



Scattered trees throughout a neighborhood increase surface roughness, thereby reducing windspeeds by as much as 50 percent (Heisler 1990). Trees and shrubs located slightly upwind of buildings provide additional protection that reduces the amount of cold outside air that infiltrates. Lower windspeed results in reduced infiltration of outside air. Reduced infiltration is beneficial during both the heating and cooling seasons. However, lower windspeed is detrimental during the cooling

tions). Micropas multiplies the hourly shading coefficients by direct and diffuse radiation values to reduce solar-heat gains on opaque and glazing surfaces.

Energy savings are calculated as the difference between the unshaded base case and results from each of the shading, ET cooling, and windspeed-reduction scenarios. Standardized results in Appendices C and D include the following



5. Two-story wood frame. One household, three occupants,  
1,761 ft<sup>2</sup> (164 m<sup>2</sup>) of floor area, constructed during 1990's

to the base load method is that the use of degree-days may  
not fully normalize energy use for different weather condi

Table 2.—Number of heating and cooling degree-days for Chicago

| Period                  | Heating degree-days | Cooling degree-days |
|-------------------------|---------------------|---------------------|
| April 1991 - March 1992 | 5,928               | 1,154               |
| April 1993 - March 1993 | 6,746               | 457                 |

Table 3.—Tree dimensions for shading scenarios in feet

| Details      | Canopy Diameter | Trunk Diameter | Clearance | Branch Height | Leaf Area |
|--------------|-----------------|----------------|-----------|---------------|-----------|
| Scenario 1   | 10              | 6              | 8         | 12            | 100       |
| Scenario 2   | 12              | 8              | 10        | 15            | 150       |
| Scenario 3   | 14              | 10             | 12        | 18            | 200       |
| Scenario 4   | 16              | 12             | 14        | 22            | 250       |
| Scenario 5   | 18              | 14             | 16        | 26            | 300       |
| Scenario 6   | 20              | 16             | 18        | 30            | 350       |
| Scenario 7   | 22              | 18             | 20        | 34            | 400       |
| Scenario 8   | 24              | 20             | 22        | 38            | 450       |
| Scenario 9   | 26              | 22             | 24        | 42            | 500       |
| Scenario 10  | 28              | 24             | 26        | 46            | 550       |
| Scenario 11  | 30              | 26             | 28        | 50            | 600       |
| Scenario 12  | 32              | 28             | 30        | 54            | 650       |
| Scenario 13  | 34              | 30             | 32        | 58            | 700       |
| Scenario 14  | 36              | 32             | 34        | 62            | 750       |
| Scenario 15  | 38              | 34             | 36        | 66            | 800       |
| Scenario 16  | 40              | 36             | 38        | 70            | 850       |
| Scenario 17  | 42              | 38             | 40        | 74            | 900       |
| Scenario 18  | 44              | 40             | 42        | 78            | 950       |
| Scenario 19  | 46              | 42             | 44        | 82            | 1000      |
| Scenario 20  | 48              | 44             | 46        | 86            | 1050      |
| Scenario 21  | 50              | 46             | 48        | 90            | 1100      |
| Scenario 22  | 52              | 48             | 50        | 94            | 1150      |
| Scenario 23  | 54              | 50             | 52        | 98            | 1200      |
| Scenario 24  | 56              | 52             | 54        | 102           | 1250      |
| Scenario 25  | 58              | 54             | 56        | 106           | 1300      |
| Scenario 26  | 60              | 56             | 58        | 110           | 1350      |
| Scenario 27  | 62              | 58             | 60        | 114           | 1400      |
| Scenario 28  | 64              | 60             | 62        | 118           | 1450      |
| Scenario 29  | 66              | 62             | 64        | 122           | 1500      |
| Scenario 30  | 68              | 64             | 66        | 126           | 1550      |
| Scenario 31  | 70              | 66             | 68        | 130           | 1600      |
| Scenario 32  | 72              | 68             | 70        | 134           | 1650      |
| Scenario 33  | 74              | 70             | 72        | 138           | 1700      |
| Scenario 34  | 76              | 72             | 74        | 142           | 1750      |
| Scenario 35  | 78              | 74             | 76        | 146           | 1800      |
| Scenario 36  | 80              | 76             | 78        | 150           | 1850      |
| Scenario 37  | 82              | 78             | 80        | 154           | 1900      |
| Scenario 38  | 84              | 80             | 82        | 158           | 1950      |
| Scenario 39  | 86              | 82             | 84        | 162           | 2000      |
| Scenario 40  | 88              | 84             | 86        | 166           | 2050      |
| Scenario 41  | 90              | 86             | 88        | 170           | 2100      |
| Scenario 42  | 92              | 88             | 90        | 174           | 2150      |
| Scenario 43  | 94              | 90             | 92        | 178           | 2200      |
| Scenario 44  | 96              | 92             | 94        | 182           | 2250      |
| Scenario 45  | 98              | 94             | 96        | 186           | 2300      |
| Scenario 46  | 100             | 96             | 98        | 190           | 2350      |
| Scenario 47  | 102             | 98             | 100       | 194           | 2400      |
| Scenario 48  | 104             | 100            | 102       | 198           | 2450      |
| Scenario 49  | 106             | 102            | 104       | 202           | 2500      |
| Scenario 50  | 108             | 104            | 106       | 206           | 2550      |
| Scenario 51  | 110             | 106            | 108       | 210           | 2600      |
| Scenario 52  | 112             | 108            | 110       | 214           | 2650      |
| Scenario 53  | 114             | 110            | 112       | 218           | 2700      |
| Scenario 54  | 116             | 112            | 114       | 222           | 2750      |
| Scenario 55  | 118             | 114            | 116       | 226           | 2800      |
| Scenario 56  | 120             | 116            | 118       | 230           | 2850      |
| Scenario 57  | 122             | 118            | 120       | 234           | 2900      |
| Scenario 58  | 124             | 120            | 122       | 238           | 2950      |
| Scenario 59  | 126             | 122            | 124       | 242           | 3000      |
| Scenario 60  | 128             | 124            | 126       | 246           | 3050      |
| Scenario 61  | 130             | 126            | 128       | 250           | 3100      |
| Scenario 62  | 132             | 128            | 130       | 254           | 3150      |
| Scenario 63  | 134             | 130            | 132       | 258           | 3200      |
| Scenario 64  | 136             | 132            | 134       | 262           | 3250      |
| Scenario 65  | 138             | 134            | 136       | 266           | 3300      |
| Scenario 66  | 140             | 136            | 138       | 270           | 3350      |
| Scenario 67  | 142             | 138            | 140       | 274           | 3400      |
| Scenario 68  | 144             | 140            | 142       | 278           | 3450      |
| Scenario 69  | 146             | 142            | 144       | 282           | 3500      |
| Scenario 70  | 148             | 144            | 146       | 286           | 3550      |
| Scenario 71  | 150             | 146            | 148       | 290           | 3600      |
| Scenario 72  | 152             | 148            | 150       | 294           | 3650      |
| Scenario 73  | 154             | 150            | 152       | 298           | 3700      |
| Scenario 74  | 156             | 152            | 154       | 302           | 3750      |
| Scenario 75  | 158             | 154            | 156       | 306           | 3800      |
| Scenario 76  | 160             | 156            | 158       | 310           | 3850      |
| Scenario 77  | 162             | 158            | 160       | 314           | 3900      |
| Scenario 78  | 164             | 160            | 162       | 318           | 3950      |
| Scenario 79  | 166             | 162            | 164       | 322           | 4000      |
| Scenario 80  | 168             | 164            | 166       | 326           | 4050      |
| Scenario 81  | 170             | 166            | 168       | 330           | 4100      |
| Scenario 82  | 172             | 168            | 170       | 334           | 4150      |
| Scenario 83  | 174             | 170            | 172       | 338           | 4200      |
| Scenario 84  | 176             | 172            | 174       | 342           | 4250      |
| Scenario 85  | 178             | 174            | 176       | 346           | 4300      |
| Scenario 86  | 180             | 176            | 178       | 350           | 4350      |
| Scenario 87  | 182             | 178            | 180       | 354           | 4400      |
| Scenario 88  | 184             | 180            | 182       | 358           | 4450      |
| Scenario 89  | 186             | 182            | 184       | 362           | 4500      |
| Scenario 90  | 188             | 184            | 186       | 366           | 4550      |
| Scenario 91  | 190             | 186            | 188       | 370           | 4600      |
| Scenario 92  | 192             | 188            | 190       | 374           | 4650      |
| Scenario 93  | 194             | 190            | 192       | 378           | 4700      |
| Scenario 94  | 196             | 192            | 194       | 382           | 4750      |
| Scenario 95  | 198             | 194            | 196       | 386           | 4800      |
| Scenario 96  | 200             | 196            | 198       | 390           | 4850      |
| Scenario 97  | 202             | 198            | 200       | 394           | 4900      |
| Scenario 98  | 204             | 200            | 202       | 398           | 4950      |
| Scenario 99  | 206             | 202            | 204       | 402           | 5000      |
| Scenario 100 | 208             | 204            | 206       | 406           | 5050      |

the role of any single tree. Yet, they are important because 1.0°C) decrease in temperature for every increase of 10- percent in vegetation cover. On the basis of these data





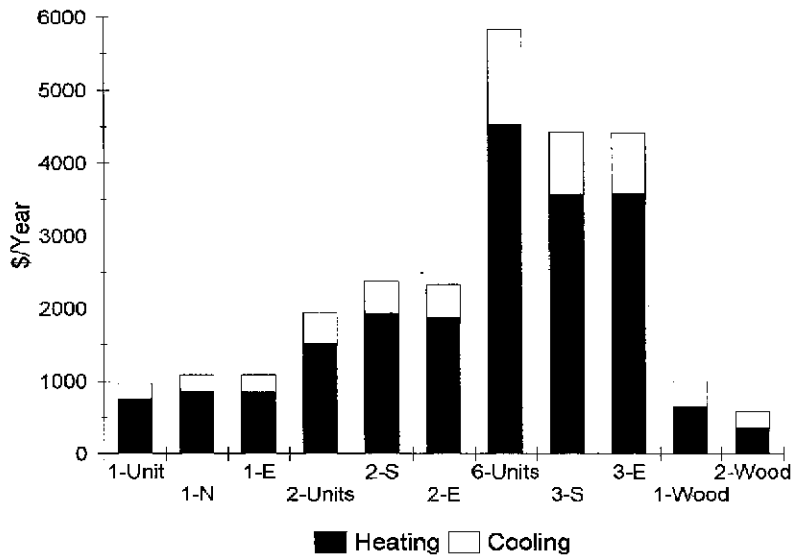
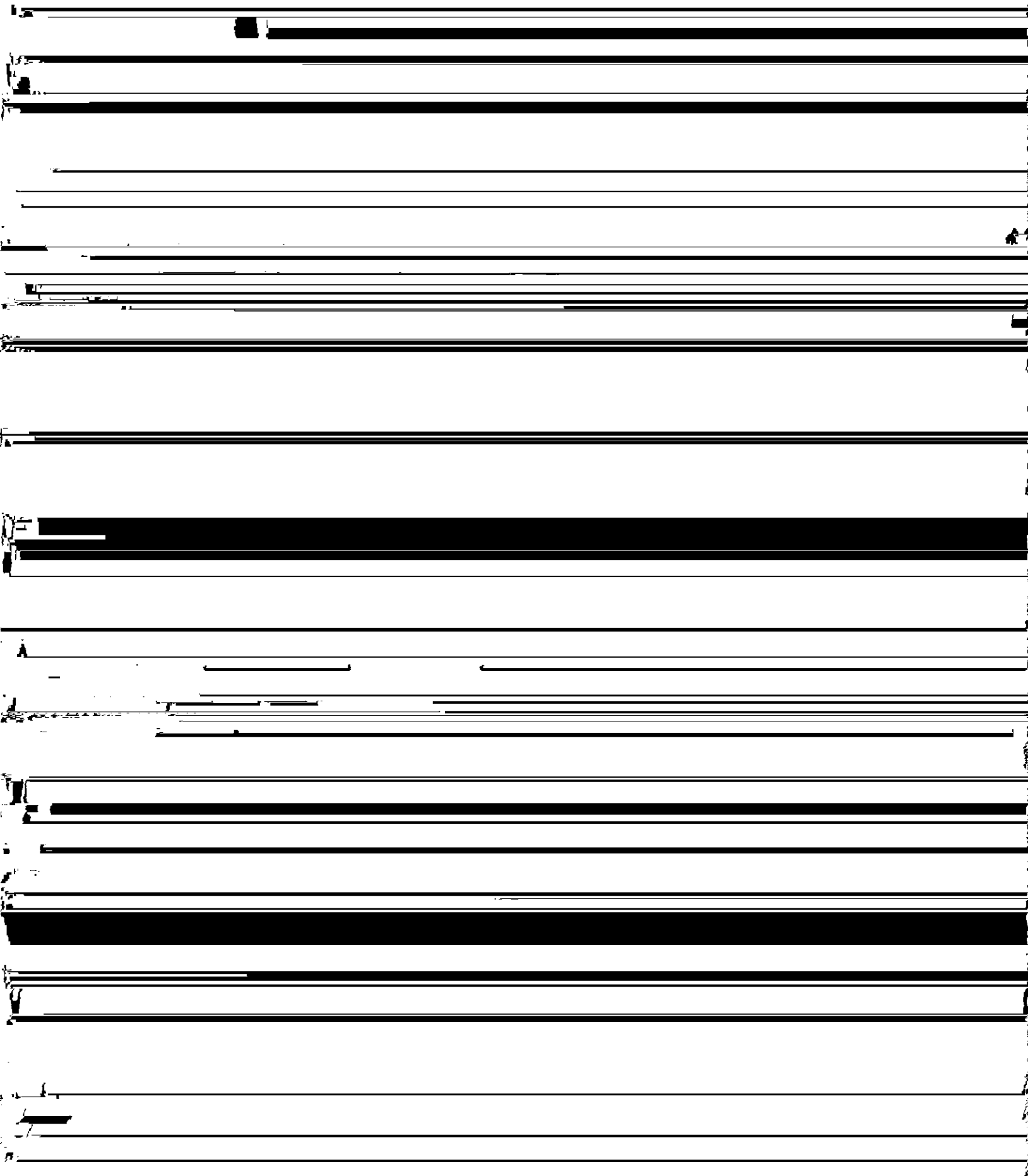
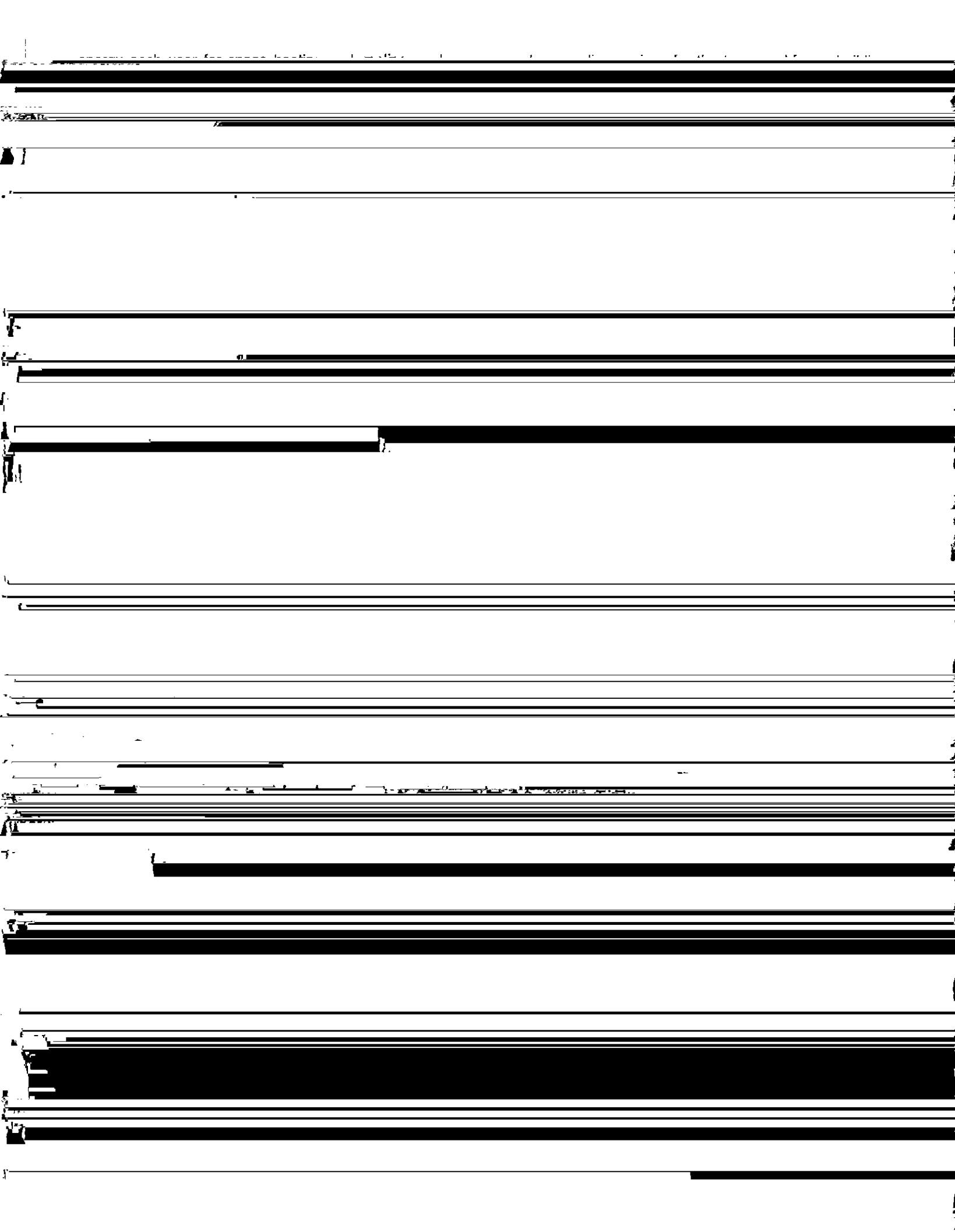


