THE IMPACT OF STREET LIGHTING ON STREET CRIME

Part 1: Results
Part 2: Technical Appendices

By Roger Wright, et. al.

THE IMPACT OF STREET LIGHTING ON STREET CRIME

Part 1: Results

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The figure of 0.2% for Miami is remarkably close to the figure of 0.18% estimated by the General Electric company. Similarly, the Edison Electrical Institute estimates that .77% of all electrical energy consumption goes for street and highway lighting. This figure is **also** quite close to the 0.8% estimated by General Electric.

Since the current energy crisis is often considered in terms of barrels or gallons of gasoline, these figures for electrical energy consumption may be more usefully presented as petroleum equivalents. One gallon of gasoline contains 126,000 BTU. The average conversion efficiency of gas and oil to heat is 32%, and this produces twelve KWH per gallon of gasoline. Thus the estimated annual energy consumption for all street lights in the United States is equivalent to 1,240,000,000 gallons-- or six gallons per person per year.

This figure is derived from the following computation. There are approximately 12.4 million street lights nationwide. Of these, 20% are incandescent (filament), 75% are mercury, and 5% are sodium. The average wattage of each of these types of lights is 300, 330, and 350, respectively; or a national average of 325 watts each. In terms of annual energy consumption, these lights use 1200, 1320, and 1400 KWH annually. These figures are based on an average annual street light usage of about 4,000 hours, or a little less than twelve hours a day. At twelve KWH per year, and at 12 KWH per gallon, each light uses an average of one hundred gallons of gas per year, or 100 gallons per light for 12.4 million lights, or 1,240,000,000 gallons of gas for all lights each year.

In terms of efficiency of utilization of energy, different types of lights are differentially efficient. Depending on their wattage (higher wattage lights being more efficient), incandescent lights produce 20 to 23 lumens per watt, mercury lights produce 40 to 55 lumens per watt, and sodium lights produce from 100 to 130 lumens per watt. Clearly, sodium lights are much more efficient than either of the other two types.

Table 4-22. Displacement [1] Indications for

Night Street Crime to Nonrelit Blocks

	Commercial [2]		Residential [3]	
	Baseline (1970/1971) [4]	Test (1971/1972) [5]	Baseline (1970/1971)	Test (1971/1972)
Violent Crimes:				
Robbery + Assault	**+6%** (36/38) [6]	-2% (54/53)	-34% (92/61)	-5% (87/83)
Robbery	-25% (28/21)	-25% (32/24)	-41% (49/29)	0 (42/42)
Assault	+113% (8/17)	32% (22/29)	-26% (43/32)	-9% (45/41)
Property Crimes:				
Larceny	+57% (21/33)	-45% (44/24)	-33% (33/22)	-15% (27/23)

Notes:

[1] Defined as increase, or reduced rate of decrease, in Test period relative to Baseline period.

[2] Blocks with 10 or more employees.

[3] Blocks with fewer than 10 employees and more than 38 residents.

[4] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[5] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[6] Percent change from 1970 to 1971 is indicated by +6%. Numerical change is indicated by (17/18) or 17 offenses for the 1970 period and 18 offenses for the 1971 period.

Table 4-21. Changes in Burglaries in Relit Blocks During the Test Period (1971/1972) [1]

	Night	Day
Burglaries of Commercial Establishments	-56% [2] (84/37)	-27% (15/11)
Burglaries of Residences	-18% (82/67)	+9% (140/152)

Notes:

[1] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Percent change from 1971 to 1972 is indicated by -56%. Numerical change is indicated by (84/37) or 84 offenses during the 1971 period and 37 offenses during the 1972 period.

Figure 4-8. Percentage Changes in Assault in Selected Locations in Relit Commercial and Relit Residential Blocks (1971/1972).
(See also Table 4-19 and 4-20)

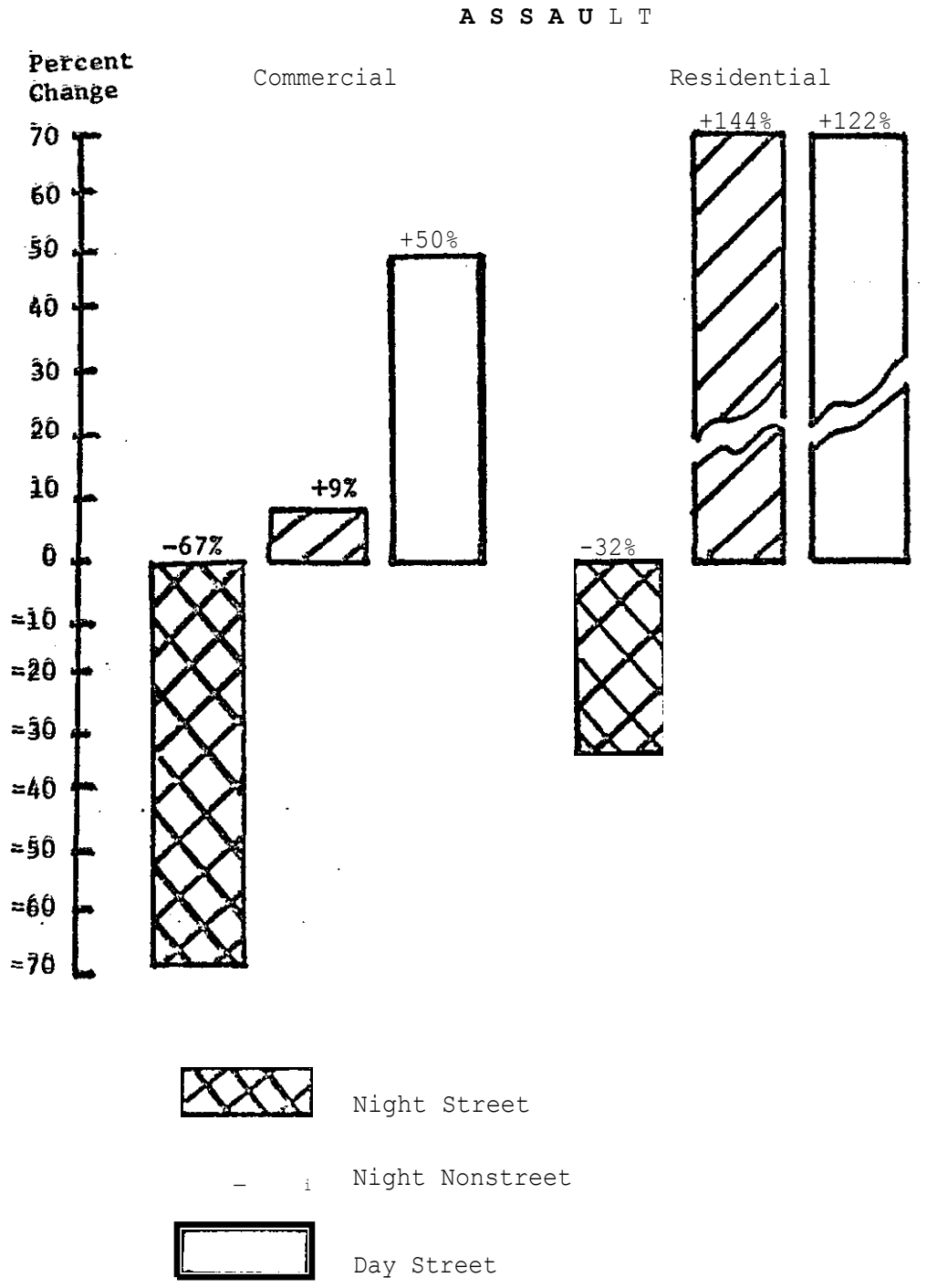


Table 4-17. Changes in Night Street Crime in Residential [1] Blocks During the Test Period (1971/1972) [2]

	Relit	Nonrelit	Citywide Sample	Statistically Significant [3]
Violent Crimes:				
Robbery + Assault	-41% [4] (56/33)	-5% (87/83)	-16% (180/151)	No
Robbery	-46% (37/20)	0 (42/42)	-14% (85/73)	No
Assault	-32% (19/13)	-9% (45/41)	-18% (95/78)	No
Property Crimes:				
Larceny + **Auto** Theft	-11% (46/41)	-28% (112/81)	-13% (209/172)	No
Larceny	-36% (22/14)	-15% (27/23)	-14% (53/71)	No
Auto Theft	+13% (24/27)	-32% (85/58)	-20% (126/101)	No

Notes:

[1] Blocks with fewer than 10 employees and more than 38 residents.

[2] Test Period (1971/1972) compares twelve-month periods: October **1970-September** 1971 and April 1972-March 1973.

(3)Statistical tests compare Relit to Nonrelit blocks.

(4)Percent change from 1971 to 1972 is indicated by -41%. Numerical change is indicated by (56/33) or 56 offenses for the 1971 period and 33 offenses for the 1972 period.

Table 4-4. Crime Changes in Relit Blocks

During the Test Period (1971/1972) [1]

	Night Street	Night Nonstreet	Day Street	Statistically Significant
Violent Crimes: Robbery + Assault	-48%. (104/54) [2]	+26% (42/53)	+3% (58/60)	Yes (p(,0012)
Robbery	-52% (67/32)	-14% (21/18)	-30% (40/28)	No
Assault	-41% (37/22)	+67% (21/35)	+78% (18/32)	Yes (p<.02)
Property Crimes: Larceny + **Auto Theft**	-26% (84/65)	-11% {18/16)	-36% {103/81)	No
Larceny	-39% (51/31)	-11% (18/16)	-21% (75/48)	No
Auto Theft	+3% (33/34)	-- [3]	+18% (28/33)	No

Notes:

[1] Test Period {1971/1972) compares twelve month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Percent change from 1971 to 1972 is indicated by -48%. Numerical **change** is indicated by (104/54) or 104 offenses for the 1971 period and 54 offenses for the 1972 period.

[3] Auto Thefts are Street only, with no Nonstreet offenses.

Figure 4-2. Percentage Changes in Night Street Crime in Relit and Nonrelit Blocks During the Test Period (1971/72). (See also Table 4-3)

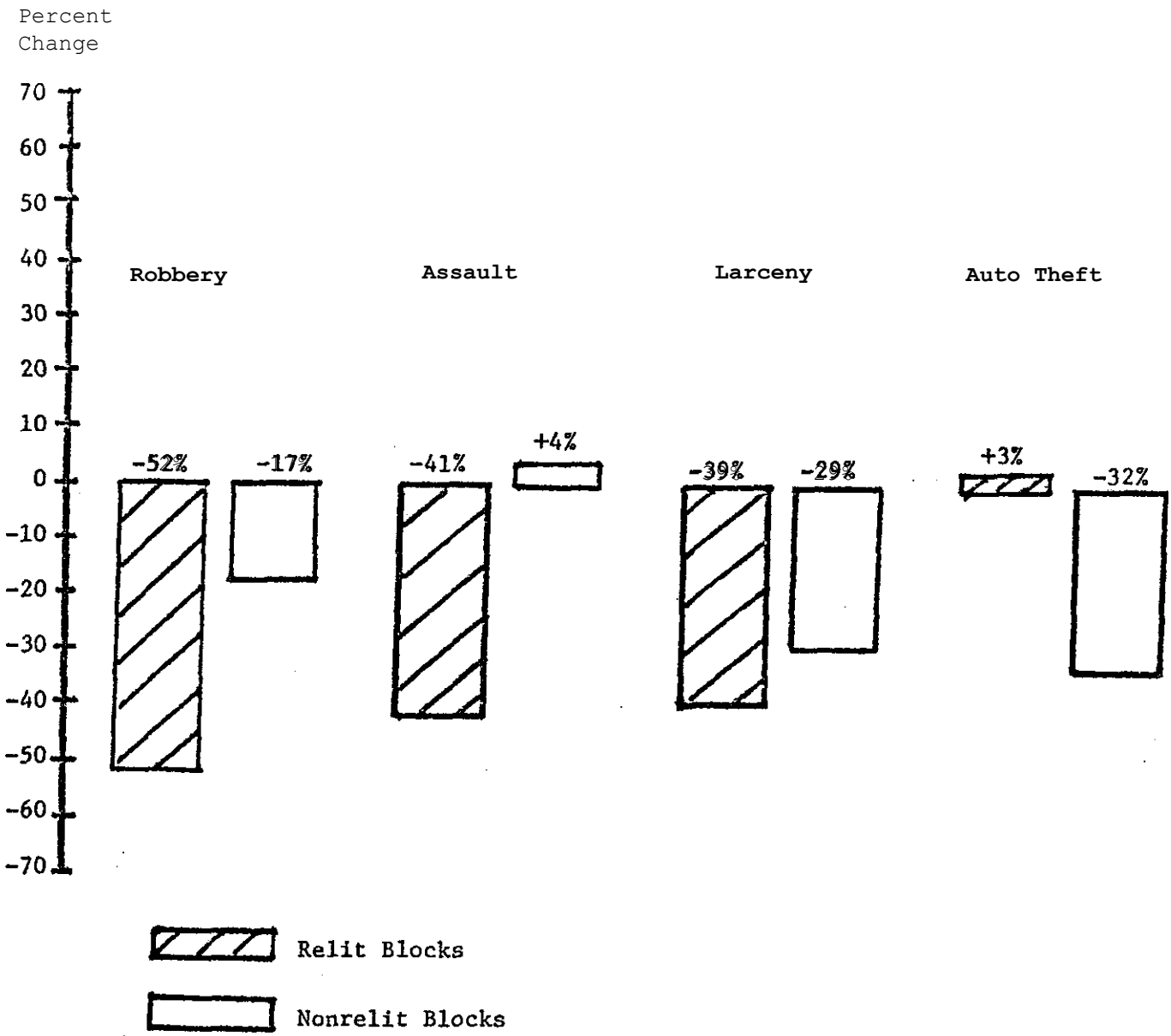
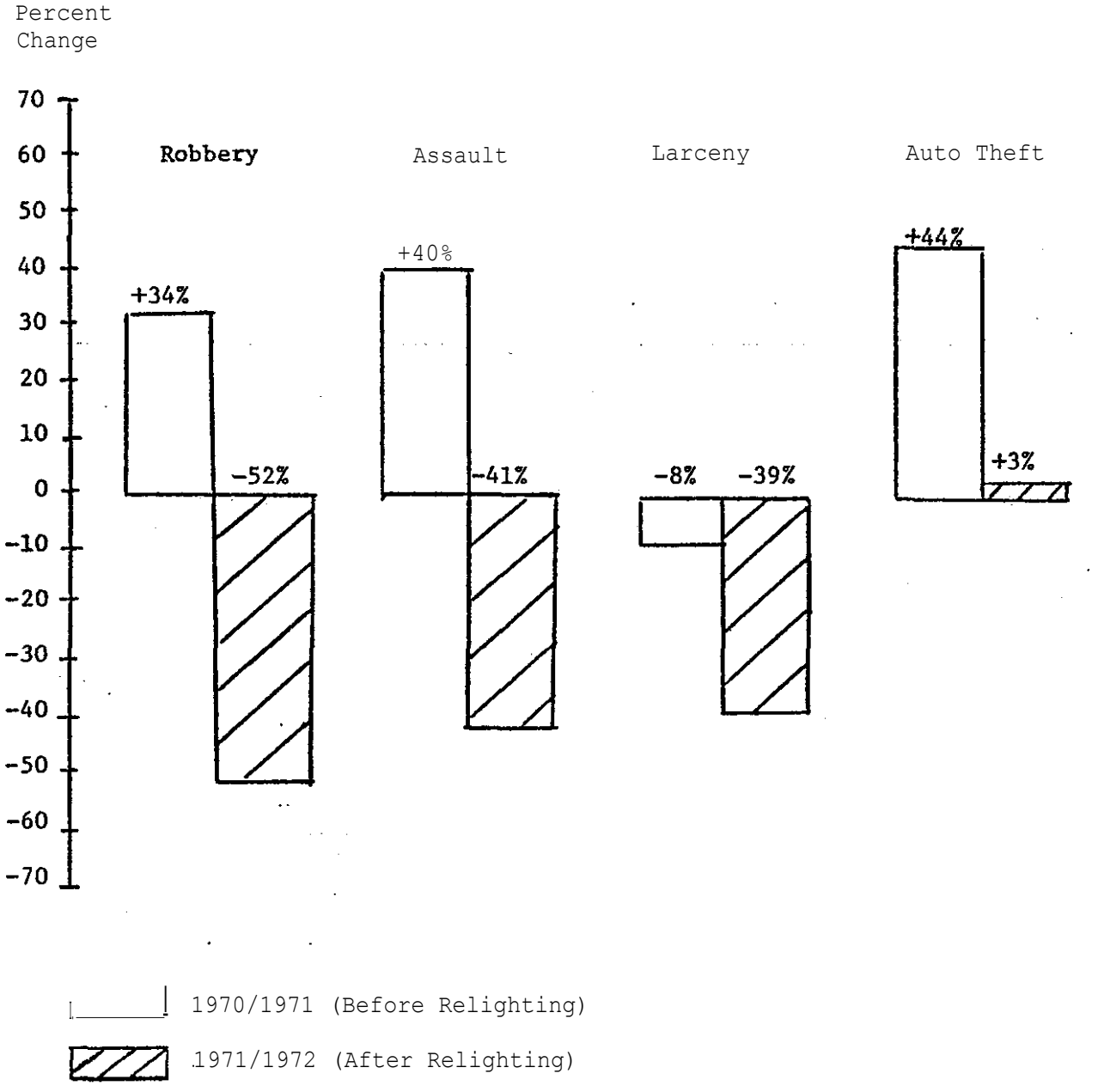


Figure 4-1. Percentage Change in Night Street Crime in Relit Blocks. (See also Table 4-2)



NOTICE OF ERRATA, PART 1

The attached pages (numbered 47, 50, 52, 83, 90, 92, 95, and 111) correct errors existing on the same-numbered pages in Part 1 of this report.

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THE IMPACT OF STREET LIGHTING ON STREET CRIME

SUMMARY

The crime-deterrent effects of upgrading street lighting from incandescent to mercury and sodium vapor were investigated in selected high-crime commercial and residential areas in Kansas City, Missouri, from 1970 through the first quarter of 1973. These effects were assessed by comparing changes in rates of night street crime following the upgrading program to changes prior to the upgrading program. Comparisons were also made to changes in crime rates in locations not affected by improved street lighting.

Results indicated that crimes of **violence-robbery** and assault--were significantly deterred, while crimes against property were largely unaffected. Prior to relighting, crime rates in blocks with commercial activity were considerably higher than in blocks with residential activity. Following relighting, crime decreased in these commercial blocks somewhat faster than in the residential blocks.

Displacement of crime was also investigated. A small. portion of the robberies appeared to relocate into blocks that were not affected by the upgrading program. Displacement of assaults could not be confidently determined because increases in areas not affected by relighting may have been due to the general citywide increase in this offense.

Recommendations are made for street lighting, both for energy conservation and for crime deterrence. Street lighting represents a very small amount of the total national energy consumption and thus a small potential for conservation, although some areas of savings are suggested. For crime deterrence, recommendations call for continual upgrading of street lighting, and are built around specific suggestions for crime type, crime location, other anticrime measures, and anticipated displacement,.

CHAPTER 1

INTRODUCTION

This is a study of the impact of street lighting on *street* crime in Kansas City, Missouri. This study assesses crime rates before and after installation of new street lighting in selected high-crime areas in the area south of the Missouri River. This area included the commercial downtown business district and a nearby area of mixed commercial and residential character.

Between October 1971 and March 1972, 1800 mercury and sodium street lights were installed in approximately 500 blocks in the downtown busines district and a mixed residential/commercial neighborhood. These lights replaced the older incandescent illumination in these blocks, as part of an ongoing upgrading or relighting program. These lights were installed at an approximate annual maintenance cost of $140,000 or $4.50 per light per month ($54.00 annually).

In order to assess the impact of street lights on street crime, crime records were examined for the 39 months from January 1970 through March 1973, for a sample of 1427 of the approximately 7000 blocks in Kansas City, Missouri. These sampled blocks included 129 of the 500 relit blocks. The 39 months under investigation were divided into three periods: (1) 21 months preceding relighting (January 1970 - September 1971); (2) 6 months of actual changeover (October 1971 - March 1972); and (3) 12 months following relighting (April 1972 - March 1973). Crime trends were examined for relit blocks and for a sample of nonrelit blocks.

This study was conducted under the auspices of the National Institute for Law Enforcement and Criminal Justice (NILECJ). In June of 1971, NILECJ initiated a 3-phase study to determine the deterrent effects of street lighting on street crime. Phase I and Phase II were supported by a direct grant to the Kansas City, Missouri, Department of Public Works, with a subcontract to The University of Michigan to develop and carry out this research. Phase III was supported by a direct grant to The University of Michigan. Kansas City was originally chosen because of its willingness to cooperate with the investigation, and its willing-

ness also to make use of the research design proposed by The University of Michigan.

Phase I developed a model of criminal behavior and of the relation of crime to street lighting. Procedures for data collection and sampling were developed and implemented. Some analysis was done comparing areas in Kansas City receiving relighting to areas that were not relit. Phase II developed better methods of measuring street lighting, including actual on-site measurements of footcandle levels, and specified the degree and nature of changeover from old to new lighting in the relit areas. In Phase III the research was completed and the final report prepared. In this last phase, described in this report, a longitudinal analysis was conducted in the relit areas, comparing trends in street crimes prior to relighting to crime trends afterwards, Trends were also investigated for street crimes in nonrelit blocks, as well as for non-street night crimes, and for day crimes.

During the course of this study there has been unlimited access to data and procedures in both the police and the public works departments. These data have been collected for the selected areas in Kansas City, Missouri, and matchmerged at the individual block level to establish a cohesive data-set amenable to statistical analysis.

This report presents the major findings on the impact of lighting on crime. More detailed and technical information on methods and results from this report project, particularly the methods of sample selection, data collection, and data management, are available in the technical appendices.

There are a number of people without whom this work could not have been done, and the authors are happy to acknowledge their indebtedness.

In the Kansas City Department of Public Works there were Mr. Myron Calkins, Director of Public Works; Mr. M.B. Flint, Public Services Engineer; and Mr. James A. Houston, General Services Engineer.

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CHAPTER 2

PURPOSE, BACKGROUND, AND PROCEDURES

A. Purpose.

The objective of this three-phase study was to test the hypothesis that street lighting deters night street crime; to investigate the types and character of crimes that are deterred; and to determine the kinds of neighborhoods in which this deterrent effect occurs. This study provides evidence and conclusions about the effects of lighting, and contributes substantially to the findings developed by previous investigations and conclusions.

This investigation is best understood in the context of the dramatic nationwide increase in crime that took place in the nineteen sixties, and subsequent attempts to fight crime by improving street lighting. Across the United States, cities and towns have initiated major programs of improving their street lighting. Reports from these areas with upgraded lighting generally show that crime is reduced following these lighting programs.

Kansas City was among the cities that experienced this dramatic crime rise in the nineteen sixties, and responded with a program of substantially improved street lighting. The effects of improved lighting in Kansas City, as in other areas, has been to substantially reduce certain target crimes. This report presents in detail the results in Kansas City.

The primary target for deterrent effects of street lighting consists of those crimes that occur at night and on the street. For purposes of this study, this class of crimes was limited to crimes that are generally considered serious, and are defined by the FBI's Uniform Crime Reports (UCR) as "Part I Crimes."

Effects of street lighting, or of any other anticrime program, are sometimes investigated only with regard to planned (as opposed to spontaneous) crimes. Planning is thought to include an evaluation of risk, and street lighting is considered to increase the risk or otherwise make crimes harder to commit. In this study, both categories--crimes that are generally considered planned, and crimes that are considered

spontaneous—have been investigated. Planned crimes are more likely to be property crimes, while spontaneous crimes are usually "crimes of passion" culminating in attacks on persons.

Effects of street lighting have been analyzed only for those crimes that occur frequently enough to allow meaningful statistical comparisons. Because the two most serious crimes (murder and rape) occur relatively infrequently, they have been excluded from analysis in this study. This is a limitation in the analysis.

In general, street crimes can be prevented at the level of individual action only by avoiding the streets entirely. This is unsatisfactory and, further, implies that a few offenders would effectively be allowed to terrorize and imprison the remainder of the populace.

Street robbery is of special interest in this study of effects of lighting on crime. It is one of the most frequent of Part I crimes, involves confrontation with violence or the threat of violence, occasional serious injury, and loss of money or goods of value. Since robbery is often a stranger-to-stranger contact, all strangers can be perceived as potential offenders, and use of the streets becomes all the more frightening.

The study also investigated crimes that occurred in nonstreet locations. Since the most frequent of these, burglary, sometimes involves elements of on-street activity, such as the act of illegal entry, or exit with stolen goods, burglary may be responsive to improved street lighting. In fact, a few studies have shown such a deterrent effect for burglary. It should be noted that burglaries have different characteristics, depending on whether the target is a commercial establishment or a residence. For this reason, burglaries are divided into two categories, commercial and residential. Residential burglaries are usually day crimes, as homes are empty when residents go to work, while commercial burglaries are more likely to be night crimes, as businesses close and are vacant for the evening.

B. Background: Crime and Street Lighting

1. Crime Trends

a. National crime trends The nineteen-sixties and early seventies were marked by a nationwide increase in crime rates, including street crime. Since 1967, armed robbery has increased 112%, while unarmed robbery (also called strongarmed) has increased more slowly (49%). In 1972, nearly one-half of all robberies occurred on the street, two-thirds of all robberies were committed by armed offenders, and the average loss in goods was $250.

Table 2-1 presents nationwide crime rates per 100,000 population for the years 1970 --1973, the period of investigation in this study. For year 1972 saw the first decline in crime rates for most of the crimes under consideration, although there was an increase in 1973, according to recently available figures.

For violent (or person) crimes, robbery reached its peak in 1971, dipped in 1972, and rose again in the following year but did not reach its peak 1971 level. Assault has continued to increase each year. Of the property crimes, larceny over $50 reached a new high in 1973, as did burglary, while auto theft increased but did not reach its 1971 peak level.

It should be noted that the UCR data do not allow for a distinction that is of interest here, between commercial and residential burglary. Additionally, it may be seen that robbery follows a pattern of increase and decrease that is closer to that of property crimes than to assault. This occurs even though robbery is a crime against persons and is often accompanied with considerable personal violence.

b. Kansas City crime trends Table 2-2 presents crime per 100,000 population in Kansas City, for the years 1970 - 1973, and for the crimes under consideration in this study. There are some similarities between these figures and the national ones, with a long rise followed by a peak in the early seventies, although for Kansas City, declines start to

Table 2-1. Selected Index Crime Offenses

per 100,000 Population Nationally

	1970	1971	1972	1973
Violent crimes				
Robbery	171	187	179	181
(percent change)		(+9%)	(-4%)	(+1%)
Assault, aggravated	163	177	187	198
(percent change)		(+9%)	(+6%)	(+6%)
Property crimes				
Larceny over $50	**861**	**909**	**883**	**918**
(percent change)		(+6%)	(-3%)	(+4%)
Auto theft	448	457	423	440
(percent change)		(+2%)	(-7%)	(+4%)
Burglary	1,071	1,148	1,126	1,205
(percent change)		(+7%)	(-2%)	(+7%)

After: Uniform Crime Reports for the United States: 1973

Table 2-2. Selected Index Crime Offenses per 100,000 Population, Kansas City.

	1970	1971	1972	1973
Violent crimes				
Robbery	588	487	412	460
(percent change)		(-17%)	(-15%)	(+12%)
Assault, aggravated	379	356	386	386
(percent change)		(-6%)	(+8%)	(0)
Property crimes				
Larceny over $50	1,328	1,213	1,245	1,256
(percent change)		(-9%)	(+3%)	(+1%)
Auto theft	1,098	1,065	772	765
(percent change)		(-3%)	(-28%)	(-1%)
Burglary	2,222	2,276	1,867	2,048
(percent change)		(+2%)	(-18%)	(+10%)

After: Annual Reports, Kansas City Missouri Police Department (1970-1973).

appear in 1971, a year earlier than in the national rates.

For violent crimes, robbery shows a sharp rise (67% from 1968 to 1970) in the years preceding this study, and a drop since then, until a rise occurred in 1973. Assault has shown a pattern of alternating rise and fall, differing from the national pattern of assaults. This rise and fall also distinguishes assault from the pattern of robbery. Simple assault follows the pattern of aggravated assault, and for purposes of this study, both forms of assault will be considered together.

Of the property crimes, larceny and auto theft have continued their drop from 1970, while burglary rose in 1973. As of 1973, larceny over $50 was combined with other larcenies, but adjusted comparison shows a continued decline. For purposes of this study, all larcenies will be considered together. This study will also consider the single category of auto theft, although there are some differences between theft for use, or joyriding, and theft for retention, or resale. UCR figures show that upwards of eighty to ninety percent of auto thefts are recovered, and so are considered as theft for use.

It may be seen that in Kansas City (as in nationwide data) robbery patterns do not closely follow those of assault, although unlike the nationwide data, robberies are also not similar to larcenies.

Crime rates per 100,000 population are considerably higher for Kansas City than nationwide. This probably reflects the fact that nationwide data are a composite of data from cities (which have higher crime rates) and from nonurban areas (which have lower crime rates), while the Kansas City data are city data exclusively.

2. Street Lighting. One response to this rise in crime in *the* nineteen sixties has been to improve street lighting. Since there is considerable feeling that darkness hides attackers, and reduces the likelihood of witnesses, brighter illumination is thought to make streets safer for pedestrians. Safety is enhanced by changing the climate--from one of fear of going out at night, to one of security because streets are lit and crime deterred. This change in climate results in more pedestrian traffic, which in itself provides an additional deterrent to criminals,

who prefer largely deserted streets, with only an occasional passerby for target.

Street lighting is justified by other benefits as well: by improving visibility for traffic and pedestrians and reducing nighttime vehicle-related damage, injury, and death; by improving the dark nighttime street environment to one of brightness and visibility, and by the very simple effect of helping people to find their way. Street lighting is also justified by raising night shopping activity, and thereby commercial revenues, and may enhance property values for homeowners.

The rapid rise in crime in the last years of the sixties has been a stimulus for implementing street lighting as a primarily anticrime-measure. Substantial sums have been spent, and the night character of streets has been changed, and yet little systematic research has been done using adequate controls and other methodological safeguards. The purpose of this study has been to implement these controls and other procedures to more accurately assess the effects of street lighting as an anticrime aid.

a. Other programs nationwide As part of this research, reports of other street lighting anticrime projects were reviewed. In general, it is clear that street lighting represents a large expenditure of money for both installation and maintenance, and a substantial energy expenditure as well. This latter has only recently become salient, during the period of energy shortages. The magnitude of street lighting programs in the U.S. may be indicated by the regular presence of an "Outdoor Lighting" section in American City, a monthly journal for city planners and urban managers. In that section, street lighting projects are reported as they are instituted. Within the reports there is large variation among reported' costs, depending on'whether installation is reported separate from maintenance, and depending on the size of the area to be relit, as well as the type and size of fixture chosen. New York's six-year (1958-1964) relighting program probably represents the upper limit of expenditure. At a cost of $28 million, 5,800 miles of streets were relit, with mercury vapor fixtures replacing incandescent. In Kansas City, Missouri, street li[g]htin[g] annually costs about $2.000.000, or $150,000 per month, for 30,000 fixtures. The annual cost is less than four dollars per capita, or $285 per block.

b. The Kansas City relighting program The 1800 fixtures installed in this relighting program replaced an approximately equal number of incandescent lights. These old incandescent lights produced an average level of maintained footcandles that was estimated by the Kansas City Public Works Department as being less than 0.1 footcandle. This is considerably lower than the recommended standards of the Illuminating Engineering Society (IES) of 0.4 or more footcandle for residential streets and 0.9 to 1.6 footcandles for commercial areas

For the most part, old lighting was of the 225-watt, 4400-lumen type incandescent, with some 330-watt, 6000-lumen bulbs. The new lighting consisted of two types of mercury fixtures, and one type of sodium, described as follows.

