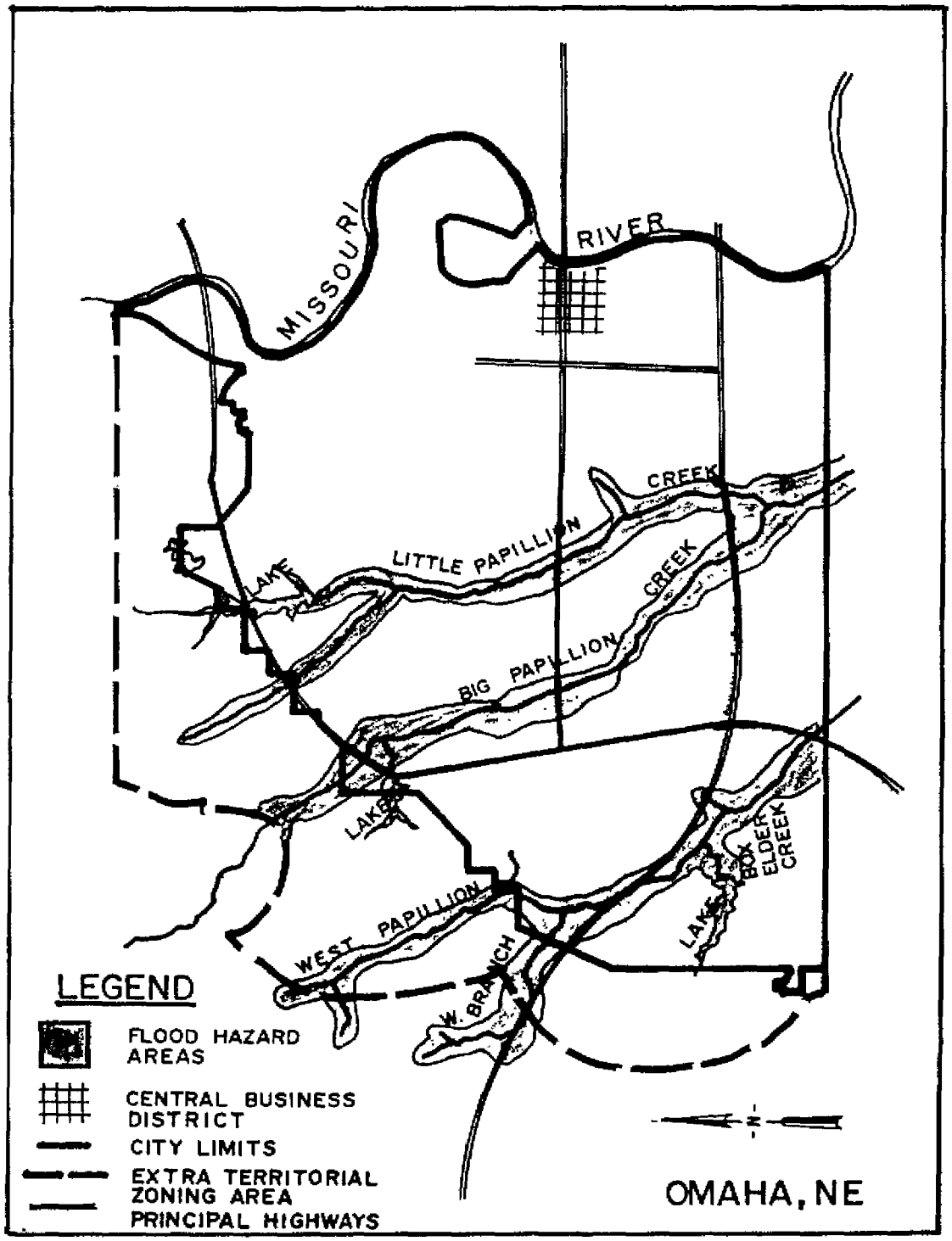
FIGURE 2-6



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elevation. Permits to build in the floodplain required approval of the city council and, in order to create compensatory flood storage, Omaha's regulations required that fill had to be obtained from the same site where it was to be used. In the latter half of the 1970s, Omaha abandoned the S3 and A zones and, instead, adopted an overlay zone to accomplish the same ends.

The planning department, which had a staff of 125 professional planners, engineers and building inspectors, administered Omaha's floodplain management program. In addition, it obtained help from the Papio Natural Resources District (a special district created to undertake flood control and stormwater management planning and projects) in reviewing proposed development. The city checked building sites for compliance (elevations were confirmed visually), but it did not operate a surveillance program to detect illegal filling. No variances to the regulations were granted during the study period.

With a considerable amount of past development at risk from flooding, the flood hazard management program also included the construction of flood control structures by the Papio Natural Resources District. During the study period, the district completed two dams and reservoirs, at a cost of $16 million, that provided some flood protection within the city limits. In addition, the city invested about $1 million a year on stormwater management projects (including widening and channel improvements to Big Papillion Creek) through its capital improvements program. City officials viewed the stormwater management program as far more important in dealing with flood problems in Omaha than land use and building regulations. Although the city's 1977 comprehensive plan called for the development of a park system along the streams, no steps to implement that proposal had been taken by 1985.