Figure 3.—Simulated annual heating and cooling costs are shown for each base case building, where the number corresponds to the number of stories and the letter corresponds to the brick building's front orientation (e.g., 1-N is one-story brick building facing north, 1-Wood is the one-story wood-frame base case). For comparison, average costs per Chicago household have been extrapolated for buildings with one, two,

located 22 feet from the building produces about one-third the savings as the 50-foot tree at the same location. Savings from the 24-foot tree (small) located 12 feet away from the west wall are about half the savings produced by the 36-foot tree at 22 feet. The 24-foot tree opposite the east wall produces no net savings because cooling savings are offset

4a  
30  
20





7a



the brick buildings resulted from a large tree (50 feet and 36 feet wide) located 22 feet from the west wall, while a 25-foot tree located 12 feet from the west wall produced maximum savings for the wood-frame buildings.

Annual savings in air conditioning energy usage from 100 to

Table 5.—Per-tree maximum annual savings in air-conditioning (AC) from tree shade<sup>a</sup>

| Base case buildings        | Base case AC |     |         | AC saved |      |       | Peak AC saved |      |
|----------------------------|--------------|-----|---------|----------|------|-------|---------------|------|
|                            | kWh          | \$  | Peak kW | kWh      | %    | \$    | kW            | %    |
| 1-story brick north facing | 1,795        | 215 | 4.2     | 187      | 10.4 | 22.85 | 0.3           | 6.2  |
| 1-story brick east facing  | 1,928        | 231 | 4.5     | 149      | 7.7  | 18.21 | 0.5           | 10.5 |
| 2-story brick south facing | 3,682        | 442 | 10.6    | 399      | 10.8 | 48.76 | 1.3           | 12.3 |
| 2-story brick east facing  | 3,725        | 447 | 10.1    | 297      | 8.0  | 36.29 | 1.0           | 9.7  |
| 3-story brick south facing | 7,199        | 864 | 16.7    | 345      | 4.8  | 42.16 | 1.0           | 5.8  |

Ba  
60  
50

The relative magnitudes of cooling savings from shade and ET cooling vary with building type and orientation. Annual savings from shade range from \$4 (37 kWh, 2 percent) per tree for the one-story brick building facing north to \$22 (186 kWh, 6.3 percent) per tree for the one-story wood-frame

high rates of air infiltration, and inefficient heating equipment

responsiveness to tree shade and dry-bulb temperature de-

21

22

23

24

25

26

27

28

29

30

years 1 to 20 (Appendix E). It is assumed that one typical tree is planted for energy savings near each typical building in

Robinette 1977; Sand 1991; Sand 1993a; Sand 1993b). In this section, general guidelines for energy-efficient residen-



Deciduous vines and shrubs can provide both summer shade and winter solar access.

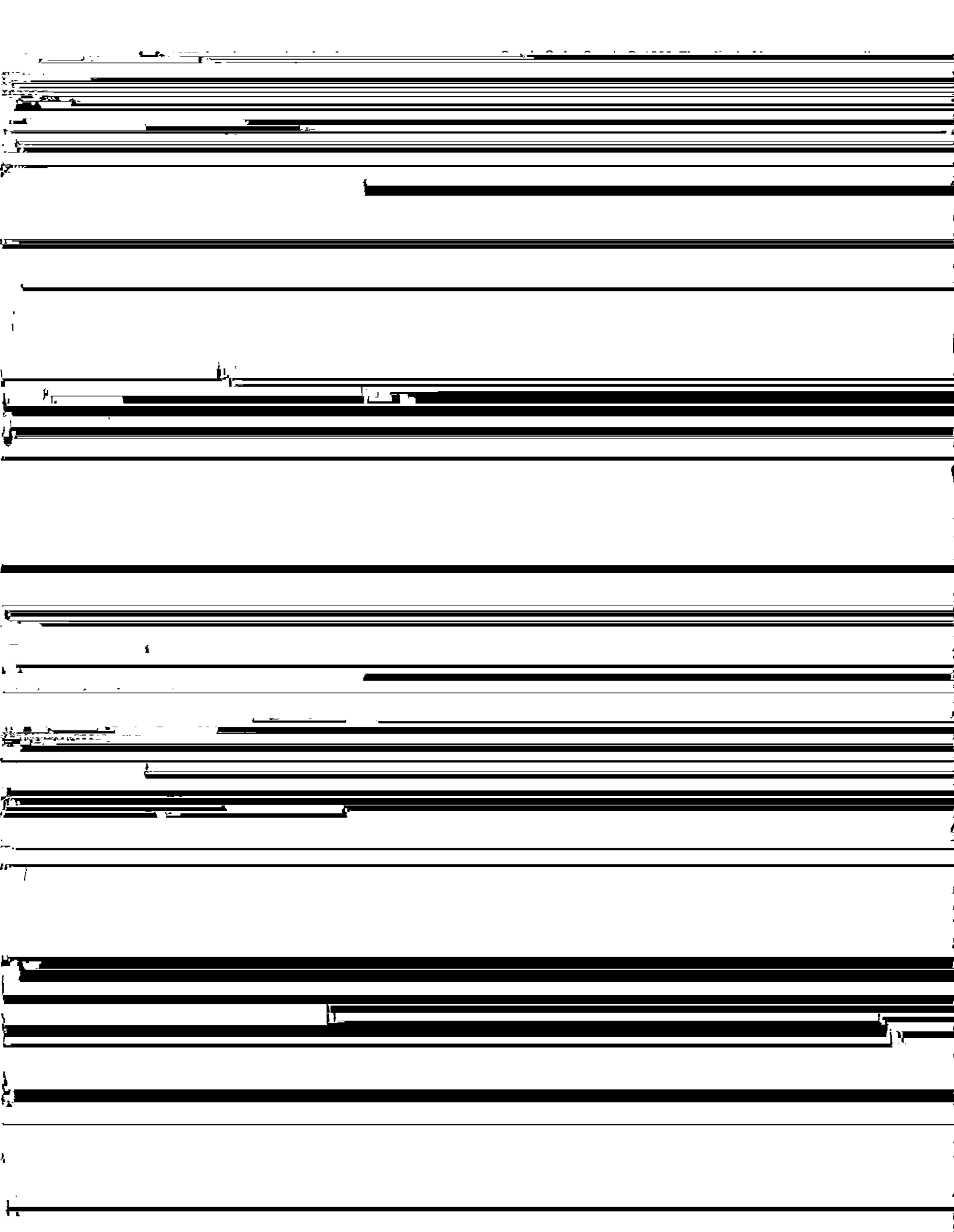
South shade can reduce summer peak cooling demand more than east shade, especially for taller residential and com

costs. Shade from large street trees to the south increase heating costs more than they decrease cooling costs for the buildings studied. Planting solar friendly trees to the south and east can minimize the energy penalty associated with blocking irradiance during the heating season.

## Acknowledgments

This study would not have been possible without information

Heisler, G. M. 1991. Computer simulation for optimizing wind-break placement to save energy for heating and cooling buildings. In: Trees and sustainable development. M. ...





**Chapter 8**

**Benefits and Costs of Tree Planting and Care in Chicago**

E. Gregory McPherson, Research Forester, USDA Forest Service, Northeastern Forest Experiment Station, Davis, CA

\_\_\_\_\_ damage property. Thorns and low-hanging branches can be  
injurious. ~~Thorns and low-hanging branches are magnified when trees do not~~

172

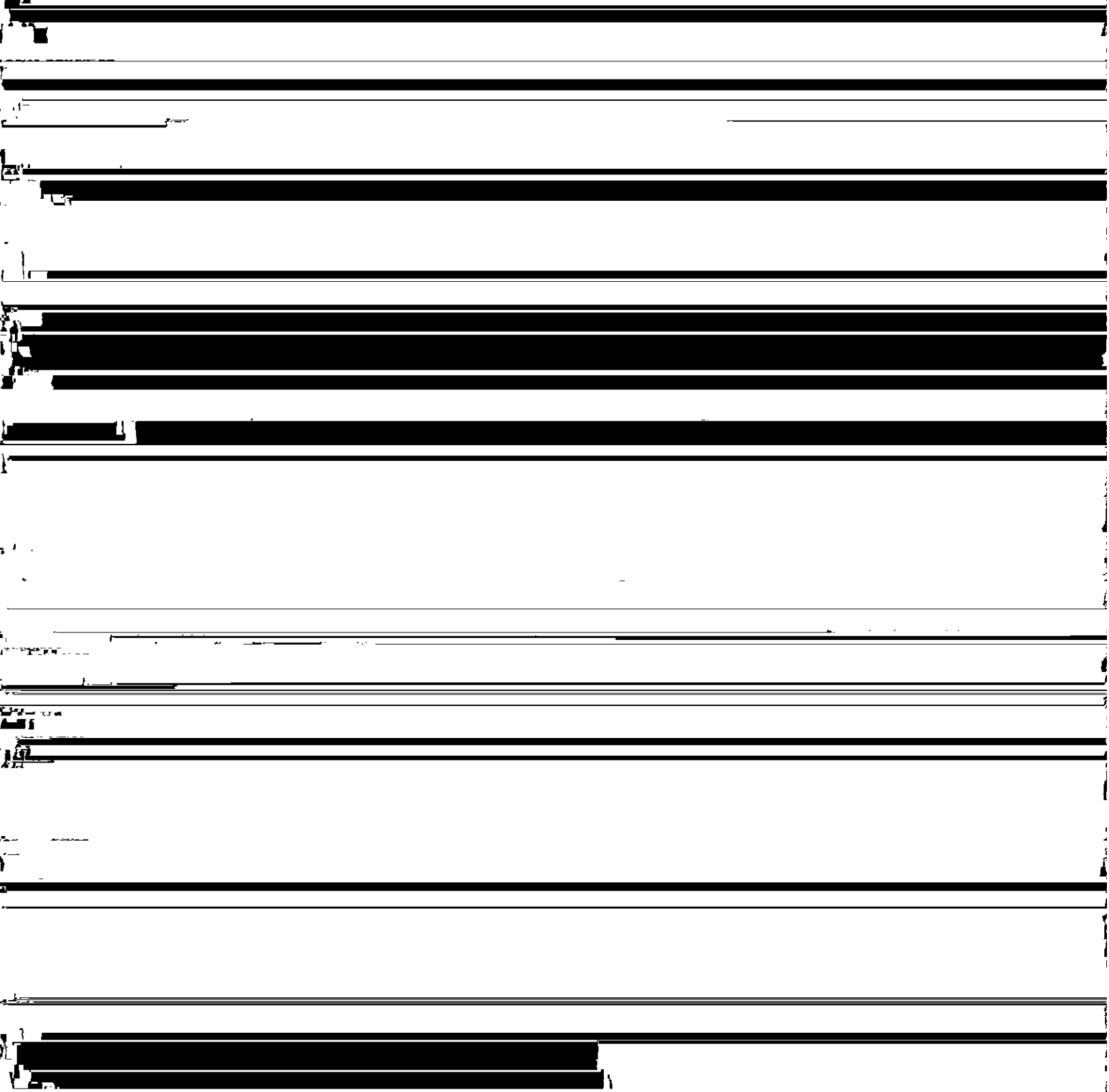
produce, and costs associated with infrastructure repair,

