES	COLORS USED
1. Vacant land	White
2. Parks and outdoor recreation	Green
3. Single-family detached residence	Very light yellow
4. Single-family attached residence	Yellow
5. Two-family residence	Orange
6. Walk-up apartment	Light brown
7. Elevator apartment	Dark brown
8. Office and store	Red
9. Warehouse, loft and light industry	Blue
10. Automotive	Light purple
11. Objectionable industry	Dark purple
12. Public buildings and institutions	Dark green
13. Transportation	Grey

In the final stages of presentation, however, color may be too expensive to reproduce and the use of symbols for various patterns is desirable in black and white reproduction. The greatest variety of black and white patterns available is offered by the Para-Tone Inc. (547 South Clark Street, Chicago 5, Illinois). Zip-a-tone, the trade name of their product, is a plastic material which is readily cut out from large sheets and applied in any desired shape. The product is

available in more than 300 patterns. A similar product is the Contak Shading Film manufactured by the Transograph Company of New York City. Contak has the additional advantage that it may be used in the blue-printing process. This is not possible with Zip-a-Tone which has a wax base and melts under heat. Symbltak, another of their products, offers letters and graph pictorial symbols.

A complex system which permits identification of multiple land uses is that suggested in the New York State Department of Commerce publication, Handbook of Map Symbols. Single-family and two-family dwellings and flats and apartments are distinguished by means of one set of symbols superimposed upon another set which distinguishes between public housing and the various rental levels. Commercial uses, governmental, industrial, institutional and vacant are all refined in similar fashion. Mixed land uses may be clearly presented by this system.

In Mapping for Planning, Wilkens indicates another method for depicting multiple uses. A simple case of this type would be a building with stores on the first floor and apartments on the second and third floors. A diagonal line is drawn across the rectangle of the parcel or area occupied by the structure, and each half is colored with the appropriate color for that use.

SOURCES OF DATA FOR LAND-USE MAPS

A few of the many sources from which land-use information may be obtained are: (1) from previous surveys done in the community, (2) from the Sanborn insurance maps, (3) from aerial photographs, (4) from trade, industrial, and telephone directories, (5) from telephone interviewing, and (6) from field work.

Field Work

Field survey work is perhaps the most time-consuming and expensive of these sources of land-use data. Where trained personnel is scarce and salaries high, field checking should be used only after all other sources of information have been tapped. Some smaller communities, finding that adequate field work was not within their means, have mobilized citizen groups for the collection of pertinent information. High-school students, Boy Scouts, women's organizations, and civic and betterment groups have all been used in field surveying with a fair degree of success. Among those communities which have enlisted interested groups of citizens in gathering information are New London, Connecticut; and several of the New Jersey suburbs. A limitation of this method is, of course, that, when untrained lay persons are used, information of a very complex nature requiring on-the-spot judgments cannot be collected with confidence. Because of this, a detailed refinement in land-use classification may not be possible.

Previous Surveys

One of the least expensive methods for obtaining land-use data is from previous land-use surveys. During the thirties, land-use surveys of many com-

munities were made under the W.P.A. If one is available, it will have to be brought up to date. The task of bringing a previous land-use survey up to date may be performed without a complete re-survey. First, all records, such as building permits, conversion permits, business licenses, etc., should be checked. From spotting these on the map, a pattern of change may be seen, and areas which have undergone most extensive changes since the last land-use survey may be delimited. These areas will have to be studied in more detail. Other areas in the city may have undergone little or no change since the previous survey. The accuracy and adequacy of permit records should be checked by sample field investigations.

Sanborn Insurance Maps

An indispensable aid in the collection of land-use data is the Sanborn Map. These fire insurance maps are available for more than 12,000 cities and towns, including all places with populations in excess of 1,000, and many with less.

Information is available on the location and address, the area of the building and the parcel, the frontage of the parcel, the number of stories in the structure, the date of construction, the construction material, and the use or uses of the parcel (in most cases). The multiple uses are sometimes identified by floors. Additional information on the types of data available from the Sanborn Map and the uses to which it may be put is available from Description and Utilization of the Sanborn Map, published by and available from the Sanborn Map Company (10 Cedar Street, New York, New York); Its a Fact - Sanborn's Got It, (available from the Sanborn Map Company); and "The Sanborn Map as a Source of Land-Use Information for City Planning," by Robert L. Wrigley, Jr., in Land Economics, May, 1949.

