One Hundred Years of Land Value

Data Documentation

Olcott's Land Values for Chicago (1913 - 1990)

Berlin, June 2012

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1. Introduction

This document summarizes the extraction of historic land values from Olcott's Blue Books of Chicago between 1913 and 1990. The extraction project was funded by the Lincoln Institute of Land Policy. The project was hosted by the Center for Metropolitan Studies at the Technical University of Berlin. This is also where the main extraction work was carried out.

Olcott's Land Values – Blue Book of Chicago provide an exceptional source of land values for Chicago, Illinois, and its surrounding suburbs. The books are unique in spatial detail, geographical as well as in time coverage. Our extraction process collects the land value data contained in Olcott's Blue Books at the maximal spatial detail. Land values are extracted from historic maps and aggregated to a grid which is made up of 86.205 grid squares. Based on these grid cells, we create a (quasi) balanced panel for time periods between 1913 and 1990 covering an area of more than 340 square miles.

In the next chapter (two) we give an overview of the land value source, Olcott's Blue Books. We then explain the extraction process and use two example maps of Olcott (1939) to illustrate the methodology step by step (chapter three).

2. Data source

2.1. Olcott's Land Values – Blue Book of Chicago

The series *Olcott's Land Values – Blue Book of Chicago* reports land values for Chicago, Illinois, and was originally established in 1900. In the beginning George C. Olcott only published individual subsections of Chicago on a monthly base. He later switched to the annual issuing of books covering the entire city area plus the surrounding suburbs of Cook County. Land values were collected and published until the first half of the 1990s.

Olcott's Blue Books were "designed by means of valuation maps to enable one to determine the approximate values of lots in each block of the city" (Olcott 1913). The reported land values are conservative, "impartial estimates" (Olcott 1913) based on sales, bids, and asking prices as well as on opinions of people working in real estates. The value collection involved a careful exploration of the territory, interviews with local dealers, and consolations of data on sales, leases, etc. They are supposed to reflect the current market value of pure land and to follow actual market transactions.

Olcott's Blue Books present estimated land values in various units. They are mainly reported in US $ per front foot for inside lots not coming under corner influence. The standard lot depth is 125 feet and 100 feet in high-priced downtown areas. For lot sizes that differ from the standard depth, Olcott provides detailed tables with conversion factors that facilitate the adjustment of the standard land value. The assessors also suggest various rules to determine corner values.

Land values are quoted in four different ways:

- Standard land values in US $ per front foot for inside lots not coming under corner influence with a standard depth of 125 feet (100 feet in downtown),
- prominent corners in US $ per front foot with a standard depth of 125 feet (100 feet in downtown),

- industrial, railroad, and dock land in US $ per square foot,
- unsubdivided lands by the acre.

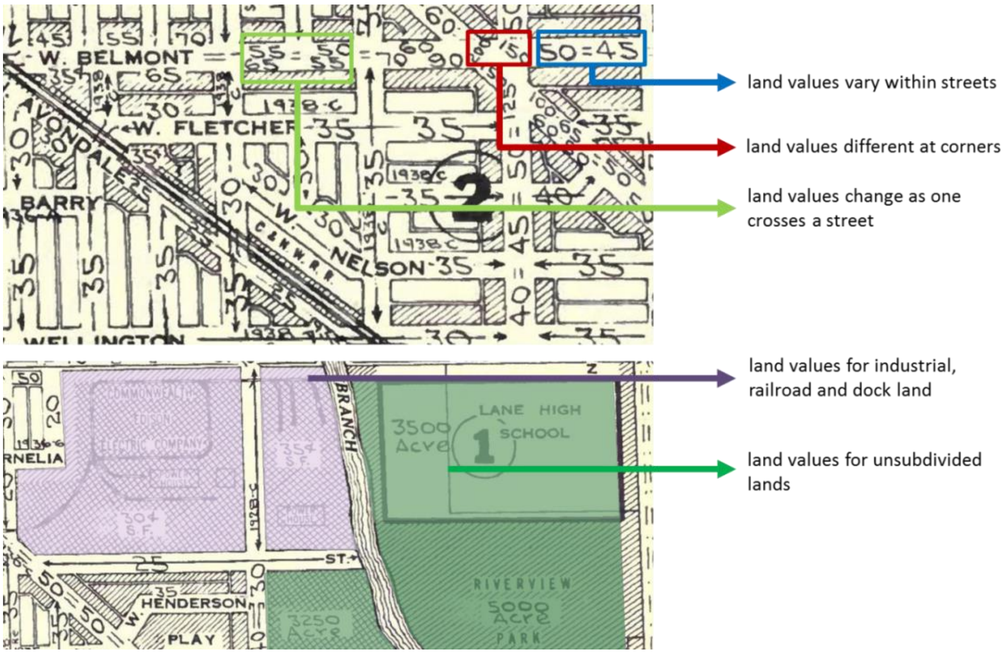


Figure 2.1a: Illustration of land values (Olcott, 1939, map piece 50).

The land value information is represented in map form. The Blue Books do not only cover a long time span but also a large geographical area. In the 1990 issue the observation area is bordered by Fort Sheridan in the North, Palatine in the West, and Steger in the South. At the same time, the land value maps provide a high level of spatial detail at the local level. As indicated by Figure 2.1, land values vary within streets and can even differ on opposite street sides. Additional corner values take the particularity of a corner location into account. An average annual issue is made up of up to 224 map pieces which are each 1 mile wide and 1.5 miles tall. Frequently, there are more than 300 land values reported per map piece. For the later years, land values for Chicago's and Evanton's downtown areas are available on extra maps that cover 0.5 x 0.35 miles and come in an even greater spatial detail.

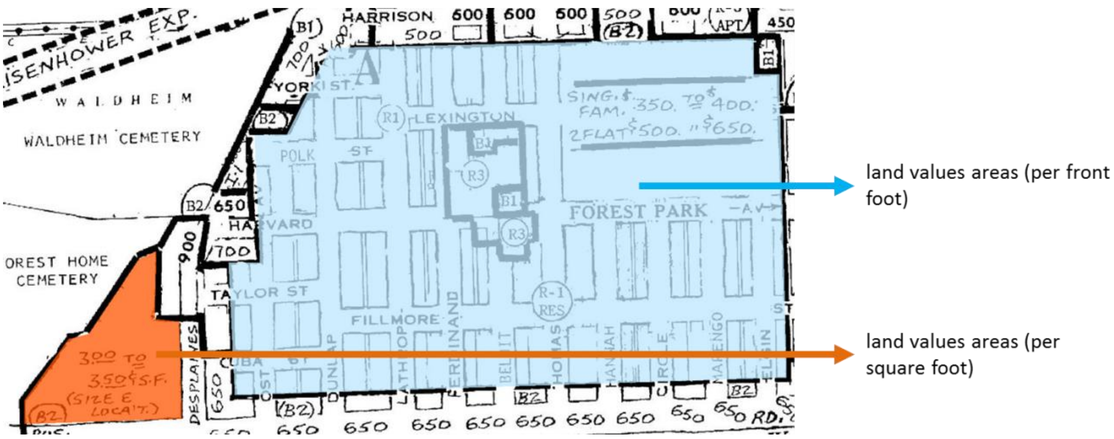


Figure 2.1b: Illustration of land values (Olcott, 1981, map piece 72F).