assigned to each cost (e.g., planting, pruning, removal,

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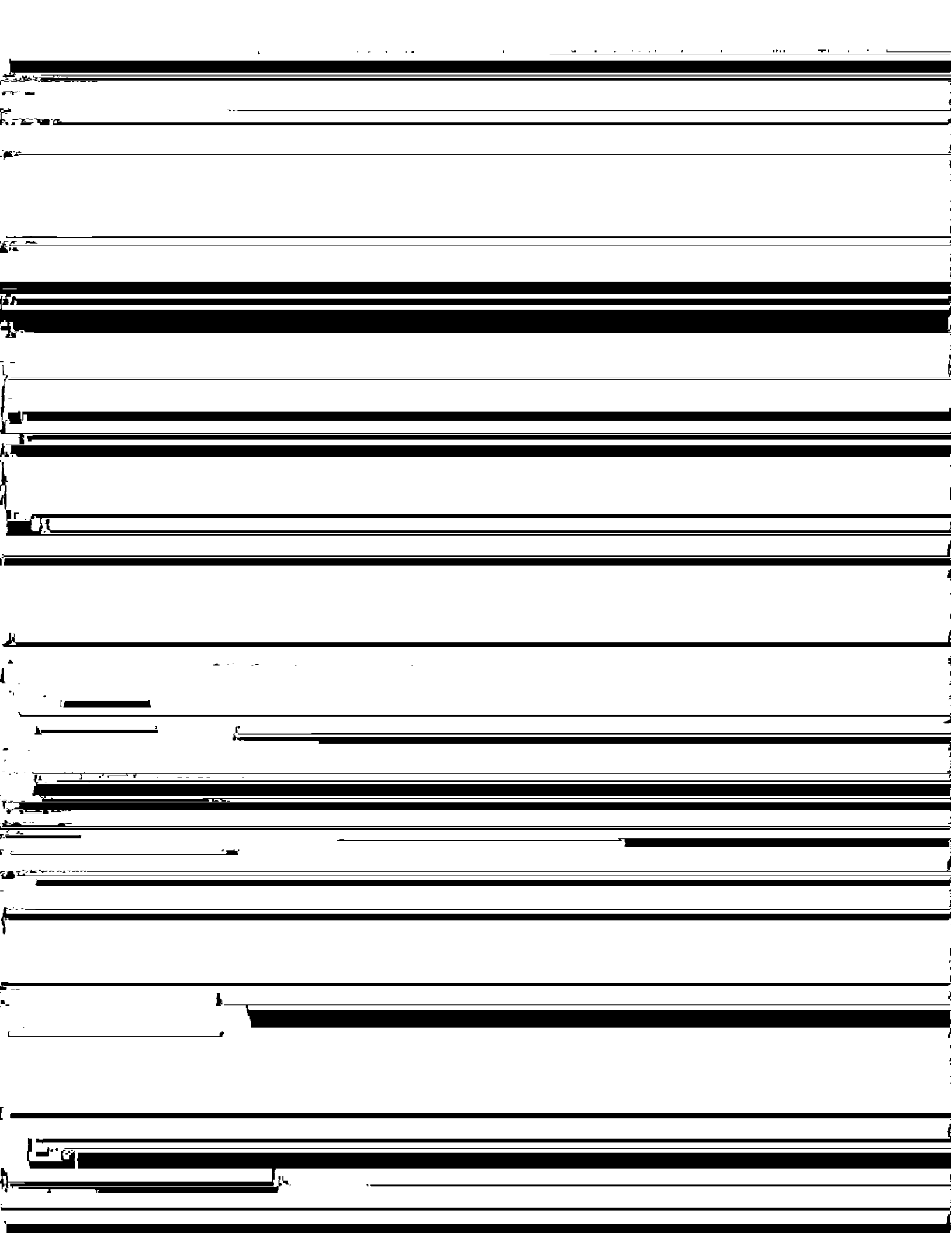
different functions (e.g., linear, sine, cosine). For parameters such as sidewalk repair, costs are small for young trees but increase relatively rapidly as tree roots grow large enough to

presented by McPherson (1994: Chapter 7, this report) are used in this study to directly estimate energy savings due to shading, temperature modification, and wind speed reductions from trees. Other benefits are estimated using implied









windspeed. During winter, trees can conserve energy use for heating by lowering windspeeds and associated infiltration of cold outside air. However, even bare branches of deciduous

10  $\mu\text{m}$  (PM10), ozone ( $\text{O}_3$ ), nitrogen dioxide ( $\text{NO}_2$ ), sulfur dioxide ( $\text{SO}_2$ ), and carbon monoxide (CO) are derived from the limited literature on this subject (Devides and Mc 1999)

Table 4.—Assumptions for estimating implied value of air quality Improvement

| Item                         | PM10  | O <sub>3</sub> | NO <sub>2</sub> | SO <sub>2</sub> | CO     |
|------------------------------|-------|----------------|-----------------|-----------------|--------|
| Deposition velocity (cm/sec) | 0.60  | 0.45           | 0.40            | 0.66            | 0.0006 |
| Control costs (dollars/ton)  | 1,307 | 490            | 4,412           | 1,634           | 920    |
| Emission factors (lb/MWh)    | 0.14  | 0.03           | 2.10            | 6.81            | 0.63   |

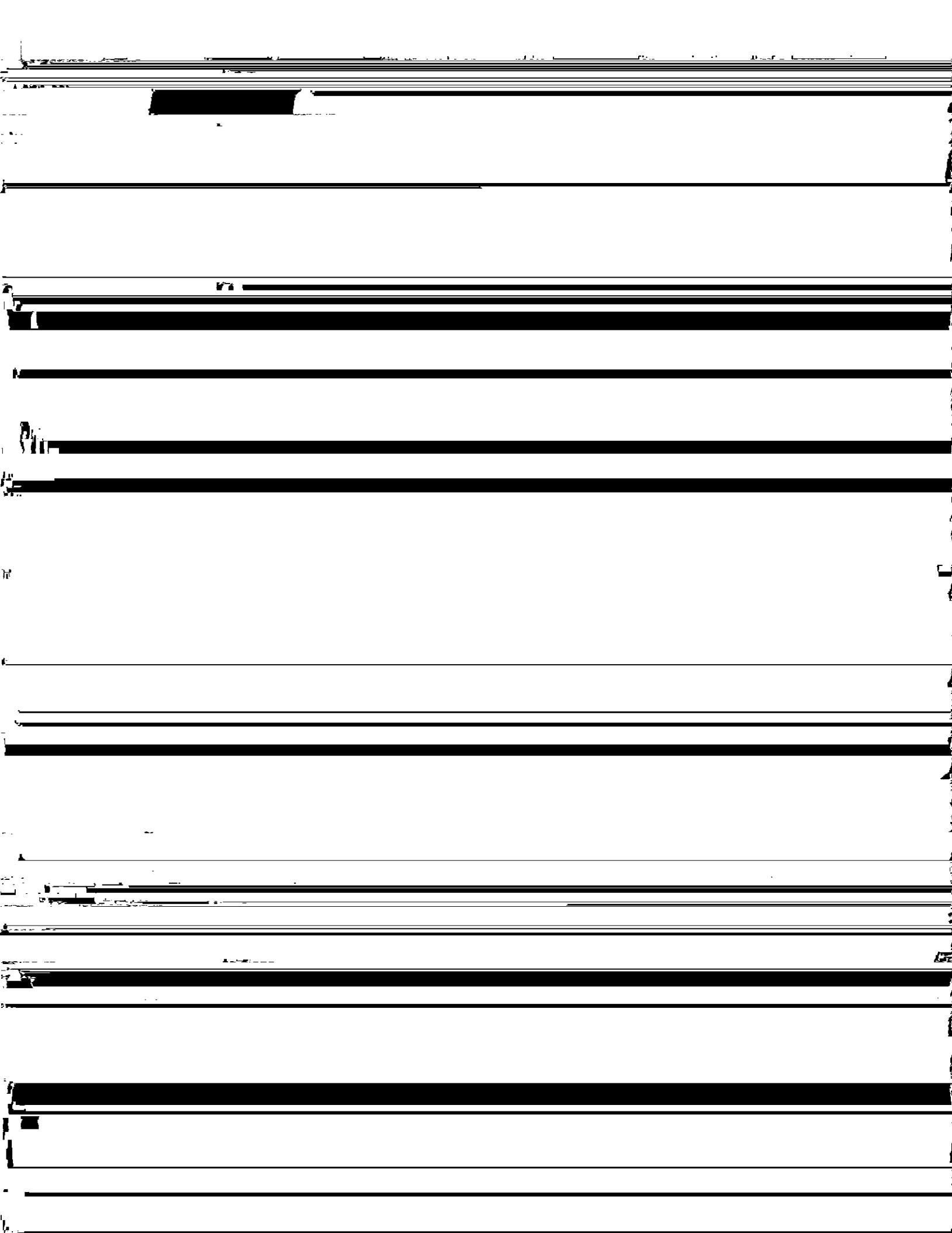
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## Results and Discussion

### Growth, Mortality, and Leaf Area

Growth curves for the typical trees are shown in Figure 2. The green ash in park, yard, and public housing sites display similar growth rates. Growth rates for trees along highways and residential streets are slower because less favorable growing conditions are assumed.

and 36 percent of new tree cover. Together, park and street-tree plantings contribute 56 percent of total future tree cover; trees planted along highways and on public housing sites account for the remaining 6 percent.

To place the magnitude of future tree cover in perspective it was compared to the amounts of current tree cover and total land area of Chicago. Based on our analysis of aerial photographs, trees and shrubs cover about 18,608 acres (7,530 ha) and 1 percent of total land area in Chicago (35.7%)

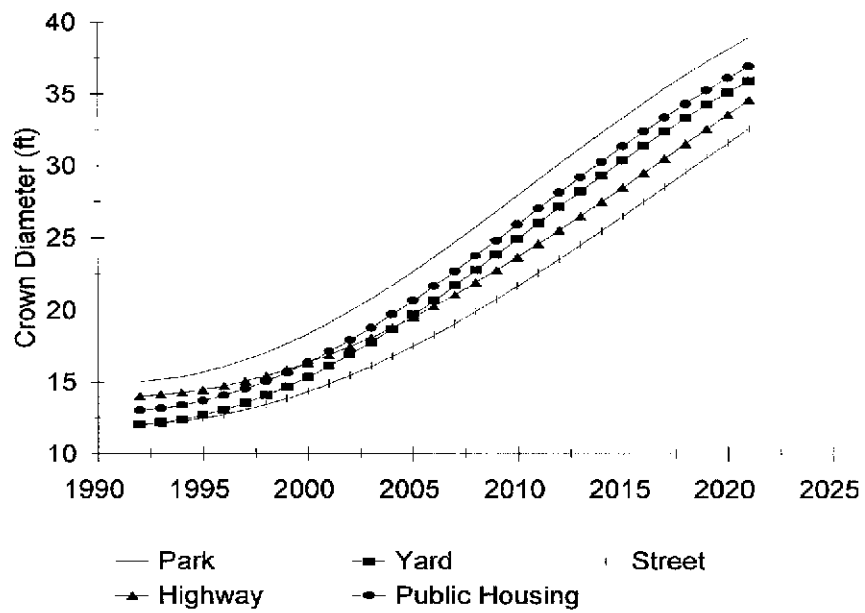


Figure 2. Growth curves modeled for the typical green ash tree at each

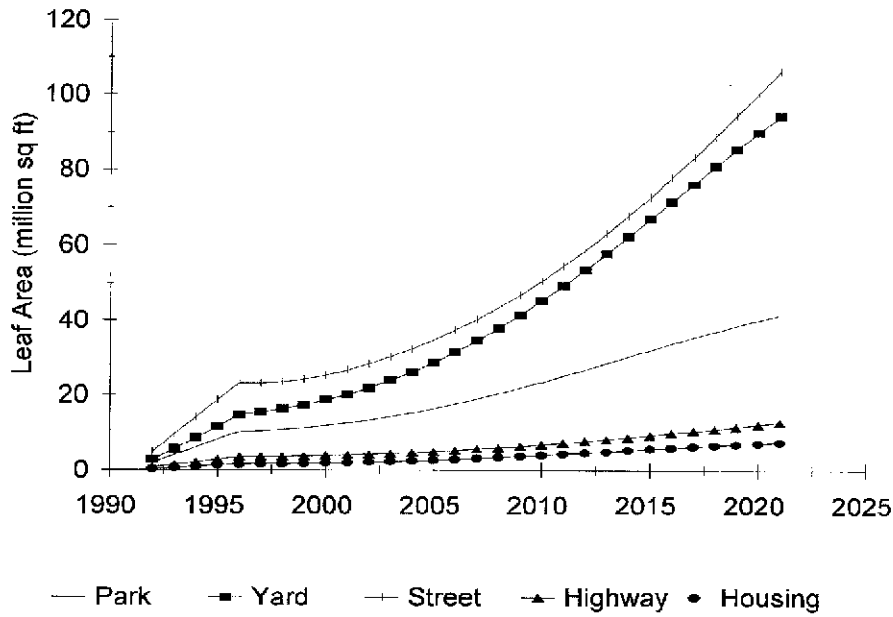


Figure 4. —Projected leaf-surface area for trees at each planting location.

discount rates, ranging from \$638,153 at public housing sites with a 10 percent discount rate to \$30.6 million for street trees with a 4 percent discount rate. At a 7 percent discount rate, the NPV of the entire planting (95,000 trees) is projected to be \$38 million or about \$402 per planted tree (Table 5). This means that on average the present value of the yield on

this 30 year analysis. Given this result, a 7 percent discount rate is assumed for findings that follow.

