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SPECIFICATIONS FOR UPDATING USGS LAND USE AND LAND COVER MAPS

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ABSTRACT

To meet the increasing demands for up-to-date land use and land cover information, a primary goal of the U.S. Geological Survey's (USGS) national land use and land cover mapping program is to provide for periodic updating of maps and data in a timely and uniform manner. The technical specifications for updating existing USGS land use and land cover maps that are presented here cover both the interpretive aspects of detecting and identifying land use and land cover changes and the cartographic aspects of mapping and presenting the change data in conventional map format. They provide the map compiler with the procedures and techniques necessary to then use these change data to update existing land use and land cover maps in a manner that is both standardized and repeatable. Included are specifications for the acquisition of remotely sensed source materials, selection of compilation map bases, handling of data base corrections, editing and quality control operations, generation of map update products for USGS open file, and the reproduction and distribution of open file materials. These specifications are planned to become part of the National Mapping Division's Technical Instructions.

INTRODUCTION

Land is dynamic; its use and cover characteristics change with time. Since information on current land use and land cover[1/] conditions is needed for the effective planning, management, and use of land resources, maps that portray these data need to be revised periodically. In addition to current information, data are needed on the types, amounts, and rates of changes in land use that occur with time. In order to meet these data needs, research has been undertaken to develop a procedure for updating land use and land cover maps and digital data on an operational basis in a way that both produces and uses data on land use change in the updating process. Various approaches to updating maps within the scope of the present USGS national land use and land cover mapping program have been evaluated (Milazzo, 1980). It is required that an operational map update capability be established that (1) is timely; (2) is cost-effective; (3) is standardized; (4) maintains an appropriate level of information; (5) achieves an acceptable measure of accuracy; (6) relates to and builds upon the existing USGS land use and land cover cartographic and digital data base; and (7) addresses the varying needs of land use and land cover data users at national, regional, and State levels.

Background

Since 1974, the U.S. Geological Survey (USGS) has been engaged in nationwide baseline mapping of land use and land cover and associated data at a scale of 1:250,000, and at 1:100,000 scale for special areas and applications. Such scales are appropriate for acquiring land use and land cover data on a nationwide basis within a practical time frame, and with an acceptable degree of standardization, accuracy, and level of detail in categorization. The land use and land cover and associated data set provided under this mapping program consists of the following maps:

(1) Land Use and Land Cover
(2) Political Units
(3) Hydrologic Units
(4) Census County Subdivisions
(5) Federal Land Ownership (provided only in cooperative mapping programs or when complete States or regions are mapped)
(6) State Land Ownership (provided only in cooperative mapping programs when data are supplied by cooperator)

Land use and land cover data have been mapped from remotely sensed data using Level II of the classification system (table 1) presented in USGS Professional Paper 964 (Anderson and others, 1976) and using standardized map compilation specifications documented by USGS Open File Report 77-555 (Loelkes, 1977). This provides a systematic and comprehensive land use and land cover data base which is uniform in categorization level and

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1/ For ease in reading and documentation, land use and land cover will hereafter be called only land use, except where specifically worded in full for greater comprehension.

Table 1.--U.S. Geological Survey Land Use and Land Cover Classification System for Use with Remote Sensor Data (Anderson and others, 1976).

LEVEL I		LEVEL II	
1	Urban or Built-up Land	11	Residential
		12	Commercial and Services
		13	Industrial
		14	Transportation, Communications and Utilities
		15	Industrial and Commercial Complexes
		16	Mixed Urban or Built-up Land
		17	Other Urban or Built-up Land
2	Agricultural Land	21	Cropland and Pasture
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
		23	Confined Feeding Operations
		24	Other Agricultural Land
3	Rangeland	31	Herbaceous Rangeland
		32	Shrub-Brushland Rangeland
		33	Mixed Rangeland
4	Forest Land	41	Deciduous Forest Land
		42	Evergreen Forest Land
		43	Mixed Forest Land
5	Water	51	Streams and Canals
		52	Lakes
		53	Reservoirs
		54	Bays and Estuaries
6	Wetland	61	Forested Wetland
		62	Nonforested Wetlands
7	Barren Land	71	Dry Salt Flats
		72	Beaches
		73	Sandy Areas Other than Beaches
		74	Bare Exposed Rock
		75	Strip Mines, Quarries, and Gravel Pits
		76	Transitional Areas
		77	Mixed Barren Land
8	Tundra	81	Shrub and Brush Tundra
		82	Herbaceous Tundra
		83	Bare Ground Tundra
		84	Wet Tundra
		85	Mixed Tundra
9	Perennial Snow or Ice	91	Perennial Snowfields
		92	Glaciers

cartographic portrayal for the entire United States. The associated maps provide selected natural or administrative data. These allow users to relate or extract the graphic or statistical information on land use and land cover for the areas portrayed on the associated maps.

As part of this program, the land use and land cover and associated data are digitized and the information stored in a digital data base. The computerized Geographic Information Retrieval and Analysis System (GIRAS) (Mitchell and others, 1977) is used to input, store, manipulate, and retrieve the data. The system makes possible the generation of digital tapes and a wide array of graphic and statistical products that can be used by planners, resource managers and other decisionmakers at national, regional, and State agency levels.

Purpose and Scope

This report presents the proposed specifications for updating land use and land cover maps within the framework of the present USGS national land use and land cover mapping program. It provides the map compiler with the procedures and techniques necessary to update land use and land cover maps in a manner that is both standardized and repeatable. This report establishes the specifications covering both the interpretive techniques of detecting and identifying valid land use changes and the cartographic procedures for presenting the land use change data in conventional map format in accordance with the present USGS classification system in PP 964 and the map compilation specifications in OF 77-555.

These specifications describe a revision procedure in which maps are updated by incorporating new polygon information (change data). In this approach, existing maps are updated by replacing only the obsolete land use and land cover data with newer information, while retaining as much of the original land use and land cover map data as are still useable and correct. It is expected that the vast majority of land use and land cover maps will be updated in this manner. These specifications are not intended to be used for updating maps that were compiled according to a different set of classification standards and (or) map compilation specifications. For such maps, complete recompilation (remapping) of data is required. In cases of recompilation, the procedures for initial map compilation as documented in OF 77-555 are to be followed. The specifications for map updating presented in this report apply only to the land use and land cover map. Specifications for updating the associated maps will be provided in a separate document at such time as these data are considered for revision.

This report is divided into nine major Sections. The following topics are discussed:

(1) Selection and acquisition of remotely sensed source materials
(2) Preparation of compilation map bases
(3) Detection and identification of land use and land cover changes
(4) Compiling the land use and land cover change map
(5) Data base corrections

(6) Editing and quality control
(7) Map update product generation
(8) Preparation of map update materials for open file
(9) Reproduction and distribution of open-file materials

The specifications for map updating have been designed to augment the classification standards and map compilation procedures already developed and described in PP 964 and OF 77-555 and used in the baseline land use and land cover mapping program. In some cases, essential sections from OF 77-555 have been extracted and repeated here for clarity and continuity and to facilitate the use and understanding of these specifications by the map compiler. In other instances, the compiler/reader is referred in the text to the appropriate section(s) in each of those documents as needed for other helpful information. The compiler should have copies of both documents in addition to these specifications for reference use during land use and land cover map updating. These specifications are intended for use by compilers who are experienced in photointerpretation and mapping, and are already familiar with the procedures and specifications for land use and land cover map compilation.

SECTION 1

ACQUISITION OF REMOTELY SENSED SOURCE MATERIALS

As in baseline land use and land cover mapping, the approach to map update should be designed to make maximum use of remotely sensed data sources. Present remote sensing technology offers a wide selection of sensors, platforms and capabilities. The sources chosen for update, however, should parallel those that have been used, or could expect to be used satisfactorily, in the mapping of land use and land cover, since the data requirements remain essentially the same for both.

From past experience in land use and land cover mapping, some general guidelines have been established (OF 77-555, p.11) for the selection of remotely sensed source materials. These guidelines should be followed in the map update phase if such updating is to be completed optimally. It should be emphasized that whatever source is chosen, the new remotely sensed source should permit the same level and class of information to be extracted during updating as in the earlier mapping. The criteria for the selection of photographic source material are as follows:

(1) For updating, the source material must be as current as possible, but in no case older than 3 years at the time of map authorization.
(2) The format of the remotely sensed data must be such that it is or can be rectified, if necessary.
(3) The scale should be no larger than 1:60,000.
(4) The resolution should be sufficient to interpret Level II land use and land cover categories and changes accurately and consistently.
(5) Source photographs for the winter season (leaf-off condition) should be used, if available.

(6) There must be no snow cover (except for areas of perennial snow or ice).
(7) The photographs should contain no more than 10 percent cloud cover.

There are several available remotely sensed sources that could be used for map updating. The level, amount, and accuracy of the land use and land cover data that may be obtained from remotely sensed sources depend on the flight altitude and resolution of the sensor and, to some extent, on the scale of the final product. High-altitude source data (40,000 feet or above, with scales of 1:80,000 or smaller) are recommended for the extraction of Level II land use and land cover data (Anderson and others, 1976). In keeping with this recommendation, the principal remotely sensed source for mapping Level II land use and land cover data has been National Aeronautics and Space Administration (NASA) high-altitude aerial photographs. Such photographs are usually black-and-white panchromatic or color-infrared, are obtained from altitudes of 40,000 to 60,000 feet, and have nominal photographic scales between 1:80,000 and 1:120,000. High-altitude photographs have been used successfully for compiling nearly all past land use and land cover data and are capable of meeting each of the seven recommended guidelines for remotely sensed source selection. It is expected that these or similar sources will continue to be the mainstay of future land use mapping and it is recommended that they continue to be the primary photographic sources for map updating.

In addition to these sources, the Geological Survey is acquiring (through contract services) high-altitude photographs under the Federal National High-Altitude Photography (NHAP) Program. Under this program, aerial photographic coverage for one-third of the conterminous U.S., by 1° x 1° areas, is targeted to be flown annually. This would yield a repetitive coverage cycle of 3-5 years (not taking into account any delays for acquiring missed-area coverage). Under this program, a repetitive national photographic data base would be available, thus enabling a systematic review and update of land use and other maps from a uniform and timely data source. This photographic source will also be used when available.

USGS has a computerized program that provides a graphic index showing the extent of high-altitude photographic coverage for any 1:250,000- or 1:100,000-scale map. If coverage information is needed before authorization of a map for updating, the National Cartographic Information Center (NCIC) queries the EROS Data Center data base for NASA aerial photographic coverage information to aid in authorization decisions. Two copies of the photographic index and the printout of source information are reviewed by NCIC for completeness and are forwarded to the National Mapping Division Office of Program Management (OPM). This office will coordinate these indexes with other indexes of known photographic source material such as USGS quadrangle-centered photographs and National High-Altitude Program (NHAP). These indexes will be reviewed to insure that sufficient photographic source material is available for map updating. If sufficient source material appears to be available, the map sheet will be officially authorized for revision. For areas previously authorized, a copy of the index, corrected if required, is mailed with the printout to the appropriate Mapping Center by NCIC.

The Mapping Centers will then be able to order photographs for updating from the information provided on the photographic index and the accompanying printout data. Quad-centered high-altitude photographs and other coverage to be identified by NCIC can be used to supplement this coverage. Aerial photographs should be ordered in the form of positive transparencies. If the Mapping Center, after ordering the photographic source material as indicated on the photographic index and accompanying data printout, has found the photographic source material inadequate for use in map updating, the Mapping Center will notify the OPM of the photographic source problem. At the same time as an additional photographic source material search is started by the OPM, the appropriate Mapping Center personnel should also initiate a search for additional photographic source material within the region.

When appropriate, ancillary sources of information useful for land use map updating should be acquired for the compiler's use before revision is started. In general, however, no precompilation field data will be gathered prior to updating. This is so because the provision of supplemental information for use in map updating would generally not be required since many of the decisions made during initial compilation concerning the mapping of indefinite land use boundaries and categories, which precompilation and field check data are intended to resolve, would not be a problem in the updating phase. The only precompilation and (or) field check data available for use by the compiler during updating, if such data should be needed, would be that already gathered in connection with the baseline mapping.

SECTION 2

PREPARATION OF COMPILATION MAP BASES

There are two primary map bases that will be used in the updating of USGS land use and land cover maps. These are the planimetric portions of the USGS 1:250,000-scale topographic map and the 1:100,000 intermediate-scale quadrangle map. Authorization will be given by the NMD Office of Program Management concerning the map base to be used for each land use map to be updated. It will also specify what portion of the map is to be updated if revision is authorized for less than the full map sheet.

In the preparation of the compilation base to be used for map updating, two maps are required--the standard topographic map base (at either 1:250,000- or 1:100,000-scale), and the open-file land use and land cover map at either 1:250,000 or 1:100,000 scale. These maps will be combined to produce a composite base on which to compile the land use change data. The topographic base will be used primarily as an aid in the proper orientation and alinement of the land use features on the photograph with those on the map; the land use map will be used for the correct placement, delineation and coding of identified polygons of land use change with respect to the existing polygon data.

In preparing the planimetric base, the planimetric base already on open file will be used. If this base is no longer the most current one available, then the most up-to-date 1:250,000- or 1:100,000-scale color

separation plates containing only the planimetric and hydrologic data will be used to develop the base sheet. The negative color separation plates for the base map sheet will be obtained and used to make a film positive base. This composite film positive will include border information, culture, drainage, and land net. No screens will be used with any of these separation plates.

In addition, the most up-to-date master negative or open-file positive of the land use and land cover map will also be obtained and used to make a film positive base. This film positive base will include only the land use polygons, land use identifiers, tick marks, and neatlines. Open-file marginalia need not be reproduced.

Each of these two publication-scale base positives (planimetric and land use) will then be punch-registered (if not already so) and a separate punch-registered negative of each will be made either at contact-scale (for 1:100,000-scale maps) or enlarged to the appropriate photographic source and (or) compilation scale for 1:250,000-scale maps.[2/] The two compilation-scale negatives will then be registered together and contact-printed to produce a single composite scribecoat manuscript. In making this composite, the planimetric base will be screened to 20 percent of original; and the land use base will be rendered in solid blue- or black-line. See figure 1 for proper compilation base preparation procedure. For proper punch-registration for 1:100,000-scale change compilations, see "Base Preparation" instructions under Section 8.2 of this report.

The 1:250,000-scale composite scribecoat base will be prepared in the Mapping Center that has been authorized the map. If there are circumstances in which a Mapping Center cannot provide the 1:250,000-scale base they must promptly inform the Eastern Mapping Center. The Eastern Mapping Center will then duplicate and provide composite scribecoat positives of these base materials to the Mapping Center. Normally, delivery time will be 2 to 3 weeks after receipt of the request by the Eastern Mapping Center. The 1:100,000-scale composite base will be prepared in the Regional Mapping Center that has been authorized the map revision.

SECTION 3

DETECTION AND IDENTIFICATION OF LAND USE AND LAND COVER CHANGES

3.1 General Explanation

Change detection is a separate and distinct step in the map updating process. It deals with the detection and identification of temporal changes in land use and land cover from a comparison of remotely sensed and (or)

2/ Do not make a composite negative of the planimetric base and land use and land cover map at the change compilation scale.

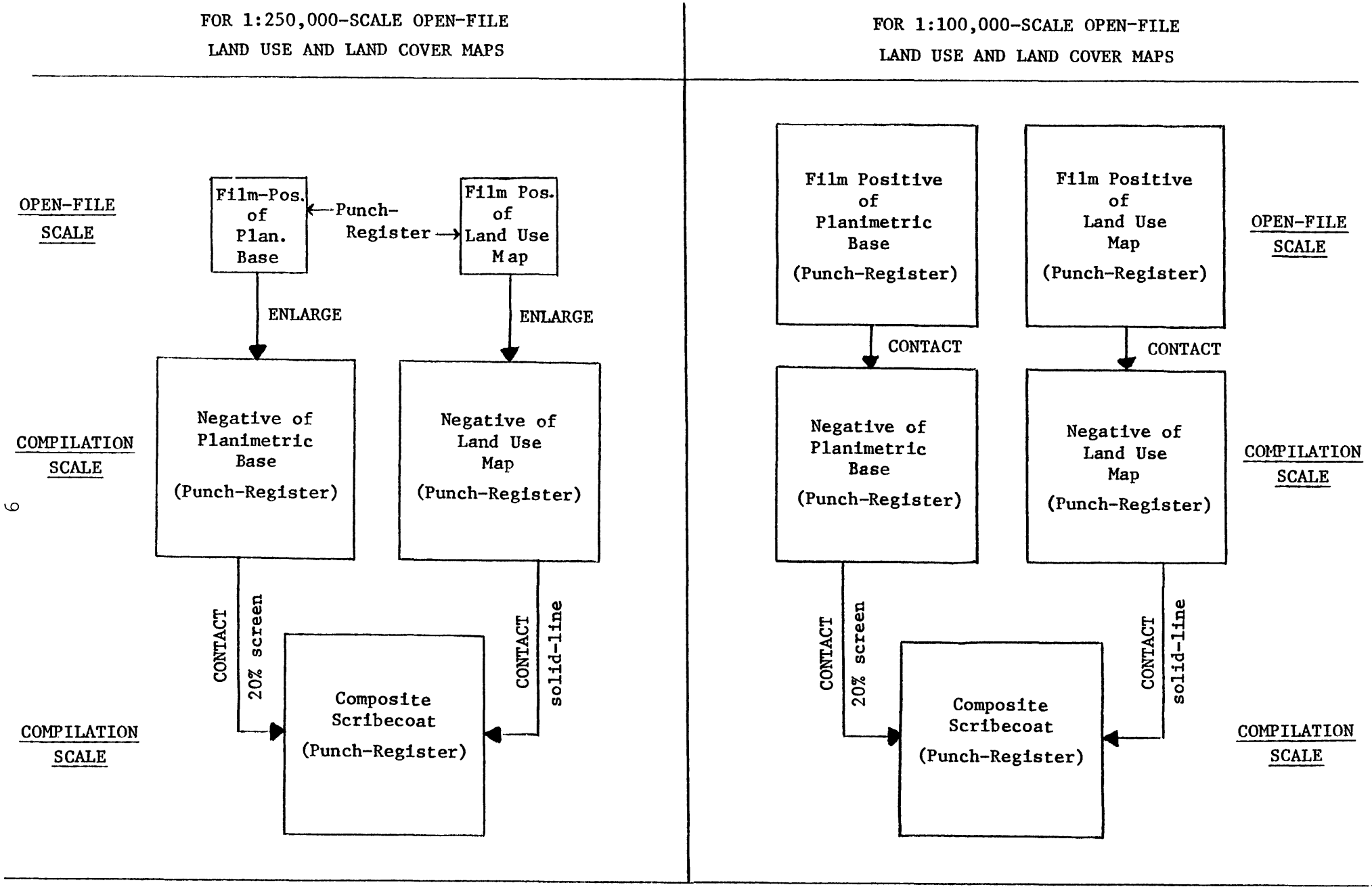

Figure 1.--Change compilation-scale base map preparation procedure for 1:250,000- and 1:100,000-scale open-file land use and land cover maps.

map source materials of two or more time periods, and the mapping of those changes in accordance with established land use classification standards and map compilation specifications. The following specifications cover those aspects of map update that take place after a map has been authorized for update, and after remotely sensed source material has been acquired and the compilation base map prepared. The specifications in this Section deal specifically with the procedures for detecting and identifying land use and land cover changes.

