Chicagoland

Geology and the Making of a Metropolis

Field Excursion for the 2005 Annual Meeting
Association of American State Geologists

June 15, 2005

Michael J. Chrzastowski

Open File Series OFS 2005-9

Rod R. Blagojevich, Governor

Illinois Department of Natural Resources
Joel Brunsvold, Director

ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

1905-2005 ISGS Illinois State Geological Survey

97th Annual Meeting
St. Charles Illinois

AASG
Association of American State Geologists

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"Make no little plans; they have no magic to stir men's blood and probably themselves will not be realized. Make big plans; aim high in hope and work."

Daniel Hudson Burnham (1846–1912)

Architect for the 1893 World's Columbian Exposition held at Chicago and lead author of the 1909 *Plan of Chicago*.

OFFICE OF THE MAYOR

CITY OF CHICAGO

RICHARD M. DALEY
MAYOR

June 15, 2005

GREETINGS

As Mayor and on behalf of the City of Chicago, I am pleased to welcome the members of the Association of American State Geologists (AASG) to our city for its 2005 Annual Meeting.

This meeting is held as part of the centennial celebration of the Illinois State Geological Survey (ISGS), which was established in 1905. The highlight of today's field excursion, hosted by ISGS, is a guided tour of the Chicago lakefront and the Chicago River. Both attractions have played major roles in the history of our city.

In addition, I invite you to take time to discover all that makes our city a great place to live and visit. I know you will like what you find. From our world-renowned cultural institutions and Millennium Park to our magnificent restaurants and exciting nightlife, Chicago offers something for everyone.

May you have an enjoyable and memorable visit.

Sincerely,

Richard M. Daley

Mayor

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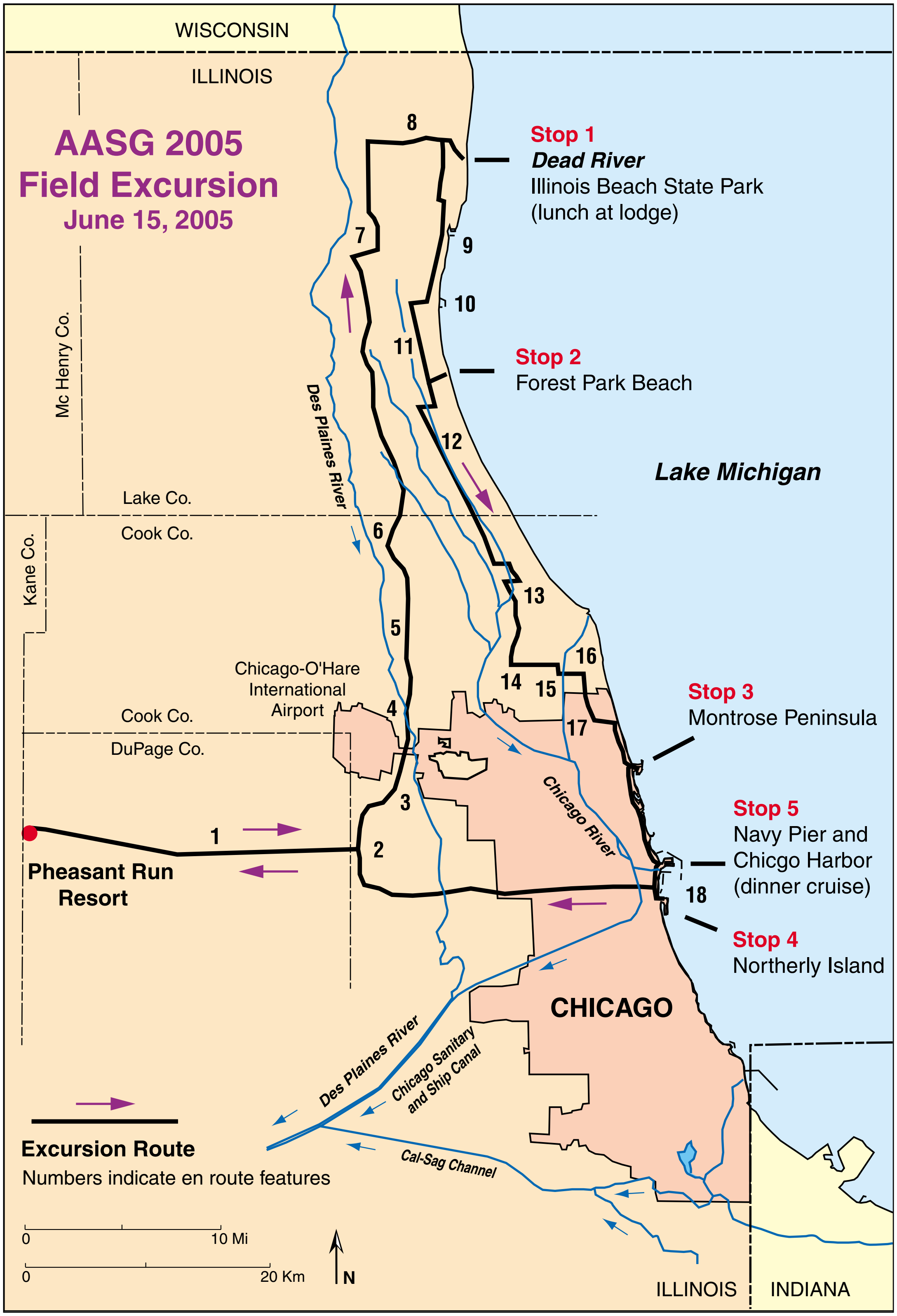

WISCONSIN
ILLINOIS
AASG 2005
Field Excursion
June 15, 2005
Stop 1
Dead River
Illinois Beach State Park
(lunch at lodge)
8
7
9
10
11
Stop 2
Forest Park Beach
12
Lake Michigan
Mc Henry Co.
Des Plaines River
Lake Co.
Cook Co.
Kane Co.
6
13
5
16
14
15
Stop 3
Montrose Peninsula
Chicago-O'Hare
International
Airport
4
17
Cook Co.
DuPage Co.
Chicago River
3
Stop 5
Navy Pier and
Chicgo Harbor
(dinner cruise)
1
2
18
Pheasant Run
Resort
Stop 4
Northerly Island
CHICAGO
Des Plaines River
Chicago Sanitary
and Ship Canal
Cal-Sag Channel
Excursion Route
Numbers indicate en route features
0
10 Mi
0
20 Km
N
ILLINOIS
INDIANA

INTRODUCTION

From Marsh to World-Class City

No major city in the world has had a growth history like Chicago. In 1830, there were only 50 people living here in cabins along the marshy banks of the Chicago River. In 60 years (1890), the population was over one million, and Chicago was the second largest city in the nation (Cronin 1991, Miller 1996). During this growth, Chicago became the second busiest port in the nation and the busiest inland port in the world (Karamanski and Tank 2000). Then, as its maritime commerce diminished, Chicago became the busiest railroad center in the nation.

Chicago is a product of its unique location and physical setting. The key factor leading to the strategic and economic importance of Chicago was its position near a natural passage between the watersheds of the Mississippi River and the Great Lakes. Near Chicago, the Eastern Subcontinental Divide separating these watersheds was low enough that in wet seasons there was no division of waters and one could canoe across the "Divide." In dry times, only a short portage was needed. The history of glacial processes and changing water levels in southern Lake Michigan had combined to produce a geomorphic setting unique on the North American continent.