-Mercury vapor "cobra head" luminaires: These fixtures are widely used, primarily to illuminate trafficways and major commercial streets. They take their name from the shape of the luminaire. These fixtures direct their light primarily onto the street, rather than the sidewalk. These lights range from 11,000 lumens at 250 watts, to 20,000 lumens at 400 watts, to 20,000 lumens at 400 watts. The larger bulbs are more prevalent.

-Mercury vapor "crime fighter" luminaires: These fixtures are designed to cast an elliptical or football-shaped light pattern, and are used to light up sidewalks and front yards, as well as streets. This feature is important, since "street" crime is usually sidewalk crime, with doorways or front yard obstructions providing cover for attackers. The mercury "crime fighter" was initially used in the mid-1960's in Chicago's extensive program of relighting alleys, where the emphasis was exclusively for crime deterrence and not at all for traffic illumination. These 7700-lumen lights, rated at 175 watts power, constituted more than half of all upgrading.

-Sodium vapor lights: Only one type of sodium light was used. These 400-watt bulbs ranged from 42,000- to 44,000-lumen ratings, although more recent changes in design now produce over 50,000 lumens from this size bulb. These lights are *very* bright, and (unlike the mercury lights) permit identification of facial features and clothing color.

Sodium lights were used for the downtown business district, and constituted about a third of the fixtures in the relighting program.

3. Lighting Impact on Crime.

a. National review. An extensive summary of reports on street lighting and crime is presented in Appendix B. The overall thrust of the studies is that street lighting is effective in reducing street crime (although there are a few reports that show either no change associated with lighting, or an actual crime increase). The studies vary as to what factors are reported, whether police crime data or other measures of crime are used, and whether the reduction of crimes is for all crimes or for the logical target of night street crime. The simple total of all crime is more available but less relevant than the subcategory of night street crime.

The reports also vary on how control areas are defined. A control area is necessary in order to determine if crime reduction in a relit area is due to street lighting or is associated with other factors (the most usual of which is an increase in police patrols). Some studies use adjacent streets as a control area, others use citywide or nationwide crime rates. Some use similar cities.

It is **also** important to consider crime rate trends prior to relighting. Lighting may be associated with an increase in crime and appear unsuccessful when in fact lighting may have slowed the rate of increase, and thus may represent some degree of success. Similarly, lighting may be associated with a decline in crime and appear successful, when in fact, there was a reduced rate of decline, and thus some degree of failure. Use of prior crime rates is important, but adds some further complexities to the analysis, and is accordingly included only rarely. This prelighting crime trend is sometimes referred to as a baseline, or base period.

The reports themselves are presented in various forums. Since lighting upgrading programs are sometimes in response to civic pressure, or community volunteer groups, results are often presented in reports oriented to those groups. These are often concerned only with results

and have little methodological rigor. Other reports come from the press, as crime makes news. Lighting companies conduct their own studies of product effectiveness and report these in their company journals. City management journals (such as Arerirag CiW, noted above) present some reports but mostly describe the programs--number and type of fixtures--and not results. Police departments keep records of crime statistics and publish digests that can be used to assess lighting impact. For the most part, published reports are primarily concerned with a simple statement of results, and show little concern with reporting the methods of determining these results. In general, absence of description of methods makes it difficult to systematically compare reports, or even to specify exactly what changes have occurred. More recent studies, however, have presented more careful reports than earlier studies. The most useful reports on the impact of lighting come from lighting or public safety or traffic departments in municipalities where lighting has been upgraded. These reports are often quite competent and detailed. They are also generally unpublished, and are obtained only by individual contacts with the appropriate departments. In a nationwide review of lighting studies, collection of these reports can become a substantial project.

b. Street lighting and street crime in Kansas City: some questions. The logical target for the impact of street lighting is the set of crimes that occur on the street at night, under cover of darkness, where street lighting can dispel darkness. This section presents some general questions and considerations about the impact of street lighting on these crimes, and the mechanisms operating to effect any observed changes.

What are the crime-deterrent effects of lighting? Do these effects vary by type of crime? Are those crimes that are usually considered planned more deterrable (because of an assessment of increased risk due to lighting) than are crimes usually considered unplanned, or spontaneous? Are property crimes deterred while person crimes are not? The issue of night street crime deterrence can be understood only by contrast to other types and other sites of crime: is there an equal impact on night street crime in areas without relighting; or in the relit areas during the day; or in the relit areas at night, but only for offstreet crime?

Each of these contrasts further isolates the unique character of lighting impact on night street crime.

It is sometimes thought that street lighting, or any anticrime measure operating in any one area, works to reduce crime in that area by relocating it, or displacing it, elsewhere. Within the Kansas City data, what displacement indications are there? Do crimes displace from relit to nonrelit areas, or from night to day, or from street to nonstreet? Or is there a displacement across types of crime: e.g., a shift from street robbery to offstreet robbery is a shift of location; a shift from street robbery to street larceny is a shift from a violent crime to a property crime; a shift from street robbery to burglary is a shift of type and location of crime.

Burglaries of residences occur more often during the day, as people vacate residences to go to work or school. Consequently, if lighting produced a shift from street robbery to residential burglary, the shift would be from night to day, from street to nonstreet, and from person (or violent) crime to property crime.

Some types of neighborhoods have higher crime rates than others. Blocks with commercial establishments, and presumably with pedestrian traffic such as shoppers, or late-hour employees going home, have higher rates of street crime, compared to blocks that are exclusively or primarily residential. What is the differential impact of lighting on these two types of blocks?

If lighting has a deterrent impact on crime, it is of interest to determine if some characteristics of lighting are more significant than others. Does the type of lighting--usually a choice between mercury and sodium vapor--make a difference for crime impact? Are illumination characteristics, such as footcandles or uniformity, related to crime impact? These questions are directly pertinent to an anticrime strategy of resource allocation, of where and how many and what type of street lights to install.

Implicit in these questions are some general theoretical assumptions about how lighting works to reduce crime. In one model, increased

lighting makes criminal acts more visible, either to police or to other witnesses who may intervene or call the police. Since these acts are more visible, and the likelihood of either police intervention or intervention by others increases, the risks to the offender who commits street crimes increase. Potential criminals are aware of this increase and are deterred. In this model, the risk is increased and the increased risk is directly perceived; it is the perceived increase in the risk that deters criminals. (By contrast, a hidden detection system would increase the risk, but not the direct perception of risk.)

Alternately, but in a similar manner, this perception of the increased risk for criminals is shared by potential victims and others who use the streets. This perceived increase in risk for offenders suggests increased safety for users, and results in more pedestrian use of streets. In this model it is this mechanism alone (increased pedestrian traffic) that actually accounts for a reduction in crine, by increasing the number of potential witnesses, or individuals who might intervene or might call the police.

Reports from crime scenes tend to confirm the accuracy of these perceptions about how lighting prevents crime, but it should be noted that a street criminal contact is still a relatively rare occurrance, and the chance of being interrupted by witnesses or police patrols is still small.

There are at least two other ways in which lighting may affect crime, and these may be part of the general perceptions associated with lighting. (1) Increased visibility may work to alert pedestrians to specific potential offenders sufficiently in advance to allow for evasive action--such as crossing the street. This possibility is derived from the findings of Feeney and Weir (1973) that as many as half of the robbery victims interviewed in their survey knew they were about to be robbed, when they saw the assailant approach or await or overtake them.

(2) Lighting may also work to make streets safer by a very different mechanism. Some reports of lighting programs indicate that offenders may be more easily identified because of better lighting, and that this results in increased apprehension and courtroom identification. Thus the streets

may be made safer simply by clearing the streets of criminals.

The mechanisms through which lighting deters crime may all be related to increased citizen participation, at the initial level of alerting the police, and at other stages in the criminal justice process, including being conscientious witnesses. No anticrime measure alone is successful without citizen cooperation.

C. Procedures.

In order to assess the effects of light on crime, a sample of 1427 blocks was drawn from the total of approximately 7000 blocks in Kansas City. The sample was thus approximately twenty percent of the total number of blocks. A total of about 500 blocks received relighting during the current relighting program, from which 129 blocks were included in the 1427-block sample. These 129 relit blocks represent about one-fourth of the relit blocks, but only about nine percent of all the blocks in the city. The relit blocks, then, were somewhat oversampled.

1. Sampling. The sample was drawn to represent all of Kansas City. The areasof special interest (the areas that received relighting and their nonrelit adjacent areas) were overrepresented, while the outlying areas in the city were underrepresented. The sampling procedure assigned blocks to various levels, or strata, according to several demographic characteristics sometimes associated with crime. Blocks were also assigned to strata according to the kind of street lighting that existed prior to relighting. Within each of these levels, blocks were randomly chosen. The sampling is described in detail in Appendix C.

Kansas City is composed of about 7000 blocks, and from these a sample of 1427 blocks (or about 20%) was drawn. These 7000 blocks included 500 that were relit, from which 129 (or about 25%) were drawn. Relit blocks were of special interest to this study, and were accordingly somewhat oversampled. The 500 relit blocks were primarily composed of 400 relit with mercury, from which 93 (or 23%) were drawn. The remaining 100 relit blocks were relit with sodium, and from these 36 (or 36%) were drawn.

2. Control. In order to compare changes in relit blocks with crime changes in nonrelit blocks, one further procedure was implemented. This involved designating as control blocks a subset of all the sampled, nonrelit blocks in Kansas City. This designation was necessary because of the great variation between nonrelit blocks in different parts of the city. Since nonrelit blocks varied, it would have been misleading to compare all relit blocks to all nonrelit blocks. Instead, relit blocks were compared to the subset of nonrelit blocks having similar demographic characteristics.

3. Nine Areas. This designation of similar nonrelit blocks was done by dividing Kansas City into nine areas that had distinct characteristics. This division attempted to follow neighborhood and historical qualities, and to make use of Census data collected at tract level. As it turned out, four of these nine areas received relighting, and five *did* not. For purposes of comparison to relit blocks, only the nonrelit blocks in the four relit areas were chosen. All 129 relit blocks and 600 nonrelit blocks, or a total of 729 blocks, were included in the four relit areas. The remaining 698 blocks, all nonrelit, *were* located in the five nonrelit areas. Of the 600 nonrelit blocks in the relit areas, 21 were relit at other times.

These nine areas of Kansas City are discussed in Chapter 3, which describes the relevant characteristics of Kansas City and of the nine areas in particular.

4. Four Relit Areas. The four relit areas were collapsed into two, with the effects of lighting on crime studied separately for each of these two new areas. One of these new areas was the city core (CC) and included the central business district, while the second was the aggregate of three remaining relit areas. This 'second al-ea was called the residential upgrade (RU) because of its large residential component, and included the residential/commercial area. For three reasons, effects of lighting on crime were assessed separately in the RU and CC areas, rather than for either the aggregate of all four relit areas or each of the four separately.

-The city core included the downtown business sector, and had little night street traffic, while the residential upgrade area was primarily residential with some mixed commercial activity, and had more night street traffic.

-The city core had been relit by sodium lighting, while the RU was relit with mercury lights.

-The city core had some of the highest crime blocks in the city, and had previously (1968-1969) received sodium relighting in some blocks. Accordingly, the city core relighting program was in some respects a supplementary relighting program, while the RU was being upgraded for the first time. Some of these previously relit city core blocks fell into the control block sample, and so the CC sample was not totally comparable to the RU sample.

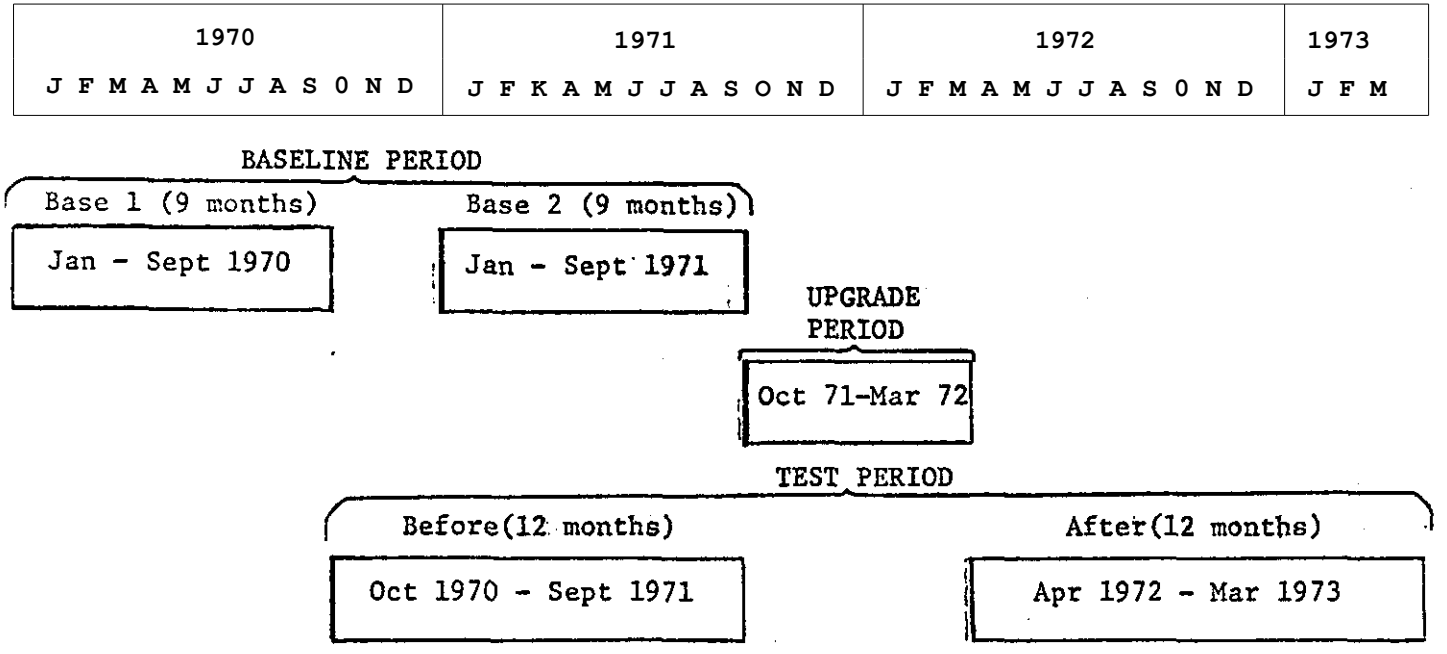
For these reasons the city core area was considered separately from the residential upgrade area. Notwithstanding these differences between the two areas, results on the impact of lighting in each were largely similar, and so the use of these two areas serves to some degree as a built-in replication. Since the pattern of results was similar, results for the two areas were combined and are reported together.

5. Crime Data. Crime data were collected over a 39-month period, from January 1970 through March 1973. (See Table 2-3.) The first 21 months, January 1970 through September 1971, preceded relighting. The next six months, October 1971 through March 1972, were the months of actual changeover from old to new lighting, for the bulk of relighting. The final twelve months, April 1972 to March 1973, followed relighting.

Crime data were compared from 1970 to 1971 to establish a baseline of crime trends prior to relighting. Comparison of crime rates from 1971 to 1972 and the first three months of 1973 indicated changes from before to after relighting.

Crime data were considered for both relit and nonrelit blocks, allowing for comparisons of change over time in these two sets of blocks. Crime data were also considered for night street crime, which is the set

Table 2-3. Division of the 39 Months of the Study Into Baseline, Upgrading, and Test Periods.



Note: Baseline Period compares nine-month periods.
Test Period compares twelve-month periods.

of crimes that are considered the logical target of street lighting. As an additional contrast, night crime that occurred offstreet, and day street crime were also analyzed for change over time.

6. Night and Day. "Night" was defined for night street crime as the hours of darkness, and consequently varied according to seasons, with more hours of darkness in the winter, fewer in the spring and fall, and fewest in the summer. Hours of darkness for the winter months of November, December, and January were from 5 p.m. to 7 a.m. For the summer months of May, June, and July, they were from 7 p.m. to 5 a.m. For the spring and fall months remaining, hours of darkness were from 6 p.m. to 6 a.m.

"Hours of darkness" refers only to largely or totally dark skies. Dusk (which was defined as the two hours preceding dark), and dawn (defined as the two hours following dark), were considered as part of "day".

7. Blocks vs Blockfaces. It should be noted that the unit of analysis is the entire block, and not the side of the block (blockface) that was relit. This unit was chosen because of characteristics of the data, which located crimes` according to block, and not blockface. Blocks are identified by Census designations.

One consequence of using blocks, rather than blockfaces, is that an entire block is considered as relit even when only one face is relit. Similarly, a light on a street relights both sides of that street, and so both blocks are counted as relit. Lights at intersections relight parts of four blocks, and so four blocks are counted as relit.

This is a limitation in the design. However, since relighting occurred on adjacent streets, blocks that were relit were, for the most part, relit on all four sides. Relighting occurred in approximate rectangular areas so that only the blocks on the perimeters of these relit rectangular areas were partially relit. Of the total of 500 relit blocks, some 100 were perimeter, or partially relit blocks. Of these, the sample included about 25.

8. Street vs Nonstreet. Street crime was defined as all crime occurring outside buildings. Thus, street crime includes not only

offenses occurring on pedestrian and traffic thoroughfares, but also in alleys and other nonenclosed areas such as driveways, yards, parks, and school yards; and includes assaults on vehicles left in open places.

CHAPTER 3
DESCRIPTION OF KANSAS CITY

A. Introduction to Kansas City.

1. Geography. Kansas City, Missouri, is located along the western border of Missouri, at the junction of the Kansas and Missouri rivers. It is located within 250 miles of the geographic center of the United States. The city lies in three or the counties--Clay, Jackson, and Platt--of the seven-county Metropolitan Region, or Standard Metropolitan Statistical Area (SMSA). Between 1947 and 1963, Kansas City grew from 60 to 316 square miles through annexation. Figure 3-1 presents a map of Kansas City, indicating the expansion through annexation.

2. Population. The SMSA population for the 1970 Census was roughly one and a quarter million people, ranking 26th in the nation. Forty percent of the people, slightly over half a million, are located in Kansas City, Missouri, in 191,907 dwelling units. Average population density is approximately 1600 people per square mile. Median age is thirty years. (Age and sex distribution is presented in Table 3-1.) Of interest is the fact that for street robbery, the age group 15 to 24 years is associated with offender populations, and the age group 50 years or over is associated with target populations.

3. Racial Composition. The 1970 Census reports Kansas City to be 78% white, reduced from 82% in 1960. Most of the decline in the percentage represented by the white population has been produced by an increase in the black population. Although most of Kansas City's black population lives in the inner city, black population increases have caused their expansion into areas adjacent to the inner city (i.e., into the southeastern city), as well as an increase in the population density in the inner city area.

4. Economy. The economic base of Kansas City is diversified. Table 3-2 presents a breakdown by type of industry for 1970 data. Relatively small changes are projected in the size of each segment of the labor force.

Figure 3-1. Kansas City, Missouri; with Growth Through Annexation

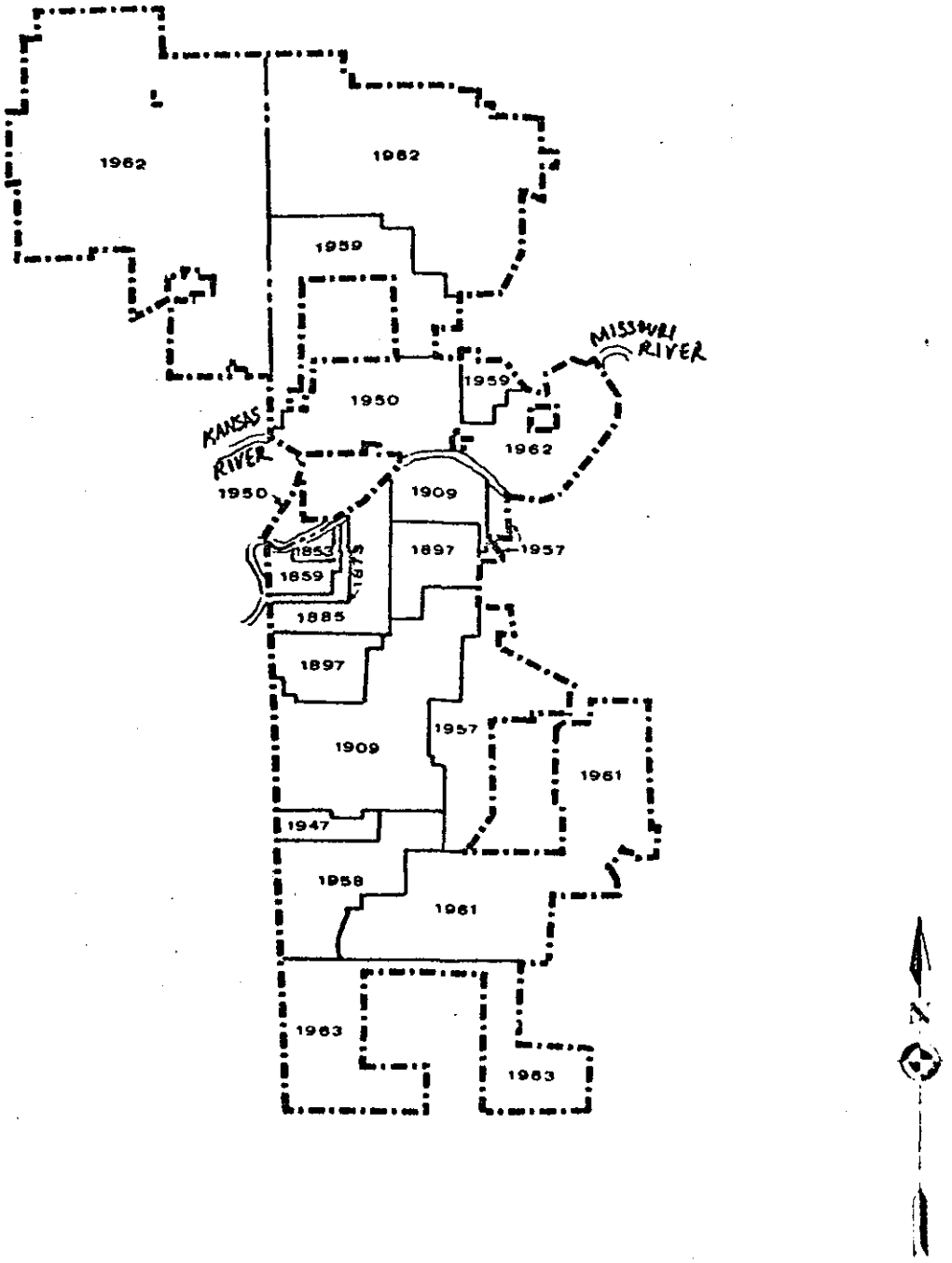


Table 3-1, Age and Sex Distribution of the

Kansas City Missouri SMSA, 1970

Age	Percent of Males	Percent of Females
0-14	31	28
15-19	09	09
20-24	07	08
25-34	14	13
35-49	18	17
50+	22	**25**

After: Mid-America Regional Council (MARC), Estimates and Projections, 1973 Population and Employment: Kansas City Metropolitan Region. October, 1973, p. 13.

Table 3—2. Kansas City Metropolitan Region

Employment by Industry Type, 1970

Industry	Percent of Labor Force
Industrial[1]	41.81
Services[2]	18.83
Retail Trade	15.37
Government	12.10
Agriculture	1.76
Mining	0.13
Unclassified	10.00
Unemployed	4.90

(total labor force 597,000)

[1] Construction, manufacturing, wholesale trade, transportation, communications and public utilities.

2 Service, finance and real estate.

After: Mid—America Regional Council, Estimates and Projections, 1973 Population and Employment: Kansas City Metropolitan Region. October 1973, p. 29.

5. Land Use. In the area south of the Missouri river, the city is characterized by a downtown area of commercial office buildings and an outer area of mixed commercial and residential use. North of the river and further outlying in the south are suburban areas. Some of the residential/commercial areas surrounding the downtown central business district contain the primarily black areas, although there are white enclaves with old ethnic traditions in this area. Relighting occurred for the most part in this downtown business and adjacent residential/commercial area.

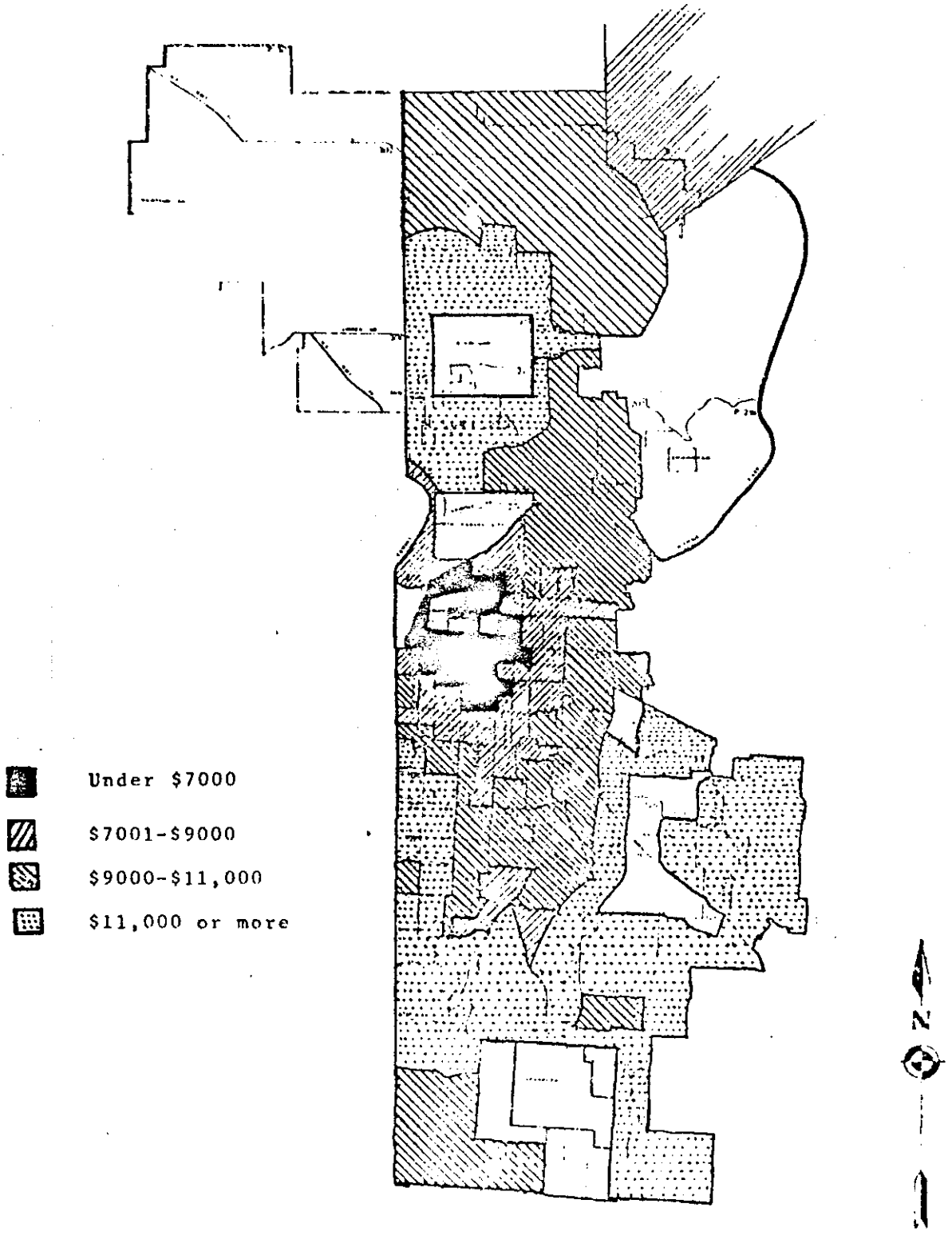
6. Demographic Distribution. Census data at the tract level were used to analyze Kansas City for three important demographic characteristics: median family income, percentage black population, and percentage elderly. Maps with distributions of these three variables are presented in Figures 3-2 through 3-4. The income distribution map (Fig. 3-2) shows that the poorest live in the center of the city, in the area south of the river. This area includes families in the lowest category, with less than $7,000 per year median income; and those in the next category, with $7,000 to $9,000.

Figure 3-3 presents racial composition in the city. There is substantial overlap between those areas with low annual incomes and those areas with predominantly or substantial black populations--blacks are also more concentrated in the center of the city, in the area south of the river.

Figure 3-4 presents percentage elderly (defined as 62 years or older). This variable is of interest in that the elderly are prime targets for street robberies. Only a few areas fall into the highest category with 30% or more of the residents in any census tract above **age** 62. In the next category, 20% to 29%, elderly, there are a larger number of census tracts. Many of these are also in the center of the city area.

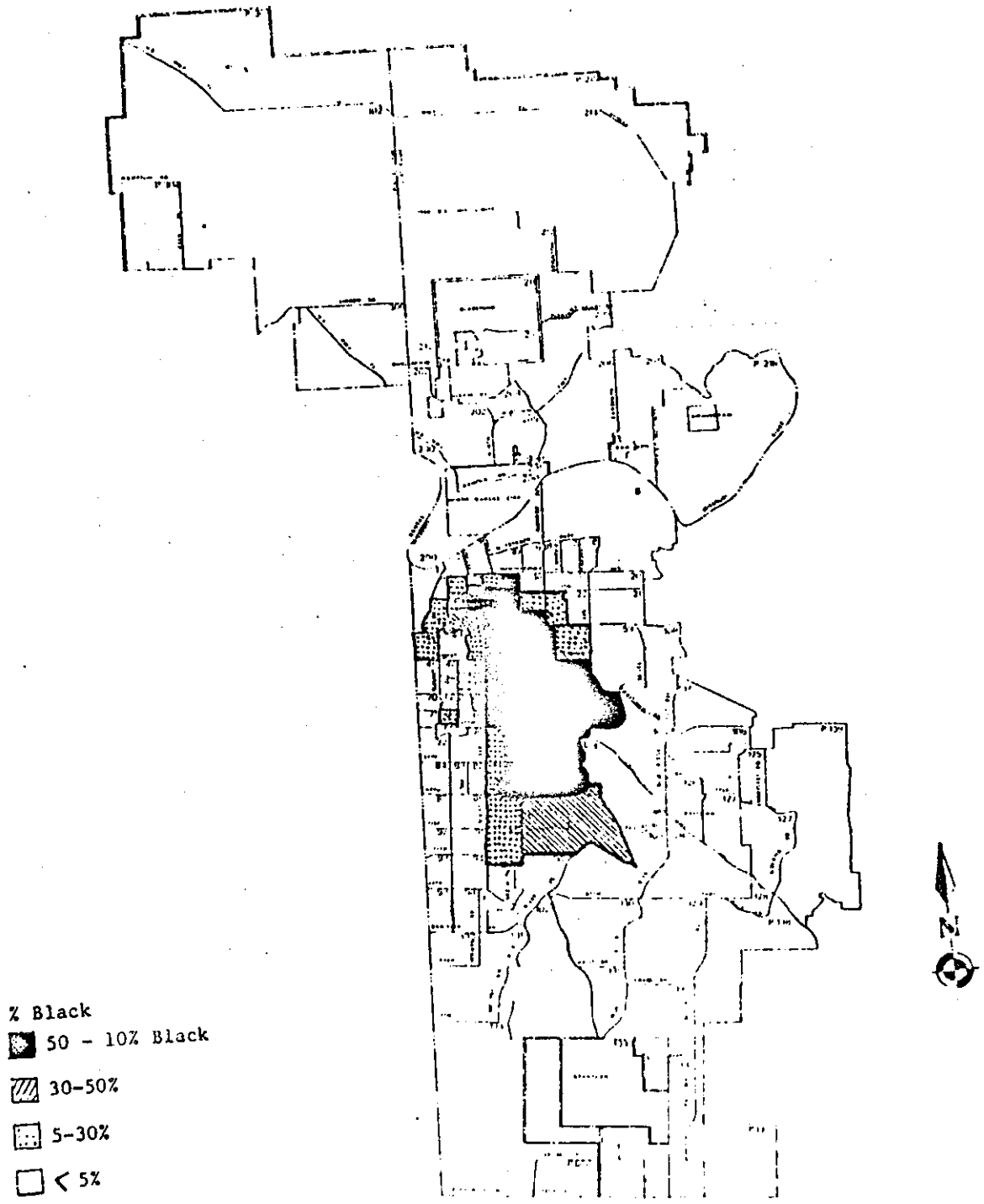
From these maps it may be seen that these three characteristics, which are sometimes associated with crime rates, cluster roughly in the central area in Kansas City south of the Missouri River.