3.2 Description of Basic Approach

The land use changes identified in the change detection process serve two purposes--(1) to update existing land use and land cover maps and digital data, (2) to produce graphic and statistical products on land use changes for use in change data analysis, modeling, and other land resources studies. The simplest technique for deriving valid change data and, at the same time, updating an outdated map is by comparing the old map with new remotely sensed source material. In this approach map updating is accomplished by incorporating the land use changes derived from a comparison of the old land use data compilation with the new remotely sensed source material. In this procedure, the original compilation serves as the base control against which to evaluate and map all land use changes. Thus, continuity of compilation style is preserved in that the same general level of detail or generalization in mapping is retained. This method of change detection also permits a fairly complete review or edit of the old land use compilation since every delineated polygon portrayed on the map is compared with the corresponding area on the new photographic source. Thus, more cartographic and interpretation errors are likely to be identified as well as any suspicious "changes."

One limitation of an old map-to-new source material comparison is that the old land use compilation has to be accepted as being essentially correct since there is no opportunity to see the mapped land use features as they appeared in the old compilation source. Thus, there is no real way to challenge the land use category interpretations or boundary delineations. As a result, there is the possibility that errors in the original compilation may either go undetected in an update, or they may be mapped as sequential land use change when in actuality no change occurred.[3/] It is believed, however, that the old map-to-new source update approach will still provide an overall map accuracy level commensurate with the established accuracy standards for land use mapping.

3.3 Change Detection Procedure

The procedures for land use change detection specified here remain the same for each map regardless of the geographic extent of the area to be updated. Land use change detection is accomplished by using essentially

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3/ These "changes," however, when incorporated into the old land use and land cover map can serve to make the final, updated map more accurate.

the same viewing techniques as those used in compiling the original land use map. Identification of land use and land cover changes can either be accomplished by photogrammetric techniques or direct transfer of detail. If the photogrammetric approach is taken, the procedure and equipment selected will be the responsibility of the Center updating the map. The change mapping scale should be determined according to the characteristics of the photogrammetric equipment being used. The direct-detail transfer technique may require a film viewer or hand-lens magnifier and backlighted table to be used as interpretive aids in determining the categories of land use and land cover change to be delineated. For the direct-detail transfer technique the positive base transparencies for 1:250,000-scale maps will be formatted, scaled, and composited to develop the compilation base scribecoat at either the scale of the source material or other suitable compilation scale. If compilation scale differs from that of the new photographic source, the remotely sensed source material will be brought to compilation scale. For 1:100,000-scale maps, the remotely sensed source materials will always be scaled to that of the compilation base (1:100,000-scale).

Once scaling of the compilation base scribecoat or remotely sensed source materials has been accomplished, the compilation scribecoat is superimposed on the new rectified and (or) scaled photograph. Using either the base photograph or the viewing film (if any), each land use polygon delineated on the base map is compared with the corresponding land use feature appearing "under" it on the new source photograph. This review can be accomplished in a number of ways: by a systematic scan of the photograph beginning at one corner and proceeding east/west or north/south until the entire photograph has been evaluated, by employing a grid template overlay, or by using any other arbitrary sectioning technique or system as long as it permits complete, systematic review of the entire photograph (or that portion not duplicated on an overlapping photograph) against each polygon on the map base.

Land use changes are to be identified according to the same classification level, standards, and mapping criteria (minimum size, etc.) as that used in mapping the original land use and land cover data and as specified in PP 964 and in OF 77-555 on pages 21-25. In mapping changes the compiler extracts the same level and type of information as if this were a new compilation. If the compiler were to map a land use feature from the new photographic source substantially different from the way it had been mapped on the old land use compilation, then a potential change exists. In general, the compiler should be looking primarily for land use changes between Level I classes (even though these changes will be identified at their corresponding Level II categorizations). Level II category changes within Level I classes are generally of lesser concern for the purposes of map update.

There are three precautionary guidelines that must be emphasized and should be kept in mind when making change assessments:

(1) The original land use map should be accepted as being correct in terms of land use classification, boundary delineation, cartographic generalization and observance of minimum mapping unit sizes.

(2) Land use change detection should be approached from the point of view that it is not intended as an opportunity to disagree with the earlier land use compilation--the way in which land use and land cover was mapped and what it was called.

(3) Avoid laboring over observed differences in land use that involve indefinite boundary and (or) indefinite land use category areas (more about this point later).

3.4 Categories of Land Use and Land Cover Change

All Level II categories of land use and land cover that can be mapped are subject, in one way or another, to a change in use. However, some land use category changes such as conversions of cropland and pasture to urban uses and clearing of forestland for agricultural use are, by their very nature, considerably more likely to occur than are others. For example, urban or built-up classes and stable land areas such as tundra or rangeland where catalysts to change are often absent, are less likely to undergo changes in use.

Two change possibility matrices are shown in tables 2 and 3. Table 2 indicates the likelihood of land use change occurring between Level I categories, and table 3 identifies the likelihood of land use change occurring for each Level II category to and from every other Level II land use category. Every "from-to" change category pair in the matrices is evaluated on the basis of change probability and assigned into one of three change possibility groups representing the most likely changes, possible but not probable types of land use changes, and those changes considered to be either highly unlikely or not possible. The latter group also includes those category changes that, for the purpose of map updating, will not be mapped.

Those land use category changes identified in the first group as being the most likely to occur are in general those changes that it is the primary purpose of map updating to identify. These changes represent the more critical (and typical) conversions of land in terms of their cultural, environmental, and economic consequences.

The second group identifies those types of land use category changes that, while it is possible for them to occur, "normally" are not likely to be found. Such changes involve predominantly conversions of the more intensive categories of land use and land cover, such as the Urban or Built-up land use categories, to less intensive uses of the land as represented by Agricultural, Forestland, Rangeland, etc. categories. Since changes between the second group of land use categories are to be found only rarely, the compiler should be "suspicious" when such changes are found. In such cases, if the compiler cannot account for these changes on the basis of cartographic generalization or compiler judgment the update compiler should "flag" these polygons of difference for possible further check using the original compilation source materials (provided these materials are still available for use) before proceeding to map these areas as valid changes. These apparent "changes" may instead be indicative of errors or omissions in the original map compilation.

Table 2.--Level I category land use and land cover change possibility matrix.

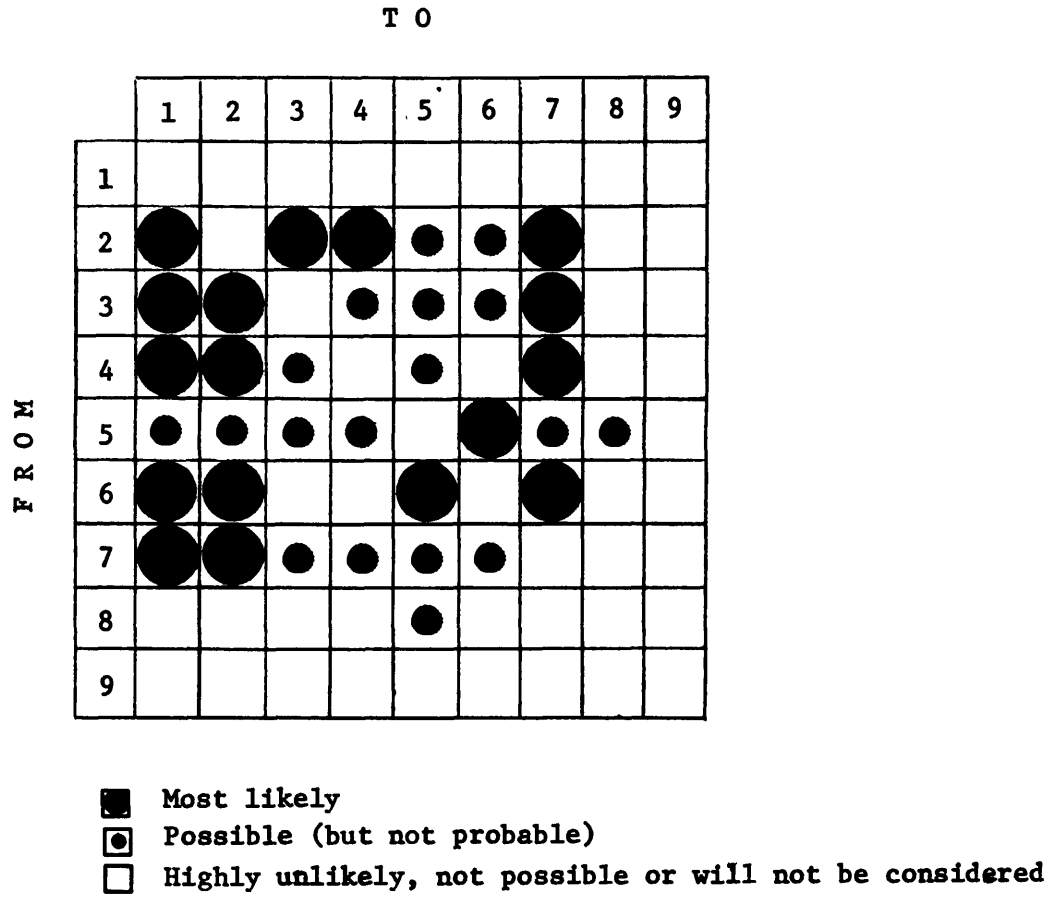
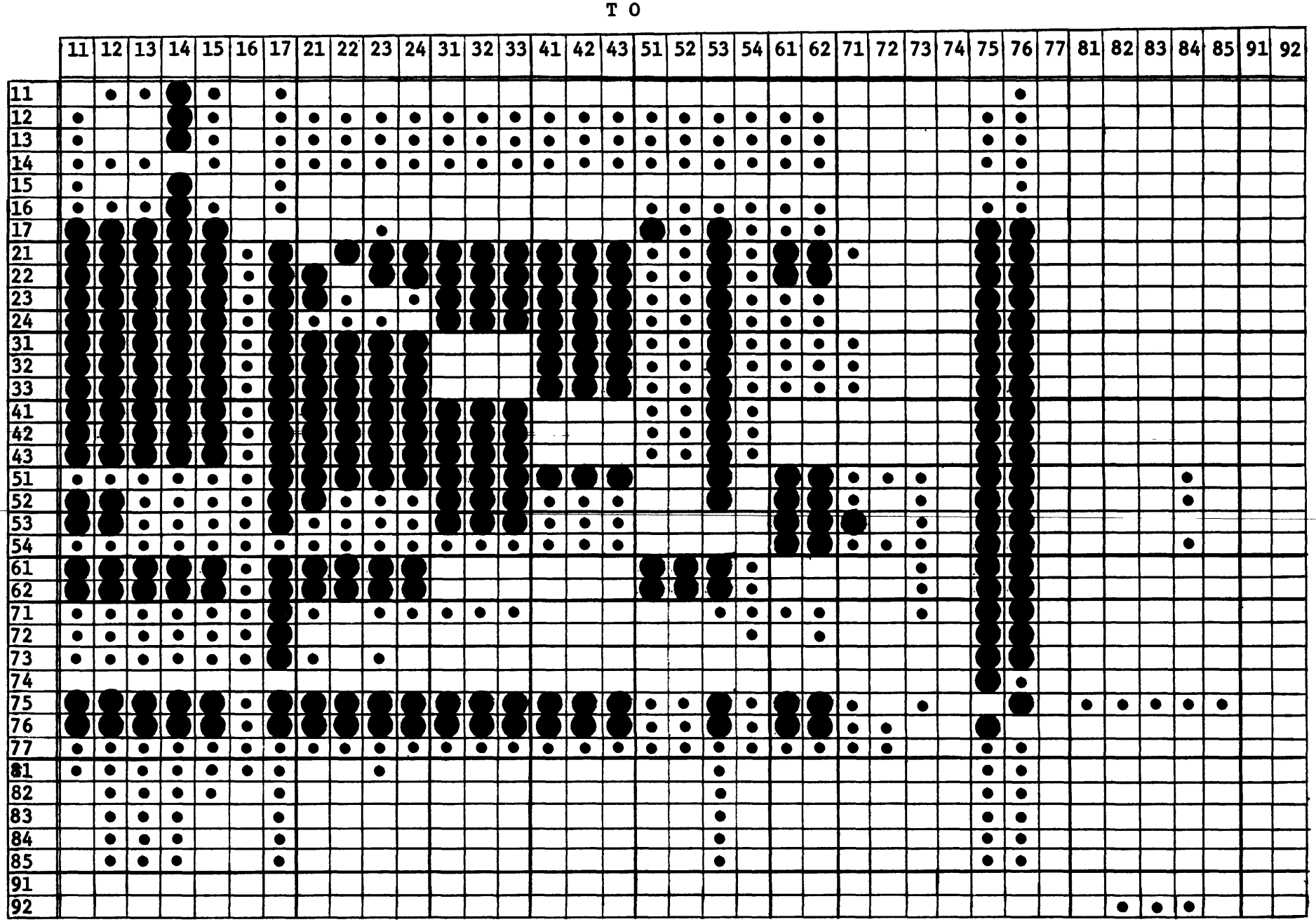


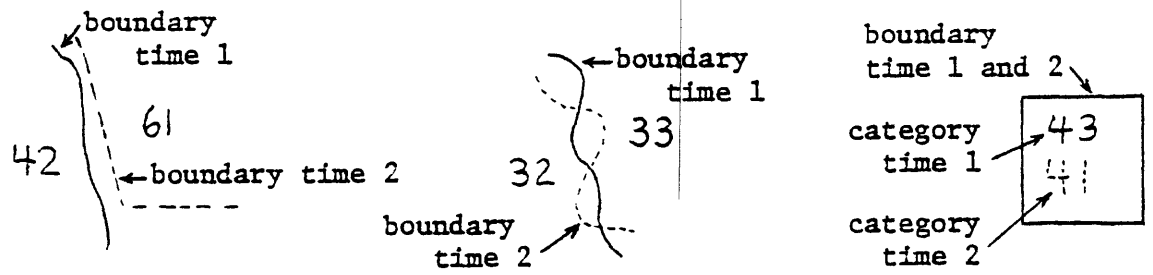
Table 3.--Level II category land use and land cover change possibility matrix (based on changes detectable from high-altitude remotely sensed source materials).



The third group of land use change possibilities involves those types of changes that will generally not be mapped during update since it is either highly unlikely, or not possible for them to occur, or they do not constitute valid sequential land use changes. Within this third group are changes among the following Level II categories:

From	To
11	16,21,22,23,24,31,32,33,41,42,43
12	13,16
13	12,16
14	16
15	12,13,16,21,22,23,24,31,32,33,41,42,43, 51,52,53,54,61,62,75
16	21,22,23,24,31,32,33,41,42,43
17	16,21,22,24,31,32,33,41,42,43
*31	32,33
*32	31,33,41,42,43
*33	31,32,41,42,43
*41	32,33,42,43,61,62
*42	32,33,41,42,61,62
*43	32,33,41,42,61,62
51	52,54
52	51,54
53	51,52,54
54	51,52,53
*61	31,32,33,41,42,43,61
*62	31,32,33,41,42,43,61
71	72
72	73
*81	82,83,84,85
*82	81,83,84,85
*83	81,82,84,85
*84	81,82,83,85
*85	81,82,83,84
*91	92
*92	91

In general the compiler should consider carefully what seem to be observed differences between the old compilation and the new photograph involving these category pairs, and should be most cautious in mapping either category or boundary changes in these cases. This must be emphasized especially for those listed "from-to" category changes preceded by an asterisk (*). Apparent changes or, more appropriately, differences observed between these asterisked categories are more often attributable to subjective differences in interpretation and boundary delineation between the way the original compiler mapped it and what the update compiler sees on the new photograph, rather than reflecting true sequential changes. Such land use categories are known as indefinite boundary categories. An indefinite boundary category can be defined as a land use category whose exact classification and (or) boundary delineation cannot be definitely determined from remotely sensed sources and as such is a matter of compiler subjectivity, and which could be delineated in any number of ways, each one as likely to be correct as the other. It cannot be overemphasized that in map update, differences in land use classification and/or boundary delineation between indefinite boundary category pairs that are the result of individual compiler judgment in either category interpretation or boundary delineation are not to be mapped as sequential land use change.[4/] Three common examples from among the numerous indefinite boundary and category changes are illustrated in the following diagram:



Example 1 **Example 2** **Example 3**

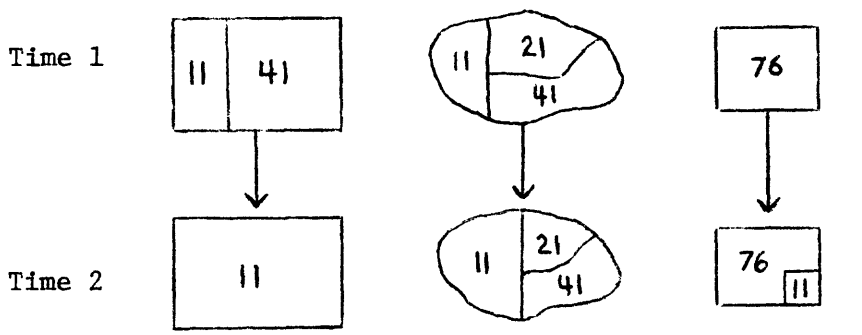
4/ There is an exception which is applicable in only rare instances. If an update compiler is certain that much of the original mapping of an indefinite boundary category(ies) is grossly in error (for example, due to source material problems in the earlier mapping), it should be brought to the attention of the appropriate personnel in the Mapping Center to which update of the map was authorized. If it is estimated that the magnitude of these mapping discrepancies is sufficient to significantly alter the area statistics and map accuracy level, then map recompilation, either partial or complete, may be authorized. If partial recompilation is done, the polygons so mapped will not be identified or counted as actual (temporal) land use change in the graphic or statistical data but will be considered as corrections to the data base and recorded differently (more about data base corrections later).

In each of these examples the solid lines represent the land use boundary or category mapped in the original compilation at time 1. The broken lines represent the land use boundary or category that the update compiler would map at time 2 for the same areas. While it is possible for legitimate changes to occur between the category pairs shown in the examples, most often boundary and category changes involving these types of land use situations reflect compiler subjectivity. Therefore generally avoid mapping such differences during updating.

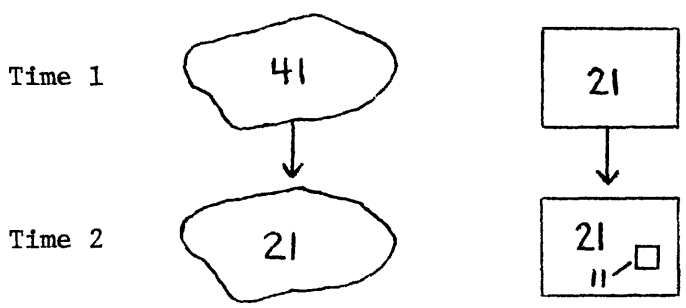
3.5 Types of Land Use and Land Cover Change

There are almost limitless variations and complexities of land use change. As such, it is not possible to illustrate every possible type or configuration of change likely to be found. However, there are three basic types or groups of land use change, from which all other change variations derive. One involves changes at or to land use or land cover boundaries. Another involves changes in land use categories, which may or may not involve a change in boundary. The third group involves changes in land use or land cover intensity, with no change in boundaries or categories. A fourth group of changes can also be considered. This group is composed of the previous three types of change but the change is attributable to factors other than those associated with true sequential change. Examples of each of these types of changes are presented below.

(1) Change in land use or land cover polygon boundary.



(2) Change in land use or land cover polygon category.