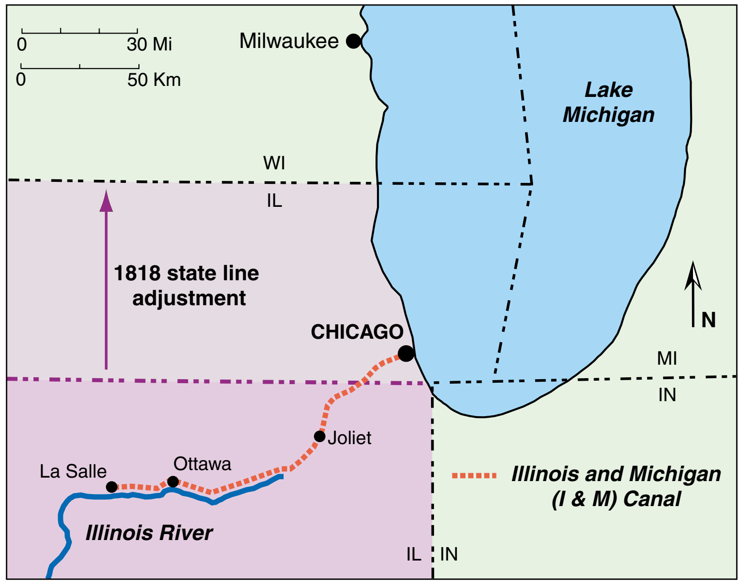
The regional landscape gave Chicago advantages that led to its becoming a major commercial and transportation center, but to make this happen required substantial geo-engineering. Chicago was not a site that was naturally favorable for settlement. The Native Americans never established a settlement here. The Indian word *Checagou* is generally considered to be a reference to the wild onion (leek) that grew in the extensive marsh area that is now the Chicago central business district known as "The Loop" (Andreas 1884, Chicago Public Library 1997). The site of Chicago was not even included within the original proposed northern boundary for Illinois (map, p. 3).

The challenges for the city's growth were numerous. Much of the Chicago area had poor drainage and was subject to flooding. There was no natural harbor along the Lake Michigan shore, and the mouth of the Chicago River was commonly restricted by sand accretion. The growth of the city required straightening and defending the river mouth, building canals, tunneling, dredging, filling, and re-grading. Some of this work was done on a grand scale. For example, the flow direction of the Chicago River into Lake Michigan was reversed, all of the land area of the Chicago central business district was raised as much as eight feet, and the 1890s building of the Chicago Sanitary and Ship Canal was one of the engineering wonders of the nineteenth century and involved excavating more material than that excavated in building the Panama Canal.

Excursion Overview

Chicagoland is the commonly used name for the eight-million-person metropolitan area that is around and including Chicago. This full-day field excursion traverses a major part of northern Chicagoland parallel to and along the Lake Michigan shore. The objective of the excursion is to examine the geologic setting that set the stage for the growth of Chicagoland and how this growth required both working with and modifying the landscape.

As Illinois gained statehood in 1818, the Illinois-Wiconsin state line was adjusted northward so that the proposed I & M Canal would be built within one state. The adjustment brought the Chicago area into Illinois.



Guidebook Orientation

Most of this excursion is by motor coach and will traverse approximately 190 miles, concluding with a three-hour cruise on Lake Michigan to view the geo-engineering needed in building Chicago's world-famous lakeshore. Selected geologic features that relate to the growth of this metropolis are highlighted. This guidebook illustrates the story with maps and photos.

The guidebook is designed for use on the motor coach during the excursion travel. A bus host will provide a brief narrative of selected en route geologic features. The guidebook shows graphics and text for each feature being discussed by the hosts. The GEO-FRAMEWORK pages of the guidebook provide an overview of the regional geology and geomorphology.

Acknowledgments

Several people from the Illinois State Geological Survey assisted in the development of this excursion plan and guidebook as well as assisted in conducting the excursion. Sallie Greenberg is acknowledged for her efforts in the excursion planning and logistics from the earliest stages. Robert Bauer, Jonathan Goodwin, William Shilts and Cheryl Nimz completed reviews of the guidebook. Pamella Carrillo completed the guidebook layout and production. For assistance during the excursion, special appreciation is extended to Daniel Adomaitis who shared responsibilities as a bus host, and Dale Schmidt and Mark Collier who provided logistical assistance at the excursion stops.

For assistance at Illinois Beach State Park, appreciation is extended to Illinois DNR park employee Robert Feffer and his assistants. The City of Lake Forest Recreation Department provided assistance with the excursion stop at Forest Park Beach. Most of all, appreciation is extended to Dr. Charles Shabica and the staff of Shabica and Associates, Inc. who graciously arranged for, sponsored, and hosted a food and beverage event at the Montrose Peninsula stop.

GEO-FRAMEWORK

Physiographic Divisions

The landscape of Chicagoland is primarily the result of glacial processes and is dominated by depositional features. The few erosional features are stream valleys and coastal bluffs.

Gradual changes in elevation often make much of the relief difficult to perceive. However, within Chicagoland there is as much as 600 feet of elevation difference between the Lake Michigan shoreline and the morainal hills in McHenry County near the Illinois-Wisconsin state line. The Chicagoland landscape contains four major physiographic divisions.

Wheaton Morainal Country

Nearly all of the features attributed to continental glaciation occur here, such as moraines, eskers, kettles, and outwash plains. This upland is dominated by multiple, juxtaposed end moraines that formed from about 15,500 to 14,000 years B.P. The individual end moraines are best defined in the Lake Border Morainic System, which is located in the suburbs north of Chicago.

Chicago Lake Plain

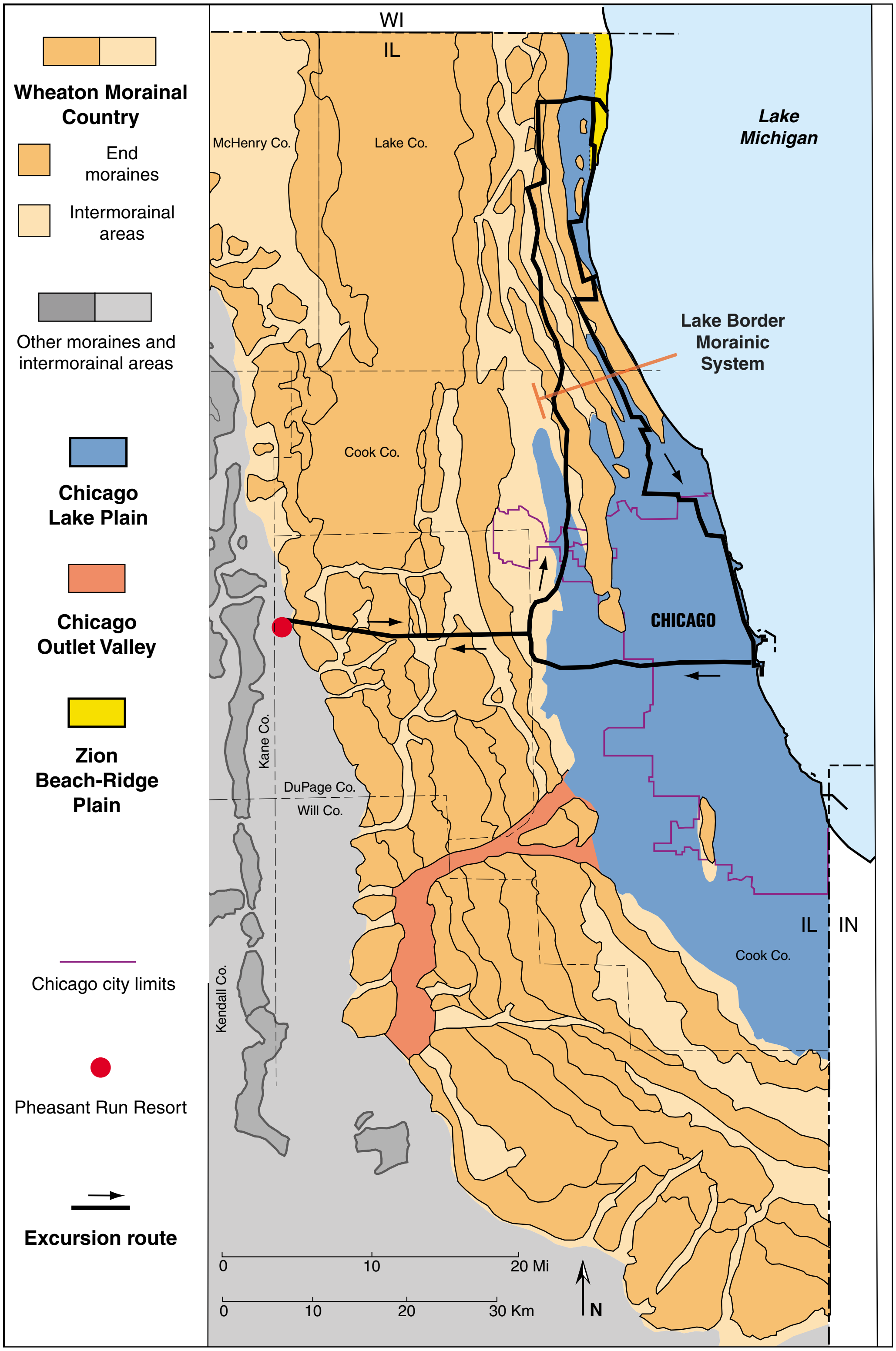
This broad, low-slope area was the floor of glacial Lake Chicago when the ice margin was within the Lake Michigan basin. Most of the city of Chicago resides on this plain. There is also a narrow band of Chicago Lake Plain near the Illinois-Wisconsin state line.