Wayne, New Jersey (Program Strength Index: 58)

Profile

	1975	1985	% Change
Population	47,808	48,156	+1
Dwelling units	14,042	14,676	+5
Flood hazard source	Passaic River, Pompton River, Singac Brook, Haycock Brook		

Floodplain use	
Total acreage of floodplains, 1975	2,700 acres
Developed, 1975	1,250 acres
Residential	420 acres
Nonresidential	830 acres
Flood history	Flood disaster in 1984
Average annual flood damage potential, 1975	$2,508,000
Population at risk, 1975	6,323

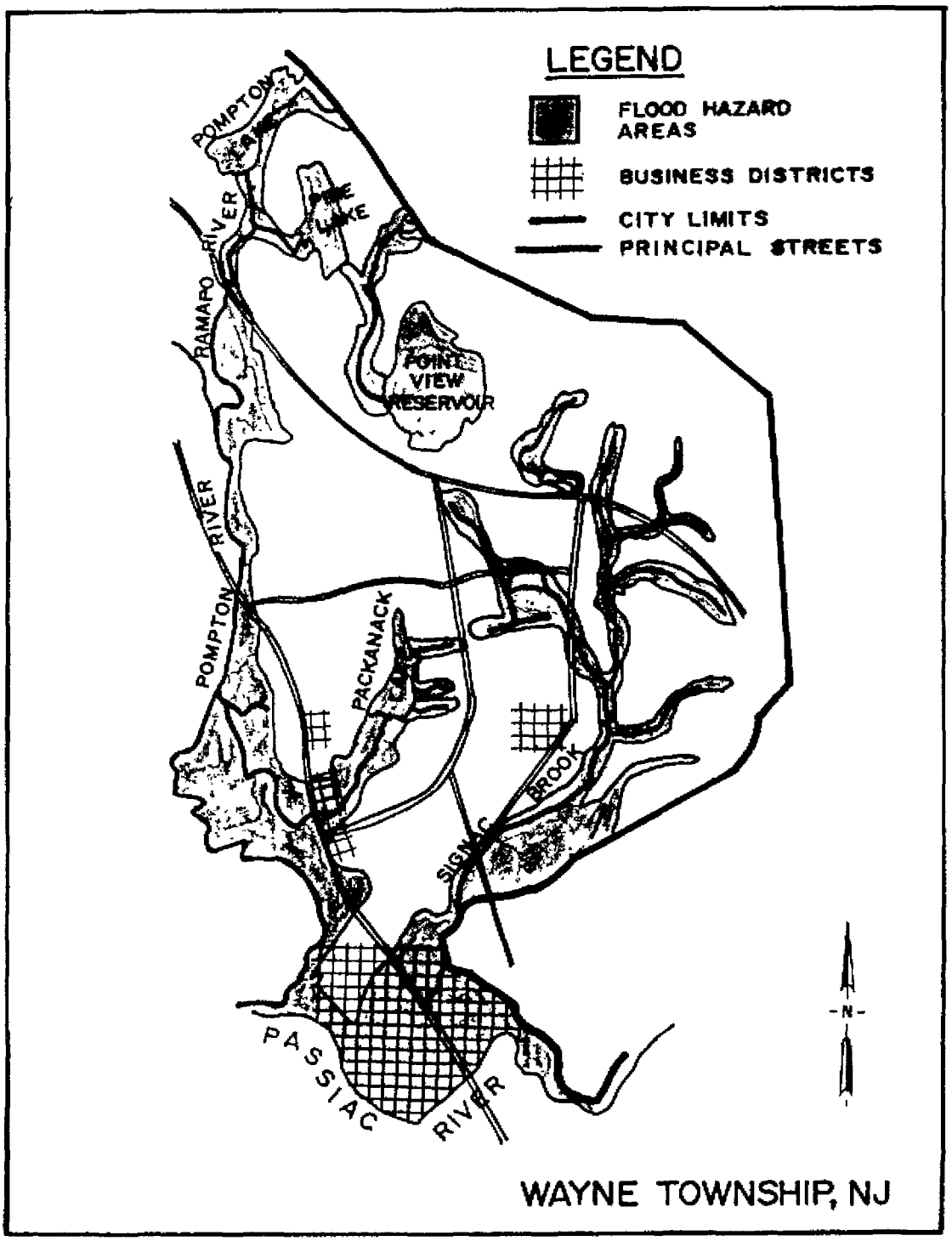
The Community and Its Flood Hazard

Wayne Township, a suburban community west of Newark, became a popular resort area during the period between 1920 and the end of World War II. Many people buying vacation property during those years sought waterfront sites along the streams running through the township. After the war, Wayne became a bedroom community as people sought permanent homes in a pleasant environment within commuting distance of employment opportunities in northern New Jersey. People moving to the community acquired many of the stream-side vacation homes, winterized them, and in the process, created a serious flood problem. Some of the worst flooding in this century in 1984 caused three persons to lose their lives and property damages to approach $80 million in Wayne.

Wayne's floodplains comprised almost one-fifth of its total land area in 1975, but two thirds of one census tract (number 2463)--which included a number of older, poorer neighborhoods and several major transportation arteries--lay within the floodplain (see Figure 2-7). At the start of the study period, some 90% of the 1,880 dwellings at risk from flooding in Wayne Township were located in Tract 2463. The tract also included a major shopping center located partially in the floodplain and several floodplain mobile home parks.

In the mid-1970s, after several decades of rapid home building (the population doubled each decade after World War II), residential development slowed considerably and Wayne began to attract commercial land uses, becoming a regional employment center. As employment within the township doubled, owners of the remaining undeveloped acreage in the floodplain (1,450 of 2,700 acres) began to look to industrial uses for their land. That property included an area of small lots, some still with small houses, in Old Wayne (Tract 2463) which the township rezoned from residential to industrial use in

FIGURE 2-7



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anticipation of its eventual redevelopment as an industrial park.

The Floodplain Management Program

Wayne Township officials designed the floodplain management program so that it would limit increases in residential property at risk from flooding and encourage the use of flood hazard areas as sites for commercial and industrial expansion (the township rezoned various portions of the floodplain to commercial and industrial use to promote the latter end). To ensure that new development in the floodplain was protected from flood damage, the township amended the zoning ordinance to establish an overlay zone within which it required new construction to be elevated at least one foot above the base flood elevation. No variances from the elevation requirement were granted during the study period.

In 1973, Wayne Township imposed a moratorium on new construction in the floodplain, pending delineation of the floodway (which was not accomplished during the period studied), and used that as a basis for denying applications for twenty floodplain dwellings. In 1977, however, the moratorium was modified to allow construction of elevated structures in areas of the floodplain served by sanitary sewers. Wayne also used subdivision regulations to ensure that new development was protected from flooding. Subdivision plats had to show ground and proposed building elevations, and developers had to submit drainage plans in order to secure approval of their projects. The building and subdivision regulations were administered by a town staff of 27 persons in engineering, planning, and building and zoning.