2.2. Books used for extraction

We have extracted land values from Olcott Blue Books between 1913 and 1990. The selection was based on three criteria. First, Olcott Blue Books were not published or are no longer accessible for all years. Second, we aimed to capture of the evolution of the city in regular and approximately 10-year intervals. Third, we reduced the length of these intervals around important historic event, e.g., the 1920s zoning ordinance.

Table 2.1 provides an overview of the different years we have extracted land values for. The number of georeferenced map pieces increases with geographical coverage. Moreover, more detailed maps with a smaller scale for downtown areas are available for later years. We were able to download the earlier issues from The Newberry Library as PDF documents and ordered the later issues as hardcopies.

Table 2.1: Olcott books used for extraction.

Year	1913	1922	1926	1932	1939	1949	1961	1965	1971	1981	1990
georeferenced map pieces	148	84	209	217	226	229	232	229	230	230	226
Source	PDF	paper copies	PDF	PDF	PDF	Book	Book	Book	Book	Book	Book

The geographical coverage was determined based on the book from 1929. Figure 2.2 shows that the area covered by our data set exceeds the boundaries of the city of Chicago (black solid line) substantially from 1929 onwards. For years earlier than 1929 the coverage is a little smaller since Olcott initially reported the land values for a slightly smaller area of Chicago. An exception is 1922, for which our land value data set was extracted based on a set of paper copies that did not cover the entire city (red solid line). Unfortunately, we were not able to obtain a hardcopy of the book for this year.

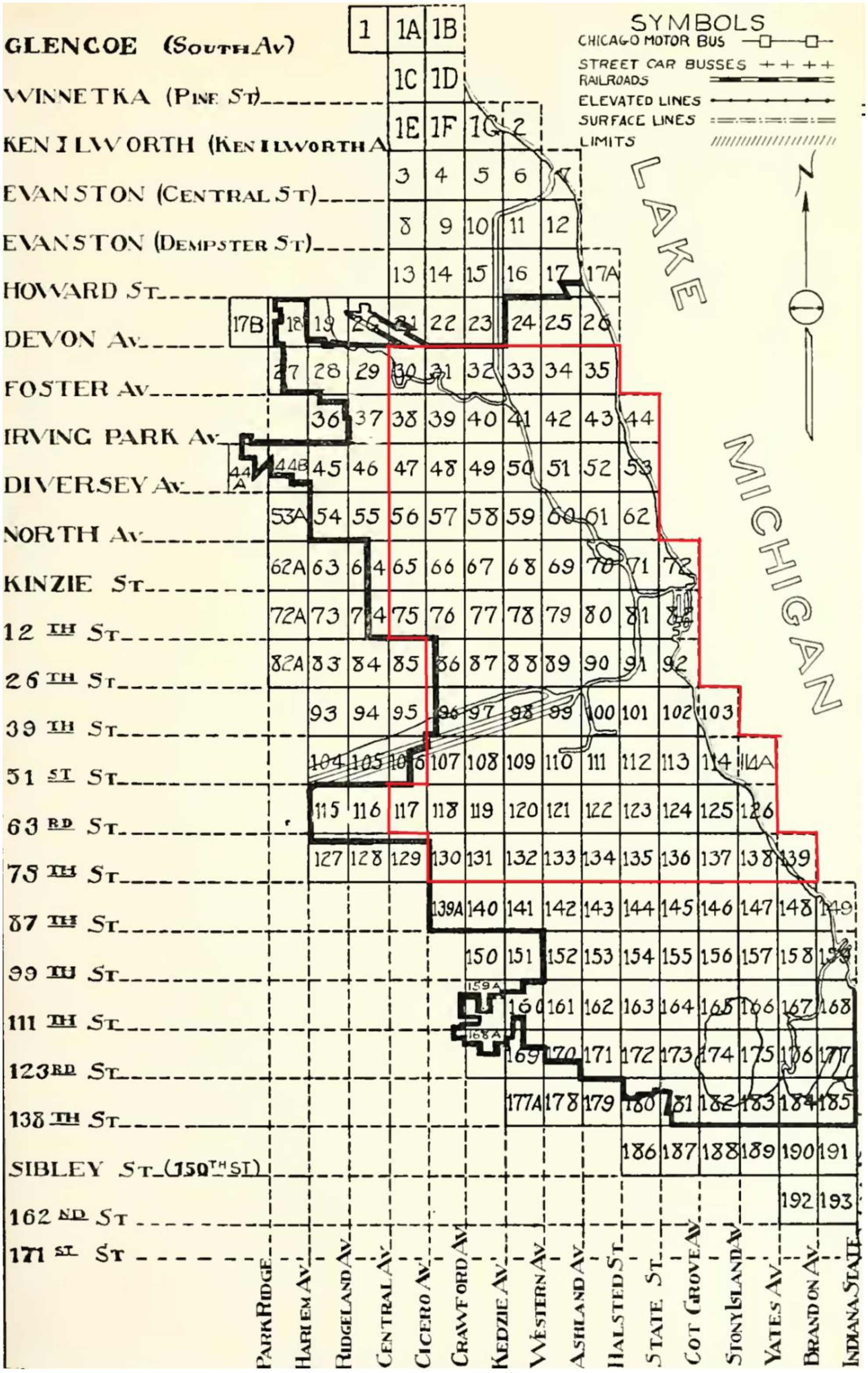


Figure 2.2: Project coverage based on Olcott 1929 (in red of 1922).

3. Extraction process

To fully exploit the rich and spatially detailed data provided in the Blue Books, the extraction process must follow two main principles:

(i) collect the data at maximal spatial detail that can be merged with other micro data
(ii) result a balanced panel that can be used for spatiotemporal analyses

The applied extraction process consists of four different steps: (i) collection and digitization of map pieces, (ii) its georeferencing, (iii) the actual data extraction, and finally (iv) the aggregation of the raw values to grid squares.

3.1. Georeferencing maps

We concentrate on two particular map pieces to illustrate the actual data extraction process, one covering a part of the central business district (CBD, Olcott 1939, p. 71) and the other one covering a less central area (p. 50). Figure 3.1 illustrates our selected example map pieces.

