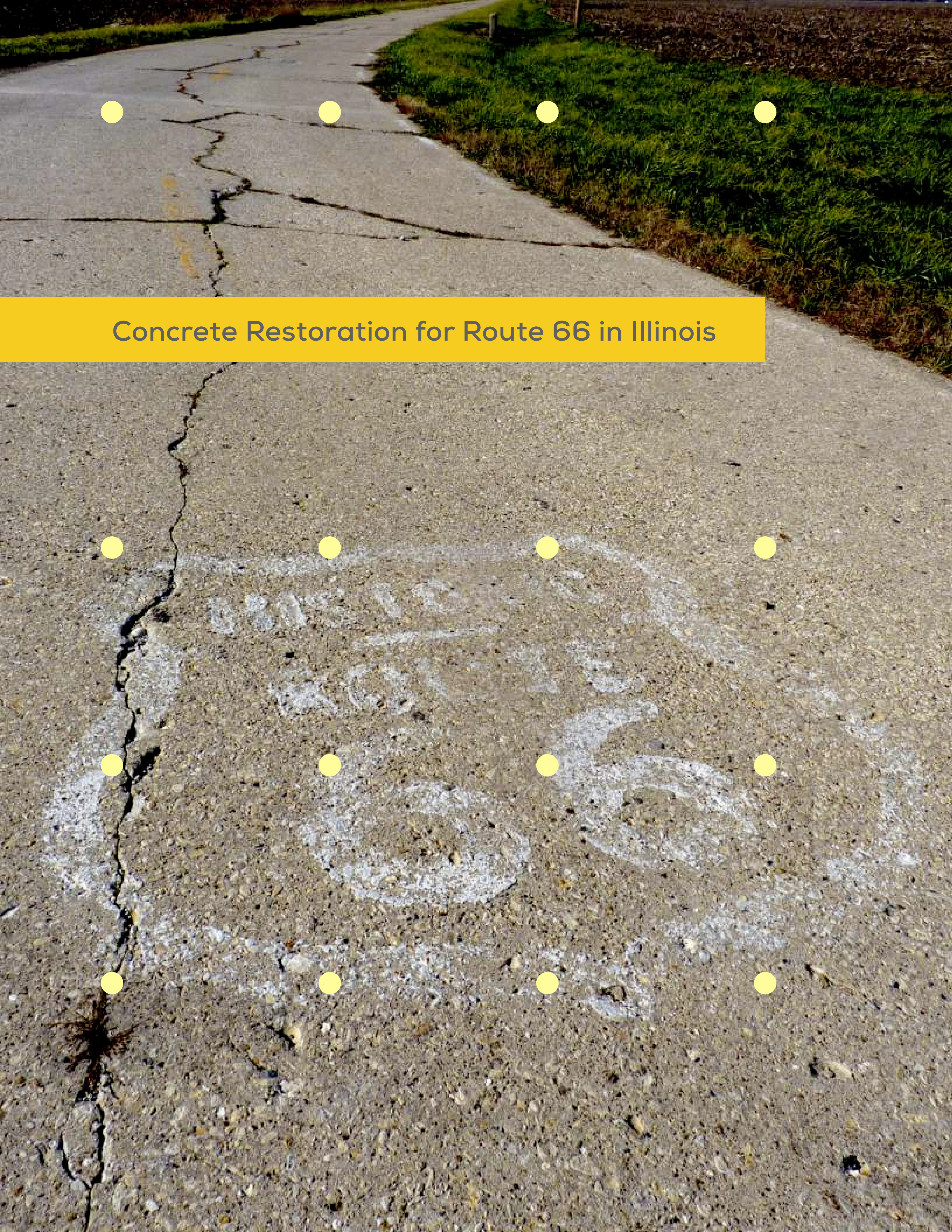
Concrete Restoration for Route 66 in Illinois



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INTRODUCTION

ILLINOISANS HAVE LONG HAD PRIDE IN BEING THE PLACE where Route 66 began. The Route 66 Association of Illinois is a large group of very active and dedicated volunteers promoting the resource as well as a newly invigorated Illinois Route 66 Scenic Byway Association funded in part by the Federal Highway Administration. Thousands of tourists from around the globe begin a pilgrimage down the route from Chicago's Grant Park by car, tour bus or even bicycle. It is an important historic and economic resource for the people of Illinois and a major national tourism destination. The Illinois Historic Preservation Agency has long recognized this importance. In the mid 1990's, the state of Illinois Department of Transportation contracted with the engineering firm of Barton Aschman to undertake the first comprehensive study of Route 66, its alignments and associated historic resources. This report was published in 1998 as the Historic Route 66 Corridor Study. This document led to a nomination of several segments of Route 66 to the National Register of Historic Places. This list has continued to grow. Today there are seven segments designated as historic and shown on a map within this document:

Livingston County
Route 66, Cayuga to Chenoa, Rte. 66 between just N of Township Rd. 2200 North and just S of Township Rd. 3000 North (listed 7-23-03)

Macoupin County
Route 66, Girard to Nilwood, Rte. 66, between IL 4 S of Girard and IL 4 Nilwood vicinity (listed 5-23-02)

Montgomery County
Route 66, Litchfield to Mount Olive, US 66, N of IL 16 in Litchfield to Mount Olive (listed 11-29-01)

Sangamon County
Illinois Route 4-North of Auburn, Curran and Snell Rds. (listed 8-6-98)
Route 66 S of Lake Springfield, Olde Rt. 66/Olde Carriage Way (listed 5-12-09)
Route 66 by Carpenter Park, Old Route 66 between Cabin Smoke Trail and N bank of Sangamon River (listed 5-9-02)

Will County
Alternate Route 66, Wilmington to Joliet, IL 53 bet. Wilmington and Joliet (listed 5-5-06)

It also led to a treatment plan for these historic roads and a plan among the Federal Highway Administration, the Illinois Department of Transportation and the Illinois Historic Preservation Agency to ensure that the roads were historically maintained for public enjoyment. Despite the best efforts of state and local agencies, concrete repairs of historic concrete often did not match or holes in original concrete pavement were filled with asphalt, a non historic material. In researching the problem, IHPA realized that little had been done to provide appropriate guidance to public agencies for the proper repair and maintenance of the road. After discussion with the National Scenic Byway Program within the National Park Service, it was decided that they were desirous of having Illinois develop this information not only to assist Illinois in furtherance of its preservation goals for the historic resource but as a model for other states to follow as well.

In 2008, the Illinois Historic Preservation Agency received a grant through the National Park Service Route 66 Corridor Preservation Program to survey original concrete road segments of Route 66 through Illinois and to prepare a preservation plan for their restoration and maintenance by the various governmental entities that own and maintain them.

The first task in this project was to hire an historic preservation specialist to gather historic survey data such as official highway maps and historic photographs to ascertain the original alignments of the highway from its beginning point in Grant Park Chicago through to the MacArthur Bridge across the Mississippi River. This information was then ground truthed to see where pavement samples existed and assess their condition. This information was digitized using GPS equipment along with roadside structures historically associated with Route 66, such as gas stations and restaurants. These structures provide a context for the road segments. (The locations of found road portions are listed in Table 1).

The second feature of the grant entailed contracting with a materials engineer specializing in historic concrete to analyze several areas where historic concrete exists and to provide a specifications template for repair along with a hierarchy of repair recommendations that meet both the AASHTO Standards and the Secretary of the Interior's Standards for Rehabilitation. For this the agency hired the firm of Thornton Thomasetti. In addition to the funding from the NPS grant, IDOT staff pulled cores from the highway for study and the Federal Railroad Administration provided funding for their petrographic examination.

The final product will be a useful guide not only to highway engineers but to advocates for preservation of historic Route 66 across the United States. The first part defines historic original concrete road sections that will be a planning tool for state and local governments alike to promote preservation and guide tourists to these important resources while they enjoy other local amenities that the various communities have to provide. For the highway professional, the recommendations and specifications for road maintenance will be a useful desktop reference for, at the very least, the formally listed segments of the resource, as outlined in second half of the report.

Finally, we hope that this guidance is a useful tool for other state historic preservation offices, state transportation departments and scenic byway associations as a starting point for them to protect this National Scenic Byway for the enjoyment of future generations.

LOCATION	TRAFFIC LANE	CONDITION OF HIGHWAY	LENGTH OF SEGMENT (MILES)
Dwight Bypass	4 lane - 2 northbound were used - abandoned	growth of vegetation	5.20
Odell Bypass	4 lane - 2 northbound were used - abandoned	growth of vegetation, overlay chipping off	3.40
Cayuga to Chenoa	4 lane - 2 northbound are being used (24" wide)		-
Chenoa	2 lane - abandoned	growth of vegetation, cracking	0.90
Lexington Bypass	4 lane - abandoned	growth of vegetation, large cracks	4.00
Lexington Memory Lane	2 lane - 9' width each	good shape with minor cracking, small patches of vegetation	0.60
Towanda Bypass	4 lane - two northbound were being used - abandoned	good shape with minor cracking, small patches of vegetation	3.00
Towanda - Jackson St.	2 lane - 9' width each		-
North 1075 East Road - Shirley	not a portion of Route 66		-
Atlanta - NW Arch St.		80% torn away w/20% of original portland cement intact, vast amount of vegetation	-
Non-named segment, Lincoln	2 lane		0.20
Cobblestone Ave., Lincoln	2 lane - 9' width with curbing	growth of vegetation	1.20
Elkhart	2 lane	fair shape, some northern portions are breaking and sinking off	0.30
Taylor St., Williamsville	2 lane	fair shape, some northern portions are breaking and sinking off	0.30
Route 66 through Route 66 Park, Sherman		broken into parts, bridge was removed	0.30
Sherman 4 lane segment	4 lane - 2 northbound lanes are in use	growth of vegetation, abandoned bridge built in 1953	0.40
Olde Carriageway, Springfield	2 lane - 8' width and 6" deep		1.20
Service road at intersection of Peoria Rd. and Evergreen St., Springfield	2 lane - 9' width		0.06
Route 66, Carpenter Park, Springfield	16' wide and expansion joints every 30', with curbing	growth of vegetation in expansion joints and other cracks	0.40
North Cotton Hill Road, Springfield	16' wide, covered with brick overlay (45% of brick is removed)	deteriorated, covered w/dense vegetation (due to sandy soil atop the brick overlay)	-
Old Chatham Road and Bridge	18' wide with curbing, bridge had a brick overlay		0.40
Illinois Route 4, Auburn	16' wide originally, expanded to 20' wide and covered with brick overlay		1.10
Girard - Nilwood segment	16' wide		-
Donaldson Rd., Nilwood vicinity	2 lane - 8' wide each and 6" deep	growth of vegetation through the cracks	2.20
Harvest Rd. - north of Carlinville	16' wide and 6" thick	small cracks patched with tar and minor cracks	1.00
Carlinville	16' wide and 6" thick	lot of mud present over roadway in certain segments	16.50
Deerfield Rd. - south of Carlinville	16' wide	Rock and chip paving over original concrete	5.40
Deerfield Rd. - south of Carlinville, north of Gillespie	16' wide and 6" thick with gutters on either side of road		0.50
Staunton Country Club Rd./private drive	16' wide and 6" deep, no gutters		0.40
Bush Creek Rd., Divernon	18' wide and 6" deep		-
Litchfield - Mt. Olive segment	4 lane bypass		7.70
White City - Mt. Olive segment		Dirt was dumped atop to protect original pavement & prevent road use by travelers	2.70
Hamel	16' wide with square gutter, certain segments have brick overlay		-
		TOTAL LENGTH OF SEGMENTS (MILES)	**59.36**

Table 1: Remaining historic concrete segments along Illinois' Route 66

Route 66: Finding Illinois' Original Roadbed Segments

from Chicago to St. Louis

Travis Ratermann

IN ALL OF THE RESEARCH ABOUT US ROUTE 66 THROUGHOUT the United States, one area in particular has been left disengaged for the most part. That area consists of the original roadbed segments of US Route 66, which can still be found stretched along the Illinois landscape. The intention of this report is to map out the original roadbed segments throughout Illinois to provide a better understanding of where these segments are located so those that are eligible for the National Register of Historic Places are surveyed prior to listing, while also providing data for those segments eligible for inclusion in the Historic and Architectural Resources of Route 66 Through Illinois Multiple Property Nomination. With the new data presented both the Illinois Historic Preservation Agency and the National Route 66 Corridor Preservation Program will be able to take steps to further preservation efforts for US Route 66 in Illinois.

INTRODUCTION/METHODOLOGY

In putting together a study of the original roadbed segments of US Route 66 the goal was to be able to illustrate exactly where the original roadbed segments are remaining. The data used to create the roadbed survey maps came from a variety of sources. The previous survey by Barton-Aschman Associates, Inc., researching other areas related to US Route 66 and completing a physical survey of the roadways which were once used by US Route 66 was a major starting point. Original state highway maps were also used. With all of this data in place, the field survey of the starting and ending points of each road segment took place. The locations of the beginning and ending of the historic locations relating to US Route 66 and the data available for these locations, were mapped into a Global Positioning System (GPS) device (Trimble Geo XM) then incorporated into the physical data computer program like ArcGIS. The physical nature of the roadway itself was documented as well as the locations. This data can further help in identifying and preserving the heart of the US Route 66 movement across America.

BRIEF HISTORY OF US ROUTE 66 THROUGH ILLINOIS

Iconic Route 66 became many things to the communities that were touched by the ribbon that raveled its way across the Illinois landscape between 1926 and 1977, when it was commissioned. The road brought communities together during the depression of the 1930's, the nation together during the years of World War II, and the world together during the roar of the 1950's and 60's as people of all nationalities took to the “Mother Road” to find happiness and glory in the many destination spots along the route. However, it is also during this final period of boom and bust, that the road began to be replaced and on its way to being decommissioned by the United State Highway Department in 1977.[1] Illinois was home to the eastern most terminus of Route 66 and by January 17, 1977, the last marker for Route 66 was removed from a light standard near Grant Park in downtown Chicago, IL.

Route 66 began as a dream to construct a continuous route from the Midwest's bustling city of Chicago, IL, to Santa Monica, CA, along the Pacific Coast. The Route encompasses nearly two-thirds of the continental United States, yet this dream became a reality by 1925. However, in Illinois, Route 66 connects two of the biggest distribution centers in the Midwest, Chicago and St. Louis. With Route 66 being the link between these two impressive distribution hubs, the transportation route that brought them together in the mid 1920's became unparalleled throughout the rest of the state of Illinois.

Route 66 took its beginnings from “the Federal Aid Post Road Act of 1916, when the federal government began to supply individual states with funding to construct highways.”[2] Of this appropriation of $75 million, “the money was to be for the construction of roads but not the maintaining of roadways.”[3] Of that $75 million was designated in “matching funds for road construction in the State of Illinois.”[4] By this time, a plan had been developed for the construction of hard roads stretching nearly 4,000 miles throughout the State of Illinois. However, in order to fulfill this developmental plan, the state would have to pass a bond issue of $50,000,000, which was completed in 1918.[5] As part of this bond issue, the passage from Chicago to East St. Louis become standardized and paved under the name of State Bond Issue 4 (SBI4). The bids were taken on February 21, 1921 for the paving of SBI4 and over the next three years it would be paved from Chicago to St. Louis.[6]

By the completion of the paving of Illinois Route in 1924, the new Bureau of Public Roads and the American Association of State Highway Officials suggested a “comprehensive and uniform scheme for the designation of primary national highways.”[7] Though it was suggested in 1924, it was not until 1927 that US Route 66 became available on Illinois State maps. Even by 1928, portions of Route 66 still showed up on Illinois maps as a Temporary Routing of the alignment.

The first alignment of US Route 66 follows the current alignment of IL Route 4. This alignment runs from Chicago to St. Louis while passing through Joliet, Odell, Pontiac, Lexington, Towanda, Bloomington, Atlanta, Lincoln, Springfield, Carlinville, Edwardsville, Granite City and Madison on its way to the Illinois and Missouri border. In the beginning, the road material varied by location with either 18 foot Portland cement concrete or 16 foot concrete in places like Benld, Pontiac, and Thayer. It was also quite frequent to have small segments of brick pavement through urban areas.[8] It would not take long before young entrepreneurs began using the new roadway to promote gas stations, motels and even restaurants by the early 1930's. However, it was by this time that the second of three alignments was taking shape.

By 1930, the temporary alignment that ran south of Springfield on IL Route 4 to Staunton was diverted to the new alignment that now ran through Divernon, Farmersville, Waggoner, Litchfield, Mt. Olive, and reconnected in Staunton. On the 1930 Illinois Highway map, US Route 66 continued to travel the temporary alignment south of Springfield to Staunton. However, the second alignment that ran through Mt. Olive was finished by this period. It was not until 1931 that the designation of US Route 66 begins to show up on highway maps in Illinois. However, this alignment of US Route 66 would also have a short tenure. Already by 1936, plans were announced to bypass portions of the alignment throughout Springfield to eliminate hazardous turns between Sherman and Springfield. Similar changes would begin to take place in other larger cities and towns, in which US Route 66 passed through at the time. "Plans were made to construct belt lines and bypasses around Lincoln and Springfield."[9] At the same time a new connection was being constructed to the east of Staunton to allow for quicker travel time, "by avoiding going through Staunton and the narrow pavement and sharp turns on the old road."[10] This bypass around Staunton was completed in 1940.[11]

By 1940 though, more road improvements were invested into US Route 66, due to the advent of World War II. As part of the defense system, US Route 66 was designated a national strategic highway in 1942.[12] As part of the infrastructure of a country on the brink of war, the logistics of improving the roadway became ever more apparent. However, following the entrance into the war, all repair and construction stopped.[13] It was not until the height of the war, in 1943, that "the right-of-way for a four lane highway was purchased by the Division of Highways for the entire length of the route."[14] This idea of a four lane divided highway was constructed under the Defensive Highway Act of 1941. As part of this act, a "modern four-lane pavement of limited access"[15] would be constructed as part of US Route 66. However, most of the proposed four-lane highway was not constructed until the 1950's and 60's.[16]

Still the fast paced life on US Route 66 would not come to life until the end of World War II, with the return of the American GI's. It is during this period after the war, that US Route 66 became part of many Americans experience while traveling on the road. It is also during this time period, that US Route 66 became part of many families throughout the country through guidebooks published by the likes of Jack Rittenhouse, the song made famous by Bobby Troup and even later by the television show entitled "Route 66." All of these aspects began to make US Route 66 the iconic roadway that it is today. However, even with the iconic measures inadvertently taken on by the entertainment business which made US Route 66 loved by so many, also became its downfall with the necessity of speed and ease of travel.

With the passing of the Interstate Highway Act in 1956 and the construction of the four-lane roadway, the small roadside tourist attractions began to be overrun by the large commercial strips located at every exit and interchange. These new commercial strips contained much of the same establishments located within the downtowns of these smaller localities, but due to their proximity to the road and ease of travel, these commercial strips began to seal the fate of many of previous US Route 66 segments and the businesses that once occupied the routes roadside. It did not take long before both the businesses and then the roadway to become abandoned, left to be traveled by those wanting to regain the nostalgia of long ago. Some of the businesses would remain and downsize the operations that once flourished, others moved out to the commercial strips and some areas were lucky enough to have the on and off ramps come to them, like in the case of Art's Motel and Restaurant in Farmersville, IL. Circumstance like that of Art's Motel and Restaurant are few and far between many segments of US Route 66 and the businesses operating along them would become lost forever and only remain in the experiences and pictures left to those who have traveled the Iconic US Route 66.

CONCLUSION

The compiled research for the pavement survey has been documented in a series of maps and data tables. The various segments of the early Route 4 alignment south of Springfield were particularly noteworthy for some of the oldest pavement sections. With these locations and physical conditions noted, the evaluation and designation of historic pavement sections can move forward. The future conservation of the noteworthy pavement segments of Route 66 can be added to the matrix of historic resources that are the hallmark of the Route 66 experience.

ENDNOTES

[1] James Depree, Photographer, “End of the Road,” Chicago Sun-Times. 18 January 1977. Page 5.
[2] Ryburn-Lamont, Terri and Dorothy R. L. Seratt. “Historic and Architectural Resources of Route 66 Through Illinois.” National Register of Historic Places, Multiple Property Documentation Form. United States Department of the Interior. Illinois Historic Preservation Office. Springfield, IL. 2 Oct. 1997. Section E, Page 8.
[3] Ibid.
[4] Wrone, 1965. 68.
[5] Ibid.
[6] Barton-Aschman Associates, Inc. *Historic Route 66 Corridor Study.*
[7] Krim, Author. *Route 66: Iconography of the American Highway.* Center for American Places, Santa Fe, NM.
[8] Department of Public Works: Division of Highways. *Route Bulletin.* September 7, 1925.
[9] “Historic and Architectural Resources through Illinois.”
[10] 21st Annual Report of the Department of Public Works. “Historic and Architectural Resources through Illinois.”
[11] Ibid. 25
[12] Corridor section 4-6.
[13] “Historic and Architectural Resources through Illinois.” 24.
[14] Corridor, 4-7
[15] “Historic and Architectural Resources through Illinois.” E-26.
[16] Corridor, 4-7.

Photo Appendix: Historic Road Segments and Associated Resources – Location and Condition*

*Download an Excel spreadsheet of the resource here.

FIG. 1

FIG. 2

FIG. 1
Joliet, IL. The Rich and Creamy. Located on Broadway St. Camera facing northeast.
Photograph by Travis Ratermann, 2 July 2008.

FIG. 2
Wilmington, IL. The Gemini Giant at the Launching Pad. 810 E. Baltimore St. Camera facing south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 3

Fig. 4

Fig. 3
Gardner, IL. The Riviera. Camera facing northeast.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 4
Gardner, IL. 2 cell jail. Camera facing southeast.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 5

Fig. 6

Fig. 5
Dwight, IL. Ambler-Becker Texaco at Rt. 17 and old Rt. 66. Camera facing southeast.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 6
Dwight, IL. Section of Rt. 66 bypass near Dwight Rd. Camera facing north.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 7

Fig. 8

Fig. 7
Near Dwight, IL. Close-up of Rt. 66 bypass by Mazon Rd. Camera looking south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 8
Dwight, IL. Rt. 66 bypass by Mazon Rd. Camera looking south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 9

Fig. 10

Fig. 9
South of Dwight, IL. Rt. 66 bypass. Camera looking south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 10
Dwight, IL. Rt. 66 bypass south of Dwight. Between Dwight and Odell. Camera facing south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 11

Fig. 12

Fig. 11
Odell, IL. Segment of Rt. 66 bypass. Camera facing south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 12
Odell, IL. Segment of Rt. 66 bypass between Odell and Pontiac. Camera facing south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 13

Fig. 14

Fig. 13
Odell, IL. Segment between Odell and Pontiac looking up close at the pavement. Camera facing north.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 14
Odell, IL. Standard Oil Service Station. Camera facing north.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 15

Fig. 16

Fig. 15
South of Cayuga, IL. Meramec Caverns Barn Sign. Camera facing west.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 16
Pontiac, IL. Pontiac Division St. Bridge marked by the Rt. 4 marker. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 17

Fig. 18

Fig. 17
Pontiac, IL. Overall view of the Pontiac Division Street Bridge marked by the Rt. 4 marker. Camera looking northeast.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 18
Pontiac, IL. Old Log Cabin. Camera facing west.
Photograph by Travis Ratermann, 8 July 2008.

Fig. 19

Fig. 20

Fig. 19
Pontiac, IL. Station 1180-22-2. Camera facing east.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 20
Chenoa, IL. Abandoned 1926-30 segment of Rt. 66 off of Moorehead and Cemetery Rds. Runs along RR tracks. Camera facing northeast.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 21

Fig. 22

Fig. 21
Chenoa, IL. Abandoned 1926-30 segment of Rt. 66 off of Moorehead and Cemetery Rds. Runs along RR tracks not visible to the left due to trees. Camera facing southeast.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 22
Chenoa, IL. Bridge North of Chenoa, IL. Camera facing north.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 23

Fig. 24

Fig. 23
Lexington, IL. Lexington's Memory Lane segment of Rt. 66 from 1926-30. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 24
Lexington, IL. Lexington's Memory Lane segment of Rt. 66 from 1926-30. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 25

Fig. 26

Fig. 25
Lexington, IL. Center of Lexington's Memory Lane segment of Rt. 66 from 1926-30. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 26
Lexington, IL. Lexington's Memory Lane segment of Rt. 66 from 1926-30. Tape measure marking the road at 18ft wide. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 27

Fig. 28

Fig. 27
Lexington, IL. Segment of Rt. 66 north of Lexington on Rt. 66 bypass. One lane of roadway has been torn up and replaced with grass. Camera facing north.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 28
Towanda, IL. Rt. 66 bypass north of Towanda. Now used as a bike path. Camera facing south.
Photograph by Travis Ratermann, 2 July 2008.

Fig. 29

Fig. 30

Fig. 29
Towanda, IL. Rt. 66 segment (Jackson St.) that has been paved over. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 30
Towanda, IL. State Right of Way marker at the corner of Jefferson and Jackson St. Camera facing east.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 31

Fig. 32

Fig. 31
Shirley, IL. Funk's Grove Maple Syrup Shop. Camera facing southeast.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 32
Shirley, IL. Funk's Grove Country Store and Antiques. Corner of 550N and Maple Lane. Camera facing south.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 33

Fig. 34

Fig. 33

Shirley, IL. Station 159489-8.2. About 1/4 mi. south of Funks Grove Rd. Camera facing northwest.

Photograph by Travis Ratermann, 3 July 2008.

Fig. 34

McLean, IL. Dixie Truck Stop. Camera facing west.

Photograph by Travis Ratermann, 3 July 2008.

Fig. 35

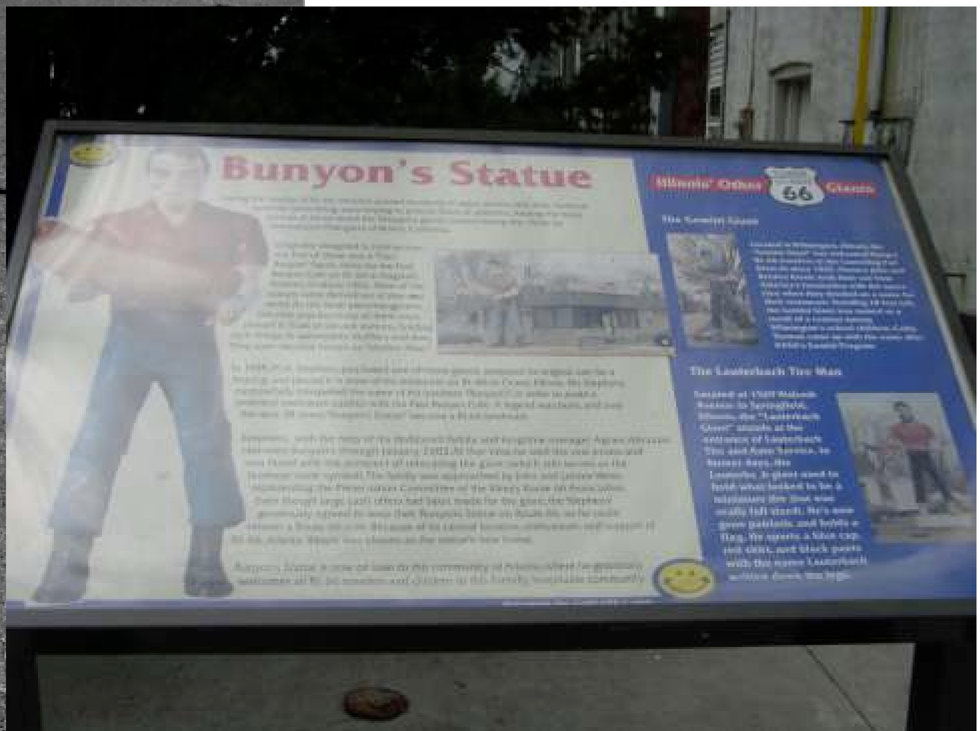


Fig. 36

Fig. 35
Atlanta, IL. Bunyon Statue sign. Camera facing west.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 36
Atlanta, IL. Bunyon Statue. Hot dog added in 1965. Camera facing west.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 37

Fig. 38

Fig. 37
Atlanta, IL. Rt. 66 in Atlanta 1926-30 segment. Portion is along RR tracks and a farm. Golf course in located on other side of RR tracks. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 38
Atlanta, IL. Rt. 66 in Atlanta 1926-30 segment. Portion is along RR tracks and a farm. Golf course in located on other side of RR tracks. Camera facing north.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 39

Fig. 40

Fig. 39
Atlanta, IL. State ROW marker (Right of Way) at the corner of Northwest Arch St. and Sycamore St. Camera facing east.
Photograph by Travis Ratermann, 8 July 2008.

