QUANTITATIVE INVESTIGATION OF MAP DRAWING ON SCREEN (ABSTRACT)

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INTRODUCTION

A great deal of data in a geographic information system are graphically represented on a screen. Graphic representation of these objects on a screen affects the overall performance of the entire system. The choice of methods for efficient storage and retrieval of objects, as well as for graphic display are directly influenced by the amount of spatial objects drawn on a screen. The effectiveness of user interfaces and human perception are also affected by the amount of objects to be displayed. The purpose of this research is to determine the optimum amount of objects that can be displayed on a screen as a basis for performance evaluations in the mentioned areas. A preliminary investigation found that a map drawing on a Macintosh color screen can contain around 2000 to 3000 objects.

METHODS

This study is conducted in two types of environments. The first is an IBM PC with a NEC Multisync color monitor. The second is a Macintosh with an Apple standard color monitor. Several types of map drawings have been used to conduct this study.

Object Classification

Spatial objects can be represented graphically using several kinds of primitives--points, lines, polygons. They can have annotations related to their properties. They can also have pattern or color fills to be distinguished as different types of objects. In order to count objects meaningfully, the definition of objects with respect to how they were created graphically is discussed.

For example, a building is outlined by a polygon but is counted as one object. A contour line for one elevation is counted as one object. A water network is more complicated, however, and is determined by the amount of main lines, secondary lines, and branching lines. The amount of data storage space for different objects varies depending on the complexity of the object itself.

Graphic objects are simplified representation of real world objects. The object classification of this study emphasizes graphic display of objects rather than the amount of data being stored. The size of data corresponding to each object type is recorded for further studies. Data storage is certainly a concern but it merits a separate discussion.

Software Used

Several programs have been used to conduct this study. CAD or generic CAD drawing software was used to create different types of map drawings. On the IBM PC study, AutoDesk's software AutoCAD (release 10) was used while in the Macintosh domain, Deneba's software Canvas was used. Both programs are able to create drawings in separate layers for later counting purposes. On the Macintosh, another software for map overlaying called GiGi, a program developed by Jeff Jackson at NCGIA, was used for counting the objects.

Hardware comparison

Monitor	Effective Area	Size
NEC Multisync	16" x 12"	19" diagonal
Macintosh	9" x 7"	13" diagonal

Map Drawings and Counting

On the PC several AutoCad drawings were examined to estimate the possible number of objects that may be displayed on the screen. The effective screen of the IBM PC is 16" x 12". AutoCad uses approximately 90% of the effective screen to display drawings. The following table is a summary of the counts.

IBM PC AutoCad

Drawing type	Data size (bytes)	Objects
GPS network	6,108	76
Roomsketch	16,133	147
Soil map	1,001,378	479 (1/4 window)
Section	48,889	32
Parcel map	210,198	3336

On the Macintosh, several Canvas drawings were created to estimate the number of objects which can be displayed on the screen. The effective screen area on the Mac II is 9" x 7". The image or drawing uses only part of the screen which is 6" x 4", the remaining screen is used for other purposes, such as an index map, legends, menus etc. Thus, only 50% of the screen is used to display the main drawing.

Macintosh Canvas

Drawing type	Data size (bytes)	Objects
Zoning	3,000	9
Contour	4,000	15

Road	7,000	45
Soil	14,000	87
Water Network	30,000	277
Buildings	63,000	320
Parcels	36,000	336
Master Plan	105,000	1102

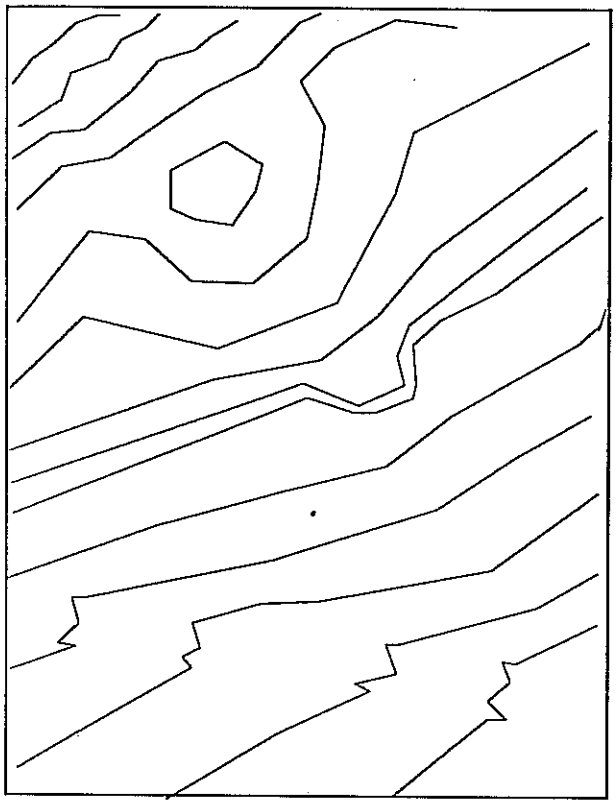
Thus a complete map drawing in the size of a screen contains approximately 2,000-2,500 in a Macintosh color monitor (13" diagonal) and approximately 3,500-4,000 in a Multisync color monitor (19" diagonal). However, these numbers don't take into account the limitations by human perception and aesthetic criteria.