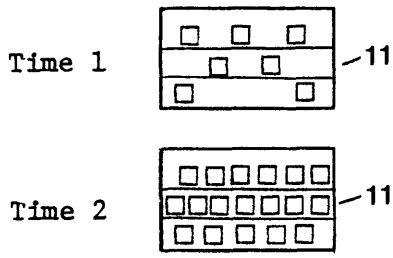
The identification of boundary and category changes, as illustrated in (1) and (2) on the previous page, is fairly straightforward. However, caution should be exercised when identifying the areas of land use boundary and (or) category change to insure that observed differences in the appearance, or signature, of the same land use feature at two different times are not interpreted as changes in use. Several parameters can affect the appearance of the same feature (and the way it might be mapped) at two different times, such as the time interval between photographs, time of year (season), sun angle, quality of photographs (either inherent resolution capability of the system, ground resolution, or quality imposed by photo-processing), film/filter types, and scale. Changes in any one of these factors between two sets of photographs can result in misleading change appraisals and the mapping of false change areas. This is particularly true for many non-urban land use situations, especially those involving indefinite boundary categories. The interpretation of forestland types and wetland/non-wetland areas, for example, is especially sensitive to certain temporal factors. Differences in the time of year between two sets of photographs can affect the ability of the compiler to identify forest types and categories of wetland as well as to discriminate reliably and consistently between forest cover and forested wetland from one time to the next. This can cause differences to occur in both category identification and boundary placement that are not the result of valid sequential land use changes. Another area of difficulty is often found in the Level II Cropland and Pasture category. Here, field pattern differences between two time periods can be noticed. This can be due to changes in the moisture content of the soil (which in turn affects reflectivity response), temporal/seasonal variations, crop type, stage in crop growth calendar, intensity of cultivation, and some farming practices, such as crop rotation and changes in field plowing directions, all of which alter the appearance of the land use feature but not its use category.

Finally, in addition to errors by commission, omission of valid changes may occur. The use of photographs acquired during the peak leaf-on season, for example, can limit the ability of the update compiler to identify changes in land use. As such, many small, isolated polygons of change (particularly to urban or built-up land use), if immersed in a surrounding matrix of rural land use and land cover categories, may go undetected.

(3) Change in Land Use Intensity

In addition to changes involving land use categories and boundaries between Level II categories, changes within a single Level II land use category can occur. These are known as changes in intensity of use where only the degree of the land use activity within a particular land use polygon is changed (either increased or decreased) but not its use or cover category. For example, intensity change is often found in residential subdivisions where housing fill-in has taken place between the time of baseline land use mapping and the time of update. Since the use or cover category of the land is not altered (nor its boundary changed) by a change in intensity, this type of change is not mapped for the purpose of map updating. An example of an intensity change involving residential land use is illustrated in the diagram on the following page.

(3) **Change in land use intensity.**



(4) Change in land use due to factors other than the natural process of sequential land use change.

This group consists of two types of land use changes. The first group is composed of those areas mapped falsely as changes due to differences in their spectral appearance at two different times. This group has already been discussed. The second group consists of "changes" which are really corrections to the original map compilation. These data base corrections can be derived from various sources, among them field checking, editing of digital data, and user/field reviews. Corrections to the original data will be made as needed during map updating so as to correct mapping errors such as omissions of data, misinterpretations in either land use categorization or boundary delineation, and logical or cartographic errors. Since data base corrections do not constitute actual temporal land use changes, they will be distinguished from these changes, both on the map and in the statistics so as not to yield erroneous data on the extent of land use change for a given area and time. The procedures for incorporating data base corrections will be described more fully in Section 5 of this report.

SECTION 4

COMPILING THE LAND USE AND LAND COVER CHANGE MAP

When a difference in land use and land cover between the original map compilation and the update photographic source is observed, the alleged change must be evaluated prior to mapping. Each candidate polygon of land use change must be reviewed in terms of several land use classification and map compilation criteria.[5/] These considerations are listed on the following page.

5/ This evaluation is actually an intuitive step in the change mapping decisionmaking process and usually takes place simultaneously with the identification of a land use change. It is not intended necessarily to be performed as a separate exercise. For the purpose of clarity and instruction, the identification and subsequent mapping of change are discussed in this report as two separate and independent components of map update.

4.1 Land Use Classification Criteria

(1) What is the Level II category classification of the land use observed on the new photographic source?

(2) Does it represent a change in Level II category classification from that shown on the map?

(3) Does the change constitute a valid Level II category change resulting from the process of sequential land use change?

4.2 Map Compilation Criteria

(1) Does the change polygon meet the minimum mapping unit size specified for the land use category?

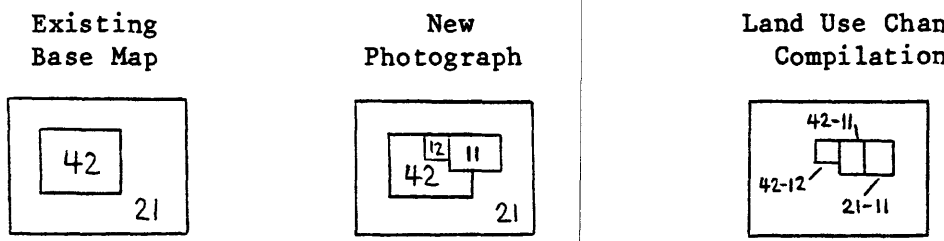
(2) Is the observed land use change attributable to mapping differences due to compiler judgment concerning (a) indefinite boundary categorization or (b) cartographic generalization?

(3) Does the land use change represent a correction to, or is it likely to indicate an error in, the previous data base (either in category interpretation, boundary delineation, or map presentation) rather than an actual sequential land use change? If so, this may represent a data base correction. Data base corrections are handled differently from other changes and are discussed in Section 5 of this report.

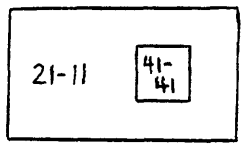
After determining that a valid sequential change in land use has occurred, only the area of change, as it appears on the new remote sensing source, is delineated on the compilation scribecoat base. In mapping the polygons of land use change, adherence to the classification categories and definitions in PP 964 and to the land use and land cover compilation specifications in OF 77-555 is required. In addition, the following compilation specifications are to be used.

4.3 Coding of Land Use and Land Cover Changes

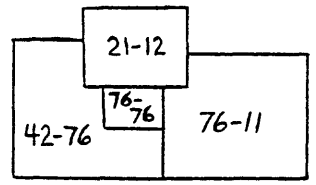
Each mapped polygon of land use change is to be labelled by a four-digit "from-to" change code composed of two Level II category identifiers separated by a hyphen. This code identifies both the prior Level II category (as mapped on the land use scribecoat base) and the new Level II category (appearing on the remote sensing source material). For example, a change polygon coded as 21-11 would denote a change in land use from Cropland and Pasture (21) to Residential land use (11). A graphic example is shown in the following diagram:



A polygon of non-change which is artifically created on the change compilation because it is surrounded by a polygon(s) of change would be labelled by a duplicate Level II code. This denotes that there is no change and the polygon is intentionally excluded from the surrounding change. Otherwise, by leaving the polygon blank, it could be misconstrued as a change polygon whose identifier is missing. Two examples are shown below.



Example 1



Example 2

4.4 Natural Boundary Delineation

All of the change polygon boundaries will be delineated as they appear in the new photographic source material. Generalize polygon boundaries only as required (a) by map scale constraints, (b) to meet minimum area size and width specifications, and (c) to conform to the configuration of any adjoining land use polygons and boundaries already mapped on the original compilation.

4.5 Minimum Mapping Unit Areas

(1) The size of the minimum mapping unit for the change polygon to be delineated will be either 10 or 40 acres, depending upon category classification, regardless of the final publication scale. All Level II categories will be mapped as follows:

10 acres	40 acres
Urban or Built-up Land (11-17)	Cropland and Pasture (21)
Confined Feeding Operations (23)	Orchards, Groves, etc. (22)
Other Agricultural Land (24)	Rangeland (31-33)
Water (52-54)	Forestland (41-43)
Strip Mines, Quarries, Gravel Pits (75)	Wetland (61,62)
Transitional (Urban) (76)	Barren Land (71-74, 77)
	Transitional (Rural) (76)
	Tundra (81-85)
	Perennial Snow or Ice (91,92)

(2) In mapping changes the minimum mapping unit area is determined by the new Level II land use category and not the former use. Thus, for example, a land use change from Cropland and Pasture (21) to Residential (11) will be mapped if the area of the new polygon meets or exceeds the minimum mapping size of 10 acres. A change from Lakes (52) to Nonforested Wetland (62) will be shown only if the new use meets the 40-acre minimum mapping unit area.

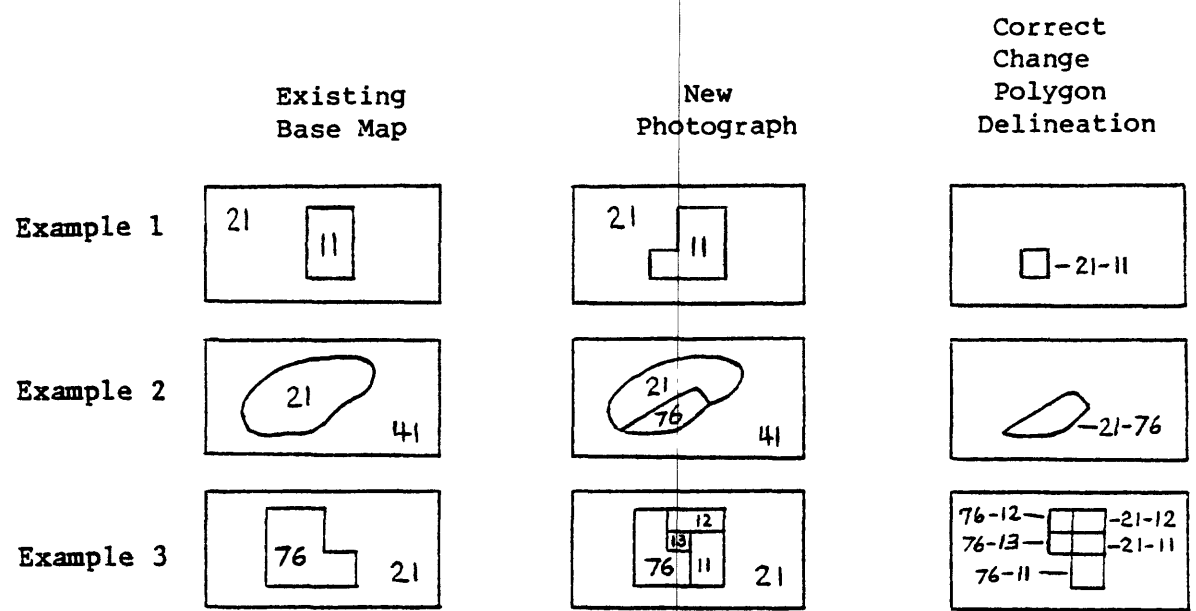
4.6 Minimum Mapping Unit Widths

(1) All land use change polygons mapped using a 10-acre minimum mapping unit area must have a minimum mapping unit width of 660 feet in order to be shown. This minimum width precludes the delineation of very long tracts of land use change below 660 feet in width (even though total area may exceed the 10-acre minimum). All polygons of land use change mapped using the 40-acre minimum mapping unit area will use 1,320 feet minimum width. However, appendages and enclaves from and into polygons of those categories with a minimum width of 1,320 feet can be shown down to a minimum width of 660 feet, providing the polygon body still meets the original specification of 1,320 feet. Exceptions to this specification are all interstate and limited access highways and all "double-line" rivers on the 1:250,000-scale base which shall have a minimum width of 300 feet.

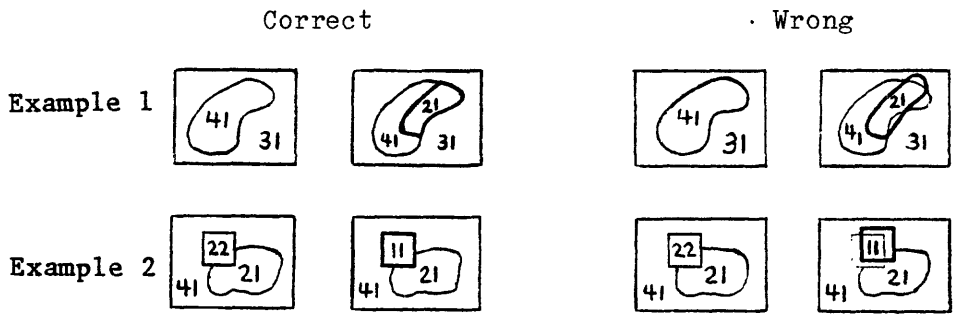
(2) Again, as in minimum mapping area, minimum mapping width is dictated by the new Level II land use category, not by the prior use category.

4.7 Land Use Change Polygon and Boundary Delineation

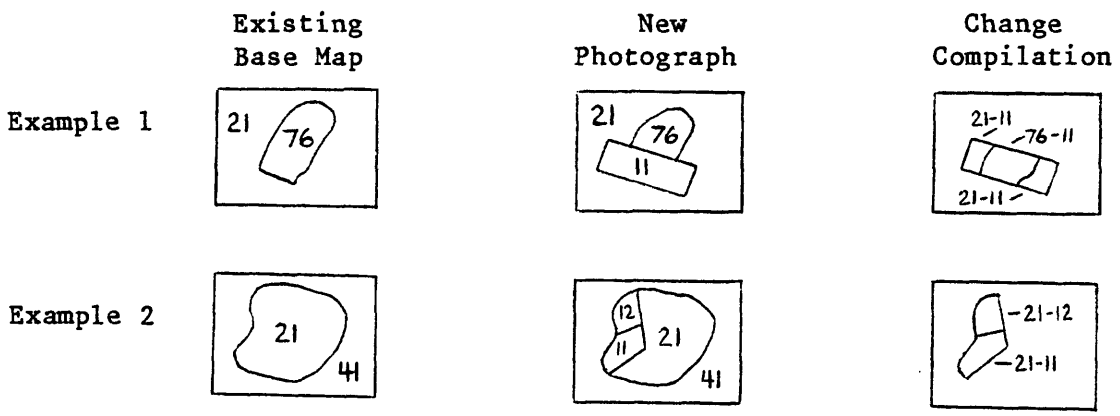
(1) Every land use and land cover change will be scribed as a complete polygon, that is, all boundary lines enclosing the polygon of change will be mapped in their entirety. A separate polygon is delineated for every change in category and boundary that occurs, even when two or more contiguous change polygons have the same new use category, but each is derived from a different prior use category, and vice versa. The diagrams below illustrate these cases.



(2) Care must be exercised when mapping polygons of change to insure that placement of change polygon boundaries is correct with respect to the existing land use polygon on the compilation base map. Repositioning of the base map and remote sensing source should be made as often as necessary to maintain proper registration of like features on both the map and photographic source. Boundaries which are common to both the new (change) polygon and the previously mapped polygon must be scribed so as to faithfully reproduce the existing polygon configuration. Where the boundary between the new data being added and the old data remaining is intended to coincide (that is, it is the same), the old boundary should be traced on the change compilation as precisely as possible with the differences in delineation being less than one scribed line width apart. This is illustrated in the following two diagrams with the heavier lines in each case representing the way the change polygon boundary should or should not be delineated.



(3) Every land use change that involves a change in category pairs is to be delineated as a separate polygon, even though the old or new use comprises only one polygon and (or) land use category (see illustrations below).



4.8 Cartographic Generalization

In the original land use and land cover compilation, some polygon boundaries had to be generalized (that is, naturally-occurring boundaries could not be followed) so as to meet the minimum mapping area and width

specifications. In order to maintain the same level of mapping detail or data generalization in change mapping as that contained in the prior mapping, a certain amount of cartographic generalization is required in delineating the boundaries of new, or change, polygons. In addition to observing minimum mapping unit sizes in mapping new land use polygons, minimum sizes must be maintained with regard to the existing polygons on the base as well. This is necessary because each time a land use and land cover map is updated, more land use and land cover information, and thus more detail, is added as portions of previously mapped polygons are subdivided into smaller polygons of other land use and land cover data. (Entire polygons infrequently are converted to another use(s) with original boundaries unchanged.) As a result, fragmentation of prior land use and land cover polygons occurs which in some instances causes them to fall below the specified minimum mapping areas and widths. Thus, polygon generalizations that deviate from the natural boundary portrayal of land use and land cover change polygons must be made to eliminate the occurrence of below-minimum-size polygons and "slivers" not only with respect to the new data being mapped, but also in relation to the previously compiled and remaining "background" polygons.

Cartographic generalization is to be applied only to the mapping of the new land use and land cover data, not to the previously compiled polygons. This means that only the new polygons of land use and land cover change will be generalized where needed, to maintain mapping specifications. No change in previously mapped land use and land cover boundaries that are not involved in a change will be made to achieve the required level of map generalization on the change compilation.

Minimum mapping sizes must be maintained for land use change polygon delineations in four mapping situations. These involve:

(1) the change polygon itself;
(2) the change polygon with respect to other new change polygons;
(3) the change polygon with respect to existing land use polygons on the base involved in change;
(4) the change polygon with respect to existing land use polygons on the base not involved in change.

In each of these situations, the appropriate minimum areas and widths must be observed in accordance with the Level II land use and land cover category involved. Several types of land use and land cover changes drawn from each of these situations are given in figure 2. They are representative of those most likely to be encountered and illustrate for the compiler the correct mapping procedure for the delineation of change polygons.

4.9 Edge Joins

The purpose of an edge join between adjacent maps is to insure that every land use change polygon extending from one map to the other has the same change category identifier and that its boundaries join at the map edge. During update, edge joins will be required in only certain cases. The following guidelines will be used.

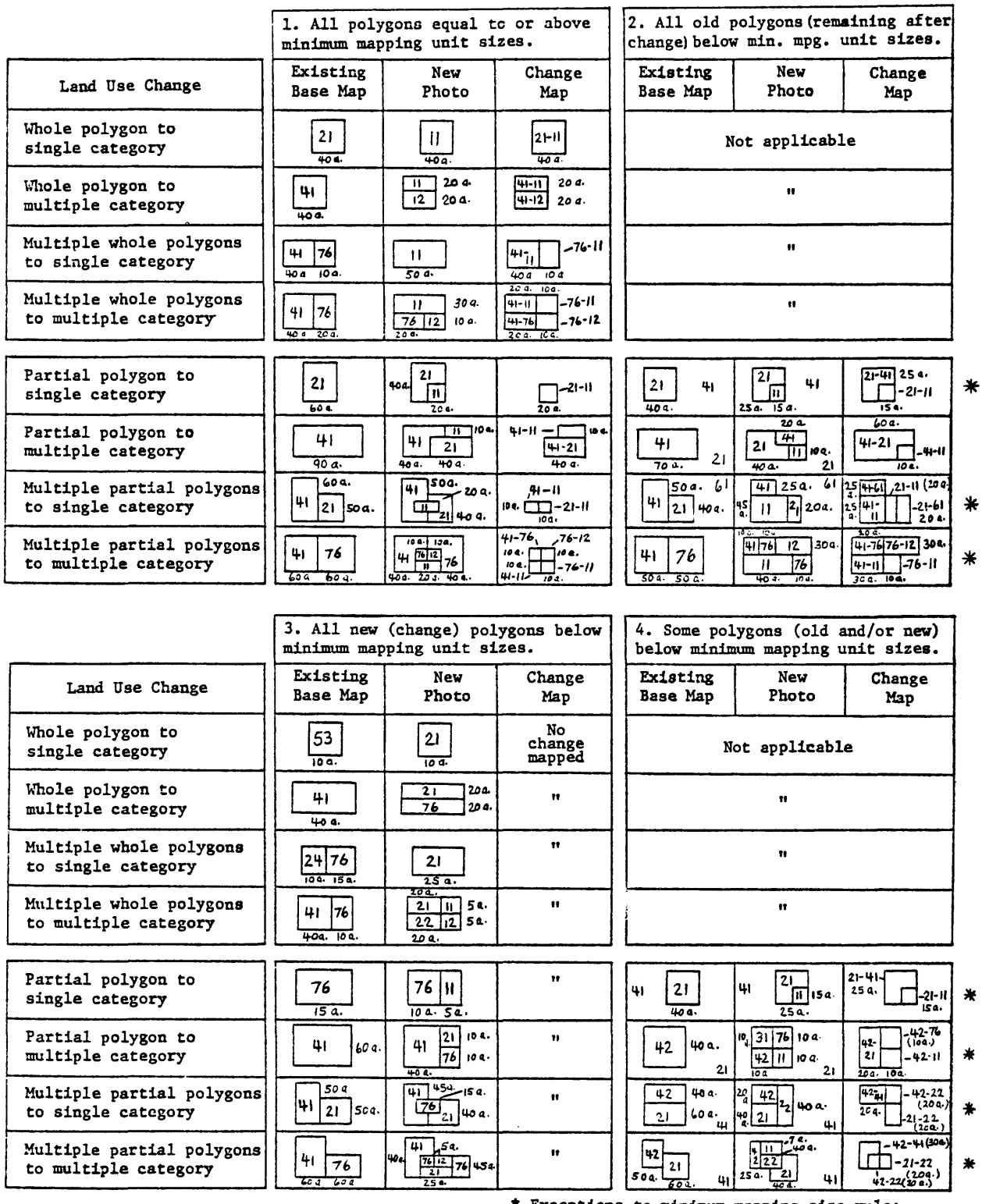


Figure 2.--Correct mapping procedures for various types of land use and land cover change polygons.