Fig. 40
Atlanta, IL. State signage by entrance at the corner of Northwest Arch St. and Sycamore St. stating - Penalty for Dumping on State Highway. Camera facing west.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 41

Fig. 42

Fig. 41
Atlanta, IL. Station 572-29. In the background is the Amtrak bridge. Camera facing west.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 42
Lincoln, IL. Segment of Rt. 66 West of the Lincoln along Rt. 66 Bypass looking at the sign proclaiming no dumping along state route found on the site. Camera facing north.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 43

Fig. 44

Fig. 43
Lincoln, IL. Segment of Rt. 66 West of the Lincoln Rt. 66 Bypass looking at the split in the road. Camera facing northeast.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 44
Lincoln, IL. Segment of Rt. 66 west of the Lincoln Rt. 66 Bypass. Camera facing north.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 45

Fig. 46

Fig. 45
Lincoln, IL. Postville Courthouse. Camera facing north.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 46
Lincoln, IL. Rt. 66 segment off of Cobblestone Ave. with in the cemetery in Lincoln, IL. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 47

Fig. 48

Fig. 47
Lincoln, IL. Rt. 66 Segment off of Cobblestone Ave with in the cemetery in Lincoln, IL. Picture shows curbing along stretch of roadway. Camera facing east.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 48
Lincoln, IL. On the south side of the city within boundaries of a cemetery. Marker reads - FA 23 1922 N - Cemetery is the Logan County Cemetery Dist. Camera facing north.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 49

Fig. 50

Fig. 49
Lincoln, IL. Rt. 66 Segment off of Cobblestone Ave with in the cemetery in Lincoln, IL. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 50
Lincoln, IL. Rt. 66 Segment off of Cobblestone Ave within the cemetery in Lincoln, IL. Shows Ghost bridge at end of roadway crossing over river. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

FIG. 51

FIG. 52

FIG. 51
Lincoln, IL. Rt. 66 Segment off of Cobblestone Ave with in the cemetery in Lincoln, IL. Shows the Ghost Bridge at end of roadway crossing over Deer Creek River. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

FIG. 52
Broadwell, IL. Pig Hip Restaurant. Camera facing south.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 53

Fig. 54

Fig. 53
Elkhart, IL. Rt. 66 1926-30 Segment along ditch behind trucking company. Camera facing north.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 54
Elkhart, IL. Rt. 66 1926-30 segment along ditch behind radio tower. Camera facing southeast.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 55

Fig. 56

Fig. 55
Williamsville, IL. Segment of Rt. 66 1926-30 along Taylor St. By Brandt Consolidated. Camera facing north.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 56
Sherman, IL. Linear view of Rt. 66 Park in Sherman along with original roadbed segment. Camera facing north.
Photograph by Travis Ratermann, 23 June 2008.

FIG. 57

FIG. 58

FIG. 57
Sherman, IL. Linear view of Rt. 66 Park in Sherman, road bed continues north of the road closed sign. Camera facing north.
Photograph by Travis Ratermann, 23 June 2008.

FIG. 58
Sherman, IL. Overall view of Rt. 5 bridge. Camera facing west.
Photograph by Travis Ratermann, 23 June 2008.

Fig. 59

Fig. 60

Fig. 59
Sherman, IL. Plaque on Rt. 5 Bridge used by Rt. 66. Camera facing east.
Photograph by Travis Ratermann, 23 June 2008.

Fig. 60
Sherman, IL. Rt. 66 bypass north bound lane, within the Median of Business 55 as it heads out toward I-55. Camera facing south.
Photograph by Travis Ratermann, 23 June 2008.

Fig. 61

Fig. 62

Fig. 61
Springfield, IL. Olde Carriage Way south of Lake Springfield. Camera facing north.
Photograph by Emilie Eggemeyer, 24 June 2008.

Fig. 62
Springfield, IL. Pioneer Motel. Camera facing north.
Photograph by Travis Ratermann, 18 June 2008.

Fig. 63

Fig. 64

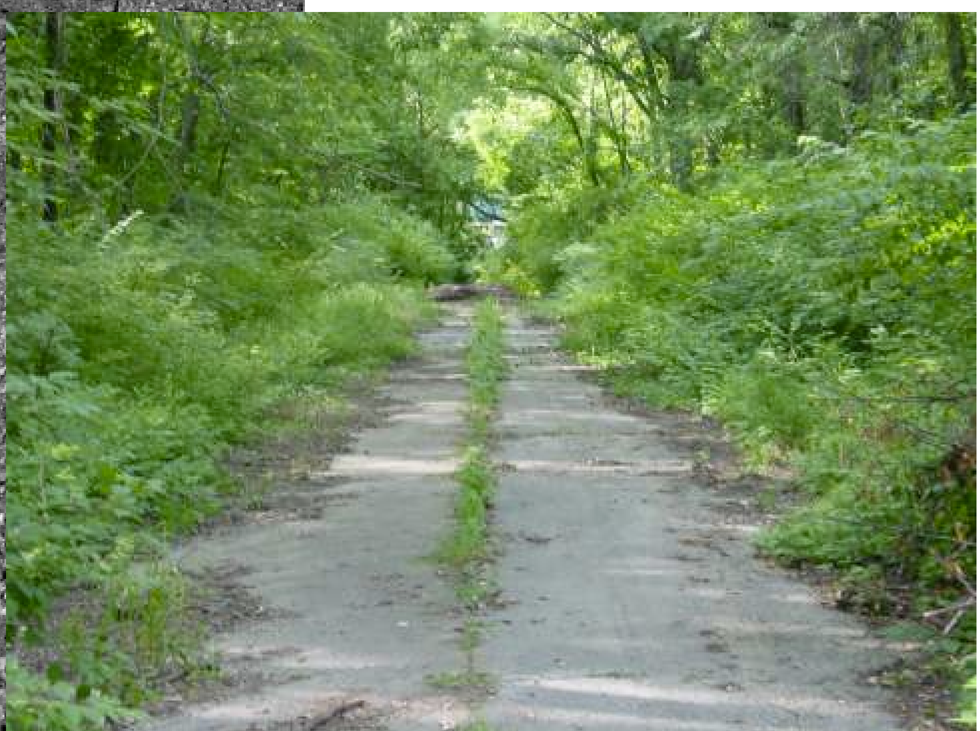


Fig. 63
Springfield, IL. The section of Rt.66 which runs in to Lake Springfield. Section is south of North Cotton Hill Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 64
Springfield, IL. The section of Rt.66 which runs in to Lake Springfield. Section is south of North Cotton Hill Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 65

Fig. 66

Fig. 65
Springfield, IL, Rt. 66 1926-30 segment at the intersection of Peoria Rd. and Evergreene. Camera looking north.
Photograph by Travis Ratermann, 3 July 2008.

Fig. 66
Springfield, IL. Rt. 66 segment in Carpenter Park adjacent to The Rail Golf Course. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 67

Fig. 68

Fig. 67
Springfield, IL. Rt. 66 segment in Carpenter Park adjacent to The Rail Golf Course. Photo showing the guttering of the old road. Camera facing south.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 68
Springfield, IL. Rt. 66 segment in Carpenter Park adjacent to The Rail Golf Course. Camera facing north.
Photograph by Emilie Eggemeyer, 8 July 2008.

Fig. 69

Fig. 70

Fig. 69
Springfield, IL. Hidden on the right of North Cotton Hill Road parallel to first left corner. Camera facing north.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 70
Springfield, IL. Hidden on the right of North Cotton Hill Road parallel to first left corner. Camera facing west from north end of visible brick.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 71

Fig. 72

Fig. 71
Auburn, IL. Brick section of Old Rt. 66, Snell Rd. Brick done during the depression, after the route had changed. Camera facing west.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 72
Auburn, IL. Brick section of Old Rt. 66, Snell Rd. Camera facing east.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 73

Fig. 74

Fig. 73
Girard, IL. Bridge marked Station 1616-70 on Cambridge Rd. Concrete still visible under blacktop. Camera facing west.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 74
Girard, IL. Plaque marking station 1616-70 on Cambridge Rd. Camera facing west.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 75

Fig. 76

Fig. 75
Girard-Nilwood, IL. Section of Rt. 66 located on Cambridge-Wylder-Morean Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 76
Nilwood, IL. Cross section of Donaldson Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 77

Fig. 78

Fig. 77
Nilwood, IL. Rt. 66 painted on Donaldson Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 78
Nilwood, IL. Linear view of Donaldson Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 79

Fig. 80

Fig. 79
Carlinville, IL. Bridge on Harvest Rd. Camera facing north.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 80
Carlinville, IL. Cross section of Rt. 66, Harvest Rd, north of Carlinville, IL. Camera facing west.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 81

Fig. 82

Fig. 81
Carlinville, IL. Rt. 66, Harvest Rd. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 82
Carlinville, IL. Rt. 66 segment on Deerfield Dr. Portland is covered by rock and chip that is crumbling. Camera facing south and down.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 83

Fig. 84

Fig. 83
Carlinville, IL. Rt. 66 segment on Deerfield Dr. Portland is covered by rock and chip that is crumbling. Camera facing south and down.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 84
Carlinville, IL. 1st segment south of Carlinville. Located within the cemetery. Used as entrance road. Located off of Country Club Lane. Segment is 16ft wide. Camera facing north.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 85

Fig. 86

Fig. 85
Carlinville, IL. 1st segment south of Carlinville. Located within the cemetery. Used as entrance road. Located off of Country Club Lane. Segment is 16ft wide. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 86
Carlinville, IL. 2nd segment. Rt. 66, IL Rt.4 through cemetery south of Carlinville, IL. Roadway used as a entrance to cemetery. Camera facing north.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 87

Fig. 88

Fig. 87
Carlinville, IL. 2nd segment. State ROW (Right of Way) marker on the north end of the road within the Carlinville, IL cemetery. Camera facing east.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 88
Carlinville, IL. 2nd segment. State ROW (Right of Way) marker on the north end of the road within the Carlinville, IL cemetery. Camera facing east.
Photograph by Travis Ratermann, 24 June 2008.

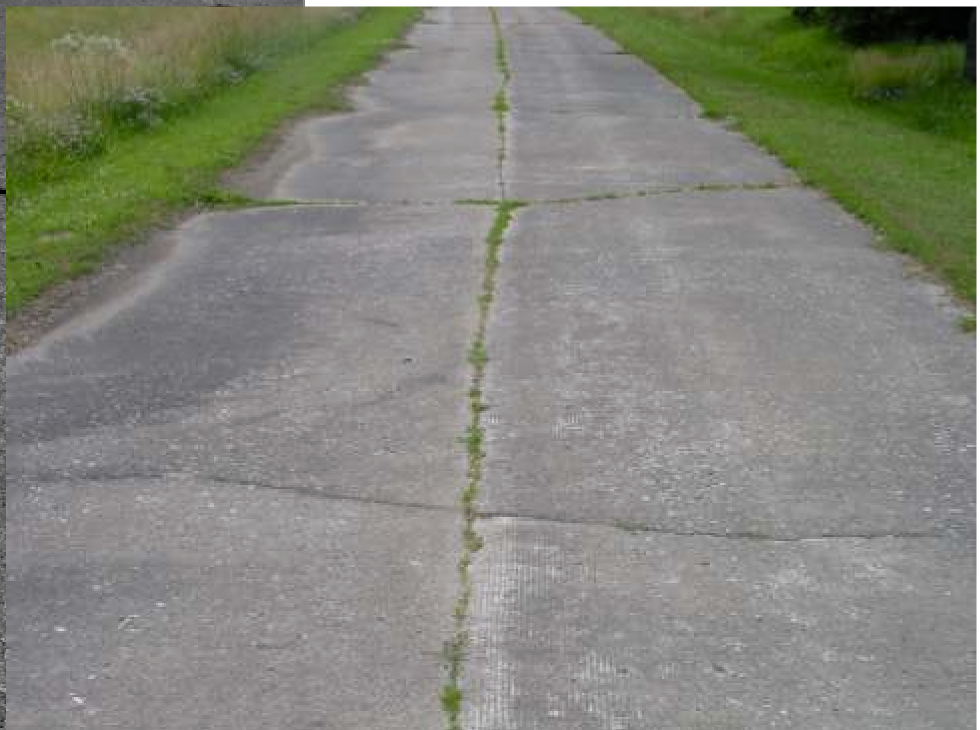


Fig. 89

Fig. 90

Fig. 89
Carlinville, IL. 2nd segment south of Carlinville. Up close look at the Rt. 66, IL Rt. 4 roadway that runs through the west side of the cemetery. Camera facing southeast.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 90
Carlinville, IL. 3rd segment south of Carlinville. Located just south of both cemeteries. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 91

Fig. 92

Fig. 91
Carlinville, IL. 3rd segment south of Carlinville. Located just south of both cemeteries. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 92
Carlinville, IL. 4th segment of Rt. 66 located at 17500 N or Barnett Lane. Section winds back through the thick brush and is on private property. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

FIG. 93

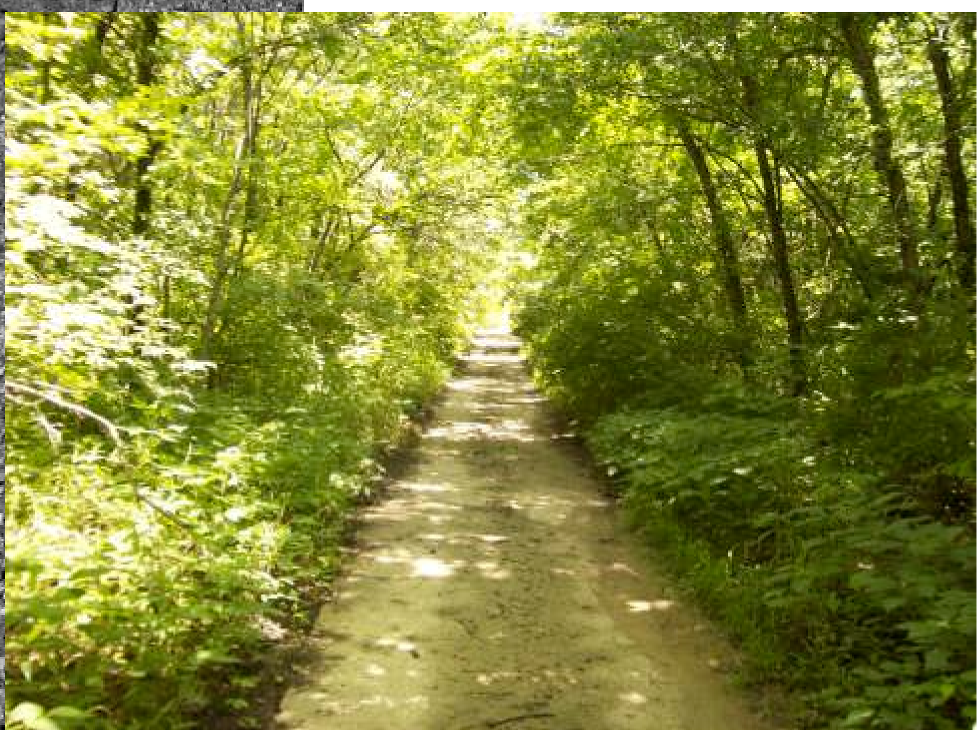


FIG. 94

FIG. 93
Carlinville, IL. 4th segment of Rt. 66 south of Carlinville. Located at 17500 N or Barnett Lane. Section winds back through the thick brush and is on private property. View from midpoint on road. Notice where Barnett Lane veers left in the picture. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

FIG. 94
Carlinville, IL. 4th segment of Rt. 66 south of Carlinville. Located at 17500 N or Barnett Lane. Narrow portion in the woods. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 95

Fig. 96

Fig. 95
Carlinville, IL. 4th segment of Rt. 66 south of Carlinville. Located at 17500 N or Barnett Lane. Section winds back through the thick brush and is on private property. View of the State ROW marker. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 96
Gillespie, IL. Section of Rt. 66 just south and to the east of Deerfield Dr. after crossing Rt. 4. This section is just to the north of the Gillespie Country Club. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 97

Fig. 98

Fig. 97
Gillespie, IL. Section of Rt. 66 just south and to the east of Deerfield Dr. after crossing Rt. 4. This section is just to the north of the Gilespie Country Club. Notice the gutters, which are unique to Rt. 4. Camera facing south and uphill.
Photograph by Travis Ratermann, 24 July 2008.

Fig. 98
Gillespie, IL. Section of Rt. 66 just south and to the east of Deerfield Dr. after crossing Rt. 4. This section is just to the north of the Gillespie Country Club. Camera facing south.
Photograph by Travis Ratermann, 24 July 2008.

Fig. 99

Fig. 100

Fig. 99
Divernon, IL. Corner of Ping Rd. and Brush Creek Road along I-55's southbound lane. Just north of Diveron with access from Diveron. No Outlet. Camera facing North.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 100
Divernon, IL. Station 552-37.80, Bridge on Brush Creek Road. Camera facing east.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 101

Fig. 102

Fig. 101
Farmersville, IL. Art's Motel and Restaurant, 101 Main St. Camera facing southwest.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 102
Farmersville, IL. Art's Motel and Restaurant, motel portion of the business. Located at 101 Main St. Camera facing southwest.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 103

Fig. 104

Fig. 103
Farmersville, IL. Segment of Rt. 66 on an inlet just south of the Station 1067-45.3. Camera facing north.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 104
Farmersville, IL. Station 1067-45.3 along Frontage Rd. done for SBI 126. Camera facing east.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 105

Fig. 106

Fig. 105
Farmersville, IL. Station 1067-45.3 along Frontage Rd. work done as part of SBI 126. Camera facing east.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 106
Farmersville, IL. Our Lady of the Highways. 22353 Frontage Rd. South of Farmersville. Camera facing west.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 107

Fig. 108

Fig. 107
Litchfield, IL. Ariston Café. Camera facing southwest.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 108
Litchfield, IL. Rt. 66 bypass segments. Most of this section is covered with multiple layers of rock and oil. Camera facing south.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 109

Fig. 110

Fig. 109
Litchfield, IL. Rt. 66 bypass segments. Most of this section is covered with multiple layers of rock and oil. Camera facing north.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 110
Litchfield, IL. Section of Bypass Rt. 66 south of Litchfield. Camera facing north.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 111

Fig. 112

Fig. 111
Litchfield, IL. Section of Bypass Rt. 66 south of Litchfield. Camera facing south.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 112
Litchfield, IL. Section of Rt. 66 bypass across from the Rt. 66 Diner in Mt. Olive, just south of Rt. 138. Camera facing south.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 113

Fig. 114

Fig. 113
Litchfield, IL. Section of Rt. 66 Bypass in front of a house marked 4378 Rt. 66. Camera facing south.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 114
Litchfield, IL. Segment on east side of Bypass just north of the Old RR bridge. Camera facing south.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 115

Fig. 116

Fig. 115
Litchfield, IL. Segment on east side of bypass just north of the old RR bridge. Large embankment to the right has rolled over on to the roadway. Camera facing north.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 116
Mt. Olive, IL. Intersection of Historic 66 and Neubert Rd between Mt. Olive and Staunton. Camera facing north.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 117

Fig. 118

Fig. 117
Mt. Olive, IL. Soulsby's Gas Station. Camera facing southwest.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 118
Staunton, IL. Intersection of Wolf Rd. and US Highway 66 north of Staunton and south of Mt. Olive. Camera facing northwest.
Photograph by Travis Ratermann, 30 June 2008.

Fig. 119

Fig. 120

Fig. 119
Staunton, IL. Section of Rt. 66 located within the boundaries of the Staunton Country Club Golf Course on Country Club Lane. Camera facing north.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 120
Staunton, IL. Section of Rt. 66 located within the boundaries of the Staunton Country Club Golf Course on Country Club Lane. Camera facing south.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 121

Fig. 122

Fig. 121
Staunton, IL. South of Staunton Country Club. This section connects with the portion located on the golf course. Camera facing north.
Photograph by Travis Ratermann,24 June 2008.

Fig. 122
Staunton, IL. South of Staunton Country Club. This State Right of Way (ROW) marker is located adjacent to the roadway connection on the Staunton Country Club Golf Course. Camera facing east.
Photograph by Travis Ratermann, 24 June 2008.

Fig. 123

Fig. 124

Fig. 123
Staunton, IL. It is used as a access road to several houses. One marked 2335 Rt. 4. Camera facing southeast.
Photograph by Travis Ratermann, 1 July 2008.

Fig. 124
Hamel, IL. Scotty's Bar and Grill. Camera facing southeast.
Photograph by Travis Ratermann, 1 July 2008.

Fig. 125

Fig. 126

Fig. 125

Hamel, IL. South of Hamel, IL at IL 157 and Staunton Rd. Curb crosses Staunton Rd. Camera facing south.

Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 126

Hamel, IL. South of Hamel, IL at Il 157 and Staunton Rd. Brick under asphalt. Camera facing north.

Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 127

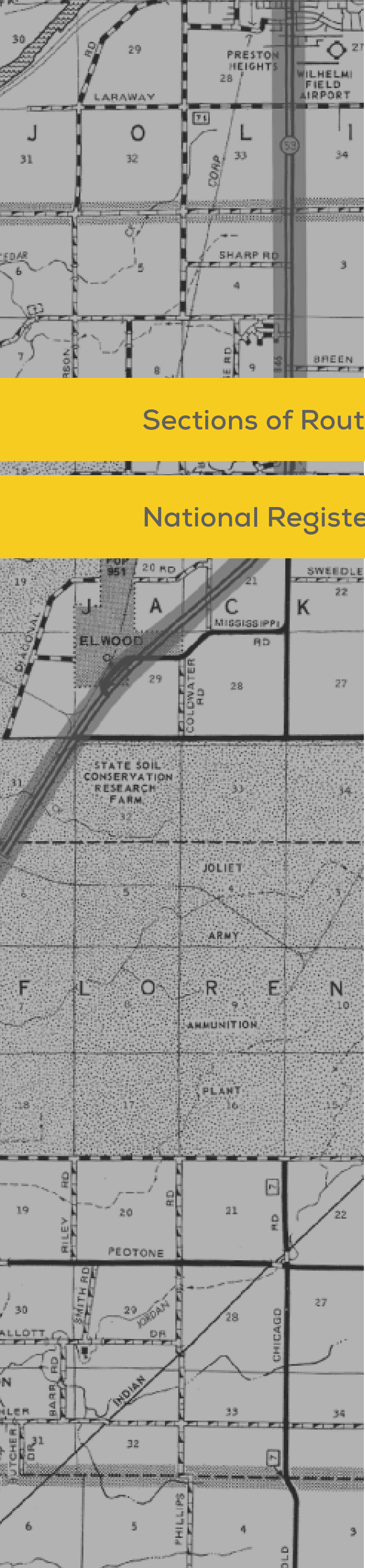
Fig. 128

Fig. 127
Hamel, IL. South of Hamel, IL at IL 157 and Staunton Rd. Curb crosses Staunton Rd. Camera facing north.
Photograph by Emilie Eggemeyer, 9 July 2008.

Fig. 128
Madison, IL. Bel-Air Drive In sign. Camera facing north.
Photograph by Travis Ratermann, 1 July 2008.

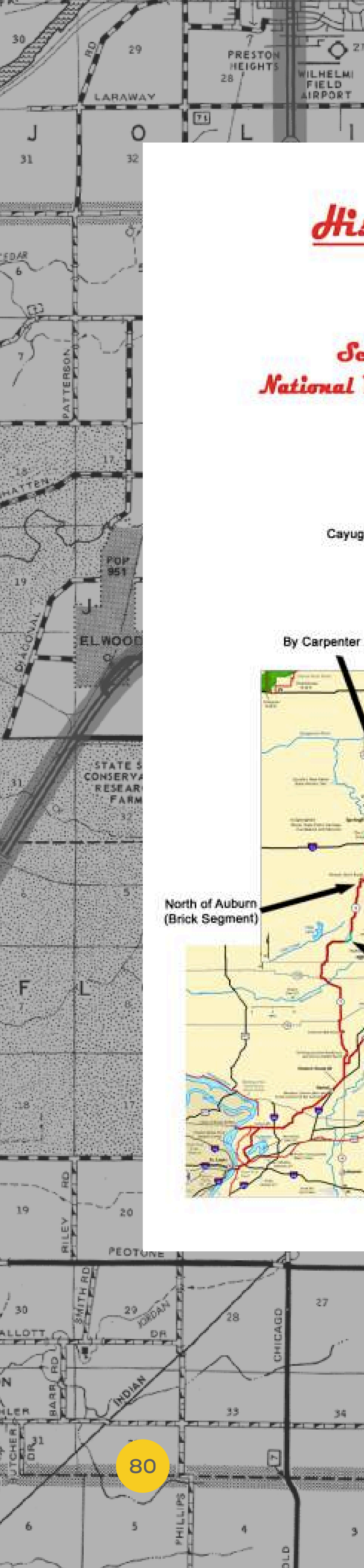
Fig. 129

Fig. 129
Mitchell, IL. The Luna. Camera facing southwest.
Photograph by Travis Ratermann, 1 July 2008.



Sections of Route 66 in Illinois listed on the National Register of Historic Places

FIG. 1



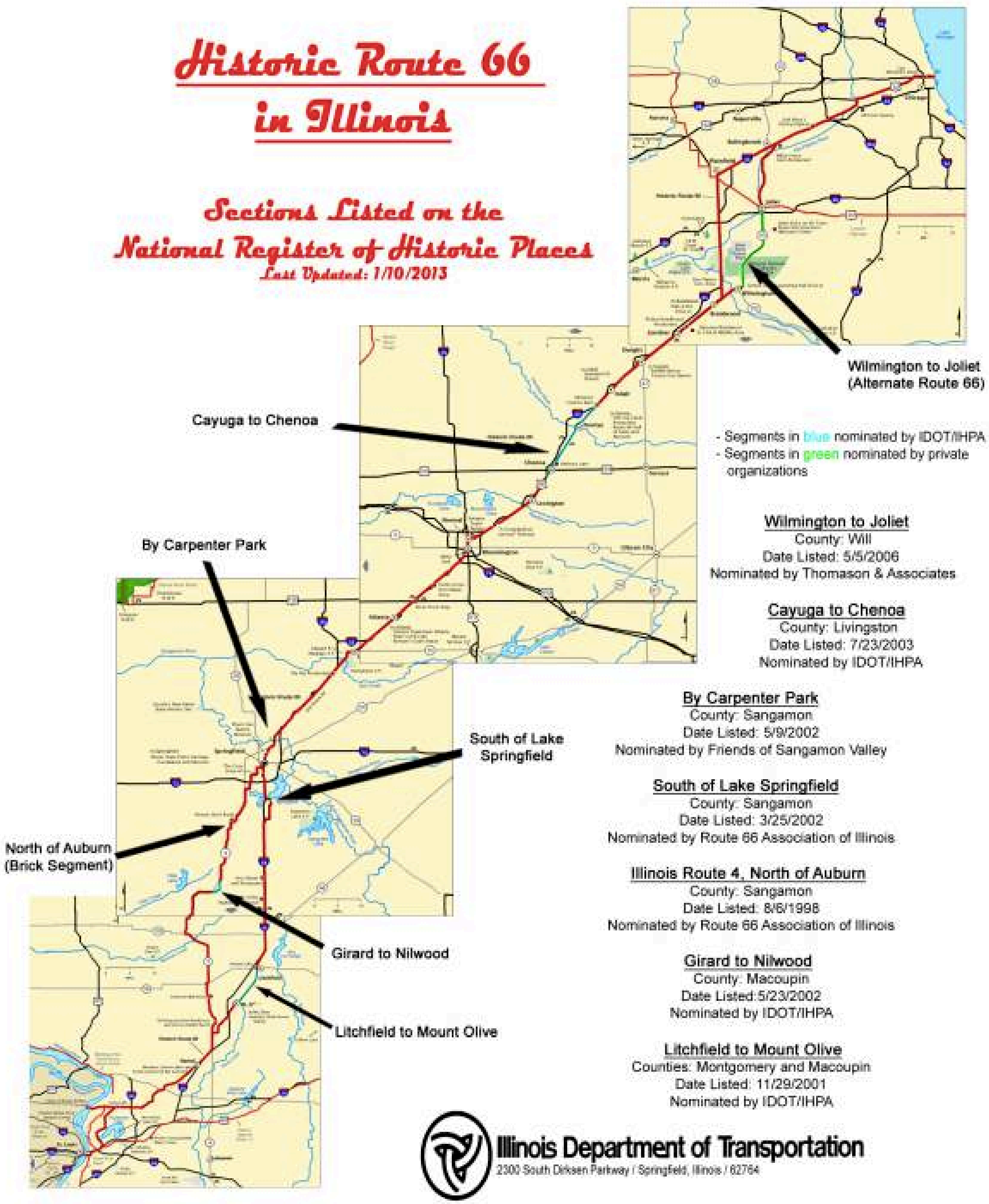


FIG. 1

Historic Route 66 in Illinois. Sections listed on the National Register of Historic Places.