Resolvable Displaying

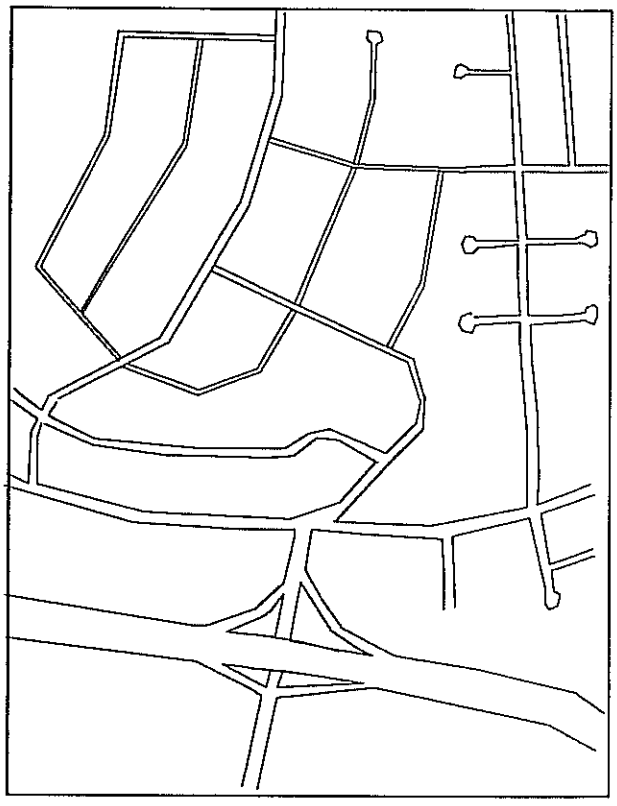
If all layers of drawings were displayed in monochrome black & white, a map drawing which can be comfortably viewed and meaningfully distinguished by the human eyes at 18" distance contains approximately 1,200-1,500 objects on a Macintosh screen. If the map is displayed in multi-color, the total objects in a map drawing which can be comfortably viewed and meaningfully distinguished by the human eyes at the same distance was found to be approximately 2,000-2,500 on a Macintosh screen. Further study in this area is necessary in order to subjectively quantitify the amounts of objects which human are able to perceive and consider aesthetically pleasing. Color fill, pattern fill, line weight, instance field of vison, and viewing distance should all be considered.

CONCLUSION

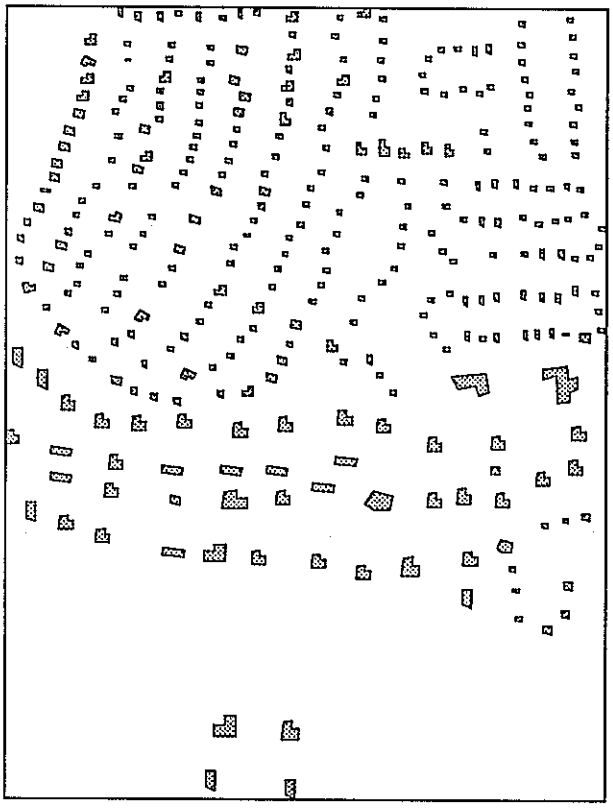
This is a preliminary study of the number of objects in a map drawing displayed on a screen. This number is limited by perceptual and aesthetic factors. An estimate of its magnitude is a necessary prerequisite for performance discussions. The study brings up many related subjects, such as clustered storage of data, efficient user interfaces, and graphic software performance, etc.