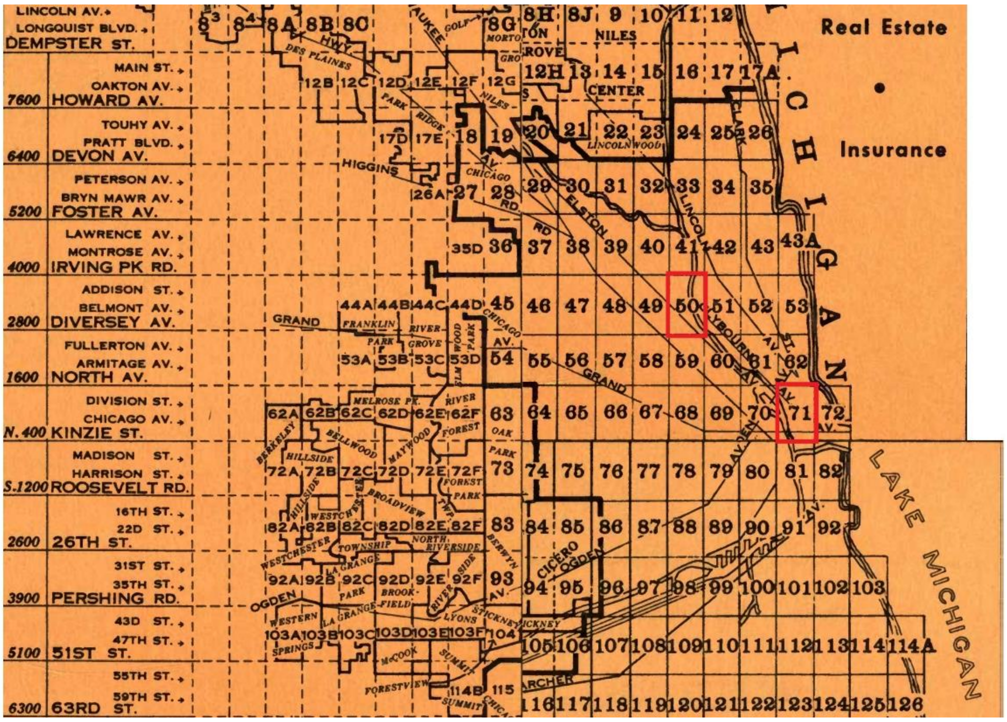


Figure 3.1: Selected example map pieces (Olcott 1939).

The first step is to import the Olcott books into a geographic information systems (GIS) environment. This involves working with both pre-digitized copies of the books and scanning hardcopies. Therefore, all images must be converted to an appropriate format and cropped to exclude extraneous borders and margins. The next step is to individually georeference each map piece in ArcGIS, using the official 2000 census block shapefile[1] as a reference (see Figure 3.2). Georeferencing describes the process of *referencing* a map image to a *geo*graphic location. The georeferenced map

[1] Available from the City of Chicago website: www.cityofchicago.org.

pieces are then assigned spatial coordinates based on a standard system for Chicago.[2] This allows for computing distances between different features on the land value maps.

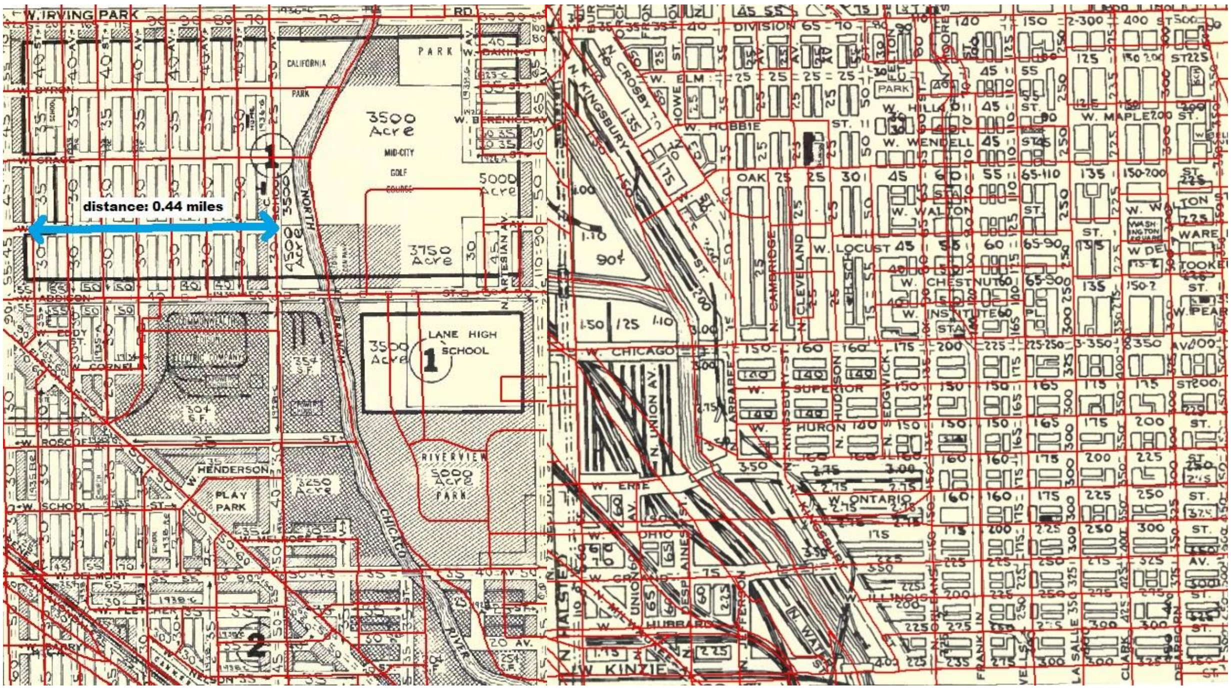


Figure 3.2: Georeferenced map pieces 50 and 71 according to census blocks (2000).

3.2. Data entry

The actual data extraction process involves two steps: (i) creating a shapefile which describes the spatial geometry of the land value data (we use ArcGIS polylines/polygons), and (ii) entering the respective land values into underlying attribute tables. The land values on the map are unit values per front foot for inside lots in each block, not coming under corner influences. In addition to these standard unit land values, the book provides numerous rules and tables that allow for the calculation of specific values for lots with respect to their different geometric shapes and sizes and proximity to street corners. The procedures result in standard unit land values that abstract from the actual perimeters of individual plots. Any extra impact on the land values derived from specific lot geometry or proximity to corners, if existent, is expected to be a fixed effect that can be differentiated out using the panel nature of the data.

The standard unit values refer to the blocks which are located along a street, as is illustrated in Figure 3.3a. The most accurate way of extracting the data is to extract the land values on a street level. Polylines are drawn along street stretches with identical land values (Figure 3.3b). Moreover, we create an extra shape file, for the prominent corners, that contains polylines for every corner (Figures 3.3c and 3.3d).