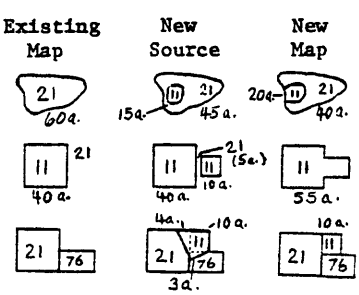
Definitions:

Old use polygon: 21

Change polygon: 21-11

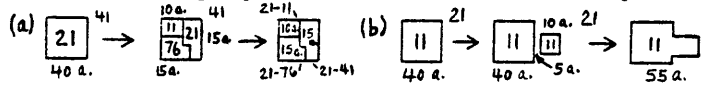
New use polygon: 11

Boundary generalization:

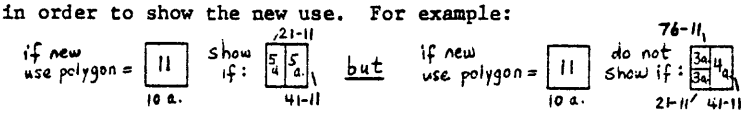


*** Exceptions to minimum mapping size rule:**

1. Where a change makes a remaining old polygon fall below minimum mapping size it may be mapped on the change compilation. Either (a) change it to surrounding/adjacent use polygon, or (b) group it with the new use. For example:



2. Where change polygons are less than minimum size but the new use polygon meets minimum size, change polygons can be mapped down to 5 acres for urban and 20 acres for non-urban in order to show the new use. For example:



(1) No edge join required--

a. Between an updated land use and land cover map and adjoining non-updated maps where dates of remote sensing source materials are 3 years or more apart.

b. Between adjoining updated land use and land cover maps where dates of update remote sensing source materials are 3 years or more apart.

c. Between updated and non-updated portions of the same land use and land cover map (if entire map is not authorized for revision) when age differences between remote sensing source materials is greater than 3 years.

(2) Edge join required--

a. Between an updated land use and land cover map and adjoining non-updated maps where dates of remote sensing source materials are less than 3 years apart.

b. Between adjoining updated land use and land cover maps where dates of update remote sensing source materials are less than 3 years apart.

c. Between updated and non-updated portions of the same land use and land cover maps (if entire map is not authorized for revision) when age differences between remote sensing source materials are less than 3 years apart.

In each situation where a join is required, it will be the responsibility of the Mapping Center personnel to insure that the join has been made before editing the map. The updated map will always be made to join to the surrounding maps or data except as noted previously. If two or more Mapping Centers are updating adjacent maps at relatively the same time, the Mapping Center which first completes the update will forward a 4-inch map edge strip as the required data for the join to the Mapping Center updating the adjoining map or maps.

4.10 Line Weights and Type Styles

To obtain uniformity for compilation of the change map, all change polygons will be scribed and the following line weights will be used for publication scales of 1:250,000 or 1:100,000. The specified line weights should be proportionally enlarged or reduced when the map is compiled at a scale other than publication scale.

(1) change polygon boundaries ..... 0.04"
(2) change polygon identifiers ..... 0.04"

The category identifiers for land use and land cover change polygons may be hand-scribed or a number template may be used. There should be sufficient identifiers in the larger polygons to insure ease of identification,

but not to clutter the map with identifiers. Identifiers should be placed centrally in simple polygons and used only as necessary for clarity in identifying polygons with complicated configurations. Change polygons too small to hold a number should have the number placed in close proximity with a leader line pointing to, but not touching, the polygon boundary. Leader lines should not be closer than 0.015" to the polygon boundary. All number identifiers should be positioned parallel to the southern geographic latitude projection line of the map. If numbers must be placed diagonally, they should read from left to right regardless of the angle. If numbers must be placed vertically and parallel to the meridian, the number will proceed from south to north and be read from the east side of the map. The numbers should be sized according to the size of the polygon being numbered. Identifiers will have a minimum height of 0.05 inch and an optimum height of 0.10 inch. In no case should the number exceed 0.25 inch in height at publication scale. Numbers must be clear and legible.

SECTION 5

DATA BASE CORRECTIONS

5.1 General Explanation

A data base correction is a change made to the original land use and land cover data that corrects an earlier mapping error in the compilation. Data base corrections can involve a category classification, a boundary delineation, an addition of data omitted, or a deletion of data mapped. It does not reflect or constitute a temporal change in land use and land cover as a result of sequential land conversion.

5.2 Guidelines

It is the general recommendation that for the purpose of change and update mapping, decisions to undertake major or, in some cases, even minor corrections to the data base should be made cautiously, and then only where it is considered absolutely necessary or required so as to "significantly" improve the quality of the map product or to bring the accuracy of the land use and land cover data up to an acceptable level, which is defined in PP 964 as 85 percent. This recommendation is based on the following considerations.

(1) In most cases, the accuracy of the existing land use and land cover map already meets or exceeds the recommended accuracy standard (85 percent) and any further corrections to the data base would not substantially improve map quality. Although not every land use and land cover map has been evaluated for accuracy, it has been found generally that among those tested (which were chosen as representing a greater number of maps having similar regional land use features and patterns) a given land use and land cover map achieves an 85 percent or better accuracy in category interpretation and boundary delineation at a 90-percent

level of confidence. This meets or exceeds the recommended accuracy level for land use and land cover mapping specified in PP 964. Thus, mapping errors present in the original compilation are considered to fall within the 15 percent range of accepted error and, if they remain uncorrected in an update will not lower the accuracy level of the compilation further.[6/] Given the relatively small number of the total land use and land cover polygons that will be affected by the updating process, it is expected that the same level of accuracy will be maintained in the updated map product as well.

(2) The original remote sensing source and other auxiliary maps and data used in the initial mapping would be required input for all data base corrections. In many instances, this information is no longer available or would be unduly costly to obtain. Often a land use and land cover interpretation or mapping decision is not based solely on the information garnered from the remotely sensed source material but also on supplemental data such as field check notes and photographs, precompilation data, existing land use maps, and cooperator reviews. The ability to make corrections to the data base depends on the availability of all these source materials used in compiling the original land use and land cover map. Because of the time and expense involved in re-acquiring the compilation source materials in those instances where it is no longer readily available, corrections should be considered very carefully and any potential benefits measured against the expenditures involved.

(3) Many data base corrections more often than not will change land use and land cover data that are not really in error, but rather reflect subjective mapping differences. Land use and land cover interpretation and mapping from remotely sensed sources is not an exact science. Rather, it often requires the interpreter/cartographer to make many subjective decisions concerning land use and land cover category interpretations and boundary delineations. For many of these situations, no completely correct decision is possible or any number of decisions could be considered equally correct. As such there can occur many "gray" areas that reflect compiler judgment and style. There are three such situations in land use and land cover mapping. These involve:

6/ It has generally been the practice that if during baseline land use and land cover mapping, the compilation is found to contain a number of problem areas that would result in a map product having an unacceptable accuracy level, the map compilation is either cancelled, or suspended to await clarification or field checking to resolve specific mapping problems.

a. Indefinite category interpretations--those polygons of land use and land cover whose boundaries can be determined accurately from remote sensing sources but whose categorizations are often confused with one another in the absence of supplementary information. Examples occur between Level II categories 11 and 16, 12 and 13, and 13 and 14.

b. Indefinite boundary delineations--those categories of land use and land cover in which the boundaries between them are subjective and cannot be delineated with total accuracy without supplemental information. Depending on the quality of the remote sensing source materials used, these include boundaries between such categories as: 41, 42, and 43; 31, 32, and 33; 61 and 62; 41 and 61; 42 and 32; and others listed with an asterisk (*) in Section 3, part 3.4 of this report. In addition there is some overlap between indefinite category and boundary areas in that a polygon having an indefinite boundary placement may have an indefinite category identification as well.

c. Compiler mapping style--those polygons of land use and land cover whose boundary configuration is a matter of individual cartographic style and reflects the compiler's personal preference or judgment in presenting the data. This involves delineations of polygon boundary lines as either curved or straight, rounded or angular, smooth or jagged, loosely generalized to include dissimilar data or tightly generalized to exclude dissimilar data, etc.

In each of these three polygon category and boundary situations, the mapping of changes and (or) data base corrections generally is to be avoided since such changes most often reflect differences in judgment and style between compilers rather than actual changes or mapping errors.

5.3 Sources of Data Base Corrections

Corrections to the land use and land cover data base (original compilation) can be derived from six sources. They are:

(1) Arc to polygon (ATP) editing of the digital land use and land cover tape.
(2) Post-compilation/post-open-file field check.
(3) Public (user) response.
(4) Cooperator/field review.
(5) Known problems or errors noted at the time of compilation (contained in compilation history).
(6) Those errors discovered in the course of map updating.

All papers, corrections, notes, review maps and other pertinent information on which errors, questions, or comments are noted concerning the original land use and land cover compilation, should be provided to the compiler at the time of updating so that the necessary corrections can be made to the data base.

5.4 Types of Data Base Corrections

Even though it is recommended as a general rule that data base corrections arising from the change mapping process be avoided where possible, there are some cases nonetheless where they are not only justifiable but desirable to make. Data base corrections involve two types of errors which are listed below together with their commonly associated forms:

(1) Cartographic errors

a. Illegible identifiers
b. Missing identifiers
c. Missing boundaries
d. Adjoining polygons with the same identifier
e. Boundaries between like polygons
f. Polygons mapped that are below minimum mapping unit size
g. Polygons omitted that are of minimum size or greater

(2) Interpretation errors

a. Boundary delineation errors
b. Category identification or classification errors

5.5 Identification of Data Base Corrections

The recommended procedures to be followed during change mapping for identifying corrections to the original land use and land cover data base are as follows:

Step (1) The compiler should note all polygons of suspicious category or boundary change as items for further check. This should be done in the same way as polygons for field check were noted on the original compilation. These polygons can be identified on the change compilation scribecoat by a marginal notation "DBC" with a leader line drawn to the polygon in question. An entry should also be made on the compiler problem list describing the nature of the change or data base correction thought to be needed.

Step (2) These correction calls are to be forwarded with the land use change compilation and all other required materials to the change map editor at the end of change mapping. Each "DBC" item noted will be reviewed by the editor and as many as possible will be resolved in accordance with the guidelines for data base corrections described previously. Those correction calls that remain or any that are added during editing will be forwarded to the appropriate personnel at the time of quality control.

Step (3) Each remaining "DBC" call will be reviewed in quality control. If it cannot be resolved or the number and type of corrections are considered sufficient to affect significantly the accuracy of the map, then:

Step (4) The appropriate Mapping Center personnel will submit a request for acquisition of compilation remote sensing source materials and any other data used in the initial land use and land cover mapping (for those maps for which the original compilation source materials are not already on hand). The errors noted will then be compared with the compilation source materials to verify the need for data base correction.

Step (5) If the data base corrections are minor and can easily be corrected during updating, the change compilation together with the appropriate original source materials will be returned to the compiler at the end of quality control for correction of those polygons so indicated. The compiler will then follow the specifications in this report covering the mapping of data base corrections.

Step (6) If the data base corrections are major or extensive, then partial or complete recompilation of those portions of the map in error may be authorized. In cases of recompilation, mapping will be conducted on the change compilation scribecoat according to the specifications used for initial land use and land cover mapping (OF 77-555) and the specifications described in the following Section.

5.6 Mapping of Data Base Corrections

Once a data base correction is identified and verified, only that part of the old, incorrect polygon is mapped on the change compilation scribecoat. Data base corrections are to be scribed as complete polygons using the same mapping procedures as those specified in Section 4 for the compilation of land use and land cover changes. There are two types of data base correction polygons to be mapped:

(1) Those polygons involving a data base correction only; and
(2) Those polygons that involve both data base corrections and temporal land use changes.

In order to distinguish data base corrections from polygons of temporal change on the change compilation, and also for later digitizing, polygons of data base correction will be coded differently from other changes as follows:

(1) For polygons only correcting the data base, use two Level II category identifiers, separated by a hyphen, with an asterisk after the first two digits. For example, a polygon coded as 12*-24 would read:

12 = land use and land cover polygon mapped on original (baseline) compilation as Commercial and Services category.
* = signals that preceding Level II category (12) is in error.
24 = the correct and current land use and land cover category for the polygon mapped in the original compilation is Other Agricultural Land (24).

(2) In rare cases, a temporal change polygon may also be involved in a data base correction. Such cases usually cannot be identified but there are a few exceptions. For example, a polygon was mapped on the original compilation as category 12, Commercial and Services. A user review or field check indicates that it actually was Category 24, Other Agricultural Land. The new update remote sensing source shows the polygon as being Residential, category 11. If the data base correction was not made, the change polygon would be mapped and identified as 12-11 at the time of update. If the data base correction is made, however, and the land use change also noted, the polygon would be coded as 12*-24-11, which reads:

12 = land use and land cover polygon mapped on original compilation as Commercial and Services category.
* = signals that preceding Level II category (12) is in error.
24 = the correct land use and land cover category for the polygon mapped in the original compilation is Other Agricultural Land (24).
11 = indicates that the former land use identified for that polygon, category 24, has been changed. The new land use is now Residential, category 11.

It must be re-emphasized that the original compilation remotely sensed source material plus any additional maps, notes, precompilation photographs, and any other materials used for the baseline land use and land cover mapping are required to verify a suspected error in the compilation and to make the appropriate correction to the data base. It must be remembered that in many instances, if the quality of the remotely sensed source material used in the update phase is appreciably different from that used in the baseline compilation, then it is likely that more data base "corrections" will be noted. Because of these photographic source differences and the possible use of supplementary sources, unknown to the update compiler, for making land use interpretation and mapping decisions during the baseline compilation, each call for correction during update must be evaluated very carefully.

Polygons of data base correction will have the same line weights and identifier type styles as those for land use and land cover change polygons specified in Section 4 of this report.

SECTION 6

EDITING AND QUALITY CONTROL

6.1 General Explanation

The purpose of map editing is to prepare a final product that is free of discernible cartographic error, consistent in interpretation and presentation, and clear to the map user. The map editor should have an extensive knowledge of photointerpretation and standard mapping practices, combined with a broad knowledge of cartography.

The editing procedure will provide a critical review of the compiled land use and land cover changes for general conformance to established mapping standards. The editor will inspect each change compilation for error, data omission, clarity, legibility, compliance with specifications, and accuracy of content and format. Each map must be reviewed to insure that the edges have been properly joined to each adjacent map (where required) and that explanations are complete.

If any corrections are necessary, the change compilation is to be returned to the compiler for corrections and then returned to the editor for additional review. If an orderly sequence of editing operations is followed, many omissions and errors will be prevented.

In the editing phase, the land use and land cover change compilation will be corrected and prepared for quality control, final reproduction, and for digitizing. The responsibility for editing and quality control of all maps rests with the compilation Mapping Center.

The following editing procedures are being used currently in the baseline compilation of land use and land cover maps and will prove useful in editing the change map.

6.2 Change Map Editing Procedures

The editing phase will begin with the collection of all base maps, remotely sensed source materials, and any auxiliary information used to compile the change data. The information on the land use change compilation will be checked against the update photographic source materials. One way to note editorial corrections is to overlay the change compilation with a sheet of matte film. The matte film is punch-registered to the change compilation and secured with registration pins. Next, each corner and selected internal areas of the mylar film are marked with geographic reference ticks. The geographic ticks must be on the mylar sheet to register the border frame. Other methods are to make editorial comments and corrections in pencil directly on the scribecoat compilation along the margins or to produce a matte-film positive of the scribecoat compilation on which editorial comments may be noted.

The editing of the change compilation will be accomplished in two steps. The first step will be to check for mechanical and drafting errors. The second will be to review the interpretation for correct identification of changes. All notes or corrections to the map will be made along the borders.

A 4- by 4-inch template can be used to focus the editor's attention on one small area of the map at a time. The procedure for using the template is as follows: The editor should mark each polygon within the area of the template with a check mark placed on the editing overlay or scribecoat. The purpose of marking each polygon is to insure that no polygons are missed. With the template, begin in the corner of the map and, as each 4- by 4-inch square is checked, move the template in one of the cardinal directions. This procedure is then repeated until the entire map has been reviewed. Again, check each 4- by 4-inch square for the following mechanical or drafting errors:

(1) Land use and land cover change polygons without numbers;
(2) Lines not connected;
(3) Numbers not legible;
(4) Areas not meeting minimum size requirements;
(5) Any other obvious discrepancy.

Each recognized discrepancy will have a leader drawn from that location to the border of the mylar overlay, scribecoat base, or matte positive where a note will explain the error.

Once the editor has checked the map for drafting errors, he or she must review the accuracy of the interpretation. Obviously, the editor must be a competent photointerpreter. The following items are needed for editing the land use change compilation: viewing and (or) base photographs, original compilation remotely sensed source material (if needed), viewer or hand-lens magnifier, definitions from PP 964, land use and land cover compilation specifications from OF 77-555, and update mapping specifications. The editor sets up the remotely sensed source material and the land use change compilation manuscript in the same manner as previously described in the compilation phase.

Editing the land use and land cover change polygons with the photographic source material is accomplished in the following manner: The land use change scribecoat is positioned over the base film and brought into coincidence with like features. The viewing film (if any) is placed in the viewer so that the accuracy of the land use interpretation can be checked visually. The editor must be able to combine his knowledge of photointerpretation with the classification system in PP 964 and the map update specifications. Using the 4-inch square template, the editor checks and marks selected polygons for corrections, using the editing correction codes in table 4. Special care must be taken to review those problem areas indicated by the compiler. If interpretation and classification of the problem area still is undetermined after editing, the problem must be so noted for further clarification during quality control.

The editor has now reviewed the change compilation and noted where drafting and interpretation errors occur on the map. If there are any adjoining maps, the borders must be reviewed to insure that every polygon extending from one map to the other has the same land use and land cover category. Requirements for edge joins are noted in Section 4 of this report. Usually, the joining requires polygon adjustment from map to map. Some of the adjustments are due to differences in delineation of the same change category by different compilers. Another reason for adjustment from map to map may be differing category interpretations of the same area. When the editor has noted the corrections that must be made for proper join, the land use change compilation is ready to be returned to the compiler for correction. The map is subsequently returned to an editor for a final edit to insure that corrections have been made properly. The Mapping Center editor has the responsibility of determining if the land use and land cover change interpretations and delineations are accurate. When editing is complete, and if no further changes are necessary, the land use change compilation is ready for quality control.