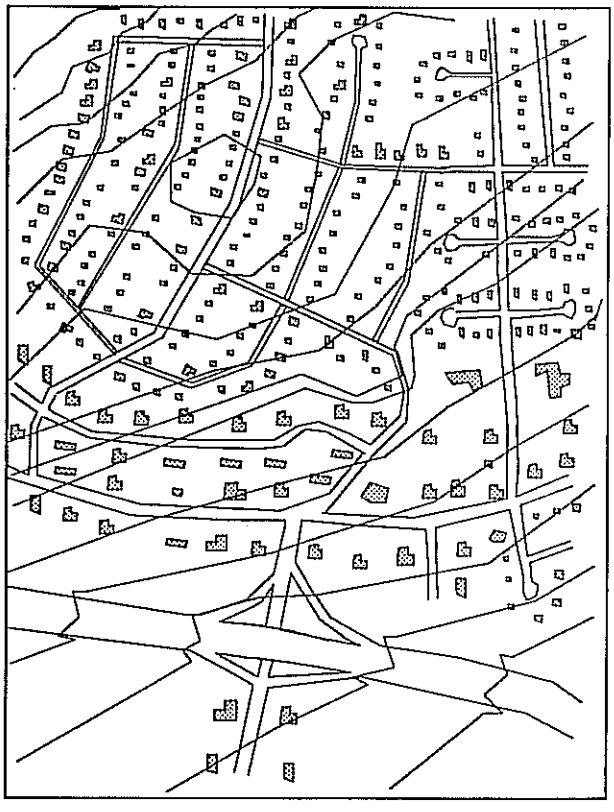
a. Contour map



b. Road map

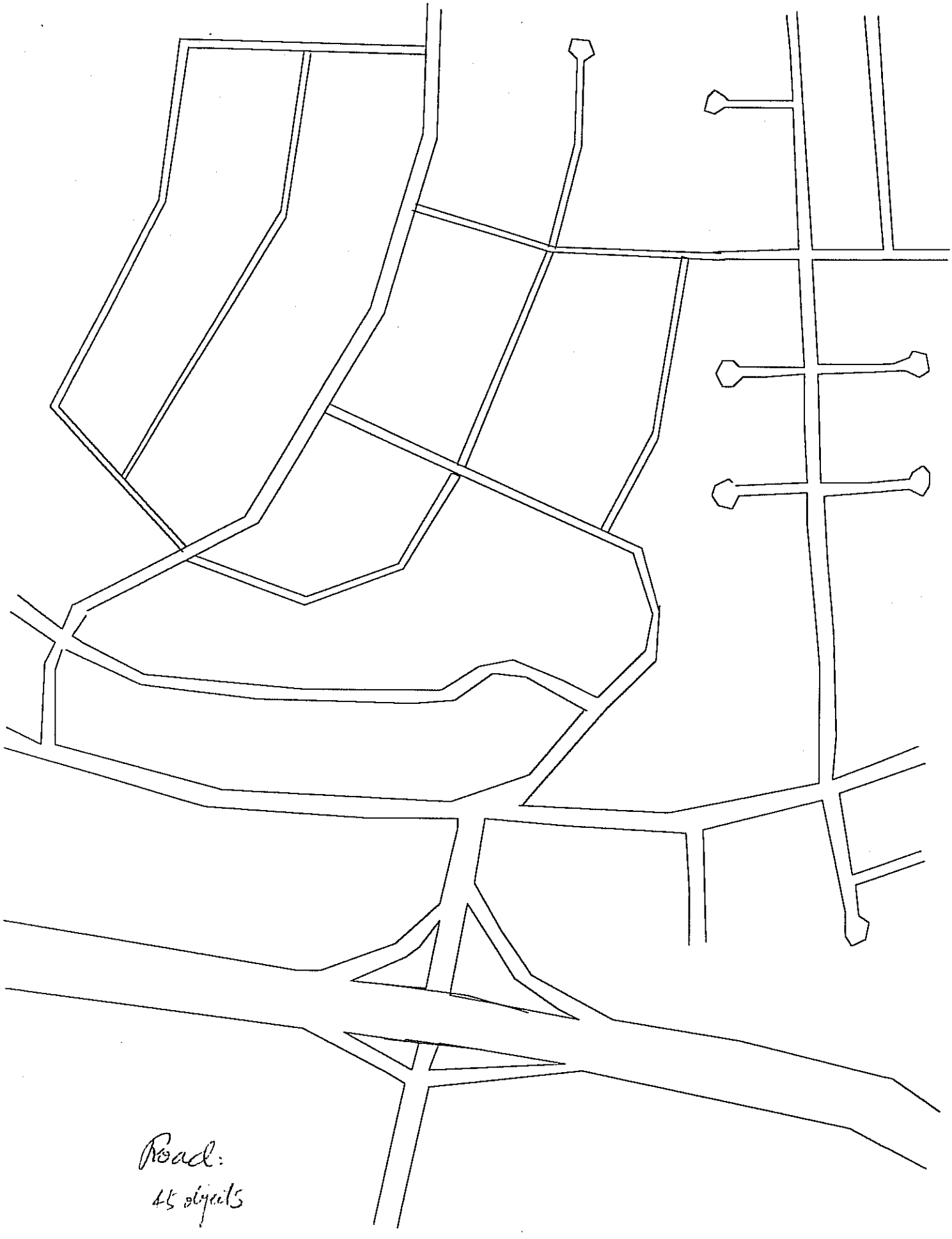