The township engineering and planning staffs took a number of steps to mitigate the flood problem for existing homes and commercial properties in the floodplain. To alert property owners and prospective buyers to the flood threat, the engineering staff noted the flood hazard on deeds and parcel maps. The township used the housing code to eliminate 75 substandard floodplain dwellings in the Old Wayne area, and it persuaded owners to elevate 50 other flood-prone structures. It also required homeowners to floodproof their structures as a condition for obtaining a building permit for home improvements. Although no important structural flood control projects were implemented in Wayne Township during the period studied, township officials hoped the Corps of Engineers would construct a storm drainage pipe (with a 45-foot diameter) to divert up to 36,000 cfs of floodwater in the Passaic River.

Finally, the State of New Jersey played an important role in floodplain management in Wayne Township. The New Jersey Administrative Code prohibited new building, addition, impediments to flow, and the net importation of fill to state-delineated floodways. Fill could not cover more

than 20% of a site, and any filling that would raise the elevation of the 100-year flood stage by more than 0.2 feet was prohibited. Although floodways were not mapped in Wayne Township, building permit applicants had to have an engineer's certification that their structure complied with the state floodway regulations.

The state also required structures built in the floodplain to be elevated one foot or more above the base flood elevation, based on the 1903 flood of record (the floodplains delineated by the National Flood Insurance Program based on the 100-year flood and by the State of New Jersey based on the 1903 flood of record were somewhat different). Wayne Township applied its floodplain regulations to development located within either floodplain. Administration of the New Jersey flood management regulations had not been delegated to Wayne Township and, as a result, two permits--one from the state Department of Environmental Protection and one from the township--were required for new construction in the floodplain.

Arvada, Colorado (Program Strength Index: 64)

	Profile		
	1975	1985	% Change
Population	68,137	88,412	+30
Dwelling units	21,670	33,321	+54
Flood hazard source	Tributaries of South Platta River (Ralston, Layden, Van Bibber, and Little Dry Creeks)		
Floodplain use			
Total acreage of floodplains, 1975	634 acres		
Developed, 1975	358 acres		
Residential	322 acres		
Nonresidential	36 acres		
Flood history	Minor flooding in 1973		
Average annual flood damage potential, 1975	$3,390,000		
Population at risk, 1975	4,147		

The Community and Its Flood Hazard

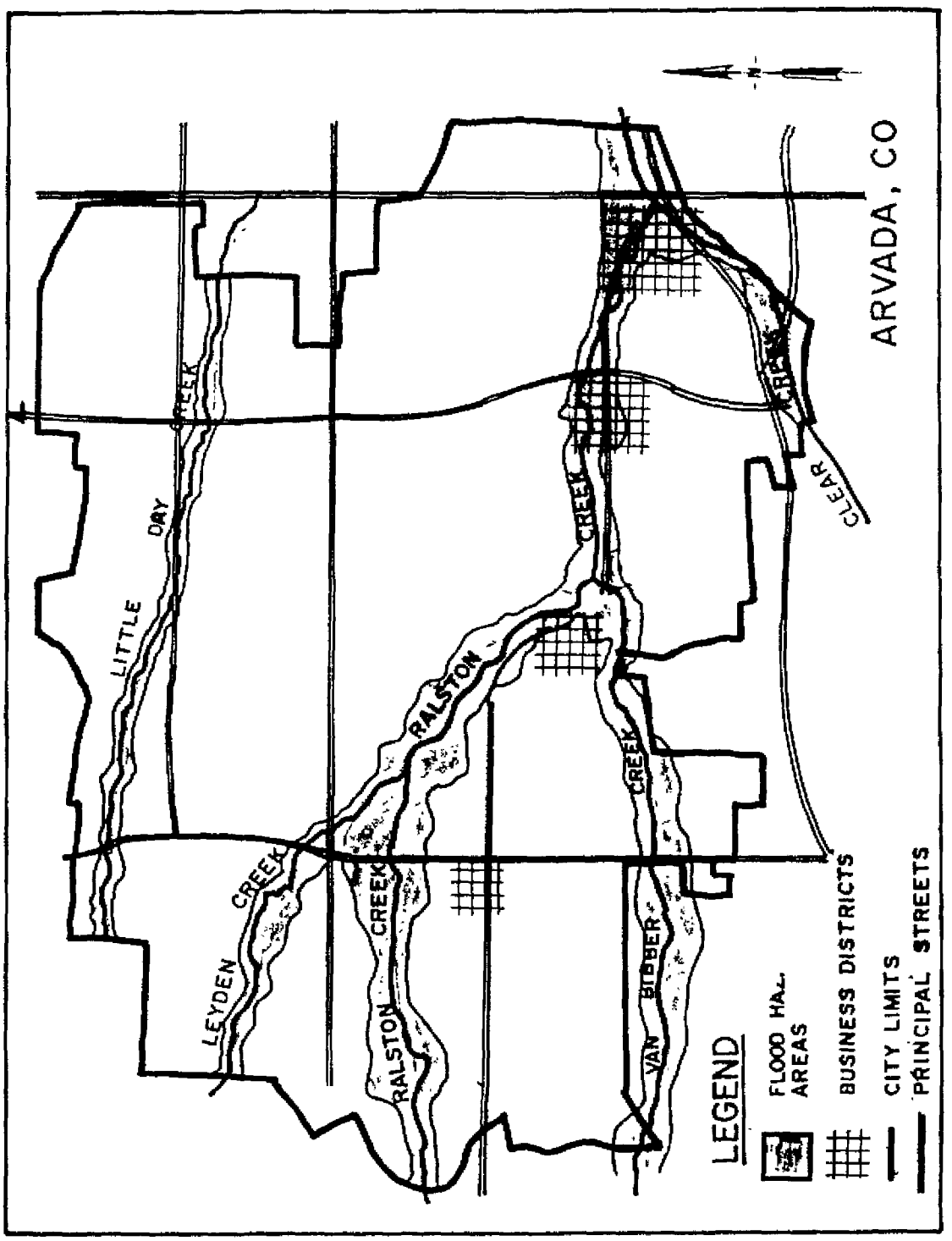
Originally platted in 1880, Arvada remained a small mining and agricultural center in the foothills of the Rocky Mountains until the late 1950s, when it began to grow rapidly as a bedroom suburb of Denver. From an original core of development in the south and eastern sections of the present city, residential subdivisions spread to the north and west and encroached on the floodplains of four creeks: Leyden Creek and its tributaries, Ralston Creek and Van Bibber Creek, and Little Dry Creek to the north (see Figure 2-8). Each was subject to flash floods from high-intensity summer storms over the front range of the Rockies. As development engulfed the streams, developers and the city modified channels to increase their capacity to carry stormwater, but numerous streets that crossed the creeks were built with bridges which constricted the flow of water in large storms. Because of the potential for rapid rises in water levels and deep water at channel constrictions, the creeks posed a serious threat to life and property. Nevertheless, as of 1975 there had not been a major flood (some minor flooding occurred in 1973), and there was none during the ten-year study period.