Chicago Outlet Valley

This prominent valley was eroded by glacial floodwater and outflow from glacial Lake Chicago. Outflow from ancestral Lake Michigan flowed through here as recently as about 2,500 years B.P. Much of the valley floor is eroded to the bedrock surface. The valley provides a means for modern surface drainage to pass from east to west through the Wheaton Morainal Country.

Zion Beach-Ridge Plain

This sand plain of beach and dune ridges and inter-ridge swales results from coastal deposition. The plain is up to one mile wide and extends 18 miles along the southern Wisconsin and northern Illinois shore. This migratory coastal landform has translated southward by erosion along its northern reach and deposition along its southern reach. The entire Illinois portion of the plain formed within the past 3,800 years.



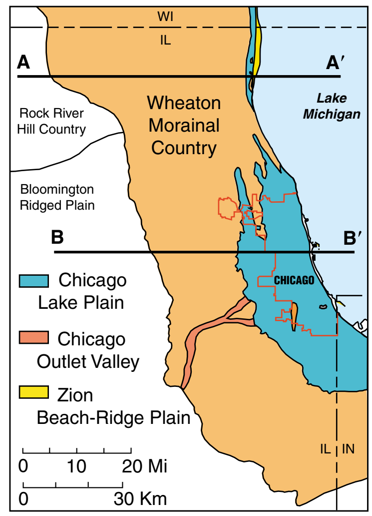
Chicagoland major physiographic divisions, end moraines, and intermorainal areas (*modified from Willman 1971*).

GEO-FRAMEWORK

Surficial Geology

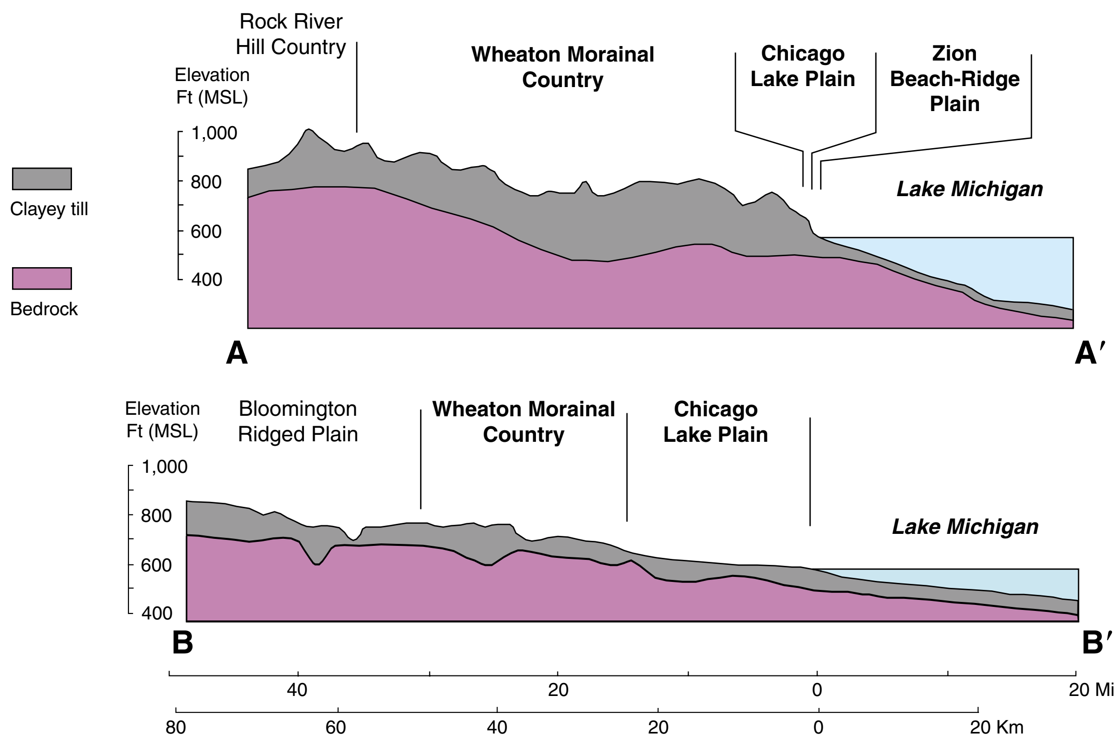
Clayey till is the dominant surficial sediment across Chicagoland. Where till is not the surface sediment, it typically underlies the other glacial, lacustrine, or littoral sediments. The thickness of till and other sediments over the underlying bedrock is variable. Along the excursion route, the thickness ranges from less than 10 feet to 200 feet or more. The Chicago lakefront includes a band of made land from lakeshore filling.