The Sanborn Maps are available in most localities at a scale of 1" - 50'. For peripheral areas where use is not intensive, the Sanborn Map may be at a scale of 1" to 100'. Each map sheet is approximately 12" x 20" and generally shows two or more blocks. These separate sheets are bound into volumes. A volume of Sanborn Maps containing 100 sheets has an initial cost of $150. For large cities, many volumes may be necessary, whereas for a small city, only a few sheets will be needed. For small cities, the cost ranges from $10 for one sheet to $110 for over 50 sheets. A newly-purchased set contains the most recent corrections, which are usually made every year. Subsequent corrections vary in cost, but are available for approximately $35 per volume per year. Where a community finds the expense of purchasing a set too high, arrangements may often be made for using the map of the local fire insurance company.

In addition to the regular Sanborn Map, the company has expanded its services to planning agencies to include fact analysis, special mapping, special field surveys, and the construction of separate transparent overlay maps scaled to fit any land-use map for the following: streets, recreation facilities, housing, transportation, off-street and street parking, and areas adapted for urban expansion. The company also prepares finished land-use maps and maintains a publishing service.

Aerial Photography

Aerial photography, like the Sanborn Map, is a device which enables the planner to minimize the time and expense of going to the field for information. A skilled and experienced interpreter of aerial photographs is able to identify practically all types of transportation facilities, including streets, railroads, terminals, ports and dockage, and is even able to single out the most heavily-traveled roads. Various types of residential buildings may be distinguished. For example, the single-family dwelling may be clearly distinguished from the apartment house or the row house, etc. Institutional buildings of all kinds, such as hospitals, churches, schools, post offices, libraries, etc., are readily recognizable from aerial photographs. Commercial areas may be identified, and the open uses of land such as lumber yards, junk yards, auto-wrecking yards, and other storage yards, are easily recognized. Recreational uses, such as playing fields, golf courses, forests and parks, playgrounds and tot lots, and the like, may all be spotted on aerial photographs. Extractive industries are easily identified, as are distinctive industrial plants, such as steel mills, paint factories and proving grounds, large assembly-line plants, furniture factories, etc.

The ease with which specific land uses may be identified is greatest in the less dense areas of the community, but the task becomes increasingly difficult in the central, older and more crowded portions of the urban area. In these districts, there is often no external indication of the activities carried on within particular buildings. Undifferentiated buildings may contain loft factory uses, commercial uses, storage and wholesale uses, and even residential uses not identifiable from the exterior appearance of the building. These difficulties confronting the interpreter of aerial photos are due to the high number of conversions in the older core areas of the city, the loft or other multi-story buildings which may be used for a variety of purposes with different uses on different floors, and the absence of open space, which, in outlying areas, is often a clue to the uses carried on within adjacent buildings. A more complete description of the techniques for identification and of the limitations of such identification for urban land-use surveying is found in Aerial Photography in Urban Planning and Research, by Melville C. Branch, Jr. (Volume XIV of the Harvard City Planning Series, Harvard University Press, Cambridge : 1948).

There are two major varieties of aerial photographs, vertical and oblique. An oblique photograph is one taken from an angle so that the vantage point of the camera is displaced laterally from the subject area which is being photographed. It shows the photographed area in perspective. The advantages of oblique photographs are (1) a greater area of coverage is obtained than is possible from a vertical photograph taken from the same altitude; (2) it is easily read by the layman and is particularly effective in promotional and citizen liaison work; and (3) it gives relative heights of structures, data which, although calculable from a vertical photograph, are most easily and immediately grasped from an oblique.