6.3 Quality Control

All copies of maps and data, or sections thereof, submitted for quality control should contain the following: (1) date of update source materials (year); (2) join information (sheet name, month/year); and (3) credit legend (along each sheet edge) - "Edited by" (name/month/year). In addition, the following materials should be forwarded for the quality control check:

(1) Scribecoat manuscript of the land use and land cover change compilation (or a matte positive);
(2) Editing notations;
(3) All source materials used during updating;
(4) Compiler problem list;
(5) Edge join strips (if required).

Table 4.--Editing correction codes (from OF 77-555).

Instructions

(A)	ADD	(SP)	SPELLING
(AJ)	ADJUST	(TT)	TIME TEST
(C)	CONNECT	(ST)	STRENGTHEN
(AL)	ALIGN	(X)	EXTEND
(CG)	CHANGE		MOVE TO LEFT
(CK)	CHECK		MOVE TO RIGHT
(CL)	CLEAN/CLEAR		RAISE
(D)	DELETE		LOWER
(M)	MOVE		REVERSE
(R)	RESTORE	√√	AS INDICATED
(RV)	REVISE		

NOTES

1. Instructions shall be circled - Examples: (A) DIA (M) RR
2. Use quotation marks to indicate words, letters, and numbers affected by call - Examples:
   (SP) "Paris" (CG) to "56"
3. On type calls specify the case number and whether caps or lower case, or both.

The quality control function is performed by designated personnel within the regional Mapping Center. The quality control function is concerned with the following:

(1) Insures uniformity of final NMD land use and land cover map products regardless of compiling Mapping Center or method of compilation.

(2) Determines the classification and mapping of unique regional expressions of land use and land cover in terms of the classification system in PP 964 and the map compilation specifications in OF 77-555.

(3) Insures adherence to specifications for all land use and land cover change and update mapping completed.

SECTION 7

MAP UPDATE PRODUCT GENERATION

7.1 General Explanation

The land use and land cover change data that have been mapped as part of the updating process are used (1) to update the existing land use and land cover map, (2) to update the computerized digital file so that updated graphics and statistics can be generated, and (3) to create a supplemental overlay showing land use and land cover changes. This section and figure 3 describe the sequence and procedures for achieving these three product objectives.

If update of the existing land use and land cover map and the production of a new land use map and a final map of changes are to be accomplished by the computer, (after digitizing and merging the change data with the existing land use data base,) then follow only the procedures outlined in part 2 of this Section.7/ If the existing land use map is to be updated manually and a change map is to be produced by conventional map preparation methods, then follow the specifications in all parts of this Section.

The steps within any one of the following three parts of this Section need not be done separately or in any particular sequence. Steps may be combined where appropriate to do so for economy (for example, all photographic laboratory work may be done at the same time rather than separately).

7/ It is the eventual aim of this revision program to have all land use and land cover maps updated and produced by automated cartographic methods.

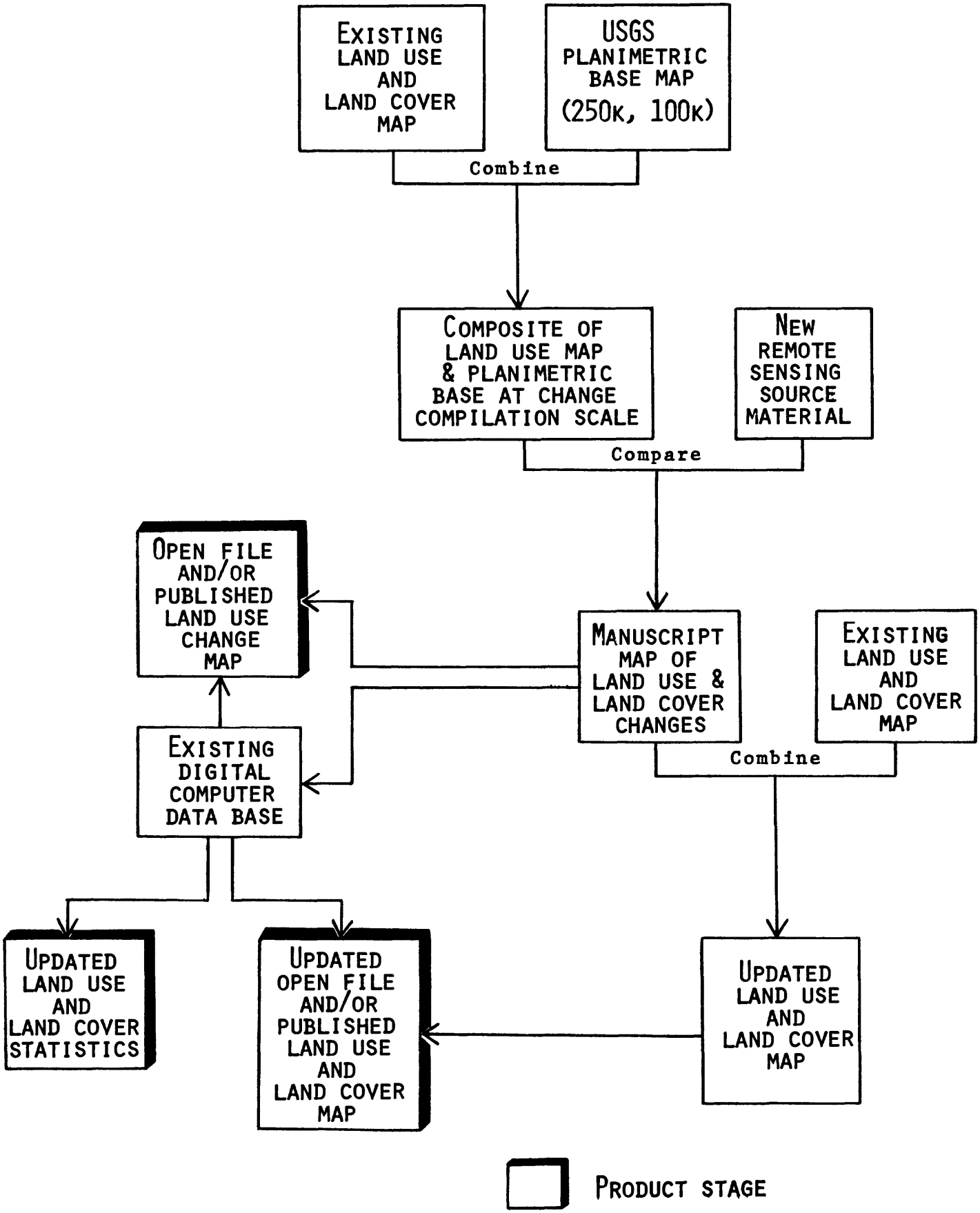


Figure 3.--Flow diagram of sequence and procedures for updating land use and land cover maps and digital data and for generating updated products.

7.2 Preparation of Digitizing Copy of Land Use and Land Cover Changes

Step (1) After the land use and land cover change compilation is completed (that is, through editing and quality control, and after all compilation corrections have been made) make one (1) punch-registered contact film positive of the change compilation scribecoat showing all polygons of land use and land cover change, data base corrections, and polygon identifiers.

Step (2) Bring the film positive generated in step 1 to publication scale, if different from compilation scale, and fit to and combine with plate containing neatline and tick marks prepared earlier (see Section 8, part 8.2 of this report). Make a composite negative and one right-reading film positive.

Step (3) Attach self-adhesive labels to both negative and positive copies showing (1) sheet name, (2) year(s) of update photographic source, (3) area of update (full sheet or "_____" only; for example, State name, county name, or quadrant), and (4) whether map data was updated, recompiled, or both.

Step (4) Retain negative in compilation Mapping Center. Forward film positive to Eastern Mapping Center for digitizing.

Step (5) If a supplemental map of land use and land cover changes and an update of the existing land use and land cover map are to be made manually by conventional cartographic methods, go directly to part 7.3, step (1). Otherwise, go to step (6) below.

Step (6) If update of the existing land use and land cover map is to be made by conventional cartographic methods and no supplemental map of changes is to be prepared, go directly to part 7.4; otherwise, see step (7) below.

Step (7) NMD Mapping Center land use and land cover map updating procedures are completed. No additional specifications are applicable. No further work is required.

7.3 Preparation of the Land Use and Land Cover Change Map

Step (1) After the land use and land cover change compilation is completed (that is, through editing and quality control, and after all compilation corrections have been made) make one (1) punch-registered, contact, right-reading film positive from the composite negative showing land use and land cover changes plus neatlines and tick marks at publication scale generated in part 7.2, step 2 of this Section.

Step (2) Go to Section 8, part 8.4 of this report and follow instructions for collaring of land use and land cover change map.

7.4 Update of the Existing Land Use and Land Cover Map

The following procedures outline the specifications for incorporating changes to the existing land use and land cover map. In many ways, these procedures are similar to those used by the NMD in revising standard topographic maps. Update of the existing land use and land cover map will be accomplished by first reviewing both the mapped change data together with the existing land use and land cover map and making the appropriate cartographic changes (additions or deletions) on each so that the new land use and land cover polygon data from the change compilation add to or replace the corresponding data on the original land use and land cover map. A composite is then made combining the data from the two compilations to create a new, updated map of land use and land cover in which the new change data are now indistinquishable from the rest of the map data.

The procedures for incorporating changes to the original land use and land cover map are outlined below:

Step (1) Make a contact film positive from the compilation-scale negative of the land use and land cover map used in making the change compilation scribecoat base. This will be used side-by-side with the change compilation scribecoat. Boundary and identifier deletions will be made directly on this film positive copy.

Step (2) After the land use and land cover change compilation is completed and after the compilation-scale film positives of the change scribecoat have been made for digitizing and for preparation of the supplemental change map (if required), begin comparison of the scribed change data (polygons and codes) with the existing background land use and land cover polygons appearing on the scribecoat compilation base.

Step (3) Each change polygon on the compilation scribecoat is to be checked against all other surrounding change polygons and those polygons of land use and land cover on the scribecoat base. For each change polygon being evaluated, make the appropriate adjustment to polygon boundaries and identifiers first to the change compilation then to the original land use and land cover map positive at compilation-scale. Make sure that for every adjustment made to a change polygon on the change scribecoat, a corresponding adjustment is made also on the land use and land cover positive.

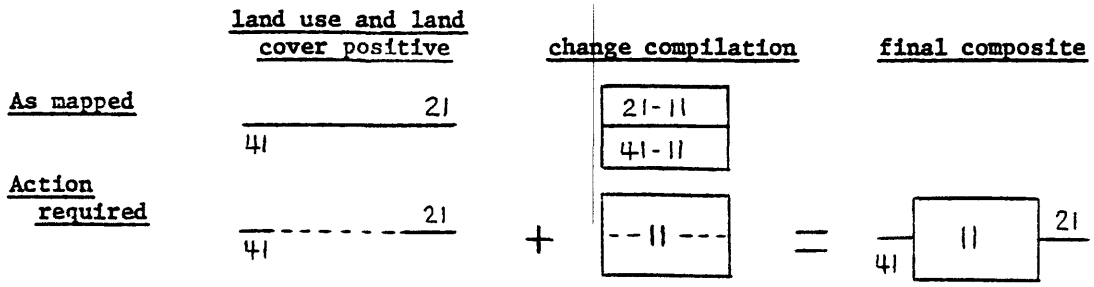
Step (4) There are only two types of cartographic changes that will be made:

a. deletions of polygon boundary lines and identifiers; and
b. additions of polygon boundary lines and identifiers

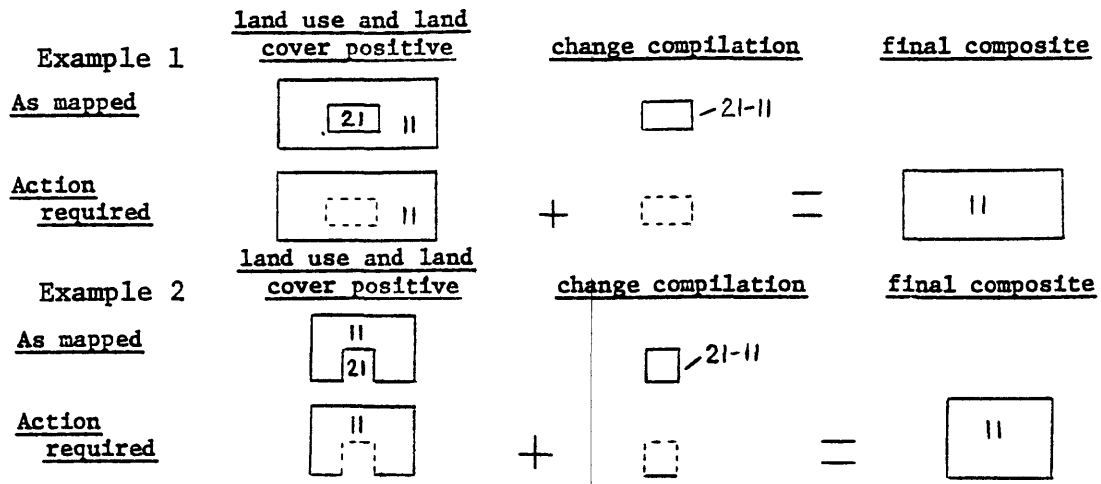
Adjustments to the land use change scribecoat will include deletions and all data additions. Adjustments to the original land use and land cover map positive at compilation-scale will involve deletions only.

Step (5) Several types of polygon boundary adjustments are to be made during map updating. These are described below together with illustrations showing the appropriate procedures to be followed in making these adjustments to both the change compilation scribecoat and the land use and land cover map positive (broken lines indicate deletions). Data base corrections will follow the same procedures.

a. Delete all boundaries that separate identical "to" change polygons.*



b. Delete all boundaries that separate identical "to" change polygons and existing land use and land cover polygons.



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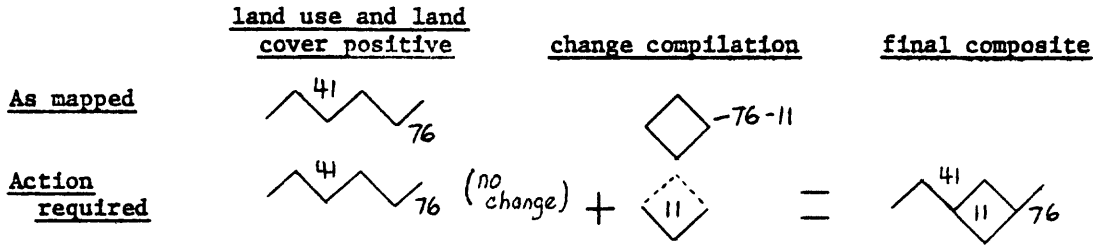
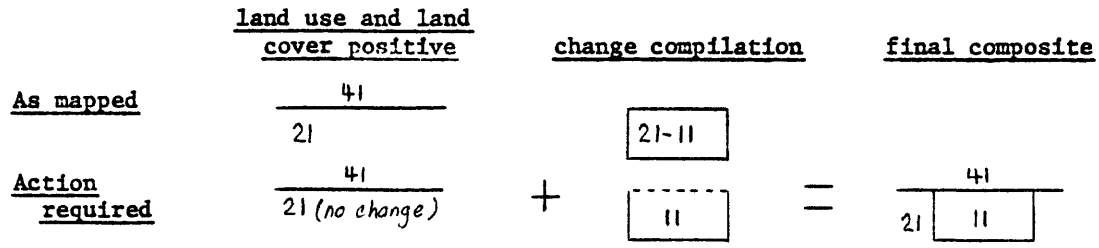
* Broken lines (---) are used in the following diagrams to indicate lines that are to be deleted (opaqued) on the land use and land cover positive and (or) the change compilation scribecoat.

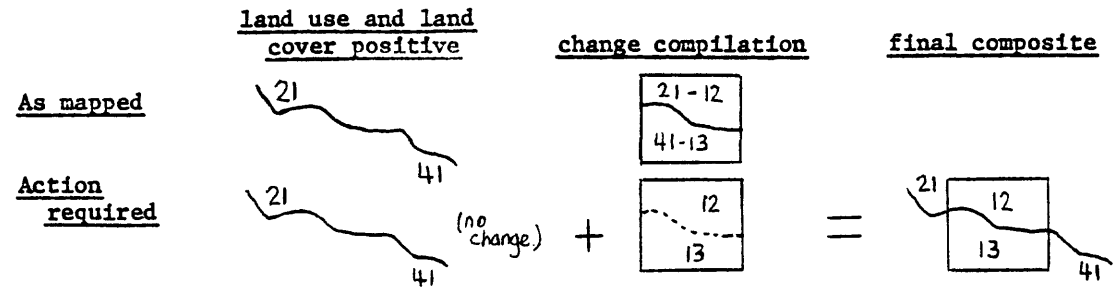
c. Delete all boundaries of change polygons on the change compilation scribecoat that duplicate those polygon boundaries appearing on the existing land use and land cover map.



d. Retain all boundaries on the change compilation scribecoat that are needed to complete new polygons not appearing on the original land use and land cover map.



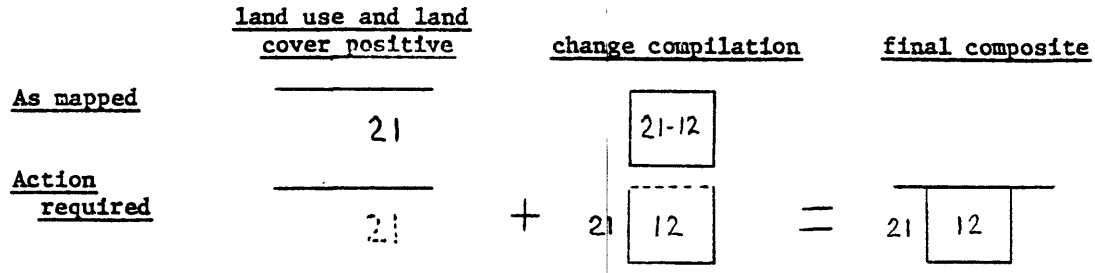
Example 1



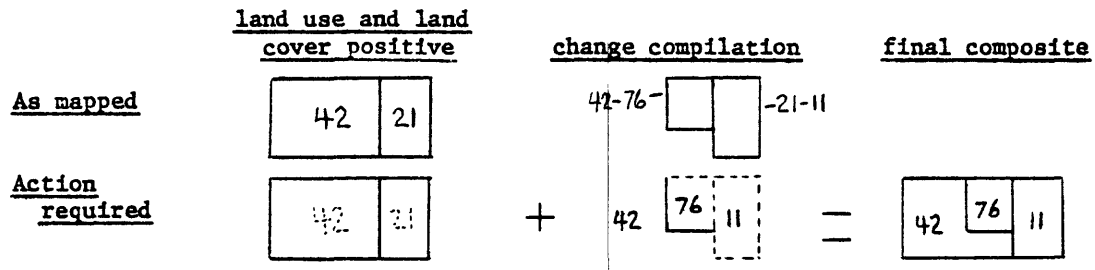
Example 2

Step (6) Several types of polygon identifier adjustments are to be made during map updating. These are described on the following page together with illustrations showing the appropriate procedures to be followed in making adjustments to both the change compilation scribecoat and the land use and land cover map positive (broken lines indicate deletions). Use the same procedures for data base corrections.