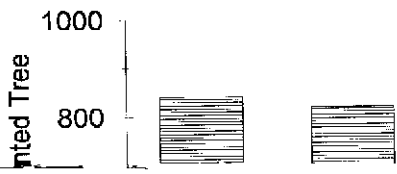
The estimated present value of total benefits and costs is \$59 and \$21 million, respectively (Tables 6 -7). Expenditures for planting alone are expected to account for approximately 20



Table 6 Projected present value of benefits for tree plantings in Chicago (30 year analysis, 7-percent discount rate). In

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slightly longer at the 10 percent discount rate (11 to 18 years), and shorter at most locations with a 4-percent discount rate (9 to 13 years).

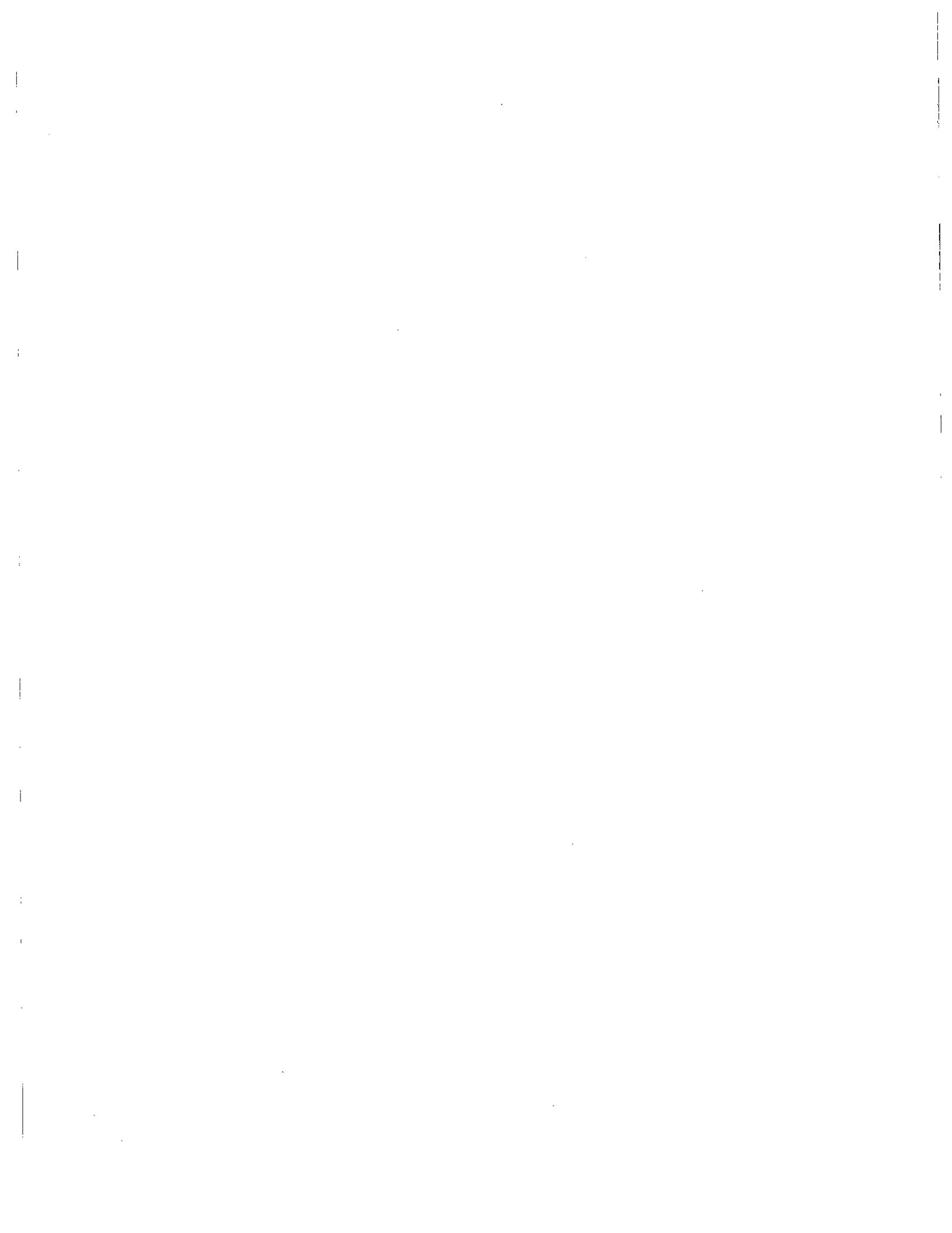
Early payback at public housing sites can be attributed to several factors. Trees are projected to add leaf area at a relatively rapid rate due to low initial mortality and fast growth compared to trees at other locations. These trees are rela-

maximize net benefits from investment in Chicago's urban forest. These concepts are not new and many currently are being applied in Chicago. Most of the following recommendations also have application in communities outside Chicago as well.

1. Select the right tree for each location. Given that planting and establishment costs represent a large fraction of total









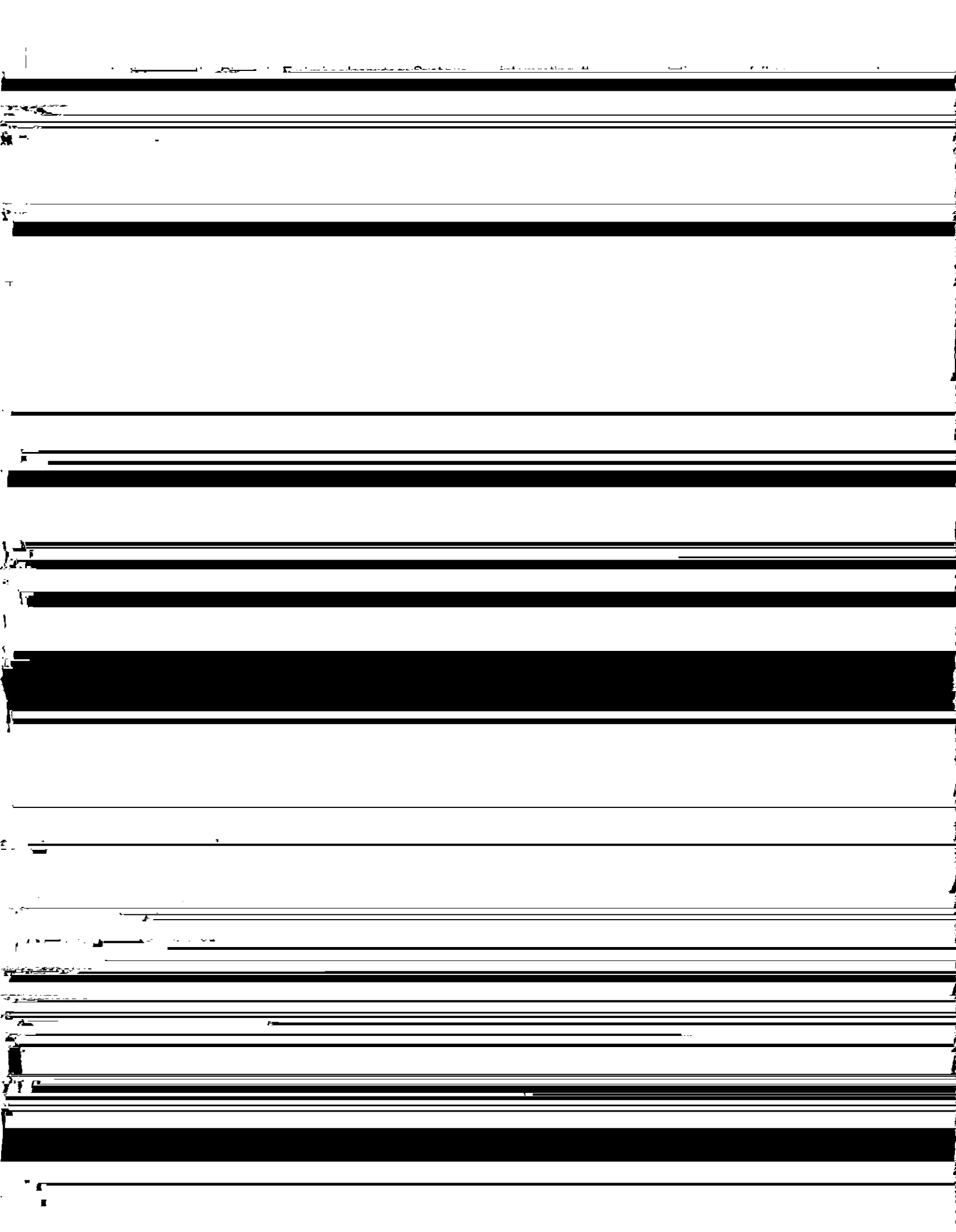
## Chapter 9

### 9.1. *Chapter 9: The Role of the Teacher*

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the greatest need for increased tree cover. Finally, business opportunities for local entrepreneurs might be increased in a more serene and attractive retail environment associated with a healthy urban forest.

produced by yard trees in Chicago can be 3 1/2 times their cost. Trees provide benefits other than energy savings that should interest utilities, such as removal of air pollutants and atmospheric carbon dioxide. (Chapter 5, p. 12)





# Appendix A

## Supplemental Tables for Chapter 2

TABLE 4. Average characteristics of fish in each year

| Year | Length (mm) | Weight (g) | Sex    | Age | Condition |
|------|-------------|------------|--------|-----|-----------|
| 1980 | 120         | 150        | Male   | 1   | Good      |
| 1981 | 115         | 140        | Female | 1   | Fair      |
| 1982 | 130         | 180        | Male   | 2   | Good      |
| 1983 | 125         | 160        | Female | 1   | Fair      |
| 1984 | 140         | 200        | Male   | 2   | Good      |
| 1985 | 135         | 170        | Female | 1   | Fair      |
| 1986 | 150         | 220        | Male   | 3   | Good      |
| 1987 | 145         | 190        | Female | 2   | Fair      |
| 1988 | 160         | 250        | Male   | 3   | Good      |
| 1989 | 155         | 210        | Female | 2   | Fair      |
| 1990 | 170         | 280        | Male   | 4   | Good      |
| 1991 | 165         | 240        | Female | 3   | Fair      |
| 1992 | 180         | 300        | Male   | 4   | Good      |
| 1993 | 175         | 260        | Female | 3   | Fair      |
| 1994 | 190         | 350        | Male   | 5   | Good      |
| 1995 | 185         | 310        | Female | 4   | Fair      |
| 1996 | 200         | 400        | Male   | 5   | Good      |
| 1997 | 195         | 360        | Female | 4   | Fair      |
| 1998 | 210         | 450        | Male   | 6   | Good      |
| 1999 | 205         | 410        | Female | 5   | Fair      |
| 2000 | 220         | 500        | Male   | 6   | Good      |
| 2001 | 215         | 460        | Female | 5   | Fair      |
| 2002 | 230         | 550        | Male   | 7   | Good      |
| 2003 | 225         | 510        | Female | 6   | Fair      |
| 2004 | 240         | 600        | Male   | 7   | Good      |
| 2005 | 235         | 560        | Female | 6   | Fair      |
| 2006 | 250         | 650        | Male   | 8   | Good      |
| 2007 | 245         | 610        | Female | 7   | Fair      |
| 2008 | 260         | 700        | Male   | 8   | Good      |
| 2009 | 255         | 660        | Female | 7   | Fair      |
| 2010 | 270         | 750        | Male   | 9   | Good      |
| 2011 | 265         | 710        | Female | 8   | Fair      |
| 2012 | 280         | 800        | Male   | 9   | Good      |
| 2013 | 275         | 760        | Female | 8   | Fair      |
| 2014 | 290         | 850        | Male   | 10  | Good      |
| 2015 | 285         | 810        | Female | 9   | Fair      |
| 2016 | 300         | 900        | Male   | 10  | Good      |
| 2017 | 295         | 860        | Female | 9   | Fair      |
| 2018 | 310         | 950        | Male   | 11  | Good      |
| 2019 | 305         | 910        | Female | 10  | Fair      |
| 2020 | 320         | 1000       | Male   | 11  | Good      |
| 2021 | 315         | 960        | Female | 10  | Fair      |
| 2022 | 330         | 1050       | Male   | 12  | Good      |
| 2023 | 325         | 1010       | Female | 11  | Fair      |
| 2024 | 340         | 1100       | Male   | 12  | Good      |
| 2025 | 335         | 1060       | Female | 11  | Fair      |

Table 2. —Scientific names of tree species or genera

| Common name | Scientific name | Common name | Scientific name |
|-------------|-----------------|-------------|-----------------|
|-------------|-----------------|-------------|-----------------|







Table 4. —Tree composition in suburban Cook County based on number and percentage of trees, and species dominance based on percentage of total leaf-surface area

| Species            | Tree population |           |         |      | Species dominance |      |
|--------------------|-----------------|-----------|---------|------|-------------------|------|
|                    | Number          | SE        | Percent | Rank | Percent           | Rank |
| Buckthorn          | 4,601,600       | 1,430,800 | 14.5    | 1    | 2.9               | 12   |
| Green/white ash    | 3,181,900       | 745,300   | 10.0    | 2    | 9.6               | 3    |
| <i>Prunus</i> spp. | 2,619,300       | 660,100   | 8.2     | 3    | 4.0               | 9    |
| American elm       | 2,126,400       | 741,700   | 6.7     | 4    | 9.8               | 2    |
| Boxelder           | 1,757,800       | 447,200   | 5.5     | 5    | 4.6               | 6    |
| Hawthorn           | 1,715,600       | 440,100   | 5.4     | 6    | 3.6               | 10   |
| Alder              | 1,337,200       | 1,130,400 | 4.2     | 7    | 0.5               | 33   |
| Silver maple       | 1,220,200       | 287,900   | 3.8     | 8    | 10.9              | 1    |
| Red/black oak      | 1,044,100       | 328,200   | 3.3     | 9    | 5.2               | 4    |
| Poplar (other)     | 841,400         | 527,800   | 2.6     | 10   | 1.3               | 21   |
| Black locust       | 831,000         | 618,200   | 2.6     | 11   | 0.4               | 38   |
| Slippery elm       | 732,900         | 582,800   | 2.3     | 12   | 1.2               | 23   |
| Cottonwood         | 715,700         | 352,600   | 2.3     | 13   | 3.0               | 11   |