Bedrock

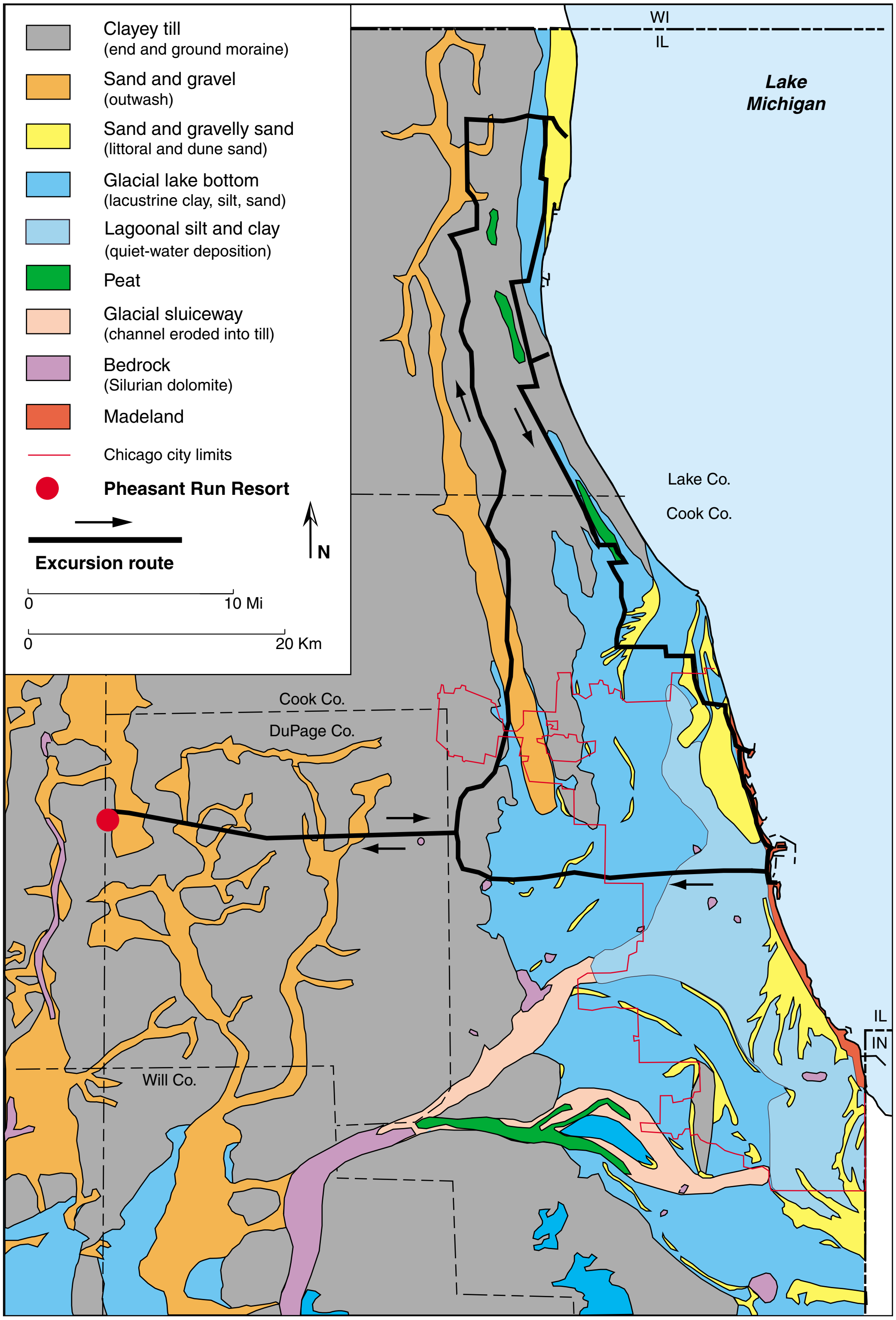


The uppermost bedrock layer across Chicagoland is Silurian dolomite. This rock is the Racine Formation of the Niagaran Series. The bedrock surface is an undulating plain with incised valleys of a pre-glacial dendritic drainage pattern. The modern streams are in the glacial sediments and have no relationship to the ancient drainage.

Bedrock is exposed along the Fox River Valley near the Pheasant Run Resort and along the Chicago Outlet Valley. Other exposures include mound-like reef deposits that rise above the surrounding bedrock surface. The hard lithology and structure of these reef deposits made them more resistant to glacial erosion. Many of the Chicagoland dolomite quarries mine these localized reef deposits.



The thickness of glacial sediment is generally greatest in the northern part of Chicagoland (after Willman 1971, Herzog et al. 1994).

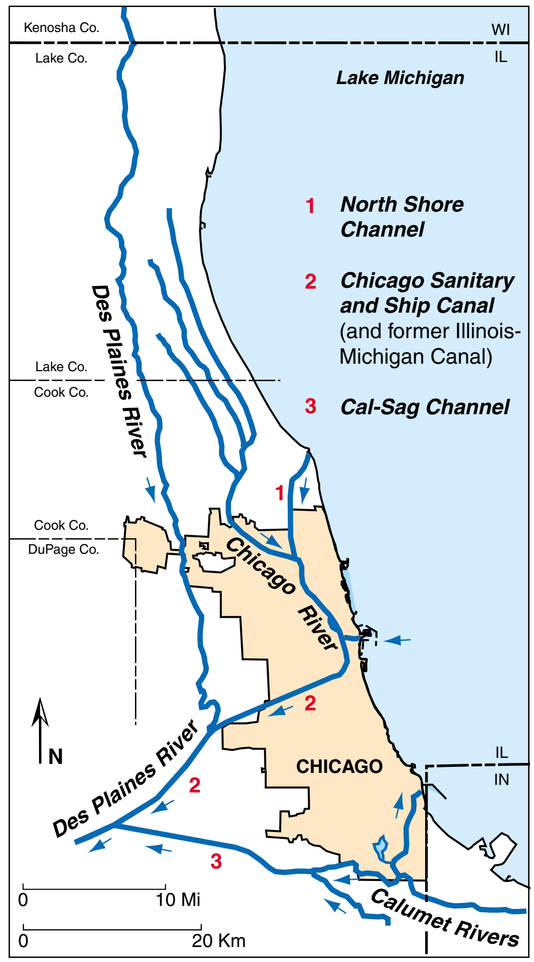


Generalized surficial geology along the excursion route (modified from Willman and Lineback 1970).

Surface Drainage

Nearly all of Chicagoland is drained by one of three river systems. These are the Des Plaines River, Chicago River, and Calumet Rivers (Little Calumet, Grand Calumet, and Calumet). Each of these has been engineered to some degree such that present channel characteristics and even flow directions are altered from the pre-development setting.

The Chicago and Calumet Rivers naturally flowed to Lake Michigan. Canals now provide the means to redirect this flow away from Lake Michigan and into the Des Plaines River. Canal building in the Chicago area began in the 1820s with work on the Illinois and Michigan Canal. This historic, 96-mile barge canal was so named for providing a navigable link between the Illinois River and Lake Michigan.



Surface drainage of most of Chicagoland is directed southwestward.

Lake Michigan

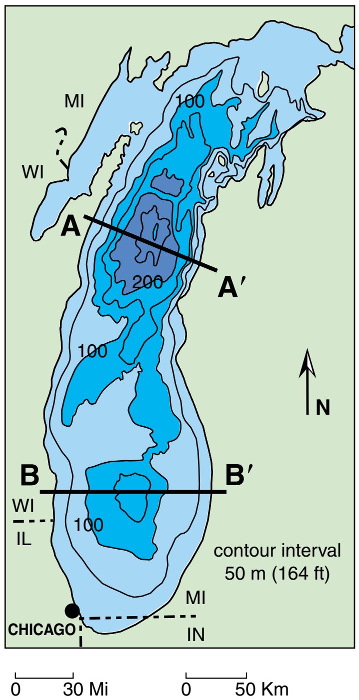
Bathymetry

Lake Michigan is the second largest of the Great Lakes in volume and the second deepest of the lakes. It is the only Great Lake entirely within the United States. The bathymetry is such that the lake is divisible into northern and southern basins.

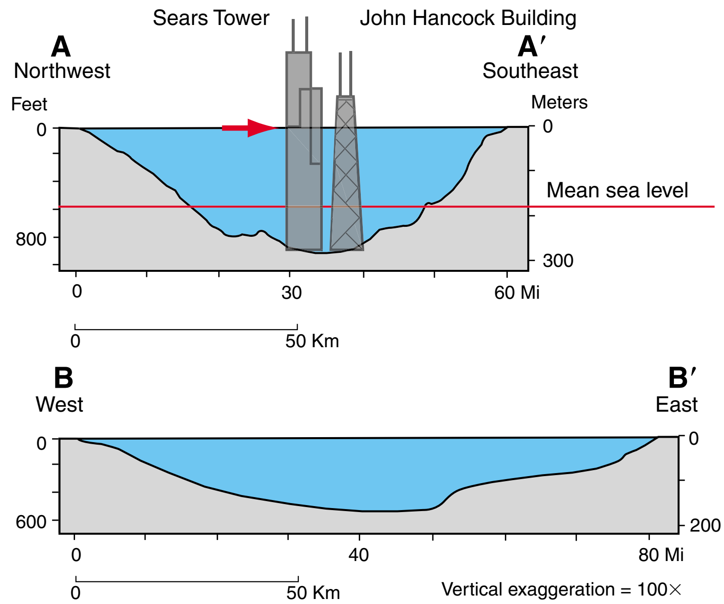
Lake Level

The Lake Michigan water level has fluctuated widely over the past 14,000 years. The causes included shifting ice positions, opening and closing different lake outlets at different elevations, erosion of outlet threshold elevation, isostatic adjustments, and changing lake volumes. Lake levels above the historical mean involved different degrees of submersion of the Chicago Lake Plain.