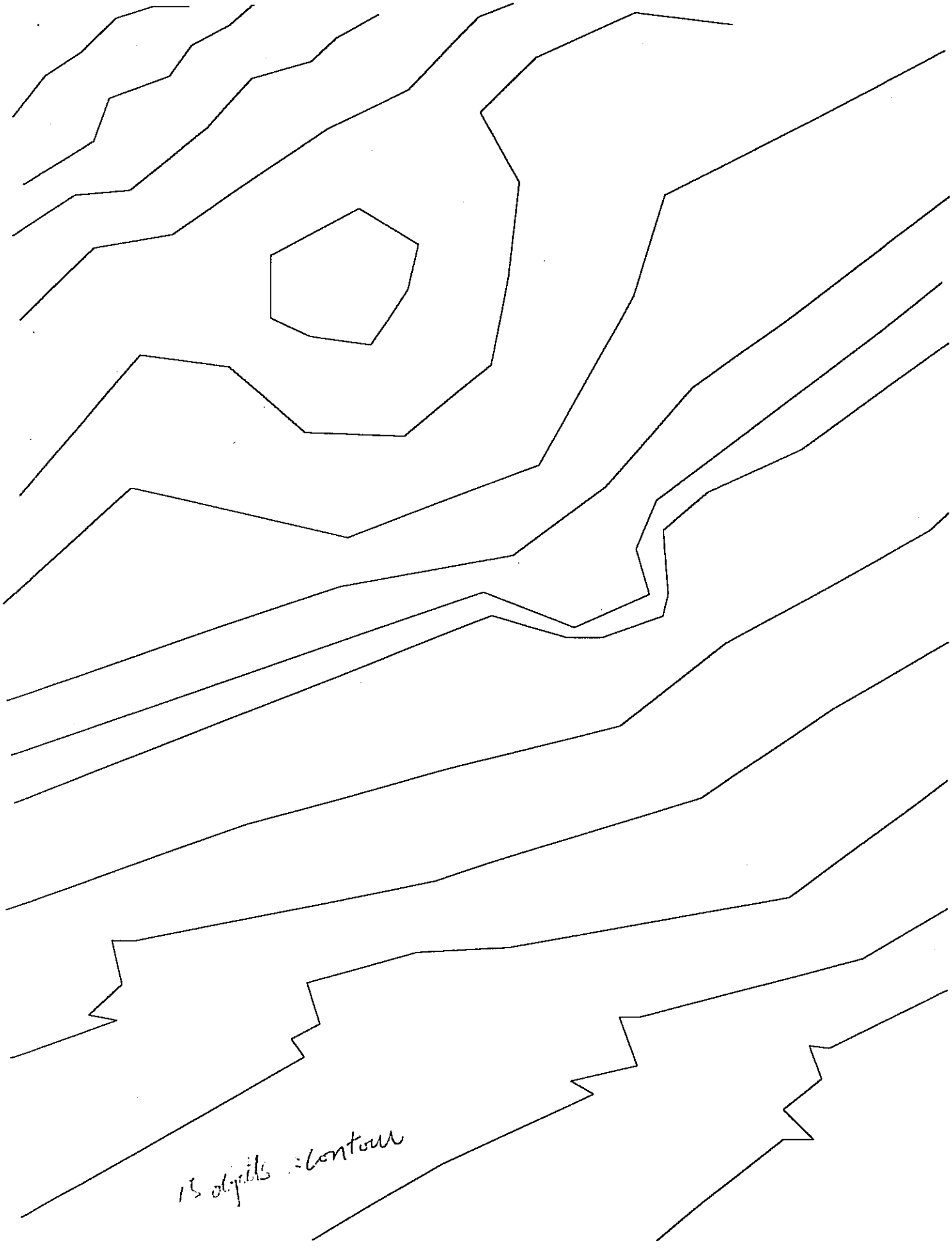
c. Building map

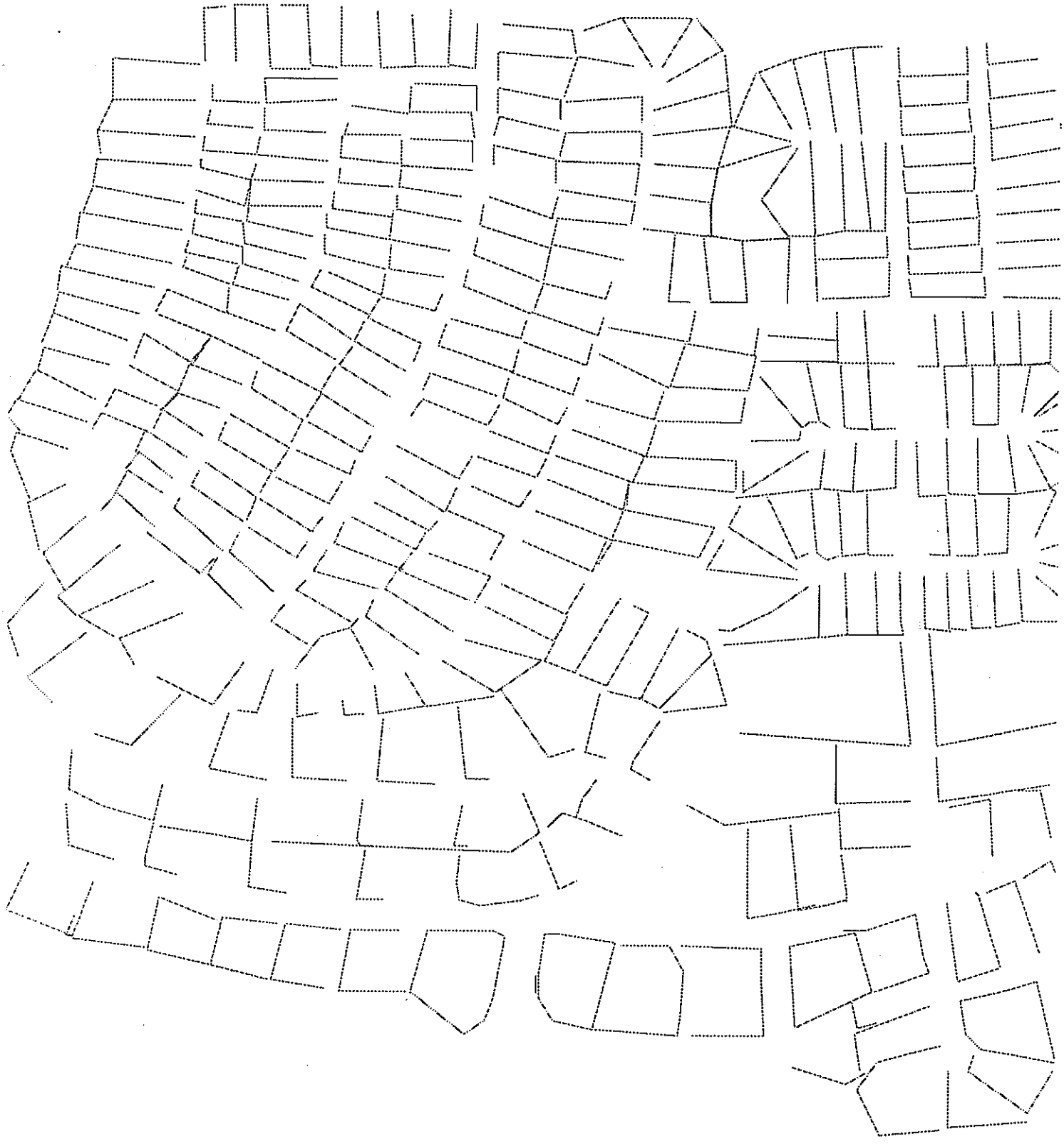


d. Contour, road, building overlays

(reduced size)