[2] This coordinate system is called “NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet”.

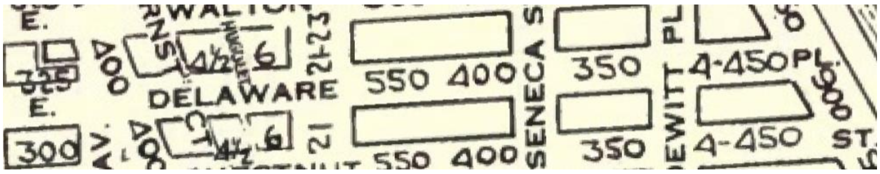


Figure 3.3a: Land values along the streets.

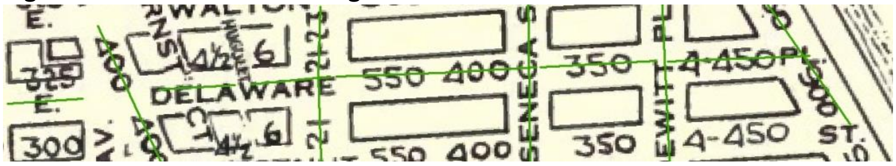
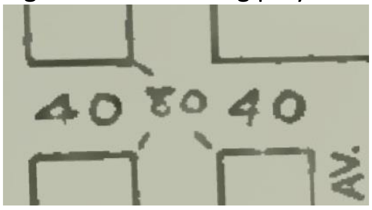


Figure 3.3b: Drawing polylines according to the values.



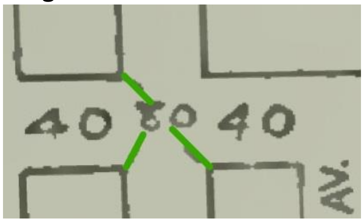
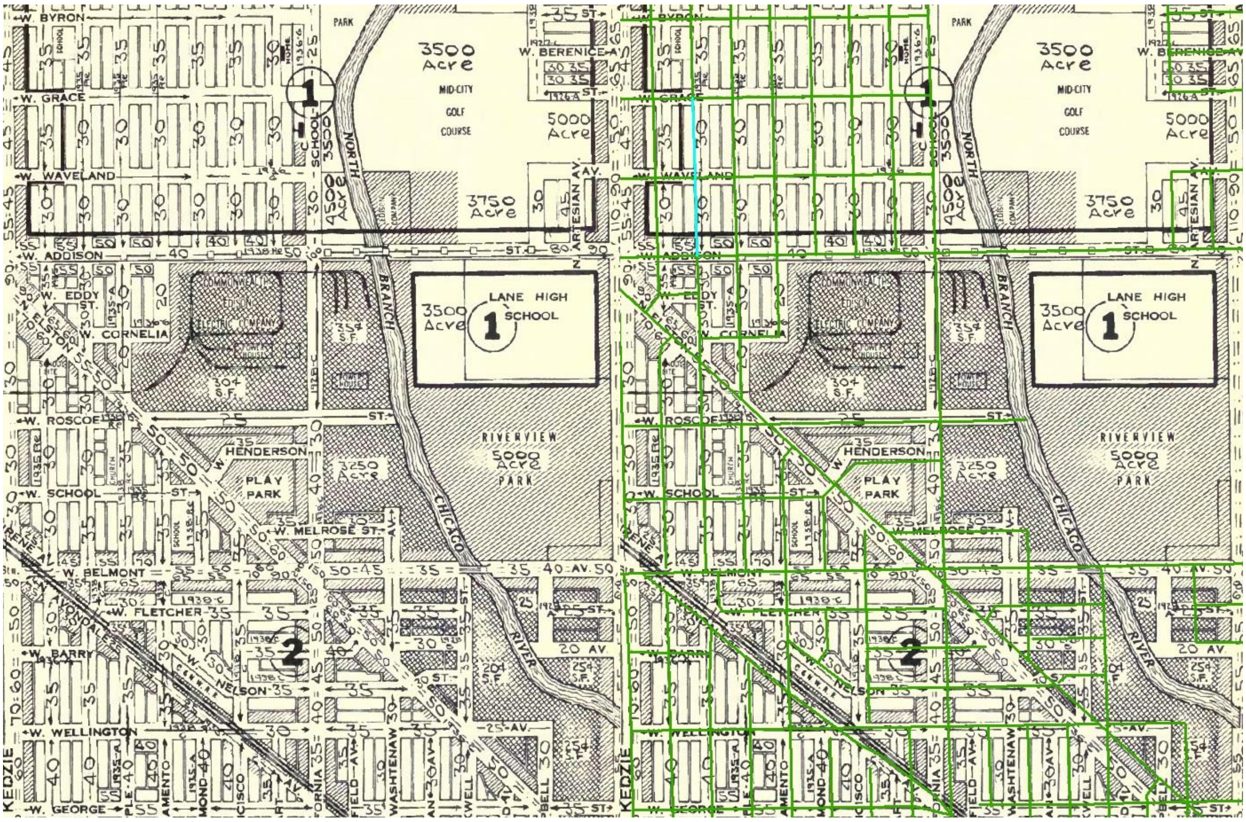


Figure 3.3c: Prominent corner. Figure 3.3d: Drawing polylines for a prominent corner.

Figure 3.4 shows a section of map piece 50 with and without polylines. The highlighted blue line shows a single street section with uniform land values of $30/front foot.



blank with polylines

Figure 3.4: Drawing polylines for map piece 50 (Olcott 1939).

The next step involves the data entry. For each polyline the respective land value reported on the Olcott map is entered into an attribute table that underlies the electronic polyline map. We have drawn about 200 lines for map piece 50 and another 315 for the piece 71 alone. Figure 3.5 shows the land values assigned to the polylines for a small section of map piece 50.