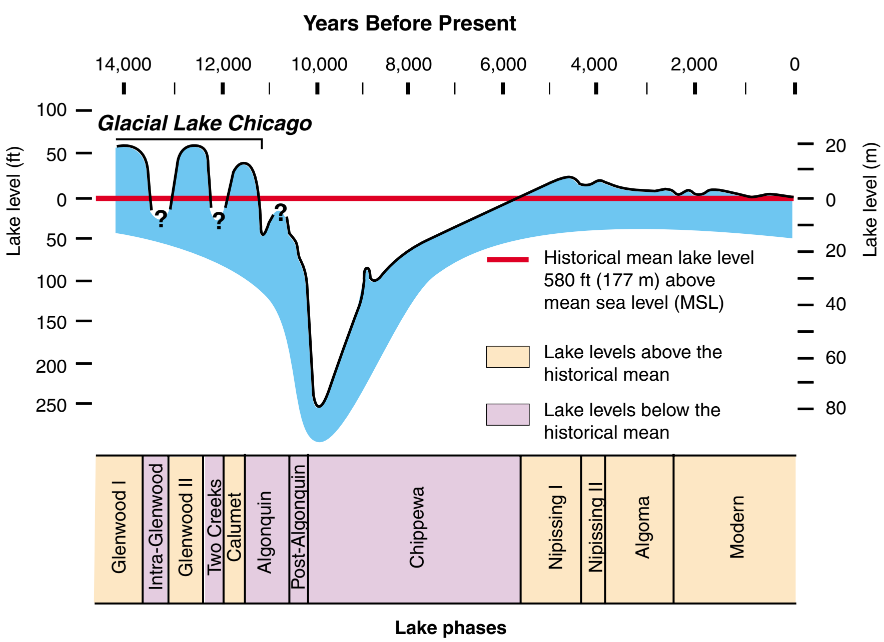
The modern lake level continues to fluctuate slightly due to atmospheric influences as well as changes in the lake water budget. Annually, the lake level fluctuates about one foot with high water in summer and low water in winter.



(After Holcomb et al. 1996, Chrzastowski 2000.)



Lake Michigan's maximum depth is 923 feet (281 m), which is 343 feet (105 m) below sea level. One of the building recesses on the Sears Tower and the bottom of the uppermost diamond on the John Hancock Building provide reference points for the maximum depth.



Glacial Lake Chicago and southern Lake Michigan lake-level curve for the past 14,000 years.

(After Chrzastowski and Thompson 1992, Colman et al. 1995.)

1 Wheaton Morainal Country

Illinois Highway 64 (North Avenue) between Pheasant Run Resort and Interstate 294 (Tri-State Tollway) crosses a series of juxtaposed end moraines of the Wheaton Morainal Country. The highway gently rises and descends as it traverses the ridges and inter-ridge swales. Approximately 125 feet of relief occurs between the highest ridges (~795 ft MSL) about 9 miles east of the Resort and the lowest swale (~670 ft MSL), which is occupied by Salt Creek.

The average thickness of glacial materials over bedrock along this segment of Highway 64 is about 80 feet. However, the bedrock rises to near the surface just south of the highway on the east side of Salt Creek. This bedrock knob is typical of the numerous mound-shaped reef deposits in the Chicago area that bring the bedrock near or to the ground surface (Willman 1971, Willman and Lineback 1970).

Valparaiso Morainic System

Most of the end moraines along this segment of Highway 64 are part of the Valparaiso Morainic System. The close spacing of the Valparaiso end moraines suggests that they represent minor pulses of the ice front or brief still stands.

Tinley Moraine

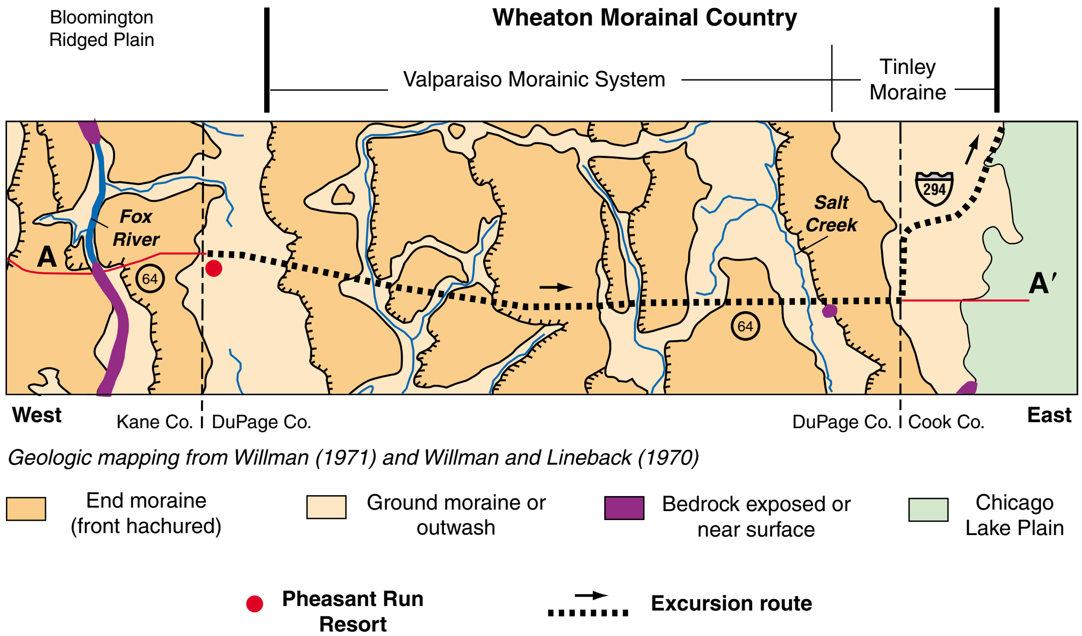
The Tinley Moraine at the east end of this highway segment (between Salt Creek and Interstate 294) has a history differing from that of the Valparaiso Moraines. The Tinley Moraine records a major ice recession and readvance onto the back slope of the Valparaiso Morainic System. The ice margin apparently withdrew into the Lake Michigan basin before readvancing, as suggested by red clays present in the Tinley Moraine but not in the Valparaiso Moraines. The red clay is derived from shales that underlie the Lake Michigan basin (Willman 1971). Glacial Lake Chicago began to form as the ice margin withdrew from the Tinley Moraine about 14,500 years ago.