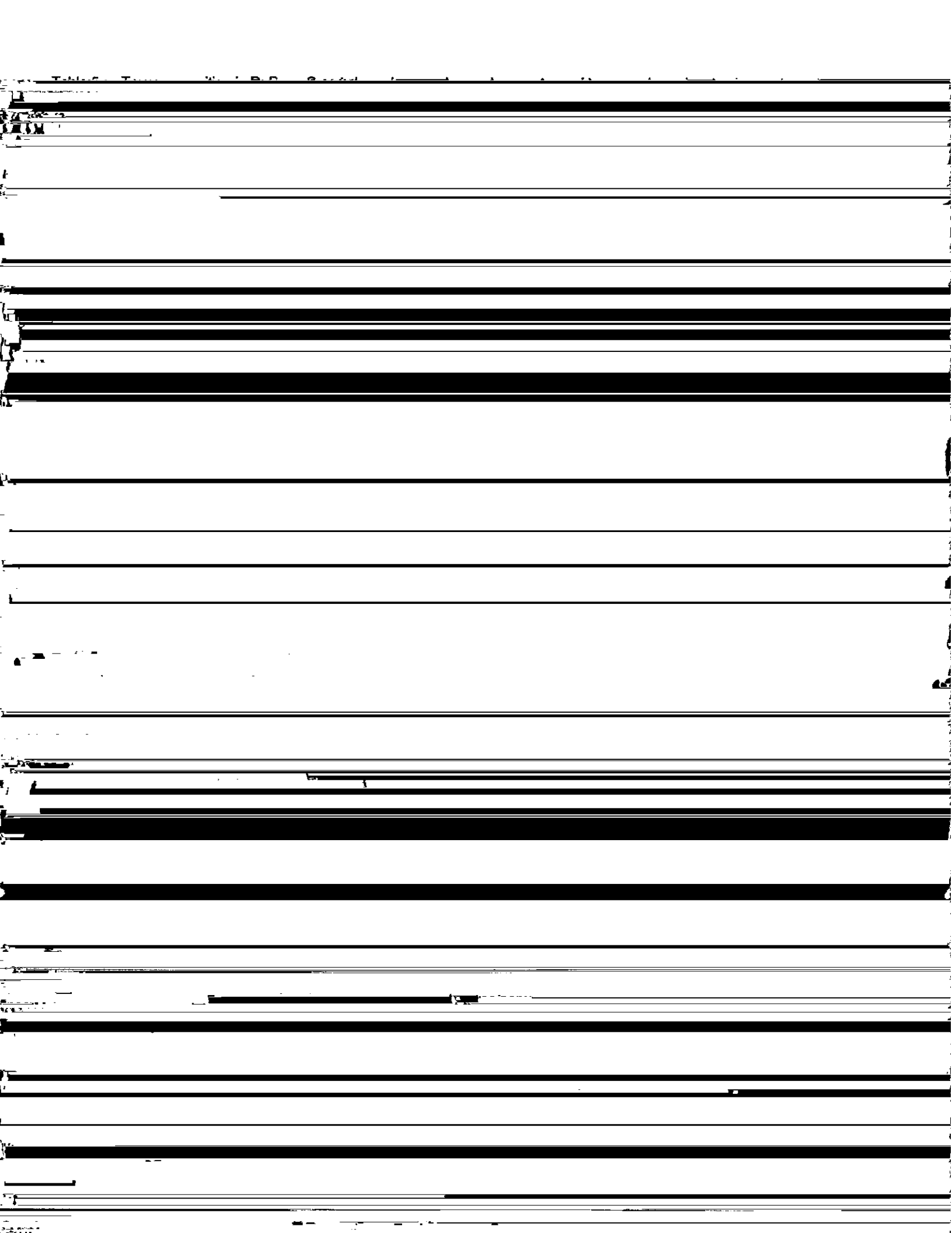


Table 5. —continued

| Site | Tree population |         |      |    | Species dominance |      |
|------|-----------------|---------|------|----|-------------------|------|
|      | Number          | Species | Mean | SD | Species           | Mean |
| 1    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 2    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 3    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 4    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 5    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 6    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 7    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 8    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 9    | 10              | 1       | 10   | 0  | 1                 | 10   |
| 10   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 11   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 12   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 13   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 14   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 15   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 16   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 17   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 18   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 19   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 20   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 21   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 22   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 23   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 24   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 25   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 26   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 27   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 28   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 29   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 30   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 31   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 32   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 33   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 34   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 35   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 36   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 37   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 38   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 39   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 40   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 41   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 42   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 43   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 44   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 45   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 46   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 47   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 48   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 49   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 50   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 51   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 52   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 53   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 54   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 55   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 56   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 57   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 58   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 59   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 60   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 61   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 62   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 63   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 64   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 65   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 66   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 67   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 68   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 69   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 70   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 71   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 72   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 73   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 74   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 75   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 76   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 77   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 78   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 79   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 80   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 81   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 82   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 83   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 84   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 85   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 86   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 87   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 88   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 89   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 90   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 91   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 92   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 93   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 94   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 95   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 96   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 97   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 98   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 99   | 10              | 1       | 10   | 0  | 1                 | 10   |
| 100  | 10              | 1       | 10   | 0  | 1                 | 10   |

Table 6. —Tree composition in study area based on number and percentage of trees, and species dominance based on percentage of total leaf-surface area.



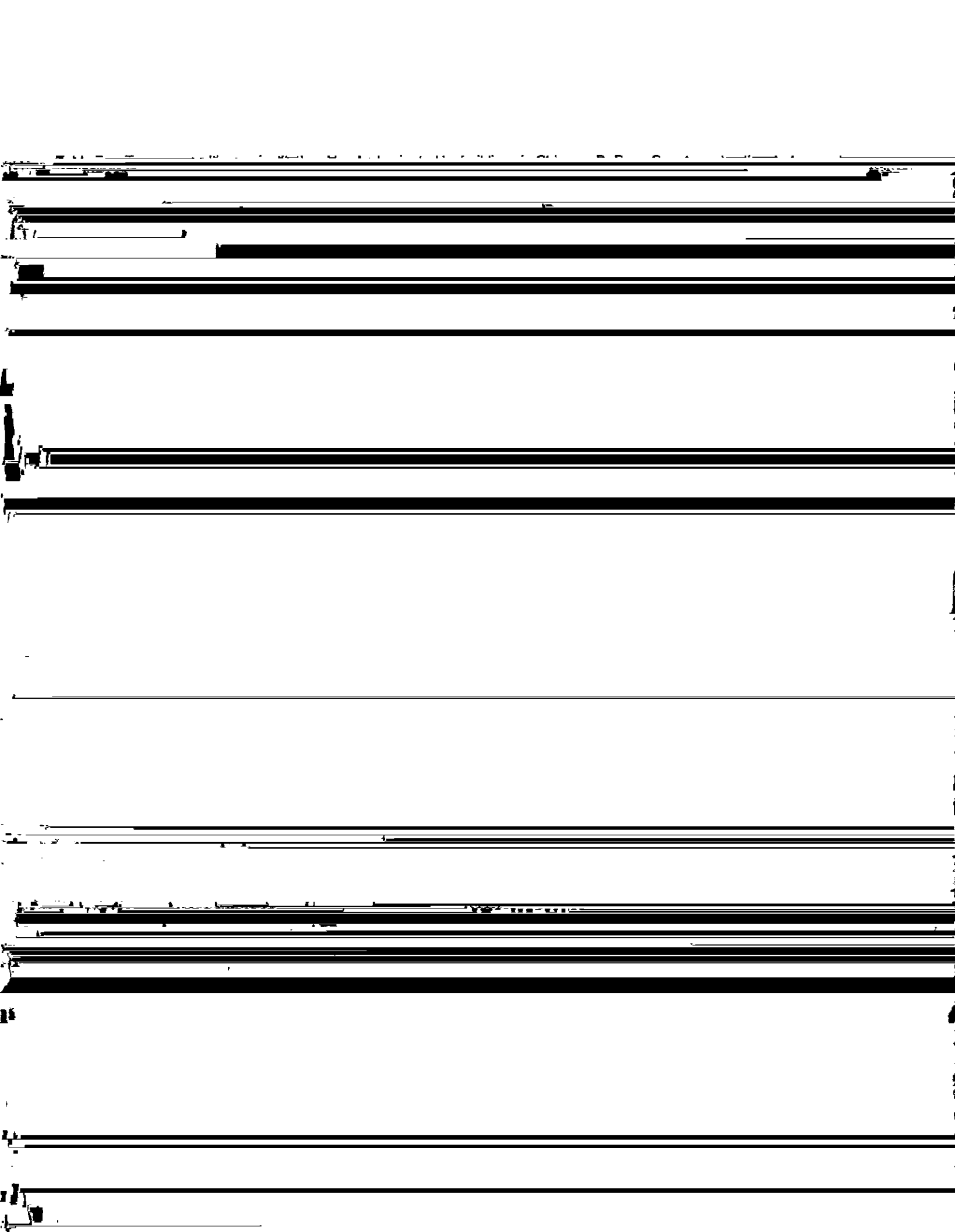




Table 8. —Tree composition on transportational lands in Chicago, DuPage County and entire study area (no trees were sampled on transportational lands in suburban Cook County) based on number and percentage of trees, and species dominance based

Table 10. —Tree composition on multifamily residential lands in Chicago, suburban Cook County, DuPage County, and entire study area based on number and percentage of trees, and species dominance based on percent of total leaf-surface area in each sector

| Species              | Tree population |        |         |      | Species dominance |      |
|----------------------|-----------------|--------|---------|------|-------------------|------|
|                      | Number          | SE     | Percent | Rank | Percent           | Rank |
| CHICAGO              |                 |        |         |      |                   |      |
| Boxelder             | 68,700          | 68,700 | 34.5    | 1    | 23.3              | 3    |
| Cottonwood           | 34,400          | 34,400 | 17.2    | 2    | 34.9              | 1    |
| Green/white ash      | 34,400          | 34,400 | 17.2    | 2    | 7.7               | 5    |
| Honeylocust          | 20,600          | 20,600 | 10.3    | 4    | 8.5               | 4    |
| Crabapple            | 20,600          | 20,600 | 10.3    | 4    | 25.0              | 2    |
| Norway maple         | 20,600          | 20,600 | 10.3    | 4    | 0.7               | 6    |
| SUBURBAN COOK COUNTY |                 |        |         |      |                   |      |
| Honeylocust          | 64,500          | 33,400 | 27.8    | 1    | 20.5              | 2    |
| Boxelder             | 51,600          | 51,600 | 22.2    | 2    | 10.4              | 5    |

Table 11. —Tree composition on commercial/industrial lands in Chicago, suburban Cook County, DuPage County, and entire study area based on number and percentage of trees, and species dominance based on percent of total leaf-surface area in each sector

| Species    | Tree population |        |         |      | Species dominance |      |
|------------|-----------------|--------|---------|------|-------------------|------|
|            | Number          | SE     | Percent | Rank | Percent           | Rank |
| CHICAGO    |                 |        |         |      |                   |      |
| Cottonwood | 16,700          | 16,700 | 50.0    | 1    | 84.1              | 1    |
| Alder      | 16,700          | 16,700 | 50.0    | 1    | 15.9              | 2    |

Table 12. —Tree composition on vacant lands in Chicago, suburban Cook County, DuPage County, and entire study area based on top 20 species in number and percentage of trees, and species dominance based on percent of total leaf surface area

Table with multiple columns and rows, containing data on tree composition. The table is mostly blank with some faint lines and noise.



Table 13. —Tree composition on residential lands in Chicago, suburban Cook County, DuPage County, and entire study area based on top 20 species in number and percentage of trees, and species dominance based on percent of total leaf-surface area in each sector

| Species            | Tree population |        |         |      | Species dominance |      |
|--------------------|-----------------|--------|---------|------|-------------------|------|
|                    | Number          | SE     | Percent | Rank | Percent           | Rank |
| CHICAGO            |                 |        |         |      |                   |      |
| Green/white ash    | 116,100         | 43,600 | 9.2     | 1    | 11.8              | 2    |
| Mulberry           | 112,000         | 34,400 | 8.9     | 2    | 2.8               | 12   |
| Honeylocust        | 108,400         | 29,800 | 8.6     | 3    | 4.6               | 7    |
| Norway maple       | 96,800          | 22,800 | 7.7     | 4    | 12.7              | 1    |
| Silver maple       | 78,000          | 18,400 | 6.2     | 5    | 8.0               | 5    |
| <i>Prunus</i> spp. | 76,700          | 25,700 | 6.1     | 6    | 1.6               | 15   |
| Blue spruce        | 58,900          | 25,200 | 4.7     | 7    | 3.2               | 10   |
| Ailanthus          | 55,200          | 20,900 | 4.4     | 8    | 8.4               | 4    |
| American elm       | 45,200          | 23,900 | 3.6     | 9    | 1.5               | 17   |
| Swamp white oak    | 42,300          | 33,900 | 3.4     | 10   | 3.6               | 9    |
| Honeysuckle        | 38,700          | 25,300 | 3.1     | 11   | 1.0               | 22   |
| Ash (other)        | 34,800          | 21,300 | 2.8     | 12   | 2.7               | 13   |