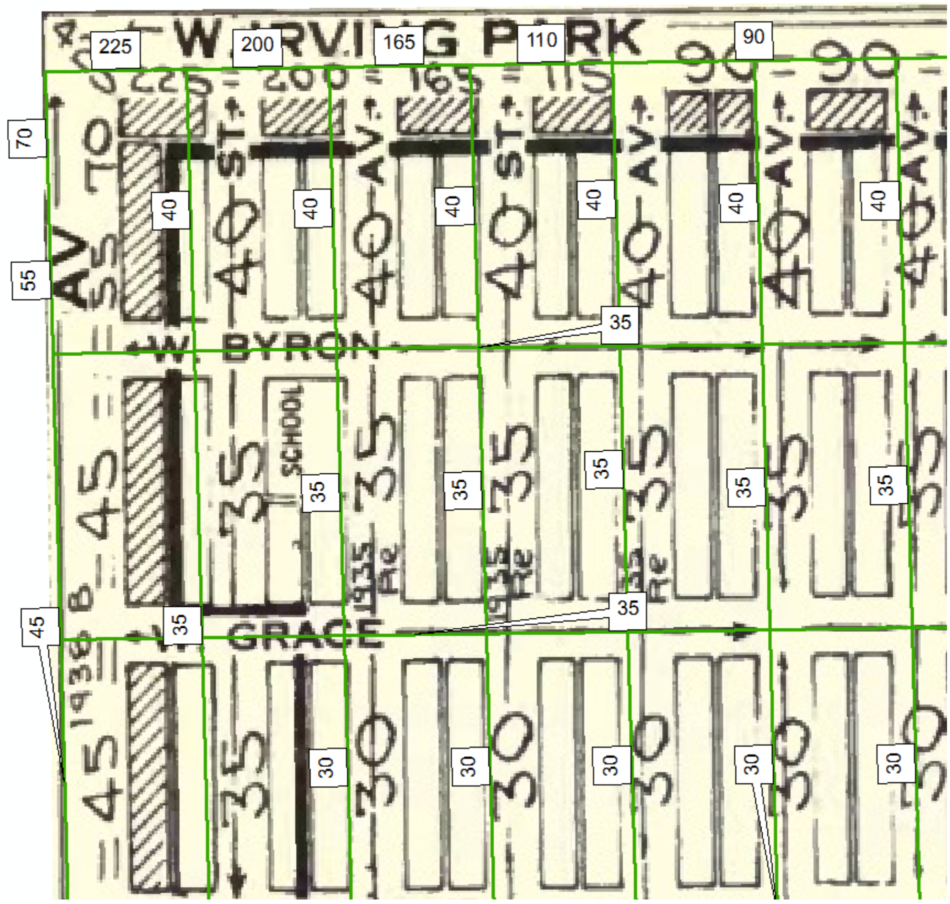


Figure 3.5: Entered land values for the different polylines.

As previously mentioned, Olcott's Blue Books do not only contain land values for residential and business areas but also for industrial areas and unsubdividable areas which are reported in square foot or per acre price units. We generate separate layers for industrial zones and acres. We draw polygons around the respective areas and enter the per square foot/per acre value into the underlying attribute table. With this approach we are able to distinguish the different "land uses" and valuation units. However, integration into one data set is still possible as we aggregate our data to grid cells. Examples of these polygons for industrial (pink) and unsubdividable areas/"acres" (green) are shown in Figure 3.6 joint with the assigned values.

Starting in 1971, Olcott introduces two new land value indicators. Firstly, now not only industrial, railroad or dock land is expressed in US $ per square foot but also business/commercial areas. For these areas we apply the same approach as for the industrial areas; we draw polygons and enter the square foot value into the attribute table. Secondly, and complementary to the disaggregated land values drawn along the streets, Olcott aggregates standard front foot values for presumably homogenous areas. For those areas only the minimum and the maximum values are reported. In these cases we again apply the same methodology as described above and draw polygons around these areas. We assign the mean value that is representative for the area (see Figure 3.7).

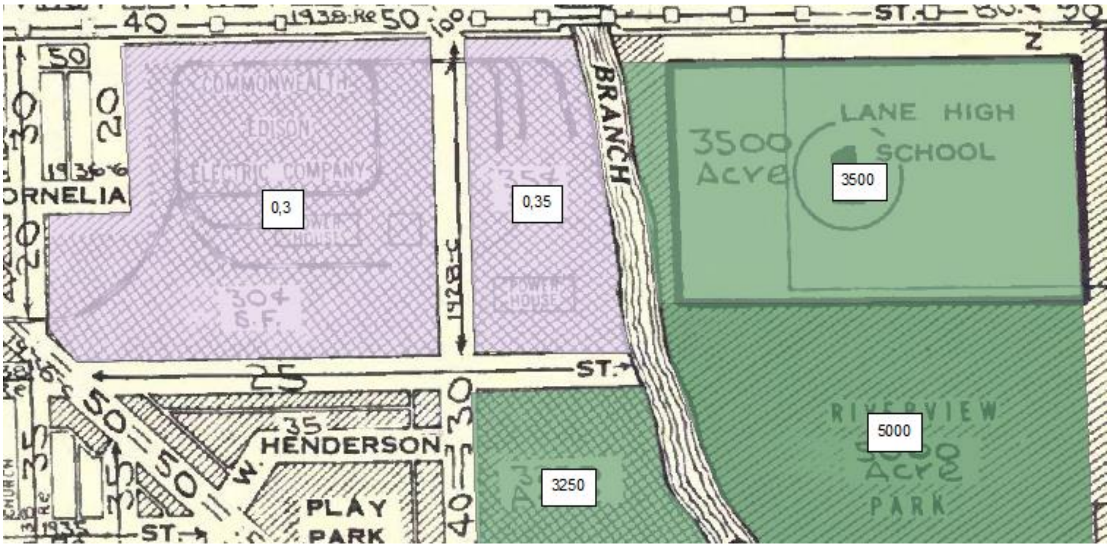


Figure 3.6: Entered values for industrial and acre polygons (Olcott 1939, 50).

Figure 3.7: Entered values for business areas and standard land value polygons (Olcott 1971, 72F).

3.3. Aggregation

In the last step of the data extraction procedure, we aggregate land values to a spatial grid which we lay over the city. This aggregation is a necessary step to convert the polyline data that lie along the streets into the consistent geographic areas that do not change over time. The grid squares approach has various advantages: It is not density biased, it embodies the underlying grid structure of the city, and yet the areal units remain consistent over time and space.

Each individual grid measures a size of 330 x 330 feet which is 1/256 of a square mile. As each map piece measures 1 x 1.5 miles it covers exactly 384 grid squares. The application of this grid is greatly facilitated by the fact that Chicago's block structure follows an almost perfect grid. Therefore, where the streets conform to the standard structure for Chicago, the individual grid squares cover either an inside street section or an intersection. As the land values are captured by the lines located along the streets, the streets and intersections are located in the middle of the grid squares.

Figure 3.8 illustrates the grid approach using the sample map piece 50 of Olcott (1939). In Figure 3.8a the highlighted grid square (light blue) covers a street with a unit land value of $30. This grid square takes on the value of the polyline that passes through the grid, as illustrated in Figure 3.8b. Figure 3.8c illustrates a grid square which covers an intersection. All the polylines and polygons that pass through the grid square are taken into account (Figure 3.8d) in calculating the value for the grid.