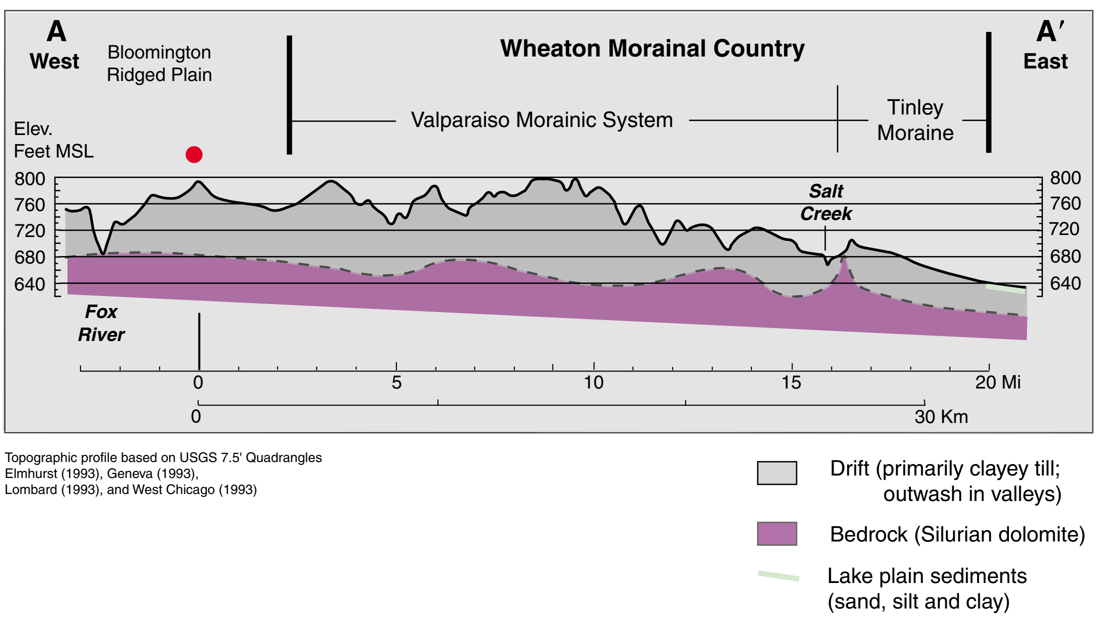
Weather and the Valparaiso Moraines

The elevations of many of the morainal ridges of the Valparaiso Morainic System are enough higher than the elevations of the surrounding landscape that the morainal uplands can influence local weather.

The moraines along the excursion route on Highway 64 are as much as 215 feet above Lake Michigan. Even higher elevations occur along the Valparaiso Moraines to the north in Lake County. These uplands can induce an orographic lift for wind coming from the east blowing off Lake Michigan.

During winter, such easterly winds combined with the orographic temperature decrease and precipitation can cause the higher elevations along the Valparaiso Moraines to receive snow while rain falls in the lower elevations across the Chicago Lake Plain.





Glacial features and topography along the excursion route on Illinois Highway 64 (North Avenue) (after Willman 1971).

2 Tri-State Tollway and the Chicagoland Interstate Highways

Chicagoland has both toll and free highways within the interstate system. Local residents commonly refer to most of these superhighways by their names rather than their numbers. Much of the system was opened within an 11-year period between 1950 and 1961 (Chicago Area Transportation Study 2001). Several of these highways were built before the 1956 passage of the Federal-Aid Highway Act that began the national interstate program. Expansion, improvements, and rebuilding have occurred over time.

Notable Aspects of the Chicago Interstate Highway System

- The tollways were built and are maintained by the Illinois State Toll Highway Authority—a state agency established in the mid-1950s specifically for building tollways in Chicagoland. All non-toll interstates in Illinois are the responsibility of the Illinois Department of Transportation (IDOT).

- A section of the Stevenson Expressway (I-55) is built atop and buries a seven-mile segment of the historic Illinois and Michigan Canal (1848-1933).

- A rest stop on the Tri-State Tollway is called an “oasis,” and each has a uniquely designed building built on a bridge over the roadway.

The Chicagoland interstate highways follow two general patterns. A radial pattern focuses on downtown Chicago. This pattern reflects the trails and roads that led to and from Chicago in its early history. Also present is a grid pattern that reflects the road grid first surveyed and established for the 1830s settlement at Chicago. The grid expanded outward with the urban growth. The Chicagoland landscape of gradual slopes and limited relief presented no topographic hindrance to either the radial or grid pattern.

Tri-State Tollway Facts

Origin of name: Extends from near WI-IL state line to near IL-IN state line and links three states

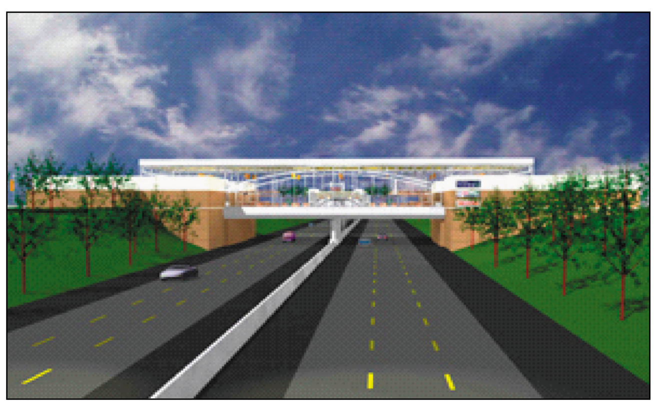
Opening: 1958

Length: 83 miles

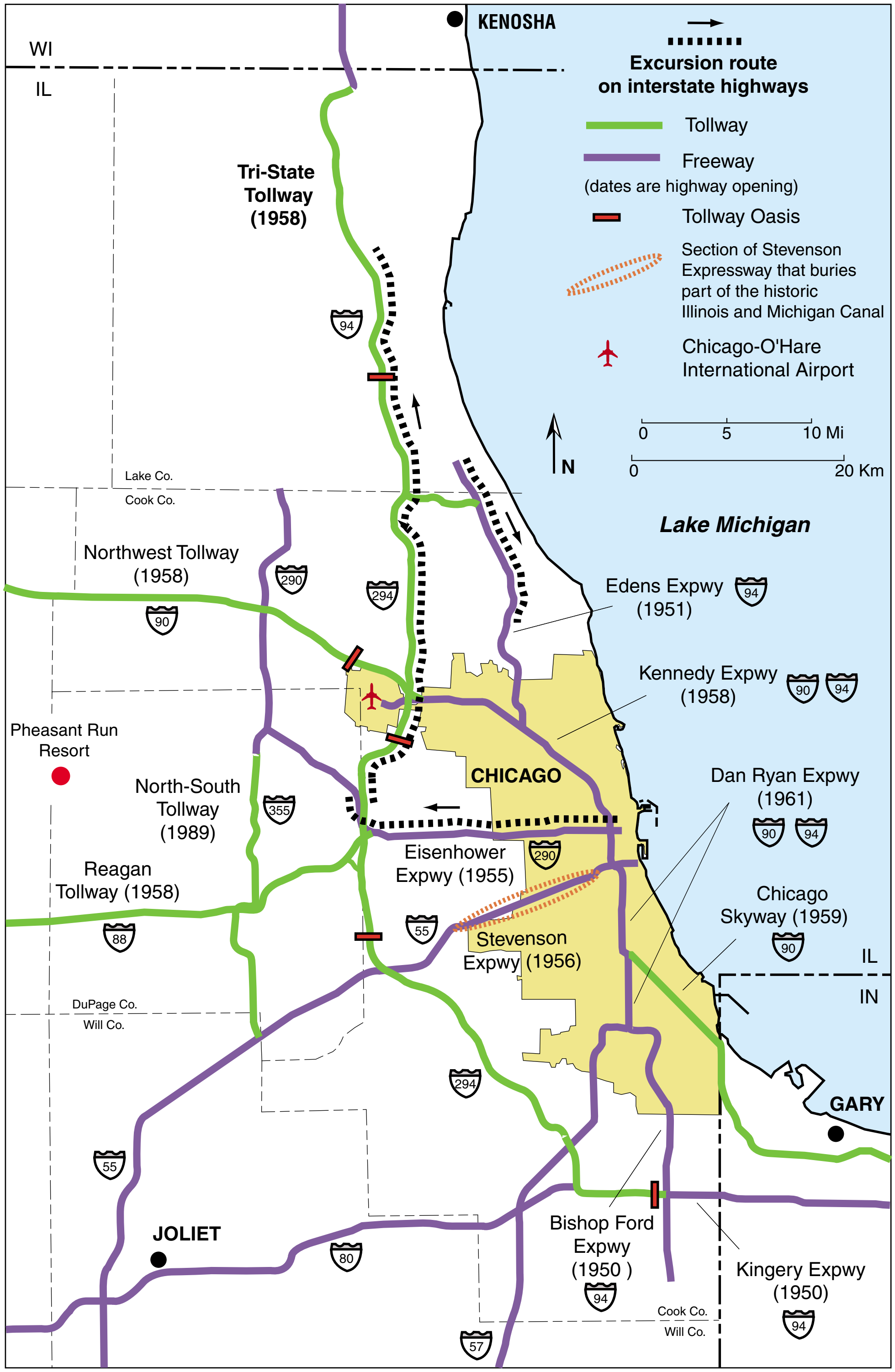
No. of toll plazas: 7

Passenger car toll: $0.80 cash
 $0.40 I-Pass

No. of oases: 4
(Lake Forest, O’Hare, Hinsdale, Lincoln)



Artist’s rendering of a remodeled oasis such as the O’Hare and the Lake Forest Oases on the Tri-State Tollway. Both are passed on the excursion route (from Illinois State Toll Highway Authority 2004).