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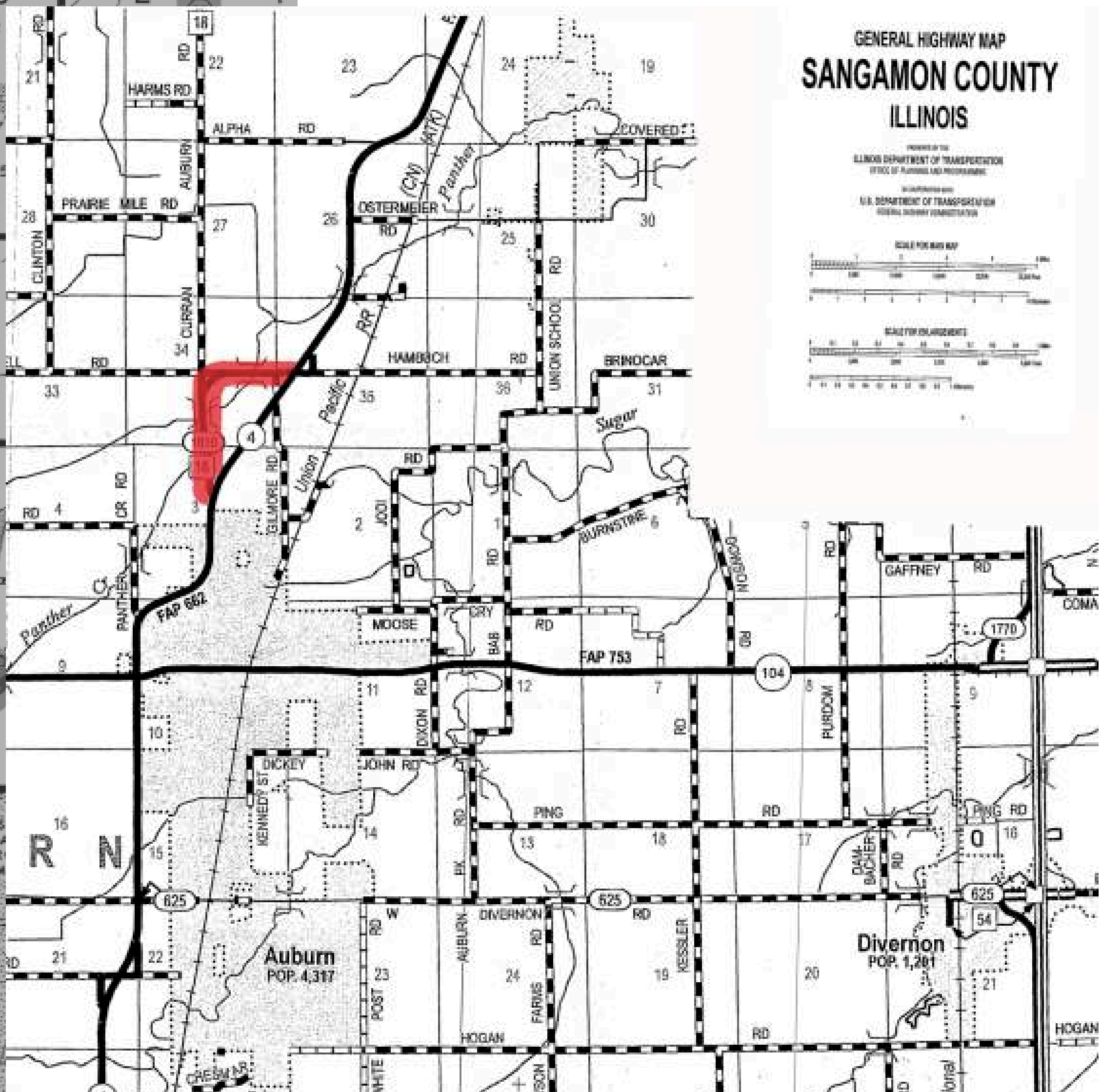

FIG. 2

FIG. 2

NRHP Section - Sangamon County, Illinois Route 4, north of Auburn; Curran and Snell Roads

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Fig. 3

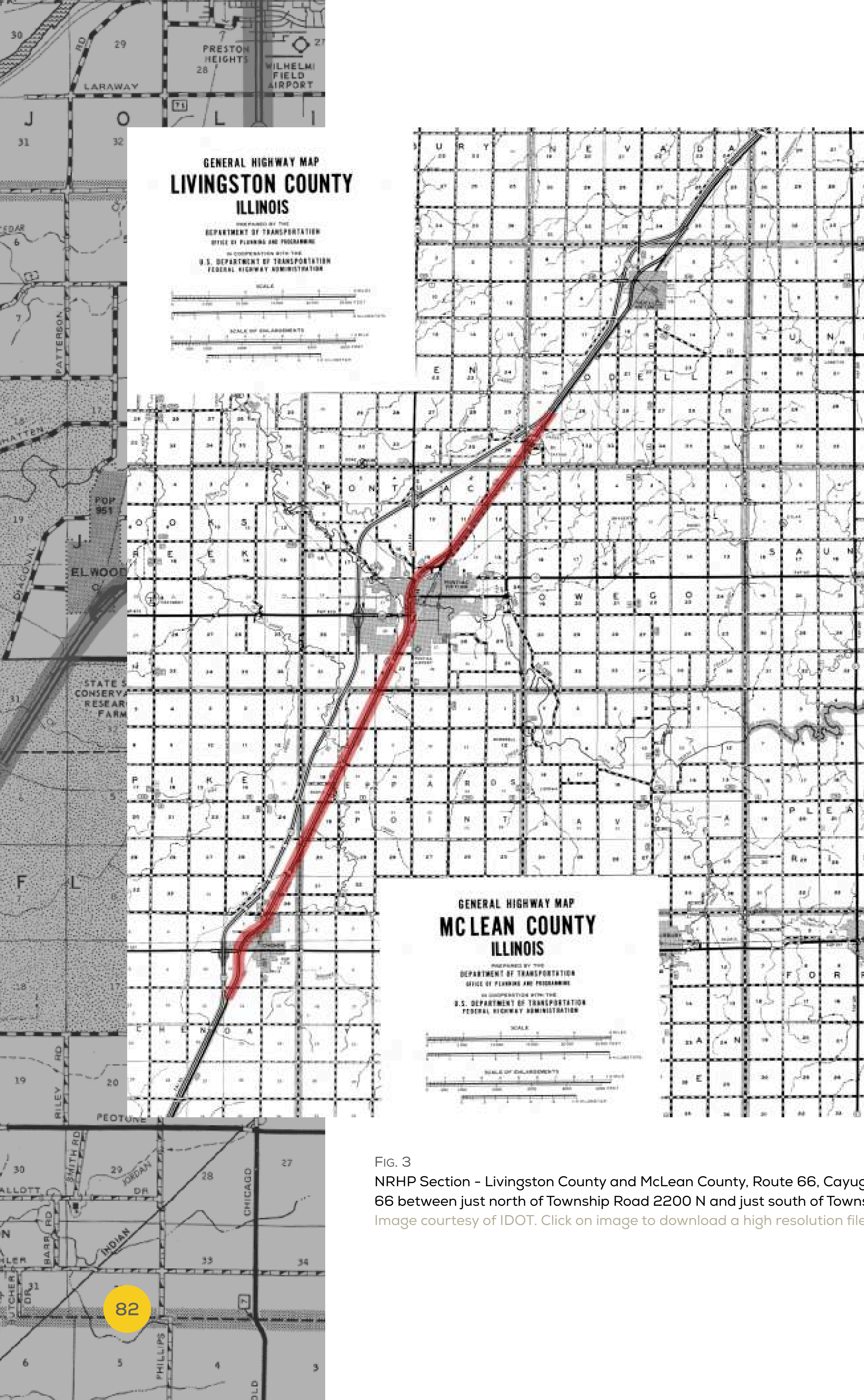

Fig. 3

NRHP Section - Livingston County and McLean County, Route 66, Cayuga to Chenoa; Route 66 between just north of Township Road 2200 N and just south of Township Road 3000 N.

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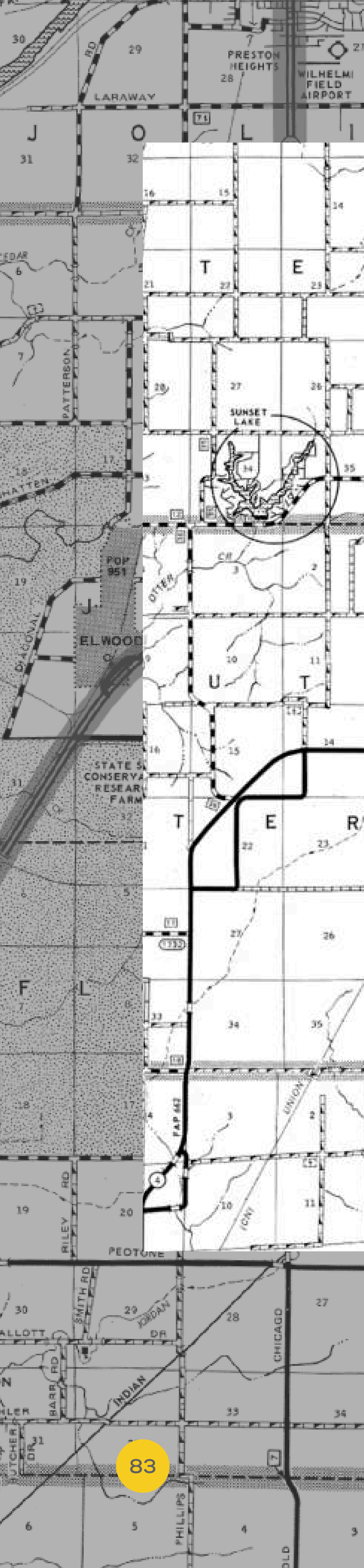
FIG. 4



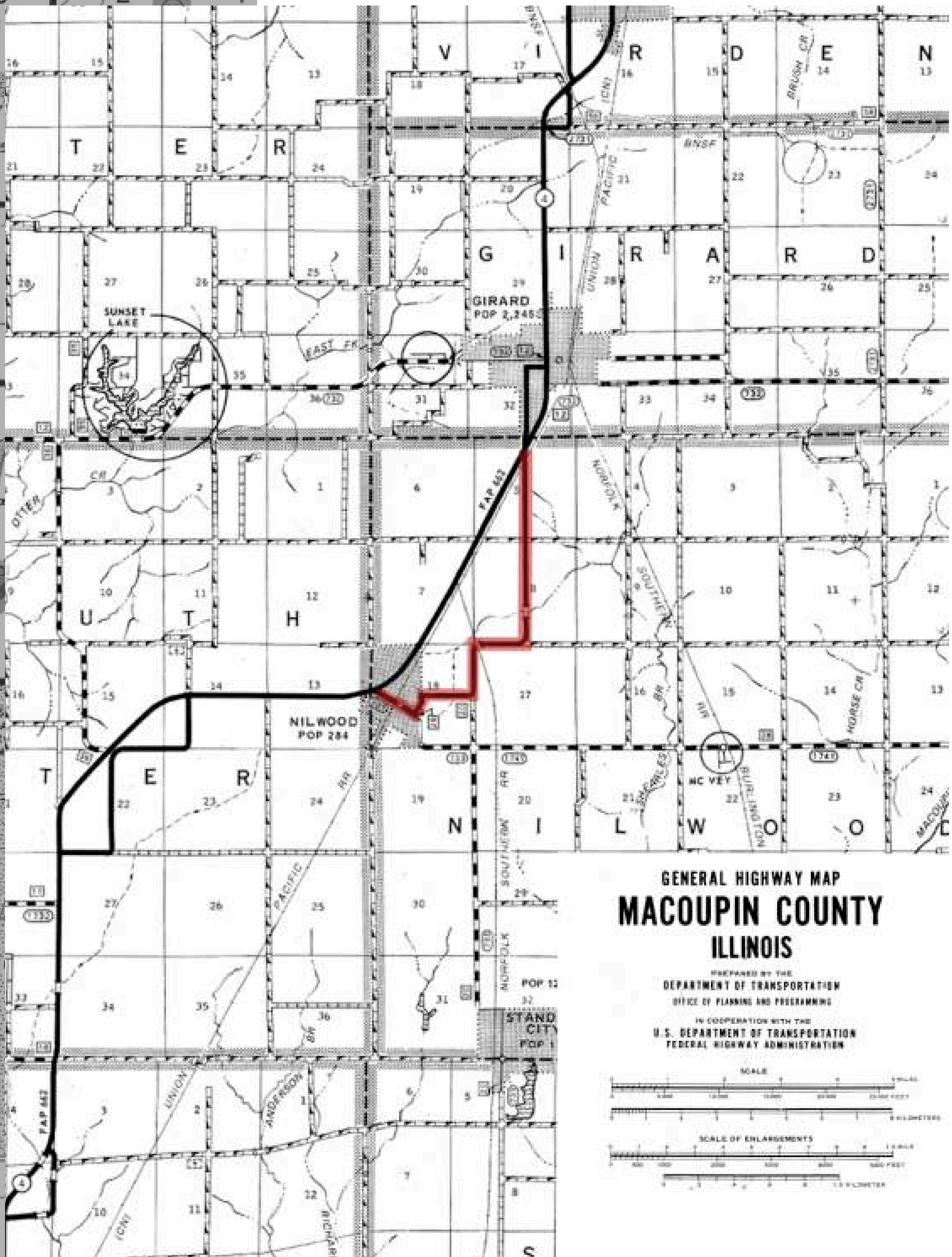


FIG. 4
NRHP Section - Macoupin County, Route 66, Girard to Nilwood; Route 66, between IL 4 south of Girard and IL 4.
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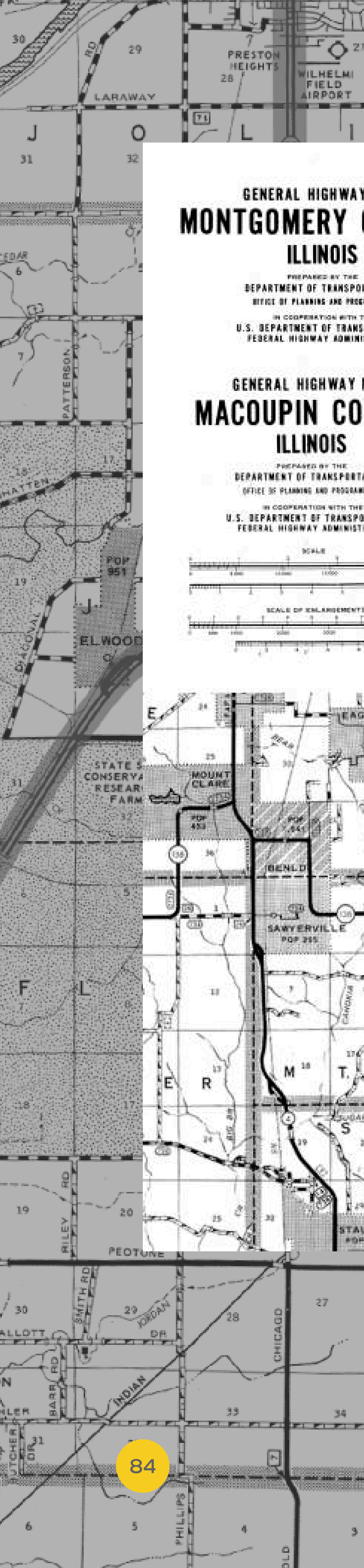

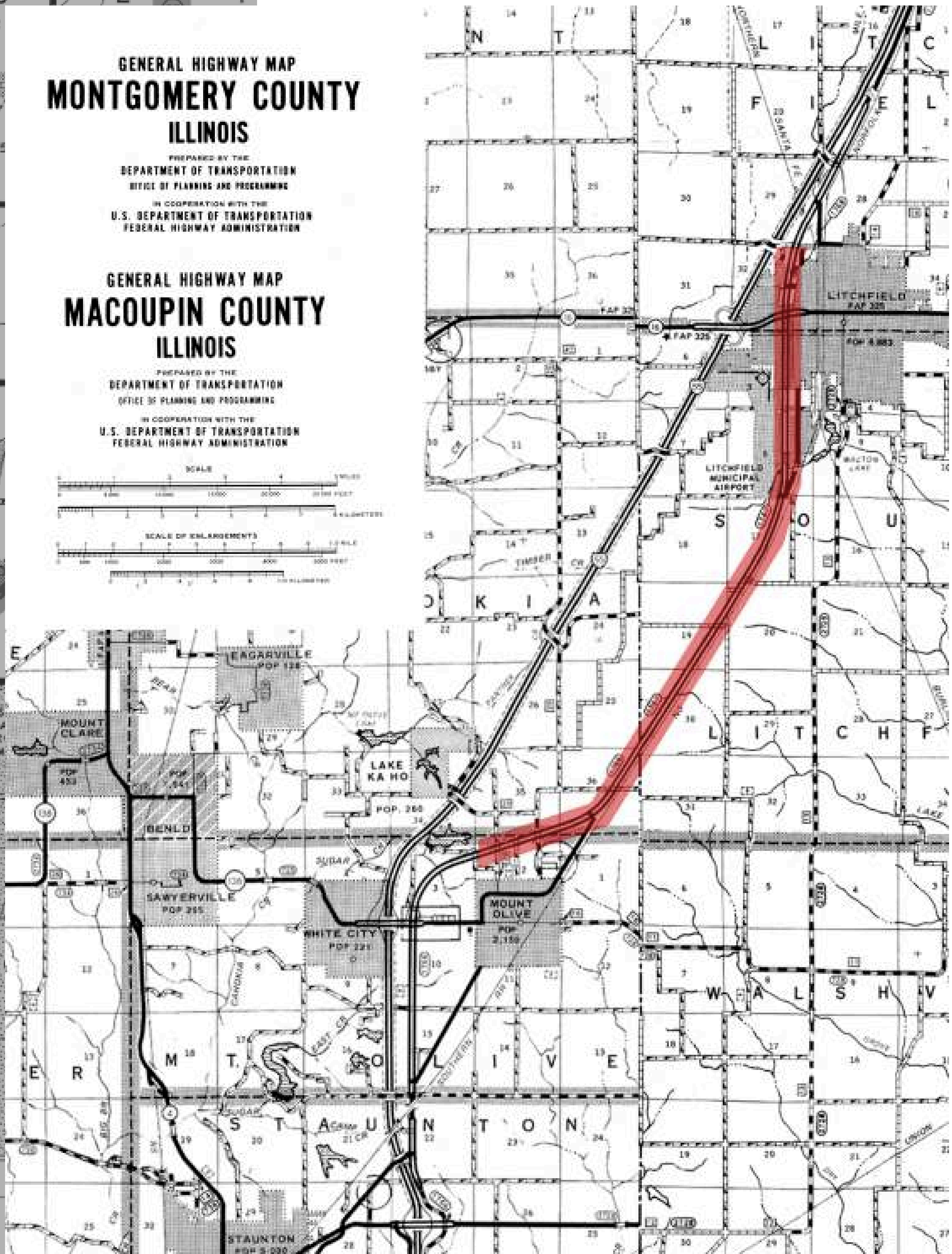

Fig. 5

Fig. 5

NRHP Section - Montgomery County and Macoupin County, Route 66, Litchfield to Mt. Olive; US 66, north of IL 16 in Litchfield to Mt. Olive.

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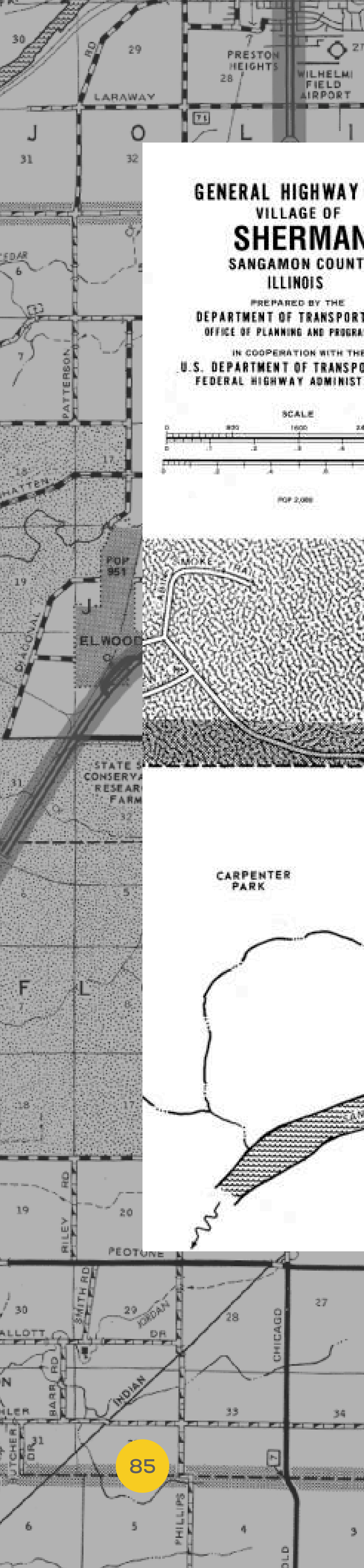
Fig. 6



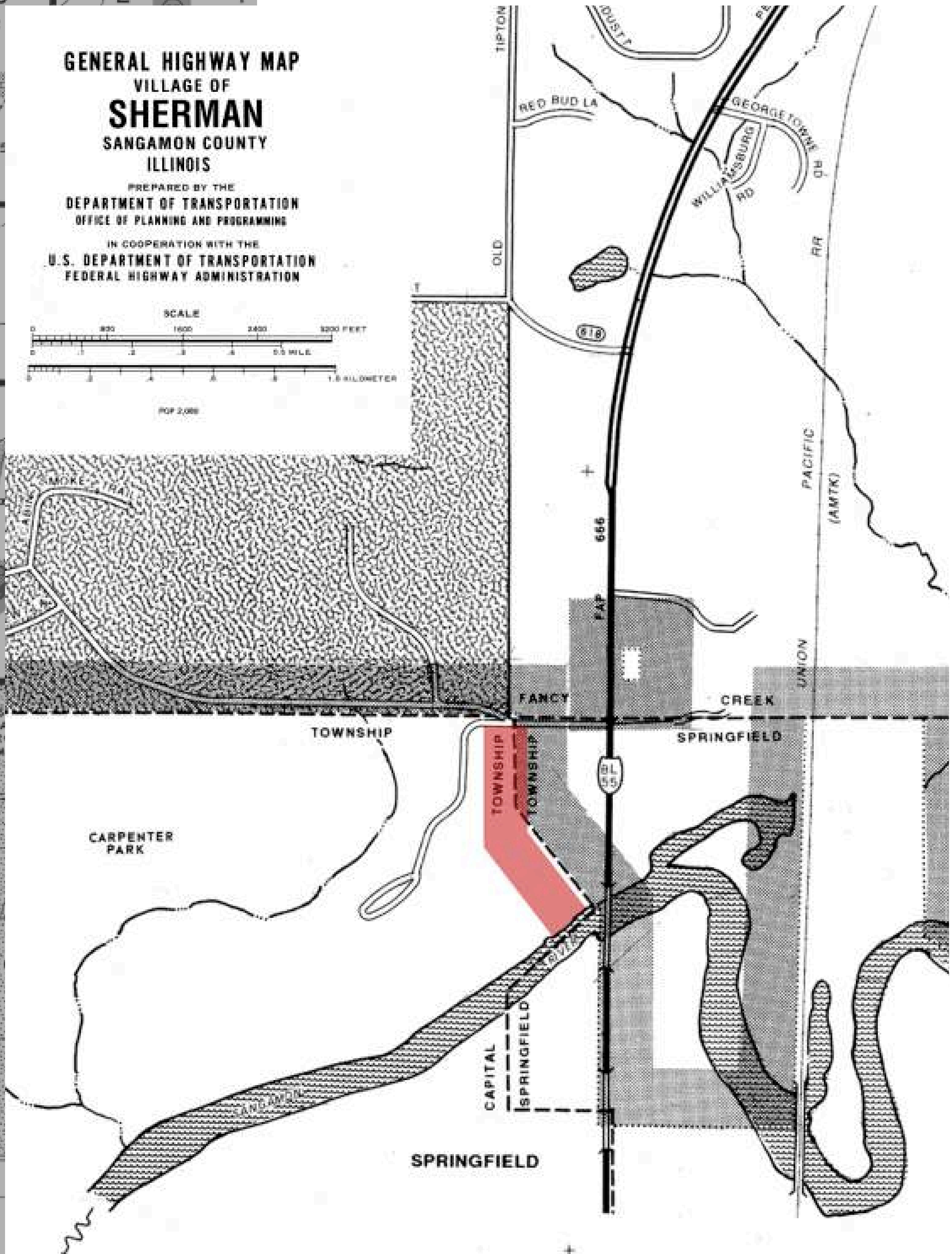


Fig. 6

NRHP Section - Sangamon County, Sherman, Route 66 by Carpenter Park; Old Route 66 between Cabin Smoke Trail and the north bank of the Sangamon River.

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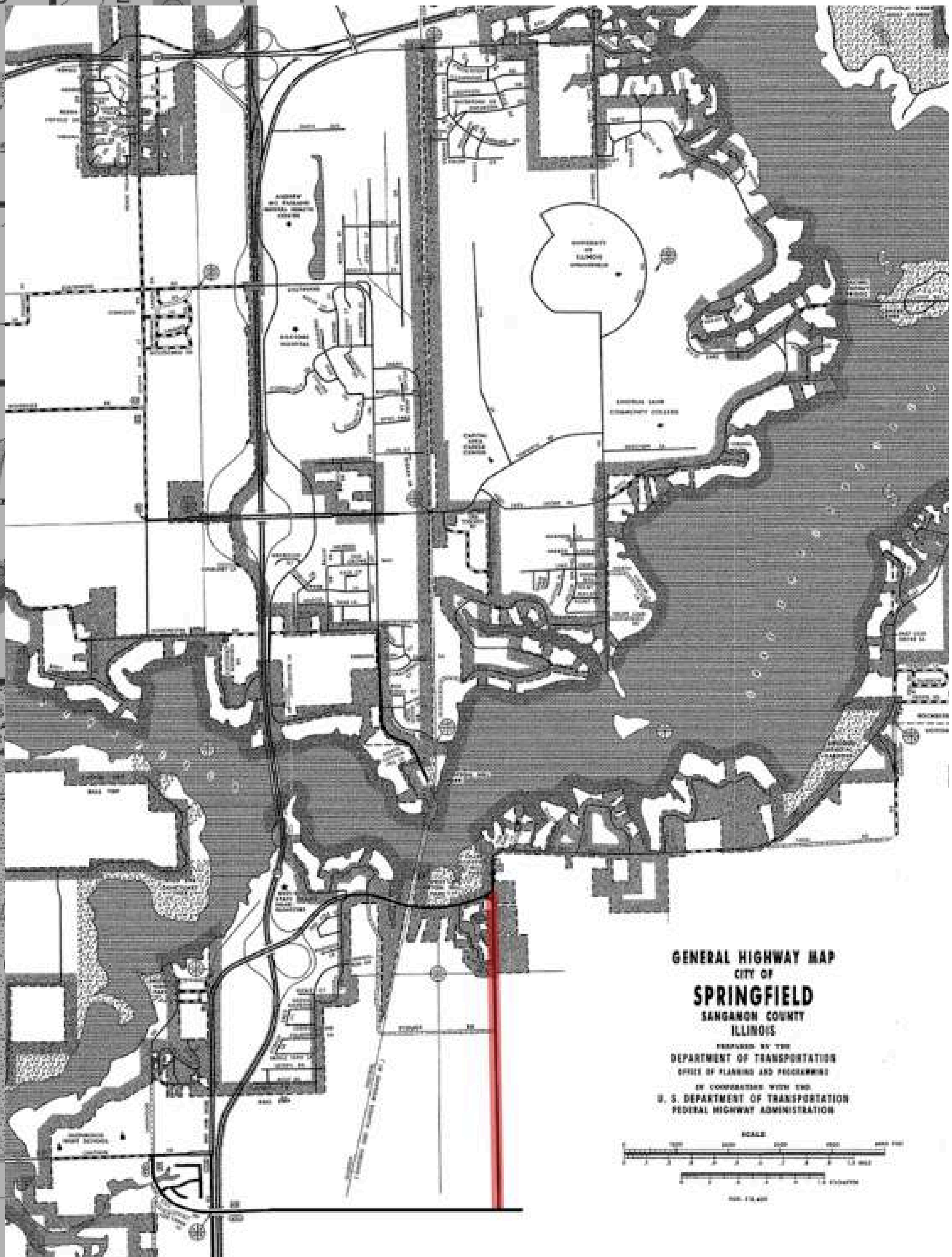

Fig. 7

Fig. 7
NRHP Section - Sangamon County, Springfield, Route 66, south of Lake Springfield; Olde Route 66/Carriage Way.
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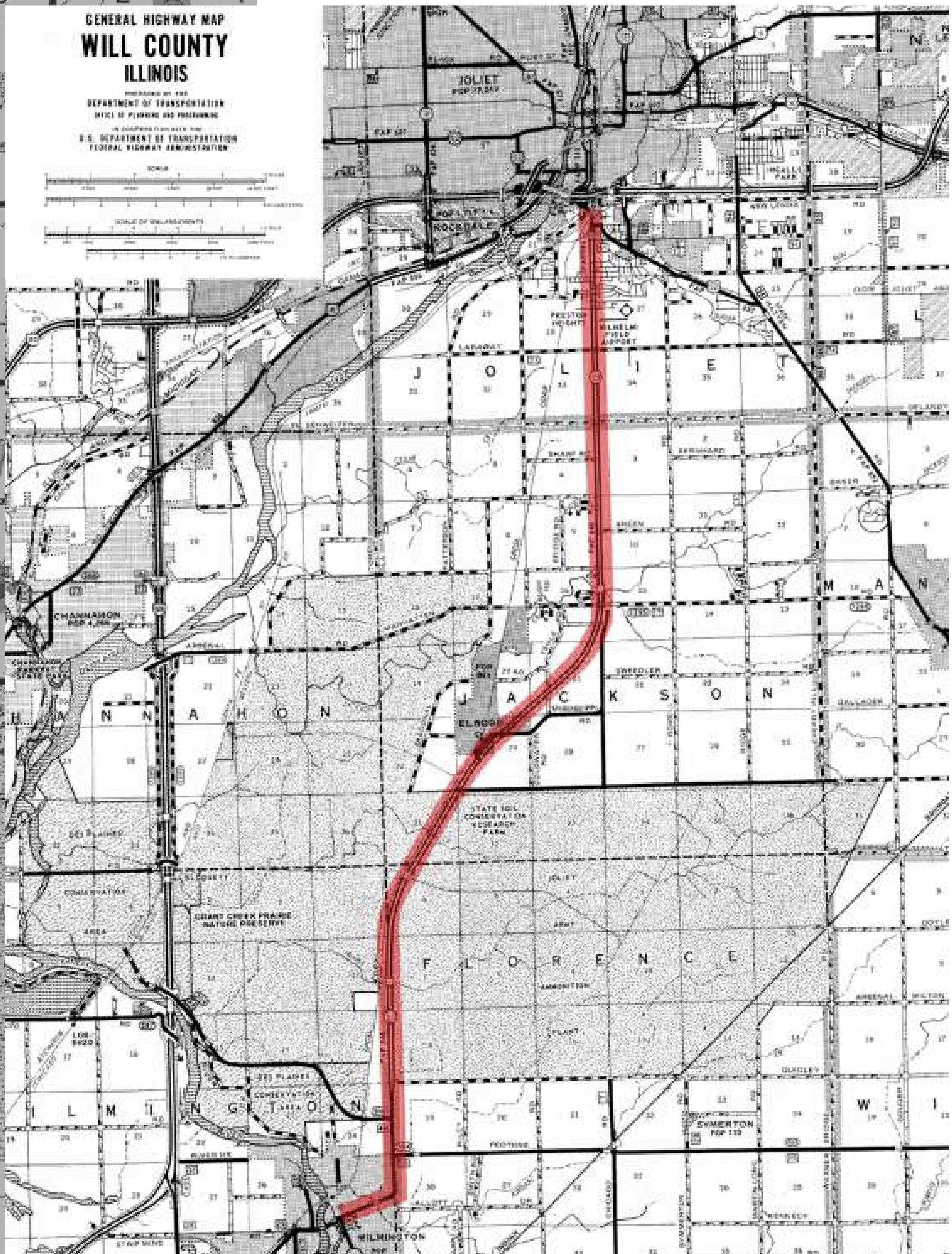

Fig. 8

NRHP Section - Will County, Alternate Route 66, Wilmington to Joliet; IL 53 between Wilmington and Joliet.