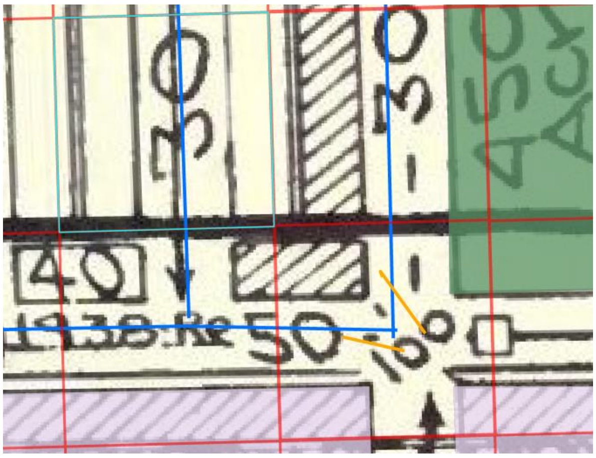


Figure 3.8a: Grid square covering a street.

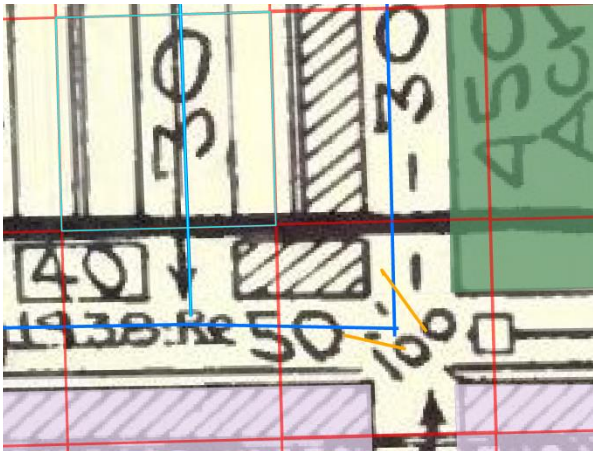


Figure 3.8b: Grid square covering a street with respective polyline.

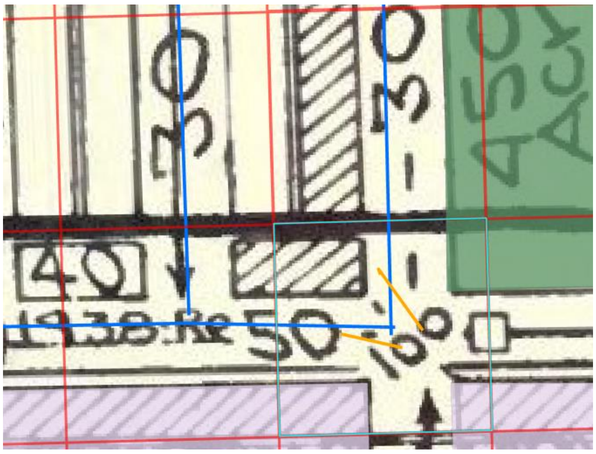


Figure 3.8c: Grid square covering an intersection.

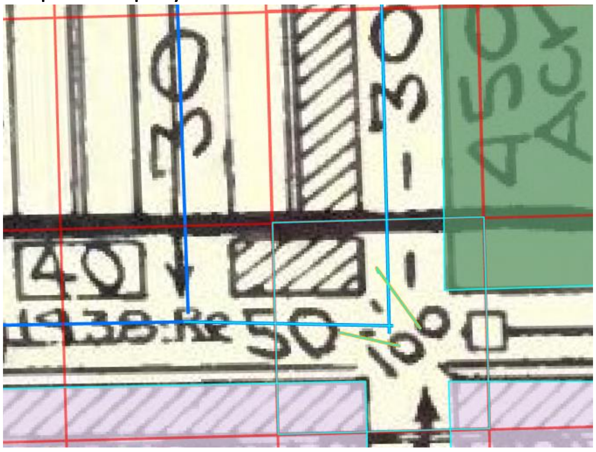


Figure 3.8d: Grid square covering an intersection with respective polylines and polygons.

There are often several polylines and polygons representing street, corner, industrial, and acre values which fall inside a grid square. We aggregate the different values represented by the polylines based on a simple mean. However, since the different land values are all on a different scale we need to convert the entered raw values first. We multiply each value by the factor indicated in Table 3.1 to obtain US $/square foot as common unit of measurement. Standard lots have a depth of 125 feet whereas the high-priced downtown areas have a depth of 100 feet, so the conversion factor depends on whether a grid is located in a downtown area or not. These high priced areas are explicitly marked in the Olcott books and vary over time (see Table 3.2). We do not need to convert industrial and per square foot land value since they are already reported in our final unit of measurement.

Table 3.1: Factors used for land value conversion.

Year	Abbreviation	standard	downtown
Land values per front foot (polylines)	street	(1/125)	(1/100)
Prominent corners (polylines)	corner	(1/125)	(1/100)
Industry (polygons)	industry	-	-
Acres (polygons)	acres	(1/43,560)	(1/43,560)
Land values per front foot (polygons)	streetFF	(1/125)	(1/100)
Land values per square foot (polygons)	streetSF	-	-

Notes: Designation of downtown areas varies over time.

Table 3.2: Designated downtown areas.

Year	1913	1922	1926	1932	1939	1949	1961	1965	1971	1981	1990
Designated downtown areas	81, 82	71, 72, 81, 82	71, 72, 80, 81, 82, 92	71, 72, 81, 82	72, 81, 82	81 A-M	81 A-M	81 A-M	81 A-M	81 A-M	81 A-M

Notes: We report the labels of the map pieces which are designated as high-priced downtown areas.

Olcott gives street intersections with prominent corners a special weight. We therefore distinguish between situations where prominent corners fall into a grid square and where not. If there are no corner values we compute the simple mean of all polylines and polygons falling in the grid square:

$$\overline{V_n} = \frac{N_{street}}{N_{total}}\overline{lv_{street}} + \frac{N_{industry}}{N_{total}}\overline{lv_{industry}} + \frac{N_{acres}}{N_{total}}\overline{lv_{acres}} + \frac{N_{streetFF}}{N_{total}}\overline{lv_{streetFF}} + \frac{N_{streetSQ}}{N_{total}}\overline{lv_{streetSF}}\,,$$

where N denotes the respective number of features of a polygon or polyline shapefile falling into the grid and $\overline{lv}$ the mean land value assigned to the features of the respective shapefile. Abbreviations for the different shapefiles are reported in Table 3.1.

When dealing with prominent corners we weigh the corner by their length compared to the total length of blocks. Olcott defines the size of a prominent corner as 50 x 125 feet and 100 x 100 feet in the CBD. Assuming an average street width of 80 feet, one prominent corner takes up 175/250 front feet, whereas in the CBD a prominent corner takes up 200/250 front feet. Based on these proportions and on the simplifying assumption that the number of normal (≠ prominent) corners at an intersection is four, the final mean value of a grid square is computed by

$$grid\ value = \frac{175}{250}\frac{N_{corners}}{4}\,\overline{V_x} + \left(1 - \frac{175}{250}\frac{N_{corners}}{4}\right)\overline{V_n}$$

where $N_{corners}$ denotes the number of prominent corners that fall into the square, $\overline{\mathrm{V_x}}$ is the average value of prominent corners and $\overline{\mathrm{V_n}}$ is the mean value for a grid not coming under prominent corner influence as calculated above. Where the grid square covers a CBD section, the fraction (175/250) is replaced by (200/250).

