APPLICATION OF A GRAPHICS DATA BASE MANAGEMENT SYSTEM: COMPUTERIZED MASTER PLAN OF DRAINAGE

T.V. Hromadka II[1]
R.W. Corchero[2]
C. Laird[3]

Key Words: drainage, land use planning, software, storm water management, urban hydrology

Abstract

A Graphics Data Base Management System is developed for use with computerized Master Plans of Drainage. The Master Plans are prepared according to Agency specifications involving multiple hydrologic and hydraulic modeling options, integrated into a single software package. Data bases are prepared for graphical representation of streets, land uses, hydrologic soil groups, rainfall, master plan system elements, topographic, and other data, as well as computational results developed from the Master Plan of Drainage computer model. Two applications are available; an integrated package enabling editing and upgrading of the Master Plan, and another package designed to publish and distribute the Graphics and the Master Plan of Drainage data bases to the public in an access-only data base retrieval environment. The opportunities provided by such public information programs are significant, in that the entire Master Plan becomes available to the public in an easy-to-read and easy-to-use environment. The public therefore becomes an integral and important member of the Master Plan team, exchanging input and easing the way for acceptance of the project.

---

1 Principal Engineer, Boyle Engineering Corporation, 1501 Quail Street, Newport Beach, California 92658

2 Chief, Flood Control Planning Division, County of San Bernardino, 825 East Third Street, San Bernardino, California 92415

3 Assistant Director, Transportation/Flood Control, County of San Bernardino, 825 East Third Street, San Bernardino, California 92415

INTRODUCTION

An integrated hydrology/hydraulics/planning/deficiency-analysis Master Plan of Drainage computer model is developed which performs several master planning and engineering analysis tasks simultaneously. The computer modeling approach evaluates each link of the Master Plan of Drainage for deficiencies with respect to several defined street flow criteria, and determines mitigation measures of parallel and replacement systems. Because different hydraulic systems have different flow velocity characteristics, hydrology estimates are recomputed as the master plan is developed. Although small areas (less than about one square mile) are modeled by a rational method technique, the computer model integrates the small area hydrology techniques with the unit hydrograph technique for areas greater than one square mile.

The entire Master Plan is represented by a Graphics Data Base Management System (or GDBMS) which allows for rapid communication of master plan data and estimates in graphical form. Two applications are developed:

Application 1: Graphical representation, storage, and editing via an AutoCAD environment, wherein hydrologic, planning, topographic, and geographic data are accessible for processing in AutoCAD, and thence transferable to the Master Plan of Drainage computer model, with access to a data base retrieval system; and

Application 2: Graphical representation of data, and access to a data base retrieval system, which is noneditable, and which can be published and distributed to the public.

In the following, each major element of the above described HMS will be discussed. An application of HMS to an example Master Plan of Drainage will be used to demonstrate graphical display opportunities.

COMPUTERIZED MASTER PLAN OF DRAINAGE AND GRAPHICS DATA BASE MANAGEMENT SYSTEM

The total Master Plan of Drainage software package and data base system contains numerous elements and components that span several technical fields including data base management, geographic information systems (or GIS), hydrologic/hydraulic computer modeling, graphical data base management, flood control engineering and planning, among others. In the following is provided a brief survey of the key elements of the total software package.

Coupled Hydrologic Modeling Technique

Most flood control agencies at city, county or state level require specific procedures for the calculation of flood flow quantities. Often the procedure may involve the use of two or more estimates, depending on conditions such as watershed size. In Southern California, several county flood control districts require use of two floodflow estimation techniques dependent on catchment area; namely, the rational method for areas smaller than about one square mile, and the design storm unit hydrograph method for areas larger than about one square mile. The transition between techniques has been coupled into an integrated computerized Master Plan of Drainage model, enabling the development, for the first time, of an integrated hydrologic computer model with one pass of the analysis, rather than two separate studies. As a result of coupling hydrologic techniques into just one computer model, a single system analysis is available for use in preparing Master Plans of Drainage and upgrading the master plan, thereby greatly reducing the complexity, review process and cost involved.

The Master Plan of Drainage software contains internal editing and computational elements that involve 152 hydraulic and hydrologic submodels and global modeling commands. The software enables analysis of an integrated open channel or closed conduit flood control system on a study-wide basis.