The Chicagoland interstate highway system has a combined grid and radial pattern. The Tri-State Tollway serves as a beltway around the city of Chicago (after Chicago Area Transportation Study 2001).

3 Chicago-O'Hare International Airport

Chicago-O'Hare International Airport—commonly called "O'Hare"—is within the corporate limits of Chicago. However, unlike the rest of the city, the airport is west of the Des Plaines River and is separated from the main area of the city. A narrow land corridor makes the airport contiguous with the city proper. Land acquisition to expand the airport property is an ongoing process.

During World War II, the site of O'Hare was several miles beyond the Chicago city limits. The local small town of Orchard Place was located near the present northeast limits of O'Hare. This corner of the present O'Hare property then included an airfield (Orchard Field) and the Douglas Aircraft Company assembly plant where transport aircraft were built.

In 1946, Chicago acquired this airfield and purchased a large expanse of land to the south and west. The purpose was to build a new and second airport for the city to relieve congestion at Midway Airport located on Chicago's southwest side. In 1949, the city renamed Orchard Field "O'Hare Field" in honor of Lt. Cmdr. Edward "Butch" O'Hare (1914–1942). He was a Chicago native, a graduate of the U.S. Naval Academy, and the recipient of a Congressional Medal of Honor for heroic acts as a combat naval aviator in the South Pacific (Chicago Department of Aviation 2004, Heise and Frazel 1987). The letters "**ORD**," used by the FAA as the official designation for O'Hare, come from the former name, **OR**char**D** Field.

Chicago-O'Hare Facts

Origin of name:
World War II naval-air hero

Official opening: 1959

Elevation: Approx. 650 ft MSL
(~ 70 ft above Lake Michigan)

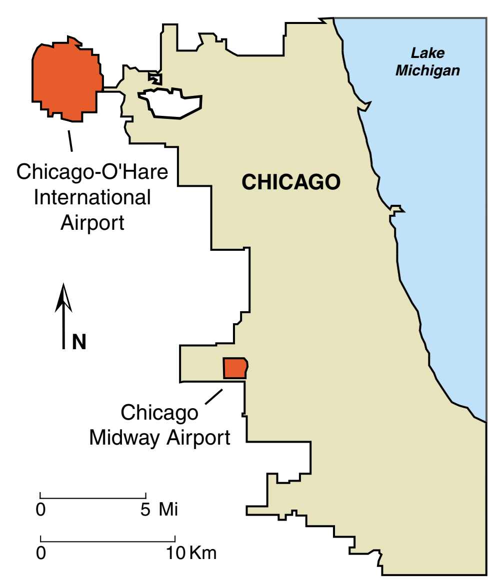
Physiographic setting:
Wheaton Morainal Country

Watershed: Des Plaines River

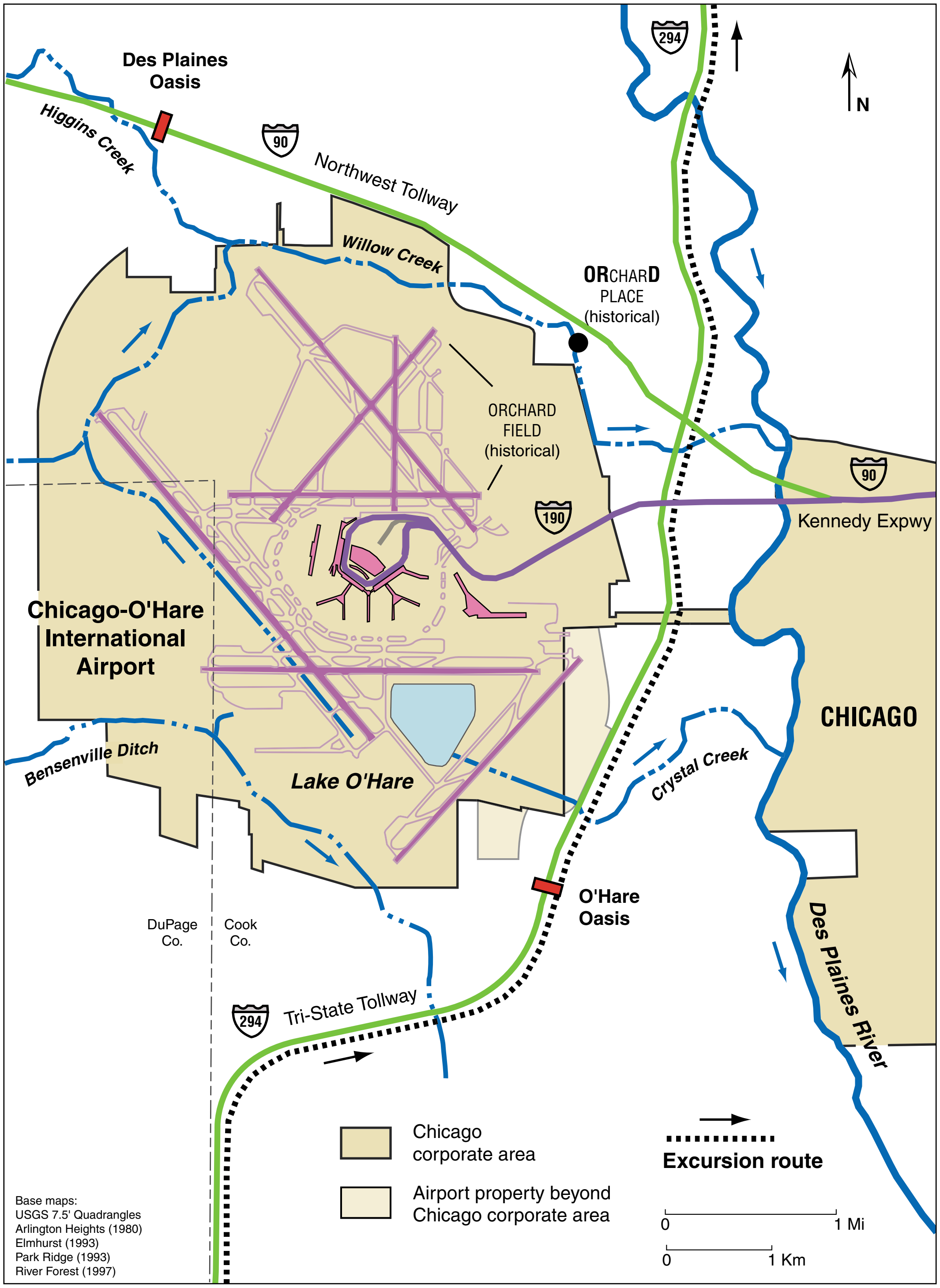
Surficial geology: Till
(Tinley ground moraine)

Depth to bedrock: ~ 75 ft

Bedrock: Silurian dolomite
(Niagaran Series; Racine Fm)



Chicago's other airport was dedicated in 1927 as Chicago Municipal Airport. It was renamed in 1949 in honor of the World War II naval-air victory at Midway Island.