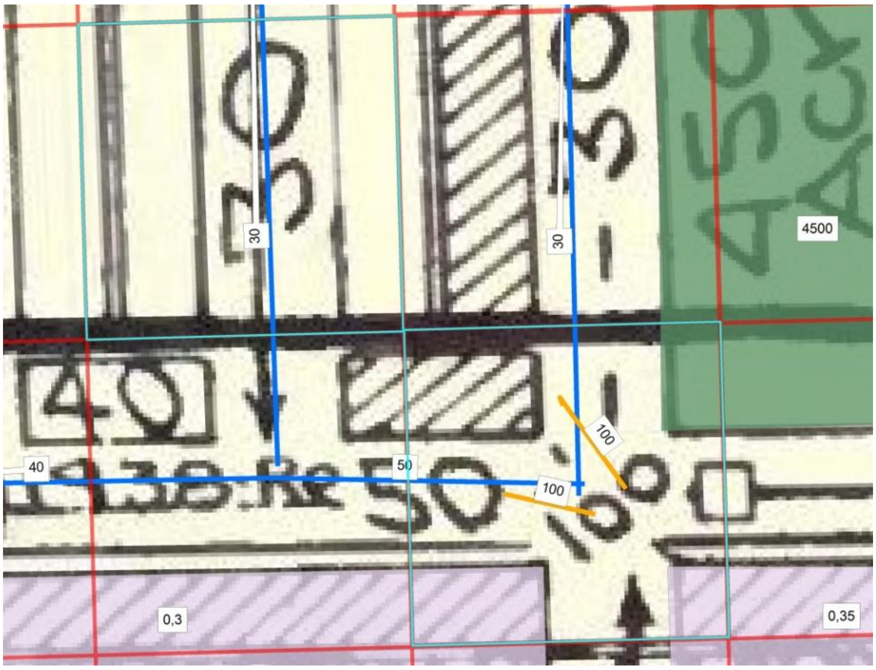


Figure 3.9a: Individual shapes with entered raw values (input).

Figure 3.9b: Aggregated output.

We use the example grids from Figure 3.8 to illustrate the computation of the aggregate grid cell value. The upper grid square from Figure 3.8a and 3.8b takes on the following value:

$$\overline{V_n} = \frac{1}{1}\left(30\ \frac{1}{125}\right) = 0.24$$

$$grid\ value = \frac{175}{250}\frac{0}{4}\,0 + \left(1 - \frac{175}{250}\frac{0}{4}\right)0.24 = 0.24$$

The land value for the second grid square from Figure 3.8c and 3.8d which covers multiple shapefiles is calculated as follows:

$$\overline{V_n} = \frac{2}{5}\left(40\ \frac{1}{125}\right) + \frac{2}{5}(0.325) + \frac{1}{5}\left(4500\ \frac{1}{43560}\right) = 0.2787$$

$$grid\ value = \frac{175}{250}\frac{2}{4}\left(100\ \frac{1}{125}\right) + \left(1 - \frac{175}{250}\frac{2}{4}\right)0.2787 = 0.4611$$

The aggregation results for these two squares are also illustrated in Figure 3.9.

Not all squares of the grid we lay over the map take on a value. For some areas Olcott does not report any land values. This is often the case for parks or water bodies. In earlier years the area Olcott covers is also smaller than our grid. There are a few exceptional situations where neither a polyline nor a polygon falls into a grid square but ends right at the border. Since there is some inevitable fuzziness in the extracted shapefiles we allow for a 100 feet tolerance buffer, i.e., empty grid squares take on the average value of all input files within a distance of 100 feet around the empty square. The buffer size of 100 feet is chosen because it is just large enough to include the shapes which are very close by without creating too much additional noise.

Table 3.4 gives an overview of the extracted raw data and the number of final land value grids for each year. The total number of extracted raw shapes peaks in the middle of our sample between 1932 and 1949. This indicates that for those maps land values were either more heterogeneous in the spatial distribution of land values or the data was reported more accurately. The number of land value grids to which land values were assigned – our final observation unit – fluctuates around 70,000 except for the two initial years 1913 and 1922.

Table 3.4: Summary of the extracted data.

Year	1913	1922	1926	1932	1939	1949
Extracted raw data						
Land values per front foot (polylines)	19,695	16,076	25,042	33,467	29,063	30,727
Prominent corners (polylines)	1,875	1,477	1,721	2,361	2,332	2,436
Industry (polygons)	850	1,037	1,705	1,553	1,630	1,442
Acres (polygons)	1,078	194	914	900	1,145	883
Land values per front foot (polygons)	-	-	-	-	-	-
Land values per square foot (polygons)	-	-	-	-	-	-
Total raw data (shapes)	23,498	18,784	29,382	38,281	34,170	35,488
Number of land value grids	49,890	28,286	67,575	69,772	71,381	72,284

Table 3.4 continued: Summary of the extracted data.

Year	1961	1965	1971	1981	1990
Extracted raw data					
Land values per front foot (polylines)	25,012	20,965	18,579	19,738	10,816
Prominent corners (polylines)	1,414	513	999	390	581
Industry (polygons)	2,137	1,675	1,113	1,114	942
Acres (polygons)	228	131	59	33	12
Land values per front foot (polygons)	-	-	-	226	1,036
Land values per square foot (polygons)	-	-	119	491	481
Total raw data (shapes)	28,791	23,284	20,869	21,992	13,868
Number of land value grids	70,366	71,203	72,301	71,605	71,472

Notes: The 1922 sample is smaller due to incomplete copies of that year.

3.4. Results

Figures 3.10a and 3.10b illustrate the final output of the data extraction process for the two example map pieces 50 and 71. The color scheme ranges from green to red whereas red stands for high values. Figure 3.11 sums up the extraction process in four steps using Olcott (1939) as an example: (i) georeferencing the map, (ii) drawing shapes, (iii) entering values, (iv) aggregating.