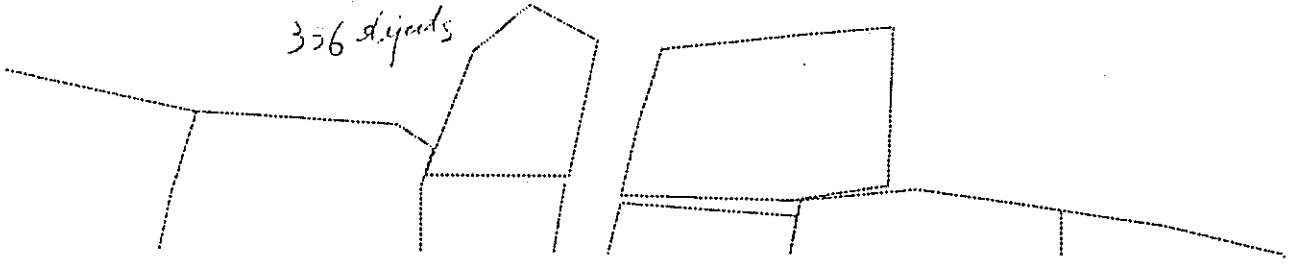

Road:
45 objects

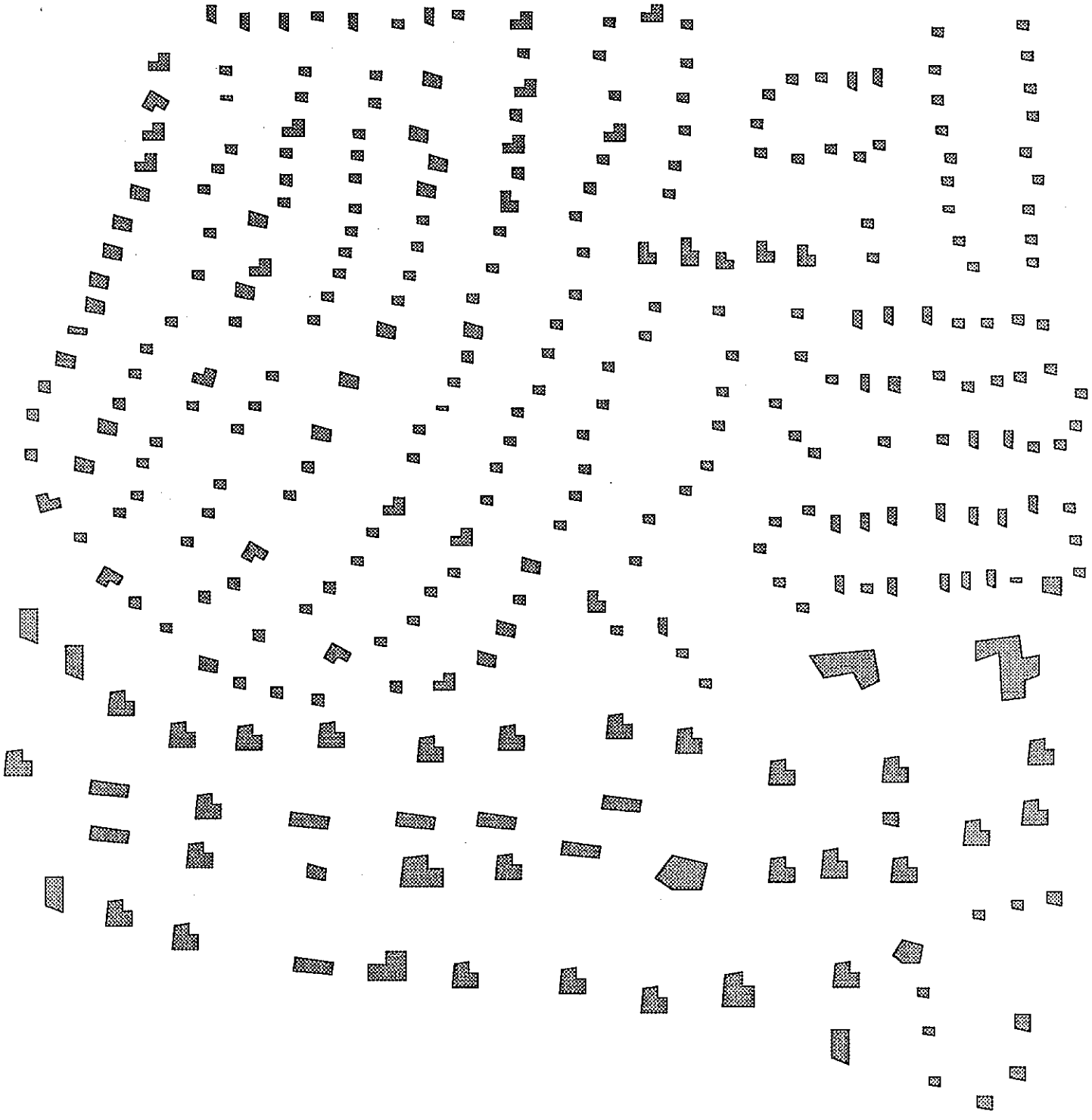