Flood-hazard areas accounted for a small proportion of the developable land in Arvada in 1975 (about 7%), and there were ample flood-free sites for growth and development. However, the tree-lined streams were attractive for home sites and, in one area, their accessibility made them attractive for commercial development as well. As a result, Arvada's floodplains had come to be occupied as intensively as flood-free property. In 1975, 55% of the land area in Arvada's floodplains was in urban use, only slightly lower than the degree of urbanization (59% of available land) in the remainder of the community. Floodplain development included 1,400 single-family homes and apartments (about 12% of which were located in the particularly hazardous floodways of the creeks) and a number of commercial and industrial establishments. Average annual flood damage potential in the community in 1975 was over $3 million.

The Floodplain Management Program

By 1975, Arvada was aware that it had a potentially serious flood problem, and the city had formulated a vigorous program to deal with the situation. In coping with flooding, Arvada was aided by strong regional and state attention to floodplain management. Following serious flooding on the South Platte River in 1965, the State of Colorado began to look for mechanisms to curb the mounting exposure of people and property in the Denver area to flooding. It adopted two mechanisms: one, the Denver Urban Drainage and Flood

FIGURE 2-8



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Control District, was put in place in 1969 (for a description of the district, see Platte, 1986); the second, state legislation establishing standards for local floodplain management, followed.

In dealing with its flood threat, Arvada put together a floodplain management program with both structural and nonstructural elements. It designed the structural element to reduce the potential for flood losses to existing development. Between 1976 and 1985, the city spent approximately $3 million on structural projects, including channel improvements and reconstruction of bridges to 100-year flood design standards. Those efforts were funded with 50/50 matching grants from the Denver Urban Drainage and Flood Control District and from revenues obtained from a drainage utility service fee, which the city charged all property based on the amount of impervious surface.

Arvada designed its nonstructural floodplain management program to allow additional floodplain development, but it tried to minimize the threat of flood damages through site improvement and building design standards. Those standards, administered through a floodplain overlay district in the zoning ordinance, required elevation of new residential construction in the floodway fringe to two feet above the elevation of the 100-year flood (one foot elevation above the base flood level was required for nonresidential construction). The city used floodplain maps prepared by the Urban Drainage and Flood Control District which were based on full development of watersheds and included more area in the floodplain than maps supplied by the National Flood Insurance Program.

The city also used some locational measures to reduce flood threats. One, a floodway overlay district of the zoning ordinance, restricted development in the floodway to open space uses; developers, however, could undertake channel improvements in order to reduce the amount of their property that was subject to regulation. A land dedication requirement applied to new subdivisions required dedication of 6% of the property to the city. The city's 1973 comprehensive plan envisioned use of that land to create a network of trails and greenways along creeks. Prior to 1975, 79 acres in the floodplain had been purchased by the city for parks and open space, but there were no new parkland purchases in the floodplain between 1976 and 1985.

Floodplain management in Arvada was strengthened in 1970, when it joined the emergency phase of the National Flood Insurance Program, and again in 1972, when it joined the regular phase. The major dimensions of the floodplain management program described above, however, remained unchanged over the ten-year study period. A professional staff of 35 planners, engineers, and building inspectors administered the program, with an assistant city engineer in charge of enforcement. No variances to the regulations were granted.

Fargo, North Dakota (Program Strength Index: 65)