Table 14. —Tree composition on institutional lands dominated by vegetation in Chicago, suburban Cook County, DuPage County, and entire study area based on top 20 species in number and percentage of trees, and species dominance based on percent of total leaf-surface area in each sector

| Species              | Tree population |           |         |      | Species dominance |      |
|----------------------|-----------------|-----------|---------|------|-------------------|------|
|                      | Number          | SE        | Percent | Rank | Percent           | Rank |
| CHICAGO              |                 |           |         |      |                   |      |
| Cottonwood           | 292,300         | 284,500   | 15.8    | 1    | 9.2               | 5    |
| American elm         | 230,300         | 164,000   | 12.5    | 2    | 11.9              | 1    |
| Hawthorn             | 230,300         | 104,100   | 12.5    | 2    | 4.8               | 9    |
| Buckthorn            | 214,700         | 100,200   | 11.6    | 4    | 2.8               | 11   |
| Green/white ash      | 195,400         | 67,700    | 10.6    | 5    | 9.6               | 4    |
| <i>Prunus</i> spp.   | 191,400         | 99,900    | 10.4    | 6    | 5.5               | 8    |
| Boxelder             | 82,800          | 50,800    | 4.5     | 7    | 2.5               | 12   |
| Hackberry            | 62,100          | 33,200    | 3.4     | 8    | 8.0               | 7    |
| White oak            | 38,800          | 28,700    | 2.1     | 9    | 11.6              | 2    |
| Silver maple         | 33,600          | 16,900    | 1.8     | 10   | 10.0              | 3    |
| Red/black oak        | 28,500          | 26,000    | 1.5     | 11   | 8.6               | 6    |
| Siberian elm         | 25,900          | 25,900    | 1.4     | 12   | 1.1               | 16   |
| Crabapple            | 23,300          | 12,700    | 1.3     | 13   | 0.9               | 18   |
| Shagbark hickory     | 20,700          | 14,500    | 1.1     | 14   | 0.5               | 24   |
| Ash (other)          | 20,700          | 15,000    | 1.1     | 14   | 0.2               | 26   |
| Hickory              | 20,700          | 8,600     | 1.1     | 14   | 0.7               | 21   |
| Honeylocust          | 19,400          | 10,500    | 1.1     | 17   | 0.8               | 19   |
| Basswood             | 18,100          | 10,500    | 1.0     | 18   | 1.5               | 15   |
| Mulberry             | 15,500          | 9,500     | 0.8     | 19   | 2.8               | 10   |
| Other                | 12,900          | 7,600     | 0.7     | 20   | 0.1               | 31   |
| Linden               | 7,800           | 4,400     | 0.4     | 22   | 1.0               | 17   |
| Norway maple         | 5,200           | 3,600     | 0.3     | 24   | 1.6               | 14   |
| Sugar maple          | 5,200           | 3,600     | 0.3     | 24   | 0.7               | 20   |
| Swamp white oak      | 5,200           | 3,600     | 0.3     | 24   | 1.8               | 13   |
| SUBURBAN COOK COUNTY |                 |           |         |      |                   |      |
| Buckthorn            | 3,999,200       | 1,423,000 | 20.0    | 1    | 5.3               | 7    |
| <i>Prunus</i> spp.   | 1,836,800       | 571,400   | 9.2     | 2    | 4.9               | 8    |
| Green/white ash      | 1,737,200       | 443,300   | 8.7     | 3    | 9.6               | 3    |
| Hawthorn             | 1,655,700       | 439,400   | 8.3     | 4    | 7.2               | 4    |
| <i>Fraxinus</i> spp. | 1,001,000       | 700,000   | 3.3     | 5    | 1.7               | 16   |



Table 14. —continued

| Species            | Tree population |         |         |      | Species dominance |      |
|--------------------|-----------------|---------|---------|------|-------------------|------|
|                    | Number          | SE      | Percent | Rank | Percent           | Rank |
| DUPAGE COUNTY      |                 |         |         |      |                   |      |
| <i>Prunus</i> spp. | 566,900         | 233,500 | 17.9    | 1    | 8.1               | 4    |
| Boxelder           | 532,900         | 265,600 | 16.8    | 2    | 9.8               | 2    |
| Hawthorn           | 430,900         | 159,400 | 13.6    | 3    | 2.9               | 11   |
| Buckthorn          | 349,600         | 162,500 | 11.1    | 4    | 3.1               | 10   |
| Jack pine          | 226,800         | 169,700 | 7.2     | 5    | 0.8               | 15   |
| American elm       | 219,200         | 115,600 | 6.9     | 6    | 5.7               | 6    |
| Cottonwood         | 207,900         | 204,100 | 6.6     | 7    | 4.1               | 8    |
| Sumac              | 83,200          | 75,900  | 2.6     | 8    | 0.1               | 23   |
| Green/white ash    | 79,400          | 36,900  | 2.5     | 9    | 3.3               | 9    |
| White oak          | 68,000          | 28,700  | 2.2     | 10   | 34.1              | 1    |



Table 16. Distribution of tree condition in Chicago, suburbs, Cook County, DuPage County, and on the study area. Includes...

| Category | Chicago | Suburbs | Cook County | DuPage County | Study Area |
|----------|---------|---------|-------------|---------------|------------|
| 1        |         |         |             |               |            |
| 2        |         |         |             |               |            |
| 3        |         |         |             |               |            |
| 4        |         |         |             |               |            |
| 5        |         |         |             |               |            |
| 6        |         |         |             |               |            |
| 7        |         |         |             |               |            |
| 8        |         |         |             |               |            |
| 9        |         |         |             |               |            |
| 10       |         |         |             |               |            |
| 11       |         |         |             |               |            |
| 12       |         |         |             |               |            |
| 13       |         |         |             |               |            |
| 14       |         |         |             |               |            |
| 15       |         |         |             |               |            |
| 16       |         |         |             |               |            |
| 17       |         |         |             |               |            |
| 18       |         |         |             |               |            |
| 19       |         |         |             |               |            |
| 20       |         |         |             |               |            |
| 21       |         |         |             |               |            |
| 22       |         |         |             |               |            |
| 23       |         |         |             |               |            |
| 24       |         |         |             |               |            |
| 25       |         |         |             |               |            |
| 26       |         |         |             |               |            |
| 27       |         |         |             |               |            |
| 28       |         |         |             |               |            |
| 29       |         |         |             |               |            |
| 30       |         |         |             |               |            |
| 31       |         |         |             |               |            |
| 32       |         |         |             |               |            |
| 33       |         |         |             |               |            |
| 34       |         |         |             |               |            |
| 35       |         |         |             |               |            |
| 36       |         |         |             |               |            |
| 37       |         |         |             |               |            |
| 38       |         |         |             |               |            |
| 39       |         |         |             |               |            |
| 40       |         |         |             |               |            |
| 41       |         |         |             |               |            |
| 42       |         |         |             |               |            |
| 43       |         |         |             |               |            |
| 44       |         |         |             |               |            |
| 45       |         |         |             |               |            |
| 46       |         |         |             |               |            |
| 47       |         |         |             |               |            |
| 48       |         |         |             |               |            |
| 49       |         |         |             |               |            |
| 50       |         |         |             |               |            |
| 51       |         |         |             |               |            |
| 52       |         |         |             |               |            |
| 53       |         |         |             |               |            |
| 54       |         |         |             |               |            |
| 55       |         |         |             |               |            |
| 56       |         |         |             |               |            |
| 57       |         |         |             |               |            |
| 58       |         |         |             |               |            |
| 59       |         |         |             |               |            |
| 60       |         |         |             |               |            |
| 61       |         |         |             |               |            |
| 62       |         |         |             |               |            |
| 63       |         |         |             |               |            |
| 64       |         |         |             |               |            |
| 65       |         |         |             |               |            |
| 66       |         |         |             |               |            |
| 67       |         |         |             |               |            |
| 68       |         |         |             |               |            |
| 69       |         |         |             |               |            |
| 70       |         |         |             |               |            |
| 71       |         |         |             |               |            |
| 72       |         |         |             |               |            |
| 73       |         |         |             |               |            |
| 74       |         |         |             |               |            |
| 75       |         |         |             |               |            |
| 76       |         |         |             |               |            |
| 77       |         |         |             |               |            |
| 78       |         |         |             |               |            |
| 79       |         |         |             |               |            |
| 80       |         |         |             |               |            |
| 81       |         |         |             |               |            |
| 82       |         |         |             |               |            |
| 83       |         |         |             |               |            |
| 84       |         |         |             |               |            |
| 85       |         |         |             |               |            |
| 86       |         |         |             |               |            |
| 87       |         |         |             |               |            |
| 88       |         |         |             |               |            |
| 89       |         |         |             |               |            |
| 90       |         |         |             |               |            |
| 91       |         |         |             |               |            |
| 92       |         |         |             |               |            |
| 93       |         |         |             |               |            |
| 94       |         |         |             |               |            |
| 95       |         |         |             |               |            |
| 96       |         |         |             |               |            |
| 97       |         |         |             |               |            |
| 98       |         |         |             |               |            |
| 99       |         |         |             |               |            |
| 100      |         |         |             |               |            |

Table 17. Distribution of ground surface materials in Chicago, suburban Cook County, DuPage County, and entire study area.

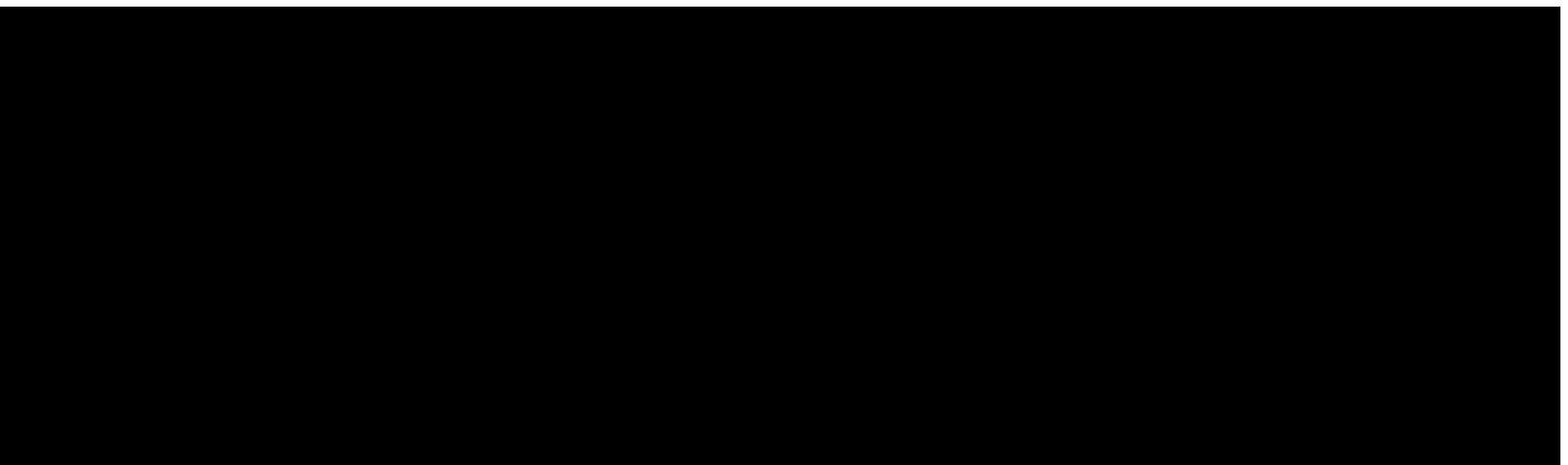
| Material  | Chicago                 |            |      | Suburban Cook County    |            |      | DuPage County           |            |      | Entire Study Area       |            |      |
|-----------|-------------------------|------------|------|-------------------------|------------|------|-------------------------|------------|------|-------------------------|------------|------|
|           | Area (km <sup>2</sup> ) | Percentage | Rank | Area (km <sup>2</sup> ) | Percentage | Rank | Area (km <sup>2</sup> ) | Percentage | Rank | Area (km <sup>2</sup> ) | Percentage | Rank |
| Gravel    | 1.2                     | 0.01       | 1    | 1.2                     | 0.01       | 1    | 1.2                     | 0.01       | 1    | 1.2                     | 0.01       | 1    |
| Sand      | 1.2                     | 0.01       | 2    | 1.2                     | 0.01       | 2    | 1.2                     | 0.01       | 2    | 1.2                     | 0.01       | 2    |
| Silt      | 1.2                     | 0.01       | 3    | 1.2                     | 0.01       | 3    | 1.2                     | 0.01       | 3    | 1.2                     | 0.01       | 3    |
| Clay      | 1.2                     | 0.01       | 4    | 1.2                     | 0.01       | 4    | 1.2                     | 0.01       | 4    | 1.2                     | 0.01       | 4    |
| Shale     | 1.2                     | 0.01       | 5    | 1.2                     | 0.01       | 5    | 1.2                     | 0.01       | 5    | 1.2                     | 0.01       | 5    |
| Sandstone | 1.2                     | 0.01       | 6    | 1.2                     | 0.01       | 6    | 1.2                     | 0.01       | 6    | 1.2                     | 0.01       | 6    |
| Limestone | 1.2                     | 0.01       | 7    | 1.2                     | 0.01       | 7    | 1.2                     | 0.01       | 7    | 1.2                     | 0.01       | 7    |
| Marl      | 1.2                     | 0.01       | 8    | 1.2                     | 0.01       | 8    | 1.2                     | 0.01       | 8    | 1.2                     | 0.01       | 8    |
| Other     | 1.2                     | 0.01       | 9    | 1.2                     | 0.01       | 9    | 1.2                     | 0.01       | 9    | 1.2                     | 0.01       | 9    |

Table 17. —continued



# Appendix B

## Trees for Energy-Efficient Landscapes in Chicago



Trees for energy-efficient landscapes in the Chicago area .

| Tree species             |                         | Solar friendly | Form | Growth rate | Longevity |
|--------------------------|-------------------------|----------------|------|-------------|-----------|
| Small (< 20 feet)        |                         |                |      |             |           |
| Dogwood, Corneliancherry | <i>Cornus mas</i>       | NA             | R    | S           | I         |
| Filbert, European        | <i>Corylus avellana</i> | NA             | S    | M           | I         |
| Hawthorn                 | <i>Crataegus spp.</i>   |                |      |             |           |
| <i>Crataegus</i>         | <i>Crataegus</i>        | Y              |      | M           | I         |



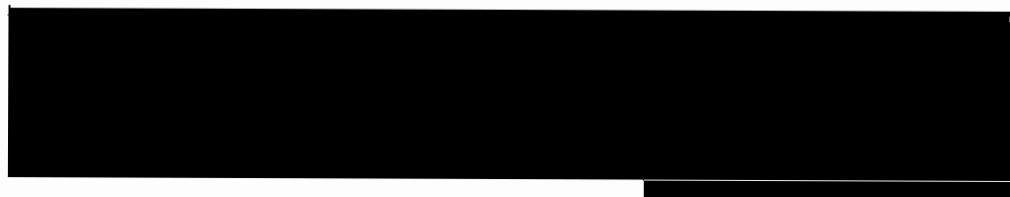
Trees for energy-efficient landscapes in the Chicago area (continued).

|              | Tree species          | Solar friendly | Form | Growth rate | Longevity |
|--------------|-----------------------|----------------|------|-------------|-----------|
|              | Large (>40 feet)      |                |      |             |           |
| Maple        | <i>Acer spp.</i>      |                |      |             |           |
| Balck        | <i>A. nigrum</i>      | Y              | O    | M           | L         |
| Norway       | <i>A. platanoides</i> | Y              | R    | M           | L         |
| Oak          | <i>Quercus spp.</i>   |                |      |             |           |
| Bur          | <i>Q. macrocarpa</i>  | N              | B    | M           | L         |
| English      | <i>Q. robur</i>       | N              | RR   | M           | L         |
| Pin or Swamp | <i>Q. palustris</i>   | N              | P    | R           | L         |
| Red          | <i>Q. rubra</i>       | N              | RR   | M           | L         |
| Sawtooth     | <i>Q. acutissima</i>  | NA             | P    | M           | L         |



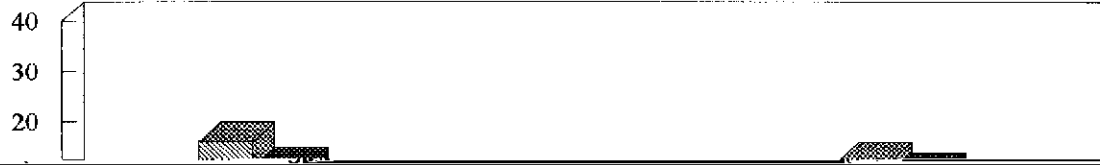
# Appendix C

## Standard Details for Brick Base Core Buildings





# Annual Heating and Cooling Savings From Base Case Due to Shade from A Large Deciduous Tree - 22 ft Away



Chicago, Illinois

Energy Analysis

Nat. Gas

(\$/therm):

0.5

1 Story Brick Construction 2,425 sq ft Residence (East End of East)

Electricity

(\$/kWh):

0.12

[The table content is almost entirely obscured by heavy black redaction bars.]