Figure 3-2. Median Family Income, Kansas City



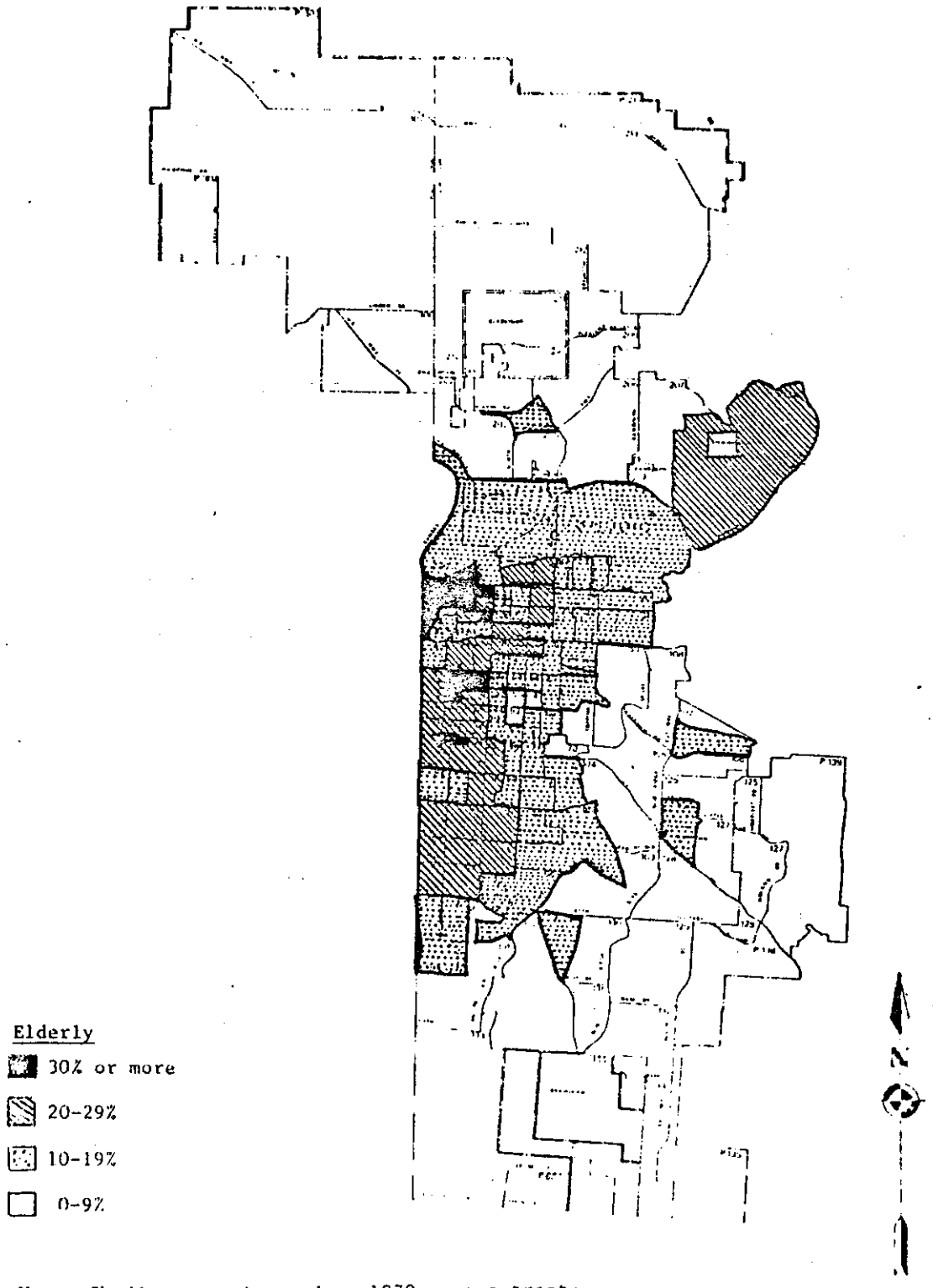
Note: Shading superimposed on 1970 census tracts

Figure 3-3. Percentage Black Population in Kansas City.



Note: Shading superimposed on 1970 census tracts

Figure 3-4. Percentage Elderly in Kansas City



Note: Shading superimposed on 1970 census tracts

7. Crime Locations in Kansas City. Figure 3-5 presents the Kansas City police patrol zones. These zones differ in geographical size but are equal in police resource allocation. Since much of police resource allocation is based on crime rates, the smaller area (Zone III) may be seen to, have a greater geographical concentration of crimes. Accordingly, this is considered the high crime area. Zone III coincides with the area of commercial/residential relighting, and also with a concentration of some of the crime-related census measures presented in the previous figures.

B. Nine Areas of Kansas City

1. Introduction. The nine areas of Kansas *City,* as finally delineated by tract-level Census data, and other information, are presented in Figure 3-6. The areas were numbered sequentially from north to south. Relit blocks were located in four of these nine areas, roughly in the middle of the city. The four relit areas were:

Area (2) City core, relit with sodium vapor lights
Area (4) Urban white northwest, relit with mercury vapor lights
Area (5) Urban black core, relit with mercury vapor lights
Area (6) Urban black expansion, relit with mercury vapor lights

The five nonrelit areas were:

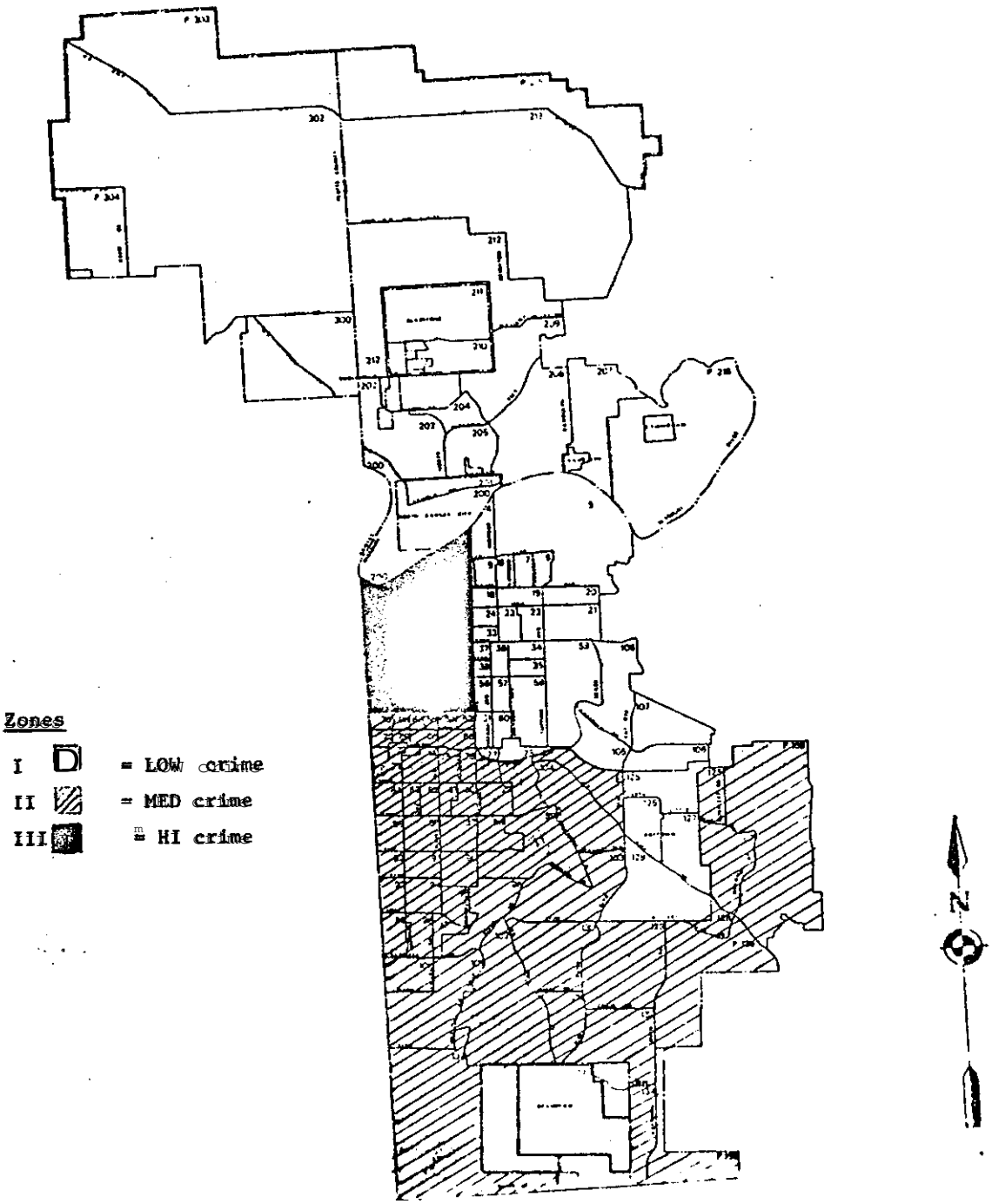
Area (1) Suburban white northwest
Area (3) Urban white northeast
Area (7) Urban white high income
Area (8) Urban white south
Area (9) Suburban white south

These nine areas are described briefly below, with the relit areas described first.

2. Four Relit Areas. The relit areas (Areas 2, 4, 5, and 6) are in the area of Kansas City south of the river, and are presented in Figure 3-7.

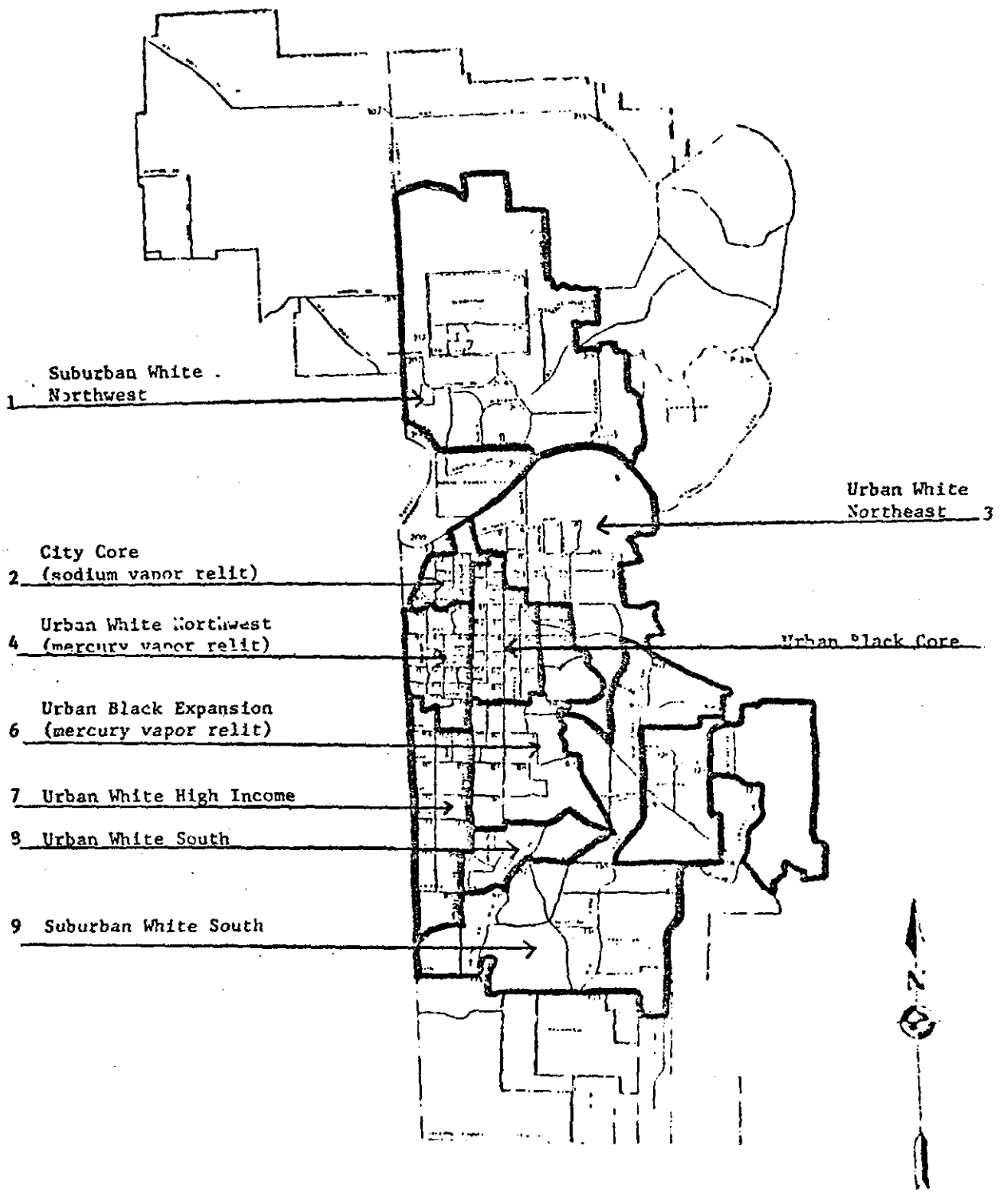
a. Area 2: City core. The area referred to as the city core is located in the *northwestern* corner of Jackson county at the intersection of the Kansas and Missouri Rivers. The city core contains tracts with the

Figure 3-5. Police Zones of Kansas City



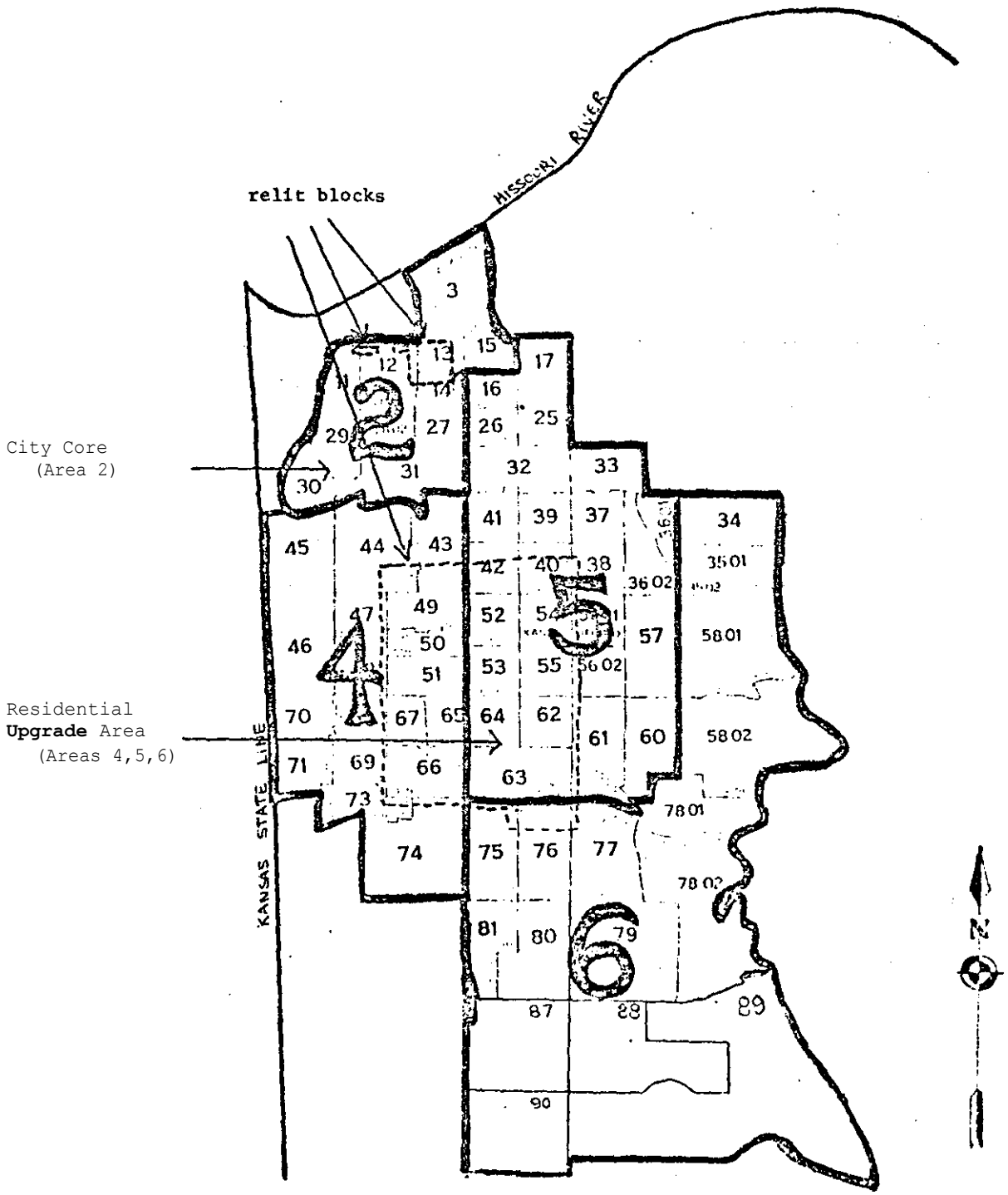
Note: Shading superimposed on 1970 census tracts

Figure 3-6. Nine Areas of Kansas City



Note: Map shows nine areas superimposed on 1970 census tract boundaries.

Figure 3-7. Location of Relit Blocks in Relit Areas



Note: Map shows relit areas superimposed over 1970 census tract boundaries

lowest median family income in the city and a large proportion of elderly. Racially, the area is mixed.

The city core appears similar to the core region of other large cities. That is, the city core contains an aging central shopping and commercial area, public and government buildings, multi-unit residences, and an overrepresentation of the low-income elderly in its residential population. It is the oldest part of the city and contains the central business district (CBD) and its surrounding tracts.

Land use in the CBD is mostly commercial, including offices, large retail establishments, warehouses, and some light industrial developments. In addition, there are a number of large public buildings, such as city hall, and public parks. The commercial activity is typical of a downtown area, again, largely because the land values are so high that only very large or significant activities, such as department stores or the headquarters of a company, are located there. Even though the area is well lit, the CBD is not considered a vital downtown area, and few of the stores are open at night. The land values are so high that the residential use is for the most part confined to large, multi-unit dwellings of ten or more units. The rents reflect a tremendous variation in the quality of these units; on some blocks, rents average as low as $43 per month, and on others the average is as high as $167. The racial character of the blocks varies also, some being as high as 93% black, but many having no blacks at all.

The surrounding (western and northern) tracts contain industrial area, particularly the stockyards and meat-packing establishments of Kansas City. Railroad yards crisscross these tracts.

b. Area 4: Urban white northwest. Area 4 lies southwest of the city core region; its boundaries follow tracts 43 through 45, and 71 through 74.

The population characteristics of this area are varied. The area is mostly white with an income level falling in the range $5,000-$11,000. The area contains part of Kansas City's Spanish-American population. Four census tracts contain a high proportion of elderly.

Generally, it is considered to be a mainly white, low- to medium-income area, with an above-average proportion of elderly residents. This area has been the target of lighting improvements, and is one of the three areas combined to form the larger "Residential Upgrade Area (RUA)."

c. Area 5: Urban black core. The Urban black core lies in the north central section of Jackson County. It is southeast of the city core with its central business district. It is comprised of twenty-four census tracts.

The population is almost entirely black. The income level ranges from low to medium ($5,000-$9,000) with the majority of tracts falling within the $5,000-$7,000 range. This is the oldest black area of the city.

This area has been the focus of many renewal projects. It is primarily residential, much of it in deteriorating condition. It is estimated that between 35-50% of the housing is substandard, although in some areas it is much higher. Urban renewal literature describes this section as an area of low education and income, with a high percent of welfare recipients, and a declining **population**, particularly in the wage-earning section of the population. This is the second area included in the larger residential upgrade area.

d. Area 6: Urban black expansion. This area is directly south of the urban black core. It is characterized by single-family dwelling units. The income range is primarily middle income, falling within the range $7,000-$11,000. Racially, it ranges from almost all black in the northern census tracts to less than 30%, black in a few of the southern census tracts.

The most interesting historical aspect of this area is that during the decade of the sixties it underwent a rapid transition from a predominantly white residential area to a predominantly black family area. This is the third area included in the larger residential upgrade area.

3. Five Unrelit Areas. The unrelit areas (Areas 1, 3, 7, 8, and 9) are immediately north of the Missouri River and in the northern and southern suburbs.

a. Area 1: suburban white north. The boundaries of this area are those of Clay County, which lies north of the Missouri River. It is generally an area of single-family housing units with some light industry scattered throughout. The median family income ranges from $7,000 up, with the modal range being $9,000-$13,000. Racially, the area is almost totally white.

The small percent of elderly and the greater than average percent of children 18 years of age or younger suggests that this is a stable residential area. As previously mentioned, there are industrial areas in this section, but in the southernmost region, these are generally concentrated along the Missouri River.

The northern section has experienced rapid growth in the past decade. In general, this area can be characterized as a white, middle-income residential suburb.

b. Area 3: Urban white northeast. This area encompasses the census tracts in the northeastern corner of Jackson County. On the east, its borders are the city limits, and to the west lies the black urban core. It is generally an area of single-family housing units with industrial areas and railroad yards on the sourthern border of the Missouri River.

The residential population is mostly white with the median family income falling in the $7,000 to $11,000 range. The proportion of elderly is roughly similar to that of the citywide area.

Historically, this area was once the site of a stable Italian-American residential population. Over time, the young have moved elsewhere and presently this area is in a decline.

c. Area 7: Urban white high income. This area edges the Kansas-Missouri state line. It is a small area consisting of thirteen census tracts.

The population is mainly white, with income levels ranging from medium to high. The dwelling units are predominantly single-family, owner-occupied, of high value.

A number of cultural and educational institutions are located on the eastern edge of this area.

d. Area 8: Urban white south. This area is very small, consisting of only four census tracts. Ic lies south of Area 6 (urban black, expansion). It is mainly white, with income levels falling within the $7,000-$11,000 range. It is defined separately because of some unique characteristics. An industrial area and parks fall within its boundaries.

e. Area 9: Suburban white south. Like its counterpart to the north (Area 1), this area is fairly well described by its title. The population is almost all white with incomes ranging from $9,000 on up. The housing is primarily single-family, owner-occupied, and of high value. It is a stable suburban residential area.

4. Comparison of Four Relit Areas to Five Nonrelit Areas. A sample of blocks was drawn from all the blocks in Kansas City, Missouri. This sample included an overrepresentation of blocks in the four relit areas, and an overrepresentation of relit blocks within those relit areas. From this sample, the four relit areas were compared to the five unrelit areas. The relit. areas had higher crime rates and were more characterized by crime-associated social variables. This distinction between the four relit areas and the five unrelit areas is consistent with the intention of the relighting program to intervene in the high-crime areas, and is described in greater detail in Appendix D.

5. Comparison of Relit Blocks to Nonrelit Blocks. Within the four relit areas some blocks received relighting and others did not. Crime rates (crimes per block) prior to relighting were compared for these two groups to determine the degree of equivalence and comparability of these two groups. This was done separately for the residential upgrade blocks and for the city core blocks. As noted above, the city core had previously received upgrading for some of the blocks in that area, and some of these prior upgraded blocks were included in the nonrelit (literally, not currently relit) blocks.

For the residential upgrade blocks, higher crime rates and crime-related social variables characterized the relit block more than the nonrelit blocks. For the smaller city core area, crime rates were considerably more similar across these two groups of blocks, and the crime-related social variables only slightly more characterized the relit blocks than the nonrelit blocks. The equality in crime rates across these two sets of blocks in the city core area may in part be due to the presence of street lighting from the prior relighting program in some blocks in the group of nonrelit blocks, although this equality may also derive in part from the approximate equality between these two groups of blocks in the presence of crime-associated variables. Further details of this comparison can be found in Appendix E.

CHAPTER 4

RESULTS

A. Introduction.

This chapter presents results for the impact of street lighting on crime. These results are organized around a series of questions that are asked of the data, and these questions, in turn, are restructured into research hypotheses.

These research questions are built around a strategy of analysis of the impact of lighting on crime. This strategy attempts (1) to determine changes in the target of street lighting (night street crime in relit blocks); (2) to compare these changes to those of night street crime in adjacent areas and again for the entire city; (3) to compare these changes to those in locations other than night street sites; (4) to determine displacement effects; and (5) to determine the net effect of lighting on crime.

This strategy is then applied to an investigation of areas with certain types of activities that are related to crime and crime prevention. Commercial and residential blocks can be distinguished on the basis of the type of activity, the nature of pedestrian traffic, and also the crime rates in those blocks. The impact of lighting on crime was assessed separately for the commercial and residential blocks within the total sample. This division of the sample into subsamples was done at the cost of reducing the number of blocks in the subsamples, and these smaller numbers may not be large enough to permit strong conclusions; rather, they allow only for some preliminary investigation, and some tentative conclusions.

The research strategy presented here allows only for a determination of what changes occurred as a response to street lighting. This strategy does not disclose wh:y or how these changes have come about. However, some general assumptions exist about how street lighting works to have an impact on crime. These assu:.tptions are built around the increased visibility that exists on relit blacks. This increased visibility makes night crime more dangerous for offenders, and so offenders are deterred by more or less rational determinations of risk and reward. These determinations may

be made in ways that are *more* characteristic of acting on impulses than of acting on any clear rational process. The current study does not have access to offender data, and in the case of prevented offenders, i.e., nonoffenders, data are not available through police records.

1. Some Research Questions.

   a. Changes in night street crime:

      (i) What happens to night street crime in places where lighting is improved?

      (ii) How does this compare to changes in crime in comparable areas where there has been no improvement?

      (iii) How do changes in night street crime in relit areas compare to overall citywide changes?

   b. Changes in night street crime compared to changes in other crime:

      (i) Within relit areas, how do changes in night street crime compare to other crime changes, such as night nonstreet crime, or day street crime?

      (ii) Similarly, how does the relation between night street crime **and** other types of crime in relit areas compare to that same relation in nonrelit areas?

   c. Overall change:

      (i) What displacement effects were observed: From relit to nonrelit? From street to nonstreet? From night to day? From one crime to another?

      (ii) What are the net effects of street lighting on crime (with net effects defined as the sum of decreases in relit blocks, adjusted for the increase in other crime sites that may be attributed to displacement, and for the expected changes in crime due to general citywide crime changes)?

   d. Commercial vs. residential:

      (i) Is the lighting impact on commercial blocks, different from that on residential blocks?

(ii) What differential effects will lighting have on commercial burglaries (primarily a night offense) and residential hurglari:s (primarily a day offense)?

2. Some Research Hypotheses.

a. Changes in night street crime:

(i) In areas where lighting is upgraded, crime will decrease. This decrease may be apparent only in comparison to changes in crime rates prior to relighting.

(ii) The decreases in relit blocks will be greater than decreases in nonrelit adjacent blocks.

(iii) The decreases in relit blocks will be greater than for the overall citywide sample.

b. Changes in night street crime compared to changes in other crime:

(i) Within the relit blocks, night street crime will show a greater decrease than night nonstreet or day street crime.

(ii) The decrease in night street crime, relative to night nonstreet or day street offenses, will be greater for relit than for nonrelit blocks.

c. Overall change:

(i) Some displacement effects will occur. These will vary by type of crime, and setting to which these offenses are displaced.

(ii) Only a portion of the decrease in night street offenses will be displaced.

d. Commercial vs. residential:

(i) Lighting will have a differential impact on blocks with a commmercial character and blocks that are largely residential.

(it) Lighting will similarly have a differential effect on commercial and residential burglaries.

3. Statistical Tests. To aid in interpreting the data, tests of statistical significance have been performed. These tests offer a more exact way of evaluating what may he intuitively understood as the strength of the findings. Since there is always some variation in crime rates over time and across areas, and since this variation will occur even in the absence of lighting changes, it is necessary to somehow distinguish between these usual (or "chance") variations, and those that may be attributable to lighting. This determination is complicated, and based in a general way on how crime rates (or anything else) change over time.

Tests of statistical significance determine the probability that observed changes in rates are part of this chance variation. When the probability is low, differences are considered not likely to be due to chance, and are called statistically significant. Other explanations for these differences are then sought, and in this study, the most likely candidate would be lighting changes.

Researchers have generally adopted conservative levels of when chance variation should no longer be considered an explanation of observed differences. This low level is set at 5%, or .05. It is reported as "p<.05," meaning "probability (of chance variation) less than .05." As this probability gets smaller (e.g., to .02, or .005 or less), the likelihood decreases that the observed differences are due to chance, the likelihood that other factors account for the differences increases. Probabilities that are greater than .05 are considered not significant (ns), meaning the probability of chance variation is not significantly eliminated as an explanation of observed differences. However, these differences may nevertheless be important and instructive. In other words, a statistical probability (of chance) greater than .05 ("not significant") means only that chance cannot confidently be ruled out; it does not mean that the observed differences themselves are necessarily not significant.

One further word is necessary about statistical tests, and this is particularly relevant to this study. In analysis of crime rates, percent changes are compared. Since small numbers may be associated with large

percentage changes, statistical tests are very sensitive to the size of the numbers being ompared, as well as the size of the differences. This means that large differences may be observed and be statistically non-significant simply because the sample size is too small, not because the differences are too small. As the sample is subdivided into smaller subsamples, in an attempt to track down the unique aspects or locations of crime that are responsive to lighting, it is inevitable that this statistical condition will occur.

The statistical test chosen for comparisons in these data was the Chi-square, with two-tailed distributions.

4. The Data Base. By way of introduction to the results, the size of the data base is discussed. Table 4-1 presents comparisons of crime figures for the sampled blocks with crime figures for the entire city. These citywide figures are taken from the Annual Reports of the Kansas City Police Department. Those reports do not distinguish between street } and nonstreet crima, and the proportion of citywide crime that was street/ crime has been estimated, using the proportion of street crime in the sample blocks.

The sample is composed of 129 relit blocks, comprising 1.8% of the 7,000 blocks in the city, and 600 nonrelit blocks in the four relit areas. These comprise another 8.6%. Together these two groups comprise a little more than a tenth (10.4%) of all blocks in Kansas City.