Graphical Data Base

Primary hydrologic parameters used in the Master Plan of Drainage computer model are land use, hydrologic soil group, rainfall, and hydrologic subarea topographic data such as area, length of water course, and elevation. In general, a study is discretized into subareas that are 10 to 20 acres in size. These subareas require definition as to each of the parameters listed above. Additionally, maps are needed in order to communicate these data. By obtaining in digital form or actually digitizing the land use maps, hydrologic soil group maps, rainfall maps, and subarea maps, not only is a digital/graphical representation available for display, but the data can then be processed by a "polygon processor" (described below) in order to partition the subareas into the intersection of all of the graphical layers. Geographic location is provided by use of street layout layers, right-of-way maps and freeway maps. The graphics data base is used to prepare hard-copy maps for reports, as well as graphical layers for display on the computer monitor. Figures 1 and 2 show hard copies of example graphical layers for a Master Plan of Drainage. Figure 1 depicts the land use map and Figure 2 depicts the hydrologic soil group map.

Polygon Processor

The use of geographic information systems (GIS) has become widespread in many facets of engineering and planning, among other fields. A key element of a GIS is the ability to intersect graphical layers so that the several forms of information are resolved into "cells" wherein all parameters are constant. Figure 3 depicts the resolution of several graphical layers of information into homogeneous cells.

In the Master Plan of Drainage, each subarea requires definition of land use, hydrologic soil group, and rainfall subarea size, and the proportions of each within the subarea. The polygon processor performs this important task, and then develops a data base for use in the Master Plan of Drainage computer model. The subarea data are stored in tabled formats, on a subarea basis, indexed according to subarea number. Thus, the retrieval of a specific subarea number will access these several data, automatically developed by the