However, for actual planning and land-use survey purposes, most planning agencies will find the vertical photograph (one taken with the axis of the aerial

camera lens perpendicular to the ground) considerably more useful. To prepare an overall photograph of a community, it will be necessary to have a series of photographs taken in consecutive order (a photo run) with each picture overlapping slightly the picture of adjacent areas. After the photo run has been completed, the pictures are spliced and fitted together in a manner similar to a jig-saw puzzle to form what is called a photo mosaic. Proper numbering and a master reference map (a photo-index) permits this to be done with relative ease.

The maximum degree of usefulness of an aerial photograph is obtained from vertical stereophotographs, and wherever possible, these should be made in preference to or in addition to the other forms of aerial photography. The additional cost will, in most cases, be more than compensated for by the tremendous increase in usefulness. The photo-run for a vertical stereophotograph is plotted in a manner similar to that required for a photo mosaic, with the additional requirement that each photo must have a 55 to 60 per cent forward overlap (that is, each consecutive photo shall include 60 per cent of the area of the following photograph) and should have a 30 per cent side overlap (that is, each line of flight shall be plotted so that 30 per cent of the area photographed in the preceding line of flight appears in the next series of photographs). This amount of overlapping is based on the requirements of stereoscopic vision. By placing the photographs of two adjacent areas a designated distance apart and viewing them through a stereoscope, the area of overlapping will appear to the viewer in three dimensions. The usefulness of this will be readily seen. It is from such stereophotos that topographical analyses can be performed and a contour map constructed. The relative heights of buildings are easily and accurately computed. This is particularly useful for the central areas of the community.

Although much of the detail work involved in plotting photo runs and in processing and piecing the pictures afterward will be performed by the company engaged to prepare the aerial survey, the planner will have to write the specifications of what he wants, and evaluate the quality of the work performed. Guides to both procedures are found in Aerial Photography in Urban Planning and Research. Specifications should include a time limit, an exact description of the extent of coverage, the scale and altitude of flight, a description of the type of photographic printing, the type of photo run, the scale of the photos, and complete specifications as to the type of photographs contracted for. The season and time during which the photographs are to be taken should also be specified. For example, in the Philadelphia City Planning Commission's specifications for an aerial survey, it is stated that photographs shall be taken during the late fall season when trees are void of foliage and there is no snow visible. Photographs should also be taken at similar times of the day, because of the length of shadows and other such details. Each photograph should be clearly marked as to date taken, and the time.

Scale is an important consideration in both the eventual usefulness of the photographs and in the cost of securing them. At a scale of 1" = 400', fairly detailed land-use information may be obtained by the use of magnifying devices. Naturally, the larger the scale, the greater ease with which the photos may be

read and the more detail identifiable. But a larger scale usually means a higher price. It results in the increase of the number of flight lines, an increase in the amount of time needed for the photography, an increase in the number of individual pictures and an increase in the amount of processing. Branch estimates, in his book cited above, that "doubling the contact scale doubles the number of flight lines, probably triples the time of photography, and quadruples the number of pictures."

Who does the aerial photography and how much it will cost are two questions which cities contemplating such surveys will want answered. Aerial photography is done by the various agencies of the Federal Government, as well as of state, local and other governmental units. There are also a considerable number of good private firms. In one or two cases, a city has undertaken to do its own aerial photography; these have been rare, and due to the complexity of the operations, not advisable under most circumstances.

A federal agency which has done considerable work in the field of aerial photography is the Aerial Photographic and Engineering Service of the Production and Marketing Administration of the Department of Agriculture. Large areas of the United States have already been photographed by them. Most of the areas so photographed are agricultural, although many urban areas have been included.

Most of the photography done by PMA has been made so that reproductions can be produced up to 1" = 400' on a single sheet, and that sectional reproductions from critically sharp negatives can be produced up to a scale of 1" = 100'. The scales of available photographs range from 1" = 1,667' to 1" = 400'.

If existing photographs are not adequate, it may be possible to obtain aerial photographs to meet the requirements of the community for a relatively low cost through cooperative agreements between the locality and the PMA. An aerial survey of Tulsa County and environs was made by the PMA early this year through such cooperative agreement between PMA and the Tulsa County Planning Commission. It is reported that the cost of this survey was about $2,000, of which the Planning Commission's share was $735.