These sampled blocks generally account for more than ten percent of all crime, thus demonstrating their character as high-crime blocks. Burglary is considerably overrepresented, perhaps because of the greater numbers of commercial establishments in these blocks, since commercial establishments have higher rates of victimization than residences. Police anaual reports do not distinguish between the two types of burglaries (commercial and residential). Larceny is slightly underrepresented.

Table 4-1. The Data Base for

Night Crime in Kansas City

Crime	Crime Frequencies: Citywide (estimated)	Crime Frequencies: Sample Blocks	Sample of Total City (percents)
Violent	2125	271	12.7%
Robbery + Assault			
Robbery	1139	156	13.7%
Assault	**986**	115	11.7%
Property	2848	303	10.6%
Larceny + **Auto** Theft			
Larceny	1578	141	8.9%
Auto Theft	1270	162	12,8%
Burglary [1]	1552	542 (307 residential, 235 commercial)	34.9%

[1] "Burglary" includes commercial and residential burglaries.

B. The Total Sample.

1. Changes in Night Street Crime.

a. Relit blocks. The initial test of the effects of lighting on crime investigates relit blocks and compares crime rates after relighting, with rates prior to relighting. These rates are presented in Table 4-2. Figure 4-1 presents a graphic representation of these changes.

For violent crimes, composed of robbery and assault, the column headed Baseline shows +36%. For the baseline period (comparing the first nine months of 1970 with the first nine months of 1971), crimes involving use or threat of violence increased from 55 to 75, or were up 36%. The test period shows -48%, comparing two 12-month periods, that largely overlap the calendar years of 1971 and 1972. During the test period, violent crimes decreased from 104 in 1971 to 54 in 1972, or were down 48%. This is a substantial and dramatic decline, and is statistically significant at very high levels.

Within the category of violent crimes, robbery increased, somewhat more slowly than assault in the baseline period, and declined somewhat faster during the test period. Robbery increased 34% during the baseline period, while assault increased by 40%. Robbery decreased by 52%, or more than half, during the test period, while assault declined during this test period somewhat less, 41%. Changes from baseline to test were statistically *significant* for both robbery and assault.

Crimes against property (larceny and auto theft) also appear favorably affected by street lighting. For larceny the rate of decline was increased, from an 8% drop during the baseline period to a 39% drop during the test period. Auto theft rose 44% during the baseline period, from 18 to 26, and rose only 3%, from 33 to 34 during the test period. These changes are dramatic, but they do not reach statistically significant levels. In part this is due to the relatively small number of offenses involved, and this is coupled with an overall change in the property crimes that wis less than the change in crimes of violence.

Table 4-2. Changes in Night Street Crime

in Relit Blocks (1970-1972)

	Baseline (1970-1971) [1]	Test (1971/1972) [2]	Statistically Significant
Violent Crimes:			
Robbery + Assault	+36% (55/75) [3]	-48% (104/54)	Yes (p<.0001)
Robbery	+34% (35/47)	-52% (67/32)	Yes (p<.0013)
Assault	+40% (20/28)	-41% (37/22)	Yes (p<.05)
Property Crimes:			
Larceny + **Auto** Theft	+9% (57/62)	-26% (84/65)	No
Larceny	-8% [1] (39/36)	-397.. (51/31)	**No**
Auto Theft	+44% (18/26)	+3% (33/34)	No

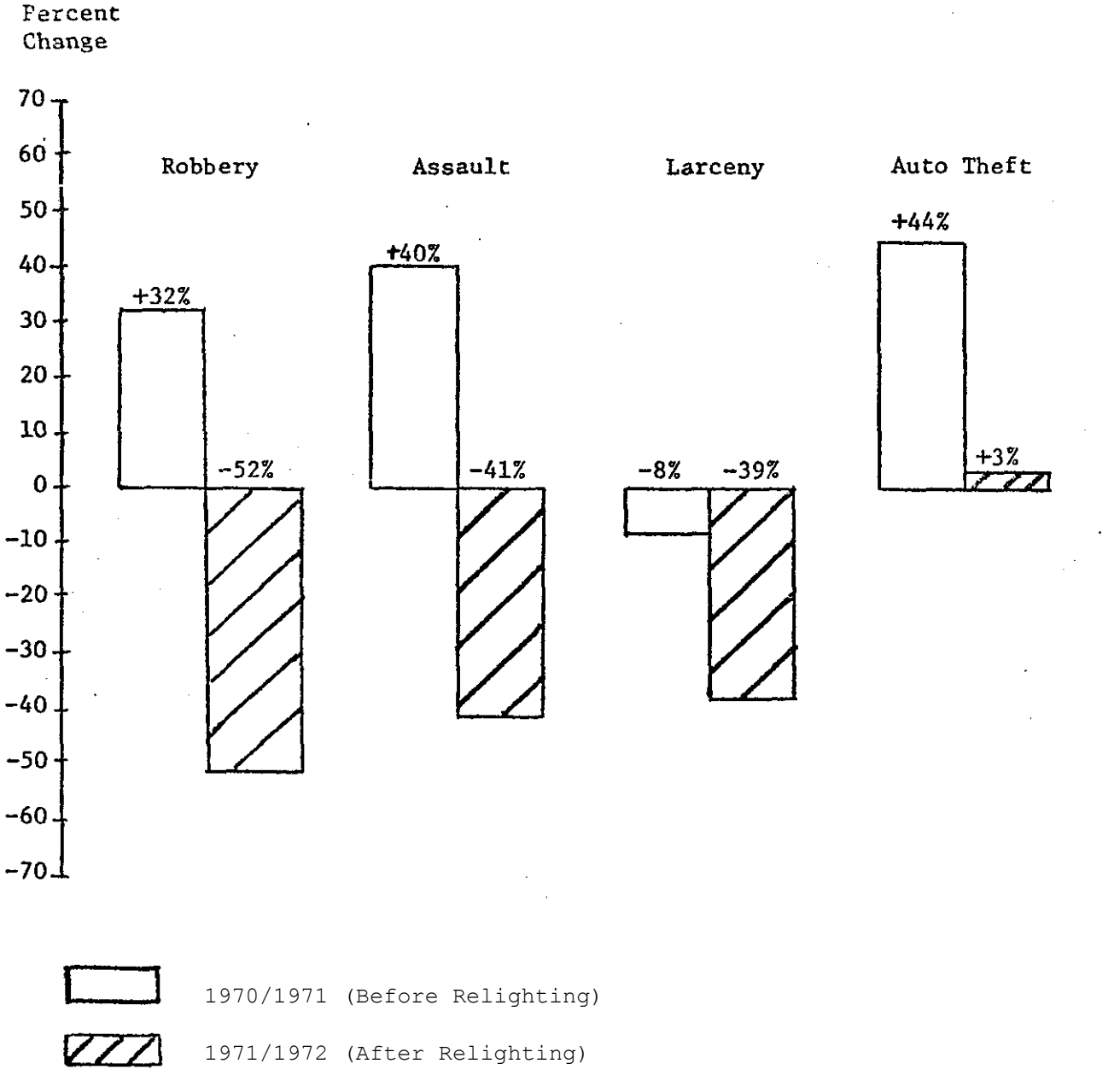
Notes:

[1] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[2] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[3] Percent change from 1971 to 1972 is indicated by +36%. Numerical change is indicated by (55/75) or 55 offenses for the 1970 period and 75 offenses for the 1971 period,

Figure 4-1. Percentage Change in Night Street Crime in Relit Blocks.
(See also Table 4-2)



In summary, in this before-after comparison, lighting was more effective in reducing crimes involving violence and less effective against crimes that involve only property.

b. Nonrelit blocks. Having determined that crime decreased in the relit blocks following relighting, it was then necessary to compare those decreases to changes in blocks that had not received relighting. Table 4-3 compares decreases in the relit blocks to changes in the nonrelit blocks, for the test period. Figure 4-2 is a graphic representation of these selected figures.

For crimes involving violence (robbery and assault), the column headed "Relit Blocks" shows -48%, or a 48% decline during the test period. By contrast, the column titled "Nonrelit Blocks" shows -7%, or a much smaller decrease of only 7%. Lighting, then, has been associated with a large decline and the absence of lighting associated with only a small decline. Robbery declined by 52% in the relit blocks, against a 17% decline in nonrelit blocks, while assault declined by 41% in the relit blocks, against an actual rise, of 4%, in the nonrelit blocks. The contrasts for violent crimes and for robbery reached statistically significant levels.

c. The citywide sample. As a further contrast, Table 4-3 presents a third column titled "Citywide Sample", which includes all sampled relit and nonrelit blocks (from the four relit areas), as well as all other sampled blocks within the city. This column reflects the average of the relit and nonrelit blocks, and also crime changes elsewhere in the sample. For violent crimes,changes in relit blocks were greater than the city wide changes.

For crimes that involved only property, results are less striking. Larceny decreased more in the relit blocks than the nonrelit blocks (a 39% decline against a 29% decline), while auto theft rose in the relit blocks and dropped in the nonrelit blocks (an *increase* of 3% against a drop of 32%). For the total of all property crimes, the decrease was greater in the nonrelit blocks than the relit blocks. As with the

Table 4-3. Changes in Night Street Crime During

:he Test Period (1971/1972) [1]

	Relit Blocks	Nunrelit Blocks	Citywide Sampple	Statistically Significant [2]
Violent Crimes;				
Robbery + Assault	-48% (104/54) [3]	-7% (167/155)	-20% (362/291)	Yes (p<.05)
Robbery	-52% (67/32)	-17% (89/74)	-30% (191/134)	Yes (p<.05)
Assault	-41% (37/22)	+4% (78/81)	-8% (171/157)	No (p<.10)
Property Crimes:				
Larceny + **Auto Theft**	-26% (84/65)	-32% (219/149)	-23% (423/325)	No
Larceny	-397. (51/31)	-29% (90/64)	-20% (219/175)	No
Auto Theft	+3% (33/34)	-32% (129/85)	-27% (204/150)	No

Notes:

[1] Test Period {1971:1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Statistical tests compare Relit to Nonrelit Blocks,

[3] Percent change from 1971 to 1972 is indicated by *-48%.* Numerical change is indicated by (104:54) or 104 offenses for the 1971 period and 54 offenses for the 1972 period.

Figure 4-2. Percentage Changes in Night Street Crime in Relit and Nonrelit Blocks During the Test Period (1971/72).

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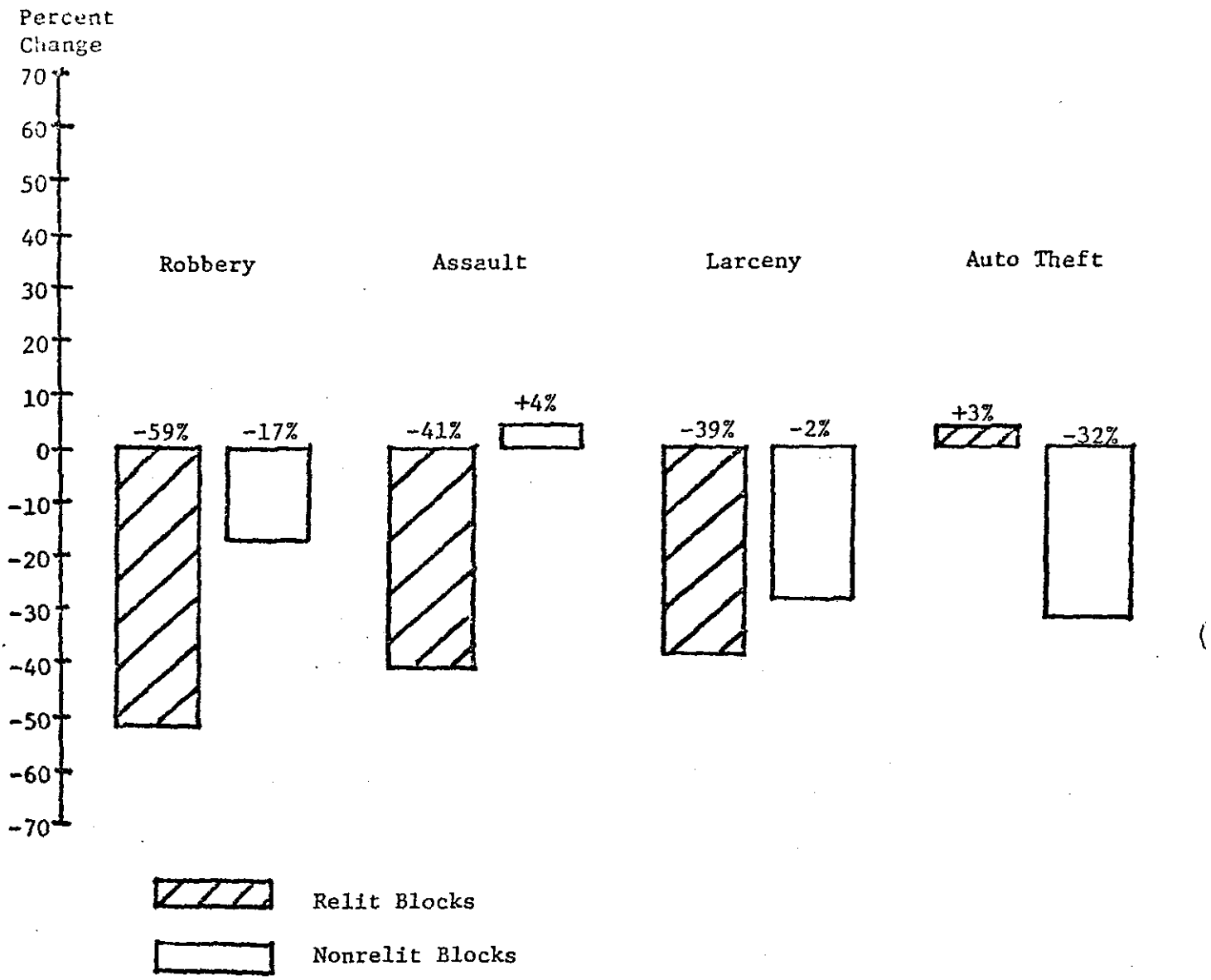
(See also Table 4-3)



figures from Table 4-2, these figures also show a greater impact of lighting on crimes of violence, as compared to crimes against property.

2. Night Street Crime Contrasted to Night Nonstreet and Day Street Crimes. The previous comparisons of changes in night street crime, in relit and nonrelit blocks, suggest that crime was decreasing on a large scale in the relit blocks, following relighting. To further specify the effects of relighting, and to determine whether changes in night street crime in relit blocks were due to lighting or to some other factor in those blocks, night street crime changes were compared to other night crimes--those occurring in nonstreet (indoor) locations--and to other street crimes--those occurring during the day.

If crime decreased during the night equally for street and nonstreet locations, it would be difficult to attribute the decline to lighting alone, since nonstreet crime would seem to be less affected by increased illumination than street crime. In a similar way, if crime decreased on the street equally for night and day incidents, it would be difficult to attribute the decline to lighting alone, since day street crime would also seem to be less affected by increased illumination, as compared to night street Crime.

a. The relit blocks. Table 4-4 presents results for relit blocks, and compares night street crime changes to changes in night nonstreet and day street. Figure 4-3 presents these same results in graphic form.

For crimes that involve violence, the column headed "Night Street" shows -48%. Violent crimes that occurred on the street and at night declined by 48% from 1971 to 1972. The column headed "Night Nonstreet" shows +26%, or an increase of almost a quarter from 1971 to 1972. Day street crimes were essentially unchanged. By contrast, then, these same crimes did not decrease either in night nonstreet locations or in day street locations. Statistical casts show that the differences between night street changes and changes for the other two locations, for violent crimes are highly significant.

Table 4-4 Crime Changes in Relit Blocks

During the Test Period (197111972) [1]

	Night Street	Night Nonstreet	Day Street	Statistically Significant
Violent Crimes: Robbery + Assault	-48% (104/54) [2]	+26% (42/53)	+3% (53/60)	Yes (p<.0012)
Robbery	-52% (67/32)	-14% (21/18)	-30% (40/28)	No
Assault	-41% (37/22)	+67% (21/35)	+78% (18/32)	Yes (p<.02)
Property Crimes: Larceny + Auto Theft	-26% (84/65)	-11% (18/16)	-21% (103/81)	No
Larceny	-39% (51/31)	-11% (18/16)	-21% (75/48)	No
Auto Theft	+3% (33/34)	_0)	+18% (28/33)	No

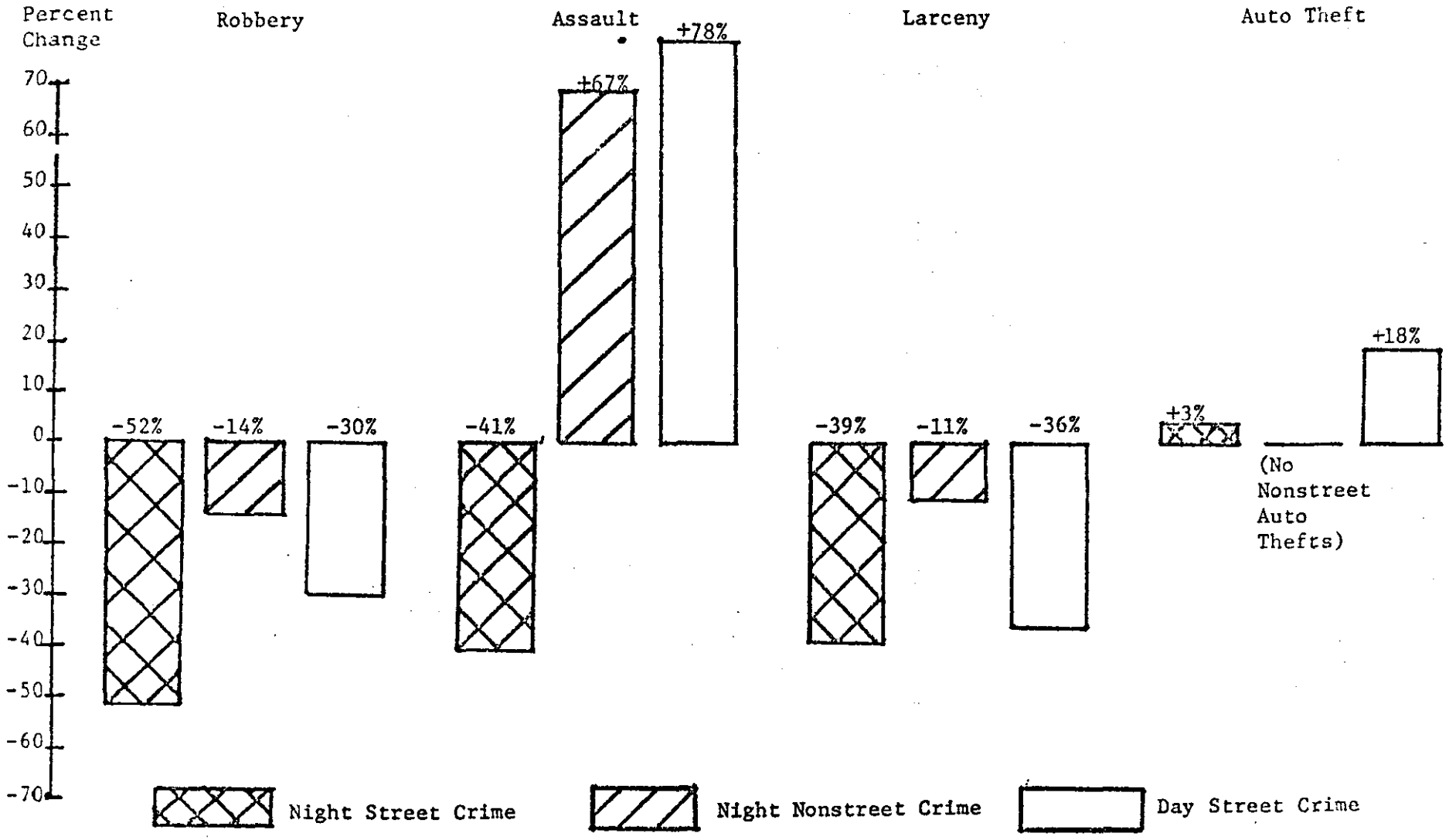
Notes:

[1] Test Period (1971/1972) compares twelve month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Percent change from 1971 to 1972 is indicated by -48%. Numerical change is indicated by (104/54) or 104 offenses for the 1971 period and 54 offenses for the 1972 period.

[3] Auto Thefts are Street only, with no Nonstreet offenses.

Figure 4-3. Percentage Changes in Crime in Several Locations in Relit Blocks, 1971/72.
(See also Table 4-4)



Within violent crimes, robbery and assault both decrease more in night street locations than for the other two locations. For robbery, there is a decline of 52% in night street crime, contrasted to declines that are smaller in the other two locations. Night nonstreet robbery declined by 14%, a decline that is not significantly different from night street declines. Crimes with a day street location declined by 30%, and this was also not statistically different from the night changes. The 52% decline of night street robberies seems different from a 30% decline of day street robberies, almost twice as great, and the lack of statistical differentiation may be due to the small numbers of crimes involved.

Assaults showed a 41% decline from 1971 to 1972, for night street locations in relit blocks. This decline was in contrast to a rise in assaults in other locations--night nonstreet assaults rose by two thirds, **and** day street assaults rose by over three fourths. The changes in night street assaults are statistically significantly different from changes in these other two locations. Since assault rose throughout the city, according to Kansas City annual police figures, it appears that lighting was successful in preventing this rise in assault from occurring in night street locations in relit blocks.

For property crimes, there was little difference between those occurring in night street locations and those occurring elsewhere. A 26% decline in night street property crimes was in contrast to an 11% decline in nonstreet night locations, and a 21%, decline in day street locations. For larceny there was likewise little difference between the three locations. For auto theft, the increase in night street crime was exceeded by the increase in day street incidents--a 3% increase at night contrasted to an 18% increase during the day--but these differences were not statistically different. Auto theft from nonstreet locations is an empty cell because automobiles are stolen only from street locations.

In summary, a comparison of changes in crime between the three locations of night street, night nonstreet and day street shows that for violent crimes declines in night street contacts were significantly

greater than for the other two locations. For property crimes, changes were in directions that favored lighting, but were not of a magnitude to be statistically different.

b. The nonrelit blocks. Table 4-5 compares crime changes within nonrelit blocks for night street incidents against incidents in the other locations of night nonstreet and day street.

For violent crimes there was a small decrease in night street contacts, and an increase in these crimes in other locations. In contrast to the relit blocks, where these differences were very large and highly significant, in these nonrelit blocks these differences were much smaller, and did not approach significance.

Robbery showed no differences of any statistical significance between these three locations, while assault seemed to indicate decreases for night street locations that were statistically greater than for the other two locations. For assault, it should be noted that the percentage differences were greater in the relit blocks, and that significant differences for assau:.t in the nonrelit blocks may reflect sample size differences rather than crime patterns. Alternately, for both relit and nonrelit blocks, night street assaults may have declined faster than other assaults, with relit blocks showing this decline faster than nonrelit blocks.

Interestingly, in the nonrelit blocks, property crimes with a night street location decreased, while night nonstreet property crimes increased. This was unlike relit blocks, where these night nonstreet property crimes decreased, along with night street property crimes. Night nonstreet declines in relit blocks suggest other factors at work in reducing crime, since nonstreet crime is not obviously deterred by relighting.

Day street crimes against property showed a decline in nonrelit blocks. This was similar to the decline in this crime in relit blocks. This profile also !eld for larceny alone.

Table 4-5. Crime Changes in Nonrelit Blocks

During the Test Period (1971/1972) [1]

	Night Street	Night Nonstreet	Day Street	Statistically Significant
Violent Crimes: Robbery + Assault	-7% (167/155) [2]	+21% (104/126)	+11% (153/170)	No
Robbery	-17% (89/74)	-38% (47/29)	-20% (89/71)	No
Assault	+4% (78/81)	+70% (57/97)	+54% (64/99)	*No* (P< .10)
Property Crimes: Larceny + Auto Theft	-32% (219/149)	+17% (63/74)	-23% (297/219)	Yes (p<.01)
Larceny	-29% (90/64)	+17% (63/74)	-28% (215/155)	Yes (p<.05)
Auto Theft	-34% (129/85)	-- [3]	-22% (81/64)	No

Notes:

[1] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Percent change from 1971 to 1972 is indicated by -7%. Numerical change is indicated by (167/155) or 167 offenses for the 1971 period and 155 offenses for the 1972 period,

[3] Auto Thefts are Street only, with no Nonstreet offenses.

Auto theft show a 34% drop at night, and a 22% drop during the day, in nonrelit blocks. As with relit blocks, crime decreases at night were greater than those during the day, and so lighting again seems to have no impact on property crimes.

3. Summary of Night Street Changes. Prior to relighting, night street crime was increasing in the sample blocks in the relit areas of Kansas City. Following the upgrading period in the relit blocks these crimes decreased dramatically. Crimes involving violence against persons decreased in the relit blocks in ways that were statistically highly significant as contrasted to prelighting rates. Crimes of violence decreased in relit blocks in ways that were also statistically different from nonrelit blocks. Property crimes showed changes that were consistent with crime—deterrent effects of lighting, but these changes were not at statistically significant levels and may, accordingly,not have been due to lighting, but rather due to chance variation.

Within relit blocks, changes in night street crime were compared to changes in other night crime—those incidents occurring in nonstreet locations--and other street crime—those incidents occurring during the day. This same comparison was performed for nonrelit blocks. For relit blocks, crimes of violence showed greater decreases for the crimes with a night street location relative to the other two locations. For nonrelit blocks, crimes of violence also decreased in night street locations to a greater degree than in the other two locations, but still less than night street crime in relit blocks.

Property crimes with a night street location seemed resistant to the effects of lighting, with no major changes observed either from before to after relighting, or between relit and nonrelit blocks. Interestingly, in relit blocks, property crimes in n'.ght nonstreet locations decreased as much as those with street locations, while in nonrelit blocks, night nonstreet property crime; did not decrease, although night street property crimes did.

The crimes of primary interest in this study--night street crimes of violence, which are the crimes that most terrorize people--showed dramatic and significant responsiveness to upgraded street lighting.

4. Displacement. Having determined that night street crime in relit areas did in fact show decreases, it was also necessary to determine if deterred crimes were prevented only in the location of night street crimes in relit blocks. Within the model of criminal behavior as sketched out above, the effects of lighting might be simply to relocate offenders to dark, or nonrelit blocks. This relocation of criminals from light streets to dark streets is one facet of a general problem considered under the heading of displacement.

Displacement of night street crime from relit to nonrelit locations has been observed on occasion, and seems plausible. It should be noted that displacement might also occur with respect to the location, relocating merely from street sites to nonstreet sites—such as from alleys to elevators, for muggings. Similarly,,the combination of lighting upgrading plus the generally lower use of streets at night and greater nighttime citizen suspiciousness might make criminal behavior so visible that crimes would shift to the daytime. In the daytime setting, the greater visibility of daylight could be offset by a reduction in citizen suspiciousness, allowing the offender to remain inconspicuous while waiting for a crime opportunity.

The data from this study allow for partial answers to these questions of displacement. Displacement was defined as the shift of crimes from a target area--night street crime--to a receptor area--nonrelit blocks, nonstreet sites, or day hours. It was operationalized as an increase in crime following a decrease, or an accelerated rate of increase, or a re- duced rate of decrease. Displacement indications are determined by comparing changes during the baseline period to changes during the test period.

With regard to a general model of displacement, it should also be noted that other modes are available, the investigation of which are beyond the scope of these data. The most obvious modes of displacement are (1) displacement across crimes (e.g., from robbery to larceny--both of which provide quick cash or goods of value); and (2) displacement across several of the dimensions.

In this latter case, criminals who are deterred from night street robbery in relit blocks because of the increased risks associated with lights, choose not to retire, but to shift from night street robbery to daytime residential burglary. This shift includes a shift from night to day, violent crime to property crime, and a shift from street to nonstreet sites. Such a shift potentially can be determined from crime data, but involves a more complicated analysis of holding constant or adjusting for shifts on any one dimension (such as street to nonstreet, or violent crime to property crime), and then determining the "remaining" amount of displacement due to multidimensional shifting. This study has not attempted such an analysis, even though this question is important in understanding the nature of the impact of lighting on crime.

Other less obvious responses to lighting might include, at least for robbery, use of weapons, violence, or accomplices (which increase the odds **in** favor of the offender), or a shift in choice of victim (again, to one that raises the odds for the'offender). These questions, too, can potentially be answered by police data, but as more crime categories are developed, the frequencies for each category decrease, thus making the interpretation difficult.

It is possible to speculate on the size of the displacement involved, to assess how much of the observed decreases in crime are offset by corresponding increases elsewhere. Change rates for the 1970-1971 (baseline) period can be used to project to crime frequencies from 1971 to 1972 (the test period), with these projected frequencies compared to observed frequencies. This procedure estimates the number of crimes prevented, when crime decreases following lighting, and the number of "excess" crimes, in areas where displacement indications were found.

a. Displacement to night street crime, nonrelit blocks. Shifts of this type involve only moving from one block to the next, with no further change required in offender behavior; i.e., movement indoors, or change of hour or crime of c'mmission. Because of this simplicity, this type of shift is thought to he most likely. In fact, relatively little indication of these shifts was fund.

Some such indications were found for violent crimes, and of these crimes, for robbery only. In the nonrelit blocks, data presented in Table 4-6 show that robbery decreased by 31% during the baseline period, and to a lesser degree, by only 17%, during the test period. This 17% decline was composed of a decrease of 15 incidents, while a projected decline, of 31%, would be composed of a decrease of 28 incidents. The difference between 15 observed and 28 projected may be taken as an indication of the size of the displaced, or "excess" crimes in this location of night street, nonrelit blocks. By constrast, in the relit blocks, figures presented in Table 4-2 show that night street robbery increased by 34% during the baseline period, and decreased by 52% during the test period. The 52% decline was composed of a decrease of 35 incidents, while a projected increase of 34% would be composed of an increase of 23. The sum of a projected increase of 23 and an observed decrease of 35 is 58, and may be taken as the size of the "prevented" robberies, in the location of night street, relit blocks.

The difference between 58 prevented robberies and 13 excess robberies indicates that only a fraction (less than a fourth) of the deterred crimes are displaced.

b. Displacement to night nonstreet crime in relit blocks. Night street crime may shift to nonstreet locations to avoid the increased visibility afforded by improved street lighting. This may require some change in modus operandi, even within the offense of robbery, since hallway muggings would seem to differ from street muggings in dimensions of concealment, escape, congregation, and surely many others. The analysis is complicated by the fact that figures on nonstreet robberies include both muggings, which are the robberies of major interest in street locations, and also an unspecified number of store robberies, or stickups.

Nonstreet displacement is also assessed by comparing baseline changes to test period changes. Since there may be a change in nonstreet patterns of crime--independent of lighting improvement--it is necessary to consider changes from baseline to test periods, for both relit and nonrelit blocks. Table 4-7 presents these figures.

Table 4-6. Displacement [1] Indications for

Nignt Street Crime to Nonrelit Blocks

	Baseline (1970/1971) [2]	Test (1971/1972) [3]
Violent Crimes:		
Robbery + Assault	-16% (146/1235[4])	-7% (167/155)
Robbery	-31% (91/63)	-17% (89/74)

Notes:

[1] Defined as increase, or reduced rate of decrease in Test period relative to Baseline period.

[2] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[3] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[4] Percent change from 1970 to 1971 is indicated by -16%. Numerical change is indicated b7 (146/123) or 146 offenses for the 1970 period and 123 offenses for the 1971 period.