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Historic Auto Road Maps of Illinois

Fig. 1

Fig. 1
Illinois Auto Road Map, 1926.
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Fig. 2

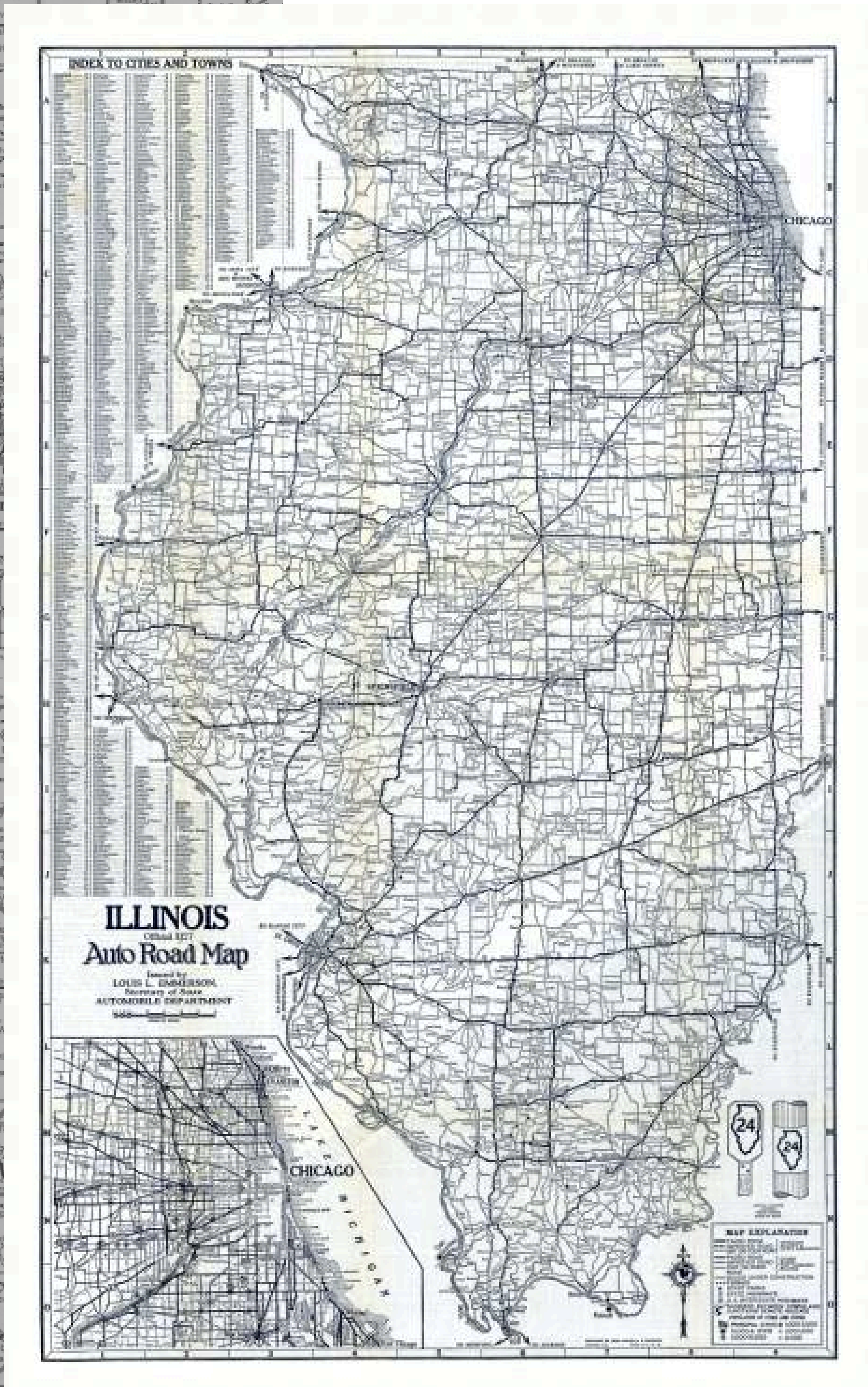

Fig. 2
Illinois Auto Road Map, 1927.
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Fig. 3

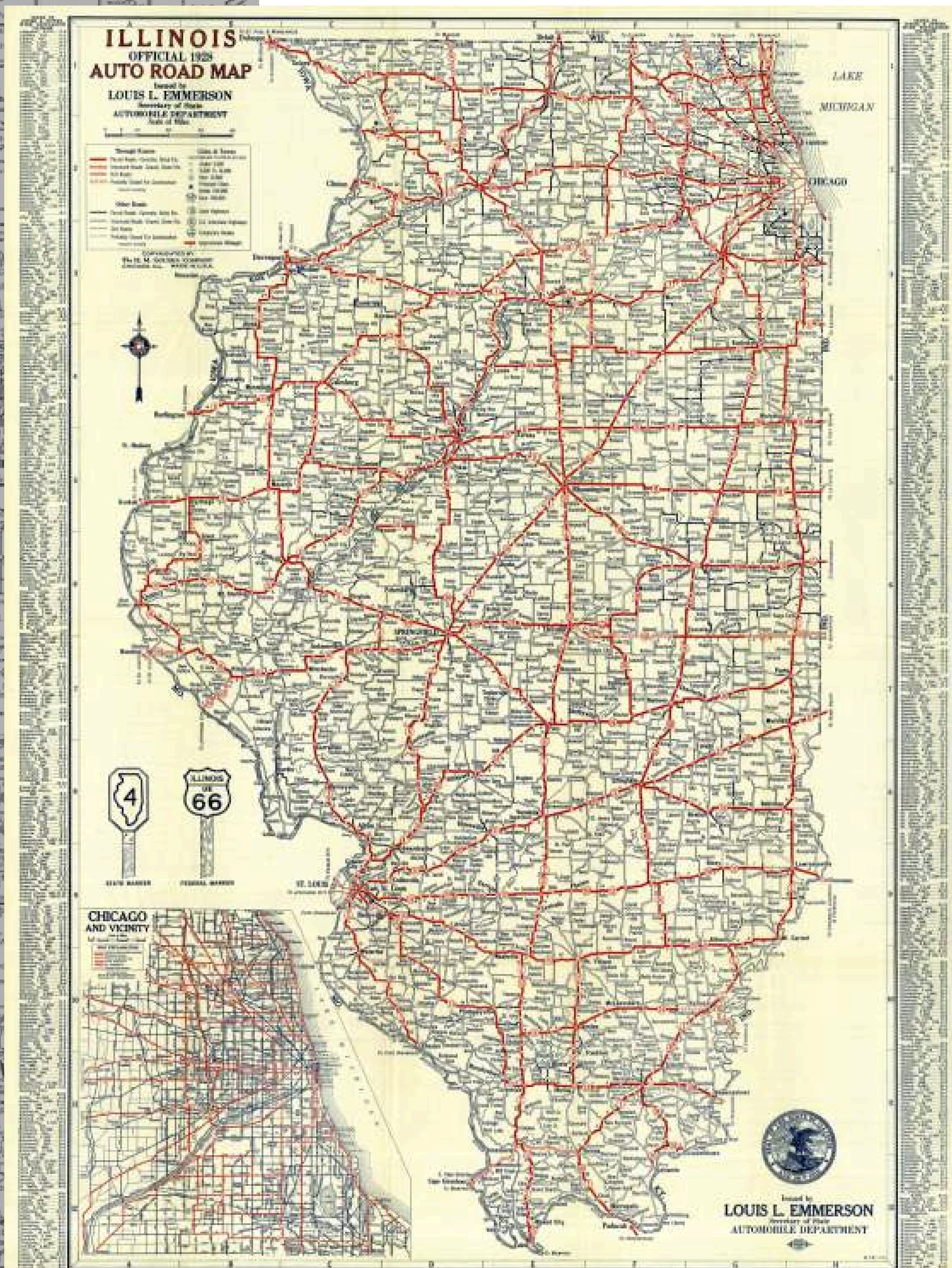

Fig. 3
Illinois Auto Road Map, 1928.
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Fig. 4

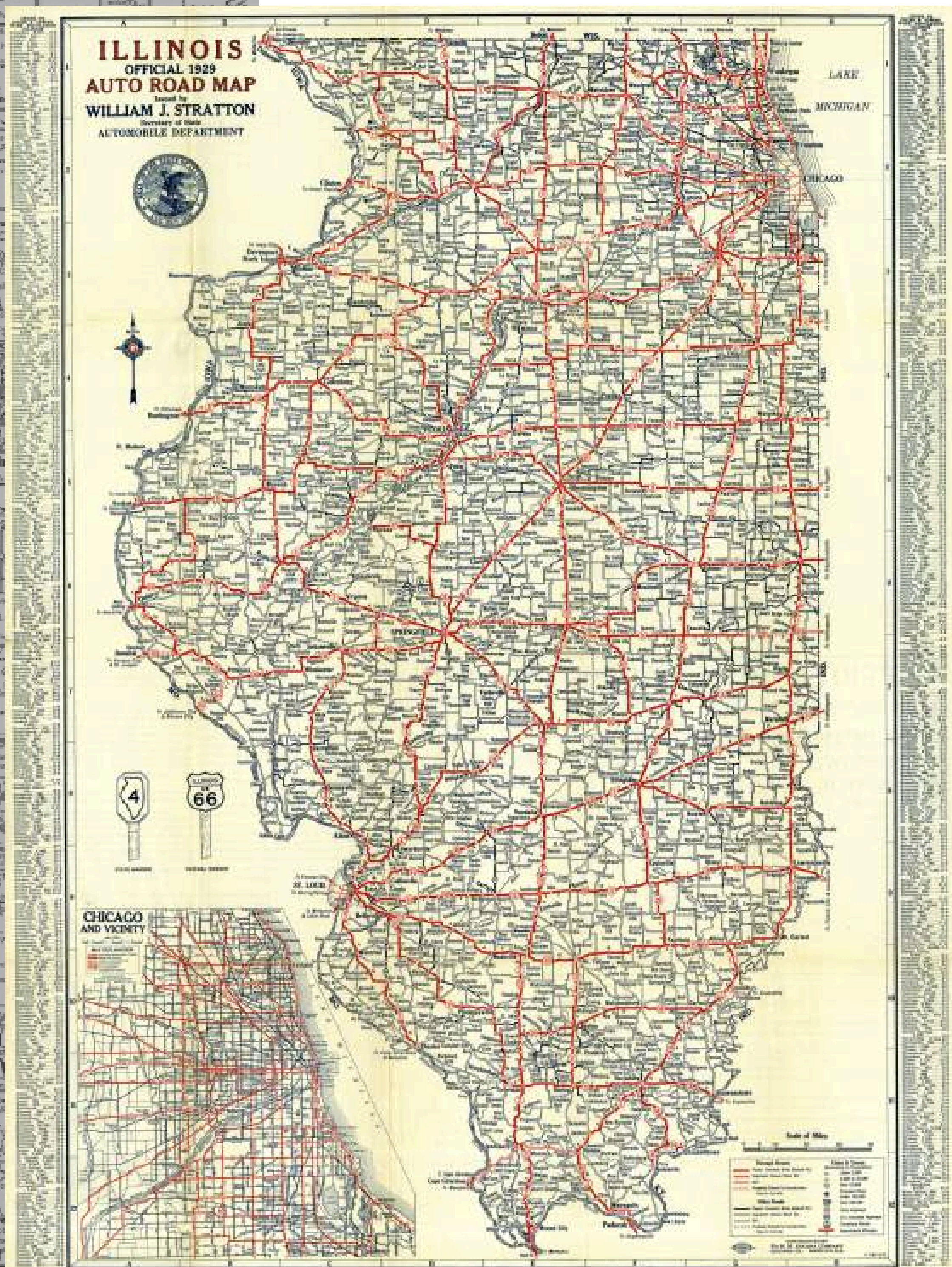

Fig. 4
Illinois Auto Road Map, 1929.
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FIG. 5

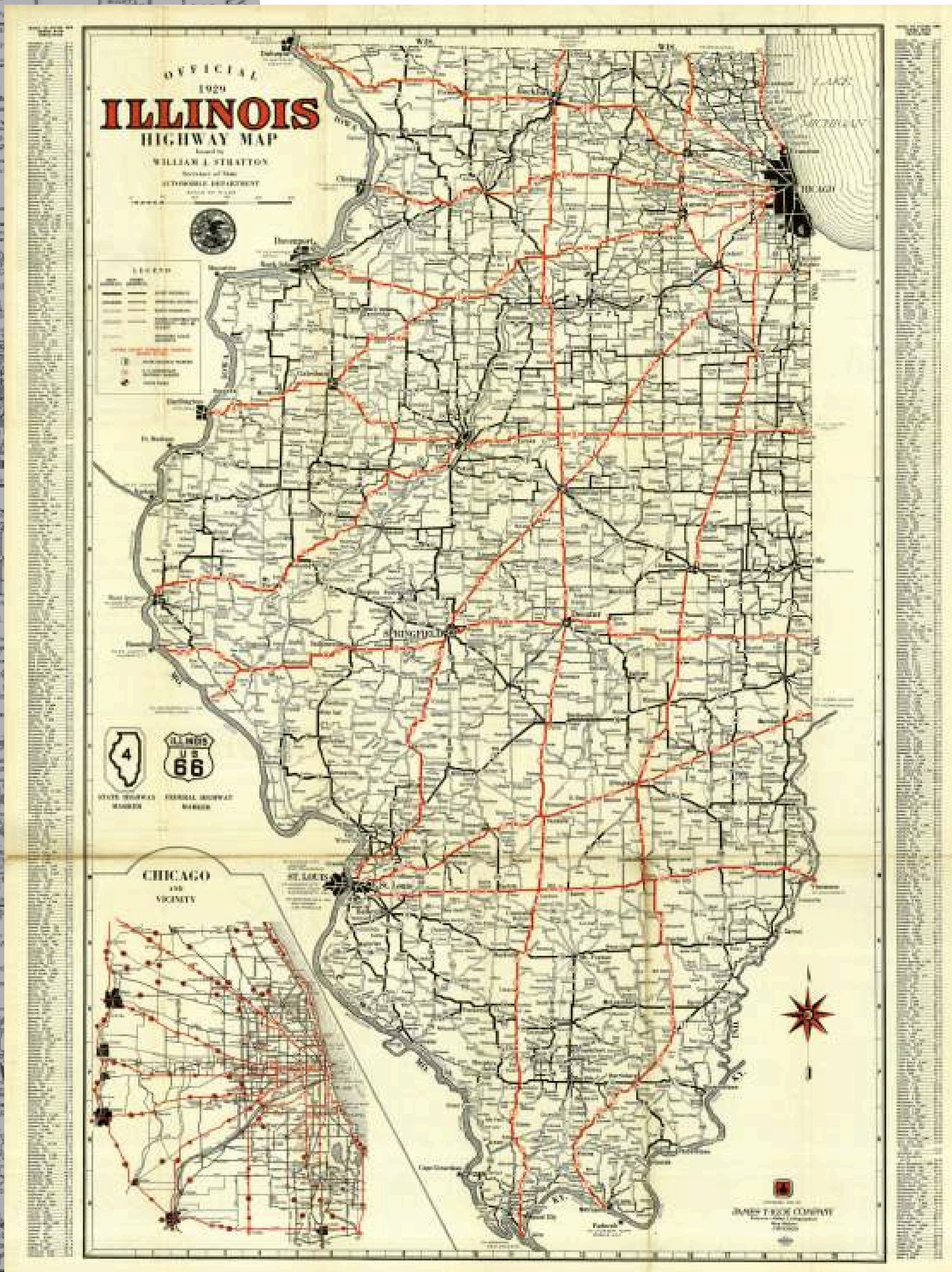

FIG. 5

Illinois Highway Map, 1929.

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Fig. 6

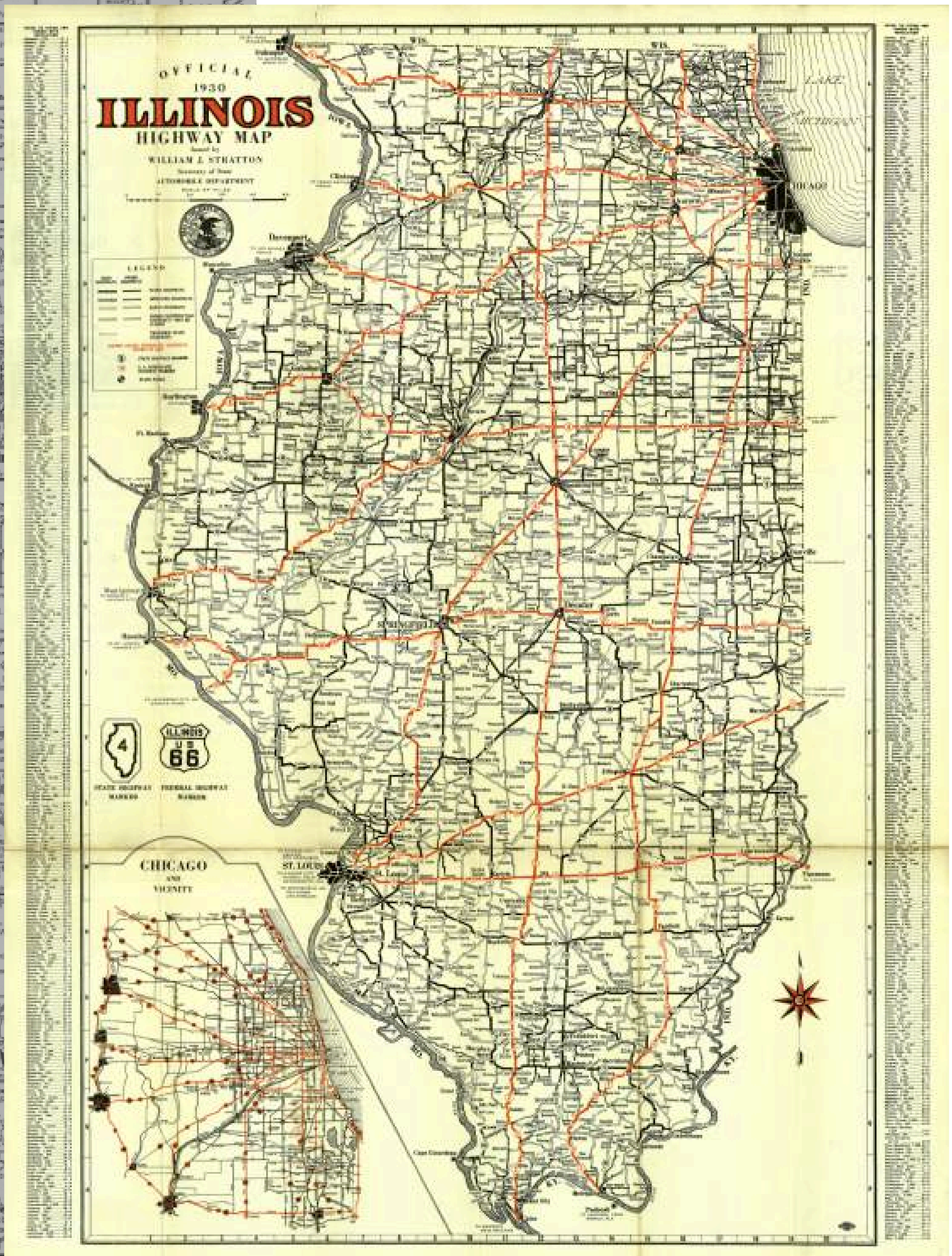

Fig. 6
Illinois Highway Map, 1930.
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Fig. 7

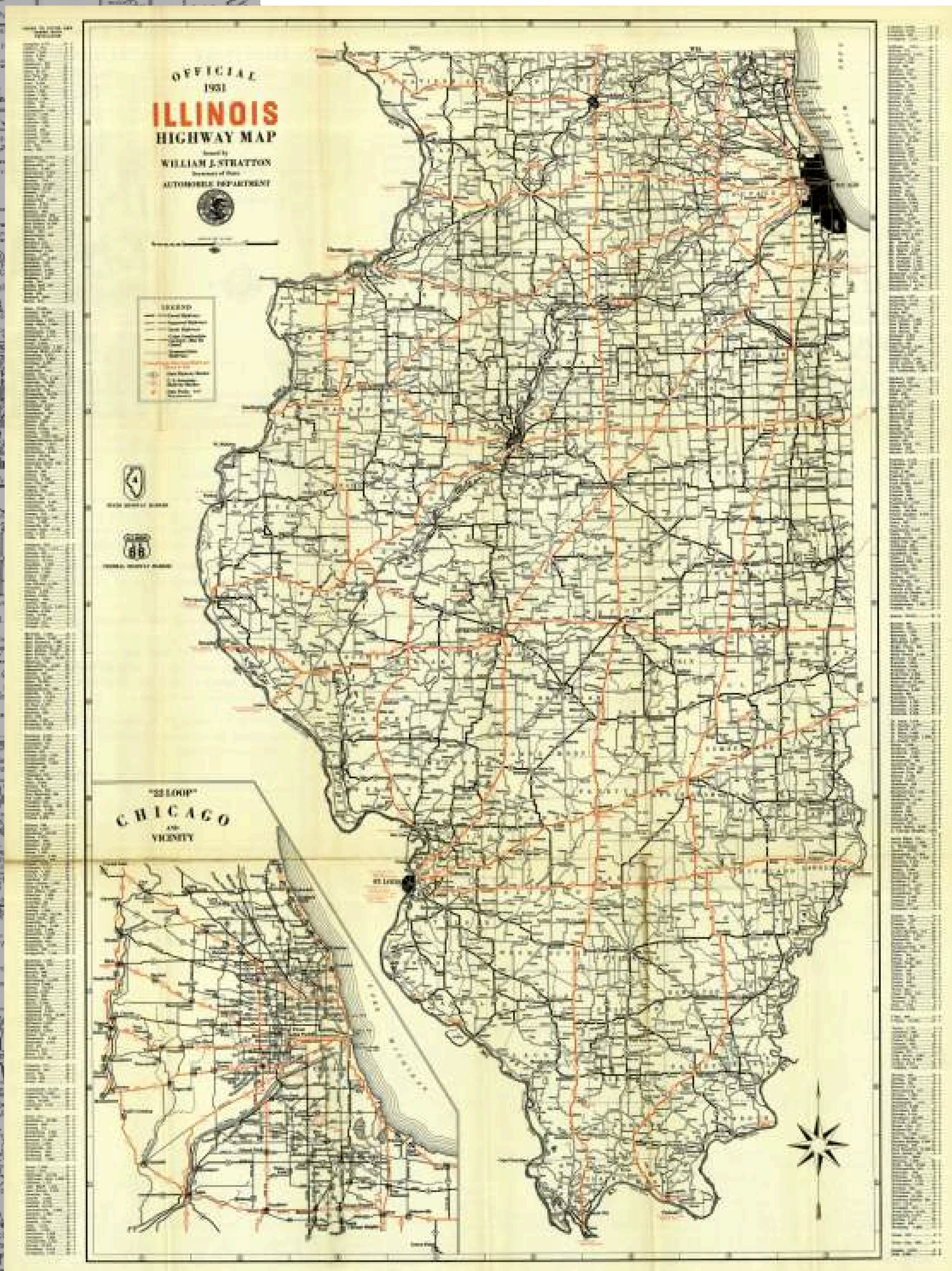

Fig. 7
Illinois Highway Map, 1931.
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Fig. 8

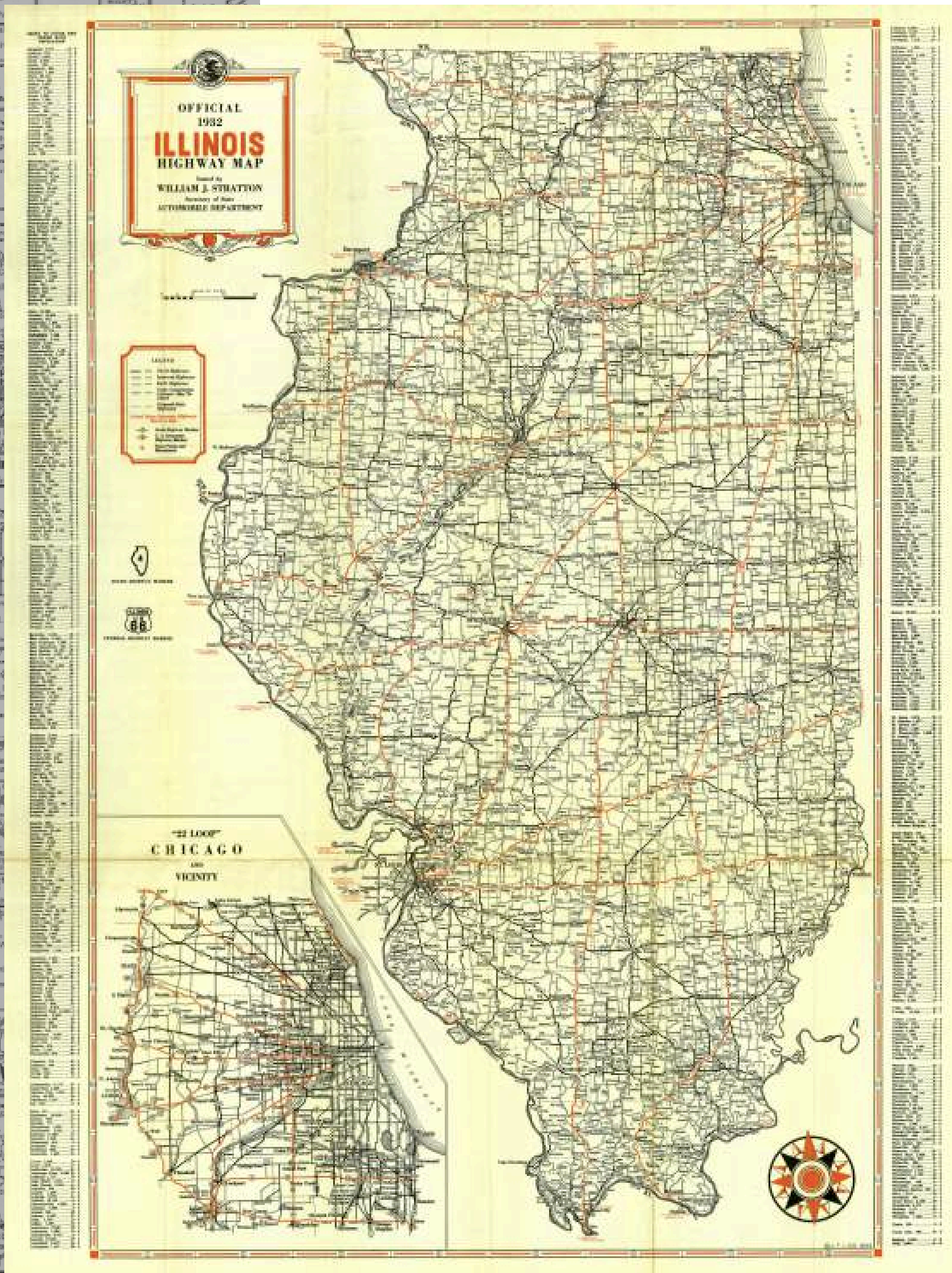

Fig. 8

Illinois Highway Map, 1932.

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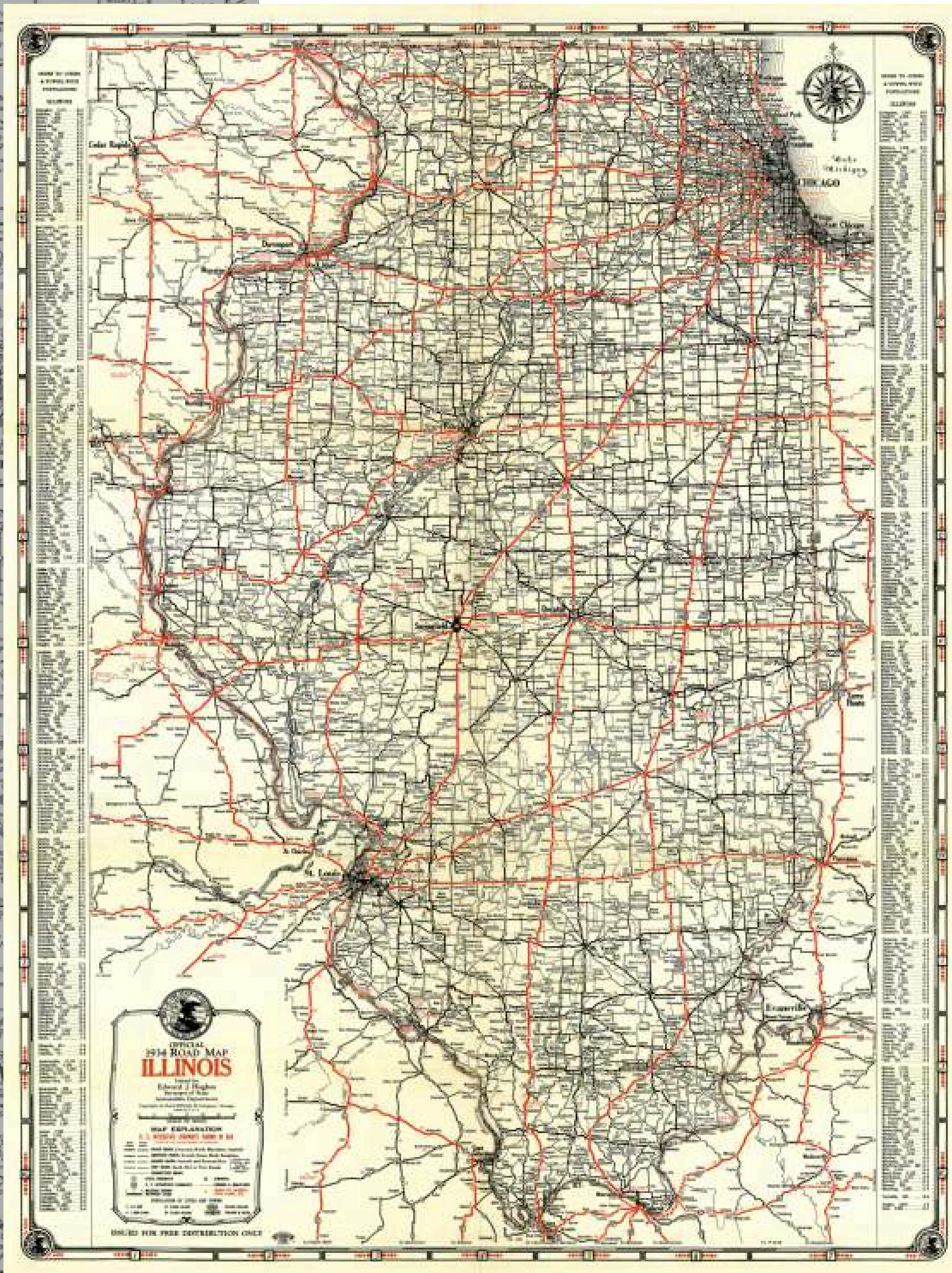

FIG. 9

Illinois Road Map, 1934.