The PMA is equipped to perform the entire job from the original photography to the developing, enlarging, indexing, etc. Their services can be enlisted for any one or all of these processes.

Other governmental agencies which have done surveys in cities and counties include the Army Air Forces, the United States Corps of Engineers, and the United States Coast and Geodedic Survey. A source of topographic mapping is the Geological Survey of the United States Department of the Interior, which maps 7 1/2 minute quadrangles at a scale of 1" = 200'. Cooperative agreements between planning commissions and the Geological Survey are also possible.

Private companies also offer aerial photographic and mapping services of good quality. Many of these are known only locally. Others are nationally known and conduct surveys throughout the United States. A partial listing of these firms is included in the appendix.

Engaging the services of a private local company, the planning agency in one large metropolitan center recently obtained a comprehensive aerial survey for its metropolitan area. They obtained a set of atlases covering an area of 1,200 square miles at a scale of 1" = 400'; a wall mosaic at a scale of 1" = 800' for an area of 800 square miles (comprised of 1,300 individual photographic prints, matched, rectified and slightly enlarged from the original flight scale); and a set of contact stereophotographs at a scale of 1" = 750'. The cost of this aerial survey, including flying, all contact prints, enlargements, index maps, and the photo mosaic, was around $20,000.

This may be contrasted with a bid of $3,000 made by a private aerial photography firm for a comprehensive aerial survey of an area of 35 square miles. This survey included complete atlas sheets at 200' to the inch, two sets of contact prints giving complete stereophoto coverage of the area at a negative scale of 800' per inch. The estimate for a similar survey of the same area, but at a scale of 400' per inch, and with atlas sheets at 100' per inch, was somewhat in excess of twice the original figure.

A table presenting some "Illustrative Costs of Aerial Surveys of Smaller Areas" is given opposite page 26 of Aerial Photography in Urban Planning and Research, by Melville C. Branch, Jr. A listing of cities and counties which have engaged the services of private aerial photography firms in recent years may be found in an article entitled, "Aerial Surveys Save Time and Money," which appeared in the January 1951 issue of Public Works Magazine.

Directories and Telephone Checking:

Whether aerial photographs or the Sanborn Map are used to identify land use, there will still be areas and specific parcels for which no identification is possible by these methods. Before resorting to field checking, there are several other sources which should be tapped. Among these are directories of various sorts, such as ordinary city directories, commercial directories, and industrial and manufacturing directories. Information may also be obtained by telephone. Knowing the location of the building, it should be possible to identify from these directories the occupants of the building, and to obtain from them the information desired.

Field checking will often be necessary because of the limitations in accuracy as well as coverage of these various survey methods. Few large directories are completely accurate and current. Even the Sanborn Atlases, despite the care which is taken to insure their accuracy, do not always indicate the present use of a given piece of land or floor space. This is due in part to the time lag

between the noting of a change in use and the map correction in the subscriber's copy. This time lag may often be a period of a year.

REVISING THE LAND USE MAP

After completion, a land-use map, like any other type of planning information, sooner or later becomes outdated. How soon a city needs to be re-surveyed depends upon a number of factors. Change generally does not take place at a uniform rate throughout the city. Districts such as stable single-family areas may remain unchanged for years. In other areas, processes of obsolescence, new building, conversion and redevelopment may be taking place at a rapid rate. Only certain portions of the city, such as the latter, may need to be re-surveyed. The rate of change differs under various economic conditions and in different communities. A land-use survey for one large city was far from useless ten years after it was completed; only minor changes had to be noted. On the other hand, the Sanborn Map Company, during the building boom of the twenties, found it advisable to re-survey certain areas at intervals of six months. Although no definite rule can be prescribed as to when to re-survey, in general, a period of five years has been suggested as the optimum time for a complete re-survey of land uses.