Table 4-7. Displacement [1] Indications

to Night Nonstreet Crime

	Relit Blocks		Nonrelit Blocks	
	Baseline (1970/1971) [2]	Test (1971/1972) [3]	Baseline (1970/1971)	Test (1971/1972)
Violent Crimes:				
Robbery + Assault	+3%, (30/31) [4]	+26% (42/53)	+3% (77/79)	+21% (104/126)
Assault	-13% (15/13)	+67% (21/35)	+28% (36/46)	+70% (57/97)
Property Crimes:				
Larceny	-20% (15/12)	-11% (18/16)	-10% (52/47)	+17% (63/74)

Notes:

[1] Defined as increase, or reduced rate of decrease in Test period relative to Baseline period.

[2] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[3] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[4] Percent change from 1970 to 1971 is indicated by +3%. Numerical change is indicated by (30/31) or 30 offenses for the 1970 period and 31 offenses for the 1971 period.

Crime during the baseline period rose relative to the test period for assault and for larceny. For both of these, however, changes over time did not reach levels of statistical significance. Nonstreet assault rose in both relit and nonrelit blocks, with the increases more than offsetting the decreases reported for street assaults in the relit blocks (see fable 4-2). This increase in both relit and nonrelit blocks is consistent with a citywide increase in assault during this period, but is larger than that increase and suggests that much if not all of the street crime deterrance is effective only in relocating crime.

For larceny the displacement shift is greater for nonrelit blocks than for relit. Larceny has increased for nonstreet locations during the 1971-1972 period, but not in a way that seems to reflect the impact of lighting.

c. Displacement to day street crime in relit blocks. Criminals may have shifted to targets in day street locations. Although this shift to day hours seems to violate the basic assumption that increased lighting deters crime, it is possible that the increased visibility afforded by upgraded street lighting, plus the general greater night-hour suspiciousness and crime-consci,usness of citizens, may actually make day hours a more desirable time in which to commit offenses. Table 4-8 presents figures for shifts to day street crime locations.

For the composite of violent crimes, displacement indications were observed, but these ware observed for both relit and nonrelit blocks. Because this increase in the 1971-1972 period, relative the the 1970-1971 period, occurred both in blocks where relighting might be expected to relocate crimes, and in nonrelit areas, where no such shift would be expected, these shifts that characterize both sets of blocks are not interpreted as displacement shifts. Of the components of violent crime, assault similarly shows a relative increase during the test period (1971-1972) for both relit and nonrelit blocks, and is not interpreted as displacement. Robbery shows this displacement profile only for the nonrelit blocks, and so is also not interpreted as true displacement.

Table 4-8. Displacement [1] Indications

to Day Street Crime

	Relit Blocks		Nonrelit Blocks	
	Baseline (1970/1971) [2]	Test (1971/1972) [3]	Baseline (1970/1971)	Test (1971/1972)
Violent Crimes:				
Robbery + Assault	-14% (56/48) [4]	+3% (58/60)	-29% (147/105)	+11% (153/170)
Robbery	+3% (31/32)	-30% (40/28)	-29% (80/57)	-20% (89/71)
Assault	-36% (25/16)	+78% (18/32)	-28% (67/48)	+54% **(64/99)**
Property Crimes:				
Auto Theft	-35% (26/17)	+18% (28/33)	+9% (55/60)	-22% (82/64)

Notes:

[1] Defined as increase, or reduced rate of decrease, in Test period relative to Baseline period.

[2] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[3] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[4] Percent change from 1970 to 1971 is indicated by -14%. Numerical change is indicated by (56/48) or 56 offenses for the 1970 period and 48 offenses for the 1971 period.

In the property crimes, by contrast, auto theft shows a displacement profile for relit blocks only. Night street auto theft has been shown to be somewhat responsive to light, and this increase in the day may reflect displacement of those prevented crimes .

For day crimes, the baseline decrease of 35% would project to a decrease of 10 incident;, during the test period. Instead there was an increase of five incidents, for a net increase of 15 excess day auto thefts. By contrast, the night quto theft change rate during the baseline period was an increase of 44, which would project to a net increase during the test period of 15 thefts (see Table 4-2). Since an increase in one auto theft was recorded, fourteen incidents were "prevented", or about the same number that were displaced. This indicates no overall change in auto theft, and so, in this displacement analysis, as well as in the above change analysis, property crimes continue to be largely undeterred by lighting, although they are somewhat responsive in terms of location.

d. Summary of displacement effects. Within this study, displacement is considered to have occurred when all the following conditions are present:

- An increase in crime during the test period, relative to the baseline period;
- when this increase takes place in a potential receptor area of relocated crime;
- when there has been a decrease in crime in the impact location of night street crime in the relit blocks; and
- when this occurs in ways that distinguish relit and nonrelit blocks.

Within this definition, the magnitude of displacement has been computed, using the baseline percentage change as a basis for projecting crime frequencies during the test period. These projections were made for both the impact location of night street crime, and for the potential receptor areas of night street crime in nonrelit blocks, night nonstreet crime. On the basis of these projections, "prevented" and "excess" frequencies may be determined. Comparison of these prevented crimes in the impact area with excess crimes in the rece?tor areas allows for a computation of

net crime-reduction effects as a result of lighting. Where prevented crimes are larger than excess crimes, reduction is considered to have occurred.

The total of violent crimes showed some displacement indications into nonrelit blocks, for night street offenses. This shift was composed of a shift of robbery into the nonrelit blocks. This displacement accounted for only a fraction of the crimes estimated to have been prevented by street lighting in the relit blocks. No such shift of robberies was found into night nonstreet or day street locations.

Assaults showed a rise both for night nonstreet locations, and for day street locations during the test period, following upon a decline in the baseline period. Since this rise occurred in both relit and nonrelit blocks, and also occurred throughout the city, it is unclear whether this rise in assaults reflects a displacement of the prevented assaults—displacement into both sets of blocks--or a general rise in citywide assault that also occurred in the sample blocks. The large size of the increases offset the decreases in assault in the impact location of night street crime.

Of the property crimes, only auto theft had a day street displacement profile. This profile showed an increase in thefts that *was* about equal to the decrease associated with lighting for night street incidents, and indicates that whatever effects lighting may have had on reducing auto theft were offset by increases during day.

It should be noted that crimes against persons--crimes of violence--displace within the night, while crimes against property--where there are no victims in the actual criminal contact--displace to the day.

5. Conclusions. Crime can only be considered reduced after a decrease has been found in the target of night street crimes in relit blocks, with no such decrease in contrasting areas and no increase elsewhere, that can be accounted for by displacement shifts.

The primary target of street lighting, within night street crime, is robbery, and it is in this crime that street lighting seems to have the most successful impact. Robberies are reduced in the relit blocks more

than they are reduced in the contrasts, or citywide, and more than they are relocated else-sere.

The response to street lighting of assault is more complicated. The percent decline in the target of night street contacts in the relit blocks is substantial, greater than the percent decline in assault in the contrasts, and greater than the very small citywide decline. However, the number of assaults that are prevented are more than equalled by increases in the contrasts, during the test period, particularly when compared to baseline assault rates. It should be *noted* that while the citywide sample shows a decline in assaults for night street contacts, the UCR reports for the Kansas City SMSA, presented above, show that assault is rising (and is the only serious crime to do so). Thus it may be that within the relit blocks there is an interruption and prevention of assault, with some shift occurring whose magnitude is difficult to determine because of the masking effect of the citywide increase in assault. Thus it *cannot* be simply determined for assault (unlike robbery), what *component* of prevented crimes in the relit areas are simply relocated, and which are suppressed. The large size of the displacement profiles for assault suggests that little or none of this crime is suppressed. This is *consistent* with a general view of assault as a crime of passion, or impulse, less deterrable by rational deterrence (i.e., lighting) than robbery.

This distinction between robbery and assault, in responsiveness to street lighting, is further *significant* in that the.UCR considers these two crimes together, as person or violent crimes. It has been shown above that for national and Kansas City trends, robbery behaves more like the property crime of larceny than it does like the person crime of assault. It should be noted that at the level of coding a criminal contact, there may be a fine line between robbery and assault, since a robbery attempt may be initiated by an assault, end if interrupted or successfully resisted, may only be coded as an assault. Similarly, what is initially an assault may grow into a robbery, as assailants escalate from an attack to an attack plus theft.

C. Commercial vs Residential

Introduction. Criminological research often distinguishes between crimes against commercial and noncommercial targets. For purposes of this study this distinction is modified somewhat, to consider as commercial crime those incidents that occur on blocks with a commercial character.. Of noncommercial crimes, this study will consider incidents on blocks with a residential character.

Commercial and residential blocks have been distinguished because of the nature of street activity. Commercial blocks draw and concentrate people, while in residential blocks traffic is more likely to be limited to area residents. Since many commercial blocks also have or are near residential areas, commercial blocks additionally are characterized by some local, or residential, street activity.

As noted above, the level of street activity is considered an important mediating variable between street lighting improvement and crime reduction. Lighting, the argument goes, makes people think the streets are safer, and accordingly they are more likely to go out at night. This in turn raises the pedestrian density in relit blocks, and it is this increased pedestrian density that acts as a deterrent to street crime, particularly for street robbery. This mechanism of additional people is more likely to operate in commercial blocks, where there are more activities **to draw people.**

Commercial blocks are additionally of interest in that a recent study in Oakland, California (Feeney and Weir, 1973), as well as a small Detroit study (Luedtke et al., 1972) both found that street robberies were located along the edges of main arteries and strips of commercial activities. Since robberies are concentrated along these commercial areas, the current study sought to investigate the impact on crime in this particular type of high-crime location.

The higher robbery rate in commercial edges, and the assumptions about increased pedestrian traffic acting as a factor to increase street safety, are both part of a general assumption about choice of victims and choice

of robbery locations. This general assumption offers that totally deserted streets are unsuitable to offenders because of the total absence of victims. Similarly, populous streets are unsuitable to offenders because of the presense of witnesses or intervenors. Some middle level of pedestrian density is most suited to offenders, or most dangerous to pedestrians. This middle level appears to be the level to pedestrian activity at the edges of these commercial areas.

The distinction between commercial and residential blocks was operationalized on the basis of numbers of employees in commercial establishments, and number of residents, on each block.

Commercial blocks were those with more than nine employees in commercial establishments. Residential blocks were those with 9 or fewer employees and more than 38 residents. Blocks with fewer than 9 employees or 38 residents were characterized as "low use", and excluded from this part of the analysis. These levels of employees and residents were chosen on the basis of decile distributions. In all, there were 15 relit and 44 nonrelit commercial blocks in the sample, and 72 relit and 440 nonrelit residential blocks. The remainder, 158, were low use.

This analysis of lighting impact on commercial and residential blocks will largely parallel the preceding analysis of lighting impact on crime in all blocks, but will differ on some points.

- Crime rates, defined as crimes per block, will be compared for these two types of blocks.
- The assessment of lighting impact on crime will be comparative, contrasting changes in commercial blocks with changes in residential blocks.
- The category of property crimes will be expanded to include the non-street crimes of commercial burglary and residential burglary.
- Tests of statistical significance will not be stressed in these comparisons because dividing the sample into commercial, residential, and low-use blocks results in small numbers of blocks in each category. With small numbers, differences must be very large to be statistically significant and it might be misleading to compare the statistical significance of differences based on these small numbers of blocks with. stgui canoe based on the larger number of blocks in the entire sample.

2. Rates for night street crime. Table 4-9 present:. grimes per block for commercial and residential blocks, for the twelve months preceding relighting. For all street crimes but auto theft, commercial blocks had higher crime rates than residential blocks. Crime rates for commercial blocks were in many cases roughly twice as high as for residential blocks. The one exception, auto theft, shows residential block rates to be almost twice as high as the rate for commercial blocks.

Rates are compared for burglaries of commercial establishments in commercial blocks, and for burglaries of residences in residential blocks. The rate for burglaries of commercial establishments is roughly twice the rate for burglaries of residences.

Table 4-10 presents crimes per block for the twelve months following relighting. For street crimes, the block rates are virtually identical for all violent crimes. For property crimes the block rates are not as close, but still are closer than for the prelighting twelve months. Burglaries of commercial establishments and burglaries of residences also have substantially identical block rates.

The differences in block rates prior to relighting, and the similarities in block rates after relighting—particularly for violent crimes—suggest something of a lower limit to the effectiveness of street lighting as a crime-prevention device. This lower limit may be the amount of crime that is effectively light-immune. It is alternately possible that the greater incidence of crime in commercial blocks, relative to residential blocks, simply allows for more *room* for improvement in crime rates, once street lighting is introduced. The greater crime rate per block for commercial blocks would not explain, however, the striking similarity in post-lighting bock rates across the two types of blocks.

The impact of lighting on burglaries of commercial establishments in commercial blocks only, and on burglaries of commercial establishments in all blocks, is substantially identical. Similarly, the impact of lighting on burglaries against residences is substantially identical for both residential-only blocks, and all blocks. Consequently, discussion of both commercial and residential burglaries will consider these offenses in all blocks.

Table 4-9. Night Street Incidents per Block Before [1] Relighting

	Commercial [2] Blocks	Residential [3] Blocks
Violent Crimes: Robbery + Assault	1.26	.75
Robbery	.74	.49
Assault	.51	.25
Property Crimes: Larceny + Auto Theft	.86	.61
Larceny	.69	.29
Auto Theft	.17	.32

	Commercial Establishments in Commercial Blocks	Residences in Residential Blocks
Burglary	1.77	.95

Notes:

[1] October 1970-September 1971,

[2] Blocks with. 10 or more employees.

[3] Blocks with *fewer* than 10 employees and more than 38 residents.

Table 4—10. Night Street Incidents per Block After [1] Relighting

	Commercial [2] Blocks	Residential [3] Blocks
Violent Crimes:		
Robbery + Assault	.49	.44
Robbery	.31	.27
Assault	.17	.17
Property Crimes:		
Larceny + Auto Theft	.46	.55
Larceny	.37	.20
Auto Theft	.09	.36

	Commercial Establishments in Commercial Blocks	Residences in Residential Blocks
Burglary	.74	.76

Notes:

[1] April 1972—March 1973.

[2] Blocks with 10 or more employees.

[3] Blocks with fewer than 10 employees and more than 38 residents.

3. Changes in n_ghht street crime.

a. The relit blocks. Table 4-11 presents changes in night street crime in the relit blocks. (See also Figure 4-4.) Table 4-12 presents those changes for burglary. Data are presented separately for commercial and residential blocks. For all crimes, decreases in commercial blocks were greater than decreases in residential blocks. Insofar as decreases are due to lighting, lighting may be seen to be substantially more effective against commercial area crime than against residential area crime.

These crime changes may be further understood by comparing baseline changes to test period changes. Tables 4-13 and 4-14 present these trend data for street crime, and Table 4-15 presents these data for burglary. In virtually all cases, crime was increasing prior to relighting, and decreased after relighting. This was true for both commercial blocks and residential blocks.. (See also Figure 4-5.)

Of the composite of violent crimes, tests of statistical significance show that the number of incidents decreased significantly for both subgroups of blocks. Of the components of violent crime, robbery decreased significantly for residential blocks and to a slightly lesser degree for commercial blocks. assault decreased significantly only for commercial blocks.

The property crimes also declined during the test period relative to the baseline period, and the percentage changes were greater in commercial than residential blocks. These declines did not reach levels of statistical significance, but do indicate the direction of effects. Burglary alone, of the property crimes, showed a statistically significant decline, and this was only for commercial targets.

b. The nonrelit blocks and the citywide sample. To further clarify these differences between commercial and residential blocks, changes in night street crime in the relit blocks were compared to changes in the nonrelit blocks and to changes **in** the citywide sample.

Comparisons of :Alt and nonrelit commercial blocks are presented in Table 4-16. For via'ent crimes, decreases in relit blocks are statistically greater than c,angos in nonrelit blocks. Robberies decrease to

Table 4-11. Changes in Night Street Crime

in the Relit Blocks During the Test Period

(1971/1972) [1]

	Commercial [2] Blocks	Residential [3] Blocks
Violent Crimes:		
Robbery + Assault	-61% (44/17) [4]	-41% (56/33)
Robbery	-58% (26/11)	-46% (37/20)
Assault	-67% (18/6)	-32% (19/13)
Property Crimes:		
Larceny + **Auto Theft**	-47% {30/16)	-11% (46/41)
Larceny	-46% (24/13)	-36% (22/14)
Auto Theft	-- [5] (6/3)	+13% (24/27)

Notes:

[1] Test Period (1971/1972) compares twelve-month periods: October 1971-September 1972 and April 1972-March 1973.

[2] Blocks with 10 or more employees.

[3] Blocks with fewer than 10 employees and more than 38 residents.

[4] Percent change from 1971 to 1972 is indicated by -61%. Numerical change is indicated by (44/17) or 44 offenses for the 1971 period and 17 offenses for the 1972 period.

[5] Percentage change not computed for low frequencies.

Cora^ercial and Relit Residential Blocks.

(See also Table 4-11)

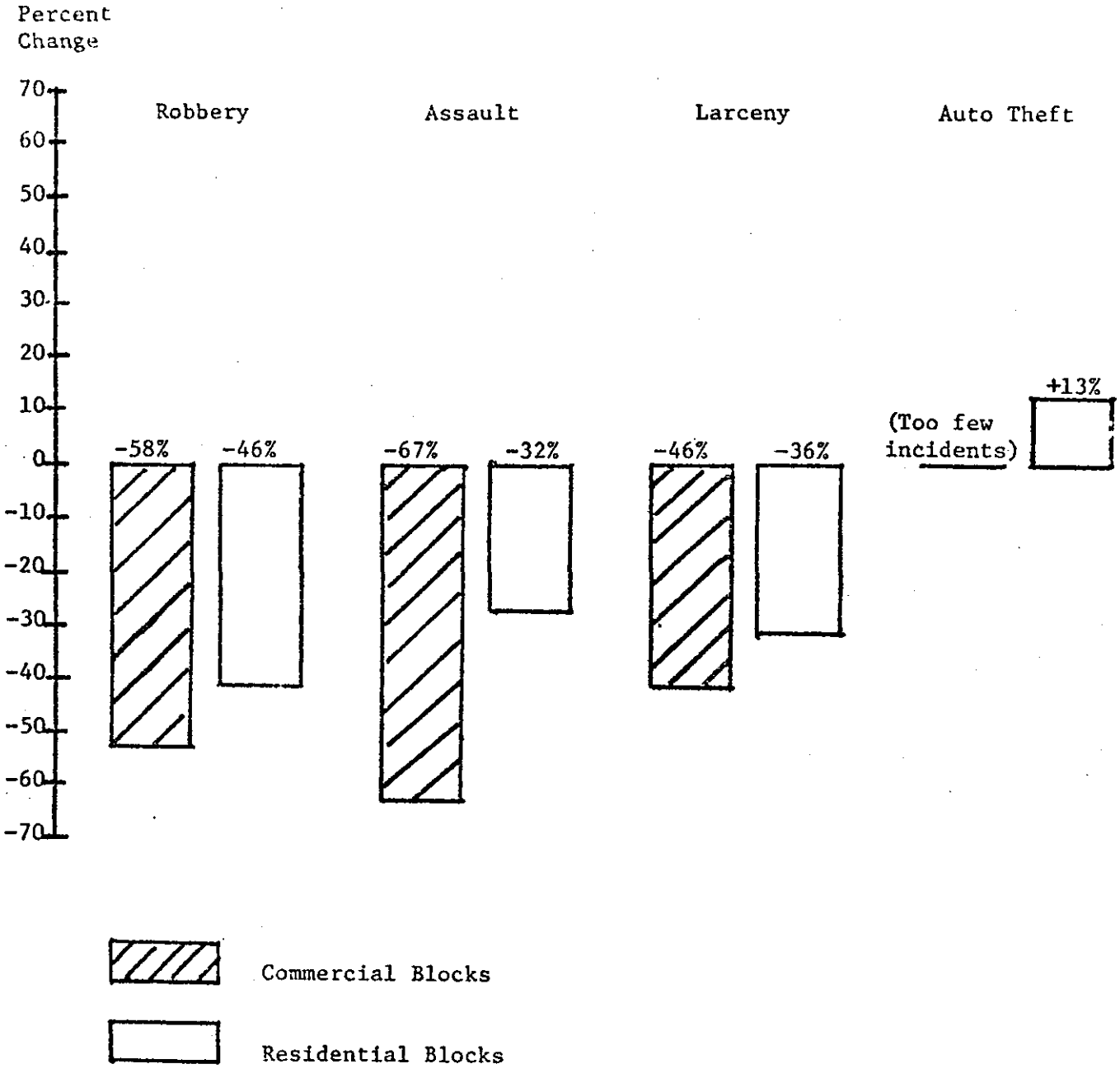


Table 4—12. Changes in Night Burglaries

in the Relit Blocks During

the Test Period (1971/1972) [1]

Burglaries of Commercial Establishments	Burglaries of Residences
-56% [2] (84/37)	-18% (82/67)

Notes:

[1] Test Period (1971/1972) compares twelve—month periods: October 1971—September 1972 and April 1972—March 1973.

[2] Percent change from 1970 to 1971 is indicated by -56%. Numerical change is indicated by (84/37) or 84 offenses for the 1971 period and 37 offenses for the 1972 period.

Table 4-13. Changes in Night Street Crime

in R-21it Commercial [1] Blocks (1970/1972)

	Baseline (1970/1971) [`]	Test 1971/1972) [3]	Statistically Significant
Violent Crimes:			
Robbery + Assault	+24% (25/31) [4]	-61% (44/17)	Yes (p<.005)
Robbery	+13% (16/18)	-58% (26/11)	No (p<.08)
Assault	+44% (9/13)	-67% (18/6)	Yes (p<.04)
Property Crimes:			
Larceny + Auto Theft	0 (21/21)	-47% (30/16)	No
Larceny	0 (16/16)	-46% (24/13)	No
Auto Theft	[5] (5/5)	-- (6/3)	No

Notes:

[1] Blocks with 10 or more employees.

[?] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[3] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[4] Percent change from 1970 to 1971 is indicated by +24%. Numerical change is indicated by (25/31) or 25 offenses for the 1971 period and 31 for the 1971 period.

[5] Percentage change not computed for low frequencies.

Table 4-14. Trends in Night Street Crime in

Relit Residential [1] Blocks

	Baseline (1970/1971) [2]	Test (1971/1972) [3]	Statistically Significant
Violent Crimes:			
Robbery + Assault	+55% [4] (27/42)	-41% (56/33)	Yes (p<.005)
Robbery	+59% *(17/27)*	-46% (37/20)	Yes (p<.02)
Assault	+50% (10/15)	-32% (19/13)	No
Property Crimes:			
Larceny + **Auto Theft**	+6% (31/33)	-11% (46/41)	No
Larceny	-17% (18/15)	-36% (22/14)	No
Auto Theft	+38% (13/18)	+13% (24/27)	No

Notes:

[1] Blocks with fewer than 10 employees and more than 38 residents.

[2] Baseline (1970/1971) compares nine-month periods: January 1970 September 1970 and January 1971-September 1971.

[3] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[4] Percent change from 1970 to 1971 is indicated by +55%. Numerical change is indicated by (27/42) or 27 offenses for the 1970 period and 42 for the 1971 period.

Figure 4-S. Percentage Changes in tent Night Street Crime in Relit Commercial ant 'e lit Residential Blocks 1970/1971 vs 1971/1972

(See also Table 4-13 and 4-14)

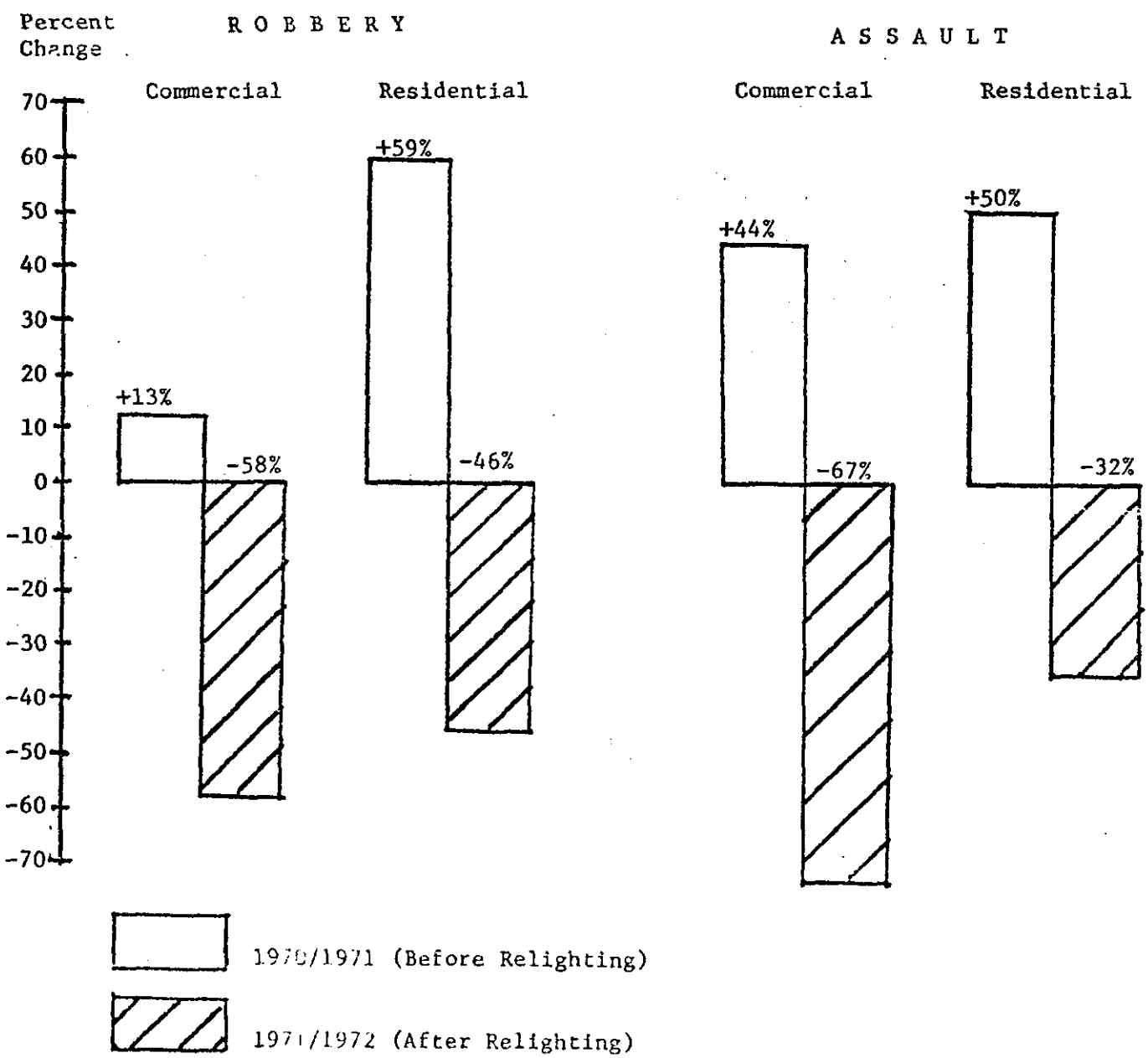


Table 4-15.' Changes in Night Burglaries

in the Relit Blocks (1971/1972)

	Baseline (1970/1971) [1]	Test (1971/1972) [2] [2]	Statistically Significant
Burglaries of Commercial Establishments	+14% [3] (57/65)	-56% (84/37)	Yes (p<.0002)
Burglaries of Residences	+11% (55/61)	-18% (82/67)	No

Notes:

(I) Baseline (1970/1971) compares nine-month periods: January 1970-October 1970 and January 1971-October 1971.

[2] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[3] Percent change from 1970 to 1971 is indicated by +14%. Numerical change is indicated by (57/65) or 57 offenses for the 1970 period and 65 offenses for the 1971 period.

a greater degree in the relit blocks also, but the difference between the relit and nonrelit blocks is not at statistically significant levels. Assault, however, shows a definite favoring of relit blocks relative to nonrelit. In the property crimes, no statistically meaningful differences are found between relit and nonrelit rates. (See also Figure 4-6.)

Table 4-17 presents comparisons of relit and nonrelit residential blocks. As with commercial blocks, the composite of violent crimes shows statistically significant differences between relit and nonrelit blocks. Unlike commercial blocks, however, robbery shows a significantly greater change in the relit blocks, *indicating* the efficacy of street lighting against this offense for these blocks. Also unlike commercial blocks, decreases in assault in the relit and nonrelit blocks cannot be statistically differentiated. Property crimes show a mixed pattern, with relit blocks showing a greater decrease only for larceny. None of the differences for property crimes reached statistically significant levels.

The reasons for the distinctions observed, between the responsiveness to improved street lighting of robbery in residential blocks and assault in commercial blocks are not immediately obvious.

Table 4-18 presents changes for night burglaries. Commercial burglaries in relit blocks decrease faster than in nonrelit blocks, but not at statistically significant levels. For residential burglaries, relit blocks show the smallest decreases.

c. Night street crime contrasted to night nonstreet and day street crime. To further isolate the effects of relighting, changes in night street crime in relit blocks, both commercial and residential, were compared to changes in two other locations--night crime that occurred in nonstreet locations, and street crime that occurred during the day.

Table 4-19 presents these results for commercial blocks. For the composite of violent crimes, night street offenses are more deterred than night nonstreec or day street offenses. This greater responsiveness of night street offenses approaches statistical significance levels.

Table 4-16. Changes in Night Street Crime in Commercial [1] Blocks During the Test Period (1971/1972) [2]

	Relit	Nonrelit	Citywide Sample	Statistically Significant [3]
Violent Crimes: Robbery + Assault	-61% (44/17) [4]	-2% (54/53)	-26% (143/106)	Yes (p<.01)
Robbery	-58% (26/11)	-25% (32/24)	-39% (84/51)	No
Assault	-67% (18/6)	+32% (22/29)	-7% (59/55)	Yes (p<.02)
Property Crimes: Larceny + **Auto Theft**	-47% (30/16)	-35% (71/46)	-30% (149/104)	No
Larceny	-46% (24/13)	-45% (44/24)	-27% (99/72)	No
Auto Theft	-- [5] (6/3)	-19% (27/22)	-36% (50/32)	No

Notes:

[1] Blocks with 10 or more employees.

[2] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[3] Statistical tests compare Relit to Nonrelit blocks.

[4] Percent change from 1971 to 1972 is indicated by -61%. Numerical change is indicated by (44/17) or 44 offenses for the 1971 period and 17 offenses for the 1972 period.

[5] Percentage change not computed for low frequencies.