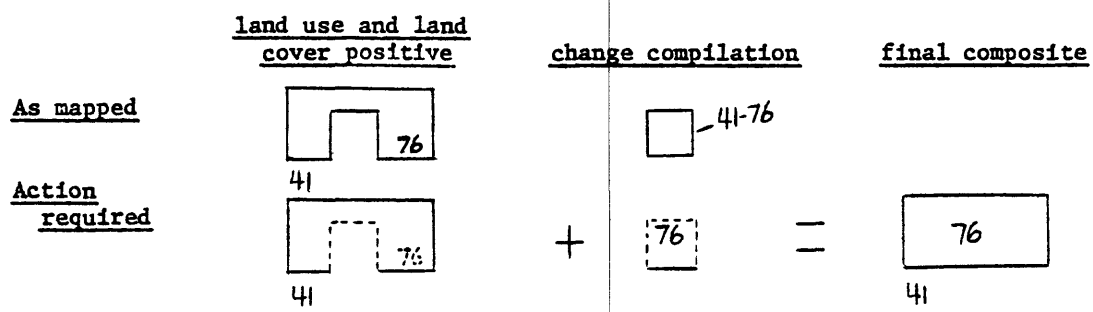
a. Delete all Level II identifiers on the original land use and land cover map that interfere with new polygon boundaries and add them in appropriate places on the change compilation scribecoat.



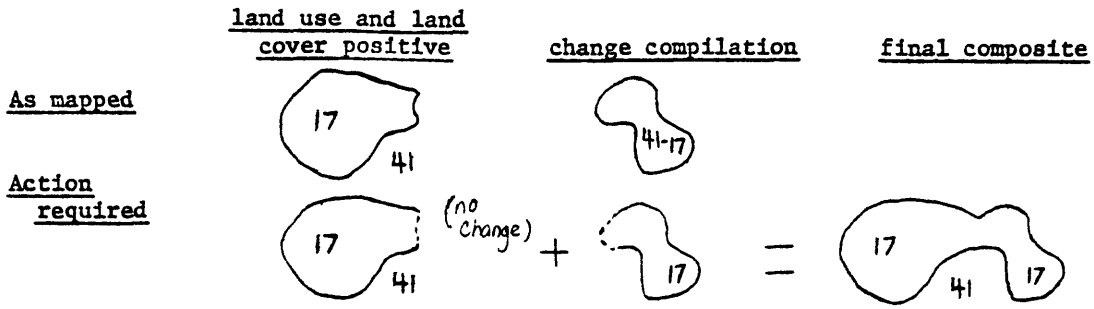
b. Delete all Level II identifiers on the original land use and land cover map identifying former use polygons and add them in appropriate places on the change compilation scribecoat.



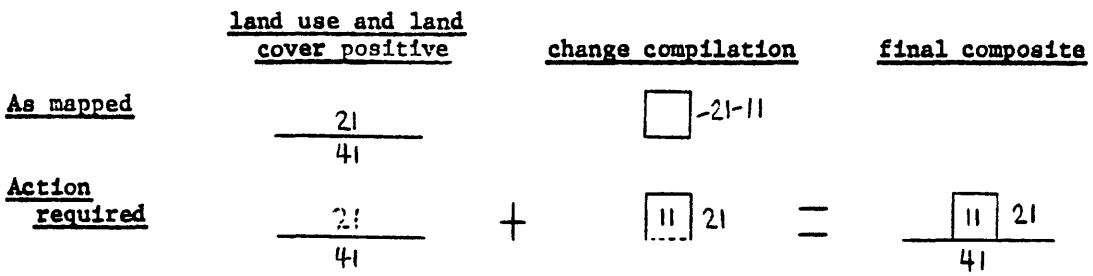
c. Delete all Level II identifiers on original land use and land cover map that are improperly positioned with respect to new change polygons and add them in appropriate places on the change compilation scribecoat.



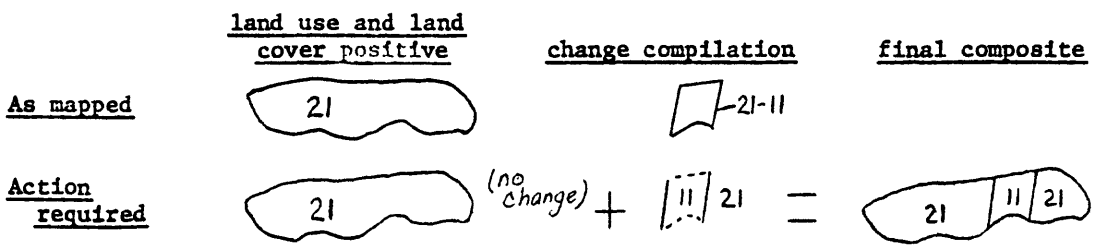
d. Add Level II identifiers to change compilation scribecoat for all new polygons not present on either original compilation or change scribecoat, or for extension of or additions to polygons already identified on the original compilation.



e. Add Level II identifiers to the change compilation scribecoat for those land use and land cover polygons on original map whose identifiers were deleted for repositioning.



f. Add Level II identifiers to the change compilation scribecoat for those polygons on the original land use and land cover map that remain unchanged but have been segmented by a change polygon so as to lack an identifier.



Step (7) As each change polygon is evaluated and the necessary boundary and (or) identifier adjustments determined, delete the land use change code (or data base correction code) from the change compilation scribecoat and make the necessary cartographic adjustments. If desired, the compiler may write the land use change

code in pencil/pen next to the change polygon on the scribecoat base. The final change scribecoat will contain appropriate polygon boundary segments and Level II category identifiers only.

Step (8) Delete all intermediate ticks, neatlines, scales, coordinates, etc., from the compilation-scale positive of the land use and land cover map so that only the internal land use data remain.

Step (9) After all required adjustments have been made to the land use change compilation scribecoat and to the compilation-scale positive of the original land use and land cover map, the compiler should forward these materials to editing, and then to quality control for review.

Step (10) After the update materials are returned to the compiler from quality control review and the indicated corrections completed, make a composite of the modified change scribecoat and modified land use and land cover map and then bring this composite to publication scale, if different from compilation scale, and fit to the plate containing neatline and tick marks prepared earlier (see Section 8, part 8.2 of this report).

Step (11) Follow collaring instructions beginning with part 8.1 in Section 8 of this report.

SECTION 8

PREPARATION OF UPDATED MAP MATERIALS FOR OPEN FILE

8.1 General Explanation

These instructions apply to the final preparation of map collar materials for reproduction of the 1:250,000- and 1:100,000-scale land use and land cover map in the open-file series. The format described in these instructions has been approved by the Director's Office for open-file products at 1:250,000- and 1:100,000-scales. The open-filing of these products will be through the regional Mapping Centers. Each Mapping Center will be the depository for those 1:250,000- or 1:100,000-scale maps which fall within its specific geographic area of responsibility. In the case where a quadrangle lies across a boundary between two Centers, the map will be open-filed in the Mapping Center that has responsibility for the major portion of the quadrangle.8/

8/ In cases where a map(s) is completed under a joint funding agreement or other cooperative arrangement, the map(s) will also be open-filed in the Mapping Center for the region in which the cooperating agency resides.

The standard open-file format for the original land use and land cover map is shown in figure 4. The open-file format for the revised land use and land cover map and the land use and land cover change map will be patterned after this style, but with some minor modifications to the legend content. In each case the collar and legend content are minimal, and standard data can be type-set once and used for all maps in a set. This procedure will reduce the time required before final reproduction.

8.2 Base Preparation

The formatted collar base showing neatline and internal tick marks should be made prior to the preparation of any of the update map products described in Section 7 of this report. The compilation manuscript for all maps must be copied to 1:250,000 or 1:100,000 scale as a positive transparency with full neatline and intermediate geographic reference ticks. This process will normally be accomplished by the Mapping Centers during preparation for collaring.9/

For a publication scale of 1:250,000, the sheet size will be 30" by 42". The format is shown in figure 5. When the publication scale is 1:100,000, the size of the base sheet will vary with latitudes. The following table indicates the sizes of the sheets to be used for 1:100,000-scale map publication. The various formats are shown in figure 6.

1:100,000-scale

Latitude	Sheet Size
41° to 50°	30" x 42"
32° to 41°	30" x 46"
24° to 32°	30" x 48"

To obtain uniformity for publication, the following line weights will be used.

(1) Neatline (full) ..... 0.003"
(2) Geographic Reference Ticks ..... 0.003"

The intermediate ticks will be 0.25 inches in length.

When the collar bases have been prepared as described and checked for corrections, they are ready for compositing with the land use update materials described in Section 7 for digitizing, supplemental change map preparation, or production of a new land use and land cover map. After this has been completed, the collar data can be affixed to the sheets as described in the following paragraphs.

9/ The master neatline plate used for the collaring of the original land use and land cover and associated maps in the map set should be used. If this is not available, the master negative or open-file reproducible of an associated map in the map set (such as political units) may be used.

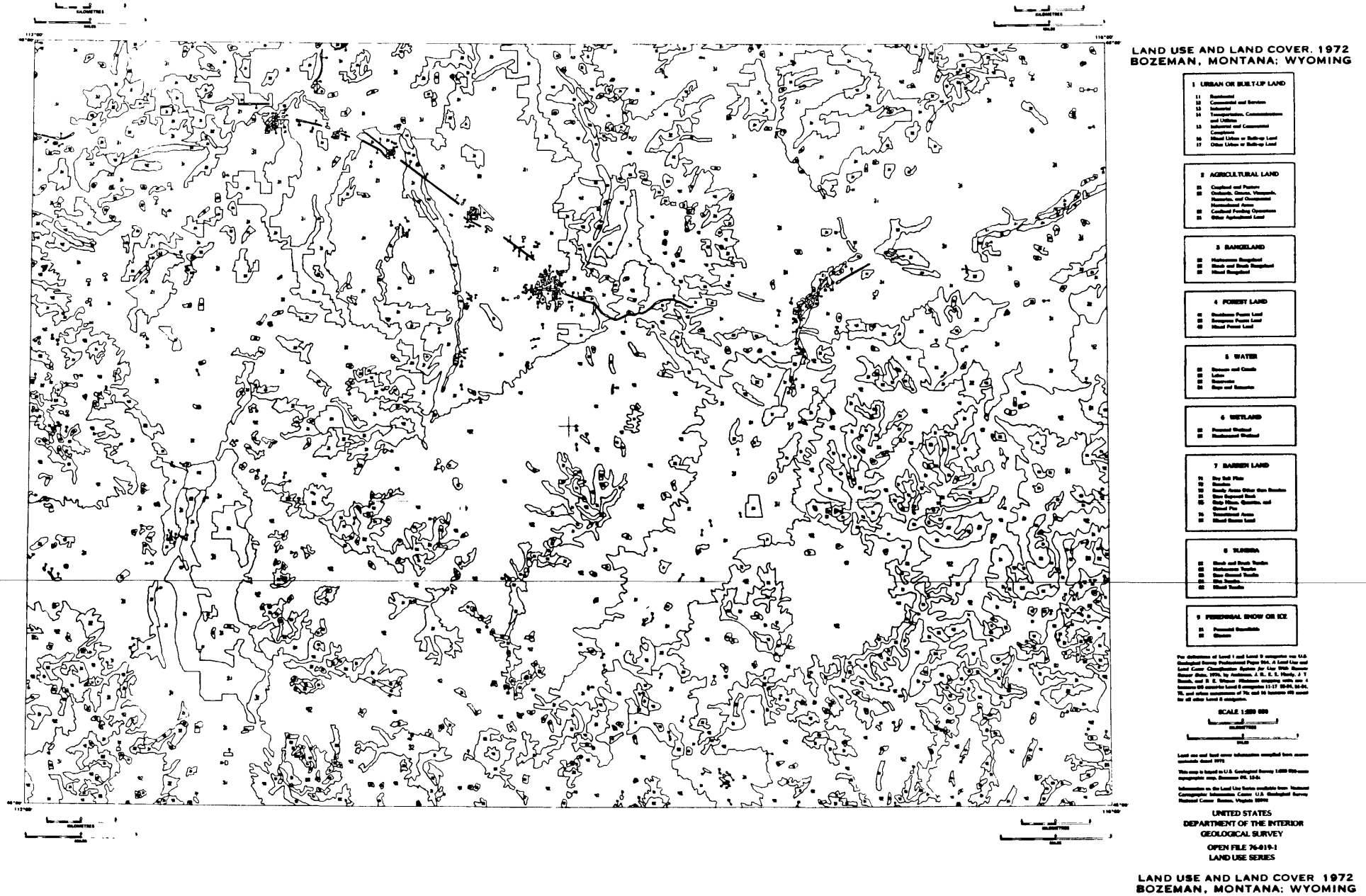


Figure 4.--Approved open-file format style for land use and land cover maps, shown reduced to page size (from OF 77-555).

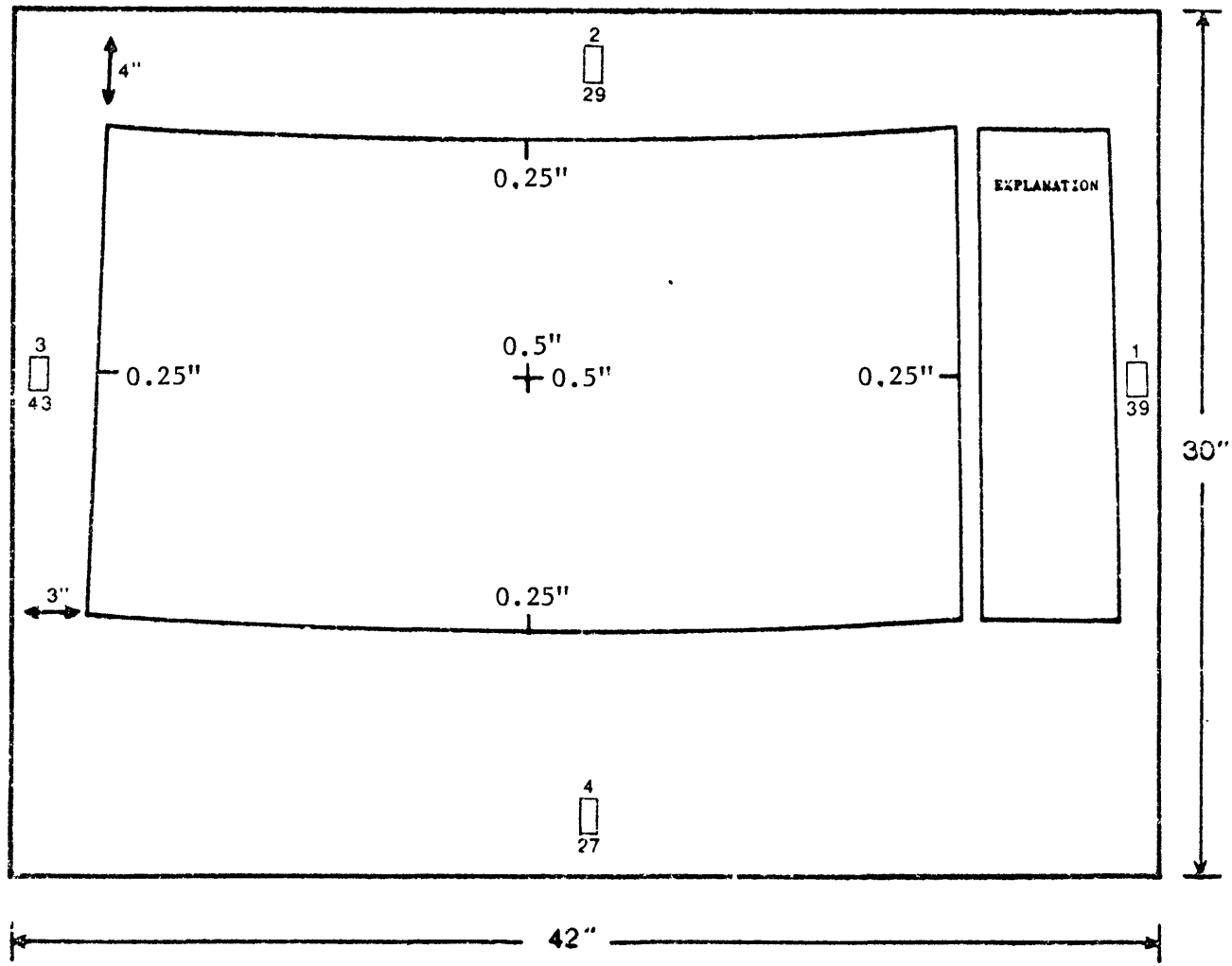
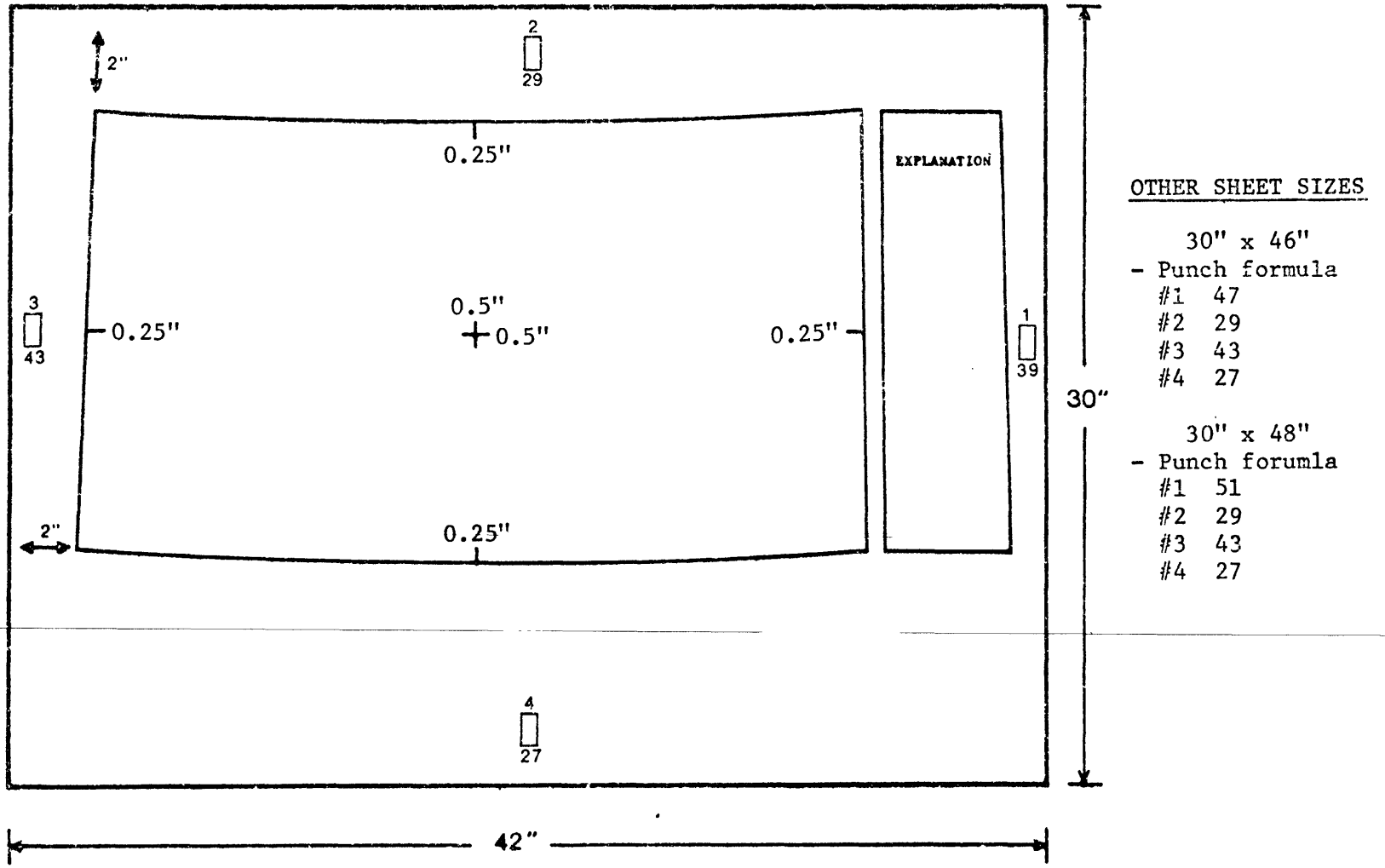


Figure 5.--Placement of punch registration, neatline and internal data for 1:250,000-scale base collar preparation (modified from OF 77-555).