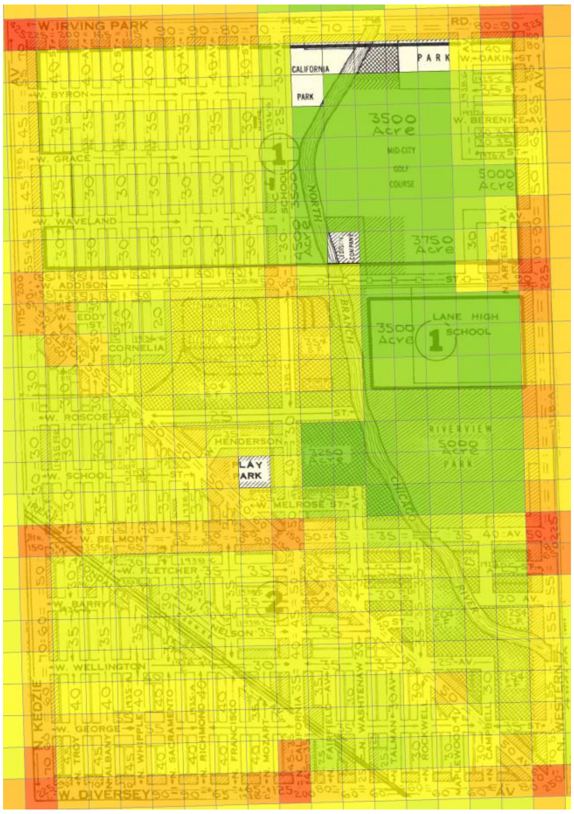


Figure 3.10a: Final land values (piece 50).

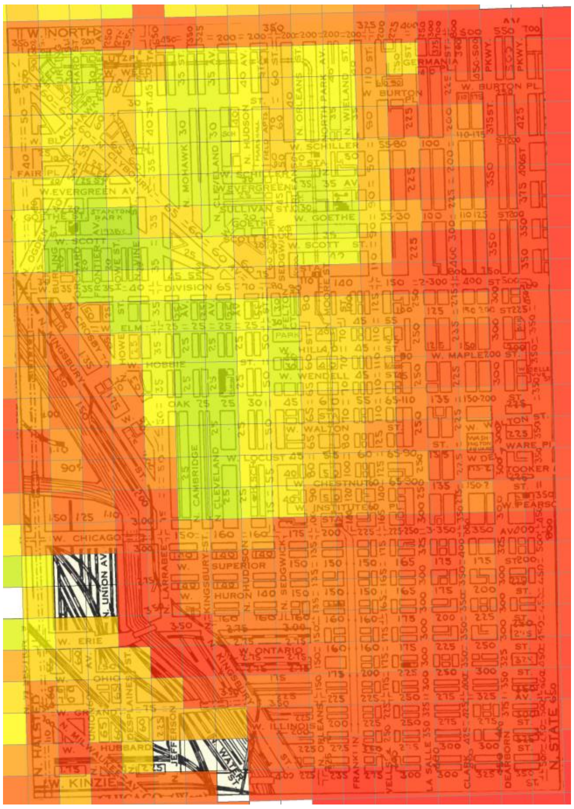
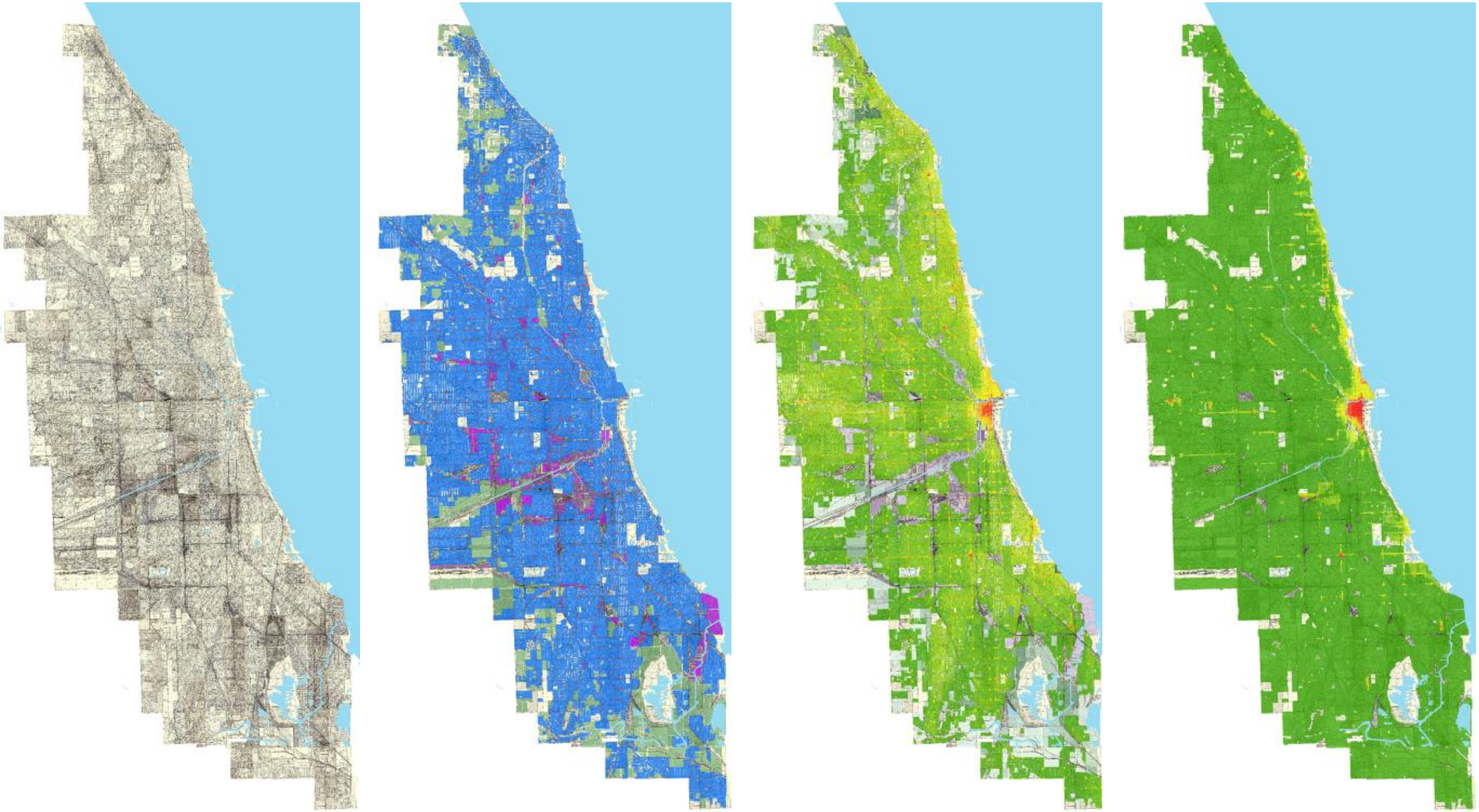


Figure 3.10b: Final land values (piece 71).



(i) georeferencing Olcott map pieces

(ii) drawing shapefiles

Street polylines (blue), corner polylines (red), industry polygons (pink), acre polygons (green)

(iii) entering values

Streets and corners (green to red), acres (light to dark green), industry (light to dark purple)

(iv) aggregating land values to grid cells
Green to red

Figure 3.11: Summary of extraction process (Olcott 1939).