Table Changes in Night Street Crime in Residential [1] Blocks During the Test Period (1971/1972) [2]

	Relit	Nonrelit	Citywide Sample	Statistically Significant [3]
Violent Crimes:				
Robbery + Assault	-41% [4] (56/33)	-5% (87/83)	-16% (180/151)	No
Robbery	-46% (37/20)	0 (42/42)	-14% (85/73)	No
Assault	-32% (19/13)	-9% (45/41)	-18% (95/78)	No
Property Crimes:				
Larceny + **Auto Theft**	-11% (46/41)	-19% (112/81)	-13% (209/172)	No
Larceny	-36% (22/14)	-15% (27/23)	-14% (83/71)	No
Auto Theft	+13% (24/27)	-32% (85/58)	-20% (126/101)	No

Notes:

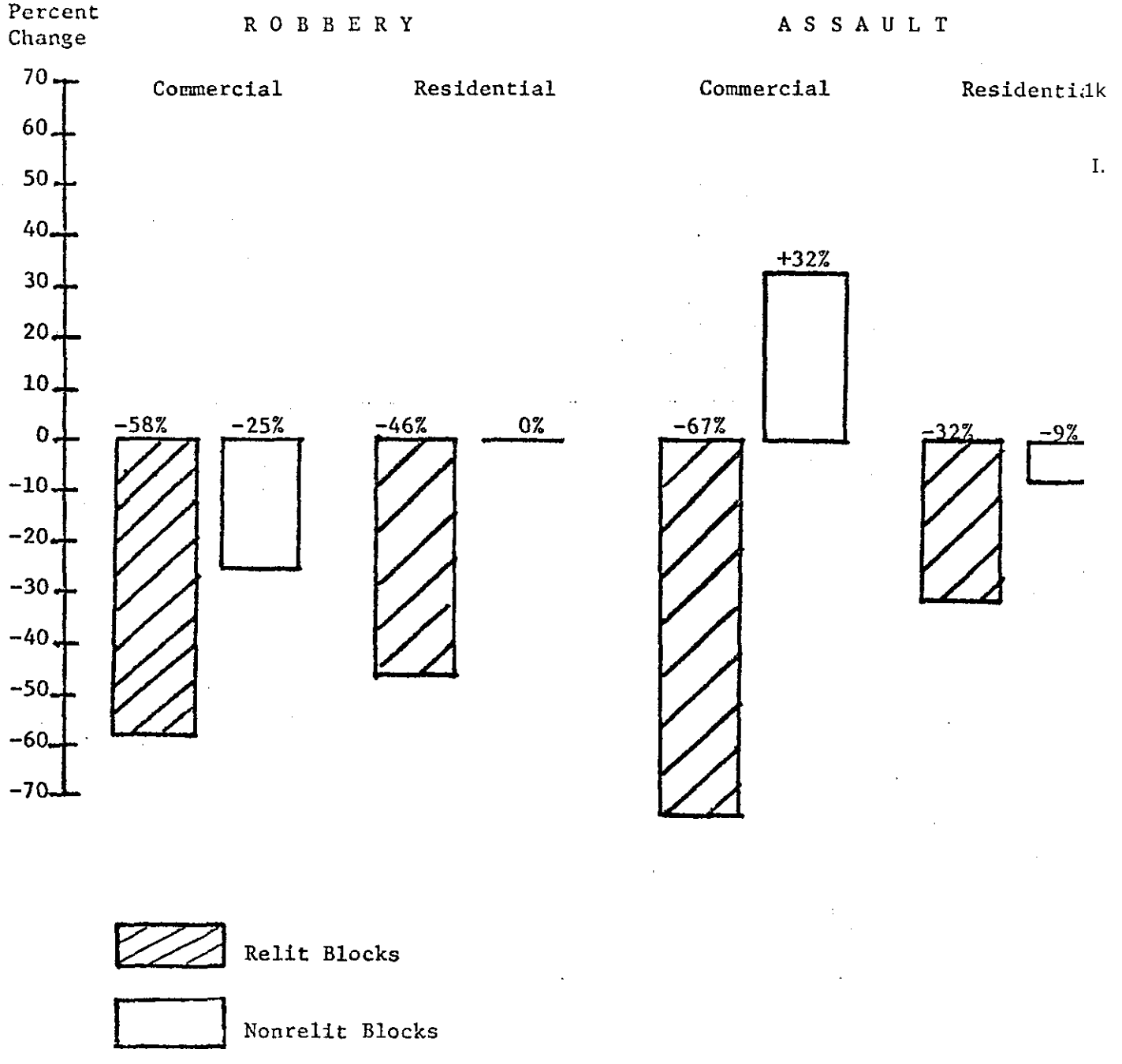
[1] Blocks with fewer than 10 employees and more than 38 residents.

[2] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[3] Statistical tests compare Relit to Nonrelit blocks.

[4] Percent change from 1971 to 1972 is indicated by -41%. Numerical change is indicated by (56/33) or 56 offenses for the 1971 period and 33 offenses for the 1972 period.

Figure 4-6. Percentage Changes in Violent Night Street Crime in Relit and Nonrelit Commercial and Residential Blocks (1971/1972). (See also Table 4-16 and 4-17)



For rubbery aim,: however, the decrease for night street contacts was equal to night no.istreot robberies, and almost equal to day street robberies. This may)e taken to Indicate that night robbery, which decreased equally for both street and nonstreet sites, declined in response to some factor other than lighting, since lighting is not likely to improve nonstreet visibility. By way of alternate interpretation, a finding in Detroit by Luedtke, et al. (1972), noted that a relation existed between street pedestrian traffic and frequency of robberies of stores. Since nonstreet robberies are often robberies of stores, and since stores are even more likely the target for nonstreet robberies in commercial blocks, it is possible that street lighting has indeed affected night crime rates for both street and nonstreet sites. Street robberies would be prevented by the mechanisms speculated on above, one of which is increased pedestrian traffic, and this mechanism as well has inhibited store robberies. Day street robberies would seem not to be reduced by this mechanism.

For assault there was a decline in night street incidents and a rise in the other two locations. These differences were statistically significant, even though the number of incidents is small. (See Figures 4-7 and 4-8.)

Property crimes -show greater decreases in relit than nonrelit blocks, although these differences are not statistically significant.

Table 4-20 presents these results for residential blocks. For the composite of violent crimes, lighting has a substantial deterrent impact in these blocks. Crimes with a night street location show a large drop, while crimes with night nonstreet or day street locations show an increase. The differences between these two changes is statistically significant. The impact that lighting has on violent crime, for all relit blocks, is maintained for the subgroup of residential blocks.

For robbery only, there is a _cline in the target of night street contacts, and a rise or smaller decline in the contrasting crime locations of night nonstreet aid day street contacts. The difference between the target and the contrast locations is also statistically *significant.* This is in contrast to commercial blocks, where declines in robbery in the target of night street crime were not statistically different *from* declines in the contrasting locations in those blocks.

For robbery atone however, the decrease for night street contacts was equal to night nonstreet robberies, and almost equal to day street robberies. This may ee taken to Indicate that night robbery, which decreased equally for both street and nonstreet sites, declined in response to some factor other than lighting, since lighting is not likely to improve nonstreet visibility. By way of alternate interpretation, a finding in Detroit by Luedtke, et al. {1972), noted that a relation existed between street pedestrian traffic and frequency of robberies of stores. Since nonstreet robberies are often robberies of stores, and since stores are even more likely the target for nonstreet robberies in commercial blocks, it is possible that street lighting has indeed affected night crime rates for both street and nonstreet sites. Street robberies would be prevented by the mechanisms speculated on above, one of which is increased pedestrian traffic, and this mechanism as well has inhibited store robberies. Day street robberies would seem not to be reduced by this mechanism.

For assault there was a decline in night street incidents and a rise in the other two locations. These differences were statistically significant, even though the number of incidents is small. (See Figures 4—7 and 4—8.)

Property crimes show greater decreases in relit than nonrelit blocks, although these differences are not statistically significant.

Table 4—20 presents these results for residential blocks. J'or the composite of violent crimes, lighting has a substantial deterrent impact in these blocks. Crimes with a night street location show a large drop, while crimes with night nonstreet or day street locations show an increase. The differences between these two changes is statistically significant. The impact that lighting has On violent crime, for all relit blocks, is maintained for the subgroup of residential blocks.

For robbery only, there is a decline in the target of night street contacts, and a rise or smaller decline in the contrasting crime locations of night nonstreet aid day street contacts. The difference between the target and the contrast locations is also statistically significant. This is in contrast to commercial blocks, where declines in robbery in the target *of* night street crime were not statistically different from declines in the contrasting :ocations in those blocks.

table 4-18. Changes in Night Burglary During the Test Period (1971/1972) [1]

	Relit Blocks	Nonrelit Blocks	Citywide Sample	Statistically Significant [2]
Burglaries of Commercial Establishments	-56% [3] (84/37)	-40% (235/142)	-43% (563/317)	No
Burglaries of Residences	-18% (82/67)	-36% (307/197)	-30% (533/375)	No

Notes:

[1] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Statistical tests compare Relit and Nonrelit Blocks.

[3] Percent change from 1971 to 1972 is indicated by -56%, Numerical change is indicated by (84/37) or 84 offenses for the 1971 period and 37 offenses for the 1972 period.

Table 4-19. Changes in Relit Commercial [1] Blocks

During the Test Period (1971/1972) [2]

	Nteht Street	Night Nonstreet	Day Street
Violent Crimes:			
Robbery + Assault	-61% (44/17) [3]	-31% (26/18)	-16% (25/21)
Robbery	-58% (26/11)	-60% (15/6)	-47% (17/9)
Assault	-67% (18/6)	__[4] (7/6)	+50% (8/12)
Property Crimes:			
Larceny + Auto Theft	-47% (30/16)	-37% (84/53)	-35% (46/30)
Larceny	-46% (24/13)	-33% (12/8)	-46% (35/19)
Auto Theft	**—** (6/3)	__[5]	0 (11/11)

Notes:

[1] Blocks with 10 or more employees.

[2] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973,

[3] Percent change from 1971 to 1972 is indicated by -61%. Numerical change is indicated by (44/17) or 44 offenses for the 1971 period and 17 offenses for the 1972 period.

[4] Percentage change not computed for low frequencies.

[5] Auto Thefts are Street only, with no Nonstreet offenses.

Table 4-1). Changes in Relit Commercial [1] Blocks

During the Test Period (1971/1972) [2]

	Night Street	Night Nonstreet	Dav Street
Violent Crimes:			
Robbery + Assault	-61% (44/17) [3]	-31% (26/18)	-16% (25/21)
Robbery	-58% (26/11)	-60% (15/6)	-47% (17/9)
Assault	-67% (18/6)	-- [4] (7/6)	+50% (8/12)
Property Crimes:			
Larceny + Auto Theft	-47% (30/16)	-37% (84/53)	-35% (46/30)
Larceny	-46% (24/13)	-33% (12/8)	-46% (35/19)
Auto Theft	-- (6/3)	__[5]	0 (11/11)

Notes:

[1] Blocks with 10 or more employees.

[?] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[3] Percent change from 1971 to 1972 is indicated by -61%. Numerical change is indicated by (44/17) or 44 offenses for the 1971 period and 17 offenses for the 1972 period.

[4] Percentage change not computed for low frequencies.

[5] Auto Thefts are Street only, with no Nonstreet offenses.

Table 4-20. Changes in Relit Residential [1] Blocks

During the Test Period (1971/1972) [2]

	Nicht Street	Night Nonstreet	Dav Street
Violent Crimes:			
Robbery + Assault	-41% (56/33) [3]	+120% (15/33)	+19% (32/38)
Robbery	-46% (37/20)	+83% (6/11)	-22% (23/18)
Assault	-32% (9/13)	+144% (9/22)	+122% (9/20)
Property Crimes:			
Larceny + Auto Theft	-11% (46/41)	-25% **(92/69)**	-15% (48/41)
Larceny	-36% (22/14)	-15% (27/23)	-36% (33/21)
Auto Theft	+13% (24/27)	-- [4]	+33% (15/20)

Notes:

[1] Blocks with fewer than 10 employees and more than 38 residents.

[2] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[3] Percent change from 1971 to 1972 is indicated by -41%. Numerical change is indicated by (56/33) or 56 offenses for the 1971 period and 33 offenses for the 1972 period.

[4] Auto Thefts are Street only, with no Nonstreet offenses.

Figure 4-7. Percentage Changes in Robbery in Selected Locations in Relit Commercial and Relit Residential Blocks (1971/1972). (See also Table 4-19 and 4-20)

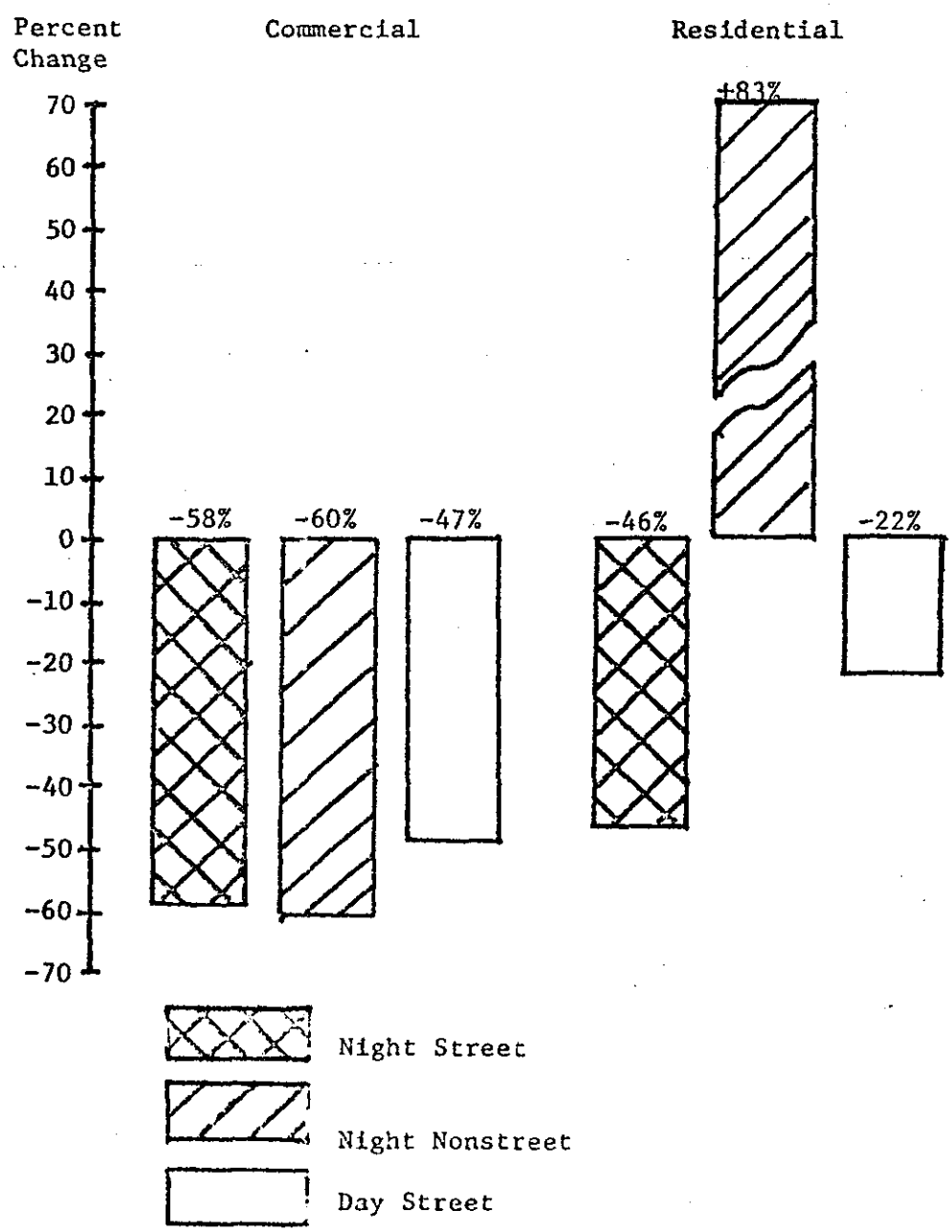
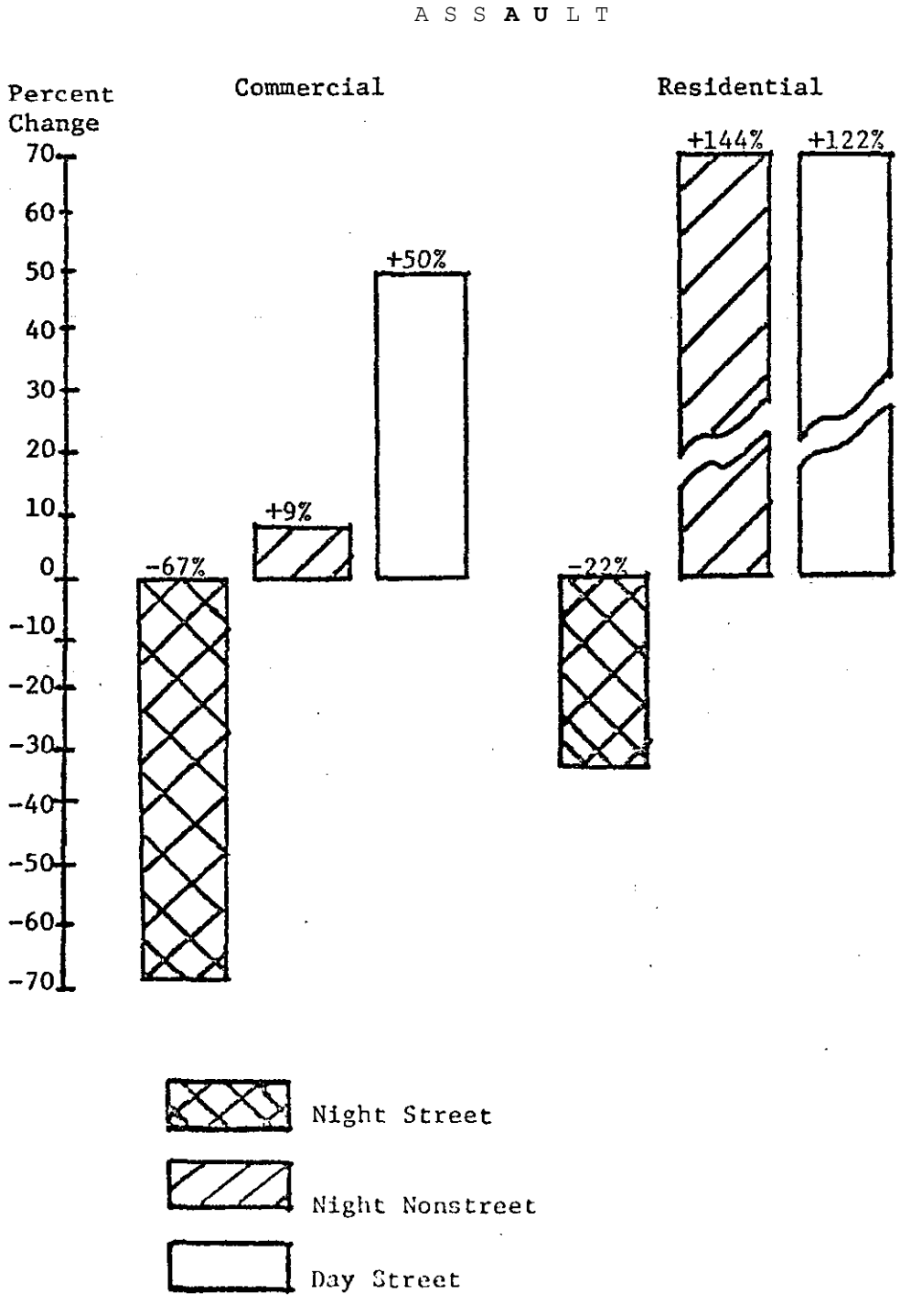


Figure 4-8. Percentage Changes in Assault in Selected Locations in Relit Commercial and Relit Residential Blocks (1971/1972).
(See also Table 4-19 and 4-20)



For assault, the declines in night street contacts, and the rise in the contrasting locations that was found for both the entire sample of relit blocks and for commercial blocks only, arc also found in residential blocks. These differences are statistically significant.

Among the property crimes no statistically significant differences were found between the night street offenses and offenses in other locations investigated. The largest of these differences was for larceny, where a 36% drop in night street locations was paired with a zero change in night nonstreet locations. Burglary changes are presented in Table 4-21.

d. Summary of night street changes for commercial and residential blocks. A distinction was made between blocks with a commercial character and blocks with a residential character. This distinction was introduced in response to differing crime rates between these two types of blocks, differing street activity, and assumed differing responses in pedestrian activity following the introduction of street lighting. The distinction was operationalized on the basis of the number of residents on each block and number of employees in commercial establishments on each block. A third category of block, in addition to commercial and residential, was developed. This was a block with essentially very few residents or employees, and was labelled "low use". These blocks were excluded from this analysis.

Crime rates were defined as crimes per block. Crime rates prior to relighting were roughly twice as high in commercial blocks as in residential blocks. Following relighting, crime rates for the two blocks were much closer, and in some cases, virtually equal. This may indicate some lower limit on the effectiveness of street lighting, or may be an indication that commercial blocks have more crime, and so have more deterrable crime. Crime rate differences between the two blocks were not statistically significant, except for burglary.

Changes from before to after relighting were investigated. For both commercial and residential blocks, the composite of violent crimes showed statistically significant declines. This maintains the declines

Table 4-21. Changes in Burglaries in Relit Blocks During the Test Period (1971/1972) [1]

	Night	Day
Burglaries of Commercial Establishments	-56% [2] (84/37)	-40% (235/142)
Burglaries of Residences	-18% (82/67)	*+9%* (140/152)

Notes:

[1] Test Period (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[2] Percent change from 1971 to 1972 is indicated by -56%. Numerical change is indicated by (84/37) or 84 offenses during the 1971 period and 37 offenses during the 1972 period.

that were found in the entire relit sample. For the components of vfolont crimes, casmmercisl 'cks showed statistically significant Ii; .es for ho,:h robbery and assault, while in the residential h3,r':::, only robbery showed a significant decline. The failure of r:h,•n;es in sssault in residential blocks to achieve significance may he due to the small numbers of crimes under consideration.

Differences between the relit and the nonrelit blocks were investigated for the test period. For commercial blocks the composite of violent crimes was statistically different in relit blocks and nonrelit blocks; and of the components, only assault was differentiated in the two groups of blocks. Robbery showed declines in both relit and nonrelit blocks. Small sample sizes, resulting from subdividing the main sample, may account for the lack of statistical significance of differences between the blocks for changes in robbery.

For residential blocks, the composite of violent crimes decreased significantly more in relit than nonrelit blocks, while in a reverse pattern to the commercial blocks, robbery and not assault showed a decline in relit blocks that was statistically greater than for nonrelit blocks.

Within the relit blocks, comparing changes in crimes with a night street location to changes in crimes with a night nonstreet or day street location, commercial blocks showed differences only for assault, while residential blocks showed differences for both robbery and assault.

4. Displacement. Analysis of displacement is more complex for commercial and residential blocks than it is for all blocks in the sample. As noted above, crimes may shift from night street sites in relit blocks to night street etes in nonrelit blocks; to night nonstreet sites within the relit blocks; or to day street sites within the relit blocks With a subdividing of all sample blocks into two groups, the numbs of displacement possibilities doubles, in that night street crime in residential blocks may relocate to any of these

alternate sites within residential blocks, or to any of these sites within commercial blocks.

Accordingly, it is necessary to consider both sets of blocks in analyses of displacement. This is more complicated, and the results may be more difficult to interpret. This analysis is further complicated by the fact that within this study, subdividing the entire sample into commercial and residential samples effectively halves the number of blocks in each group. With small numbers of blocks in each group, small changes in the data are further difficult to interpret.

In general, displacement indications were found for the two sets of blocks for those crimes which showed displacement indications for the entire sample. In this regard, subdividing the sample is not instructive as to the nature of lighting impact on crime. Of the crime displacement indications, however, it is instructive that most indications of displacement of violent crimes were found in residential blocks, while property crime indications of displacement are more located in commercial blocks. The one exception to this generalization about property crime is for larceny, which showed a displacement profile that was similar to that of robbery.

a. Displacement to night street crime, nonrelit blocks. These results are presented in Table 4-22. In the residential blocks, for violent crimes, displacement indications were found for the composite, and for both components of robbery and assault. For the total of violent crimes, the 1970-1971 period saw a decline of 34% in violent incidents, while the 1971-1972 period saw a decline of only 5%. This reduction in rate of decline was more marked for robbery than for assault. For robbery, the 1970-1971 period saw a decline of 41%, almost half, and the 1971-1972 period showed no change at all. Assault changed from a 26% drop in the 1970-1971 period, to a drop of much less, 9%, for the 1971-1972 period. Clearly, displacement indications have been found for violent crimes, for residential blocks. By contrast, the commercial blocks showed no displacement indications whatever.

Table 4-•22. Displacement [1] Indications for

Nig:Lt Street Crime to Nonrelit Blocks

	Commercial [2]		Residential [3]	
	Baseline (1970/1971) [4]	Test (1971/1972) [5]	Baseline (1970/1971)	Test (1971/1972)
Violent Crimes:				
Robbery + Assault	+6% (17/18) [6]	-31% (26/18)	-34% (92/61)	-5% (87/83)
Robbery	+20% (10/12)	-60% (15/6)	-41% (49/29)	0 (42/42)
Assault	-14% (7/6)	+9% (11/12)	-26% (43/32)	-9% (45/41)
Property Crimes:				
Larceny	+57% (21/33)	-45% (44/24)	-33% (33/22)	-15% (27/23)

Notes:

[1] Defined as increase, or reduced rate of decrease, in Test period relative to Baseline period.

[2] Blocks with 10 or more employees.

[3] Blocks with fewer than 10 employees and more than 38 residents.

[4] Baseline (1970/1971) compares nine-month periods: January 1970-September 1970 and January 1971-September 1971.

[5] Test (1971/1972) compares twelve-month periods: October 1970-September 1971 and April 1972-March 1973.

[6] Percent change from 1970 to 1971 is indicated by +6%. Numerical change is indicated by (17/18) or 17 offenses for the 1970 period and 18 offenses for the 1971 period.

In the property crimes, there was also a displacement indication, again only for the residential blocks. This was for larceny, where a 1970-1971 decline of 33% . was followed by a 1971-1972 drop of 15%, a reduction of more than half in the rate of decline. Again, for the commercial blocks, no displacement indications were found for property crimes.

b. Displacement to night nonstreet crime, relit blocks. Of the components of violent crime, robbery showed a rise in nonstreet contacts in residential blocks only, and not in commercial blocks. This relative increase in nonstreet crime in residential blocks occurred for both relit and nonrelit blocks, and indicates a movement of crime that is possibly unrelated to lighting, because of its occurrence both in blocks that were relit and blocks that were not.

For commercial blocks the offense of robbery also did not distinguish between relit and nonrelit blocks. In these blocks there were no displacement indications, either in the relit or the nonrelit group.

Assault also showed displacement indications to night nonstreet locations in residential blocks, but as with robbery, these indications were found for both relit and nonrelit blocks, and so the effects of lighting cannot be easily determined. For commercial blocks, assault did distinguish between relit blocks, where there was a small increase in 1971-1972 relative to 1970-1971, and no such increase in the nonrelit blocks. The very small numbers of offenses involved in this comparison make these differences tentative, at best.

Of the property crimes, again larceny showed the displacement profile, and again it was in the residential blocks only. As with other night nonstreet shifts, the shift for larceny occurred for both the relit residential blocks, and the nonrelit residential blocks. Again, these shifts do not distinguish between relit and nonrelit blocks, and make it somewhat difficult to draw conclusions about the effects of lighting.

c. displacement to day street crimes, relit blocks. Of the violent crimes, robbery showed no displacement profile into day street locations, while assault did show these indications. The indications of displacement that occurred for assault were found for both commercial and residential blocks, and further for each of these subdivisions were found for both relit and nonrelit blocks. Shifts in both relit and nonrelit blocks suggests factors other than lighting changes,

Of the property crimes, displacement indications were found for burglary and auto theft. For burglary, there were increases during the 1971-1972 period, relative to the 1970-1971 period, for burglaries against both commercial and residential targets. Crimes against commercial targets increased for both relit and nonrelit blocks, while those against residential targets increased only for relit blocks. Commercial burglaries, which are night crimes primarily, are equally affected in both relit and nonrelit blocks, and suggest that such changes are independent of lighting changes. Residential burglaries, whit are day crimes primarily, relocate to the day only for relit blocks, This suggests that lighting has had a differential effect in the residential relit blocks, as compared to the nonrelit blocks. Since residential burglaries are primarily a day offense--£ndicating that for whatever reason, day is the preferred time for crimes against these targets—the shift to the day is plausible, ,even if contrary to the hypothesis that light (street light or daylight) inhibits crime.

No such change has occurred for nonrelit blocks with residential targets, thus indicating an interaction between the crime of burglary of residential targets, street lighting, and time of day.

For auto theft, displacement indications exist for both commercial and residential blocks. For commercial blocks, these indications are present for both relit and nonrelit blocks, indicating that these shifts seem to occur independent of the area of relighting. By contrast, for residential blocks, displacement indications

are found for only relit blocks, and not for nonrelit blocks, Lighting seems to distinguish between residential areas that have a day shift of auto theft, and areas that do not,

For property crimes, then, shifts to day street crimes in residential blocks seem to be associated with street lighting upgrading, while for commercial areas these shifts in crime locations are not associated with the presence or absence of relighting.

d. Summary of displacement changes. Displacement was observed for a number of crimes and a number of locations. Of the violent crimes, most of the shifts to new locations were for residential blocks, and virtually none for commercial blocks. (1) Shifts to night street locations in nonrelit blocks occurred for both robbery and assault, but only for residential blocks. (2) Shifts to night nonstreet locations occurred for both crimes, but primarily for residential blocks. These shifts occurred equally for relit and nonrelit blocks, thus obscuring the effects of relighting. (3) Shifts to **day** street locations occurred only for assault, and not for robbery. This shift in assault occurred both for commercial and residential blocks, and occurred equally for relit and nonrelit blocks. The presence of this shift in both relit and nonrelit blocks makes difficult the isolation of deterrent and displacement effects of lighting.

Within the property crimes, there is generally responsiveness to lighting, and, accordingly, fewer indications of displacement.

(i) In the shift from night street locations in relit blocks to night street locations in nonrelit blocks, there are changes for larceny, but only for residential blocks. This parallels the shift in robbery, and is consistent with the presumed effects of lighting.

(ii) There are some signs of crime relocation from night street locations to night nonstreet locations. This occurs only for larceny, and only for the residential blocks, and occurs for both relit and nonrelit blocks. This movement in both relit and nonrelit blocks suggests factors other than lighting.

(iii) There ire some signs of relocation from night offenses to day offenses for both auto theft and burglary. Auto theft shows displacement indications for both commercial and residential blocks, but for commercial blocks these indications occur in both relit and nonrelit blocks, For residential blocks, these indications occur for only relit blocks, Burglary shows a similar pattern, with displacement indications observed for both commercial targets and residential targets during the day hours. For commercial targets these increases are for both relit and nonrelit blocks, while for residential targets these indications are only for relit blocks. For both these property crimes, then, displacement in response to street lighting seems to have occurred only in residential blocks, with other factors operating in commercial blocks.

In summary, displacement indications in commercial and residential blocks seem to occur in ways that differentiate between relit and nonrelit areas only for residential blocks, and not for commercial blocks. Violent crimes and larceny retain a night character while other property crimes move to the day.

5. Conclusions. To further isolate the unique geographical and criminological aspects of crime that are deterrable by upgraded street lighting, the entire relit sample was divided into subsamples. One of these subsamples contained blocks with a primarily commercial character, and another subsample contained blocks with a primarily residential character. Crime rates--defined as crimes per block—for night street crime for these two subsamples were compared. For the twelve months prior to relighting, commercial blocks had higher crime rates (roughly twice as high) than residential blocks. For the twelve months following relighting, rates for the two groups of blocks were considerably closer. For violent crimes, rates were virtually identical, and for croperty crimes, the differences *were* substantially narrowed.

A comparison of changes in night street crime frequencies showed that commercial blocks had a greater decline than residential blocks, for all categories of crime under consideration. In compar-

ison with baseline (1970-1971) data, which showed crime increases, these test period (1971-1972) declines were even more dramatic. For violent crimes, declines in the test period were near or at statistically significant levels for commercial blocks, while for residential blocks, these changes were significant for robbery but not for assault.