OTHER SHEET SIZES

30" x 46"
- Punch formula
#1 47
#2 29
#3 43
#4 27

30" x 48"
- Punch forumla
#1 51
#2 29
#3 43
#4 27

Figure 6.--Placement of punch registration, neatline, and internal data for 1:100,000-scale base collar preparation (modified from OF 77-555).

8.3 Land Use and Land Cover Map Collar

Once the base transparency has been produced with neatline, reference ticks, and internal data, the sheet is ready for preparation of the final collar. The geographic coordinates should be placed at the four corners of the sheet as shown in figure 7.

The explanation for the land use and land cover map is standard, with only a minimum amount of data to be added prior to reproduction (figs. 8 and 9). With the standard land use and land cover explanation properly attached to the base map transparency as shown in figures 8 and 9, the type needed to complete the explanation should be added to make it complete and ready for the photolab. The type sizes and styles required for all information to be added is shown in figures 8 and 9. Starting at the top of the explanation, type will be added as follows:

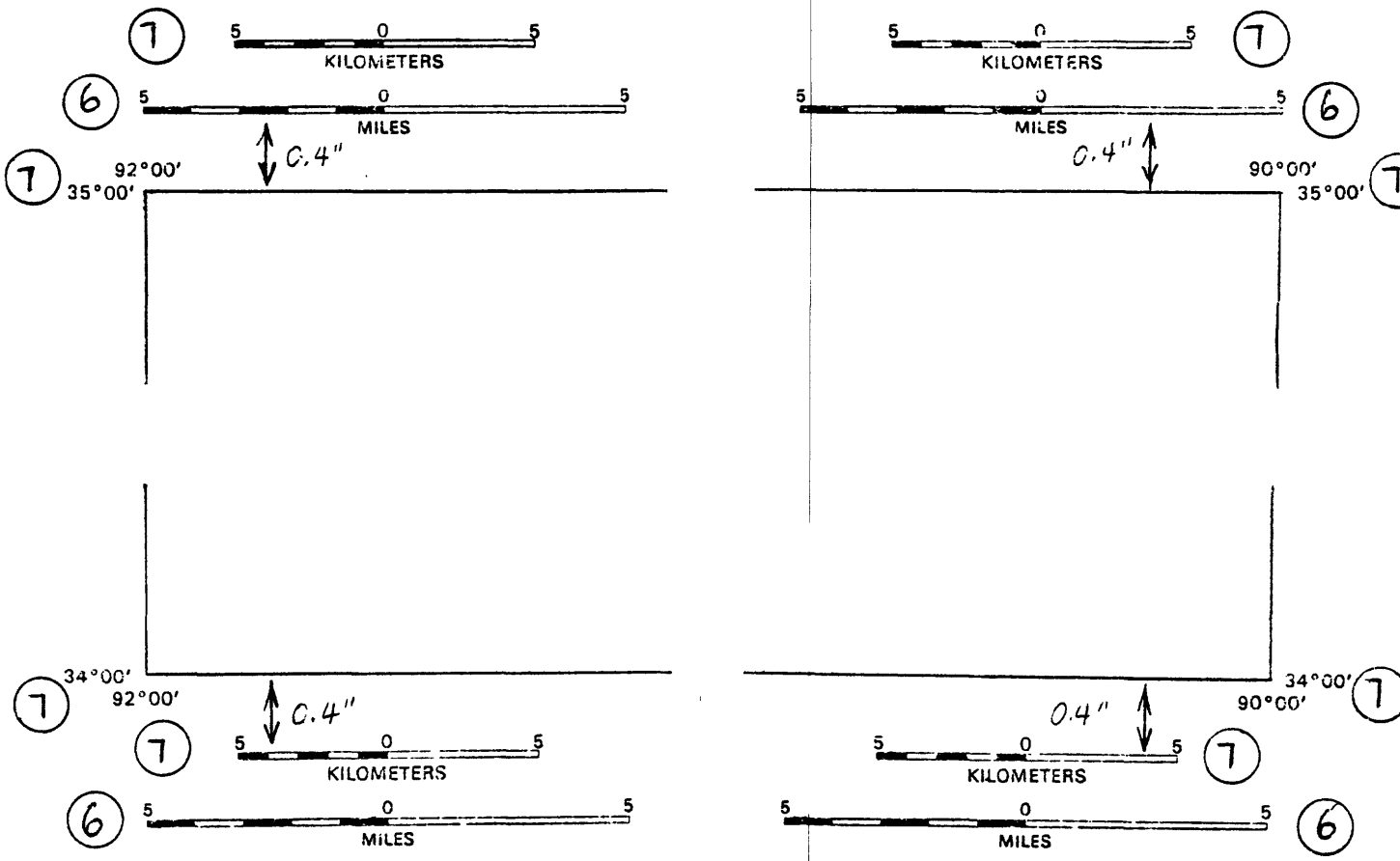
Step (1) The date of the remotely sensed source materials will be shown at the end of the title (fig. 8). If updating was performed for the complete map sheet, list only the date of the remotely sensed source materials used in updating. If update source materials from more than 1 year were used, then the earliest and latest years should be recorded, for example, "1977-1980." If only portions of the map were updated (in cases of partial map revision authorization), list dates of all remotely sensed source materials. For example, where a portion of the map was updated from the 1978 source, and the remainder of the map remains as complied from source material dated 1972-73, list source dates in title as "1972-78."

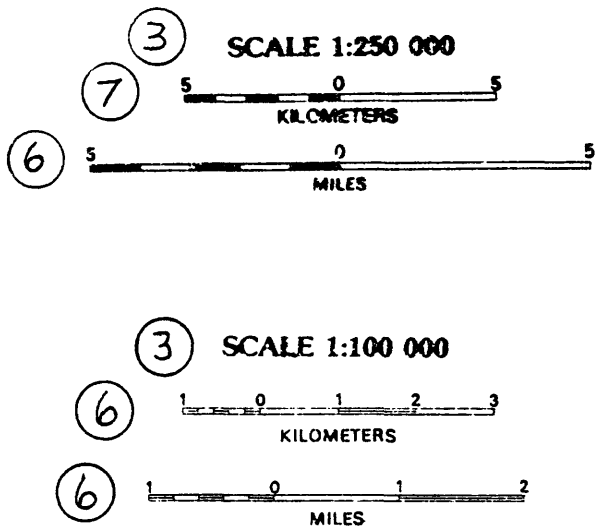
Step (2) The name of the map sheet must be added directly beneath the title (fig. 8). The name will consist of both the title of the sheet and the State or States in which the sheet lies, for example, Kansas City, Missouri; Kansas. The State names will be shown exactly as shown on the topographic map used as a base (spelled out where spelled out; abbreviated where abbreviated). If land use and land cover have been mapped for a portion of the map sheet only, then that portion of the sheet for which data have been mapped should be indicated below the map name as shown in figure 8.

Step (3) The date(s) of the remotely sensed source material used for update will be added in the lower body of the explanation and will correspond to the date added to the title at the top of the sheet (fig. 9). If update was conducted for less than the complete map sheet, then the second version of the explanatory note shown in figure 9 will be used in which all dates of the remotely sensed source materials are given and the portion(s) of the map updated is specified.

Step (4) The field check notation shown in figure 9 will be retained only when the map has been field checked by USGS personnel.

Step (5) The name and number of the 1:250,000- or 1:100,000-scale topographic map sheet will be added as shown in figure 9.





Explanation Type Style and Size

① Univers 63 Bold Extended Roman---------20 pt
② Souvenir Medium--------- 8 pt
③ Souvenir Medium---------10 pt
④ Souvenir Medium---------12 pt
⑤ Souvenir Medium Italic - 8 pt
⑥ Univers 55---------- 6 pt
⑦ Univers 55---------- 7 pt
⑧ Souvenir Medium--------- 9 pt
⑨ Univers 63 Bold Extended Roman---------14 pt

Figure 7.--Placement and style of geographic coordinates and bar scales for 1:250,000- and 1:100,000-scale collars.

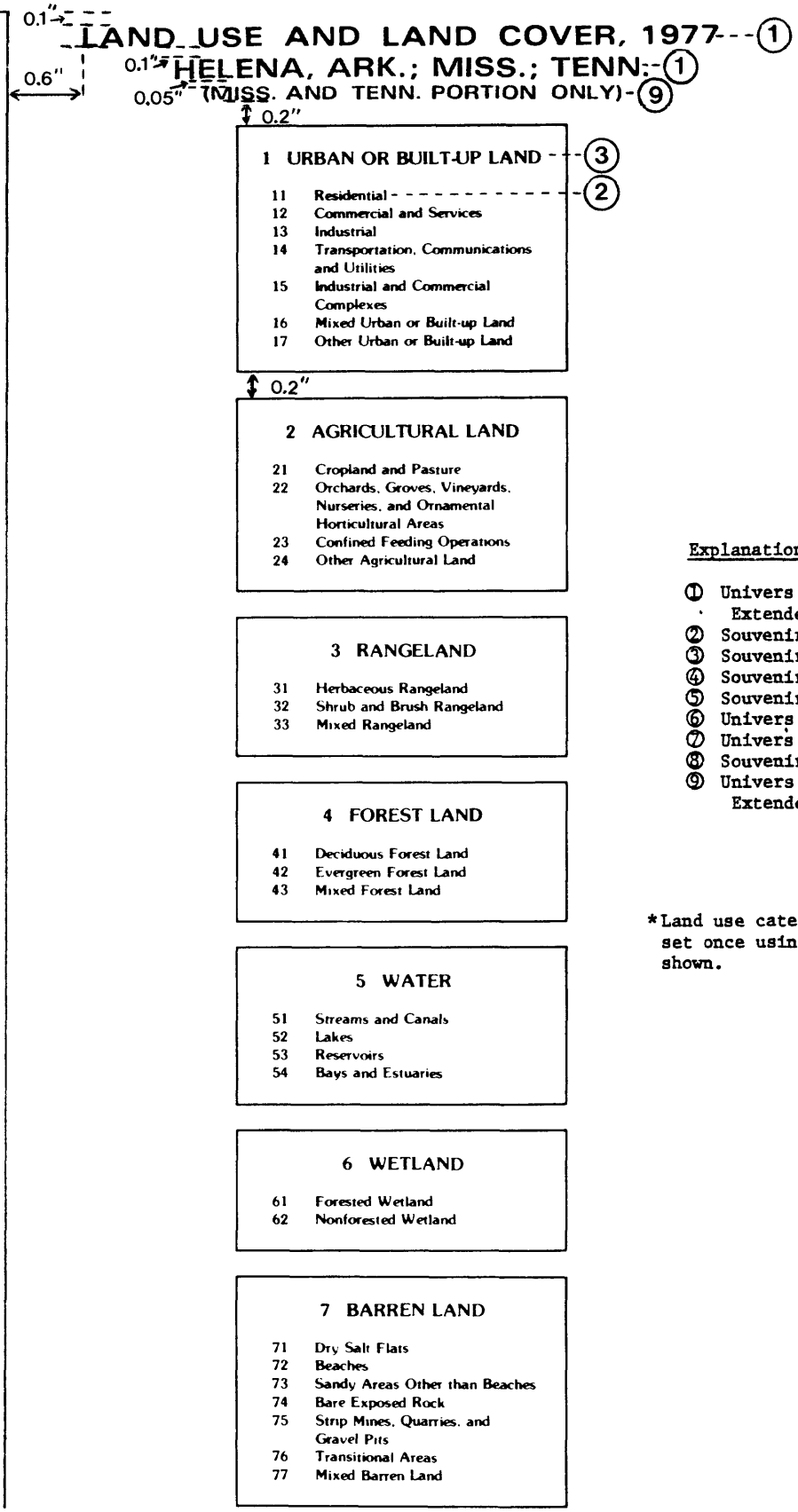
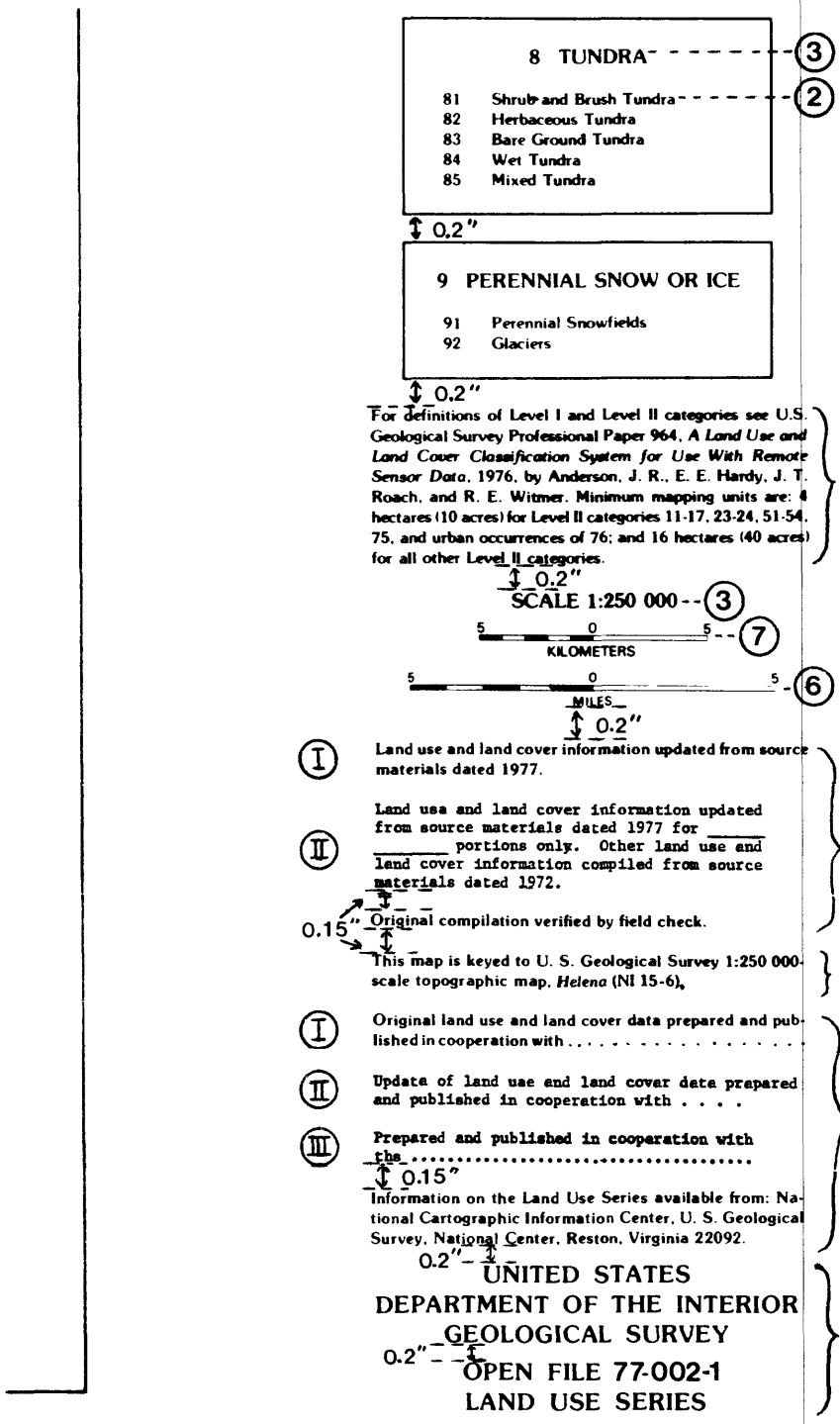


Figure 8.--Explanation for land use and land cover map collar, top half (explanation type in illustration shown at 77 percent of original size).



Explanation Type Style and Size *

① Univers 63 Bold Extended Roman——20 pt
② Souvenir Medium——8 pt
③ Souvenir Medium——10 pt
④ Souvenir Medium——12 pt
⑤ Souvenir Medium Italic——8 pt
⑥ Univers 55——6 pt
⑦ Univers 55——7 pt
⑧ Souvenir Medium——9 pt
⑨ Univers 63 Bold Extended Roman——14 pt

*Land use category legend is to be typeset once using type styles and sizes shown.

(Center all of the above information with longest line or widest block of legend information.)

Figure 9.--Explanation for land use and land cover map collar, bottom half (explanation type in illustration shown at 77 percent of original size).

Step (6) If a cooperative agreement statement is required, one of the three versions shown in figure 9 will be placed in the lower body of the explanation. If no requirement for a cooperative agreement statement exists, the space will be closed by moving up the remaining explanation.

Step (7) The new open-file number will be added as shown in figure 9.

Step (8) The last item to be added beneath the explanation is the title block which is the same as the one appearing at the top of the explanation. It is to be positioned as shown in figure 9.

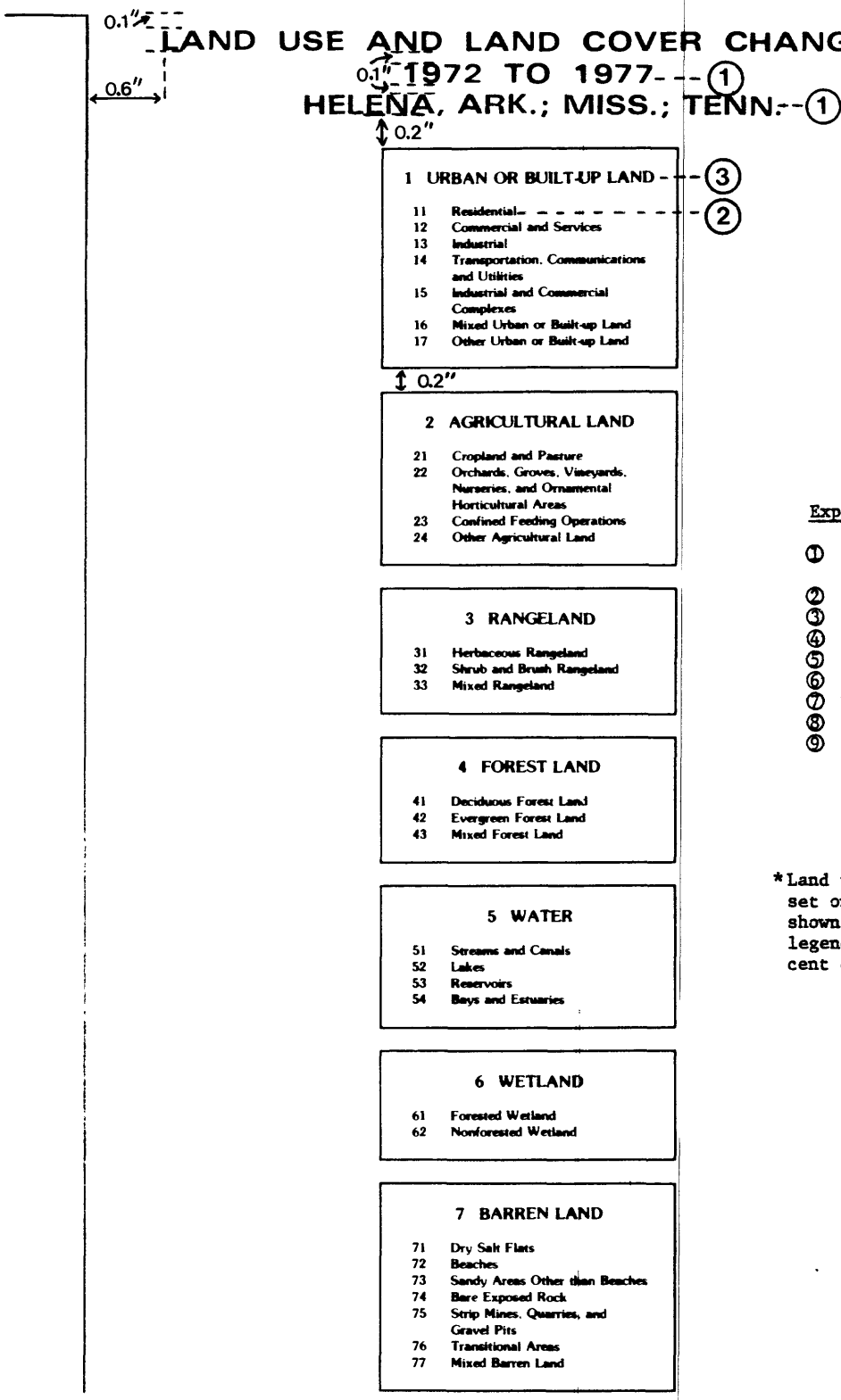
The Mapping Centers should use the information presented above and in figures 7-9 as a guide to order one set of type to be used repeatedly, thus eliminating the need for extensive separate type orders for each map. After collaring is completed, and the collar has been edited and quality controlled, the land use and land cover map may be forwarded to the photographic laboratory for negative preparation.