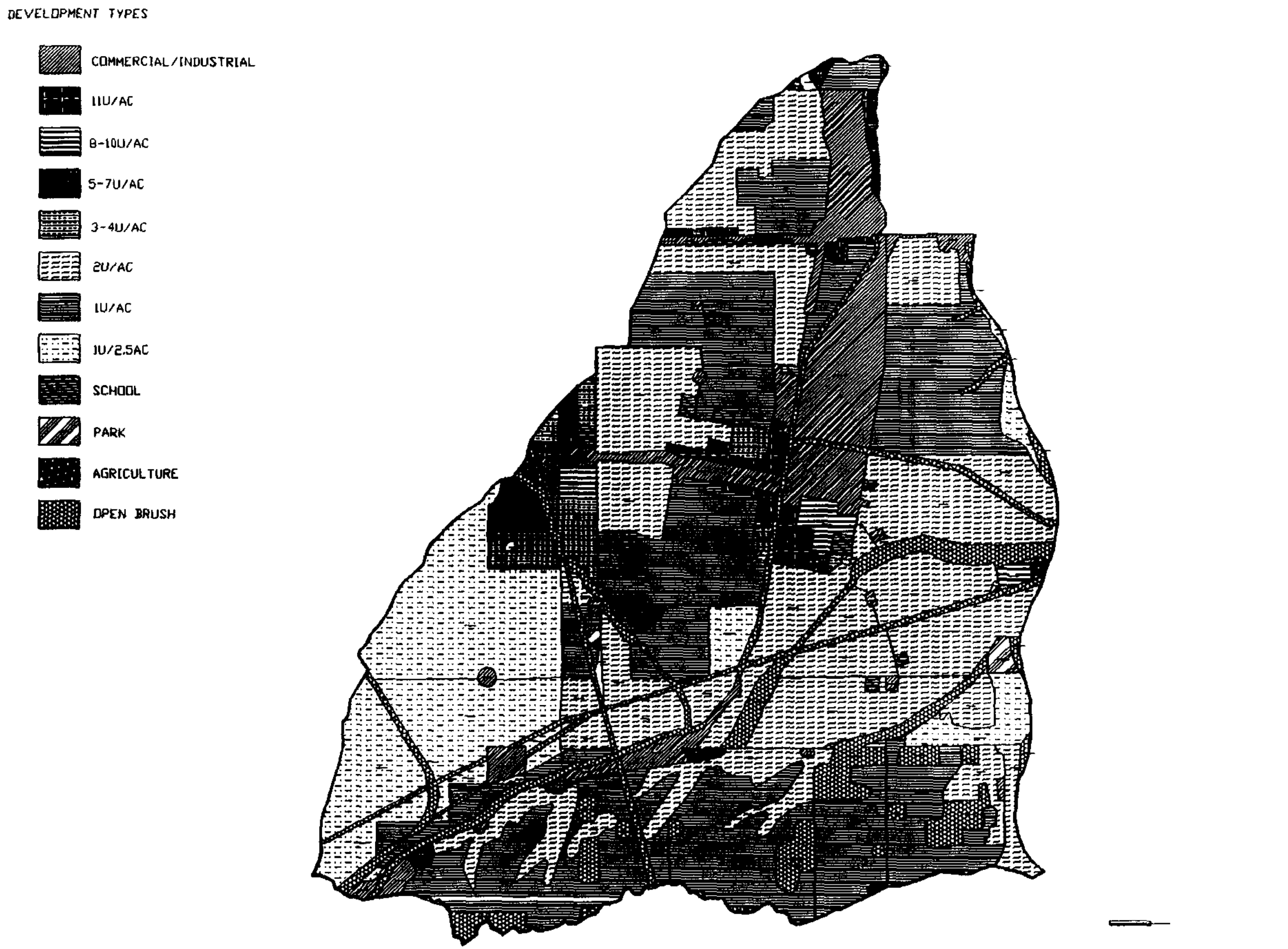

FIGURE 1. - EXAMPLE LAND USE MAP

FIGURE 2. - EXAMPLE HYDROLOGIC SOIL GROUP MAP

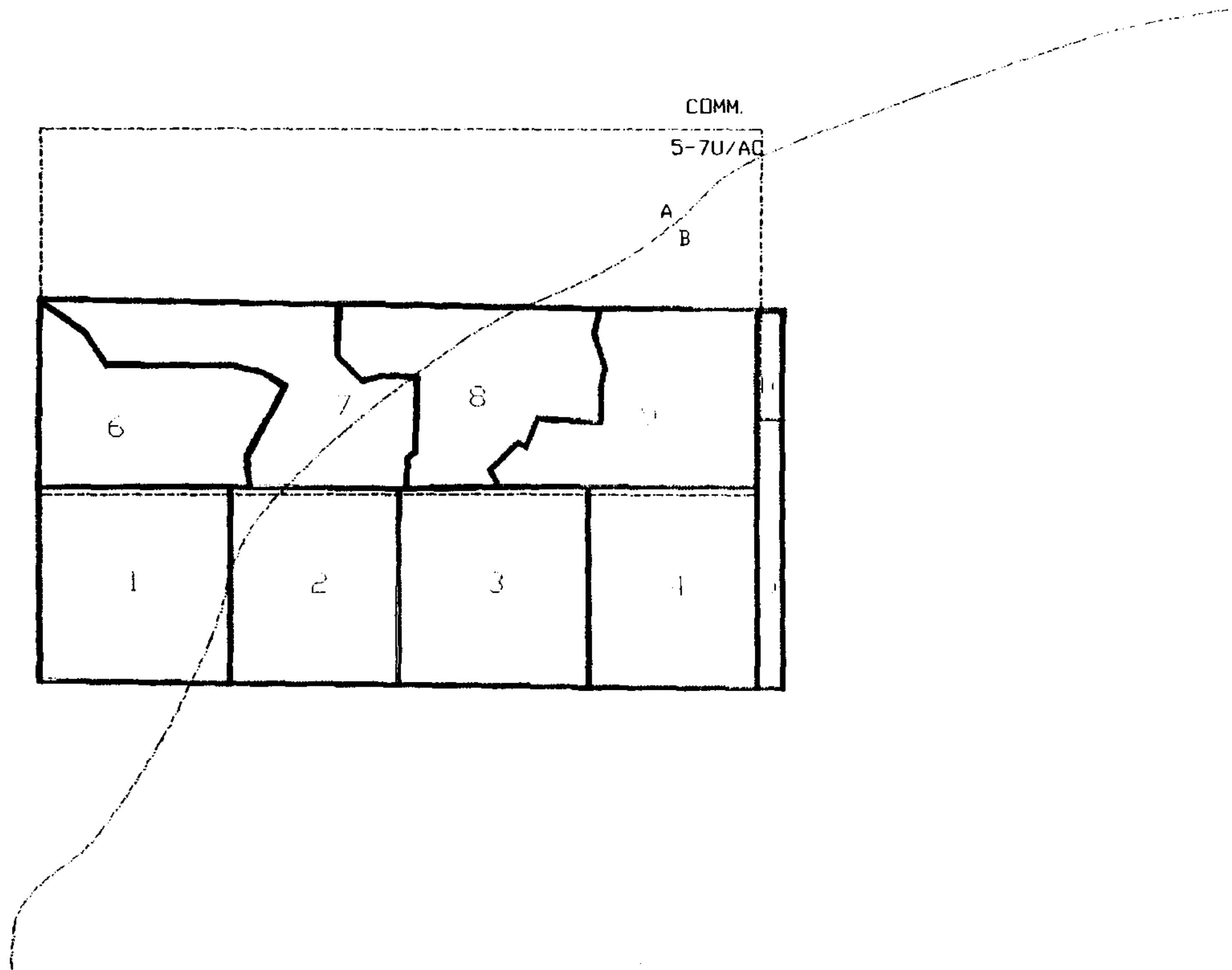

FIGURE 3. - OVERLAY OF LAND USE, HYDROLOGIC SOIL GROUP AND SUBAREAS FOR POLYGON PROCESSING

polygon processor. This GIS related processing is based upon software developed for this application, and is part of the graphics data base management system; that is, another GIS proprietary package is not required.

Master Plan of Drainage Data Base

The Master Plan of Drainage may be represented, in a data base form, as a collection of nodes (specific points along the catchment flood control system), and subareas (10 to 20 acres in size). All information computed by the Master Plan of Drainage, such as deficiency system mitigation needs, flow quantities, hydraulic properties, streetflow characteristics, flood control system characteristics, hydrologic parameters, and costs, among others, are stored in agency-designed tabled form in a data base indexed according to node number, link number, and subarea number. Also stored are data entered directly into the data base such as flood control system history, age, and so forth. Once the data base is assembled, the data base may be linked to the graphical data base which displays the digital graphical layers constructed for the polygon processing (i.e., multiple use of a data base form), while allowing easy access to the Master Plan of Drainage data base.

HydroGraphics Management System

The graphical data base and retrieval software and the Master Plan of Drainage hydrologic/hydraulic computer software are coupled together to form the Graphics Data Base Management System. Each of the above software packages are developed specifically for this application, and do not require use of other software packages.