For commercial blocks, declines in night street crimes of violence in relit blocks exceeded changes in the nonrelit blocks. This was true for residential blocks as well. Property crimes showed generally less responsiveness to lighting upgrading.

However, within relit commercial blocks, declines in night street robbery were largely equalled by declines in night nonstreet robbery and declines in day street robbery. These other changes cannot easily be attributed to street lighting upgrading. Night street assault showed a decline, while night nonstreet assault and day street assault showed increases. Within commercial blocks, then, robberies decline both in ways that would be expected in response to street lighting and in ways or locations that would not be expected.

Within relit residential blocks, in contrast to commercial blocks, night street robberies decline while night nonstreet robberies increase, and day street robberies decline to a lesser degree. This pattern is consistent with changes that would be expected in response to street lighting.

It may be seen, then, that night street robberies are declining faster in relit commercial blocks than in relit residential blocks, and that declines in each set of blocks are greater for relit than nonrelit blocks. These changes indicate the greater responsiveness to street lighting upgrading for night street robbery in relit commercial blocks than in relit residential blocks. If this is true, then this difference between commercial and residential blocks has important consequences for strategies of where to locate lighting upgrading. But other changes within relit blocks show that within commercial relit blocks, crime is decreasing in ways that are not

related, or at l=ast not obviously related, to lig:ing upgrading. By contrast, wi.t`iin residential relit blocks, cric:' does change in ways that are consistent with the effects of li[g]htti.,:,--i.e. decreases where lighting increases visibility, and no decreases where lighting does not increase visibility,

For both relit commercial and relit residenti.;; blocks, assault decreases in night street locations, and does not [d]'crease in other locations. This pattern indicates that lighting d;s seem to have an inhibitory effect on night street assault.

To measure the relation between crime decreases and crime displacement, locations that were potential receptors of displaced night street crime were investigated, The analysis of displacement is complicated by the fact that there are two crime locations that may be responsive to street lighting—commercial night street crime and residential night street crime—and twice as cony possible receptor sites for displaced crime. Displacement indications that were found differentiated between relit and nonrelit blocks only for residential blocks, and did not differentiate for commercial blocks. This is consistent with the interpretation derived from robbery decreases, that relighting does not differentiate between commercial blocks, and does differentiate between residential blocks.

Violent crimes and larceny shifted to other night locations, while property crimes of auto theft and burglary shifted to day locations.

D. Conclusions.

1. <u>All Relit Blocks,</u> Within the relit blocks crime was increasing prior to relighting. Following relighting there was a dramatic and significant decline for <u>violent</u> crimes. <u>Property</u> crimes also showed a rise prior to relighting, and a drop afterwards, but the reversal of crime trends for these offenses was not significant. Leclinss in relit blocks were greater than declines in comparable nonrelit blocks.

Within relit blocks, decreases for violent crimes were greater for night street locations than for night nonstreet locations or for day street locations. These comparisons all indicate that lighting was successful in decreasing violent crime in relit blocks, in the target location of night street offenses.

It is of interest to note that violent crimes--which are crimes against persons--show the most responsiveness to street light upgrading. The mechanisms for this responsiveness cannot be known from these data. Crimes against property are less responsive to street light upgrading. It may be that crimes against persons--which are crimes where there is at least one witness: the victim--are deterred because increased lighting makes offenders more visible to victims, and potentially more identifiable. Property crimes would then be unaffected because increased visibility would not automatically be coupled with the presence of a witness.

It may be that crimes against persons are more apparent-to potential witnesses than are crimes against property. The increased visibility due to street lighting improvement makes witnessing, intervention by police, or reporting by citizens more likely. The difference between person and property crimes may be indicated by the difference between observing a contact between two persons (e.g., an offender *who* may have a weapon and a victim *who* may standing with his hands up), and observing a person fumbling to enter a car, or merely walking down the street carrying a package.

As noted above, Feeney and Weir (1973) found that robbery victims knew shortly before their victimization that an offense was about to occur (because of the generally suspicious behavior of the offender). Increased visibility could allow potential victims to detect these suspicious cues further in advance, perhaps sufficiently far in advance to take evasive action, such as crossing the street. For property crimes this mechanism also would not apply.

Some evidence for displacement of offenses was found. Night street robberies in relit blocks decreased following relighting, while night street offenses in adjacent nonrelit blocks showed a

reduced rate o decline following lighting. The numbers of offenses involved suggest that only a fraction, between a fourth and a third, of the prevented robberies were relocated.

Offender studies have shown that offenders tend to live near the location of their offenses. This is often in contrast to victims who are victimized in non-home neighborhoods. The offender data may be biased in that these data are often obtained from apprehended offenders, who are probably different *from* nonapprehended offenders in a number of systematic ways. Nonetheless, offender data indicate that street robbery is often an impulsive act on the part of the apprehended offender, who sometimes is acting as a passive member of a group.

If these offender data are accurate, it may be that the effect of lighting is to eliminate one cue, darkness, which along with other factors triggers a response of robbery. If robbery is an impulsive act, and occurs along with other offender acts, these acts occur where offenders and potential offenders habitually congregate. This would be in the home neighborhoods of offenders. Robberies, then, would not relocate if offenders spend most of their time in their home neighborhoods. Robberies would also not relocate if there was some interaction between home neighborhood and commission of offense, such as knowledge of escape routes, willingness of other neighbors to condone such acts (perhaps because of friendship or kinship), inertia, or other factors.

Within this analysis, then, the robberies that are deterred are the impulsive and unplanned offenses, rather than those with rational preparation. Offenders who plan may plan around lighting by relocating to other blocks for night street contacts, or may compensate for the effects of light by the introduction of other tactics such as weapons, violence, accomplices, or other changes in mode of operation.

Night strut assault is also responsive to street lighting, but the displacement indications suggest a different mechanism for the response of this offense to street lighting. The size of dis-

placement is difficult to determine, because of a general rise in assault in Kansas City during the period of this study. Further, the direction of displacement is difficult to determine because assault rose in receptor sites in both relit and nonrelit blocks. Still, it seems safe to say that the magnitude of the rise of assault offenses in these other areas more than offsets the decrease in night street contacts in relit blocks, and may include those deterred offenses.

Assault shows an increase in night nonstreet and in day street locations in relit blocks, and also for these locations in nonrelit blocks. If night street assaults are displaced, their geographical displacement is less--either to nonstreet (indoor) sites, or to the same street sites, but to day hours, There is no clear reason why these contacts should move indoors or to the day. Perhaps assault is also impulsive, as with family disputes or arguments between acquaintances, and happens only when the appropriate cues are present. Appropriate cues can include darkness (as with robbery), and this awareness of cues can also happen at an impulsive level. Unlike street robberies, however, where the additional cue of target, or victim, is only sometimes present, it may be that for assault, particularly assault between acquaintances or family members, the target is present indoors and during the day.

The numbers of incidents involved for assault is also instructive, as a contrast to robbery, There seems to be an overall decline in the incidence of robbery, while there is no overall decline in the incidence of assault. This difference may suggest differences in the nature of offender attitudes and perceptions prior to commission of the offense.

The gain in robbery--cash or goods of value--may be obtainable through other means, criminal or, noncriminal, while the gain in assault is less easily transferrable.

Among the property crimes, auto theft also shows some displacement indications, in an apparent shift to day offenses. The numbers of incidents of auto theft indicates that whatever reduction in of-

fenses occurs a: night is more than offset by the day increase, and so the day increase may include those offenses deterred at night, or some large frac_ion of them. In this regard, auto theft is similar to assault, in that lighting does little to reduce the overall incidence of crime. It may be that auto theft is also similar to assault in the lack of alternate gratification of impulse.

Upwards of eighty percent of auto theft is classified as theft **for use** (joyriding) rather than theft for retention (presumably for financial gain), so auto theft may also be an impulsive act. Increased lighting at night, plus increased citizen awareness at night may make these offenses simply too hard to commit at night. But as with assault, and unlike robbery, there is no immediately available alternate mode of impulse satisfaction. Thus these impulse crimes may be resistant to simple deterrence, in terms of overall frequency, although they may be responsive to relocation.

2. Commercial vs. Residential. As with the sample of all relit and nonrelit blocks, in the subsamples of commercial and residential blocks, crime was increasing prior to relighting, and decreased afterwards in blocks that received relighting. For the composite of violent crimes, these changes were statistically significant for both subsamples. Of the property crimes, only burglary of commercial establishments changed at statistically significant levels.

Within each of the subsamples, comparisons were made between relit and nonrelit blocks. For commercial blocks, differences between changes in relit and nonrelit blocks were significant for the composite of violent crimes, and for assault. For the residential blocks, differences were not significant, but were large and approached significance both for the composite of violent crimes, and for robbery„

A further analysis within each of these subsamples was performed, considering only changes within the relit blocks in each of these subsamples. For the commercial blocks, decreases for the composite of violent crimes and for robbery were largely equal for crimes

with a night street location, where lighting should have an impact, and also for other locations where lighting would not be expected to have an impact. These other locations were night nonstreet sites, and day street sites. For the residential blocks, changes in a night street location, where lighting should have an impact, were significantly greater than in other locations where lighting would not be expected to have an impact. These other locations were night nonstreet sites, and day street sites.

For assault, changes in commercial blocks are consistent with the expected effects of lighting. These offenses decline for night street locations in relit blocks, and increase elsewhere in nonrelit blocks in night street locations, and within relit blocks, in the nonstreet and day street locations.

In residential blocks, assault changes are only slightly consistent with the expected effects of lighting. These offenses decrease for the location of night street offenses, but this decrease occurs for both relit and nonrelit blocks. Within relit blocks, decreases for night street offenses differ significantly from increases in night nonstreet, or day street offenses.

In summary, it appears that in residential blocks robbery declines in *ways* that are consistent with the expected effects of lighting upgrading, and assaults do not. In commercial blocks the reverse is true. Assaults decline in ways that are consistent with the expected effects of lighting, and robberies do not. Robberies decline in several locations, including those where lighting would be expected to reduce these offenses, and also in areas where lighting would not be expected to reduce these offenses.

Displacement effects were observed. When shifts were to night street locations in nonrelit blocks, these shifts occurred primarily in residential blocks, This suggests other mechanisms are operating in nonrelit commercial *blocks* to keep crime from relocating to these blocks. A few of these may be enumerated, One was the presence of a prior relighting program that made many of these nonrelit blocks as bright as the currently relit *blocks.* This prior

relighting pro ram ap parently continues to make these blocks safe from crime, as measured now by their resistance to crime relocation, Other factors include. the increased patrols and increased manpower, and special antirobbery units, in all high-crime blocks. These high-crime blocks include both relit and nonrelit commercial blocks.

Night street shifts in residential blocks occurred for robbery, assault and larceny. The increase in assault in adjacent areas may be accounted for by the citywide rise in this offense during the period of the study. The lack of increase in the nonrelit commercial blocks is an additional indicator of the continued effectiveness of an earlier street lighting program and other anticrime measures in those high-crime blocks. The increase in robbery in adjacent nonrelit blocks is paralleled by the displacement profile for larceny, and may indicate that crimes of theft, whether with force (as in robbery) or without force (as in larceny), have common characteristics. This parallel between robbery and larceny has been noted *throughout these* results.

Shifts to night nonstreet locations were also observed, and these were also primarily in residential blocks. These were for crimes of violence.

Shifts to day street locations were observed. These were primarily for crimes of property, and in residential blocks went to the day only in residential blocks that were relit. This presumably indicates the effects of lighting on crime, since residential blocks without new street lighting did not experience a shift to the day. In commercial blocks, crimes of property shifted to the day for both relit and nonrelit blocks. If the shift to the day indicates increased anticrime measures at night, then for commercial blocks those measures have occurred for both relit and nonrelit blocks. This is consistent with the crime deterrent patterns observed with respect to violent crimes in commercial blocks, where crimes decreased both in relit areas (where crime decreases would be expected), and in other locations (where lighting-associated decreases

RECOMMENDATIONS

A. Introduction.

The purpose of this study has been to understand the relation between street lighting and street crime. The study has been set in Kansas City, but the relationships have been investigated in ways that hopefully will allow for generalizations to other high-crime urban locales. This study has confirmed results from other research, and expanded on other research in the scope of its analysis and in methodological rigor.

Law-enforcement professionals and citizens alike share the general assumption that street lighting acts to deter crime. This study has attempted to indicate which crimes, how much deterrence, in what areas, and at what displacement costs; and to answer a number of other questions. As a result of this investigation, some recommendations can be made for optimizing further crime deterrence. While these recommendations generally call for more street lights, their value lies in their ability to make specific statements about the type of crime to be prevented and the locations in which this prevention may be expected. These recommendations also draw strength from the fact that some crimes were observed to be unresponsive to street lighting, and for these crimes other anticrime measures are necessary. Street lighting is only one of a number of anticrime measures that must be integrated for maximum anticrime effectiveness.

The recommendations for increased street lighting are made with the awareness that there are limited resources in finances and manpower for which various crime-preventior and other governmental functions compete. In times of energy shortages, recommendations for increased expenditures of energy must be made with an eye to limiting demands on scarce energy resources.

B. Street Lighting and Energy

Street lights represent one of the most conspicuous forms of energy consumption, simply because they appear to be omnipresent, consuming energy continuously throughout the night. Other forms of energy consumption seem to be more geographically localized, or to be activated for time periods. During times of energy shortages, all forms of energy consumption, including street lighting, are subjected to scrutiny for possible energy savings.

1. The Magnitude of Street Light Energy consumption. In order to understand the potential savings available from a reduction in street lighting, it is necessary first to understand the magnitude of energy consumed by all street lights.

The General Electric company, manufacturer of Lucalox® sodium vapor street lights, prepared figures for public debate as part of the nationwide response to the energy crisis. These figures indicate that of all energy consumed in the United States, a full three-quarters (75%) is energy other than electric. Twenty percent of the *energy* consumed is electrical, for nonlighting purposes, and 5% is electrical, consumed for lighting purposes. Only some of this energy for lighting is consumed by street and highway lighting. Of all this, only 0.18% of the total of all energy consumed in the United States is electrical energy devoted to street lighting.

A recent report on street lighting and street crimes, prepared for the City of Miami, included an appendix on energy consumption. Figures for October, 1973, indicate that for all street lights--including those maintained by the city, the county, the state, and the Federal government, on streets, highways, parks and trailer parks--energy consumption was 1.9 million kilowatt hours (KWH). This is 0.8% (0.008, or one part in 125) of the 240 million KWH consumed for all electrical needs during this period. Since electrical energy is only a fourth of the total energy consumption, this figure of 0.8% of the total of all electrical energy is actually 0.2% (0.002, or one part in 500) of all energy consumed.

The figure of 0.2% for Miami is remarkably close to the figure of 0.18% estimated by the General Electric company. Similarly, the Edison Electrical Institute estimates that .77% of all electrical energy consumption goes for street and highway lighting. This figure is also quite close to the 0.8%, estimated by General Electric.

Since the current energy crisis is often considered in terms of barrels or gallons of gasoline, these figures for electrical energy consumption may he more usefully presented as petroleum equivalents. One gallon of gasoline contains 126,000 BTU. The average conversion efficiency of gas and oil to heat is 32%, and this produces twelve KWH per gallon of gasoline. Thus the estimated annual energy consumption for all street lights in the United States is equivalent to 1,240,000,000 gallons-- or six gallons per person per year.

This figure is derived from the following computation. There are approximately 12.4 million street lights nationwide. Of these, 20% are incandescent (filament), 75% are mercury, and 5% are sodium. The average wattage of each of these types of lights is 300, 330, and 350, respectively; or a national average of 325 watts each. In terms of annual energy consumption, these lights use 1200, 1320, and 1400 KWH annually. These figures are based on an average annual street light usage of about 4,000 hours, or a little less than twelve hours a day. At twelve KWH per light per year, and at 12 KWH per gallon, each light uses an average of one hundred gallons of gas per year, or 100 gallons per light for 12.4 million lights, or 1,240,000,000 gallons of gas for all lights each year.

In terms of efficiency of utilization of energy, different types of lights are differentially efficient. Depending on their wattage (higher wattage lights being more efficient), incandescent lights produce 20 to 23 lumens per watt, mercury lights produce 40 to 55 lumens per watt, and sodium lights produce from 100 to 130 lumens per watt. Clearly, sodium lights are much more efficient than either of the other two types.

These figures on energy consumption may be compared to other figures on energy consumption. The six gallons per person per year that are consumed by street lighting are equivalent to roughly 72 KWH, or less than one percent of the annual household electrical consumption. These six gallons per year are slightly more than the average of five gallons of gasoline per person per year that are consumed by police patrols. The 72 KWH per person would be equivalent to leaving a forty-watt bulb lit through the night, in each household, to provide nighttime illumination and security to compensate for an absence of street lights. Street lights, however, light up streets considerably more than one forty-watt bulb per household.

These figures on energy consumption represent the potential savings if all street lights *were* extinguished. Since any program of conservation is likely to be selective in its approach to extinguishing bulbs, only a portion of this energy total is available for conservation.

2. Procedures for Energy Conservation with Street Lights. Although the magnitude of the savings is small, under some conditions it may be necessary to conserve in all possible areas, including street lighting. For example, in western states that rely for much of their electrical energy on hydroelectric sources, droughts in those states have sometimes forced reduction of electrical energy consumption, including energy for street light.

An additional reason for conservation of energy through street lighting reductions derives from the conspicuousness of this expenditure. Reducing street lighting thus serves as a public reminder to people that there are energy shortages and that conservation is necessary.

A number of procedures are possible to minimize the hardships associated with reductions of energy conservation *for* street lighting. Some of these are discussed by the General Electric bulletins on light conservation that contained the figures for total energy consumption (Light Concepts for Conservation, Fact Sheets 100-114).

Others of these are discussed in the Law Enforcement Assistance Administration Emergency Energy Committee's Energy Report Number 2, "Street Lightinga Enemy Conservation, and Crime." And still others are derived from locales that have undertaken energy-conservation programs. Some of these procedures are appropriate to light fixtures throughout the city, and others are appropriate only for selected areas. Procedures for energy conservation must be integrated with the uses of street lighting in different areas. These uses will vary, from primarily traffic and highway illumination for safety reasons, to primarily crime prevention, to other uses such as nighttime atmosphere in certain areas, or any of the other uses that street lighting serves.

a. Procedures appropriate to all light fixtures. Five major recommendations are appropriate to all street lighting fixtures. These are: (1) Keep alternate bulbs dark; (2) turn all (or some) lights off after some late hour, such as 3:00 a.m.; (3) reduce the wattage, as with dimmer transformers; (4) replace higher-wattage bulbs with lower-wattage bulbs; and (5) increase fixture efficiency. Each of these measures is discussed in the following paragraphs.

(1) Alternate bulbs. The procedure of simply not illuminating alternate bulbs may be one of the simplest, and is the procedure that was initially considered in Los Angeles. This procedure results in light areas separated by dark areas. This alternation of light and dark areas is discussed in technical terms under the heading of "uniformity," or the ratio of average footcandles to minimum footcandles. The significance of uniformity lies in the fact that dark areas between light areas can conceal potential criminals, and that the alternation of light and dark areas creates vision adaptation problems that male it harder to see into those dark areas than if a uniformly lower illumination level were imposed. Alternate-bulb nonillumination is also difficult because of costs of rewiring, degradation of lights due to moisture accumulation, and inequities in property tax .assessment.

(2) Illumination only for certain hours. Since crimes are not uniformly distributed through darkness hours, but cluster in hours of pedestrian traffic, it may be that very early morning illumination serves very little to increase security. All, or some, bulbs can be extinguished for these hours. This raises whatever risks exist for those few who do use the streets very late, but this may not be a problem in smaller towns where there are virtually no late-hour (i.e., early-morning) pedestrians.

(3) Dimmers. For filament (incandescent) bulbs, wattage can simply be reduced, producing a reduction in illumination and in energy expenditure. For vapor bulbs this cannot be done; instead, bulbs must be replaced with those of a different wattage.

(4) Replacement. In fact, the most common procedure is to replace high wattage bulbs with lower wattage bulbs (relamping). This reduces energy use. In addition, since most lighting is mercury, replacement of bulbs offers the opportunity to replace mercury bulbs with more energy-efficient sodium bulbs. In many cases, more lumens are put out by lower-wattage sodium bulbs than by the higher-wattage mercury bulbs they replace. This is both a savings in energy and an increase in illumination, and seems to serve *two* goals. (However, this effect of raising light levels may conflict with energy-shortage consciousness in two ways--it may provoke protests from conscientious citizens unaware that it actually represents energy conservation, and, of course, it cannot serve as a "reminder" of the crisis, as dimmer lighting can. However, both problems might be solved through effective public information programs.)

Replacement also involves capital expenditures, and may increase costs beyond theability of municipalities to pay. Contractual obligations occasionally involve a penalty if mercury lights are removed sooner than ten years after installation. This in turn may reflect the lighting companies' policy of single billings for installation and maintenance, with the extra cost of installation amortized over the ten-year billing period. Replacement also involves

rewiring, because_ mercury lights may be wired in series, while sodium lights require multiple wiring.

Replacement of re$_I$;,j,vwith sodium, or of lower-lumen with higher-lumen bulbs, allows for the use of fewer poles and luminaires. For maximum efficiency, these brighter bulbs should be mounted on higher poles, usually at 40-foot heights instead of the current 30-foot heights. This is an extra capital cost. In areas where esthetics and obstruction by buildings do not have to be considered (e.g., as at highway toll plazas, or parking lots), poles reach 100-foot heights, with multiple luminaires. Kansas City is currently adopting the procedure of replacement with fewer, but brighter bulbs, placed at 40-foot heights instead of 30-foot heights. Limited inventories of necessary taller poles sometimes limit the ability of municipalities to place their lights at greater heights.

The program of replacing mercury or incandescent lights with sodium lights mounted at greater heights attempts to coordinate placement of lights with the presence of natural obstacles, particularly trees. Trees, which give shade from the sun, are also very effective in shading streets from street lighting. The relighting program either relocates lights to other poles, or attempts to have trees trimmed. Tree trimming, however, falls under the jurisdiction of another department, and failures of coordination as well as conflicting interests can limit the effectiveness of relighting programs.

Replacement of mercury with sodium has at least one other initially unexpected consequence. This has been recorded in Washington, D.C., and has been anticipated elsewhere. The characteristic orange light of sodium visibly distorts colors, but this distortion is accepted because of the tradecif against higher anticrime security. However, since this light distortion is associated with high-crime-area lighting, such lighting has been resisted by some residents, particularly in ow-crime, more affluent neighborhoods. Sodium lighting, the objeqtion goes, makes the neighborhoods <u>look</u> like high-crime areas.

Kansas City, as mentioned, is introducing sodium bulbs mounted at greater heights. These sodium bulbs serve both to increase lighting and to decrease energy use. The city has also introduced a more rigorous campaign to coordinate street light placement with other natural obstacles, particularly trees. Either trees are trimmed, or lights are relocated. This means pole relocation, or use of other available poles, such as utility poles.

(5) Efficiency. Lights must be maintained, with both prisms and reflectors kept clean, shiny, and free of foreign objects (that may include storage from squirrels and birds). Kansas City figures show that while aging reduces light output by 35%, dirt and poor maintenance reduce output by 24%. Their figures note that after four years of the accumulated effects of both factors, output may be as little as 41% of original ratings. Accordingly, a more rigorous campaign of maintenance increases light levels with no other expenditure or improvement. This maintenance-derived increase in light output may be coupled with light reduction and energy savings some other way. Average maintained output is 70%, which can be raised to 90% with intensive maintenance..

The need for frequent maintenance is more urgent in dense urban areas (which are also the high-crime areas), because denser auto traffic in these when areas exposes the luminaire reflectors to additional corrosive action from car exhaust.

b. Conservation procedures for selected areas. Conservation procedures may be appropriate for only selected areas, as follows: (1) Cleared or deserted property, with no crimes recorded and little or no pedestrian traffic, may not need anticrime lighting. (2) Downtown business and theater districts are, on occasion, illuminated to levels of fifteen footcandles. This is literally bright enough to read fine newsprint by, and may be unnecessarily bright. (3) Low-residential-density, low-crime-density areas may not suffer as much from reduction of lights as do higher or denser areas. However, the results reported here with regard to displacement suggest that street robberies do relocate to other dark streets, and such selective darkening should at least be monitored for this displacement

effect. (4) Much lighting is for ornamental rather than illumination purposes, and could be reduced at little or no cost to public safety.

Some of the procedures recommended here are similar to procedures proposed in Los Angeles in December, 1973. These procedures make use primarily of available personnel and financial resources within the Department of Public Works, which contains the Bureau of Street Lighting, and the Department of Water and Power. Those procedures exceeded their own goal of a 25; reduction in energy consumption, and produced a proposed savings of 167.5 barrels of fuel per day.

3. Costs of Energy conservation. In times of shortages any savings is desirable, but savings of this small magnitude must be weighed against at least two other considerations. The first of these is the relative social costs of this savings in terms of economic and psychological values, including the potential rise in crime, or the feeling that crime is likely to rise. The second of these is the cost in energy that may be associated with reducing street lights, as a result of the change in people's habits following a reduction in street lighting.

a. Social costs of energy conservation. The results presented in this study show a decline in crime as a result of improved lighting. If this relation between lighting and crime is reversible, then reduced lighting should be followed by increased crime. As noted, lighting has been reduced on a large scale in Seattle, Los Angeles, and Portland. Results from these areas are not yet available, while the results available from two small-scale lighting-reduction programs are in conflict with each other.

One of these, according to The Wall Street Journal, January 8, 1974, reports that in Burbank, California (pop: 88,000), the embargo of Arab oil resulted in reduction of all types of outdoor lighting. This included floodlighting on streets; lighted commercial display advertising; illumination of nighttime spectator sports events, tennis courts, and other recreational facilities. The police chief reported no rise in crime. The article did report drops in night business activity for som, businesses, and a rise in pedestrian anxiety and

increased care in venturing outdoors at night.

By contrast, the town of Rennssalaer, Indiana (pop: 8,000), which also turned off its street lights, turned them back on after a few days (cf. U.S. News and World Reports, December 7, 1973). Reducing lighting was followed by a rise in vandalism, including vandalism of cars, theft from construction projects, and four commercial burglaries one Saturday night. This last was the most disturbing, in that the entries were made through the front door. This was presumably made possible by the reduced lighting.

As results become available on a larger scale, the feasibility of reducing lighting, with attendant tradeoffs in increased crime, will become clear.

The costs of crime are difficult to assess, although dollar costs can be assigned. The FBI's Uniform Crime Reports indicate that the average dollar loss per victim in street robberies is about $250. In Kansas City, police figures report the number of offenses and dollar amounts involved in each. The average loss in a "highway robbery" (street robbery) was $140. Robberies of "commercial houses" (stores) cost an average of $350. Purse snatches cost an average of $74. Pick pockets realize about $60 per offense. Burglaries involve bigger losses, with night residential burglaries costing an average of $380, and night burglaries of "nonresidences" costing slightly **less**, $350.

Crime figures are considerably higher, in social and human terms. These figures do not reflect injuries, or other costs associated with injuries. These other costs include medical costs or work impairment, the trauma of confrontation with violence, the violation of one's sense of self by criminal intrusion, and even loss of life.

These costs do not reflect the anxiety associated with pedestrian use of darkened streets; the reduction in legitimate night activity due to darkened streets, including the reduction of night commerce; and the dislocation of lives imprisoned within their homes by street crime and fear.

b. Energy costs of energy conservation. Conservation of energy is considerably more complicated than cutting back on expenditures of energy, and particularly electrical energy. General Electric points out that abandoning an electric shaver for a hand razor reduces the electrical energy consumption but increases overall energy consumption by substituting the use of hot water. Similarly, washing dishes by hand with hot water is more wasteful of energy than using electrical energy in the more efficient washing process of an automatic dishwasher. In crime prevention, there are similar tradeoffs.

Reduction of street lighting to save energy may be followed by individual attempts to increase street security with porch and garage lights. Figures cited previously show that the tradeoff point occurs at one forty-watt bulb per household, or, alternately, only a few large bulbs for an entire block. Further, use of these smaller bulbs would provide much less illumination and security than is provided by street lights.

Reduction of street lighting may be followed by an increase in street crime, which would suggest increased police patrols and a consequent increase in gasoline consumption. There are surely other increases in energy consumption, in response to darkened streets.

C. Street Lighting and Crime Prevention

1. Robbery. Since relighting has been most successful against street robberies, further relighting programs should be oriented to the location and prevalence of these offenses. Since relighting seems to be followed by displacement, or relocation of some portion of these offenses, a comprehensive anticrime strategy should attempt to anticipate and prevent this relocation.

Night street robberies have relocated to adjacent blocks that were not relit. This may indicate that offenders who are deterred in relit blocks, and who relocate, choose not to change their mode of operation, only the location. One solution is to relight large areas, so that for most of the relit areas there simply are no nearby

nonrelit blocks. These potential receptor blocks would be adjacent only to those blocks on the periphery of large relit areas, and these relit areas could be large enough to cover entire high-crime sectors, as well as lower-crime, neighboring sectors.

2. High-Robbery Areas. On a theoretical level, opportunities for robbery would seem to be at a maximum when the level of pedestrian traffic is high enough to provide targets, and not high enough to provide witnesses or potential intervenors. This level is generally thought to be streets that are largely, rather than entirely deserted. Other analyses of robbery locations show that. areas along the edges of commercial strips, and side streets along arteries, have the greatest concentration of street robberies. This is consistent with the presence of night activities along these usually well-lit commercial strips and poorly-lit adjacent side streets, where people may park their cars. Robberies would occur on the way to or from parking locations.

Lighting then, should be improved in these side-street areas normally used by people in travelling to and from locations of night activity.

Lighting side streets off major streets should also be coordinated with an analysis of land use and traffic flow, so that bars or movies or other locations to which people congregate at night could be lit, along with the parking areas around them. This has been done in some areas, particularly in parking areas around sports stadiums.

Other areas that concentrate people at night should also be relit, by this analysis. These areas would include schools that have night activities, places of employment that generally have late shifts (particularly those having small numbers of people leaving at scattered late hours), and housing projects, where residents are less likely to have traditional daytime jobs.

3. Robbery, and Other Anticrime Measures. Robberies and other crimes relocate in ways. that seem to indicate that crime is responsive to other anticrime measures as well as street lighting.

Comparisons of changes in commercial blocks, as compared with crime changes in residential blocks, have indicated this result. Lighting, then, should be placed where there are less likely to be other anti-crime measures. In a sense, lighting is more necessary on a deserted block that has no regular police patrol, than it is on blocks where patrols pass frequently.

4. Assault. Relighting has also been successful in reducing assault in night street locations. Accordingly, lighting should be located where these offenses are prevalent. Assaults are fewer in number than robberies, and this may be less useful as a guide than the distribution of robbery. Assaults rise in other areas to a degree that more than offsets the decreases in night street locations. Some of this may be due to the general rise in assault during the period of this study, and some due to displacement. To deter assault, other anticrime measures may be necessary, such as locking doors to keep potential assailants from moving to nonstreet sites. Since assault includes family disputes, or disputes among acquaintances, prevention of this offense may be more dependent on changing individual attitudes, rather than increasing anticrime measures.

5. Auto Theft. Auto theft, like assault, shows some responsiveness at night to street lighting, with an increase during the day that more than offsets the night decreases. Both assault and auto theft may partake of some impulse that is not easily gratified some other way, unlike robbery, where the goal of quick cash may be achieved some other way. Street lighting can relocate but cannot reduce auto thefts, apparently. For this offense also, other anticrime measures must be employed, such as safeguarding targets by in-car antitheft devices, and perhaps educating local citizens about the likelihood of an increase in auto thefts.