8.4 Land Use and Land Cover Change Map Collar

If no supplemental map of land use change is to be prepared with final collars, go to step 8.5. The collar specifications for the supplemental map of change are similar to those for the updated land use and land cover map collar preparation. Once the base transparency has been produced with neatline, reference ticks, and internal data, as specified in part 8.2, the sheet is ready for a final collar. The geographic coordinates should be placed at the four corners of the sheet as shown in figure 7. The size and style of type is also shown. UTM grids will not be shown on this material. Four bar scales will be positioned as shown in figure 7 at a scale 1:250,000 or 1:100,000. The style of the bar scales for both the 1:250,000 and 1:100,000 scales is shown in figure 7.

The explanation for the land use and land cover change map is standard, with only a minimum amount of data to be added prior to reproduction (figs. 10 and 11). For the change map collar only, the land use and land cover category legend (boxes) will be shown at 90 percent of original size, that is, reduced 10 percent. With the standard explanation properly attached to the base map transparency as shown in figures 10 and 11, the type needed to complete the explanation should be added to make it complete and ready for the photographic laboratory. The type styles and sizes required for all information to be added is shown in figures 10 and 11. Starting at the top of the explanation, type will be added as follows:

Step (1) The dates of the remotely sensed source materials will be shown at the end of the title. The dates of both the previous source materials used in compilation and the source materials used in updating will be shown. If source materials for more than one year are used in either the previous compilation or in the updating, or both, then the earliest and latest years of the remotely sensed source materials used for each should be recorded, for example, "1972-1973 to 1978," or "1972 to 1977-1979," or "1972-1973 to 1977-1979."



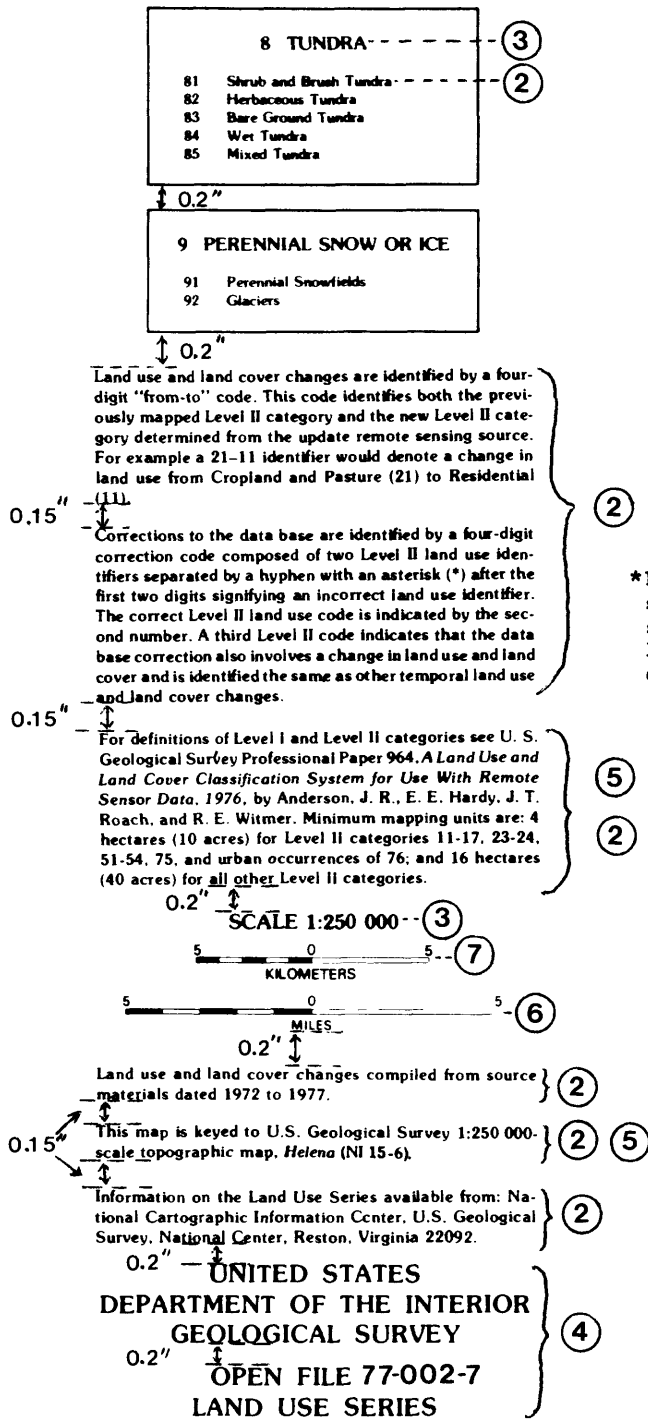
Explanation Type Style and Size *

① Univers 63 Bold Extended Roman----------20 pt
② Souvenir Medium---------- 8 pt
③ Souvenir Medium----------10 pt
④ Souvenir Medium----------12 pt
⑤ Souvenir Medium Italic--- 8 pt
⑥ Univers 55---------- 6 pt
⑦ Univers 55---------- 7 pt
⑧ Souvenir Medium---------- 9 pt
⑨ Univers 63 Bold Extended Roman----------14 pt

*Land use category legend is to be typeset once using type styles and sizes shown. For change map collar, land use legend (boxes) will be shown at 90 percent of the original size.

(Center all of the above information with longest line or widest block of legend information.)

Figure 10.--Explanation for land use and land cover change map collar, top half (explanation type in illustration shown at 77 percent of original size).



Explanation Type Style and Size *

① Univers 63 Bold Extended Roman——————20 pt
② Souvenir Medium——————— 8 pt
③ Souvenir Medium——————10 pt
④ Souvenir Medium——————12 pt
⑤ Souvenir Medium Italic— 8 pt
⑥ Univers 55——————————— 6 pt
⑦ Univers 55——————————— 7 pt
⑧ Souvenir Medium——————— 9 pt
⑨ Univers 63 Bold Extended Roman——————14 pt

*Land use category legend is to be typeset once using type styles and sizes shown. For change map collar, land use legend (boxes) will be shown at 90 percent of the original size.

(Center all of the above information with longest line or widest block of legend information.)

Figure 11.--Explanation for land use and land cover change map collar, bottom half (explanation type in illustration shown at 77 percent of original size).

Step (2) The name of the map sheet must be added directly beneath the title and source dates (fig. 10). The name will consist of both the title of the sheet and the State or States in which the sheet lies, for example, Kansas City, Missouri; Kansas. The State names will be shown exactly as shown on the topographic map used as a base (spelled out where spelled out; abbreviated where abbreviated). If land use and land cover changes have been mapped for a portion of the map sheet only (in cases where a map was authorized for partial revision only), then that portion of the sheet for which data have been mapped should be indicated below the map name as shown in figure 8.

Step (3) The dates of the remotely sensed source materials used for the change mapping and the previous compilation will be added in the lower body of the explanation and will correspond to the dates added to the title at the top of the sheet (fig. 11).

Step (4) The name and number of the 1:250,000- or 1:100,000-scale topographic map sheet will be added as shown in figure 11.

Step (5) If a cooperative agreement statement is required it will be placed in the lower body of the explanation. If there is no requirement for a cooperative agreement statement, the space will be closed by moving up the remaining explanation.

Step (6) The open-file number will be added as shown in figure 11.

Step (7) The last item to be added beneath the explanation is the title block which is the same as the one appearing at the top of the explanation. It is to be positioned as shown in figure 11.

The Mapping Centers should use the information presented above and in figures 7, 10, and 11 as a guide to order one set of type to be used repeatedly, thus eliminating the need for extensive separate type orders for each map. After the collar editing and quality control are completed, the change map may be forwarded to the photographic laboratory for negative preparation. Continue with Section 7, part 7.4.

8.5 Partial Sheet Collars

There are two situations in which maps will require partial sheet collars. Partial sheet collars will be used for (1) maps which are produced as a result of a State cooperative agreement for which data are only mapped to the State line and which have large blank areas remaining on the sheet, and (2) 1:250,000-scale maps which have one or more quarters mapped at 1:100,000-scale.

The collar preparation for cooperative maps is the same as for standard land use and land cover maps with the exception that, beneath the title and before the body of the explanation, there will be inserted a note identifying the area for which the sheet is complete. Figure 8 shows the placement of this information. The type style and size shall be Univers 63 Bold Extended Roman 14-point.

The collar preparation for "partial" 1:250,000-scale maps is the same as for standard land use and land cover maps, with the exception of the internal format. The area of the 1:250,000-scale sheet for which a 1:100,000-scale map has been published will be left blank and the following notation made in each quarter for which a 1:100,000-scale sheet has been open-filed: "For information on this area, see open-file number _____."

Where more than one quarter of the 1:250,000-scale sheet has been mapped at 1:100,000-scale, the internal boundaries will show on the final 1:250,000-scale sheet. The placement of boundaries and description data will be as shown in figure 12.

8.6 Open-File Numbers

The open-file numbers for the maps in production are to be requested by the appropriate personnel in the Mapping Center preparing the open-file reproductions. The request should be made to the Publications Liaison and Review Office at such time as to insure that the open-file number reflects the calendar year of open-filing.

SECTION 9

REPRODUCTION AND DISTRIBUTION OF OPEN-FILE MATERIALS

Upon completion of type stick-up for all sheet collars, a quality control check is to be performed by the designated Mapping Center personnel. At the completion of this quality control check, a positive transparency will be produced. When the final quality control check has been accomplished on the material prior to final reproduction, the following procedures will be followed:

(1) One positive transparency each of the land use and land cover map and the change map will be reproduced.

(2) Forward this set to the National Mapping Division's Office of Geographic and Cartographic Research (RGCR) for a final review of geographic thematic content.

(3) Upon RGCR content-review approval, a written notification will be given to the Mapping Center to proceed with open-file procedures.

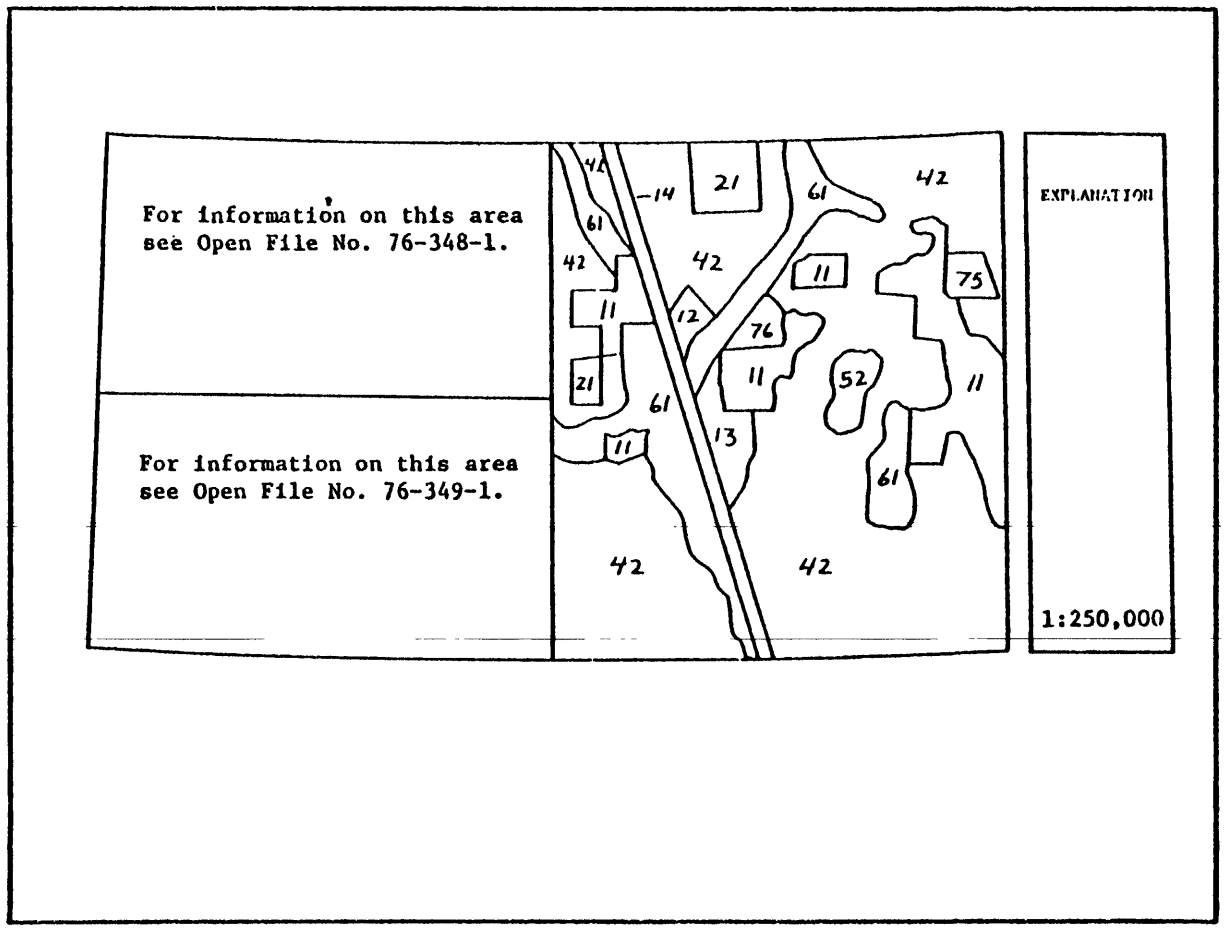


Figure 12.--Partial sheet open-file format (from OF 77-555).

(4) Upon receipt of the written notification from RGCR, the negatives of the maps will be forwarded to the photographic laboratory for reproduction of distribution copies. In addition, a positive transparency of the 1:250,000- or 1:100,000-scale topographic base map (planimetric data only) must be made. This transparency will be prepared from the map used to make the land use change compilation scribecoat base. The following is a guide for reproduction of open-file positives:

a. Use stable-base material, 0.007" thickness.
b. Make reverse-reading positive (unless noted otherwise).
c. Use clear finish mylar (open-file copy).
d. Punch-register maps.

(5) Unless otherwise specified, the final map products required for standard distribution are as listed below.

To	No.	Material	Emulsion	For
RGCR	1 each	stable base film 0.007 inch	reverse	review/file copy
*Regional NCIC	1 each	" "	reverse	Open File
Natl. Ctr. Lib.	1 each	diazo paper		files
**Regional Lib.	1 each	diazo paper		files

*Mapping Center NCIC facilities require only those maps that fall within their respective regions (unless servicing a cooperating agency agreement).

**Central and Western Region Libraries require only those maps that fall within their respective regions. The National Center Library serves as the Eastern Region Library but also requires copies of all maps released to open-file.

The addresses of the depositories are as follows:

NCIC Regional Centers

EMC/NCIC-E
USGS, 536 National Center
Reston, Virginia 22092

MCMC/NCIC-M
USGS, 1400 Independence Road
Rolla, Missouri 65401

RMMC/NCIC-R
USGS, Stop 510
Box 25046 Federal Center
Denver, Colorado 80225

WMC/NCIC-W
USGS, 345 Middlefield Road
Menlo Park, California 94025

USGS Libraries

National Center Library
Room 4A104B, MS 950
Reston, Virginia 22092

Central Region Library
U.S. Geological Survey
MS 914
Box 25046 Federal Center
Denver, Colorado 80225

Western Region Library
345 Middlefield Road
Menlo Park, California 94025

There is also a requirement to supply map copies to State cooperators, where applicable. Each joint funding agreement has a different set of requirements and must be treated individually. Check with the NMD Office of Program Management for those requirements concerning the reproduction and distribution of map copies for State cooperators.

REFERENCES

Anderson, J. R., Hardy, E. E., Roach, J. T., and Witmer, R. E., 1976, A land use and land cover classificaton system for use with remote sensor data: U.S. Geological Survey Professional Paper 964, 27 p.

Loelkes, G. L., 1977, Specifications for land use and land cover and associated maps: U.S. Geological Survey Open File Report 77-555, 82 p.

Milazzo, V. A., 1980, A review and evaluation of alternatives for updating USGS land use and land cover maps: U.S. Geological Survey Circular 826, 19 p.

Mitchell, W. B., Guptill, S. C., Anderson, K. E., Fegeas, R. G., and Hallam, C. A., 1977, GIRAS--A geographic information retrieval and analysis system for handling land use and land cover data: U.S. Geological Survey Professional Paper 1059, 16 p.

GLOSSARY OF TERMS

cartographic generalization--refers to a mapping technique in which the naturally-occurring boundaries of land use and land cover polygons are not followed exactly but are modified in order to meet minimum mapping unit area and width specifications for land use and land cover compilation.

change detection--the detection and identification of temporal changes in land use and land cover from a comparison of remotely sensed and (or) map source materials from two or more time periods.

change mapping--the mapping of identified changes in land use and land cover in accordance with established land use classification standards and map compilation specifications.

data base correction--a change made during updating to the original land use and land cover map that corrects an earlier mapping error in the compilation. Such corrections may involve a category classification, a boundary delineation, an addition of data omitted or a deletion of data mapped, and do not reflect or constitute a temporal change in land use and land cover resulting from sequential land conversion.

indefinite boundary category--a Level II land use and land cover category whose exact boundary delineation or placement cannot be definitely determined from remotely sensed sources alone. The boundaries of such polygons are a matter of compiler style and judgment, and can be delineated in any number of ways, each one as likely as another of being correct.

indefinite category interpretation--a polygon of land use and land cover whose boundaries can be determined accurately from remotely sensed sources but whose Level II classification cannot be positively identified without supplemental data.

map update--a selective cartographic revision procedure for bringing an existing, outdated land use and land cover map up-to-date. In this procedure only those land use and land cover data on the old map that are obsolete are replaced with newer information derived from interpretation of remotely sensed data. All originally-mapped data that are still correct are retained.

old map-to-new source material approach--a change detection technique whereby land use and land cover changes are derived from a visual comparison of the "old" land use and land cover map with the "new" remotely sensed source material.

recompilation--a mapping procedure whereby an outdated land use and land cover map, or portions thereof, is replaced by an entirely new map made from more current remotely sensed source materials. In map recompilation no comparative procedures are required to derive changes, since a whole new map is made.