There are several ways whereby a land-use map may be kept up to date without resorting to a complete re-survey. Periodic checking of building permits is one of the best methods. However, building permits are not necessarily accurate as a source of information, since buildings constructed may not conform completely to the permits issued. Some field checking will probably always be required to supplement this source. In addition, there are a number of public and private agencies which are concerned with new buildings and use changes and often collect pertinent information. Some of these are the tax assessor's office, transportation companies and departments, the telephone company and various other public utility companies. It might be possible to establish a continuous or periodic reporting system in which all municipal employees engaged in inspection work - building inspectors, police inspectors, health and fire officials, etc. - reported changes in land use to the planning agency. Another possibility might be an arrangement made with the Sanborn Map Company for the reporting of changes in land use.

Aerial photography, at a scale sufficient to permit determination of land uses and the erection of new structures might provide the required information. Encouraging experimental work was done in 1948 by the City Plan Board of Dayton, Ohio, which used a helicopter for a rapid and economical traffic survey. In a relatively short period of time it obtained complete information on parking facilities, traffic movements, etc. This technique might be adapted for land-use surveying. Similarly, a light airplane might be used in much the same manner. This technique is described in the March 1951 issue of the ASPO News Letter.

MAP PRESENTATION AND DUPLICATION

The specifications for work maps to be used exclusively in the planning office may be quite different from the specifications of maps used for presentation, public relations, and popular reporting. The work maps may be one of a kind, need not be completely finished, and may be relatively complex. For clarity in reading, they should, with few exceptions, be executed in color rather than in black and white. Usefulness may be greatly increased by the recording of a series of data on transparent overlays which may be superimposed, one upon the other, upon a base map. This technique is not only useful for work maps but may be highly effective in public relations and publicity. An example of this method is found in the Connecticut Development Commission publication, Mapping For Zoning, and a number of communities have adopted this method with excellent results.

The specifications for maps to be reproduced for popular distribution must take into account (1) the economics of reproduction, (2) the untrained nature of the audience, and (3) the need for "selling" an idea through maps. These requirements will generally have certain corollaries. Because of the untrained nature of the audience and the need for selling an idea, all maps prepared for popular presentation should be kept simple and clear. A good rule to follow is that only one idea should be conveyed per map. In an effort to "show all," many communities have sacrificed the effectiveness of their map presentation. The comparative cost of the duplicating process is, perhaps, in the last analysis, the most important single determinant of the final map. Because of the expense of reproducing in color, black and white symbols, although generally inferior in terms of clarity, may have to be used. Color printing, however, need not be done by expensive press methods. It is possible to produce color maps through mimeograph, multilith, hectograph and ditto processes.

A decision will have to be made in selecting the most appropriate technique for reproducing particular maps. Some of the factors which should be considered in making such a decision are: (1) how many copies will be needed originally; (2) will all of the copies be run off at once or will the item be reprinted periodically; (3) how long will the process of preparing the duplicating plate and running off the copies take; (4) is the staff trained to perform the required processes, or can they be trained; (5) what are the requirements of the finished copy in terms of clarity, detail, color intensity, etc.; (6) how durable must the final copies be; (7) will it be necessary or desirable to store the master duplicating plate for future reference or use; and (8) how much will it cost.

There are several valuable guides which may be used by the planning agency in determining the relative advantages and disadvantages of the alternative methods of duplication. Among these are a Manual on Methods of Reproducing Reproducing Research Manuals, by Robert C. Binkley (Edwards Brothers, Inc., Ann Arbor, Michigan: 1936) and the section on "Duplicating and Reproducing Processes" in the American Office Machines Research Service Reports, (published by the Office Machines Research, Inc., 630 Fifth Avenue, New York: April 1939). The following comparative table has been adapted from material given in the above.

Process	Gelatin	Direct Liquid	Stencil (Mimeograph)	Offset (Multilith)
Maximum no. of copies	Varies from 40-100 depending upon paper, ink	Varies from 50 - 400	Wax stencils-300 Cellulose " 5000 Protein " 5000 Photographic 10,000 - 40,000	Varies from 300-30,000 depending upon kind of plate and technique of preparation
Training Required	No special; neatness	No special; neatness	No special; neatness	Special training required; gets highly complicated
Durability of copies	Colors sensitive to light; fades	Colors sensitive to light; fades	Practically forever	Practically forever
Inks and colors	Hectograph inks; no black, purple best	Hectograph inks; no black purple best	Special stencil inks in various colors	Special offset inks in wide variety of colors
Sharpness and depth of impression	Limited sharpness; decreases with number of copies. Limited depth	Limited sharpness; depth rather good	Sharpness limited; depth good	Great sharpness and depth -though a little less than with type printing

A somewhat more detailed explanation of these various techniques is given here. It is intended as a simple introduction to the four major processes short of professional printing available for map reproduction.