Two applications are available. Application 1 is the actual Graphics Data Base Management System which includes all the features of Application 2, but also includes the ability to upgrade the Master Plan of Drainage due to changes in system requirements, land use, hydrologic parameters, among other factors. Because the agency can perform the upgrade, the master plan can be kept current, enabling up-to-date drainage fee assessment to be developed on an on-going basis.

The second application, or Application 2, enables a publication of the Master Plan data base for distribution to the public. Using "slides" (i.e., monitor images stored in the graphics data base), the entire study can be resolved into graphics slides of about one-half square mile in size, showing hydrologic master plan nodes, subareas, links, streets, land use, hydrologic soil group, among other designed data. Each slide is indexed to successively larger maps so that b y selecting quadrants from the monitor, one is able to navigate through the city to a select point. Additionally, each slide is cross-referenced to a Master Plan of Drainage data base map that stores all the data associated to the slide appearing on the monitor. Figure 4 shows a slide of a data base map which appears on the monitor. Data base operating commands are displayed on the monitor screen, enabling the user to access accessing the graphics slides.

The second application provides significant communication opportunities for the agency to both the public and the technical sectors. The engineering and planning communities can access the data base for other technical needs, and also inspect the Master Plan of Drainage without reviewing the usual report documents (which typically run several volumes). The public can inspect the Master Plan, and access information that would otherwise be unavailable. The cost of Application 2 is simply the cost of a 3.5-inch disc, or a micro-floppy.

Computer System Requirements

The necessary computer hardware needs for a study of 100 square miles involves the data base of some 5,000 subareas, 6,000 nodes, 5,000 links, and about 250,000 pieces of information. The total graphics and Master Plan data base requirements is in the 40 to 50 megabyte range.