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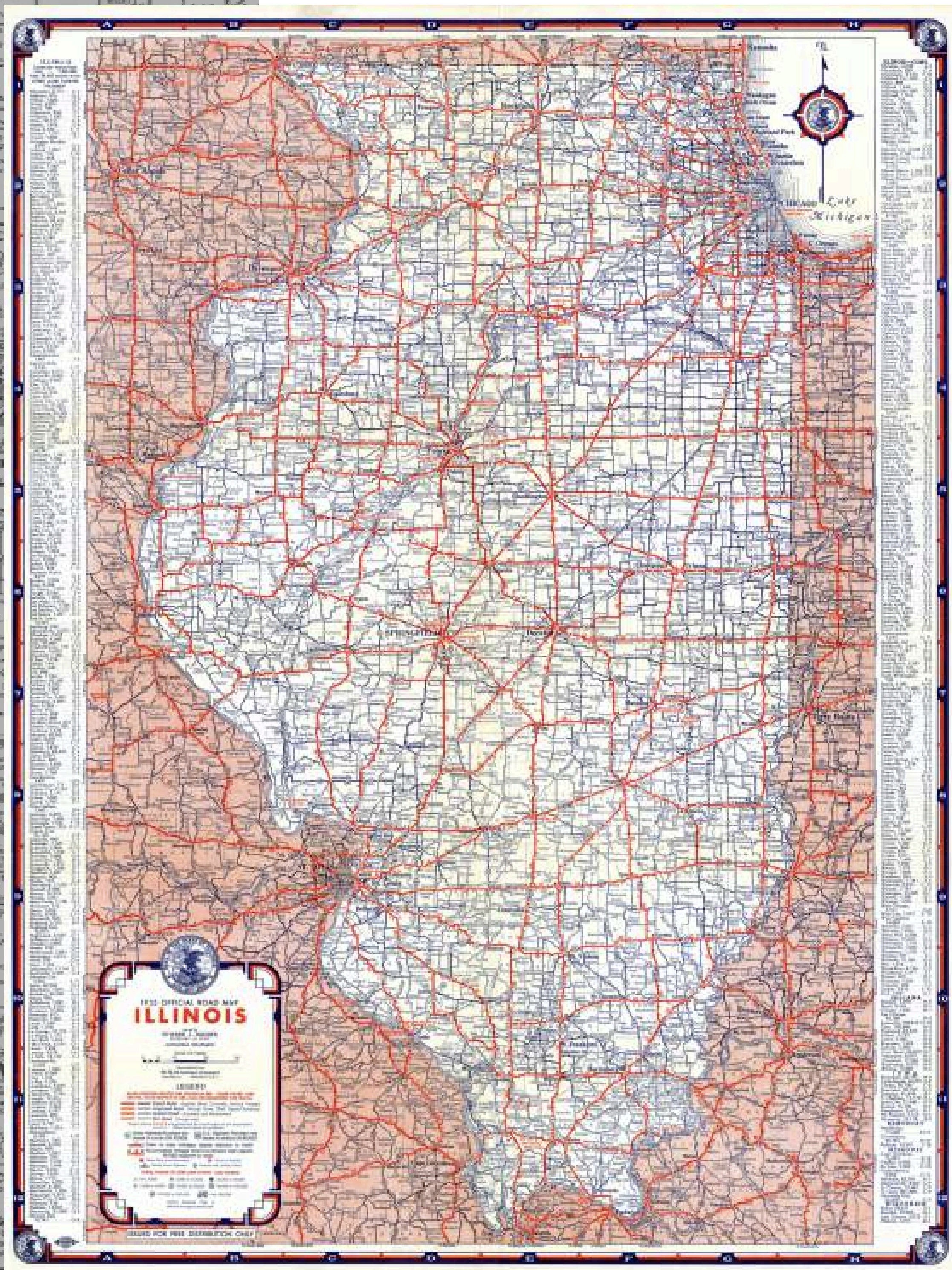

Fig. 10

Illinois Road Map, 1935

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FIG. 11

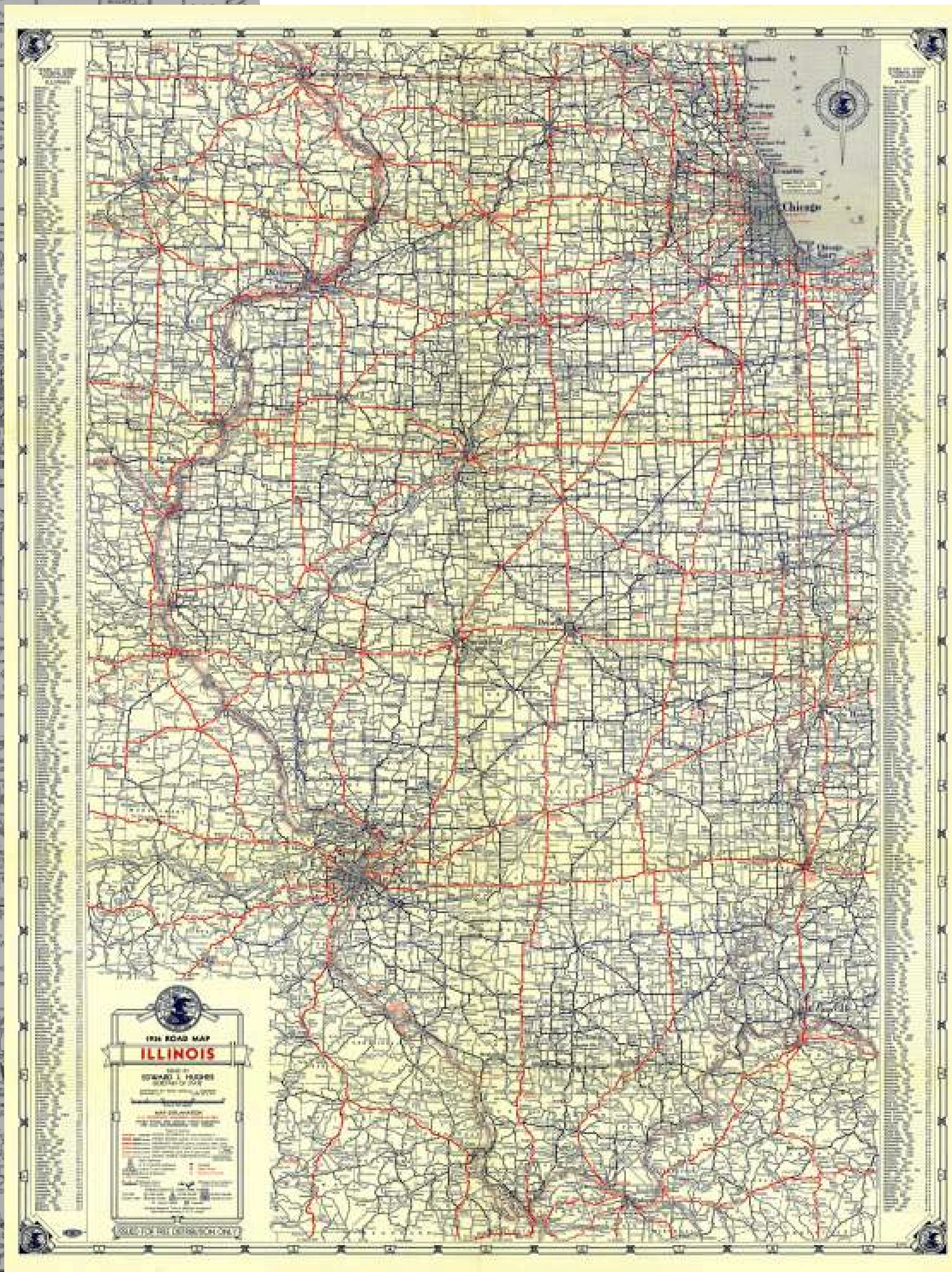

FIG. 11

Illinois Road Map, 1936.

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Fig. 12

Illinois Road Map, 1939-1940.

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Fig. 13

Illinois Road Map, 1940.

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FIG. 14

FIG. 14
Illinois Road Map, 1948.
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Illinois Route 66: Historic Concrete Treatment Guide

Thornton Tomasetti, Inc.

INTRODUCTION

BACKGROUND

THORNTON TOMASETTI, INC. (TT) WAS SOLICITED BY the Illinois Historic Preservation Agency (IHPA) to develop an historic concrete treatment guide and repair/restoration specifications for the limited remaining historic concrete roadway along Illinois' Route 66 corridor. As stated in IHPA's *Route 66: Finding Illinois' Original Roadbed Segments from Chicago to St. Louis* report, "In all of the research about US Route 66 throughout the United States, one area in particular has been left disengaged for the most part. That area consists of the original roadbed segments of US Route 66, which can still be found stretched along the Illinois landscape."

Of the over 300 miles (and closer to 400 miles if you include the areas where multiply roadways and realignments were developed) there is less than 60 miles of the historic concrete fabric that remains. Much of the original Route 66 has been covered with layers of asphalt or redeveloped into more modern highway systems. Table 1 (on page 6) lists those segments along Route 66 in Illinois that were found during a recent survey by Mr. Travis Ratermann (2009) for IHPA to be original concrete. The dates of this concrete ranges from the 1920s through the 1950s. The Illinois Department of Transportation (IDOT) created an overall map through Illinois showing these historic segments (see *Sections of Route 66 in Illinois listed on the National Register of Historic Places*).

To preserve the cultural resources of the Route 66 corridor and to authorize the US Secretary of the Interior to provide assistance, Public Law 106-45 was enacted by the 106th Congress on August 10, 1999. In response to the preceding law, Public Law 102-44, the Route 66 Study Act of 1990, the National Park Service (NPS) developed a *Special Resource Study for Route 66: Illinois, Missouri, Kansas, Oklahoma, Texas, New Mexico, Arizona, California.* This report points out that one of the primary preservation issues for Route 66 is that the route's "historical continuity has been destroyed; [and that] preservationists face a major challenge to preserve a 'living' highway as a historical route while allowing for normal change."

The goal of this report is to outline treatment options for the primary Route 66 roadway conditions observed in Illinois as guidance for preserving that which remains of the historic concrete roadways. This study was based on information received from IHPA, NPS, and IDOT. The level of preservation desired will need to be determined for each segment. It is not appropriate to use this guide as a directive for the entire corridor, but rather use this guide to help determine appropriate treatments for the site in question. For any repair or rehabilitation project, full project documents will need to be developed, including decisions for the roadway and mockups for matching the historic concrete.

ABOUT THE PROJECT TEAM

Ms. Amy Lamb Woods, P.E. is the primary author of this study. Ms. Woods has more than 15 years of experience in the field of historic preservation and forensic engineering of materials and construction systems. From the University of Illinois at Urbana-Champaign she holds a B.S. in Architectural Studies, an M.Arch with a focus on Historic Preservation, and an M.S. in Civil Engineering Building Materials. Her thesis, entitled "Parameters that Affect Cement Paste Color for Matching Replacement Concrete to Historic Concrete," researched aspects of matching historic concrete that had not been previously analyzed. This study is based on findings from her research and gives guidance for improving repairs and restoration work to match historic concrete in order to preserve the remaining Old Route 66 historic pavement segments.

Ms. Anne T. Sullivan, AIA served as team consultant to review the final report. Ms. Sullivan has more than 20 years of experience in the field of historic preservation architecture. She holds a B.A. Art History and a B.S. Architecture from the University of Illinois at Urbana-Champaign, and an M.S. in Historic Preservation from Columbia University, with a concentration in building material conservation. Ms. Sullivan is currently the Director of the M.S. Historic Preservation program at the School of the Art Institute of Chicago. She is a past recipient of the post-graduate Plym Traveling Fellowship from the University of Illinois for which she compiled a history of reinforced concrete. Anne has served as an appointed member of the Illinois Historic Sites Advisory Council, and is the recent past-President for the Association for Preservation Technology International.

Ms. Laura J. Powers served as project petrographer. Ms. Powers has more than 25 years of experience in the application of petrographic methods to the study of construction materials. She holds a B.S. in Geology from the University of Massachusetts-Amherst, and an M.Sc. in Geology from the University of Saskatchewan, Canada, with a focus on petrology (interpretive petrography).

Ms. Powers is past-President of the Society for Concrete Petrographers and is active on ASTM committee C09 Concrete and Concrete Aggregates. Ms. Powers has developed special expertise in the petrographic examination of historic construction materials and has published case studies of historic concrete.

Additionally, reviewers during the development of the study included the following: Ms. Anne Haaker and Mr. Mike Jackson of IHPA, Mr. Brad Koldehoff of IDOT Bureau of Design and Environment, and Ms. Kaisa Barthuli of NPS.

Material samples and concrete repair material information were provided by Holcim Incorporated, LaFarge North America, J.E. Tomes & Associates, Inc., and Ozinga Ready Mix Concrete, Inc.

DOCUMENT REVIEW

Critical documents reviewed for the development of the treatment options and specifications include the following:

- Route 66: Finding Illinois' Original Roadbed Segments from Chicago to St. Louis; *Illinois Historic Preservation Agency, 2011.*
- "Effect of Material Parameters on Color of Cementitious Pastes," Journal of ASTM International, Vol 4, No. 8, 2007.
- United States Public Law 106-45, 106th Congress, August 10, 1999.
- Route 66 Operational Guidelines, Prepared for the Illinois Department of Transportation, by Barton-Aschman Associates, Inc., October 1996.
- Special Resource Study, "Route 66: Illinois, Missouri, Kansas, Oklahoma, Texas, New Mexico, Arizona, California," National Park Service, July 1995.
- Illinois Department of Transportation, Partial sets of current standard pavement drawings and specifications.
- Standard Specifications for Road and Bridge Construction, State of Illinois Department of Public Works and Buildings, Division of Highways, Springfield, IL, January 2, 1952.
    - —Division III: Material Details
    - —Section 48: Portland Cement Concrete Pavement
- Standard Specifications for Road and Bridge Construction, State of Illinois Department of Public Works and Buildings, Division of Highways, Springfield, IL, July 1, 1942.
    - —Division III: Material Details
    - —Section 51: Portland Cement Concrete Pavement

- "Concrete Pavement Inspector's Manual," published by the Portland Cement Association, Chicago, IL, 1949.

SCOPE OF INVESTIGATION

This investigation and study included the following scope of services:

1. Review of available reports, drawings, and surveys for the Route 66 roadway.
2. On site observation of various roadway segments as determined and recommended by IHPA along the Illinois corridor near the following cities:
   - Pontiac
   - Atlanta
   - Springfield
   - Auburn
   - Nilwood
3. Procurement of cement and pozzolan samples from the following IDOT approved cementitious material suppliers:
   - Holcim Cement Plant, Sainte Genevieve, Missouri
   - LaFarge Cement (North America), Chicago, Illinois
4. Procurement of standard color samples from "buff" colored mix designs from a local ready-mix concrete company:
   - Ozinga
5. Review of two core samples taken by IDOT from historic roadway segments near the following cities:
   - Nilwood/Girard
   - Pontiac/Dwight
6. Review of the petrographic analysis laboratory report of the Nilwood/Girard and Pontiac/Dwight concrete core samples.
7. Comparison of the colors of the cement and pozzolan samples and ready-mix concrete color samples with core sample hardened paste color. Identification of the types of aggregates within the concrete samples for matching.
8. Discuss the availability of aggregates identified in the concrete core samples with local concrete ready-mix companies:
   - Ozinga
   - J.E. Tomes

OBSERVATIONS

VARIOUS ROUTE 66 ROADWAY SEGMENTS WERE VISITED, which were selected by IHPA to be representative of the typical conditions, near Pontiac, Atlanta, Springfield, Auburn, and Nilwood. Refer to *Appendix A – Report Figures* for photos referenced in this section. Up-close observations were made at locations where the concrete core samples were removed from the roadway.

ORIGINAL CONSTRUCTION

The Route 66 Operational Guidelines (Barton-Aschman, 1996) illustrates the historic construction of pavement roadways during 1926, 1930, 1941, 1946, 1953, and 1962. During the 1920s and 1930s the pavement width was 18 to 20 feet depending on the traffic density and from the 1940s on the width varies from 20 to 24 feet. The 1926 pavement included 3/4-inch longitudinal reinforcing bars at the edges of the pavement and 1/2-inch transverse deformed reinforcing bars along the roadway crown in the center of the road. Standard pavement thickness was noted as 6-inches and in heavy traffic sections the thickness notes 7-inches. In the 1940s the pavement thickness is increased by an inch, respectively, and a greater amount of reinforcing steel is incorporated. In 1953 a sub-base was added, the pavement thickness increased to 10-inches, and longitudinal reinforcing was added. Aprons/shoulders on the sides of the road are illustrated in 1964.

CONCRETE ROADWAY CONDITIONS

The typical conditions of the concrete observed are categorized as defined below:

A. Original Concrete in Good Condition

- Overall concrete is in good condition with minor weathering and pitting of the surface (Figure 01).
- No control joints were included in the original design and transverse cracking exists every 14 to 20 feet on centers along the length of the roadway (Figure 02). In general, the width of the concrete road is 18 to 20 feet.
- Cracks are raveled along the edges and vary in width from 1/2-inch up to 2 to 3-inches. Cracks are generally in-filled with small aggregates and minor grass growth.
- Some minor patching observed includes the use of asphalt in areas where small spalls have occurred along the cracks (Figure 03).

B. Original Concrete in Fair Condition

- Similar to the "good condition" concrete, except with more cracking, including longitudinal cracking (Figure 04).
- Grass growing within the cracks is more prominent and the crack width range is larger (Figure 05).
- A greater amount of small spalling along the cracks has occurred.
- In many cases repairs have been completed periodically along the roadway. Patches range from partial width to full width; some are concrete and others are patched using asphalt, neither match the existing concrete (Figures 06 and 07).
- In some cases the patches have small spalls and cracking (Figure 08).

C. Original Concrete in Poor Condition

- Concrete in this condition has large quantities of multi-directional cracking along with spalling and pitting throughout. Limited portions of the "poor condition" concrete appear to be sound (Figures 09 and 10).
- In many cases a variety of patching has occurred, typically what would appear to be a temporary-type patch using asphalt. The patches have also cracked or debonded and contribute to an uneven surface condition.

TRAFFIC DENSITY

The density of typical traffic at areas where original concrete was observed are described below:

A. Little to No Traffic

- Typically the segments of Route 66 that remain with the original concrete are roadways that have limited traffic and often used by local traffic for farm access. In one case, near the city of Atlanta, the original concrete segment is used to access one residence/farm and has been overgrown with grass and trees beyond the driveway (Figure 11).
- Segments with low traffic vary in condition, but appear to have a reasonable width for the current load of traffic and use. Modifications to modernize these roads do not appear needed or critical.
- The condition of roads with little to no traffic varies. In some cases they appear well maintained and in others the road is in poor condition, specifically where turn around and intersections are located.

B. Heavy Traffic Use

- Although not common, some segments of the original concrete roadway, are located along a heavily used corridor. These segments of the roadway generally have inadequate width for the type and level of traffic. In one area south of Lake Springfield, the road is heavily used, not only by cars, but by school buses and trucks regularly (Figure 12).

- Areas with heavy traffic use seem to struggle with details for increasing the width of the road. In the roadway segment noted above, asphalt has been added to the apron of the road to help give a little more width for passing traffic.
- The condition of the roads in heavy traffic areas appear to be in good to fair condition with repairs throughout. The types of repairs vary, but it appears that asphalt is added regularly to spalls and cracks.

ASPHALT OVERLAYS

Segments of the historic Route 66 roadway with an asphalt overlay are outside of the scope of this project. These segments are described below to note locations where asphalt has typically been added for information purposes.

A. Railway Intersection with Asphalt Transition Slope

- At locations where railway lines cross the roadway, asphalt has been used where elevation transitions occur (Figure 13).

B. Original Concrete with Asphalt Overlay

- Asphalt overlays have been added to a substantial amount of the historic roadways to maintain a smooth driving surface for moderate to heavy traffic load. The most extensive overlay area is the frontage road adjacent to IL I-55 Highway where a parallel two-lane road was constructed in the 1940s adjacent to the two-lane road from 1927 to create a four-lane divided highway. Currently, the 1927 lanes are abandoned and the 1942 lanes are in use as a two-lane highway (Figure 14).

ROADWAY APRONS

The types of existing aprons along the edges of the Route 66 roadway vary throughout the State. Roadway edge aprons observed include the following: grass, gravel, asphalt, and concrete (Figures 15 through 18). On rural roads with little traffic, grass up to the roadway was observed. In cases where heavy traffic exists, an asphalt apron has been added to provide a level surface and to widen the available lane space. The aprons in these locations are a large part of the visual view of the roadway. It is unknown what aprons are original and if there were earlier designs prior to 1962 that were constructed. In general, aprons are a way to create safe driving widths for modern traffic needs without needing to repave or replace the roadway.

CONCRETE CORE SAMPLES

Observations and information summarized from the petrographic analysis are included here. For the full laboratory report, refer to *Appendix B – Concrete Petrographic Analysis.*

A. Circa 1927 Concrete

A total of six concrete cores were removed from two separate locations, one set near Nilwood/Girard (Core 1 A, B, and C) and the other near Pontiac/Dwight (Core 2 A, B, and C). One set (set A) was sent to the laboratory, while set B was used for visual observation. Set C was taken for use by IDOT.

- Core 1: The concrete core samples taken from a segment near Nilwood/Girard is considered to be some of the earliest concrete used along Illinois' Route 66, which was placed circa 1927. This portion of the roadway is used as a country road (Cambridge Road) where the original concrete has been retained. Figure 19 illustrates the location where the cores were removed.
- Core 2: The concrete core samples taken from a segment near Pontiac/Dwight is from the originally placed roadway circa 1927, which parallels the expansion roadway placed around 1942. In the 1940's, both roads were used as a combined four-lane divided highway. Now only the circa 1942 roadway is in operation as a two-lane road, and the two-lane portion from 1927 is abandoned. Both have been covered with asphalt. Figure 20 illustrates the location where the cores were removed.

Note: The exact dates of the roadways have not been confirmed, but in general the two cores represent two different portions of the historic Route 66 roadway and the materials used.

B. Core Observations

- Core 1 from Nilwood/Girard was full depth and 8-inches deep. The top surface was weathered exposed aggregate surface. Aggregates are angular and large (3/4 to 1-inch). (Figures 21 and 22)
- Core 2 from Pontiac/Dwight was full depth and 10-inches deep, which included a 5-inch asphalt topping. The aggregates at the main and top portion of the core were rounded and medium (1/2 to 3/4-inch) and at the bottom rounded and large (3/4 to 1-1/2-inches). (Figures 23 and 24)

C. Petrographic Analysis (Summary)
Two cores were sent to a laboratory for petrographic analysis. The full illustrated report is included in *Appendix B – Concrete Petrographic Analysis.* The following table is a summary of the critical findings that are important for matching repair mixes with the original concrete.

The general color of both of the cores is a medium grey. Water-to-cement ratios are similar and reasonable for a typical road strength mixture of 3,500 to 4,000 psi. The aggregates do not meet current IDOT gradation standards, but the general types of aggregate are common in Illinois. One of the cores has an angular limestone and the other core has rounded gravel. The sand in general should match most natural sands available in Illinois. Air entrainment admixtures were not available in the early part of the 20th century, so both cores have limited air content, which limits their freeze-thaw durability. Microcracking was observed in both cores, likely due to freeze-thaw damage. Where chert aggregates were present, alkali-silica reaction has occurred locally. Chert, and other reactive aggregates, are prohibited in modern concretes. The concretes were observed to be in otherwise good condition. The age of the cores has left the top surface weathered, which has exposed some of the coarse aggregates and sand particles.

Table 2. Concrete material components from petrographic analysis.

MATERIAL COMPONENT	CORE 1	CORE 2
Cement Paste Color	Medium grey	Medium grey
Cement Content	6.5 +/- 0.5 bags per cubic yard of concrete	6.5 +/- 0.5 bags per cubic yard of concrete
Aggregates[1]	Crushed limestone	Calcareous and siliceous gravel (some ASR[2])
Sand	Natural siliceous sand	Natural calcareous and siliceous sand
Water-to-Cement Ratio	0.38 to 0.45	0.35 to 0.40
Air-Void System	3.5% to 4.5%	2.5% to 3.5%

[1] *Aggregate types noted from the petrographic exam are to help understand the existing type at two locations, not intended to be used to specify aggregates for a new mix.*
[2] *Alkali-silica reaction (ASR) is a reaction that occurs over time in concrete between highly alkaline cement paste and reactive non-crystalline silica, which is found in many common aggregates.*

TREATMENT OPTIONS

IN GENERAL, TREATMENT OPTIONS APPROPRIATE FOR preserving the integrity of the Route 66 roadway would include repairs to the concrete where needed while retaining as much of the historic fabric as possible. The selection of a treatment option should be based upon the level of damage as well as the amount of use. Various options are given below that should be followed together with *The Secretary of the Interior's Standards.* Options are given for both the treatment of the concrete itself as well as treatment options for the roadway's apron (shoulder).

MAINTAIN

Where the current condition of the concrete is in good condition, the treatment should maintain the concrete in its current state and limit further damage. As previously discussed, concrete in "good" condition may have some transverse cracking along the segment, but little to no spalling or multi-directional cracking.

Treatment:

- Maintenance would include no concrete repairs.
- Remove weeds and growth within the cracks. Weeds and grass will encourage water to be retained in the joint and root growth, both of which can contribute to further crack damage.
- The transverse cracks that exist likely continue to move. These cracks vary in width, and should be filled and compacted with coarse sand and/or fine crushed gravel. To route and fill with a rigid repair mortar will not be a durable solution as the cracks will tend to re-crack. Filling the joints with compacted drainable sand/gravel will help to give stability within the void and minimize further raveling of the crack edges and deter additional damage.

CONCRETE REPAIRS

Concrete repairs range from maintaining with little to no treatment to removal and replacement of large sections of the concrete. The repair option that is least invasive should be selected. The following are concrete repair treatment options:

A. Small Repairs
Small repairs would be appropriate for concrete considered to be in fair condition and include localized areas of spalling and cracking. Patching repairs should be considered for both spalls and wide cracks. Wide cracks often are associated with small spalls at the edges of the cracks.

Treatment:

- Remove damaged areas of the concrete to partial depth; minimum of 4-inch, maximum 6-inch and verify that a minimum of 6-inch sound concrete remains below.
- Remove additional adjacent sound concrete to create rectilinear sections. Rectilinear sections should maintain a maximum of 2:1 length to width ratio and ideally 1:1. Removal of sound concrete should be limited as much as possible to create a durable repair while retaining as much of the sound concrete as possible. The size of the patch should be greater than one foot square.
- Install epoxy coated steel anchorage/dowels to bridge the existing concrete and new patch area as required.
- Install supplemental reinforcing within the patch (i.e. epoxy coated welded wire mesh) as required.
- Patch with a concrete repair mix that matches the original concrete in color and texture (refer to section *Matching Historic Concrete*).
- Finish the concrete to match the existing adjacent concrete finish.
- Install control or construction joints within the new patch areas as required.
- Cure the concrete repair using techniques that will not alter the color, texture, or sheen of the repair surface.

B. Medium to Large Repairs
Medium and large full depth repairs would be appropriate for concrete in poor condition with a large degree of spalling and multi-directional cracking. Patching repairs should include the half or full width of the roadway. The repair length would depend upon the extent of damage.

Treatment:

- Remove damage areas of the concrete to full depth and partial/half width (medium size repair) or full width of the road (large size repair).
- Remove additional adjacent good concrete to create rectilinear sections. Rectilinear sections should maintain a maximum of 2:1 length to width ratio and ideally 1:1. In general, these repairs would either be a "Large repair" - the full width of the road and a minimum length of half the width of the road, or

a “Medium repair” – half the width of the road and a length of similar dimension.
- Install epoxy coated steel anchorage/dowels to bridge the existing concrete and new patch area as required.
- Install supplemental steel reinforcing within the patch (i.e. epoxy coated deformed reinforcing bars) as required.
- Patching concrete repair mix to match the original concrete in color and texture (refer to section *Matching Historic Concrete*).
- Finish the concrete to match the existing adjacent concrete's finish.
- Install control or construction joints within the new patch areas as required.
- Cure the concrete repair using techniques that will not alter the color, texture, or sheen of the repair surface.

ROADWAY APRONS

The roadway aprons (shoulders) that exist vary throughout the extent of original roadway and are not always original. Asphalt has been added in areas, some are concrete, many just have gravel, and some are grown over with grass. The decision of what apron option is appropriate will depend on the stretch of roadway and the traffic density. It can either be made to match, or similarly match, the original to maintain the historic aesthetic view of the roadway or differ from the original to illustrate the alteration from the original, which would change the overall view experience. A design professional should be involved to make appropriate decisions for each roadway segment project to address safety and aesthetic concerns. The following are options for the treatment of the aprons along the concrete roadways:

A. Maintain Existing

If the current or original apron is appropriate for the current use of the road, the apron should not be altered. Retain the original appearance and materials.