Profile

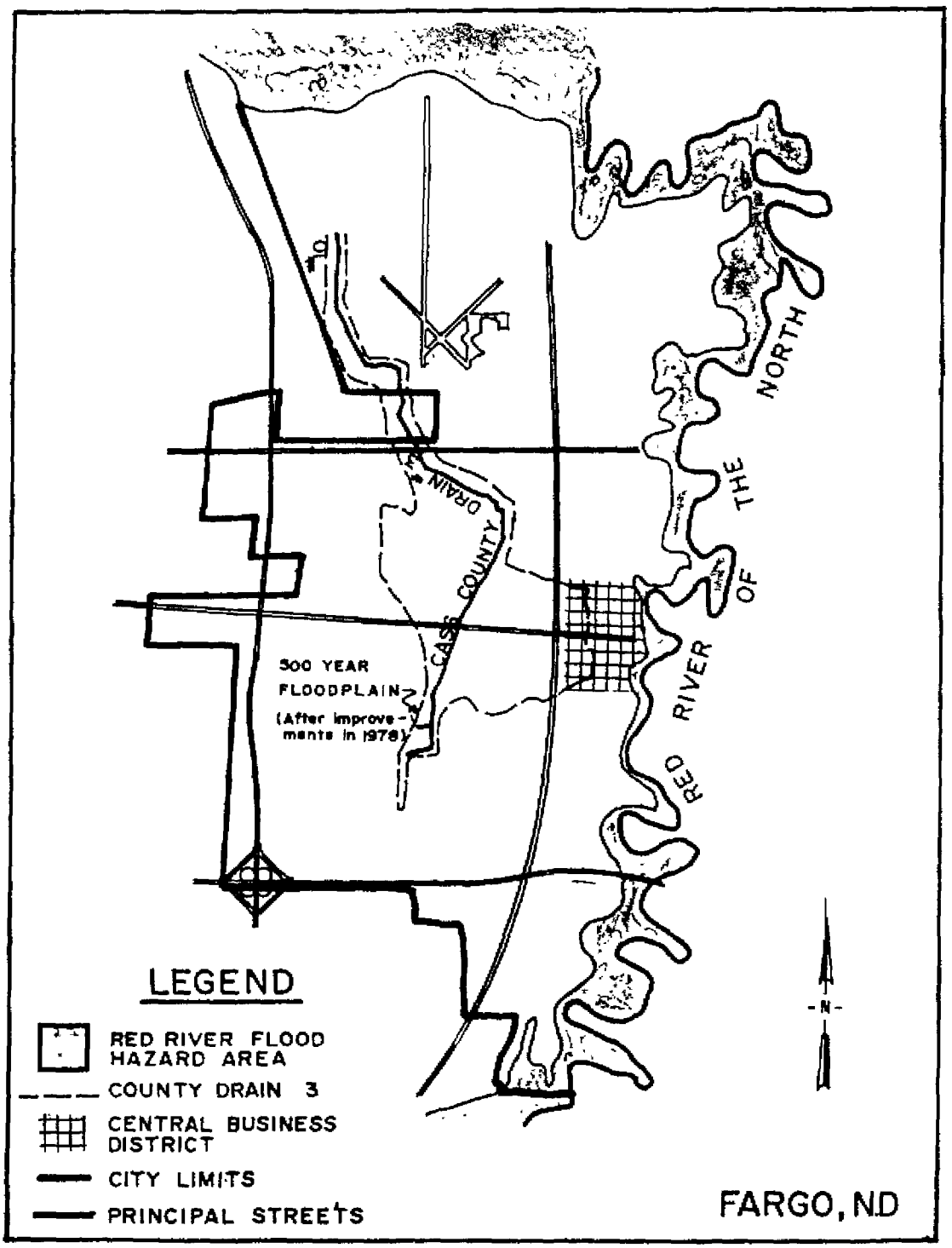
	1975	1985	% Change
Population	57,374	66,042	+15
Dwelling units	19,830	28,524	+44

Flood hazard source	Red River of the North; County Drain No. 3 (not studied since 90% expected damages were eliminated by a flood control project completed in 1978)
Floodplain use	
Total acreage of floodplains, 1975	1,862 acres (Red River of the North 80-year floodplain, i.e., area inundated in 1919 flood)
Developed, 1975	369 acres
Residential	270 acres
Nonresidential	90 acres
Flood history	1969 (most recent)
Average annual flood damage potential, 1975	$277,000
Population at risk, 1975	1,974

The Community and Its Flood Hazard

Fargo occupies the west bank of the Red River of the North across from its sister city on the east bank, Moorhead, Minnesota (see Figure 2-9). The floodplain of the river, with its woods and gentle slopes, was one of the more attractive areas to live in the Fargo area. By 1975, developers had converted 270 acres in the floodplain to residential use and 90 acres were occupied by a variety of commercial activities, although the city was aware of the flood problem. In April of 1969, the river rose to the third highest elevation on record (an estimated 80-year flood) and caused some $500,000 in damages, in spite of $117,000 in temporary earthen dikes, sandbags and protective plastic sheeting the city had put in place to stem the flood. There were also serious flooding problems along County Drain No. 3, where by 1976 3,328 dwellings

FIGURE 2-9



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were at risk from flooding. As explained below, however, most of that flood risk was eliminated by flood control works the city began in 1975 and completed in 1978.

The Floodplain Management Program

Prior to the 1969 flood, Fargo's leaders were apathetic about the flood threat. The 1969 flood, however, energized the community and led to a concerted effort to formulate an effective floodplain management program. The city initially focused its attention on County Drain No. 3. By 1978 it had completed $2 million in upstream structural improvements, which eliminated 90% of the estimated average annual flood damage to structures along the drain. No flood control works, however, were undertaken in the Red River floodplain during the period studied.

To deal with flooding along the Red River of the North, Fargo adopted regulations to minimize the exposure of new development to flooding. Fargo discouraged development of the floodway, which could occur only if the city council granted a special exception to the floodplain management regulations. To protect new development in the floodway fringe, in 1974 Fargo adopted a very detailed floodproofing code. A notable feature of the code was the allowance of construction of basements in the floodplain (over 90% of the dwellings in Fargo had basements, which provided protection from tornados). The Federal Insurance Administration granted Fargo a special exception to NFIP rules that barred habitable spaces below the base flood elevation (the NFIP, however, will not insure losses to the contents of basements).

To minimize flood damage to basements, the city's regulations required extra fill, extra rebar and sewer shut off, and extra drainage tile. In 1975, the Fargo-Moorhead Home Builders' Association estimated those additional requirements added from $350 to $650 to the cost of a home, and that elevation requirements added from $4,000 to $6,000 in building costs. Thus, the code in Fargo added significantly to the cost of building in the floodplain versus flood-free locations.

The floodplain management program in Fargo was administered by a staff of 25 professional engineers, planners, and building inspectors. The staff visually inspected new development for compliance with floodplain regulations, in addition to requiring certification of compliance from a professional surveyor (buildings) or architect/engineer (subdivisions). However, the staff in Fargo did not undertake a program of systematic surveillance of the floodplain to detect illegal filling or other violations of the floodplain regulations. No variances to the regulations were granted during the study period.