Mimeographing

Although the stencil duplicating process has obvious limitations, it is characterized by versatility, economy, simplicity. It is adaptable for multi-color reproduction, a fact not commonly appreciated.

For the ordinary black and white or one-color graphic presentation, the material to be drawn on the stencil is placed on an illuminated drawing board and the lines of the drawing are traced onto one stencil with an appropriate stylus. Large lettering may be done with a lettering guide and a lettering stylus, whereas small lettering may be added with the typewriter. A variety of shading may be accom-

plished with a screen plate, a rectangular piece of plastic, one side of which has an overall pattern embossed upon it. The plate is placed directly under the part of the stencil sheet to be shaded. With a shading stylus, the stencil sheet is gently rubbed into the plate until the perforations of the pattern show through. When the stencil is completed, stencilization (placing the stencil on the drum of the machine and transferring the impression to the blank paper) is no different from the usual method involved in reproducing a typewritten text.

In the multicolor map, the well-known principles of color separation are applied to the preparation of stencils. Every detail which is to appear in a given color on the final copy is placed on one stencil. For each color appearing on the final map, an additional stencil sheet is required. On the illuminated drawing board, the master drawing is alligned under each of the separate color stencils. In running the stencils through the mimeograph machine, the impression paper makes one trip through the duplicator for each color.

Printed base maps with color overlays applied through the mimeograph process are often superior to completely hand-drawn stencils, since the base is more refined in its reproduction and more detailed in its content.

There are many possibilities for reproducing graphic material from a photo-chemical stencil, or a die-impressed stencil, prepared without the use of an illuminated drawing board or a typewriter. The following quotation describes the technique as applicable to maps, but it should be emphasized that it is also useful for the reproduction of other graphic material.

> "In preparing a photo-chemical stencil, a master drawing may be made in India Ink on tracing vellum in the exact size at which it will be reproduced. Stick-up type, Zip-a-Tone, mechanical lettering devices, and other drafting aids may be used in its preparation. The master drawing may also be a photograph of a map or drawing. This is reproduced photographically on a transparent base at the required size. The stencil is made by exposing the opaque map image to a freshly sensitized stencil sheet. The stencil is then developed, fixed, and dried in much the same way that prints are made in the dark room. In duplicating, the photo-chemical stencil is handled like any other stencil.
>
> "A map stencil may also be prepared by die-impressing. By this method, an original line drawing in black and white is photographed such that the negative size is that of the map to be duplicated. From the negative a metal die is made. This is pressed into the stencil, which is then ready for the duplicator.
>
> "Because it replaces the drafting of stencils by hand, the photo-chemical stencil is one of the most promising innovations in the stencil-duplicating process. Through photography, it permits better known and more articulate drafting media to be utilized. The preparation of stencils by die-impressing achieves the same results.

While more costly, initially, it has special advantages in certain circumstances. In either case, the user must depend upon outside assistance."

While PLANNING ADVISORY SERVICE does not endorse any products, the products and techniques of the A. B. Dick Company are well known to most planning personnel. Attention might be called to some of their less well-known products which may be of use in the foregoing technique. Mimeograph inks are available in orange, red, yellow, brown, green, purple and blue. Thirteen patterns of screen plates to be used in shading are available from the company. An assortment of styli for all purposes is available. The company also publishes a text on the Fundamentals of Mimeographing, and has instructions for the use of its various products. Photochemical stencils are also made by the company from drawings or specifications.

Photo-Offset Process

The photo-offset process reproduces a map by photographing it, burning the negative (which may be reduced or enlarged in size as desired) onto a zinc plate by means of an arc lamp and duplicating it on an offset press by a lithographic technique. Other names for the process are photolithography, lithoprinting, planograph printing, etc. One of the most common types of offset presses in operation in small agencies and one suitable for use in a planning office is the multilith.