Treatment:

- Keep grass and weeds trimmed back along roadway edge.
- Keep gravel confined to the apron area and add gravel as needed to maintain a level side transition from the concrete roadway to the adjacent roadside.

B. Repair

Where the roadway side aprons have been damaged, repair as required to match the existing.

Treatment:
- Where a concrete apron exists, perform repairs similar to those given above for *Concrete Repairs.*
- Where asphalt has previously been added, maintain the asphalt apron and make repairs as required to prevent cracking and spalling. Asphalt aprons should maintain a slope from the edge of the concrete roadway surface to the adjacent roadside.

C. Alteration

Where the current configuration of the roadway is not adequate for a heavier traffic use it may be necessary to alter the apron size and/or material. The most common occurrence would be when the original concrete road is narrow and is used by buses and trucks. Alterations to the aprons on the side of the road should be reversible, so that in the future if the traffic is reduced, it would be possible to remove the apron without damaging the original roadway.

Design options for new aprons:
- The added material to the side of the existing concrete roadway can be made of a material to match the existing roadway. This approach will widen the proportion of the original road, but will maintain a uniform material appearance (e.g. original concrete road with a matching concrete apron must be separated by a cold joint). This option allows the historic view of the roadway to be maintained while differentiating the old and new by the control joint.
- The added material to the side of the existing concrete roadway can be made of a material that does not match the existing roadway. This approach would allow for the original proportion of the road to be visually ascertained, but the material appearances of the overall roadway will be different (e.g. original concrete road with an asphalt apron).

Designs for alterations need to be reviewed by a design professional to ensure it creates safe roadway usage, is appropriate for the specific location, and sympathetic to the historic nature of the roadway and views.

MATCHING HISTORIC CONCRETE

GENERAL PARAMETERS IMPORTANT IN MATCHING historic concrete include matching the color, type, and size of the aggregates, the cement paste matrix (cementitious materials) color, proportions of the repair mix components, and the finish and texture of the weathered concrete. The strength and general concrete properties need to be compatible and not cause additional damage to the original concrete. In order to create repairs that are durable, the repair mix needs to meet current quality standards. Figure 25 illustrates differences in the existing surface finish at two different road segments.

AGGREGATES

The majority of the concrete utilized for remaining segments of Route 66 in Illinois dates from either the 1920s or the 1940s. Aggregates used in the 1920s do not meet modern criteria.

Aggregates not meeting current standards may lead to detrimental damage such as alkali-silica reaction within the concrete or high amounts of chert that tend to crack and create pop-outs in the concrete surfaces (Figure 26). Poor quality aggregates can affect the durability of the concrete. For Route 66 road repairs, aggregates meeting current ASTM and IDOT standards should be used. The overall type and shape of aggregate and sand can be generally matched, but should be properly graded and of a quality to be used with concrete (meeting ASTM C33). An attempt should be made to select the colors and shapes of aggregate that match the existing to a reasonable degree.

Although matching is important to the aesthetic of the surface, using quality aggregates is important for the long term durability of the repair area. Aggregates should not be chemically reactive. Grading of the aggregates is important to limit shrinkage and subsequent cracking of the repair material. Although the main body of the aggregates and cement matrix may not match exactly, the top surface can be finished to allow some of the aggregates to be exposed and should blend well with the existing weathered surface.

During this study, a local concrete ready-mix company was able to select aggregates that match to the two types of aggregates found in the two Route 66 concrete core samples. Their recommendations for aggregates include the following:

- For Core 1, the crushed limestone appears to be similar to the available

aggregate in size and color to the 'Vulcan McCook CM11' or 'MS/Hanson Thornton CM1101.' The fine aggregate would appear to be a 'FM01' or 'FM02' similar to the sand found in the Henry/Chilicothe/Galena regions in Illinois.
- For Core 2, the well graded 3/4-inch rounded uncrushed gravel appears similar to the aggregates produced by Meyer Algonquin. The fine aggregate may be material that was originally mined in the same location as the gravel since the color throughout is very constant.

Figures 27 and 28 illustrate the comparison of the aggregates from the core samples compared to current readily available similar aggregates.

CEMENTITIOUS PASTE MATRIX

Visually, although aggregates are exposed on the top of the weathered surface, the view from an automobile while driving is the significant element to the Route 66 we are trying to preserve. Currently the repairs are unsightly and draw one's focus to the asphalt or dark grey patches. Matching the color and hues of the existing concrete matrix will help to preserve the overall appearance of this historic roadway.

Based on the research summarized in the *Journal of ASTM International* article, “Effect of Material Parameters on Color of Cementitious Pastes,” it was found that the “cement[ious] powder had the greatest effect on cement paste color.” The primary element of focus will be to create new concrete mix design options that focus on matching the existing concrete paste color.

A. Cement Paste Matrix
The 1920s cementitious matrix for the Route 66 concrete would have likely only included cement without the addition of pozzolans or admixtures. However, the cement of the 1920s and its manufacture is different than the cements that are available today. In the first half of the 20th century cements were produced at much lower temperatures than today, which created 'buff' tones within the cement. Today, most cement is a cool grey or dark grey in color.

From the petrographic analysis, the interior body color of the cement paste matrix is described as “medium grey,” which can be interpreted differently depending on the observer. In looking at the core samples, the color can more specifically be described as a 'light to medium warm grey with buff tones.' The hardened cement paste will likely vary throughout the different roadway segments, but in general, this is a common color for concretes placed in the 1920s in Illinois.

In matching old concretes there are two primary options that can help to create a buff-toned paste color: 1) add minerals to the cement and 2) add pozzolans to the cement. Minerals are more stable now than even a decade ago, primarily because polymer admixtures are also included with the mix, but they can fade with ultra-violet light from the sun. Pozzolans are cementitious and reactive, similar to cement, thereby creating a chemical bond within the matrix. Polymer admixtures would not be needed with the latter. Polymers can give a different sheen and the appearance of the repair mix can bead off water and look different under wet conditions. Figure 29 illustrates five different samples of concrete using minerals to achieve various colors. For this study, we recommend the combination of cements and pozzolans to create a matching color without the use of polymer admixtures.

B. Cementitious Materials

Cementitious materials include various types of cement (Type I or Type I/II are most typical for this type of application) and pozzolans, which are typically fly ash, blast furnace slag, silica fume, or metakaolin. Each of these materials has varying colors that range from white to almost black. Even within each of the materials itself, its color can vary from batch to batch, location processed, etc. Because the colors of these cementitious materials vary so greatly, consistently matching and predicting the color can be difficult. Figure 30 illustrates the variety of colors of cements and pozzolans.

TT received cement and pozzolan samples from two cement plants that supply materials within the state of Illinois region. The following is a list of the cementitious materials and their general color attributes:

- Holcim Type I/II LA with limestone cement; medium grey
- Holcim Slag grade 100; white to off-white
- LaFarge Alpena Type I cement; medium-light grey
- LaFarge Pleasant Prairie Fly Ash; buff
- LaFarge Slag grade 100; white to off-white

Blending these materials at various proportions can give additional hues and tones. Figure 31 shows examples of a few mixtures. As an example, a buff colored Fly Ash, with a light Type I cement, and some off-white Slag can produce a "light buff-grey" color that mimics historic concrete from the 1920s. The difficulty with this is developing a concrete mix design that maintains the same color through the years. The specific proportions of the cementitious materials will need to be developed with mock-ups. And the materials themselves can vary based on supplier, region, and processing, so the match will need to be created for each roadway segment during the time of the repair work.

C. Hardened Cementitious Paste

The various materials that are used to create the concrete mix affect the color, other parameters are also important to consider when matching is important. The amount of water used, the temperature and weather during placement, curing procedures and duration, are a few of the factors during concreting practices that can affect the resultant color.

Ready-mix plants that produce colored concrete pay close attention to the ingredients and placement procedures when designing a mixture to match or create a particular color. Measuring the color for quality control helps to maintain consistent batches. Even with these quality control measures, the concrete color can change from batch to batch and day to day. The goal is to limit these factors and adjust accordingly as needed.

The petrographic analysis indicated that the water-to-cement ratio is in the range of 0.35 to 0.45. This is a reasonable amount of water to give adequate workability, while not high enough to encourage shrinkage and cracking. Consistently using the same amount of water can help to create a mix that is consistent for matching.

D. Air-Void System

According to the petrographic exam, the percent of air-voids were different for each of the cores (2.5-3.5% and 3.5-4.5%). Air entrainment admixtures were not used in the 1920s to help prevent freeze-thaw damage. In both samples, although typical for the time, the air content is low. With the repair mixtures, air entrainment should be included, especially on horizontal roadways in Illinois, where freeze-thaw damage can occur. An appropriate air content would be 6% plus/minus 1.5% to be effective. It is important that too much air is not included, as that can lead to low strength and damage as well. Air entrainment will not alter the color of the repair mix; at a minimum, small air voids may be visible on the surface, but will wear away over time.

TEXTURE AND FINISHING

Matching the materials is important, as is matching the surface finish. The current surface finish has been created with years of weathering and traffic. The cement paste has worn away and exposed the top surface of the sand and parts of the coarse aggregates. Additionally, dirt has built up on the surface. The new repair when in place will not match perfectly and should be expected to weather itself, but there are things that should be done so that the finish and texture match closely.

A. Finishing

Modern finishing techniques used, such as steel trowel or a rake finish, can differ greatly from the 'weathered slightly-exposed aggregate' finish. Figure 32 shows the difference between the historic weathered finish compared to an inappropriate (yet typical) new repair finish. Tools and techniques that allow the concrete to be finished with a durable top surface are critical; however, efforts should be taken to create a finish with a matching texture. Brooms and sponge screeds can achieve this level of weathering; mockups should be conducted to determine what works most successfully.

B. Surface Retarding Agent

Time and weathering will wear away the cement paste matrix from the top surface and expose some of the aggregates. This can also be performed during the finishing of the concrete or with the use of surface retarding agents. Caution should be taken to not excessively remove the cement paste, which helps to protect the new patch material and limit microfracturing and spalling.

C. Curing

Curing is important to the durability of the concrete. In the 1940s, curing was done by laying wet burlap cloth over the new concrete. Today concrete is often cured using curing compounds that are spray or roll applied, which can leave a milky or shiny finish. A traditional wet-cure method should be used to cure the fresh concrete so that the surface can match that of the existing original concrete.

D. Special Treatment

Some areas and segments along Old Route 66 should be left in place and not altered or repaired. An example of this is an area south of Nilwood where some alleged turkeys trotted in the fresh concrete in the 1920s (Figure 33). This area has been marked and signage added to signify this portion of the concrete. Treatment of this area should be restricted for the preservation of this special area.

DISCUSSIONS AND CONCLUSIONS

MATCHING MODERN MATERIALS TO EXISTING TRADITIONAL MATERIALS

MATERIALS USED IN THE FIRST HALF OF THE 20TH CENTURY do not meet current concrete standards. The technology for the original cement is no longer available, therefore a cementitious blend will need to be created that will closely match in color. Aggregates used originally are prone to reactions within the cementitious environment and are therefore prohibited for use in concrete today. Current standards regulate the types of aggregates used and limit reactive aggregates such as chert. The grading of the aggregates is also more regulated, so the very large aggregates will not be matched with repair mixes. Due to the restrictions on aggregates, the coloration is not as varied and more uniform.

Although modern material differences will limit the exact matching of the existing historic concrete, the overall look can be achieved. Per *The Secretary of the Interior's Standards,* new or replacement material should differ from the original in order that it not be confused with the original fabric. The cementitious blend using Type I cement (grey), blast furnace slag (white), and fly ash (buff), can create a very similar color to the existing and have similar wearing and weathering characteristics. Although not exact, the general type of aggregates and sands used originally can be matched and is common to the region. The combination of materials can be used in the restoration of the Old Route 66 roadway.

MODERN TECHNIQUES TO MATCH WEATHERED FINISH

Although originally the concrete would have been finished such that the cement paste would have covered most of the aggregates, weathering over time has worn away most of the paste and left the aggregates partially exposed. Restoration efforts need to use techniques to replicate the weathering so that both the existing concrete and the repair concrete can continue to weather in symphony. Accelerated weathering techniques can aid the repairs in creating a better match to the existing more quickly. If done properly, techniques such as "sponge" screeding can be used while the repair concrete is still fresh, which allows a slight amount the fresh cementitious paste to be removed from the top surface and reveal aggregates below. The level of pre-weathering will depend on the tool and abrasiveness used.

The color of the main body of the hardened cement paste should be matched. The top roadway surface has dirt building up that darkens the appearance. However, the dirt comes as goes during different seasons, rain, and snow. By matching the internal color, both the repair and existing surfaces can build up and lose dirt similarly and grow to match over time. It is not recommended that the patches match the soiled concrete surface; it should match the matrix, as matching the "dirty" surface will lead to a repair that is too dark.

REPAIR MOCK-UPS

By matching the aggregates, cementitious paste matrix color, and surface texture and finish, a new concrete repair mix can successfully be prepared to match closely with the existing original concrete. However, mock-ups should be developed to ensure the mix is appropriate for that particular segment of roadway. As discussed, materials can vary in color and available materials may vary regionally; in addition, segments of the roadway have been shown to differ. No one mix can be used throughout the state and be expected to match exactly. A repair mix could be developed that may match in many cases, but where it is historically important, the mix needs to be refined to match adjacent material as much as possible.

Cement paste hydration and curing of the concrete does affect the color at various ages. In general, the mix will lighten as it ages, and in the first month will change drastically compared to the remainder of its life. A minimum of fourteen days is necessary to allow the repair mix to cure, hydrate, and dry out prior to examining and comparing to the existing concrete. One month is a more desirable time to compare the repair area to the original. A general rule of thumb is that the repair area should be slightly darker than the original concrete to allow it to lighten as it ages. Dirt and wear will also contribute to the repair area blending better over time.

SAMPLE CONCRETE RESTORATION SPECIFICATION

In order to implement the recommendations for the repair and restoration of the Old Route 66 historic pavement segments, a sample guide specification has been developed; refer to *Appendix C – Sample Concrete Restoration Guide Specification.* On a project by project basis, this specification may need to be supplemented with repair detail drawings depending on the road configuration, assessed damage, and repair needs. The specification is general in nature to accommodate the various conditions. It is intended to be used in conjunction with IDOT standard regulations and any current codes and regulations as mandated by the Federal, State, or regional jurisdiction. A design professional will need to be involved with developing the project documents for the intended pavement segments to receive repair/restoration work.

LIMITATIONS AND SIGNATURE

THIS REPORT SHALL NOT BE CONSTRUED TO WARRANT or guarantee the project and/or any of its components under any circumstances. Thornton Tomasetti shall not be responsible for latent or hidden defects that may exist, nor shall it be inferred that all defects will have been either observed or recorded. Thornton Tomasetti's report and sample guide specifications shall not constitute a detailed specification for construction, permit documents or permit application.

Conditions noted in this report are as of the time of observations only. It can be expected that the subject roadway will undergo changes subsequent to that date.

TT reserves the right to supplement this report, and to expand or modify findings based on review of additional material that may become available.

Respectfully submitted,

THORNTON TOMASETTI, INC.

Amy Lamb Woods, P.E.
Senior Project Director

Appendix A

Report Figures

Fig. 1

Fig. 2

Fig. 1
Concrete in "good" condition (Girard, IL).

Fig. 2
Typical transverse cracking (Girard, IL).

FIG. 3

FIG. 4

FIG. 3
Small spall previously patched with asphalt (Girard, IL).

FIG. 4
Concrete in “fair” condition (south of Girard, IL).

Fig. 5

Fig. 6

Fig. 5
Wide crack with grass growing (south of Girard, IL).

Fig. 6
Wide crack and edge spalls patched with asphalt (south of Girard, IL).

Fig. 7

Fig. 8

Fig. 7
Large previous patch that does not match existing concrete (south of Girard, IL).

Fig. 8
Small spall at edge of patch and in existing concrete (south of Girard, IL).

FIG. 9

FIG. 10

FIG. 9
Concrete in “poor” condition with multi-directional cracking and previous asphalt patches with multi-directional cracking (Nilwood, IL).

FIG. 10
Concrete in “poor” condition with craze cracking and pop-outs throughout section (Nilwood, IL).

Fig. 11

Fig. 12

Fig. 11
Original concrete segment at a farm home driveway, which then disappears into the trees in the distance overgrown with grass (Atlanta, IL).

Fig. 12
Original concrete segment at a high traffic roadway (south of Lake Springfield, IL).

Fig. 13

Fig. 14

Fig. 13
Asphalt has been used to accommodate level changes at railroad crossings. Red arrow indicates where the asphalt ends and the original concrete continues (Nilwood, IL).

Fig. 14
Asphalt overlays have been applied to both the 1920s and the 1940s segments of roadway; circa 1927 roadway is now abandoned (Pontiac, IL).

Fig. 15

Fig. 16

Fig. 15
Grass apron along rural low traffic roadway (south of Nilwood, IL).

Fig. 16
Gravel apron along rural moderate traffic roadway (Girard, IL).

Fig. 17

Fig. 18

Fig. 17
Asphalt and gravel apron along suburban heavy traffic roadway (south of Lake Springfield, IL).

Fig. 18
Concrete apron along brick light traffic roadway (north of Auburn, IL).

Fig. 19

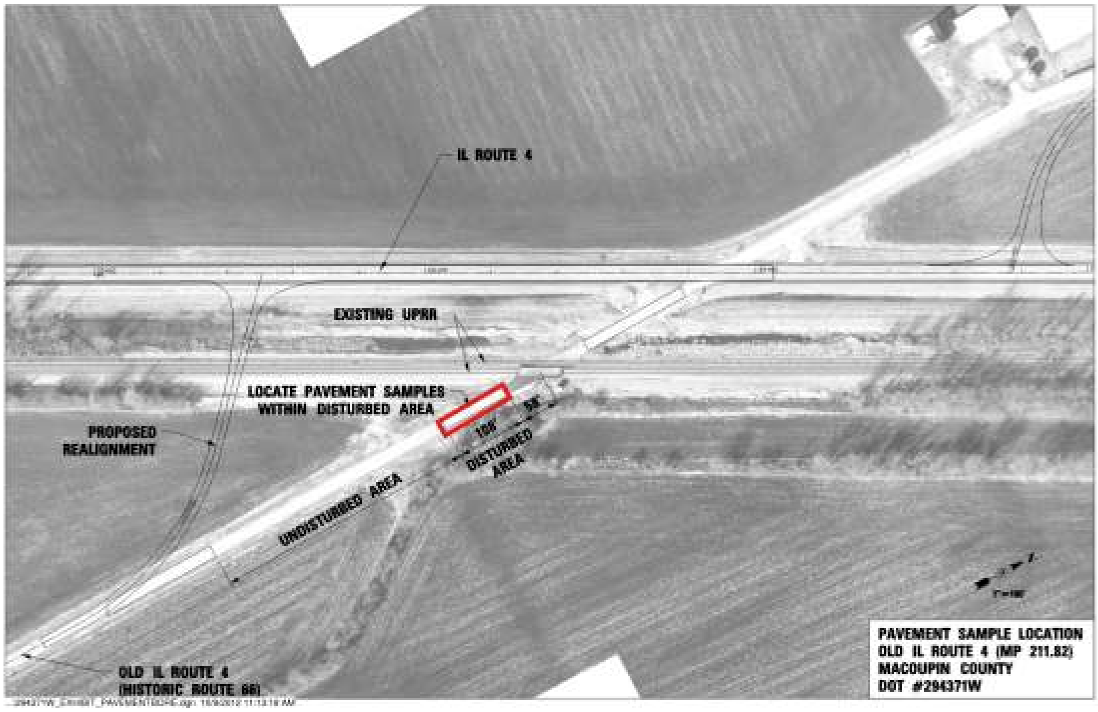


Fig. 20

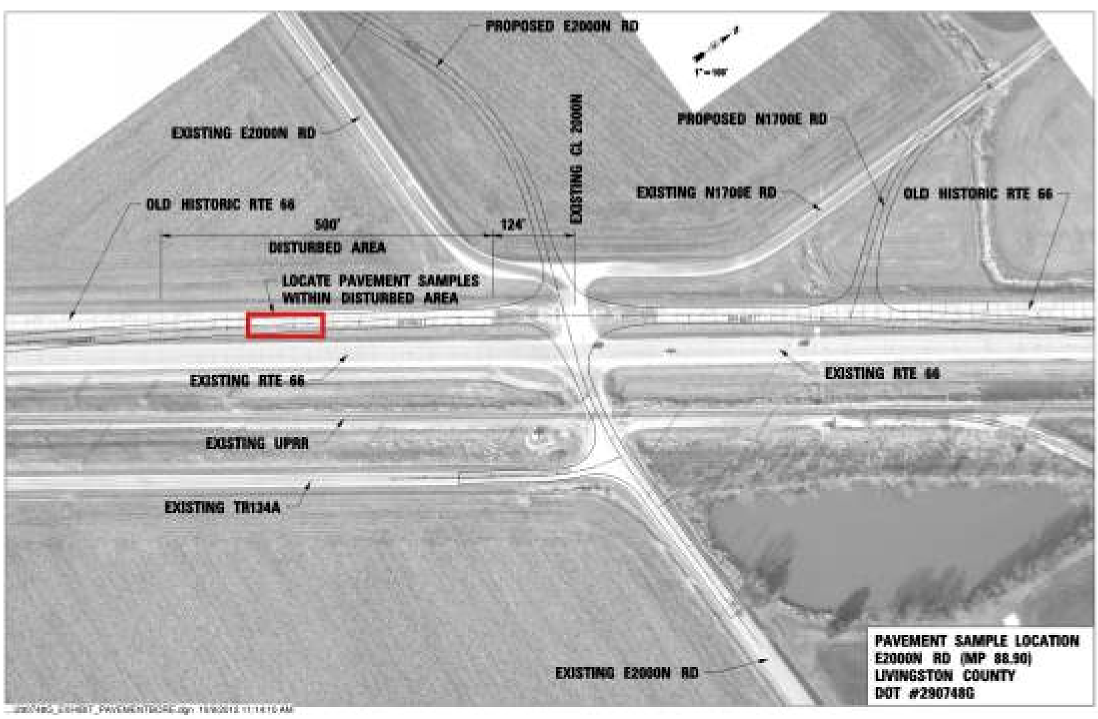


Fig. 19
Core 1 location near Nilwood/Girard, Illinois (IDOT image).

Fig. 20
Core 2 location near Pontiac/Dwight, Illinois (IDOT image).

Fig. 21

Fig. 22

Fig. 21
Core 1 (Nilwood/Girard); lapped surfaced shown on lower half of the core sample.

Fig. 22
Core 1 close-up of lapped surface showing crushed limestone aggregates within the cement paste matrix.

FIG. 23

FIG. 24

FIG. 23
Core 2 (Pontiac/Dwight); lapped surfaced shown on lower half of the core sample.

FIG. 24
Core 2 close-up of lapped surface showing rounded gravel aggregates within the cement paste matrix.

Fig. 25

Fig. 26

Fig. 25
Weathered surface finish differs throughout roadway segments. (Left) crushed limestone coarse aggregate and sand is exposed and (Right) rounded pea gravel and sand is exposed.

Fig. 26
Chert aggregate in original concrete that has cracked and created a pop-out in the concrete surface.

Fig. 27

Fig. 28

Fig. 27
Currently available crushed limestone (left) compared to aggregates in Core 1 (samples from Ozinga).

Fig. 28
Currently available uncrushed gravel (left) compared to aggregates in Core 2 (samples from Ozinga).

Fig. 29

Fig. 30

Fig. 29
Examples of a variety of mineral color concrete samples (samples from Ozinga).

Fig. 30
Cements and pozzolan samples illustrating their variety of colors (samples from LaFarge and Holcim).

Fig. 31

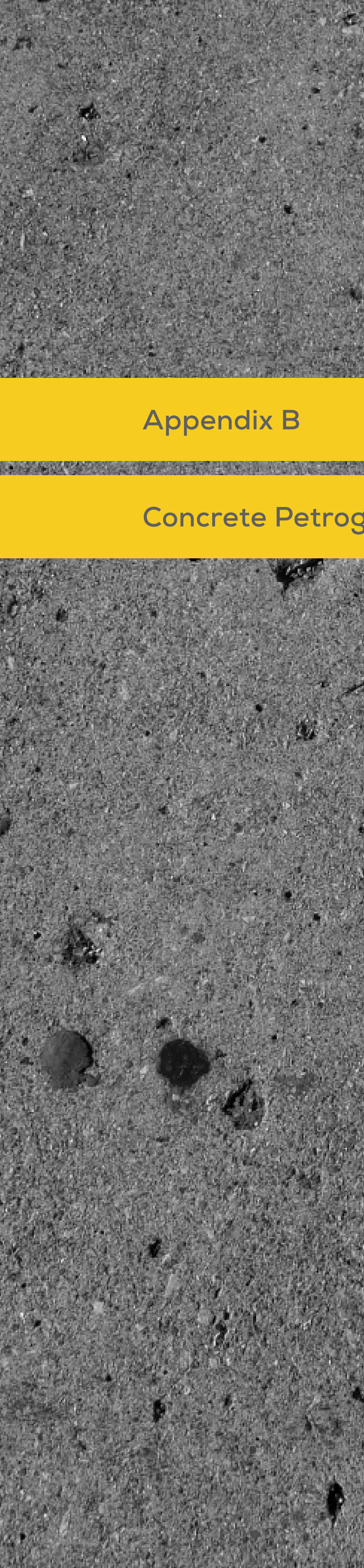
Fig. 32

Fig. 31
Blends of cements and pozzolans to create a 'light grey buff tone' cementitious color.

Fig. 32
New concrete repair patch finish (left) that does not match the original weathered concrete (right).

Fig. 33

Fig. 33
Historic Route 66 'Turkey Trot' area south of Nilwood, IL.



Appendix B

Concrete Petrographic Analysis

ROUTE 66 HISTORIC CONCRETE
Petrographic Studies of Concrete

Chicago-Springfield, Illinois

Final Report:
December 5, 2012
WJE No. 2012. 5282

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ROUTE 66 HISTORIC CONCRETE
Petrographic Studies of Concrete

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ROUTE 66 HISTORIC CONCRETE
Petrographic Studies of Concrete

Chicago-Springfield, Illinois

INTRODUCTION

This report presents the results of petrographic studies of two cores taken from concrete pavement of the historic Route 66 between Chicago and Springfield, Illinois. The concrete is presumed to have been placed between the late 1920s and early 1930s. Petrographic studies were requested to determine the current condition and characteristics of the concrete.

SAMPLES

Received for studies were two 4-inch diameter concrete cores designated *1B Nilwood/Girard* and *2B Pontiac/Dwight*, and one asphalt core designated as *Pontiac/Dwight*. The petrographic studies were conducted on the concrete cores. The length of Core 1B is 8.5 inches. The length of Core 2B is 10 inches. The top surfaces of both cores exhibit weathering. The bottom surface of Core 1B is coated with soil particles indicated that the concrete was cast on soil. The bottom surface of Core 2B contains embedded rock particles indicating that the concrete was cast on a rock base. The as-received cores are shown in Figures 1 thru 6.

The asphaltic core has a diameter of 4 inches and is 5 inches long. The top surface is somewhat weathered and exhibits protruding aggregates. The bottom surface had been formed against the substrate concrete and appears to have debonded. The core appears to contain at least three distinct horizontal layers as indicated by the size distribution of the aggregate particles and by the presence of semi-continuous planar features. The asphaltic material is well consolidated. The aggregate particles are uniformly coated with binder and appear to be of adequate quality; no aggregate degradation was observed. The as-received core is shown in Figures 7 thru 9.

PETROGRAPHIC STUDIES

The cores were examined petrographically using methods of ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*. Each core was cut in half lengthwise using a water-cooled, diamond saw blade. One planar surface of each core was lapped using progressively finer silicon carbide abrasives. The lapped surfaces are shown in Figure 10. Thin sections were prepared from the top 1.5 inch of each core. The lapped surfaces, thin sections and the remainders of the cores were then examined using stereoscopic and petrographic microscopes at magnifications ranging from 10X to 600X. A summary of petrographic data is provided in Table 1.

Core 1B

The concrete is in good general condition considering the age of the pavement. Fine-scale cracks were detected in the top region of the core. A few of these cracks are vertical, extending from the top surface to a maximum depth of 2.5 inches, and appear to be shrinkage-related. One crack is horizontal, located approximately 0.1 inch below the top surface of the core. This crack is probably due to cyclic freezing and thawing. Figure 11 shows the locations of the cracks. Bleed water voids were observed in the vicinity of some aggregate particles, but were not appear abundant. Small amounts of alkali-silica gel were detected in association with chert particles in two locations; however, no related cracking was observed. Constituents and characteristics of the concrete are described in greater detail below.

Aggregate

Coarse aggregate is crushed limestone with chert inclusions. The aggregate is moderately well graded and has a top size of 1.25 inch; finer sizes of the coarse aggregate are infrequent. The limestone particles are light beige to mottled gray and buff, moderately hard, and fairly dense. Some particles are somewhat vuggy (containing natural, small cavities), and some contain minor internal cracking that is most likely due to crushing operation. The aggregate particles are angular to sub-angular and mainly equant to irregular in shape. Small amounts of elongate particles are also present.

Fine aggregate is natural siliceous sand composed of major amounts of quartz, quartzite, feldspar, granite, and minor amounts of chert, other rock types, and small amounts of wood. Traces of slag particles were also observed. Nearly all aggregate particles are firm and moderately dense to dense. Only the wood particles were soft.

Aggregate distribution is uniform. Bond between the aggregate particles and the cement paste is generally tight.

Cement Paste

The cement paste is mostly medium gray, moderately hard, relatively dense, and exhibits a dull to sub-vitreous luster on fresh fracture surfaces. These characteristics are typical of moderate and moderately low water-cement ratio paste.