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THE IMPACT OF STREET LIGHTING ON STREET CRIME

Part 2: Technical **Appendices**

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C O N T E N T S

Part 2: Technical Appendices

TAE IMPACT OF STREET LIGHTING ON STREET CRUSE

SUMMARY

The crime-deterrent effects of upgrading street lighting from incandescent to mercury and sodium vapor were investigated in selected high-crime commercial and residential areas in Kansas City, Missouri, from 1970 through the first.quarter of 1973. . These effects were assessed by comparing changes in rates of night street crime following the upgrading program to changes prior to the upgrading program. Comparisons were also made to changes in crime rates in locations not affected by improved street lighting.

Results indicated that crimes of violence--robbery and assault--were significantly deterred, while crimes against property were largely unaffected. Prior to relighting, crime rates in blocks with commercial activity were considerably higher than in blocks with residential activity. Following relighting, crime decreased in these commercial blocks somewhat faster than in the residential blocks.

Displacement of crime was also investigated. A small portion of the robberies appeared to relocate into blocks that were not affected by the upgrading program. Displacement of assaults could not be confidently determined because increases in areas not affected by relighting may have been due to the general citywide increase in this offense.

Recommendations are made for street lighting, both for energy conservation and for crime deterrence. Street lighting represents a very small amount of the total national energy consumption and thus a small potential for conservation, although some areas of savings are suggested. For crime deterrence, recommendations call for continual upgrading of street lighting, and are built around specific suggestions for crime type, crime location, other anticrime measures, and anticipated displacement.

The report is in two parts. "Part 1: Results" presents a full discussion of the study, with results and recommendations. "Part 2: Technical Appendices," presents detailed technical background and supporting data, and other supplementary materials of relevance to the study.

Appendix A

THE STREET LIGHTING PROGRAM

Table A-1. Major Types of Lighting Used in Kansas City, Missouri, Numbers of These Types As of April, 1972, and Use Throughout the City

Type	U Lumens	Approximate Number"	Use
Incandescent			
	4,000	12,600	These lights were first used in 1950, in the first city lighting effort. Beginning in 1969, they have been replaced with Lucalox and mercury lights to some *extent,* but much of the city remains lit with this old lighting.
	6,000	2,399	
	10,000	1,000	
	15,000	422	
Mercury			
"Crime Fighter"	7,700	1,500	These lights are being used in the "residential upgrade area." The number of these lights has substantially increased since April, 1972.
"Cobra Head"	11,000	900	These lights are used to illuminate trafficways in the residential upgrade area and throughout the city.
	20,000	**2,999**	
Sodium Vapor			
	42,000	600	These lights are used in the central business district and adjoining area of public buildings, and also on hospital hill.

Table A-2. Major Types of Before/After Lighting in The Sample Blocks

Type of Lighting Before Improvement	Type of Lighting After-Improvement	No. of Blocks[1]
Unlighted		15
4000 lumen incandescent		63
6000 lumen incandescent	Sodium	30
10000 lumen incandescent		7
15000 lumen incandescent		2
Unlighted		**1**
4000 lumen incandescent		**8**
6000 lumen incandescent	20,000-lumen mercury	**8**
6000 lumen incandescent		**3**
10000 lumen incandescent		**7**
-15000 lumen incandescent		**11**
Unlighted		**9**
4000 lumen incandescent	11,000-lumen mercury	15
6000 lumen incandescent		9
10000 lumen incandescent		2
Unlighted		24
4000 lumen incandescent	7,700-lumen mercury	139
6000 lumen incandescent		4

[1]Blocks that had more than one type of change were counted more than once; consequently, block totals are greater than the number of sampled blocks.

Table A-3. Comparison of Incandescent, Mercury and Lucalox in Terms of Lumens[1], Watts[2], Footcandles Maintained and Uniformity Ratio[4]

Incandescent				Mercury				Sodium			
Lumens	Watts	Maximum Footcandles Maintained	Minimum Uniformity Ratio	Lumens	Watts	Footcandles Maintained	Uniformity Ratio	Lumens	Watts	Footcandles Maintained	Uniformity Ratio
4,000	225	.1	6 to 1	7,700	175	.3-.6	2 to 1	44,000	400	4.7-17.4[5]	
6,000	330	.1	6 to 1	11,000	250	.4[6]	2 to 1				
10,000	565	.1	6 to 1	20,000	400	86	2 to 1				

[1] Lumens refer to the amount of light operated by the bulb, cf. footcandles which is the amount of light measurable on the street (candlepower per foot)

[2] Watts refer to the power consumption of the bulb

[3] This is the average number of footcandles maintained, as estimated by the .Public Works Department. ,This seems consistent with our photometric measurements. The variation is tremendous (e.g. .03-.1)

[4] The uniformity ratio is the ratio of average footcandles maintained to minimum footcandles, between fixtures. Thus a low uniformity ratio results when the lighting is fairly consistent between fixtures (which is desirable). A high ratio results when the lighting immediately under thefixtures is relatively bright compared to the lighting between them.

[5] From our photometric data, confirmed by estimates of the Public Works Department. The variation is large because street widths vary, some blocks are not sodium-illuminated on all faces, etc.

[6] Since only one face of the block is lit with the type of mercury lighting indicated (the rest of the faces are also mercury, but lower watts), these figures are low.

[7] The lumens per watt figures indicate that sodium is twice as efficient as mercury, which in turn is twice as efficient as incandescent.

Appendix B

REPORTED EXPERIENCE WITH STREET LIGHTING

Street lighting has been upgraded in many communities around the country, in response to crime increases and needs for improved traffic visibility, as well as other factors. Results of these upgrading programs appear in the literature and generally indicate that street lighting is successful as an anticrime procedure. Some of these studies are summarized in Table B-1.

It may be seen that the studies discussed are presented in approximate order of recency. The more recent studies seem to be more methodologically rigorous and more detailed in scope, and may also be of greater relevance when attempting to understand the impact of street lighting on contemporary crime rates.

The table presents information on (i) lighting data, (ii) research design, and (iii.) crime changes for a number of cities.

The first group of columns, headed "Lighting Data," indicate the date of lighting change, the type of new light used and the number of these lights, the dollar cost of installation and maintenance, the size of the relit area, and some description of the characteristics of the area.

The second group of columns, headed "Research Design" indicates the time periods compared during the test period; time periods compared for a baseline (abbreviated as "base"), or prechange crime trends; and the nature of a control area that did not receive relighting.

The third group of columns, headed "Crime Data", indicates percentage changes in crime rates. This is by type of crime, and where appropriate, dates are given for both test (relit) and control areas, and for baseline (prechange) and test periods.

Both periods of time--baseline and test--are composed of two intervals, with crime frequencies determined for each, and a percentage change between the two computed.

For example, the first row in the table (p.1) describes the relighting program in Milwaukee. In Milwaukee lighting was improved during 1972, using sodium lights. The number of lights was not reported, nor were changeover costs. The change area was 3.5 square miles, and was characterized as having private and multi-unit residences, and also some commercial establishments. The population in this area was characterized as elderly. The Milwaukee data are *continued* on p. 2: The test period compared crime frequencies in the first seven months of 1972 with the first seven months in 1973. A baseline period compared these changes in crime rates to the changes in crime rates in this area from 1971 to 1972. Changes in the relit blocks were compared to changes in a control group composed of blacks adjacent to the relit area. In the relit area, the total of all crimes showed a decline of 23% prior to relighting, and a 15% decline after _relighting. By contrast, the control blocks showed an 8% decline in crime before relighting, and an 18% increase afterwards. Changes for individual crimes are not reported.

Table B-1. Reported Experience with Street Lighting and Crime (p.1)

(i) *Lighting Data*

City	Change Date	Lights (type, number)	Cost	Area Size	Area Type
Milwaukee	1972	sodium		3.5 sq. miles	Private and multi unit residential commercial. Elderly
Miami (1)	1971	sodium		1.8 sq. miles	Central business district. Includes apartment houses
(2)	1971	sodium 350			Garment district. Small industries
Tampa	1970-71	sodium **445**			Police designated (high crime)
Owensboro, Kentucky (pop 55,000)	1968-1970	mercury 5000	$413,00	Citywide	Streets; major, collector and residential (emphasized)
Washington, D.C. (1)	1970(late)	sodium 3800	$1.000,000	113 blocks	Four high-crime residential block-groups
(2)	1970 April	sodium			2(a)- single neighborhood, NW DC
					2(b)- RFK stadium parking lot

Table B-1. Reported Experience with Street Lighting and Crime (p. 2)

City	(ii) Research Design: Test	Baseline Period	Control Area	(iii) Crime Mann Darn.: (Total)	Murder	Rape	Robbery	Assault	Burglary	Larceny	Auto	Other (r)
Milwaukee	1-7/72 vs 1-7/73	71 - 72	adjacent streets	Base/Test Relit:-23/-15 Control:-08/+18								
Miami(1)	1971 vs 1972		citywide	test +01 control +01	-11 **-32**	-33 **-49**	-39 **-13**	-24 -14	+6 -2	-3 +15	-7 -12	
(2)	**Oct-Nov'70** yr Oct-Nov'71	**1969 - 1970**		**base/test:** (felonies)+15 (total)-49								
Tampa	1-6/70 vs 1-6/71		Other Bay Area cities	test: (Person crimes) X56 control: "rise"	--							
Owensboro, Ky., (pop 15,000)	**1967** vs. **1969**		**nationwide**	test **-34** **control +11**			**-50**		**-22**	-31	-39	
Washingtcn D.C. (1)	**1970 vs.1972**	**1969 - 1970**		base/test: -161-54			**-14/-65**		**-26/-44**		-8/-56	vandalism **-191-22**
(2)a	4-7/70		**citywide**	test: control:			**-25** -8.3		**-63** -6			vandalism declined
(2)b												

e li-1. Reported Experience with Street Lighting aad Crime (p.3)

I(i Ld;ghtd,Ag~Datp

'C'i'ty		Change 'Date	'Lights c(itype,;number)	,Coat	,Area .Size	Area Type
'Cleveland	t(L)I	11966-78	;mercury 580000	'$6,500,000	1,100 and	citywide
	(2)	1948-54		$1,500,000 4Ait1~1Z1yi $500,000,annuaLly~		if) city
Detroit		1968	mercury 675		1 square mi high night crime.	Main streets, residential streets, z lleys
Oakland, California		late '60's				
Indianapolis	(1)	1965-68				
	(2)	1959-1960	Mercury 12,000 (also 8,000 nonstreet)	$1,000,000		commercial/residential (near downtown)
Chicago	(1)	**1965-1966**	Mercury 51,000	$13,000,000	citywide 2,240 miles	17,000 alleys
	(2)	1959				"various districts"

Table B-1. Reported **Experience_with_Street_Lighting~ad.Crime (p. 4)**

	(ii) Research Design			(iii) Crime Change Data								
	Test re,soe	Baseline Period	Control A	(Total) rt.. VLiwca (L	Murder iZ,)	**Rape** (J)	**Robbery** iZ^)	Assault (U	Burglary iZ)	Larceny	Auto (z1	Other (LI
Cleveland (1)	1966-1971			+80			IPurse-snatch-7E					
(2)		**1965**		-17		-44	robbery -27					
Detroit	1968-1969	**1965**	Similar area, not adjacent	g night crimes elit -12 antral +14								
Oakland, Cal.				"abrupt drop"								
Indiana-polls (1)	1965-66	Nationwide	Nationwide	test -22 control +6								
	1966-67			test +5.2 control +11		rise **below tuitional average**						
		adjacent	adjacent	test -84% (N--225) control: Lm+102L						T		
(2)				-60								
Chicago (1)	1-3/66 vs 1-3/67	(a) nationwide (b) Chicago streets		test +18 control (a) -15 (b) +33		-40	-15	**-35**	-53	-16		
(2)							-87, -30, -30					-10

Table B-1. Reported Experience with Street Lighting and Crime (p. 5)

(i) Lighting Data

City	Change Date	Lights (type, number)	Cost	Area Size	Area Type
St. Louis (1)	**1964**				business district
(2)					high crime
New York (1)	1958-59	Mercury	$500.000	111 blocks	Four hi:h crime •recincts
(2)	1964	Mercury	28,000;000	citywide	806 city streets
(3)	1959	Mercury S incandescent			400 parks and playgrounds
Boston	**1959**				**Streets with lights in high-crime South End.**
McPherson, Kansas **(pop 9556)**	late 50's		$378,000		residential areas
Flint	**1956**	Flourescent			Civic Center, 40 dangerous intersections, six miles of downtown streets
Gary	1953-1955	Mercury 5,000		citywide	

Table B-1. Reported Experience with StreetLighting.and Crime (p. 6)

	(ii) Research Design				(iii) Crime Chanve Data							
City	**Test**	**Baseline**	**Control**	**Total)**	**Murder**	**Rape**	*Robbery*	**Assault (z)**	**Burglary**	**Larceny (z)**	**Auto**	**Other** *(fl*
St. Louis (1;	1964 (9 mos)	1963		(all)-6			**-36**	-80	-10	purse -50	-29	
(21	1965 (9 mos)		adjacent	Test: (person) -4 1 2ontrol: "More than expected"							from auto -24	
New York (1)	1957-1959			(all) -71	all person crimes: -49							juvenile -30
(2)	1960-1964			(felonies) +43								
(3)												Vandalism -80 to -100
Boston			**dark streets**	More crimes on dark sts. (N C 104)								
McPherson, Kansas **(pop 9556)**									eliminated			peeping: -90
Flint	6 weeks			-60						-80		
Gary							-60	-70				

Table B-1. Reported Experience with Street Lighting and Crime (p. 7)

(i) Lighting Data

City	Change Date	Lights (type ,number)	Cost	Area Size	Area Type
Kansas City, Missouri	1953			25Z of the city	(a) citywide
					(b) main thoroughfares
Chattanooga				12 block	high homicide
Plainfield, New Jersey				60 block	

Table B-1. Reported Experience with 4treet Lighting and Crime (p. 8)

City	(ii)Research Design: Test Period	Baseline Period	Control Area	(iii)Crimo Chant. Data: (Total) All Crimes	Murder	Rape	Robbery rzi	Assault	Burglary	Larceny	Auto ri[g]	Other
Kansas City, Missouri	1952-1953	1950-51				-05	-09		-06	-46	-17	
								-30			-45	
Chatta-nooga				-70								
Plainfield, New Jersey									**-50**			

Milwaukee — Preliminary Report - Milwaukee hieh intensity street lighting project. Department of Intergovernmental Fiscal Liaison, Room 701-F City Hall, Milwaukee, Wisconsin (December 23, 1973), c/o Harry Stein, Fiscal Coordinator.

Miami (1) — Miami relights: A report on street lighting programs and procedures in the city of Miami. Edward Francis, Department of Public Works, City Commission of Miami (December, 1973) (Report 0232).

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Tampa — Tampa relights 70 square blocks. Street and Highway Lighting, 21 (3) (September, 1971), Pp. 7-9.

Owensboro, Kentucky — Owensboro, Kentucky pulls the switch on crime. Street and Highway Lighting (December, 1970), 20 (4), pp. 13-17.

Washington D.C. (1) — New D.C. lights cut crime. William Holland, The Evening Star, Washington, D.C. (June 18, 1971).

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Also: Crime rises despite brighter street lights, George Rosenen,Cleveland Plain Dealer (January 7, 1973), pp. 18-A.

Cleveland (2) — Light on Our Streets, Robert O'Brien. National Civic Review (April, 1960).

Detroit	Light: A proven deterrent to crime. Street and Highway Lighting Bureau, 1212 Avenue of the Americas, N.Y., N.Y. 10036 (May 24, 1973), **pp. 6.** Also: Improved Street Lighting and Night Street Crime. T.J. Dworman, Report, Detroit Public Lighting Commission (August, 1969).
Oakland	Let's light up the land. Bill Brown, Street and Highway Lighting,21 (3) (September, 1971), PP. 5.
Indianapolis (1)	Planned light prevents crime and reduces accidents. The American City (March, 1973), pp. 125-126.
Indianapolis (2)	Crime? Blight? We fix it. Jack Dunn, Outdoor Lighting, Digest (January, *1969),* pp. 3-4.
Indianapolis (3)	Clubwomen turn lights on crime. Atlanta Journal and Constitution (October 22, 1972), pp. 15-H.
Chicago (1)	Chicago takes the menace out of dark *alleys.* Nation's Cities (March, 1967). Also: Light: A proven deterrent to crime. Street and Highway Lighting Bureau, 1212 Avenue of the Americas, N.Y., N.Y. 10036, (May 24, 1973), pp. 6.
Chicago (2)	Public lighting needs. Paul Box (September, 1966), Illuminating, Engineering.
St. Louis (1)	President's Commission on Law Enforcement and Administration of Justice, Task Force Report: Science and Technology. Washington: U.S. Government Printing Office, 1967. pp. 50.
St. Louis (2)	Public lighting needs. Paul Box (September, 1966), Illuminating, Engineering.
New York (1)	President's Commission on Law Enforcement and Administration of Justice, Task Force Report: Science and Technology. Washington: U.S. Government Printing Office, 1967. pp. 50.
New York (2)	More lighting and fewer juvenile problems. Alexander Lurkia, The American City (January, 1962).
New York (3)	Crime flourishes in darkness...N.Y. fights back with a $28.8-million program. Electrical World (October 3, 1960).

	Also: Crimes of darkness. Hyman Goldberg. Cosmopolitan (April, 1959), pp. 60-65.
Boston	Editorial. Christian Science Monitor (June 27, 1959).
McPherson	To make streets safe after dark. National Civic Review (April, 1960).
Flint	President's Commission on Law Enforcement and Administration of Justice, Task Force Report: Science and Technology. Washington: U.S. Government Printing Office, 1967. pp. 50.
Gary	How bright lights reduce crime. Don Murray, Coronet (February, 1960), pp. 30.
Kansas City, Missouri	Public lighting needs. Paul Box (September, 1966), Illuminating Engineering.
Chattanooga	How bright lights reduce crime. Don Murray, Coronet (February, 1960), pp. 30.
Plainfield	Light: A proven deterrent to crime. Street and Highway Lighting Bureau, 1212 Avenue of the Americas, N.Y., N.Y. 10036 (May 24, 1973), pp. 6.
General	The impact of street lighting on crime and accidents. Nancy Berla, Education and Public Welfare Division, Library of Congress Legislative Reference Service (October 5, 1965). HV6251A. Ed-108.

Appendix C

SAMPLING

The sample is essentially a stratified random sample of the entire city, with selected areas of interest--the relit areas--overrepresented. This overrepresentation allows for a more fine-grained analysis of the relationships among street lighting, social, and crime characteristics of areas.

It should be noted, however, that because of this overrepresentation of certain areas, the Kansas City sampled area is not directly representative of Metropolitan Kansas City. This reduced representation is considered acceptable, because the purpose of this investigation is to derive a general understanding of the relation between lighting and crime characteristics rather than an exhaustive understanding of lighting and crime in Kansas City. Stratification was based on two sets of variables, as described in Table C-1. The first of these was a set of four social area variables, each scored as high (H) or low (L), with the exception of percent white, which was also scored medium (M). This classification produced 20 empirically useful strata.

The second of these was a set of variables that described lighting levels. There were five light levels, ranging from the darkest (mostly unlit), through old and new incandescent, to the brightest (mercury and sodium).

The intersection of social variable levels and lighting levels produced 38 empirically meaningful strata. This procedure produced a sample of about 1500 blocks, or a 20% sample of the entire city. Table C-2 indicates the distribution of these blocks across the nine areas.

Table C-1. Strata Used for Sampling

Block	Group Characteristics				Light Level				
1.	L	L	L	L	1				
2.	L	L	L	H	2				
	L	L	H	L					
	L	L	H	H					
4.	L	M	L	L	4				
5.	L	M	L	H	5				
6.	L	M	H	L	6				
	L	M	H	H					
7.	L	H	L	L	7	8	9	10	
8.	L	H	L	H	11	12	13	14	
9.	L	H	H	L		15			
	L	H	H	H					
10:	H	L	L	L		16			
	H	L	L	H					
11.	H	L	H	L		17			
12.	H	L	H	H		18			
13.	H	M	L	L		19			
14.	H	M	L	H		•20'			
15.	H	M	H	L		21			22
16.	H	M	H	II		23			24
17.	H	H	L	L	25	26	27		
18.	H	H	L	H	28	29	30	31	
19.	H	H	H	L	32	33			34
20.	H	H	H	H	35	36	37	38	

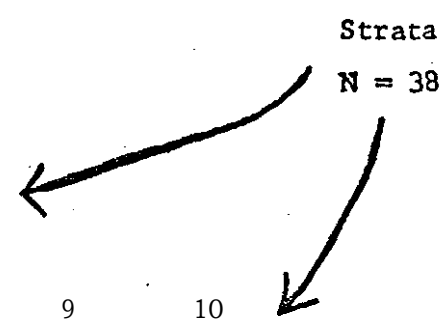

Table C-2. Distribution of Sampled Blocks Across Nine Areas

Area	Sample Blocks
1	107
2	150
3	152
4	65
5	214
6	300
7	90
8	59
9	290
Total:	1427

Appendix D

SAMPLE BLOCKS IN ALL NINE AREAS

A. Social Area Analysis: Relit and Nonrelit Areas.

Six variables were used to assess social characteristics in these nine areas. These were: (1) proportion white; (2) proportion disorganized families (defined as non-husband-and-wife families with children under eighteen); (3) proportion living alone; (4) proportion rental units; (5) average monthly rent; and (6) proportion vacant for sale. The distribution of the values for these six variables is presented in Table D-1.

For each of these variables the city-wide average is also indicated. For virtually all of these variables, the four areas that received relighting scored below the city-wide mean, indicating that these are the most socially depressed or disadvantaged areas in the city.

1. Proportion white. Kansas City, like most cities, is composed of **predominantly** white and predominantly black neighborhoods, and some mixed neighborhoods. Areas 5 and 6 have the most blacks, while the others have very few. Area 6 has had a rising black population in recent years. Area 2 has somewhat more blacks than the remaining areas.

2. Proportion disorganized families. The city-wide average proportion for this distribution is 0.18. The four relit areas all show a greater proportion of disorganized families than this mean. Such disorganization is often associated with other forms of social disorganization, including crime.

3. Proportion living alone. This variable is also often associated with lack of social cohesiveness, in that loners or unrelated are thought to have fewer strong social ties than those in jointly headed households. The proportions overall are lower on this variable than on the previously considered one, but the shape of the distribution is largely similar. The city-wide average is

11% loners, and areas 2, 4, and 5, score above this mean. Area 6 scores just below the mean.

4. Proportion rental units. This variable is also associated with higher crime rates. Whether high proportion of rental units indicates higher density, or rental indicates a more transient attachment to the neighborhood than the roots associated with being a property owner is not always indicated. The city-wide average is 39%, with areas 2, 4, and 5 again scoring higher than this average. Area six scores lower than several other areas without lighting change.

5. Average monthly rent. This variable is considered a measure of economic well-being. The four relit areas all score below or at this mean, indicating that these are the poorer areas within the city. Three of the relit areas are among the four lowest in the city in average monthly rent.

6. Proportion vacant for sale. This variable is sometimes considered as a measure of desirability of living in a neighborhood. If this is accurate, then it may be seen that the four relit areas show the highest proportions in the city on this variable; all are above the mean, with the remaining five areas well below this mean.

B. Crime Rates in the Nine Areas.

The nine divisions of Kansas City have been discussed above in terms of crime-related social area analysis. The relit areas were found to generally score in the worse half of the city-wide distribution of these variables; and predict to higher crime rates in these four areas.

Table D-2 presents results for the three years of data collection, 1970 through 1972, with crime totals given for all nine areas. In addition, block rates (crimes per block) are given for each area. Block rates are computed by dividing the number of crimes by the number of blocks. The relit areas--Area 2 (city core) and Areas 4, 5, and 6 (three residential areas)--all ranked in the high-crime half of these rankings. Table D-3 presents Census tracts associated with each of the nine areas.

Table D-1. Social Characteristics of the Nine Areas

	Relit Areas				Nonrelit Areas					Citvwide
	2	4	5	6	1	3	7	8	9	
1. Proportion white	.89	.96	.15	.43	**.99**	**.95**	**.99**	.98	.98	.72
2. Proportion disorganized families	.31	.29	.35	.21	.07	.20	.11	.16	.08	.18
3. Proportion living alone	.56	.40	.14	.09	.03	.11	.08	.11	.04	.39
4. Proportion rental units	.92	.80	.46	.22	.19	.40	.19	.52	.25	.39
5. Average monthly rent (in dollars)	81	**96**	**59**	**66**	94	**59**	113	92	114	95
6. Proportion vacant for sale	.038	.030	.029	.030	.005	.016	.007	.009	.004	.019

Table D-2. Block Rates.for Night Street Crime in Kansas City for the Nine Areas (1970-1972)

	Relit Areas				Nonrelit Areas				
Area:	2	4	5	6	1	3	7	8	9
Number of Blocks:	150	65	214	300	107	152	90	59	290
Violent Crimes									
Robberies (Total)	158	47	186	82	2	25	11	4	12
(Per Block)	1.05	.72	.87	.27	.07	.16	.12	.07	.04
Assaults (Total)	98	29	126	77	12	53	13	11	61
(Per Block)	.65	.45	.59	.26	.11	.35	.14	.19	.21
Property Crimes									
Larceny (Total)	169	55	129	87	22	64	30	18	95
(Per Block)	1.13	.85	.60	.29	.21	.42	.33	.31	.33
Auto Theft (Total)	72	29	191	135		34	14	9	32
(Per Block)	.48	.45	.89	.45	.04	.22	.16	.15	.11

Table D-3.

Census Tracts in the Nine. Areas

Area	Tracts
1	All 200's
2	1-3, 11-15, 27-31
3	4, 5, 6-10, IR-24, 59
4	43-51, 65-71, 73, 74
5	16, 17, 25, 26, 32, 33, 36-42, 52-57, 60-64
6	34, 35, 58.01-58.02•, 75-81, 87-90
7	72, R2-R6, 91-94, 9R-100
8	95-97, 103.1
9	100, 101.01, 101.02, 102.01, 102.02, 103.01, 103.02, 104.01, 104.02, 105, 106, 107, 108.01, 108.02, 125.03, 129.01, 129.02, 130.03, 131, 132.01, 132.02, 143

Appendix E

SAMPLE *BLOCKS* IN *THE* FOUR RELIT AREAS

A. Social Area Analysis: Relit and Nonrelit Blocks.

The same six variables used for social area analysis of the nine major divisions of Kansas City were also used to describe the sample blocks in the Residential Upgrade Area (areas 4, 5, and 6) and the City Core (area 2). These data are presented in Table E-1.

1, Proportion white, On this variable the Residential relit blocks show more whites than the nonrelit streets, while there is virtually no difference in the city core area.

2. Proportion disorganized families. On this variable, both sets of relit blocks (the residential area and the city core area) show greater proportions than the nonrelit areas. These differences are of fair size and with respect to crime, would predict greater crime in the relit blocks.

3. Proportion living alone. On this *variable* the relit blocks in both areas show higher proportions than do the nonrelit blocks. As with variable 2 (disorganized families), this difference would predict higher crime rates in the relit than the nonrelit blocks.

4. Proportion rental units. This variable shows a greater *concentration* in the relit blocks than the nonrelit blocks for both residential and city core areas. This difference, again, would predict higher crime rates in the relit blocks.

5. Average monthly rental. Average monthly rental shows that the relit blocks have higher rentals than the nonrelit blocks. The effects of this difference are in the opposite direction from the other variables so far considered, in that higher rent, as an indicator of economic well being, is associated with lower crime rates,

6. Proportion vacant for sale. This variable, which is assumed to measure some characteristic of desirability of living in the area, shows no clear pattern of differences between relit and nonrelit

blocks. Residential relit blocks and city core nonrelit blocks show the greatest vacancy rates.

In summary, the differences in social area variables between relit and nonrelit blocks in the relit areas do not show the same consistent patterns as are found between relit and nonrelit areas. For the most part, Residential Upgrade relit blocks show variables that indicate higher crime rates in these blocks than the Residential Upgrade nonrelit blocks, while the pattern is mixed for city core blocks. In fact, crime rates in the Residential Upgrade blocks prior to relighting were substantially higher than crime in the nonrelit blocks. This is consistent with the selection of these higher-crime blocks as targets for relighting, since relighting was introduced as an anticrime measure.

By contrast, the mixed pattern of crime-related social area variables in the city core corresponds to a pattern of equal crime rates in the relit and nonrelit blocks.

B. Crime Rates.

Table E-2 presents crime rates (crimes per block) for relit and nonrelit blocks in the city core and residential upgrade areas. Rates are presented for both total Part I offenses and again for robbery alone. Within the residential upgrade area, rates for total offenses and robberies alone are considerably higher for relit than for nonrelit blocks. This is consistent with the generally higher scores of these blocks on the crime-associated social area variables. By contrast, the crime rates within the city core blocks, for both total offenses and robberies alone, are substantially equal. This equality is consistent with the pattern of results in the crime-associated social area variables, which favor relit blocks on some variables and nonrelit blocks on others. It may be noted that the city core, as described elsewhere in this report, underwent an earlier program of relighting in the late sixties, with the high-crime streets presumably relit then. These blocks, relit prior to the relighting program studied here, accordingly form part of the control group. Blocks that were never relit, either in this earlier relight-

ing program or the current one, also form part of the control group„ Accordingly, the nonrelit area in the city core is comprised of two subareas--the previously relit blocks (with crime deterred by lighting) and the nonrelit blocks. This may account for the mixed relation between the crime—related social area variables and crime rates in the city core area. Table E—3 presents a breakdown of relit vs. nonrelit blocks for each of the four relit areas.

Table E-1. Social Characteristics of Relit and Nonrelit Blocks,

	Residential Upgrade Area (Areas 4, 5, and 6)		City Core (Area 2)	
	Relit	Nonrelit	Relit	Nonrelit
1. Proportion white	.53	.30	.86	.88
2, proportion disorganized families	.32	.27	.34	.26
3. Proportion living alone	.24	.11	.78	.46
4. Proportion rental units	**.68**	.31	**.96**	**.89**
5. Average monthly rent (in dollars)	.77	.63	**.96**	.67
6. Proportion vacant for sale	**.043**	**.025**	.021	.041

Table E-2. Night Street Crime in The Sample Blocks (1971)

	Residential Upgrade Area (Areas 4,5, and 6)		City Core (Area 2)	
	Relit blocks (N=93)	Nonrelit blocks (N=486)	Relit blocks (N=36)	Nonrelit blocks (N=114)
part I Offenses:				
Total:	155	284	37	110
Incidents per block:	,1.67	0.58	1.03	.96
Robberies:				
Total:	59	57	8	32
Incidents per block:	.63	.12	.22	.28

Table E-3. Number of Relit and Nonrelit Blocks in The Four Relit Areas

Area	Relit	Nonrelit [1]	Total
2	36	114	150
4	26	39	65
5	54	160	214
6	13	287	300
	129	600	729

[1] Twenty-one other blocks in the sample were actually relit during the 21 months prior to the 6-month change period, and 10 blocks relit during the 12 months afterward.

Appendix F

SUPPLEMENTARY MATERIALS*

*Note (17 June, 1974): Appendices A through E, preceding, contain all technical supporting data referred to in the text of "Part 1: Results." These complete the report proper.

Other materials, of supplemental relevance and of potential interest to some reader—researchers, are being prepared for subsequent inclusion. These materials may be considered an optional addendum to this report.