This technique is a highly adaptive one which yields a reproduction as fine and detailed as the original, and eliminates the tedious process of preparing the plate in the planning office. Where text is required, it is possible to type directly on the zinc plate by a technique similar to that used in the preparation of a stencil. However, for the reproduction of maps, drawing directly on the zinc plate is not advisable since it entails a considerable amount of work and yields a less precise and less satisfactory than photographing.

The production of colored maps is possible from the offset process by a method similar to that followed in mimeographing. Each separate color requires a separate plate and a separate press run. The ink is available in a wide variety of colors of good intensity.

Hectographing

There are two hectograph processes, the gelatin process and the liquid or spirit direct process. The latter is sometimes called "Ditto," a trade name. In the gelatin process, a master sheet is prepared with special hectographing ink (available in many colors but not in black). The map may be drawn with a hectograph pencil or with the ink, and text may be typed onto the master sheet using an ordinary typewriter equipped with a special hectograph ink ribbon. The ink used in this process is a highly-concentrated coloring matter such as aniline dye. The printing surface is made of a glycerine and gelatin composition which is high-

ly retentive. The master copy is transferred to this gelatin surface by pressing the inked side tightly against the gelatin, leaving it there for a few minutes, and then removing the paper which bore the original copy. The gelatin retains in reverse the pattern of the hectograph ink and, as blank sheets are pressed against it, releases small quantities of the ink to form the print. Since the inking can be done only once from each master copy, the number of copies which may be printed from the one original is dependent upon the strength of the dye and the retentiveness of the gelatin. Usually 100 copies may be printed using a strong dye, but the duplicates become increasingly lighter in intensity.

The varieties of presentation which may be obtained from the hectograph process are worthy of attention. Handwriting or drawing done with the use of a special hectograph pencil; half-tones may be printed with hectograph ink; forms may be ruled up in hectograph ink; and, most important of all, color work is greatly facilitated by this method of duplication. The different colors are painted on the original in hectograph ink. It is possible to duplicate as many as sixteen colors at one time.

In the liquid process no special printing surface is required, since the printing is done directly from the master sheet. This sheet is prepared in the following manner: The drawing is made on a specially prepared paper. Beneath this paper is a sheet of carbon paper which has been impregnated with hectograph ink of a particular color. This sheet is arranged with the inked side up so that when the drawing is made on the original master sheet, a reversed carbon copy appears on the underside of the master sheet. This underside becomes the printing surface, and as moistened paper is pressed against it, a print is made on the impression paper.

The preparation of colored maps by this process is fairly simple. A carbon sheet of desired color is placed beneath the master sheet and every line which is to appear in that color drawn on the master sheet. The same master sheet is used for each successive color; only the carbon is changed. Thus, there is no danger of poor alignment. When completed, the reversed master sheet shows all the colors which will appear on the printed matter. The impression paper must be brought in contact with the master sheet only once for a simultaneous reproduction of all colors. An example of an attractively colored ditto map is included at the end of this report through the courtesy of the City Planning Commission of Knoxville, Tennessee, which has found this method very satisfactory.

There are several characteristics of hectographing which should be taken into consideration before a choice of medium is made: (1) there is no hectograph ink available in sufficient strength to produce a black tone; purple is the deepest color obtainable; (2) the chemical character of the hectograph ink results in a fading of the print after time; (3) the color tones obtainable have a water-color quality about them which may not be desirable for certain purposes.

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Western Laboratory, Aerial Photographic and Engineering Service, Production and Marketing Administration, U.S. Department of Agriculture, 167 West Second, South, Salt Lake City 1, Utah.

Eastern Laboratory, Aerial Photographic and Engineering Service, Production and Marketing Administration, U.S. Department of Agriculture, Washington 25, D. C.

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Air Map Corporation, Brooklyn, New York.
Fairchild Aerial Surveys, 224 East 11th Street, Los Angeles 15, California.
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Lockwood, Kessler and Bartlett, Brooklyn, New York.
Standard Air Service, Hackensack, New Jersey