Chicago, Illinois

Tree Shade Only

1 Story, Brick Construction - 2,125 sq ft Residence (Front Facing North)

Nat. Gas (\$/therm): 0.5  
Electricity (\$/kWh): 0.12

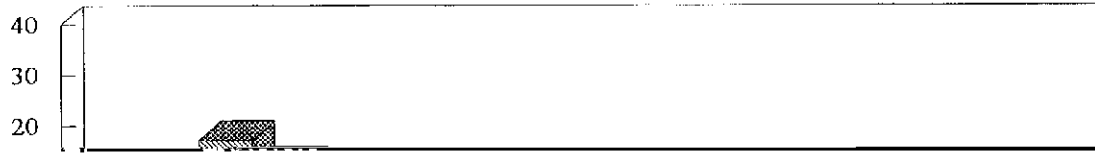
Source Energy Use (kBtu/ sq ft)

Tree Height and Distance from Building  
Small (24 ft) Med. (36 ft) Large (50 ft) Large (50 ft)

% Saved from Base Case  
Small (24 ft) Med. (36 ft) Large (50 ft) Large (50 ft)

Foot Type 24 ft 36 ft 50 ft 50 ft Foot Type 24 ft 36 ft 50 ft 50 ft

Annual Heating and Cooling Savings From Base Case  
Due to Shade from A Large Deciduous Tree - 22 ft Away









Annual Heating and Cooling Savings From Base Case  
Due to Shade from A Large Deciduous Tree - 22 ft Away

172

173

174

175

176

177

178

179

180

181

182

Chicago, Illinois

Energy Analysis

Nat. Gas

(\$/therm):

0.5

Chicago, Illinois

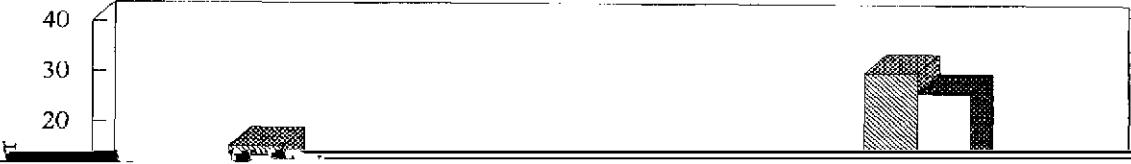
Tree Shade Only

Nat. Gas

(\$/therm):

0.5

Annual Heating and Cooling Savings From Base Case  
Due to Shade from A Large Deciduous Tree - 22 ft Away



Chicago, Illinois

Energy Analysis

2 Story, Brick Construction - 3,562 sq ft Residence (Front Facing South)

Nat. Gas  
Electricity

(\$/therm):  
(\$/kWh):

0.5  
0.12

Chicago, Illinois

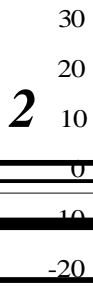
Tree Shade Only

3 Story Brick Construction - 6,048 sq ft Residence (Front Facing East)

|             |             |      |
|-------------|-------------|------|
| Nat. Gas    | (\$/therm): | 0.5  |
| Electricity | (\$/kWh):   | 0.12 |



Annual Heating and Cooling Savings From Base Case  
&om A Large Deciduous Tree - 22 ft Away



Total Savings

3 Story, Brick Construction - 6,048 sq ft Residence (Front Facing East)

Annual Percentage Cooling Savings From Base Case  
Due to Shade from One Deciduous Tree

East

South

West

Chicago, Illinois

Energy Analysis

3 Story, Brick Construction - 6,048 sq ft Residence (Front Facing East)  
Roofing: free 36-ft tall and 24-ft crown eaved, 32 ft away from building.

|                          |                 |      |
|--------------------------|-----------------|------|
| Nat. Gas                 | (\$/therm):     | 0.5  |
| Electricity              | (\$/kWh):       | 0.12 |
| Avoided Peak Electricity | (\$/Avoid kWh): | 0.5  |

Chicago, Illinois

Tree Shade Only

9 Step Brick Construction - 6,048 sq ft Residence (Front Facing South)

Nat. Gas  
Electricity

(\$/therm):  
(\$/kWh)

0.5  
0.12

Annual Heating and Cooling Savings From Base Case  
Due to Shade from A Large Deciduous Tree - 22 ft Away



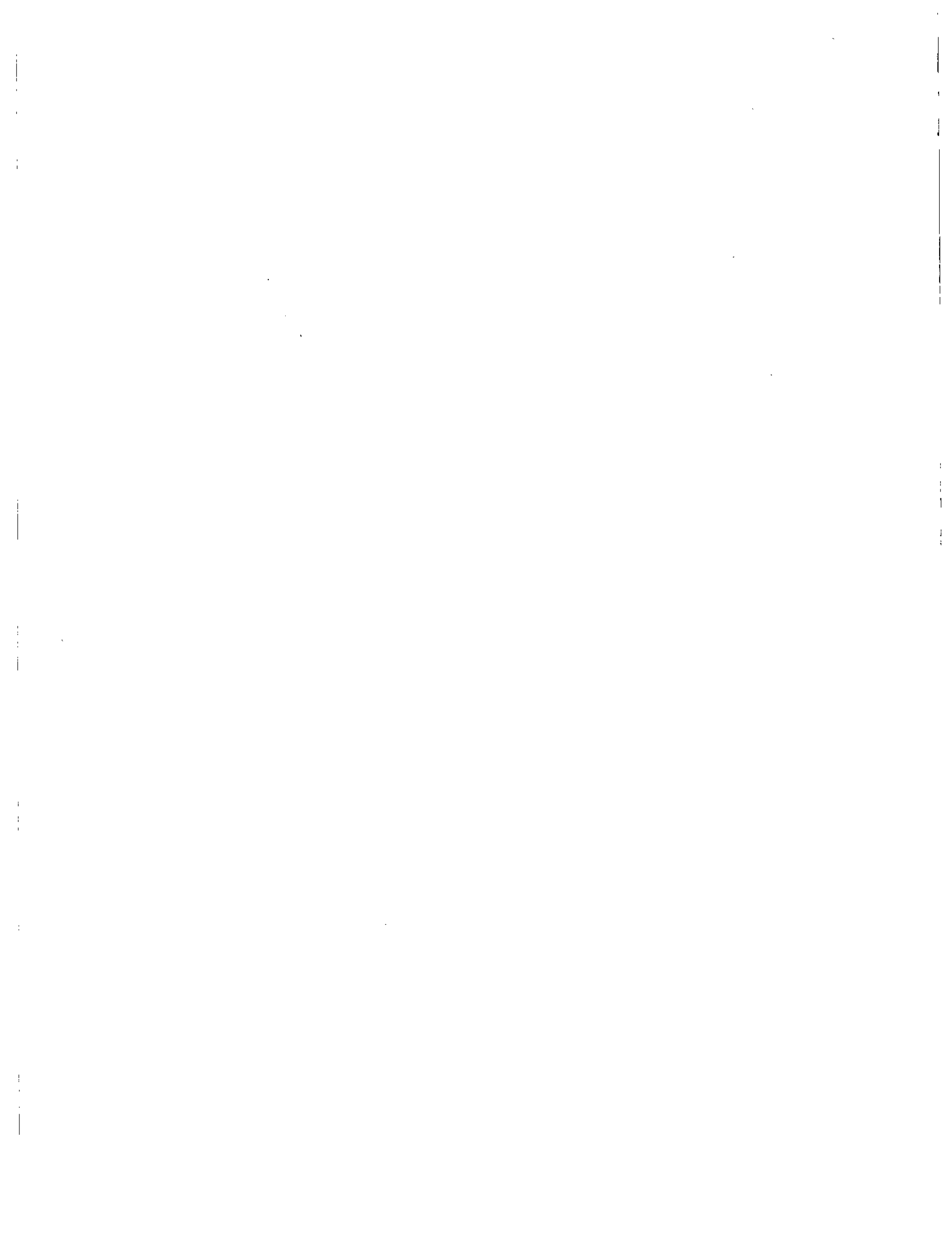
Chicago, Illinois

Energy Analysis

3 Story, Brick Construction - 6,048 sq ft Residence (Front Facing South)  
Deciduous tree, 36-ft tall and 24-ft crown spread, 22-ft away from building

Nat. Gas (\$/therm): 0.5  
Electricity (\$/kWh): 0.12  
Avoided Peak Electricity (\$/Avoid kW): 65

| Annual Energy Use | Unshaded Base Case | East | Shade South | West | ET Cooling | Reduced Wind | East Shade + ET + Wind | South Shade + ET + Wind | West Shade + ET + Wind |
|-------------------|--------------------|------|-------------|------|------------|--------------|------------------------|-------------------------|------------------------|
|-------------------|--------------------|------|-------------|------|------------|--------------|------------------------|-------------------------|------------------------|



# Appendix D

CHAPTER 10: THE HISTORY OF THE UNITED STATES

| Year | Event                            |
|------|----------------------------------|
| 1776 | Declaration of Independence      |
| 1787 | Constitution                     |
| 1800 | Move to Washington, D.C.         |
| 1820 | Missouri Compromise              |
| 1850 | Compromise of 1850               |
| 1861 | Start of Civil War               |
| 1865 | End of Civil War                 |
| 1877 | Compromise of 1877               |
| 1896 | Plessy vs. Ferguson              |
| 1904 | Spanish-American War             |
| 1914 | Start of WWI                     |
| 1918 | End of WWI                       |
| 1929 | Start of Great Depression        |
| 1933 | New Deal                         |
| 1941 | Start of WWII                    |
| 1945 | End of WWII                      |
| 1947 | Start of Cold War                |
| 1954 | Brown vs. Board of Education     |
| 1963 | MLK's 'I Have a Dream' speech    |
| 1968 | Start of Vietnam War             |
| 1973 | End of Vietnam War               |
| 1979 | Start of Iran Hostage Crisis     |
| 1981 | Start of AIDS epidemic           |
| 1989 | Start of Soviet Union's collapse |
| 1991 | End of Soviet Union              |
| 1993 | Start of Clinton administration  |
| 1997 | Start of Clinton impeachment     |
| 2001 | Start of Bush administration     |
| 2001 | Start of 9/11 attacks            |
| 2003 | Start of Iraq War                |
| 2008 | Start of Obama administration    |
| 2009 | Start of Obama's first term      |
| 2010 | Start of Obama's second term     |
| 2011 | Start of Obama's second term     |
| 2012 | Start of Obama's second term     |
| 2013 | Start of Obama's second term     |
| 2014 | Start of Obama's second term     |
| 2015 | Start of Obama's second term     |
| 2016 | Start of Trump administration    |
| 2017 | Start of Trump administration    |
| 2018 | Start of Trump administration    |
| 2019 | Start of Trump administration    |
| 2020 | Start of Biden administration    |
| 2021 | Start of Biden administration    |

**Chicago, Illinois** Tree Shade Only  
1 Story - Wood Frame Residence (1,500 sq ft)  
**Space Conditioning Source Energy Use (kBtu/ sq ft)**

Nat. Gas (\$/therm): 0.5  
Electricity (\$/kWh): 0.12

**Year 5** Base Case 1 Tree 2 Tree 3 Tree **Year 5** % Saved from Base Case 1 Tree 2 Tree 3 Tree





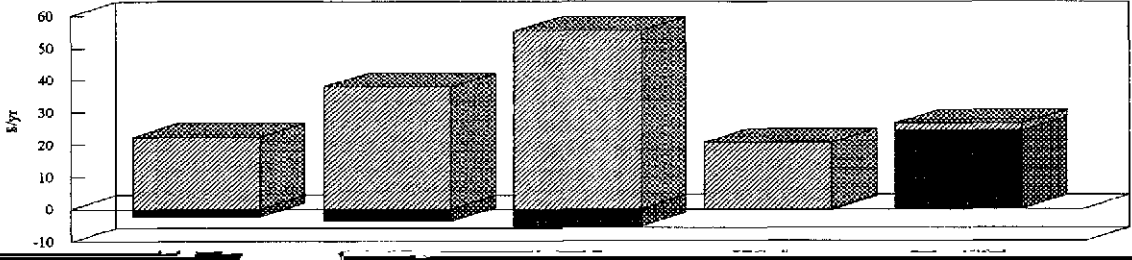
Chicago, Illinois  
1 Story - Wood Frame  
Year 20 - 25 ft trees

**Energy Analysis**  
1500 sq ft

Nat. Gas (\$/therm): 0.5  
Electricity (\$/kWh): 0.12  
Avoided Peak Electricity (\$/Avoid kW): 65