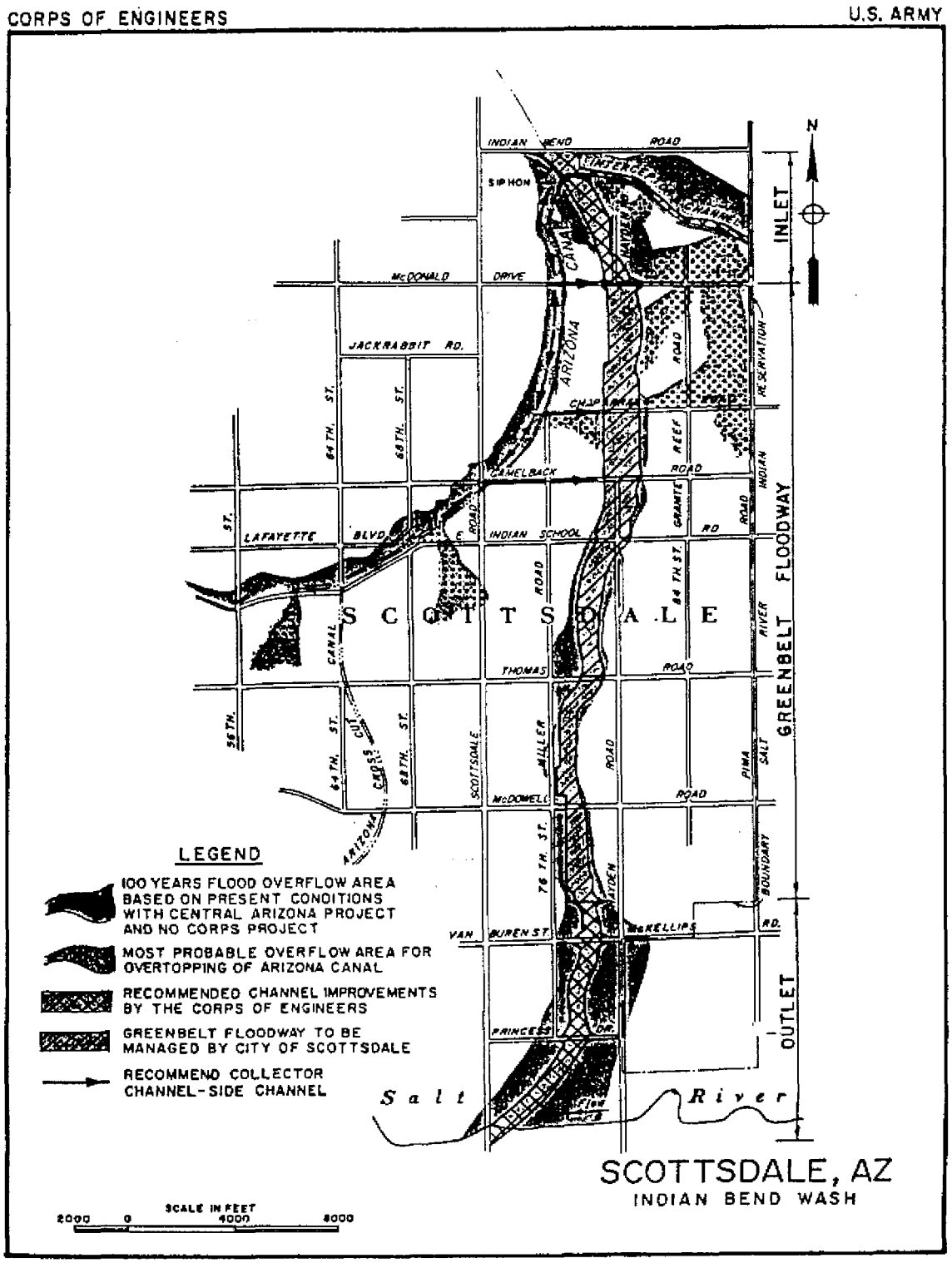
Scottsdale, Arizona (Program Strength Index: 76)

	Profile		
	1975	1985	% Change
Population	78,118	108,000	+38
Dwelling units	31,707	56,340	+78
Flood hazard source	Indian Bend Wash and Arizona Canal		
Floodplain use			
Total acreage of floodplains, 1975	1,660 acres		
Developed, 1975	490 acres		
Residential	310 acres		
Nonresidential	180 acres		
Flood history	Serious floods in 1843, 1970, and 1972		
Average annual flood damage potential, 1975	$45,000		
Population at risk, 1975	5,304		

The Community and Its Flood Hazard

Scottsdale had to contend with two major sources of flooding: 1) the Indian Bend Wash, which runs through the center of the community and had the potential for high-velocity floods in excess of four to five feet in depth; and 2) shallow sheet flooding and ponding of stormwater, a result of the flat topography over much of the city. In dealing with those problems, Scottsdale formulated the best example among the communities we studied of the use of an integrated program of structural and nonstructural measures to deal with a serious flood threat. The Indian Bend Wash Greenbelt Flood Control Project created seven miles of floodway parkland in the heart of this rapidly growing Phoenix suburb (see Figure 2-10). The project transformed the wash--which had overtopped its banks and caused serious flood damages in 1943, 1970, and 1972 (the 1972 flood caused one death and over $2.6 million in damages)--into an important community amenity which has attracted high-density development to the adjacent floodway fringe. Scottsdale combined the Indian

FIGURE 2-10


CORPS OF ENGINEERS
U.S. ARMY
INDIAN BEND ROAD
SIPHON
McDONALD DRIVE
JACKRABBIT RD.
64TH ST.
68TH ST.
CAMELBACK ROAD
LAFAYETTE BLVD.
INDIAN SCHOOL ROAD
THOMAS ROAD
McDOWELL ROAD
SCOTTSDALE
ARIZONA CANAL
CROSS CUT CANAL
SCOTTSDALE ROAD
MILLER ROAD
76TH ST.
HAYDEN
VAN BUREN ST.
McKELLIPS RD.
PRINCESS DR.
GRANITE REEF ROAD
INDIAN RESERVATION
PIMA SALT RIVER
INLET
GREENBELT FLOODWAY
OUTLET
BOUNDARY
Salt River
LEGEND
100 YEARS FLOOD OVERFLOW AREA BASED ON PRESENT CONDITIONS WITH CENTRAL ARIZONA PROJECT AND NO CORPS PROJECT
MOST PROBABLE OVERFLOW AREA FOR OVERTOPPING OF ARIZONA CANAL
RECOMMENDED CHANNEL IMPROVEMENTS BY THE CORPS OF ENGINEERS
GREENBELT FLOODWAY TO BE MANAGED BY CITY OF SCOTTSDALE
RECOMMEND COLLECTOR CHANNEL-SIDE CHANNEL
SCALE IN FEET
2000 0 4000 8000
SCOTTSDALE, AZ
INDIAN BEND WASH

. Bend Wash project with a set of stringent floodplain subdivision and building regulations, which applied to all new development in the city, to attain a reasonable degree of safety from flooding.