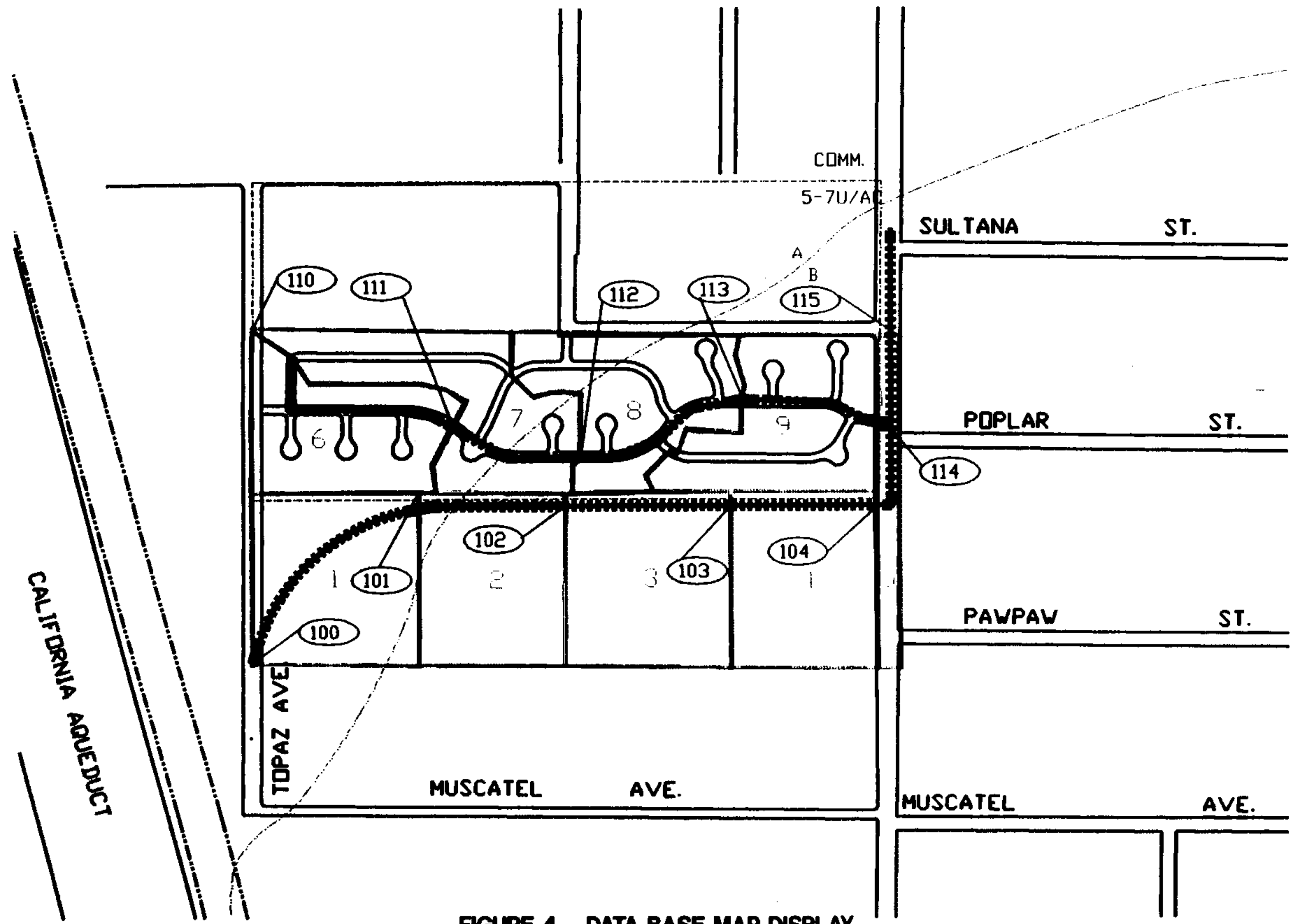

FIGURE 4. - DATA BASE MAP DISPLAY

Hard Copy Products and Mapping

Hard copy maps and reports are readily prepared using the several constructed data bases. Consequently, once the graphical data bases are assembled, drafting time is significantly reduced by using hard copy printouts. Similarly, report technical appendices can be prepared using the Master Plan of Drainage data base.

Application to Sewer, Water, Environmental Systems

Extension of the Graphics Data Base Management System to use in sewer, water, and environmental systems is straightforward and has been accomplished in several applications in Orange County, California. Both Applications 1 and 2 follow the procedural steps described for Master Plans of Drainage. A key element to use with other systems is the availability of an integrated processing model -- such as readily available integrated sewer and water system models. In the application described herein, the development of an integrated Master Plan of Drainage computer model was a crucial step in the evolution of the Graphics Data Base Management System approach for Master Plans of Drainage.