The paste contains moderate amounts of large residual unhydrated and partially hydrated portland cement particles. Residual cement particles were occasionally up to 300 microns (0.01 inch) in diameter (Figures 12 and 13); coarse particle size is a common characteristic of early 1900s portland cement. Hydration of the cement is generally advanced. Trace amounts of carbonate crusher fines were observed in the paste. Supplementary cementitious materials such as fly ash or ground granulated blast furnace slag were not observed, nor would these materials be expected in 1920s - 1930s pavement concrete.

Water-cement ratio was estimated to generally range from 0.44 to 0.50. This estimate is based on the optical and physical characteristics of the cement paste. Regions of slightly lower water-cement ratio were observed in the vicinity of some coarse aggregate particles indicating that the aggregate was dry when it was incorporated into the concrete mix. The cement content is estimated at 6.5 ± 0.5 bags per cubic yard of concrete.

The paste was carbonated from the top surface of the concrete to a depth of 0.75 inch. Paste in the bottom 0.25 inch, and locally 1 inch, was also carbonated.

Air-Void System

The concrete contains small spherical entrained air voids that are characteristic of air entrained concrete and is considered to be marginally air-entrained. The total air content is estimated at 3.5 to 4.5 percent. The air-void system also includes medium size and larger sub-spherical and irregularly shaped voids that are typical of entrapped air. The air voids are randomly distributed within the concrete. Secondary ettringite deposits were detected inside the air voids in the bottom portion of the core. These deposits are not deleterious, but their presence is indicative of prolonged exposure to moist conditions.

Purposeful air entrainment was not common practice until the 1940s. It is likely that the entrained air voids represent casual or accidental air entrainment caused by the presence of fatty acid contaminants, possibly lubricant from crushing equipment.

Core 2B

The concrete is in good general condition considering the age of the pavement. The top surface of the core is weathered and partially scaled. Aggregate particles protrude above the surface mortar layer. A few sub-horizontal cracks were observed within the top 0.4 inch of the core. These cracks pass through aggregate particle and are attributed to cyclic freezing and thawing. A transverse narrow crack extends through approximately half of the core diameter at a depth of 4 to 5 inches. This crack passes around and through aggregate particles and is attributed to alkali-silica reaction (ASR). Secondary deposits of alkali-silica gel were detected in several air voids throughout the core. The gel was mostly associated with chert particles. Crack locations are shown in Figure 14. A short vertical microcrack at the top of the core is shown in Figure 15. The crack is partially filled with asphaltic material. Constituents and characteristics of the concrete are described in greater detail below.

Aggregate

Coarse aggregate is natural calcareous and siliceous gravel. The aggregate is well graded and has a top size of 1.25 inch. The gravel consists of major amounts of limestone and dolomitic limestone, and minor amounts of igneous rocks, sandstone, and chert. The limestone particles are various shades of beige and brown, moderately hard, fairly dense, sub-rounded to rounded, and predominantly equant. Some of the particles of limestone are somewhat vuggy.

Fine aggregate is natural calcareous and siliceous sand composed of major amounts of limestone, and lesser amounts of quartz, igneous and sedimentary rocks, and chert. Except for occasional particles of the sedimentary rocks such as siltstone and shale that are somewhat soft and absorbent, all the remaining particles are moderately hard to hard and moderately dense to dense. The fine aggregate appears to be from a different source than the fine aggregate in Core 1B.

The aggregates are uniformly distributed within the concrete. The aggregate particles are well bonded to the surrounding cement paste.

Cement Paste

The cement paste is medium gray, hard, dense, and exhibits dull to sub-vitreous luster on fresh fracture surfaces. These characteristics are typical of moderate and moderately low water-cement ratio paste.

The paste contains moderate amounts of large residual unhydrated and partially hydrated portland cement particles. Residual cement particles were large, similar in size to the residual cement particles in Core 1B (Figure 16). Hydration of the cement is moderately advanced. Large amounts of carbonate dust were observed in the paste (Figure 17) indicating that the aggregate had not been sufficiently washed.

Water-cement ratio was estimated at 0.40 to 0.46. The cement content is estimated at 6.5 ± 0.5 bags per cubic yard of concrete.

The paste was carbonated to an average depth of 0.05 inch at the top of the concrete. Paste in the bottom 0.25 inch of the core was also carbonated.

Air-Void System

The concrete is non-air-entrained. Total air content was estimated at 2.5 to 3.5 percent. The air occurs as medium size and somewhat large, sub-spherical and irregularly shaped voids that are typical of entrapped air. The air voids are randomly distributed within the concrete. Secondary ettringite deposits were most abundant in air voids within the bottom 1.25 inch of the core. Small amounts of ettringite were also observed in air voids in other locations of the core.

SUMMARY AND DISCUSSION

Two concrete cores from the historic Route 66 were examined petrographically to assess their general characteristics and condition.

In general, the concrete is in good condition considering its age. No evidence of significant degradation was observed. The presence of significant amounts of ettringite in the air voids in the bottom region of each core is indicative of prolonged moist conditions below the concrete.

The cores represent two different concrete mixtures. Core 1B contains crushed limestone coarse aggregate and natural siliceous sand fine aggregate. The water-cement ratio of this concrete was estimated at 0.44 to 0.50. Core 2B contains natural calcareous and siliceous gravel coarse aggregate and natural calcareous and siliceous sand fine aggregate. The water-cement ratio of this concrete was estimated at 0.40 to 0.46. The cement content in each core was estimated at 6.5 ± 0.5 bags per cubic yard of concrete.

Core 1B is marginally air-entrained and contains approximately 3.5 to 4.5 percent air. The entrained air content of this concrete is considered to be accidental because air-entraining admixtures (AEA) were not in general use until the 1940s. Small amounts of contaminants such as fatty acids in lubricating agents or grinding aids are known to entrain air and could have been incidental contaminants of the crushed aggregate or the cement. Core 2B is non-air entrained and contains approximately 2.5 to 3.5 percent air. The air-void system in neither of the cores is considered adequate for protecting concrete from freeze-thaw damage under severe exposure conditions (moist freezing and deicing compounds).

Both cores exhibit weathering of the top surfaces that exposed aggregate particles. Core 1B contains shrinkage-related cracks in the top 2.5 inches and one narrow crack that is possibly related to freeze-thaw distress just below top surface. Core 2B exhibits freeze-thaw-related cracking in the top 0.4 inch. This core also contains a transverse crack 4 to 5 inches below the top surface that appears to be due to ASR although no alkali-silica gel was found in the vicinity of the chert particle associated with the crack. Gel may have been present in the past and may have been washed away over time.

In both cores, the cement paste is firm and dense and in good condition. The air-void systems in both cores are inadequate and the concrete is considered to be vulnerable to damage if exposed to cyclic freezing and thawing while critically saturated. Core 2B exhibits minor evidence of ASR-related damage. This deleterious reaction typically diminishes over time. After 80 to 90 years, little if any additional ASR damage is expected.

Table 1 - Petrographic Data

Core ID	Core 1B	Core 2B
Condition	-Moderately weathered top surface -Freeze/thaw crack at 0.1 in. -Drying-shrinkage cracking in top 2.5 in. of core	-Scaled top surface -Freeze/thaw cracks in top 0.4 in. -ASR crack at 4 to 5 in. depth
Coarse Aggregate	Crushed limestone	Calcareous and siliceous gravel
Fine Aggregate	Natural siliceous sand	Natural calcareous and siliceous sand
Cement Content	~6.5 ± 0.5 bags per cubic yard of concrete (cement X)	~6.5 ± 0.5 bags per cubic yard of concrete (cement Y)
Water/Cement	~0.38 to 0.45	~0.35 to 0.40
Air-Void System	Marginally air-entrained (~3.5 to 4.5 %)	Non-air-entrained (~2.5 to 3.5)

Storage: Thirty days after completion of our studies, the samples will be discarded unless the client submits a written request for their return. Shipping and handling fees will be assessed for any samples returned to the client. The client may request that WJE retain samples in storage in our warehouse. In that case, a yearly storage fee will apply.

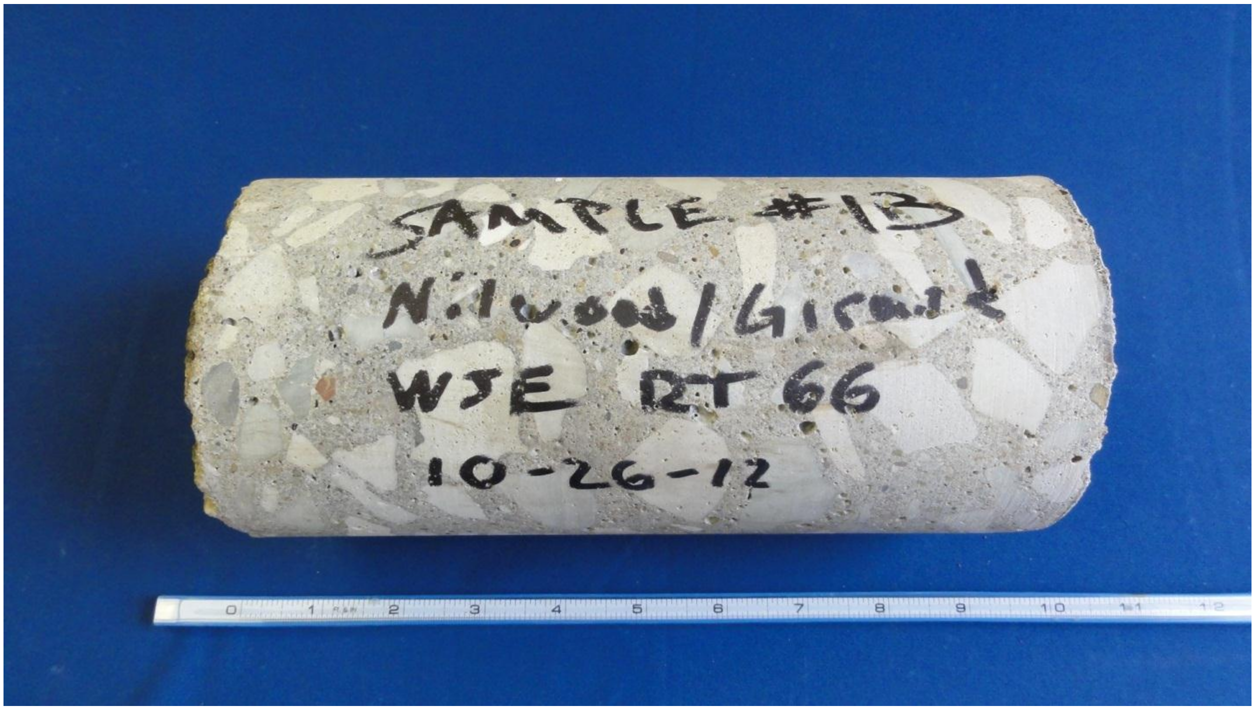

Figure 1. Core sample 1B as received. Top surface of the core is on the right of the photograph.

Figure 2. Core 1B; bottom surface of the core as received.

Figure 3. Core 1B; weathered top surface of the core as received.

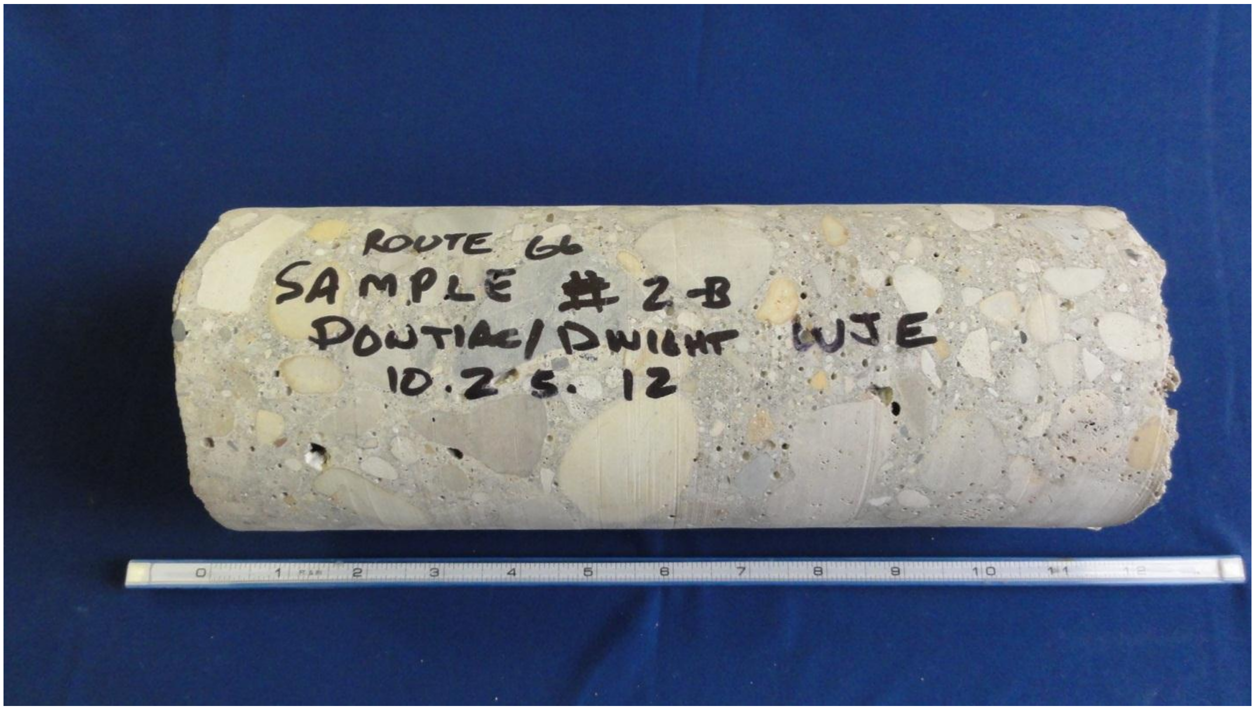

Figure 4. Core sample 1B as received. Top surface of the core is on the left of the photograph.

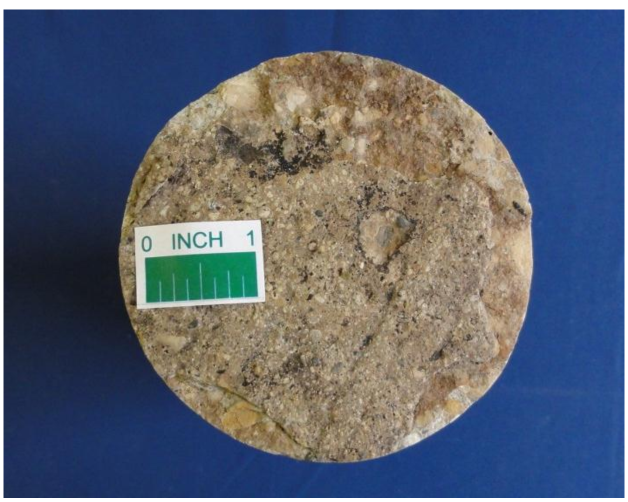

Figure 5. Core 2B; partially weathered, scaled top surface of the core as received.

Figure 6. Core 2B; bottom surface of the core as received.

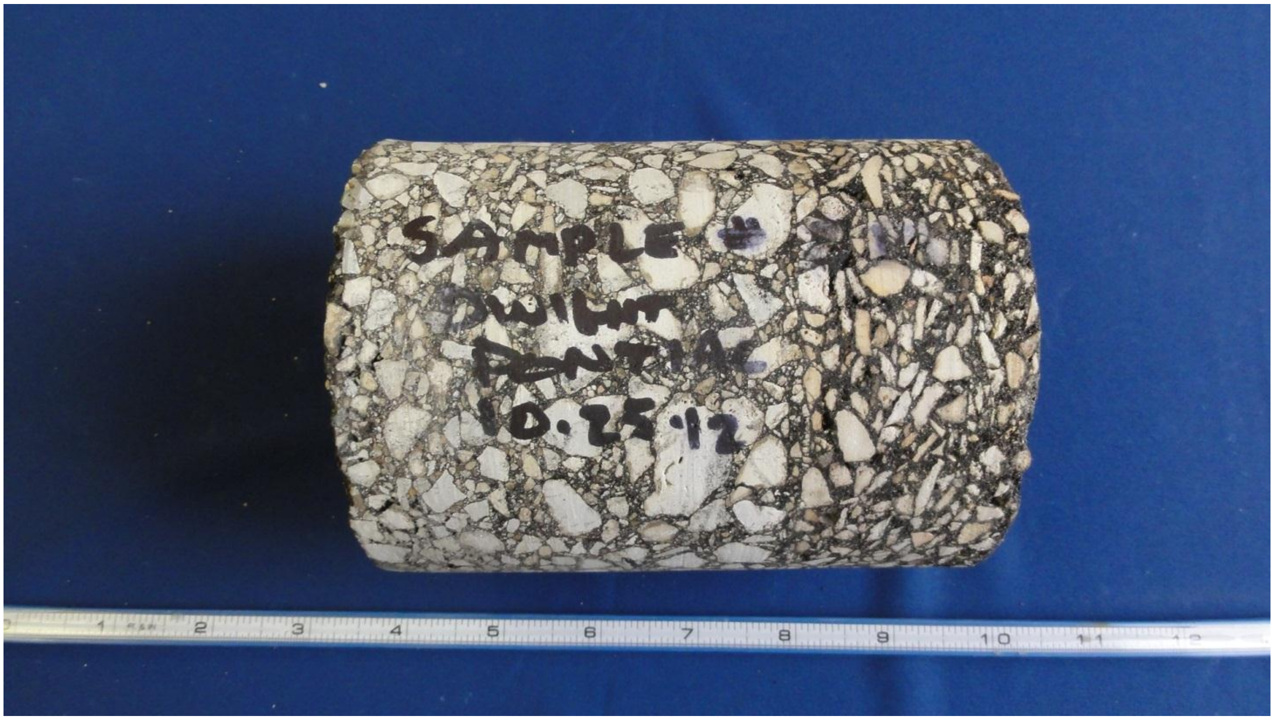

Figure 7. Asphaltic Core identified as Dwight /Pontiac (number designation illegible) as received. Top surface of the core is on the left of the photograph.

Figure 8. Top surface of the asphaltic core

Figure 9. Bottom surface of the asphaltic core.

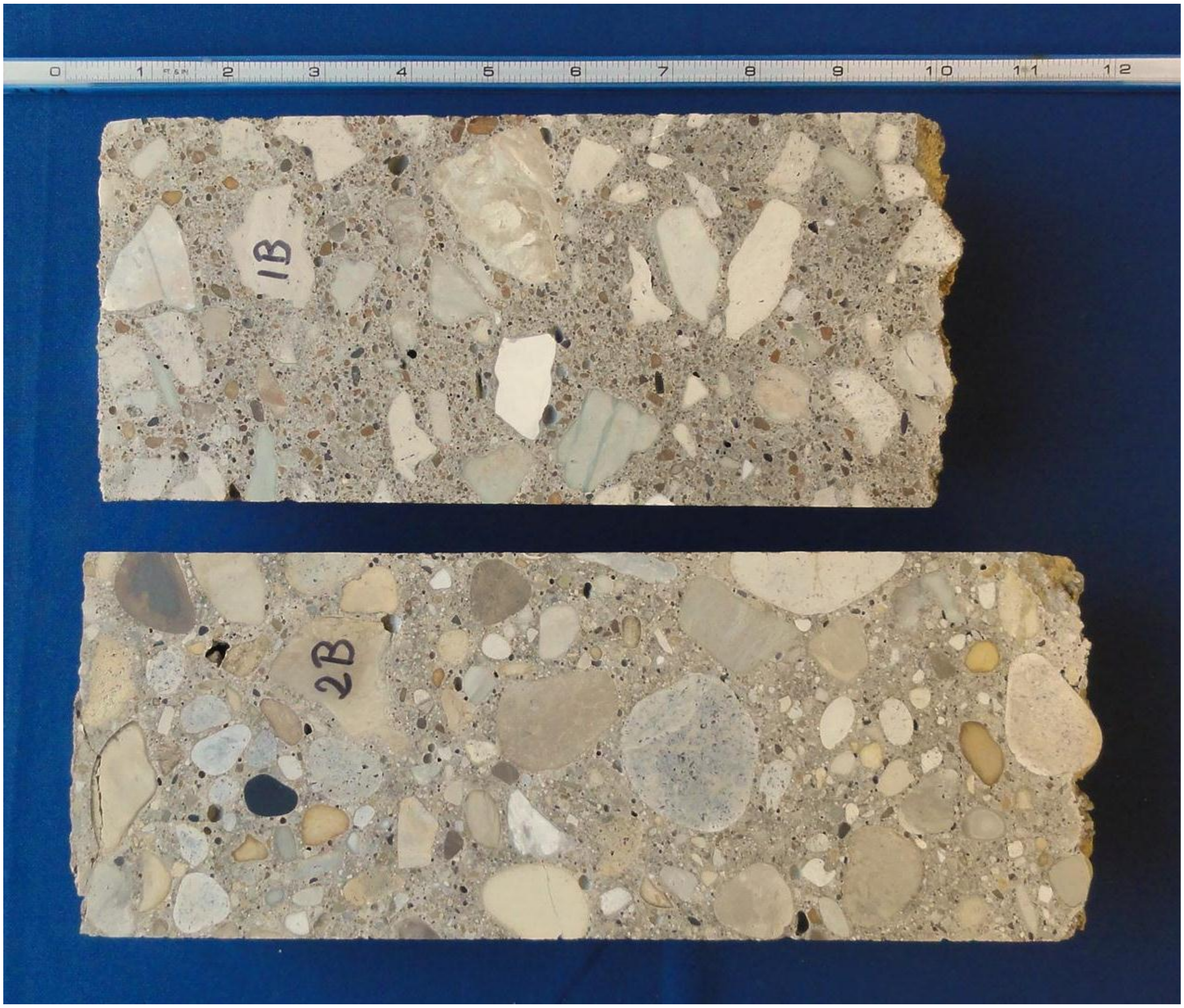

Figure 10. Lapped longitudinal cross sections of Cores 1B and 2B. Top surfaces of the cores are on the left of the photograph. Coarse aggregate in Core 1B is crushed limestone and in Core 2B it is natural calcareous and siliceous gravel. The distribution of the aggregates is uniform in both cores.

Figure 11. Lapped section of Core 1B. Crack locations are marked in red.

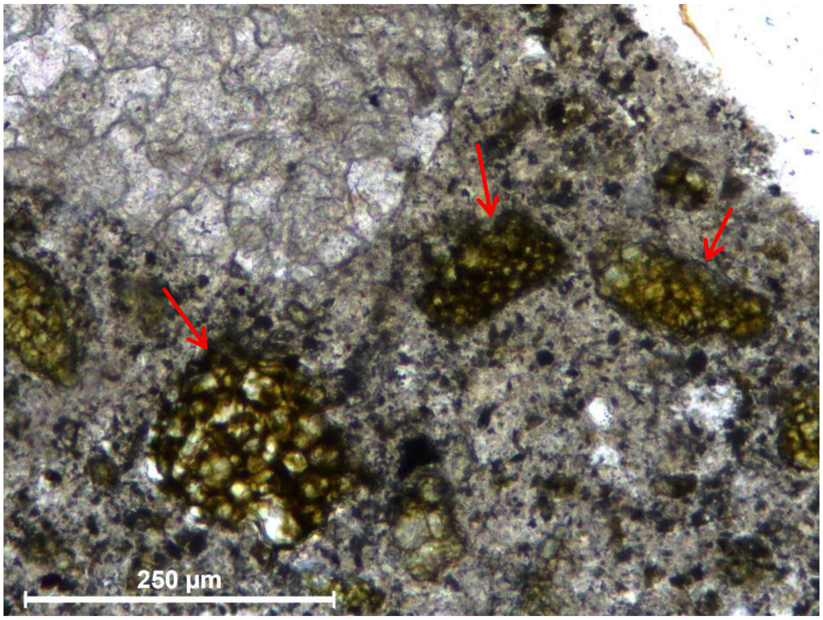

Figure 12. Core 1B - Arrows show examples of large residual portland cement particles. Thin-section photomicrograph. Plane-polarized light.

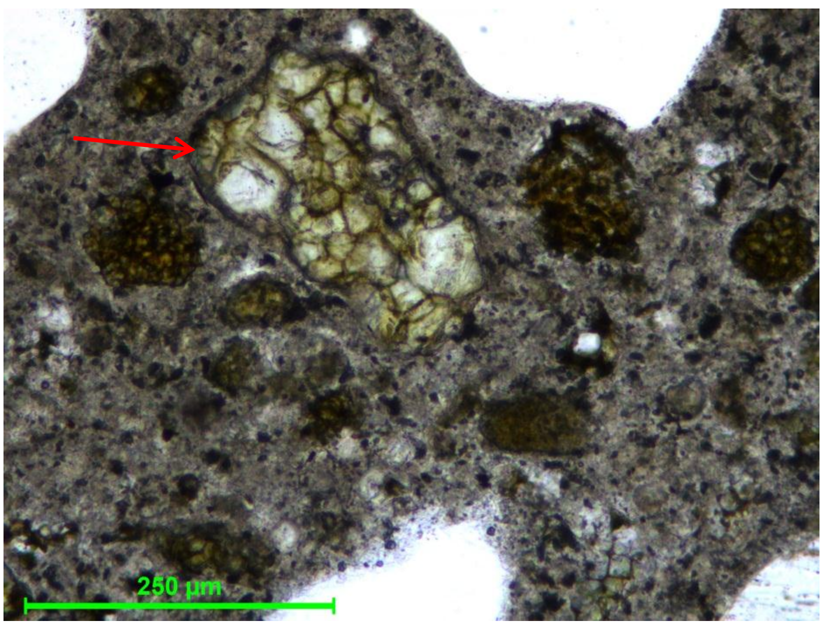

Figure 13. Core 1B - Arrow shows cement particle that is similar in size to small fine aggregate particles. Thin-section photomicrograph. Plane-polarized light.

Figure 14. Lapped section of Core 2B. Crack locations are marked in red.

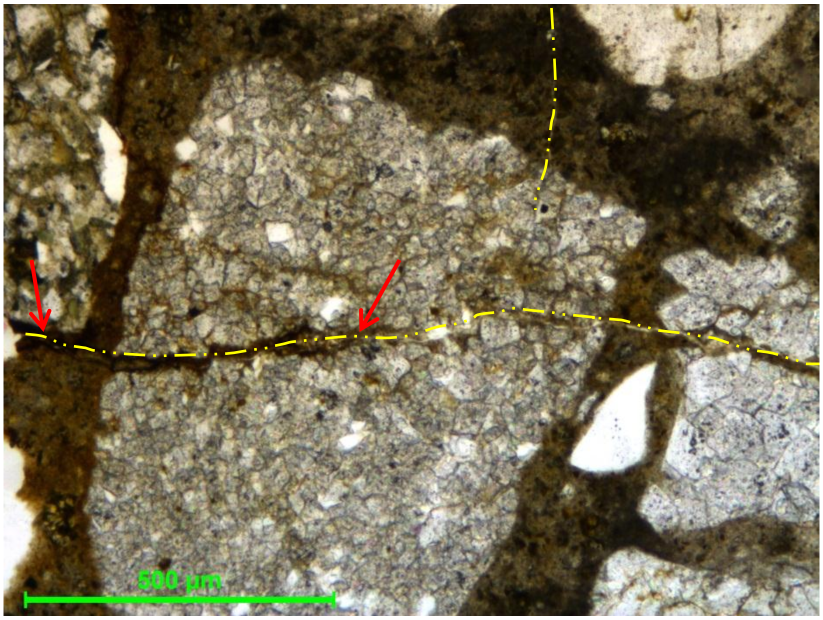

Figure 15. Core 2B - Microcracks are marked with yellow dashed lines. Red arrows show a section of a vertical microcrack that is filled with asphaltic material. Top surface is on left. Thin-section micrograph. Plane-polarized light.

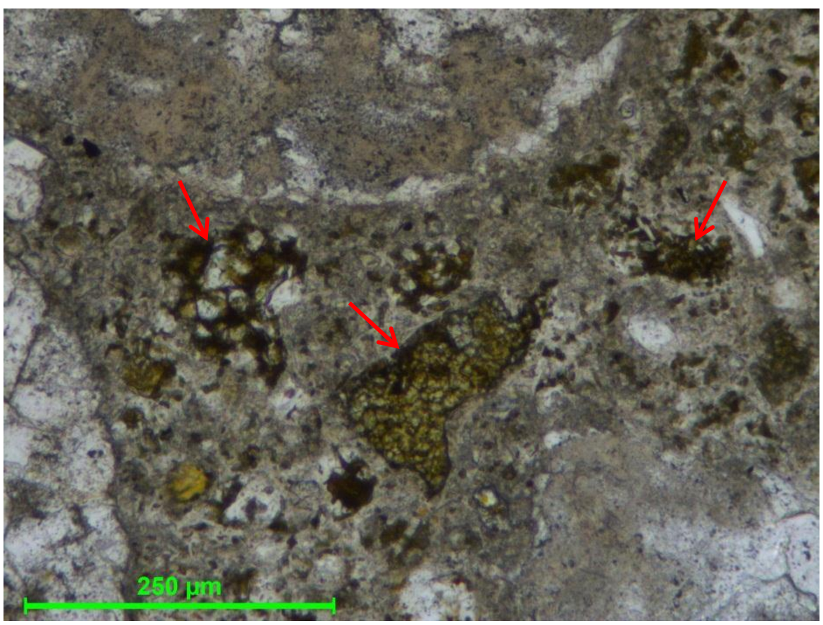

Figure 16. Core 2B - Arrows show examples of large residual portland cement particles. Thin-section photomicrograph. Plane-polarized light

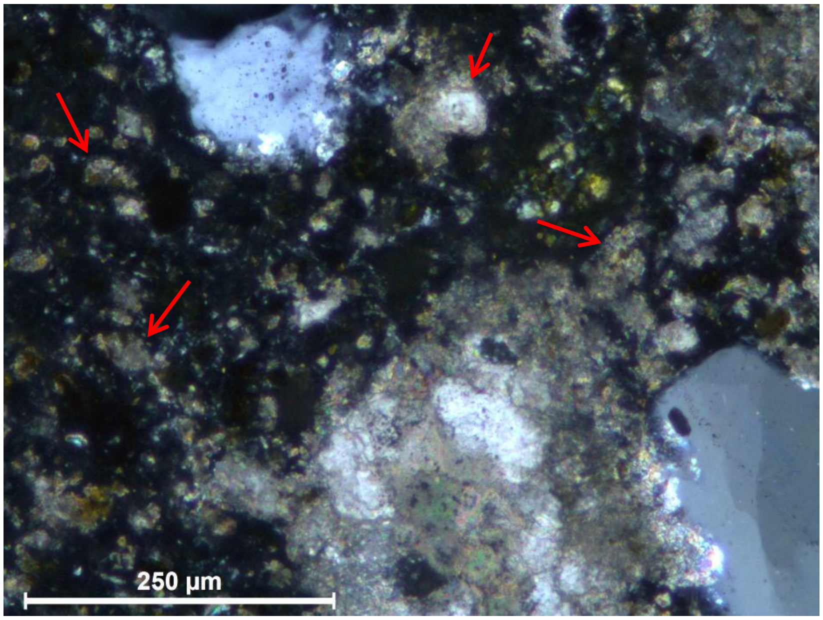

Figure 17. Core 2B - Arrows show examples of dust-size carbonate particles in the paste. Thin-section photomicrograph. Cross-polarized light.