Annual      Unshaded      Shade      ET    Reduced    3 Tree+ET    Avg. Savings

# Annual Dollar Savings From Base Case



**Chicago, Illinois**                      **Tree Shade Only**

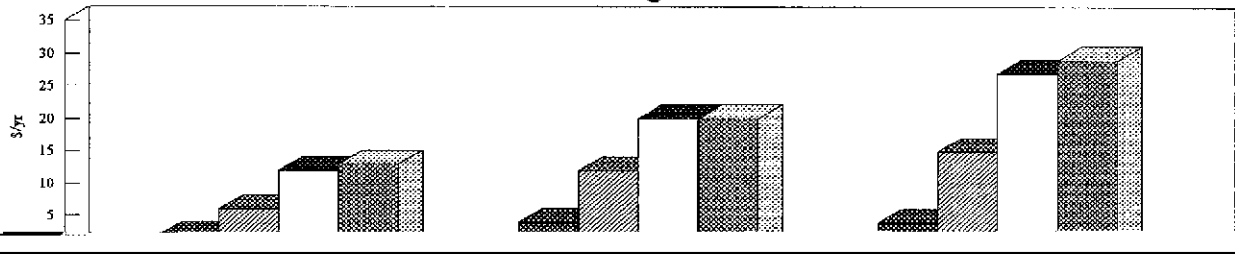
2 Story - Wood Frame Residence (1,761 sq ft)

Nat. Gas    (\$/therm):    0.5  
Electricity    (\$/kWh):    0.12

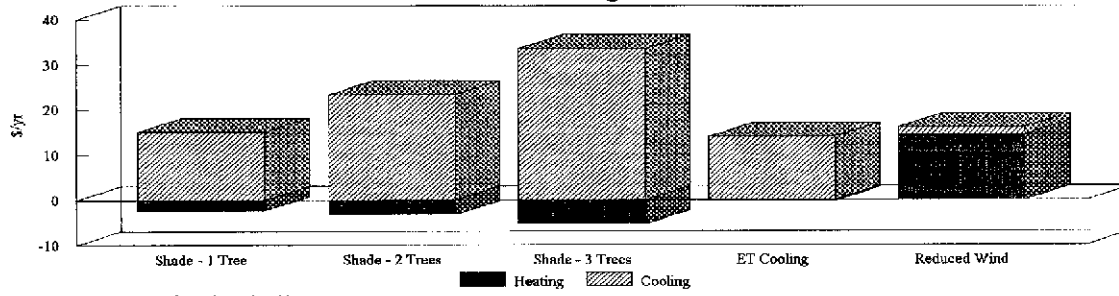
**Space Conditioning Source Energy Use (kBtu/ sq ft)**

| Year 5            | Base Case | 1 Tree | 2 Tree | 3 Tree | Year 5 | % Saved from Base Case |        |        |
|-------------------|-----------|--------|--------|--------|--------|------------------------|--------|--------|
|                   |           |        |        |        |        | 1 Tree                 | 2 Tree | 3 Tree |
| Total Heating Use | 42.24     | 42.37  | 42.39  | 42.44  |        | -0.29                  | -0.36  | -0.46  |

# Annual Dollar Savings From Base Case



## Annual Dollar Savings From Base Case



1,761 sf, 2 story wood frame home in Chicago

## Annual Dollar Savings From Base Case

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

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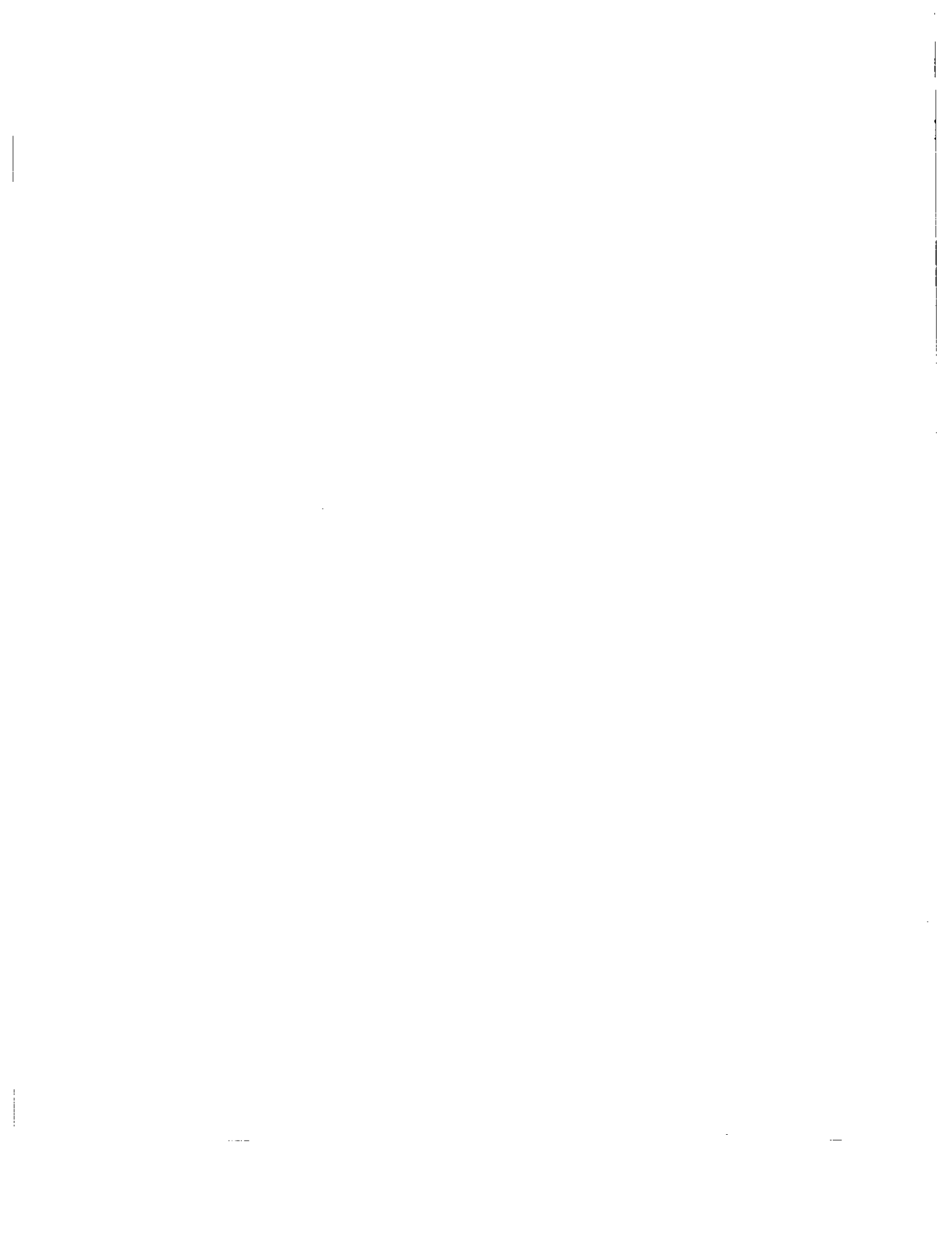
[Redacted]

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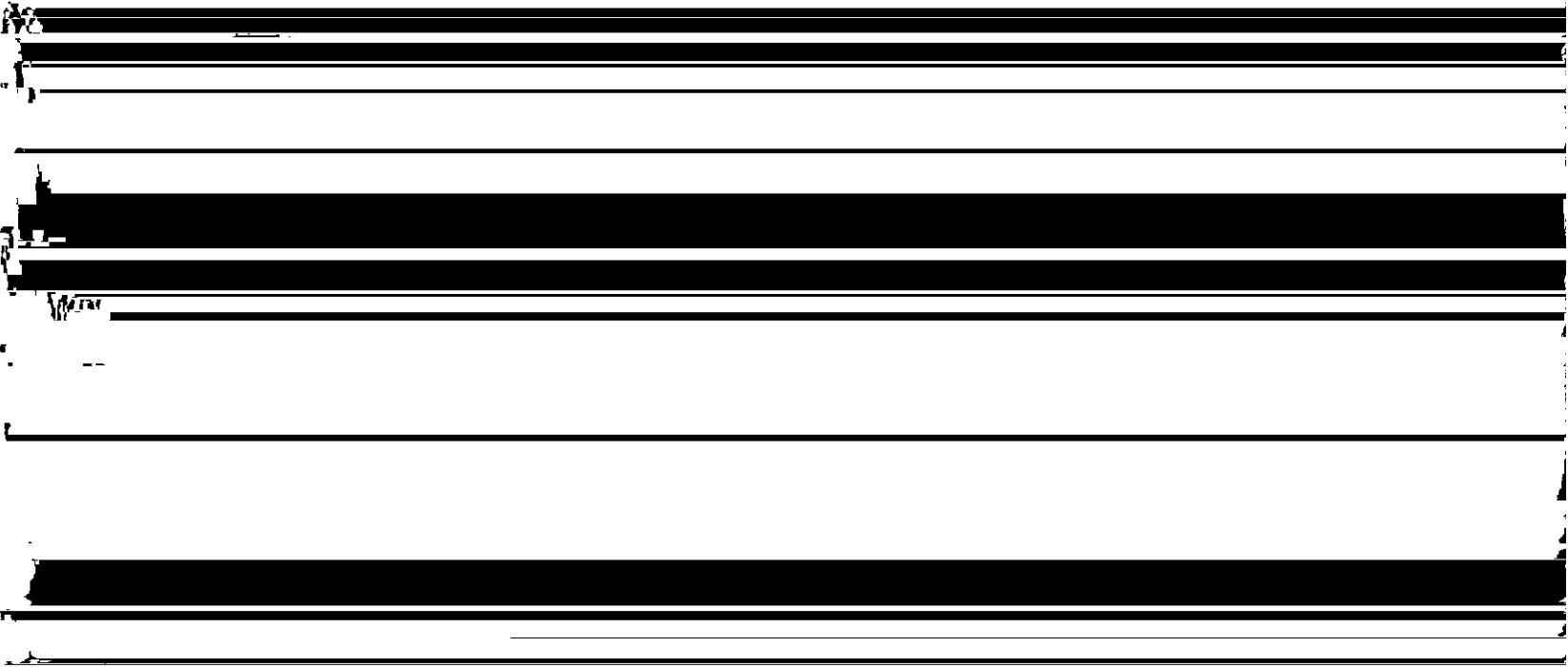
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# Appendix E

## Initial Analysis of the Cost Effectiveness of Shade Trees in Chicago



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2

ECONOMIC ANALYSIS OF SHADE TREE PROGRAM IN CHICAGO, ILLINOIS

U.S. Department of Agriculture, Forest Service, Chicago, Illinois

April 1964

SO-245

4000-10-1000

ECONOMIC ANALYSIS OF SHADE TREE PROGRAM IN CHICAGO, ILLINOIS

| Year | Number of Trees | Value of Program | Percentage of Total |
|------|-----------------|------------------|---------------------|
| 1950 | 100             | 100              | 100                 |
| 1951 | 100             | 100              | 100                 |
| 1952 | 100             | 100              | 100                 |
| 1953 | 100             | 100              | 100                 |
| 1954 | 100             | 100              | 100                 |
| 1955 | 100             | 100              | 100                 |
| 1956 | 100             | 100              | 100                 |
| 1957 | 100             | 100              | 100                 |
| 1958 | 100             | 100              | 100                 |
| 1959 | 100             | 100              | 100                 |
| 1960 | 100             | 100              | 100                 |
| 1961 | 100             | 100              | 100                 |
| 1962 | 100             | 100              | 100                 |
| 1963 | 100             | 100              | 100                 |
| 1964 | 100             | 100              | 100                 |
| 1965 | 100             | 100              | 100                 |
| 1966 | 100             | 100              | 100                 |
| 1967 | 100             | 100              | 100                 |
| 1968 | 100             | 100              | 100                 |
| 1969 | 100             | 100              | 100                 |
| 1970 | 100             | 100              | 100                 |
| 1971 | 100             | 100              | 100                 |
| 1972 | 100             | 100              | 100                 |
| 1973 | 100             | 100              | 100                 |
| 1974 | 100             | 100              | 100                 |
| 1975 | 100             | 100              | 100                 |
| 1976 | 100             | 100              | 100                 |
| 1977 | 100             | 100              | 100                 |
| 1978 | 100             | 100              | 100                 |
| 1979 | 100             | 100              | 100                 |
| 1980 | 100             | 100              | 100                 |
| 1981 | 100             | 100              | 100                 |
| 1982 | 100             | 100              | 100                 |
| 1983 | 100             | 100              | 100                 |
| 1984 | 100             | 100              | 100                 |
| 1985 | 100             | 100              | 100                 |
| 1986 | 100             | 100              | 100                 |
| 1987 | 100             | 100              | 100                 |
| 1988 | 100             | 100              | 100                 |
| 1989 | 100             | 100              | 100                 |
| 1990 | 100             | 100              | 100                 |
| 1991 | 100             | 100              | 100                 |
| 1992 | 100             | 100              | 100                 |
| 1993 | 100             | 100              | 100                 |
| 1994 | 100             | 100              | 100                 |
| 1995 | 100             | 100              | 100                 |
| 1996 | 100             | 100              | 100                 |
| 1997 | 100             | 100              | 100                 |
| 1998 | 100             | 100              | 100                 |
| 1999 | 100             | 100              | 100                 |
| 2000 | 100             | 100              | 100                 |
| 2001 | 100             | 100              | 100                 |
| 2002 | 100             | 100              | 100                 |
| 2003 | 100             | 100              | 100                 |
| 2004 | 100             | 100              | 100                 |
| 2005 | 100             | 100              | 100                 |
| 2006 | 100             | 100              | 100                 |
| 2007 | 100             | 100              | 100                 |
| 2008 | 100             | 100              | 100                 |
| 2009 | 100             | 100              | 100                 |
| 2010 | 100             | 100              | 100                 |
| 2011 | 100             | 100              | 100                 |
| 2012 | 100             | 100              | 100                 |
| 2013 | 100             | 100              | 100                 |
| 2014 | 100             | 100              | 100                 |
| 2015 | 100             | 100              | 100                 |
| 2016 | 100             | 100              | 100                 |
| 2017 | 100             | 100              | 100                 |
| 2018 | 100             | 100              | 100                 |
| 2019 | 100             | 100              | 100                 |
| 2020 | 100             | 100              | 100                 |
| 2021 | 100             | 100              | 100                 |
| 2022 | 100             | 100              | 100                 |
| 2023 | 100             | 100              | 100                 |
| 2024 | 100             | 100              | 100                 |
| 2025 | 100             | 100              | 100                 |
| 2026 | 100             | 100              | 100                 |
| 2027 | 100             | 100              | 100                 |
| 2028 | 100             | 100              | 100                 |
| 2029 | 100             | 100              | 100                 |
| 2030 | 100             | 100              | 100                 |

**Headquarters of the Northeastern Forest Experiment Station is in Radnor, Pennsylvania.  
Field laboratories are maintained at:**