The Floodplain Management Program

In the early 1960s, the Army Corps of Engineers looked at the Indian Bend Wash and proposed to reduce the flood threat by lining the channel with concrete. The city opposed the Corps' plan on aesthetic grounds and, in 1965, suggested a much modified solution to the flood problem. The city's plan featured a low-flow channel situated in a greenbelt floodway designed to hold the 100-year flow. The wash project, completed during the study period, cost $54 million, of which Scottsdale paid $14.1 million. The remainder was funded principally by the U.S. Army Corps of Engineers ($29.4 million), State of Arizona ($4.4 million), and Maricopa County Flood Control District ($6.1 million). The city and other public agencies acquired fee-simple title to 379 acres for the project and flowage easements to another 595 acres. Much of that land was devoted to public parks and private golf courses. Other features of the project included bridge improvements, levees to protect some existing development, and improvements to the Arizona Canal, which bisects the wash and had been a source of flooding in the past.

Charter amendments passed by Scottsdale voters in 1967 authorized the city to identify flood hazard areas and control their development. The following year, the city adopted an ordinance to eliminate new construction in the floodway of the Indian Bend Wash. Subsequently, the city amended the ordinance so that it allowed development in the floodway fringe as long as it was elevated on fill above the 100-year base flood elevation, and it was possible to gain access to and from the property during a 100-year storm event. The city gave developers bonuses in the form of higher allowable densities in the floodway fringe in return for keeping the floodway open and, in many cases, excavating the floodway channel and constructing other storm drainage improvements. As noted above, Scottsdale's regulations did not apply just to the Indian Bend Wash floodplain, but covered the entire city; thus, all new development in Scottsdale had to be elevated. The floodplain management program was administered by an 83-person staff of engineers, planners, and building inspectors.

Palatine, Illinois (Program Strength Index: 82)

	Profile		
	1975	1985	% Change
Population	29,038	33,413	+15
Dwelling units	8,678	12,223	+41
Flood hazard source	Salt Creek		
Floodplain use			
Total acreage of floodplains, 1975	735 acres		
Developed, 1975	184 acres		
Residential	115 acres		
Nonresidential	69 acres		
Flood history	Frequent minor flooding of basement		
Average annual flood damage potential, 1975	$260,000		
Population at risk, 1975	2,374		