Appendix C

Sample Concrete Restoration Guide Specification

SECTION 03 93 00

SAMPLE CONCRETE RESTORATION GUIDE
(Not for Construction)

PART 1 – GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections. [COORDINATE WITH IDOT PAVEMENT SPECIFICATIONS]

1.2 SCOPE

A. Furnish all labor, materials, tools and equipment and perform all Work necessary for and incidental to repair/restore Old Route 66 pavement as shown on the Drawings and specified herein; in accordance with the provisions of the Contract.

B. Work and Contractor responsibilities covered by this Specification shall include:

1. Contractor is responsible for coordination of work on site. The information provided is based on the Engineer's limited visual observations of the conditions. The contractor selected for the work will be responsible for notifying the Engineer of any hazardous conditions, unforeseen conditions, or deviations from the Engineer's observations, for possible review by the Engineer and the development of additional repair details.
2. Examine existing surface by means of acoustical examination to determine the extent of the deteriorated concrete and confirming extent of repairs with Engineer.
3. Removal of the delaminated materials, and additional areas of sound concrete required to achieve required clearances, through impact means.
4. Preparation of the substrate and reinforcement by means of sand blasting to remove laitance, loose material, bond breaking materials, or other contaminants.
5. Epoxy coating of exposed reinforcement or newly installed reinforcement.
6. Verify substrate surface condition is compatible to receive the work of this Section. Notify the Engineer if any incompatibilities.
7. Install supplemental reinforcing bar anchors at patches, as required.
8. Forming and pouring of concrete repair material at repair areas.
9. Matching repair materials and finishes to the existing concrete.

10. Properly dispose or relocate materials.

C. Record Keeping: The Contractor shall document and submit completed quantities and locations of repairs to the Engineer.

D. Compatibility: Verify substrate surface condition is compatible to receive the work of this Section. Notify the Engineer if any incompatibilities.

E. MSDS: Prior to the use of any materials, refer to the "Safety" section of the Materials Safety Data Sheets (MSDS) provided by the material manufacturer for applicable cautions and warnings.

1.3 REFERENCES

A. Reference Standards

1. The Secretary of the Interior's Standards for Rehabilitation

2. American Society of Testing and Materials (ASTM)

DESCRIPTION	ASTM TEST
Specification for Concrete Aggregates	ASTM C 33
Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	ASTM C 39
Standard Test Method for Slump of Portland Cement Concrete	ASTM C 143
Specification for Portland Cement	ASTM C 150
Test for Air Content of Freshly Mixed Concrete by the Pressure Method	ASTM C 231
Specification for Air-Entraining Admixtures for Concrete	ASTM C 260
Specification for Chemical Admixtures for Concrete	ASTM C 494
Standard Practice for Abrading Concrete	ASTM D 4259
Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction	ASTM E 329
Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	ASTM A 615
Standard Specification for Epoxy-coated Reinforcing Bars	ASTM A 775

3. American Concrete Institute (ACI)

DESCRIPTION	ACI #
"Manual of Concrete Practice", various committee reports as referenced herein, latest edition.	
Standard Specifications for Tolerances for Concrete Construction and Materials	ACI 117
Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete, ACI Committee 211	ACI 211.1
Specification for Structural Concrete in Buildings	ACI 301
Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete	ACI 304
Recommended Practice for Hot Weather Concreting	ACI 305R
Recommended Practice for Cold Weather Concreting	ACI 306R
Details and Detailing of Concrete Reinforcement	ACI 315
Building Code Requirements for Structural Concrete	ACI 318
Recommended Practice for Concrete Formwork	ACI 347

1.4 CONTRACTOR QUALIFICATIONS

A. Qualifications of Concrete: Contractor must have a minimum of 5 years experience in performing historic concrete repair work similar to the Work herein.

1.5 WARRANTY

A. Permits: The Contractor shall apply for, procure, renew, maintain, and pay for all permits required by City, State, or other governing authorities, necessary to execute work under this Contract. Contractor shall furnish copies of all permits to the Owner and Engineer.

B. Warranty: Comply with General Conditions, agreeing to repair or replace specified materials or Work that has failed within the warranty period. Failures include but are not limited to the following:

   1. Discoloration of adjacent concrete surfaces.
   2. Areas which show surface failure or defects.
   3. Areas which puddle water.
   4. Areas which do not match in color and texture to the existing adjacent concrete.
   5. Small patches that become crazed, cracked or sound hollow when tapped.
   6. Failed or multi-directional cracking in repair concrete.

C. Contractor's Warranty: Provide three-year Contractor's Warranty for materials and workmanship.

1.6 SUBMITTALS

A. Submit the following:

   1. Proposed general schedule for work and sequencing for road closures.
   2. Concrete mock-ups.
   3. Plan for matching existing concrete, including the following:

      a) Color and blend of cementitious paste matrix
      b) Aggregate type, shape, size
      c) Finishing technique
      d) Curing method and duration

   4. Mix designs shall be prepared or reviewed by an approved independent Testing Agency retained by the Contractor in accordance with requirements of ACI 301 and ACI 318, signed by a

registered Engineer licensed to practice as a Professional Engineer in the state where the project is located. Mix design must be approved by the Engineer to match the existing based on mock-ups. Mix Design data shall include but not be limited to the following:

a) Locations on the Project where each mix design is to be used corresponding the various Route 66 pavement segments.
b) Proportions in accordance with ACI 301 and ACI 318.
c) Gradation and quality of each type of ingredient including fresh (wet) unit weight and aggregates sieve analysis.
d) Water/cementitious material ratio.
e) Evaluation and classification of fly ash in accordance with ASTM D 5759.
f) Chemical analysis report of fly ash in accordance with ASTM C 311.
g) Classification of blast furnace slag in accordance with ASTM C 989.
h) Slump per ASTM C 143.
i) Certification and test results of the total water soluble chloride ion content of the design mix in accordance with ASTM C 1218.
j) Air content of freshly mixed concrete by the pressure method, ASTM C 231, or the volumetric method, ASTM C 173.
k) Unit Weight of Concrete per ASTM C 138.
l) Design strength at 28 days, as indicated on the Drawings, per ASTM C 39.
m) Test records to support proposed mixtures shall be no more than 24 months old and use current cement and aggregate sources. Test records to establish standard deviation may be older if necessary to have the required number of samples.
n) Manufacturer's product data for each type of admixture.
o) Manufacturer's certification that all admixtures used are compatible with each other.
p) Density per ASTM C 138.
q) Certification from a qualified testing agency indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity in accordance with ASTM C 33

5. Hot and cold weather procedures.
6. Product data information for each product used.
7. Concrete joint locations and layout.
8. Warranties for each of the materials and systems installed.
9. Permits for work.
10. Test results from quality assurance field testing by Testing Agency.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original and unopened containers and packaging, bearing labels as to type and names of products and manufacturers.

B. Protection and Storage: Protect materials from deterioration by moisture and temperature. Store off the ground and in a dry location or in waterproof containers. Keep containers tightly closed and away from open flames. Protect liquid components from freezing. Store and condition materials as recommended by the product manufacturer.

C. Storage: Store materials in accordance with ACI 304R. All materials shall be stored in a dry condition and protected from dirt, dust, and other contaminants. Cement bags shall be stored on pallets. Fine and coarse aggregates shall be stored in a dry place.

D. Handling:

1. Handle fine and coarse aggregates as separate ingredients.
2. Arrange aggregate stockpiles to avoid excessive segregation, and prevent contamination with other materials or with other sizes of like aggregates.
3. Do not use frozen or partially frozen aggregates.
4. Allow sand to drain until it has reached relatively uniform moisture content before use.

1.8 QUALITY ASSURANCE BY TESTING AGENCY

A. Field Quality Assurance

1. General: Testing Agency to be hired by the Contractor shall test and inspect concrete materials and operations as Work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the Engineer for final acceptance.

2. Testing Agency is responsible for monitoring concrete placement as follows:

    a) Verify use of required design mix
    b) Record location of point of concrete discharge of each batch truck tested, cross referenced to grid lines.
    c) Record temperature of concrete at time of placement.
    d) Record weather conditions at time of placement, including temperature, wind speed, relative humidity, and precipitation.
    e) Record types and amounts of admixtures added to concrete batches, including that added after departure of concrete trucks from batch plant at the project site.
    f) Record amounts of and monitor dosing of high-range water-

reducing admixtures added at site for site-added admixtures and redosing for plant-added admixtures.

g) Record amount of water added at the site and verify that total water content does not exceed amount specified in the mix design. Addition of water at the site is subject to prior approval by the Engineer.
h) Monitor consistency and uniformity of concrete.
i) Monitor preparation for concreting operations, placement of concrete, and subsequent curing period for conformance with Specifications for following procedures:

    i. Concrete curing.
    ii. Hot weather concreting operations.
    iii. Cold weather concreting operations.

3. Testing Agency shall conduct tests of concrete as follows and in accordance with ASTM C 1077:

    a) Testing frequency: Sample sets for all tests listed below of each concrete design mix placed each day shall be taken not less than once a day, nor less than once for each 50 cu.yd. of concrete, nor less than once for each 2500 square feet of surface area. Additional tests shall be performed if deemed necessary by the Testing Agency and Engineer.
    b) Determine air content of concrete in accordance with either ASTM C 231 or ASTM C 138.
    c) Determine unit weight of concrete in accordance with ASTM C 138.
    d) Conduct one test for air content for each strength test.
    e) Conduct slump tests in accordance with ASTM C 143.
    f) Conduct strength tests of concrete as follows:

        i. Secure sample sets in accordance with ASTM C 172.
        ii. Mold cylinders in accordance with ASTM C 31 and cure under standard moisture and temperature conditions in accordance with ASTM C 31, Section 7 (a). Quantity of cylinders listed below is based on a cylinder size of 4 inch (100mm) diameter x 8 inches (200mm) long. If 6 inch (150mm) diameter by 12 inch (300mm) long cylinders are used, the total quantity of cylinders may be reduced by one with two cylinders instead of three tested at the age designated for determination of f'c.
        iii. For 28 day mixes mold six cylinders. Test two cylinders at seven days and three cylinders at 28 days. The 28 day strength shall be the average of the three 28 day cylinders. One cylinder shall be retained in reserve for later testing if required.

B. Testing Agency shall submit inspection, observation, and/or test reports to the Owner and Engineer, as required herein and shall provide an evaluation statement in each report stating whether or not concrete placement conforms to requirements of Specifications and Drawings and shall specifically note deviations therefrom.

C. Immediately report deficiencies to the Contractor, Owner and Engineer.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Do not place concrete if precipitation appears imminent. Do not place concrete when the air temperature is below 40 degrees F. Adhere to specifications regarding environmental requirements, surface preparation, application methods, etc., where more stringent than required by these specifications.

B. Protection: Protect surfaces and components against damage from work. All site features shall be protected so that they will not be damaged as a result of Contractor's Work. All site features and components shall be restored to pre-job condition after the work is complete.

C. Coordination: Work to be conducted during hours designated by Owner's Representative.

1.10 MOCK-UPS

A. Prepare mock-ups of the concrete repairs for Engineers approval. Mock-ups are intended to represent the preparation, reinforcing/anchorage installation, patching and finishing work for each type of repair. Engineer will observe preparation and finish work.

B. There are three general types/sizes of repairs outlined in this specification: 1) Small, 2) Medium, and 3) Large. For those applicable for the repair project, the following mock-ups are required as a minimum:

1. Concrete Preparation Mock-Ups: Preparation of each repair type to illustrate removal of concrete, cleaning of concrete surface and existing reinforcing, cutting of patch edge conditions. Install supplemental reinforcing steel and anchors as required.

2. Concrete Matching Mock-Ups: Provide three (3) samples of the mix developed to match the existing color (main body of concrete), aggregates, and texture of the existing surface finish. Provide additional samples as needed until a mix and finish is selected by the Engineer that matches the original finish.

3. Matching for this project is critical. Mock-ups shall represent the final work for all of the repairs.

4. Approved mock-ups to become part of repair work.

1.11 EQUIPMENT

A. Jack Hammers: Hammers for the removal of concrete not more than 30 pounds.

B. Chipping Hammers: Hammers for the removal of concrete beneath reinforcing steel not more than 15 pounds.

C. Sandblasting Equipment: Equipment capable of removing rust from the exposed reinforcement and contaminants and laitance for newly exposed concrete surfaces.

D. Compressed Air: Air equipment capable of removing dust and dirt from exposed concrete and steel surfaces.

1.12 MATERIALS

A. Portland Cement:

   1. ASTM C150, Type I or Type II

B. Aggregates for Concrete:

   1. ASTM C 33
   2. Fine Aggregate: Natural sand, or sand prepared from stone or gravel, clean, hard, durable, uncoated and free from silt, loam and clay.
   3. The acceptability of aggregates for the work will depend on proof that their potential alkali reactivity is not deleterious to the concrete.
   4. Do not use fine or coarse aggregates that contain substances that cause spalling.
   5. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301.
   6. Use types of coarse and fine aggregates that match closely with the existing concrete aggregates.

C. Water: ASTM C 94. Clean, and free from injurious amounts of oil, acids, alkali, salts, organic material, or other deleterious materials.

D. Supplementary Cementitious Material

   1. Fly Ash:

a) ASTM C 618, Class C or Class F.
b) Shall not be used unless part of an approved mix design.
c) Limit Loss on Ignition to 2.5%

2. Ground Granulated Blast-furnace Slag (GGBFS)

   a) ASTM C 989.
   b) Shall not be used unless part of an approved mix design.

3. Limit the maximum content of supplementary cementitious materials for concrete exposed to deicing chemicals to values shown in ACI 318, Table 4.2.3
4. The exact percentages used shall be based on successful test placement on site. Resubmit mix design if percentages change based on test placement.
5. The fly ash or natural pozzolan supplier shall have an effective quality control program in place to guard against contamination of the fly ash and assure compliance with Specifications.
6. Fly ash and GGBFS used shall be from one source throughout the project. Substitution of sources will be acceptable only if testing of concrete mixes containing the substituted material show similar test results and if the color of concrete produced with the substituted material matches the color of previously poured concrete to the satisfaction of the Engineer.

E. Air Entrainment

1. ASTM C 260
2. For concrete exposed to freeze/thaw cycles or deicing chemicals, and concrete intended to be watertight, provide entrained air content of 6% ± 1.5%, unless specified otherwise.
3. Acceptable Product:

   a) BASF "MICRO-AIR" or “MB-AE-90”
   b) W. R. Grace “Darex Series” or “Daravair Series”
   c) Euclid Chemical Company “AEA –92 or Air 40”
   d) Sika Corporation “Sika Air Series” or “Sika AEA Series”

F. Ready Mixed Concrete:

1. Shall be batch-mixed and transported in accordance with ASTM C 94.

G. Supplemental Reinforcement, Epoxy Coating and Epoxy Grout

1. Reinforcing Bars: Conforming to ASTM A 615, Grade 60. New

reinforcing bars must have a factory-applied epoxy coating installed in accordance with the ASTM A 775-81 or a field-applied epoxy coating installed in accordance with these specifications.

2. Epoxy for Coating Exposed Reinforcing Bar:

   a) Armatec 110, manufactured by Sika Corporation.
   b) Approved equal.

3. Epoxy for Embedding Rods/Bars:

   a) HIT-HY 150 MAX Injection Adhesive Anchoring System for anchorage for concrete as manufactured by Hilti, Inc.
   b) Approved equal.

4. Welded Wire Mesh: Epoxy coated mesh to be used with small partial depth concrete repairs.

1.13 CONCRETE MIX DESIGN

A. Concrete Repair Strength: 3,000 to 4,000 psi (less than or equal to existing)

B. Color: The blend of cement and cementitious materials shall match the adjacent existing concrete paste main body (matrix) color.

C. Water-Cementitious Materials (W/cm) Ratio for Concrete

   1. Unless lower limits are stated in the Contract Documents, all concrete exposed to freezing and thawing in moist condition shall have a maximum W/cm ratio of 0.45.
   2. All concrete exposed to deicing salts shall have a maximum W/cm ratio of 0.40.
   3. The water-cementitious materials ratio shall not exceed values indicated, including any water added to meet specified slump in accordance with the requirements of ASTM C 94.
   4. Weight of fly ash or pozzolanic admixtures shall be included with the weight of cementitious materials used to determine the water-cementitious materials ratio.

D. Slump

   1. Concrete design mixes shall be proportioned to meet the following slump limitations. Slump should be measured as described in the Owner's testing agency responsibilities:

      a) Concrete slump shall not exceed 4" for normalweight concrete.

E. Chloride Ion Content

1. The total water-soluble chloride ion content of the mix including all constituents shall not exceed the limits defined in ACI 318 4.3 unless corrosion inhibiting admixtures are added to the mixture to offset the additional chloride.

2. If the specified level of water-soluble chloride ion content cannot be maintained, appropriate level of corrosion inhibiting admixture shall be added to the mix in accordance with the manufacturer's recommendation to offset the excess amount of chloride at no additional cost to the Owner.

PART 2 – EXECUTION

2.1 CONCRETE RESTORATION

A. Identifying Concrete Repair Areas: Sound the exposed concrete for areas of spalled, delaminated, or deteriorated concrete.

B. Repair Quantities: Calculate repair quantities for each type of repair and submit to Engineer.

C. Repair Area: Based on the extents of the damage as determined by Engineer; the repair area will be one of the following configurations:

1. Small:Partial depth (greater than 1 ft square)
2. Medium: Full depth and half the roadway width; should be similar dimension in both directions.
3. Large: Full depth and full width of the roadway width; should be similar dimension to half of the width with a control joint in the center.

D. Concrete Removal:

1. Removal: Delaminated, spalled, and sound areas of concrete shall be removed in accordance with ACI 201 and as indicated on Drawings and specified herein. Contractor shall use caution during removal to prevent damage to adjacent surfaces. Notify Engineer if extensive damage is observed or thought of a hazard/unsafe condition is revealed.
2. Geometry of Patch: Rectangular patch areas are recommended.
3. Sound Concrete Removal: Sound concrete shall only be removed to provide the clearances, depth, and dimension specified herein, including:

a) Partial Depth Repair: The minimum depth of a “Small” partial depth repair is 4 inches and the preference is 6 inches. There must be 6 inches of sound concrete below the partial depth repair area.

b) Perimeter Sawcut of Patch Area: Sawcut the perimeter of the concrete area to be removed to a minimum depth of 1/2-inch. Sawcuts should be made perpendicular to the surface of the concrete being cut.

c) Full Depth Repair: Thickness of the pavement according to recent core removals can range; assume 8 inches to 10 inches. If unsound concrete is found greater than 6 inches, remove for full depth repair. Notify Engineer of these locations prior to demolition.

E. Concrete Patch Preparation

1. Preparation: Remove all deteriorated concrete and sound concrete in accordance with ACI 201 and as indicated on the Drawings and Specified herein. Follow ASTM C 4259 for removal and abrading methods. Clean substrates of dirt, dust, and debris and clean reinforcing steel as indicated below.

2. Reinforcing:

a) Install #4 reinforcing bar dowels, set in epoxy, into sides of existing concrete for "Medium" and "Large" patch areas. Embed reinforcing dowel a minimum of 6 inches into existing concrete and into patch area a minimum of 1 foot. Install reinforcing within repair area as required to extend to extents of patch area.

b) Install #3 reinforcing dowels and wire mesh at "Small" patch areas. Dowel into existing and tie welding wire fabric to mid section of patch.

3. Engineer's Review of Prepared Patch: Contact Engineer when the concrete and steel is prepared, so that Engineer can review on site.

2.2 FORM WORK

A. General Locations of Formwork: Perimeters and edges of repair areas shall be at least partially formed in conformance with ACI 347.

2.3 BATCHING AND MIXING CONCRETE

A. Quality Control: All batching and mixing operations shall be developed in a manner such that the quality control is guaranteed, accurate mix proportions are maintained and all ingredients are combined and mixed to a uniform consistency.

B. Qualified Individuals: The Contractor shall designate one or two individuals as qualified to prepare the batch and mix the materials in accordance with the specifications. These individuals shall be the only people that batch and mix the concrete.

C. Measurement of Materials: Conforming to ASTM C 94

D. Mixing: All concrete shall be ready-mixed conforming to ASTM C 94 except as follows:

1. Provide concrete materials, proportions and properties as herein specified in lieu of ASTM C 94.
2. Furnish delivery ticket with each load of concrete delivered to the site to the Contractor conforming to the requirements of ASTM C 94.

E. Discharge of the concrete shall be completed within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.

F. Environment Restrictions: No concrete shall be placed at ambient temperatures lower than 45 degrees F or when the ambient temperature is projected to fall below 45 degrees F in the 24 hours following the placement.

1. Strictly follow ACI 306R during cold weather placement.
2. Strictly follow ACI 305R during hot weather placement.

G. Heating of Materials: If heated water or aggregate is used, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be added to the mixture of water and aggregate when the temperature of the mixture exceeds 70 degrees F.

H. Extreme Temperature Placement After Hours: At temperatures above 85 degrees F, the Engineer may require placements to be made at night or early morning hours, if in his/her opinion a satisfactory placement is not being achieved.

I. Addition of Water to Mix: Water may be added to the concrete to obtain a slump within the prescribed limits. Concrete with a slump less than 3 inches may be rejected if it is not placed satisfactorily and with a closed tight surface.

2.4 PLACING CONCRETE

A. Engineer's Review of Prepared Patch: Prior to placing concrete, make sure that Engineer has reviewed the prepared areas of concrete and reinforcing steel.

B. Curing of Installed Materials: Prior to placing concrete, make sure that all additional reinforcing/epoxy placed materials are sufficiently cured as determined by the material manufacturer and the epoxy manufacturer.

C. Cleaning of Tools and Equipment: Before placing concrete, all equipment for mixing and transporting concrete shall be cleaned. Vibrators shall be checked for workability.

D. Verify Prepared Patch is Ready for Concrete Placement: All debris, and water shall be removed from ground/substrate. Reinforcement shall be securely tied/set in place and thoroughly cleaned of ice and other coatings which may destroy or reduce bonding with concrete.

E. Transporting of Concrete: The concrete shall not be allowed to separate at anytime once mixed. Placing shall be at such a rate that at all times concrete shall be plastic and flow readily into all the intended locations including voids and corners. No concrete that has partially hardened or that has been contaminated by foreign materials shall be placed. When placing, concrete shall not be allowed to fall a vertical distance greater than 4 feet from the point of discharge to the point of deposit.

F. Placement: Placement of the concrete mixture shall be a continuous operation at each patch location.

G. Consolidating Concrete: The concrete shall be continuously rodded or vibrated with pencil vibrators during placement to consolidate the pour and fill all corners of the patch and voids.

1. Use equipment and procedures for consolidation of concrete in accordance with ACI 309R.
2. Do not use vibrators to move fresh concrete laterally from discharge point; shift discharge point as needed.
3. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine.
4. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

H. Cold-Weather Placement:

1. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306R and as specified in this section.
2. When air temperature has fallen to or is expected to fall below 40°F

(4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C), at point of placement.

3. Do not use frozen materials or materials containing ice or snow.

    a) Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

4. Remove frost, snow and ice from forms, reinforcement and other embedments immediately prior to concrete placement.
5. Use only the specified non-corrosive accelerating admixture previously approved as part of the cold weather mixture. Addition of calcium chloride, salt, thiocyanates or admixtures containing more than 0.05 percent chloride ions is not permitted.

I. Hot-Weather Placement:

1. Hot weather is defined as air temperature which exceeds 90°F (32°C) or any combination of high temperature, low humidity and/or high wind velocity which causes a rate of evaporation in excess of 0.2 pounds per square feet per hour (1.0 kg/m^2 per hour) as determined by ACI 305R.
2. When hot weather conditions exist that would impair quality and strength of concrete, place concrete in compliance with ACI 305R and as specified in this section.
3. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C).
4. Mixing water may be chilled, or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
5. Use of liquid nitrogen to cool concrete is Contractor's option.
6. When concrete placement will occur late in the day and reinforcing steel will be heated by the sun, cover reinforcing steel with water-soaked burlap so that steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
7. When concrete operations must be performed in direct sun, wind, high temperatures, low relative humidity, or other adverse placing conditions, the specified evaporation retarder shall be applied one or more times during the finishing operation to prevent plastic cracking.

2.5 JOINTS IN CONCRETE

A. Locate construction and contraction joints as indicated on Drawings and on approved joint location submittal.

B. Joints to match existing roadway center line.

2.6 FINISHING

A. General:

1. Patches shall be finished to match adjacent surfaces and textures.
2. Comply with recommendations for concrete finishing established by ACI 302.1R and ACI 304R.
3. Comply with dimensional tolerance limitations given by ACI 117.
4. Use techniques that will allow for a durable finish while matching the existing weathered finish (e.g. brooms, sponge screed, light retarding, etc.)

B. Patching of Ridges: Patch surfaces shall be left free from loose particles, ridges, projections, voids and concrete droppings.

C. Matching Finish: Expose the top surface of the aggregate at repair areas to match the existing in color (of the cement paste matrix), aggregates (color, size, and shape), and overall weathered finish.

2.7 CURING

A. Environmental Requirements: Concrete patches shall be maintained above 55 degrees F and in a moist condition for at least the first 24 hours after placing.

B. Normal Conditions:

1. Protect concrete from premature drying, excessive hot or cold temperature, and damage.
2. Concrete shall be kept continuously moist and above 50°F (10°C) for seven days (ASTM C 150 Type I cement) or for 10 days (ASTM C 150 Type II cement). High early strength concrete usage shall be maintained over 50°F (10°C) for three days.
3. Begin curing as soon as free water has disappeared from concrete surface and finishing has been completed.
4. Curing Methods: Cure concrete by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.

    a) Provide moist curing by the following methods:

        i. Keep concrete surface continuously wet by covering with water.
        ii. Use continuous water-fog spray.
        iii. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4" (100mm) lap over adjacent absorptive covers.

b) Provide moisture-retaining cover curing as follows:

i. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" (75mm) and sealed by waterproof tape or adhesive.

(1) Immediately repair any holes or tears during curing period using cover material and waterproof tape

5. Cure pavement, not subject to conditions of hot or cold weather concreting, in accordance with ACI 308.
6. Cure surfaces exposed to deicing salts, in accordance with ACI 308 recommendations for moist curing.

C. Cold-Weather Protection:

1. When concrete is placed under conditions of cold weather concreting (defined as a period when the mean daily temperature drops below 40°F (4°C) for more than 3 successive days), take additional precautions as specified in ACI 306R when placing, curing, monitoring and protecting the fresh concrete.

D. Hot-Weather Protection:

1. When concrete is placed under conditions of hot weather concreting, provide extra protection of the concrete against excessive placement temperatures and excessive drying throughout the placing and curing operations with an evaporation retarder.

a) Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

2. Hot weather curing is required if hot weather conditions occur within a 24-hour period after completion of concrete placement.

E. Time: Concrete repair areas must cure a minimum of 7 days prior to allowing traffic access to the repair area. Engineer to observe repairs and approve. Longer duration of cure may be needed for the larger full depth repairs.

2.8 REMEDIATION CONCRETE REPAIRS

A. Sounding of Cured "Small" Concrete Repair Areas: The Contractor shall sound all patches at the conclusion of the concrete repairs to located delaminations in the repair areas.

B. Repairing of Deteriorated Patch Areas: Any delaminated concrete shall be removed and restored at no cost to the Owner. Engineer will randomly verify concrete patches.

2.9 EVALUATION AND ACCEPTANCE OF CONCRETE

A. In accordance with ACI 301, except where otherwise specified.

B. If, at any time during construction, the concrete resulting from the approved mix design deviates from Specification requirements for any reason, such as lack of workability, or insufficient strength, the contractor shall have his laboratory verify the deficiency and modify the mix design, until the specified concrete is obtained. Modified mix to be submitted for approval to Engineer.

2.10 COORDINATION AND CORRECTIVE MEASURES

A. Conflicts: The contractor shall be solely responsible for errors of detailing, fabrication, and placement of reinforcement steel; placement of inserts and other embedded items; and the structural adequacy of all formwork.

B. Reimbursement for Additional Services: Should additional work and/or visits be required which are necessitated by failure of the Contractor to perform his work in accordance with the Contract Documents, or if additional design or drafting time is required for corrective measures caused by failure to perform in accordance with the Contract Documents, the Contractor shall reimburse the Architect and Engineer at the rate of direct personnel expense plus 150% overhead plus out-of-pocket traveling expenses incurred.

2.11 CLEANING

A. Immediately remove and clean all excess concrete, etc., from finished surfaces in accordance with manufacturer's recommendation as work progresses.

B. In areas where finished surfaces are soiled by work of this Section, consult manufacturer of surfaces for cleaning advice and conform to their advice.

END OF SECTION 03 93 00