15 objets : contour



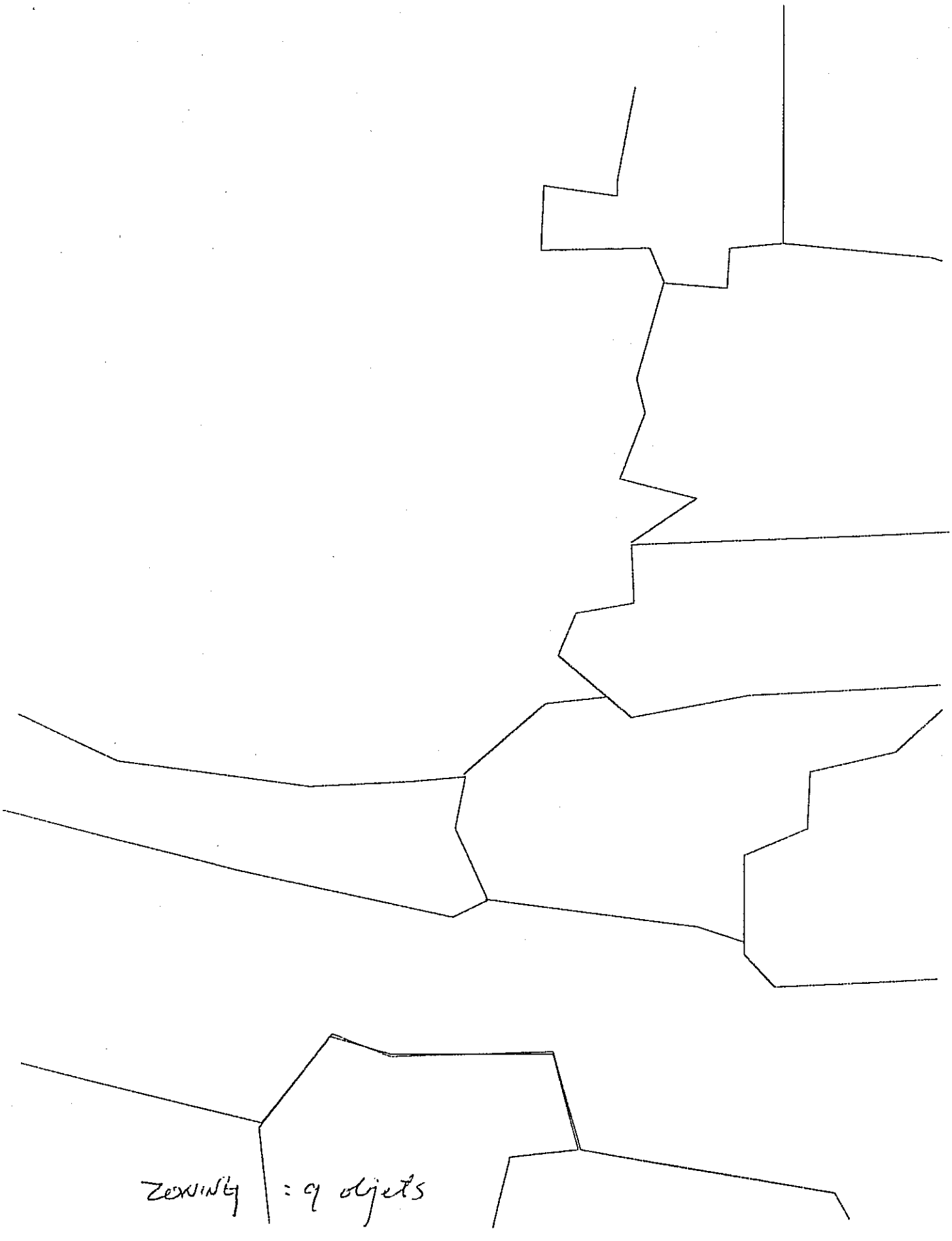
Panels:

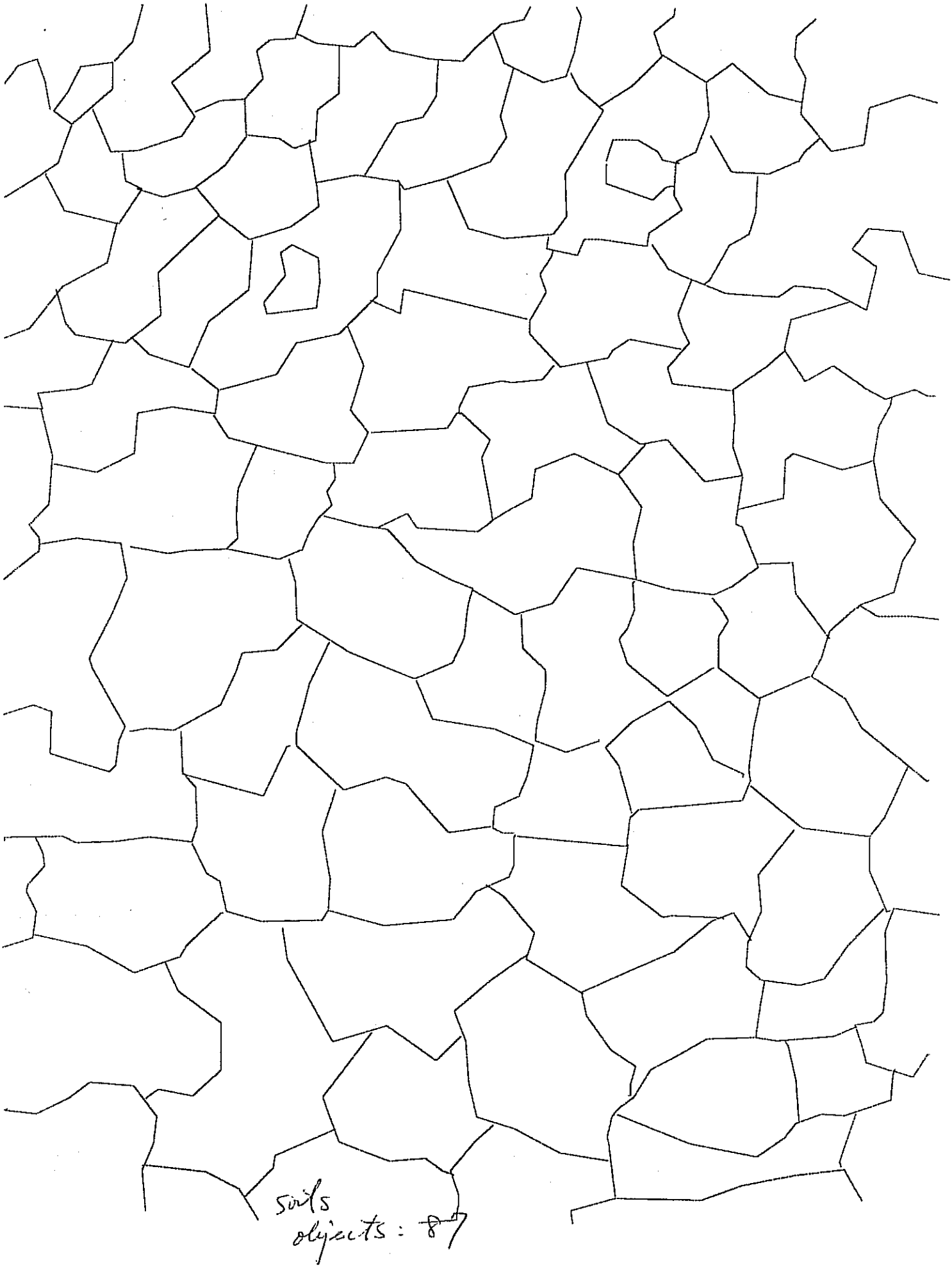
336 sq. yards





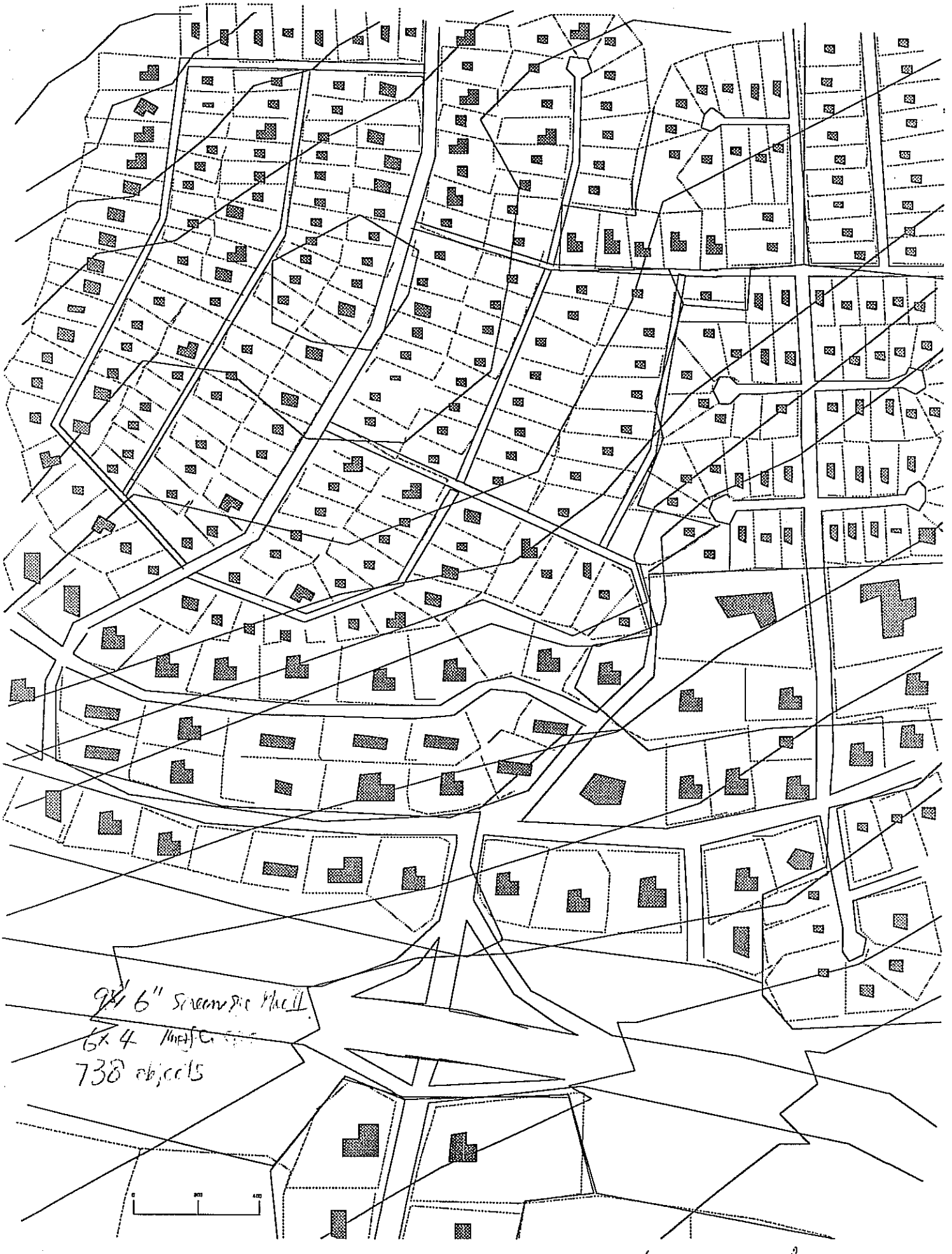
bldgs : 320
objects


zoning : 9 objets


soils
objects: 87

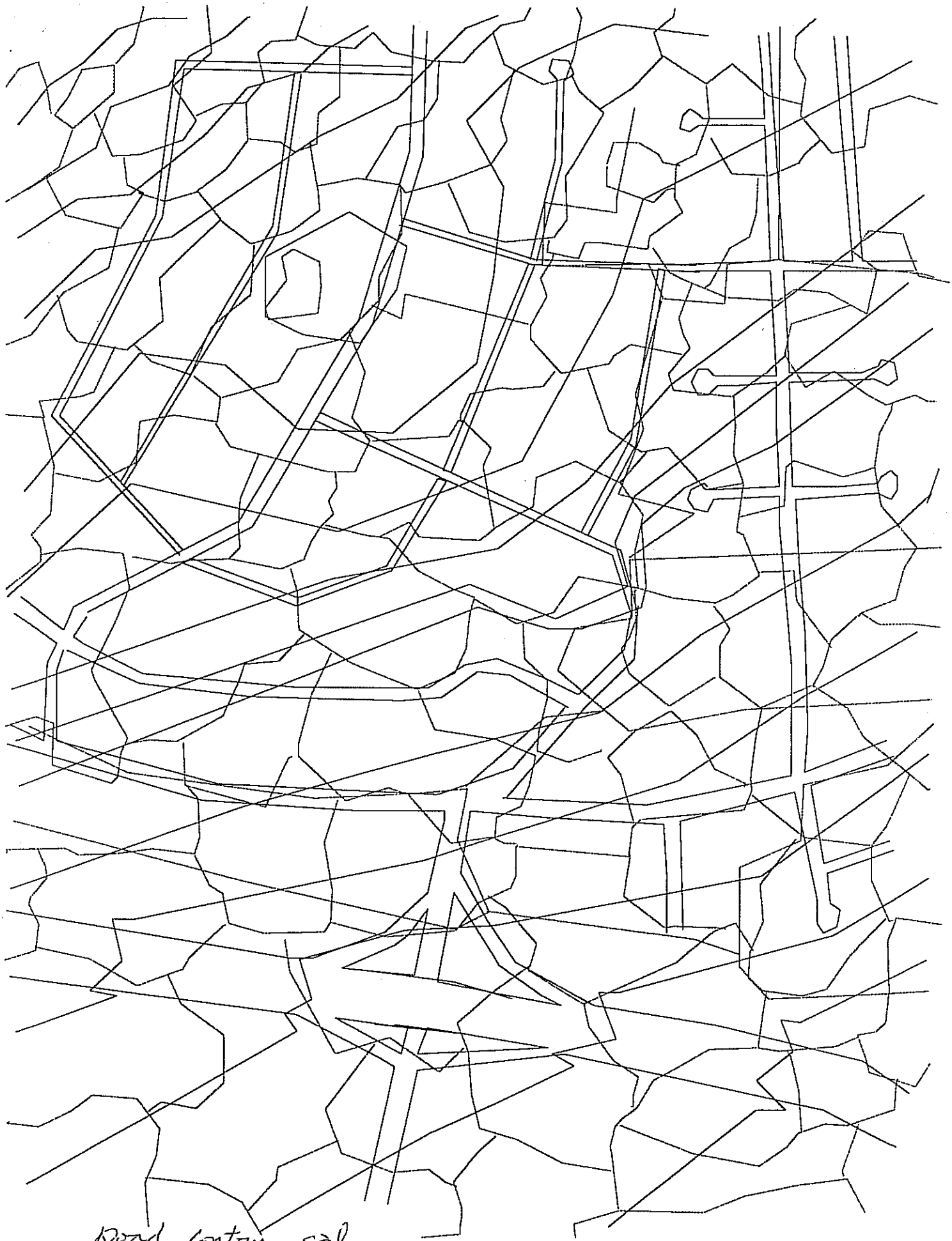
WaterNet = 277 objects.

Objects = 1102 Road, parcel, waterNet, soil, contour, zoning
Bldgs.



Bldgs, Road, contour, parcels, ZONING (without soil & watershed)


Bldgs, Road, water net. 642 objects.


Road, contour, sea
: 147 objects