Conclusions

A graphics data base management system for computerized Master Plans of Drainage is developed. Two applications are prepared which enables the agency to upgrade the Master Plan in the future, and to publish the Master Plan in computer graphics form for distribution to the public. Because of the ease of communication opportunities afforded by this approach, the utility in Agency public information programs may be significant.

References

1. Hromadka II, T.V., 1983, Computer Methods in Urban Hydrology, Rational Methods and Unit Hydrograph Methods, Lighthouse Publications.

2. Hromadka II, T.V., Durbin, T.J., and DeVries, J.J., 1985, Computer Methods in Water Resources, Lighthouse Publications.

3. Hromadka II. T.V., McCuen, R.H., and Yen, C.C., 1987, Computational Hydrology in Flood Control Design and Planning, Lighthouse Publications.

4. Hromadka II, T.V., 1988, Computational Hydraulics of Irregular Channels, Lighthouse Publications, 270 pgs.

5. Hromadka II, T.V., Durbin, T.J., DeVries, and J.J., 1990, Computer Methods in Water Resources and Environmental Engineering, Lighthouse Publications, 450 pgs (in-press).

Artificial Stream Rehabilitation: Money Well Spent or Money down the River
by **William S. Platts and Mark T. Hill**, Don Chapman Consultants
and **Robert L. Beschta**, Oregon State University

Artificial stream restoration has been in vogue in the United States over most of the last century. Although large sums of money have been invested, and even larger sums of money continue to be invested, there is little scientific evaluation to determine if this money was or is being spent wisely or if it has produced desired products. This report discusses historic and present restoration status, evaluates the success or failure of stream restoration efforts in the Western United States having a scientific evaluation, and recommends directions that stream restoration should taken in the future.

A Bioengineering Technique for River Bank Stabilization with Selected Case Studies
by **Dale E. Miller**, Interfluve, Inc.

Traditional river bank stabilization measures have relied on hard engineering applications, including stone riprap, rock filled gabion baskets and block retaining walls. These methods often have negative environmental and aesthetic impacts, and as a consequence, are increasingly considered unacceptable. Bioengineering techniques employ a combination of organic, biodegradable textile fabrics and revegetation with native and native-adapted plants to meet or exceed established engineering stability standards. The fabrics used as river bank protection provide short-term stability (less than 5 years), while trees, shrubs and grasses are planted to provide long-term stability (greater than 5 years).

An innovative bioengineering technique has been developed where stream banks are reconstructed in 1-foot high lifts of fill material, each wrapped with a dual layer of biodegradable erosion fabric. The outer fabric provides structural integrity, while the inner layer prevents piping losses of fill material. The lifts are oriented to restore a variable stream bank slope and configuration, providing for biologic and aesthetic diversity. The key to long-term stability is the eventual establishment of mature riparian vegetation on each of the lift surfaces.

Three project case studies are reviewed, including: 1) reconstruction of a mile of stream through residential neighborhood following remediation for heavy metal contamination; 2) stabilization of one-half mile of river bank along an abandoned landfill; and 3) stabilization of a river embankment adjacent to a 28 acre lake located within a state park. Engineering design criteria are described, including evaluating for such factors as internal rotational failure, drainage at rapid drawdown, surface shear stress, and bed scour. Hydrologic analysis are also described, including determination of low and flood flow magnitudes and frequencies, HEC-2 model (step-backwater analysis), and periodicity of bank inundation for plant specification purposes. Lastly revegetation species and methods are described.

Application of a Graphics Data Base Management System: Computerized Master Plan of Drainage
by **T.V. Hromadka II**, Boyle Engineering
and **R.W. Corchero, and C. Laird**, County of San Bernardino, CA.

A Graphics Data Base Management System is developed for use with computerized Master Plans of Drainage. The Master Plans are prepared according to Agency specifications involving multiple hydrologic and hydraulic modeling options, integrated into a single software package. Data bases are prepared for graphical representation of streets, land uses, hydrologic soil groups, rainfall, master plan system elements, topographic, and other data, as well as computational results developed from the Master Plan of Drainage computer model. Two applications are available; an integrated package enabling editing and upgrading of the Master plan, and another package designed to publish and distribute the Graphics and the Master Plan of Drainage data bases to the public in an access-only data base retrieval environment. The opportunities provided by such public information programs are significant, in that the entire Master Plan becomes available to the public in an easy-to-read and easy-to-use environment. The public therefore becomes an integral and important member of the Master Plan team, exchanging input and easing the way for acceptance of the project.