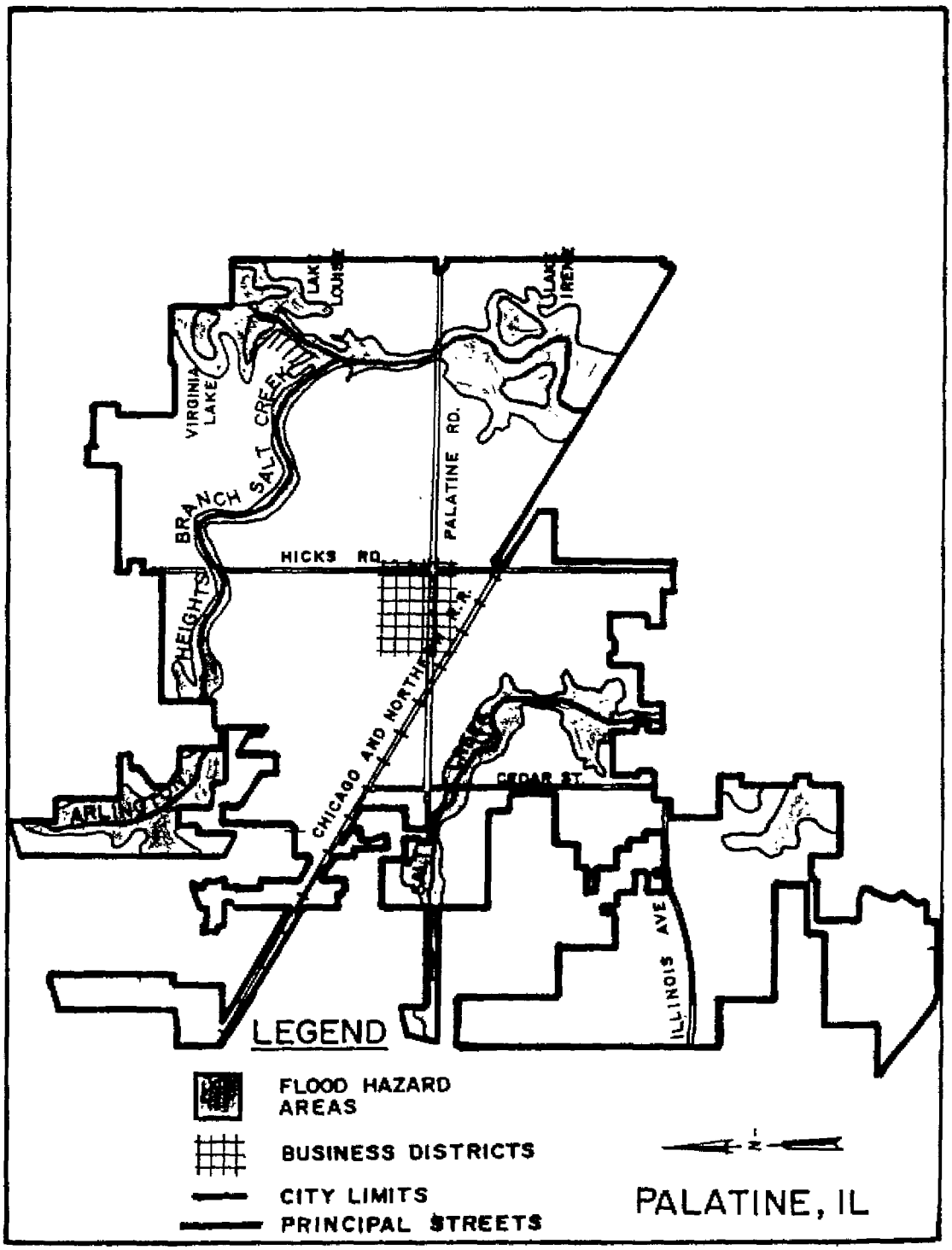
The Community and Its Flood Hazard

The Village of Palatine is a small, but rapidly growing, suburban community in the Chicago metropolitan area. Over time, the village allowed development to occur in two branches of the Upper Salt Creek floodplain and other low-lying areas, so that by 1976, 688 dwellings and a number of nonresidential structures were subject to periodic flooding when severe storms caused drainageways to fill and overtop their banks (see Figure 2-11). Frequent nuisance flooding led residents and their neighborhood associations to lobby village officials to deal with the problem. By the start of the study period, Palatine had in place the most stringent floodplain management program of any of the communities we studied.

The Floodplain Management Program

To alleviate the flood problem for existing development, Palatine participated in three flood control projects completed between 1976 and 1985.

FIGURE 2-11



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The projects--part of the Upper Salt Creek Watershed Improvement Plan sponsored by a number of federal, state, and regional agencies (State of Illinois, Metropolitan Sanitary District, Cook County Forest Preserve District, Corps of Engineers, U.S. Soil Conservation Service), as well as the village--cost over $15 million. Palatine's share of those costs was $1.5 million.

The Palatine floodplain management ordinance defined flood hazard areas so that they included not only land within the 100-year Salt Creek floodplain, but also all adjacent land less than one foot above the base flood elevation and all land subject to flood damage from ponding rather than stream overflow (based on a map of the flood of record). No new development within those identified flood hazard areas was allowed as a matter of right. Instead, the village treated proposals for development within identified flood hazard areas as special uses that required the express approval of the village board of trustees. To reduce the adverse effects of the ordinance on landowners, however, the village allowed developers to transfer development from flood hazard areas to flood-free sites, which they could then build at higher densities than normally allowed by the zoning ordinance.

During the study period, the flood hazard area regulations were enforced strictly by the village staff of 11 engineering, planning, and building inspection professionals. No variances were granted, and at least five requests for special use permits to build in flood hazard areas were denied. Although formal surveillance to detect violations was not undertaken, the staff did detect one case of illegal fill, which it required to be removed.

Variation in Program Strength

The preceding vignettes illustrate the wide variation in the character and strength of the floodplain land use management programs cities had adopted. To explain that variation, we looked at a number of factors which previous research (e.g., Burby and French et al., 1985; Hutton and Mileti, 1979) has suggested tend to stimulate floodplain management. The results, which are summarized in Table 2-1, indicate that existing flood threats--serious in each of the cities we studied--do not account for cities' propensity to develop stronger or weaker floodplain management programs. That is, the stronger programs (Palatine, Scottsdale, Fargo, Arvada, and Wayne Township) and the weaker programs (Savannah, Cape Girardeau, Toledo, Tulsa, and Omaha) each had a similar proportion (an average of 7%) of the community subject to flooding. Furthermore, prior to 1976, each had allowed a considerable proportion of the flood hazard area (an average of 30% among the communities with stronger programs and 41% of the group with weaker programs) to be converted to urban uses. Most of the communities in each group had at least one flood

TABLE 2-1

FACTORS ASSOCIATED WITH THE ADOPTION OF STRONG FLOODPLAIN MANAGEMENT PROGRAMS

Factor	Value of Factor in Median Community: Stronger Programs	Weaker Programs
Population, 1975	57,374	330,792
Growth rate, 1976-85	44%	10%
Median housing value, 1970	$27,165	$20,000
Area in floodplain, 1975	7%	7%
Community population in floodplain, 1975	6%	2%
Floodplain in urban use, 1975	30%	41%
Nonresidential uses in floodplain, 1975	10%	23%
Serious Floods, 1970-1985	1	2
Average Annual Flood Damages, 1975:		
Total	$277,000	$2,800,000
Per Capita	$9	$9
Mean Flood Control Expenditures, 1976-85		
Total	$2,000,000	$8,900,000
Per Capita	$44	$39

event from 1970 through 1985 which caused serious property losses. Potential average annual flood damages in 1975, just before the start of the study period, were similar (an average of $9 per capita among the cities in each group), as was the amount of money, per capita, communities spent on flood control works and storm drainage improvements during the study period ($44 among the communities with strong programs and $39 among the communities with weak programs).

On reflection, it is not surprising that the flood threat faced by each group of communities does not explain their attention to floodplain land use management. Floodplain land use management is aimed primarily at reducing the susceptibility of *new* development to flooding rather than solving problems due to past floodplain development. With that in mind, the one set of systematic differences we did find between the two groups makes sense. The communities with the stronger programs tended to be those that grew at a rapid rate between 1976 and 1985 (about 4% per year), while the communities with weaker programs tended not to be growing quickly over that period (an average of about 1% per year).

Rapid growth created a need for strong floodplain management programs and, politically, made it possible for communities to discourage development in the limited areas subject to flooding, since growth was occurring everywhere else and developers could pass on the added costs of construction in the floodplain to consumers. Slow growth reduced the need for floodplain management and, politically, led to hesitancy to adopt regulations that would discourage new development. We need to reiterate a point made at the beginning of this chapter, however: even the communities with weaker floodplain management programs met (and, in fact, often exceeded) the minimum floodplain management standards of the National Flood Insurance Program.