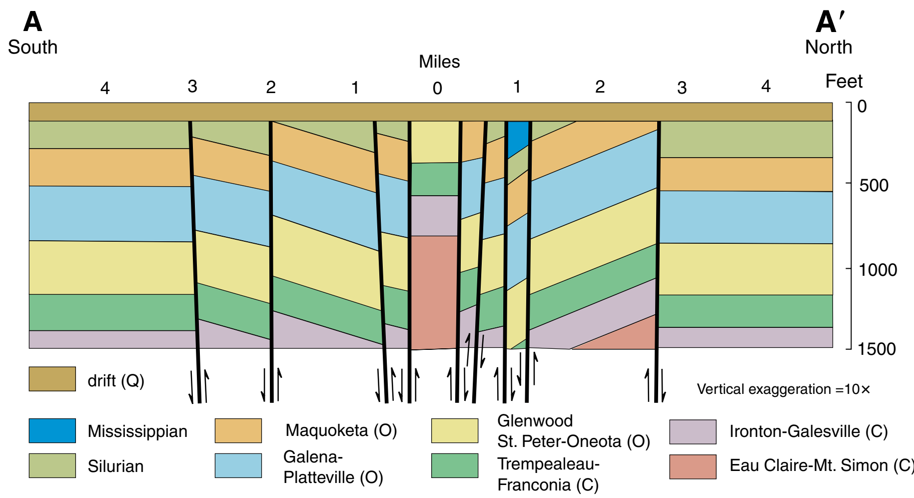
All stream drainage from O'Hare International Airport flows to the Des Plaines River. Lake O'Hare is a retention basin for the airport.

4 Des Plaines Disturbance

The Des Plaines Disturbance is a buried impact feature located north of Chicago-O'Hare Airport. Named for the city of Des Plaines, this bedrock feature, buried beneath approximately 100 feet of Quaternary cover, has no expression on the present topography. It was originally mapped across about 25 square miles (Emrich and Bergstrom 1962). However, since the original mapping, additional subsurface data suggest that the disturbance extends across a much larger area (Hier and Stephens 1996).

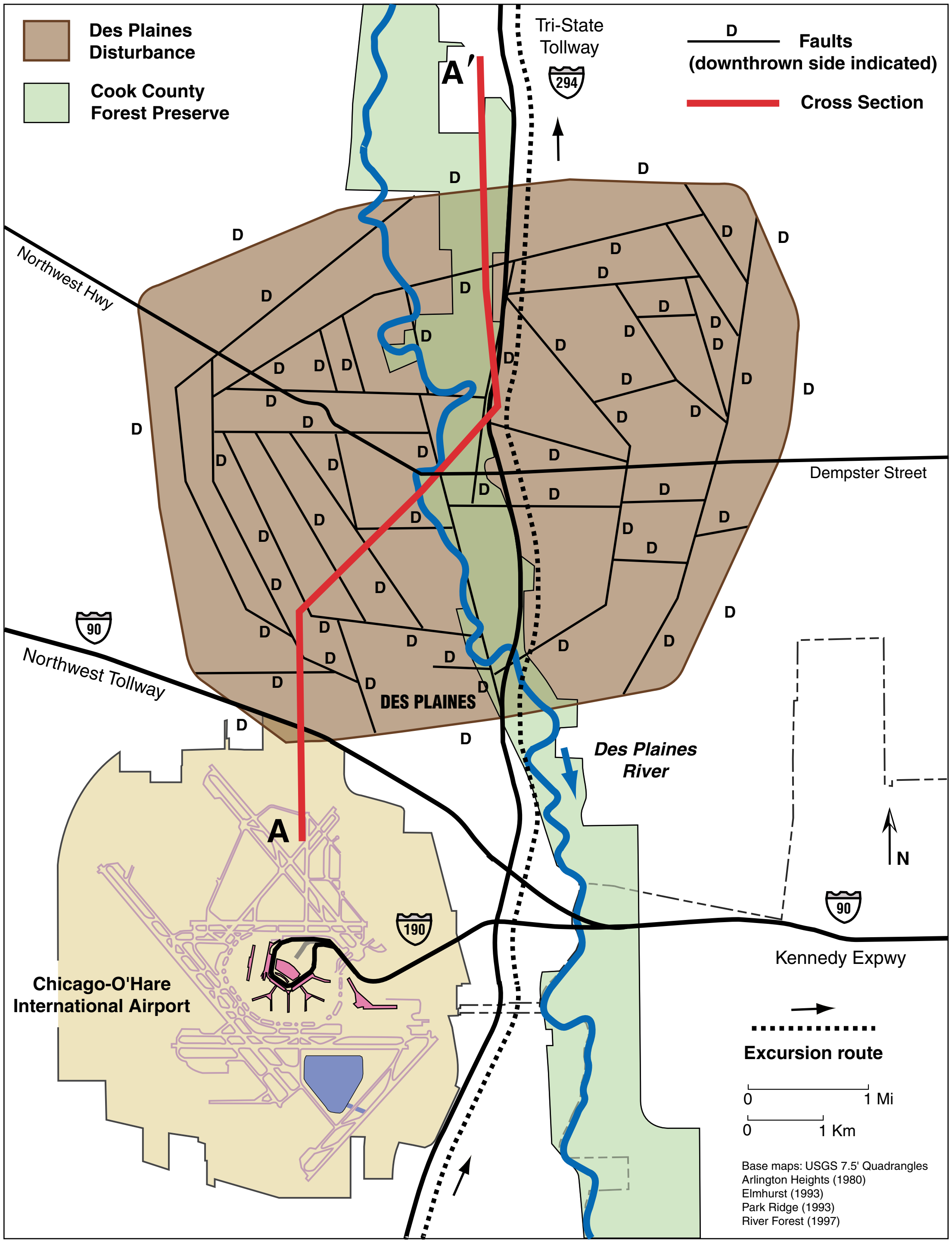
The bedrock in the disturbance is broken by numerous high-angle faults. Vertical displacements as great as 600 feet have brought basal Ordovician rocks to the surface and lowered and preserved Mississippian and Pennsylvanian rocks that have been lost to erosion in the surrounding area up to 50 miles distant. The feature has a central uplift that is characteristic of impact features (Willman 1971, Bushbach and Heim 1972).

Generalized cross section of the Des Plaines Disturbance (modified from Willman 1971).



The age of the Des Plaines Disturbance is late Pennsylvanian or younger, based on the presence of 30 feet of Pennsylvanian rocks found in one well within the disturbance (Emrich and Bergstrom 1962). Although heavily faulted, the rocks are not steeply tilted, and the stratigraphic succession in each fault block is intact. Therefore, the feature may represent only the lower part of an impact structure where the deformation is limited. The presence of Devonian rocks under Lake Michigan just a few miles from shore, the presence of Mississippian and Pennsylvanian rocks in the disturbance, and other nearby evidence all show that several hundred to a thousand feet or more of younger Paleozoic rocks may have once covered the Silurian dolomites that now form the bedrock surface.

The investigation of the Des Plaines Disturbance by Emrich and Bergstrom (1962) relied on data from nearly 300 water wells and other drill holes. Seismic profiling in the 1970s allowed more detailed mapping of the faults. Until shatter cones identified in the area confirmed the disturbance's impact origin (McHone et al. 1986), the cause of the feature remained uncertain. Other suggested origins included cryptovolcanism and the rise of a salt dome. In the late 1980s, the boring of a large tunnel through the disturbance as part of TARP (see Guidebook Feature 5) provided a more complete understanding of the complex and extensive faulting in the feature and further confirmed its impact origin (Peterson 1989).



The Des Plaines Disturbance is centered beneath the Des Plaines River about three miles north of Chicago-O'Hare Airport. This buried impact feature has an area nearly twice that of the total airport property (fault pattern from Buschbach and Heim 1972).

5 TARP

TARP (Tunnel and Reservoir Plan) is the name of a $4 billion ongoing project to complete an elaborate network of tunnels beneath Cook County for wastewater management. Most of the tunnel segments range from 240 to 350 feet below ground level. The construction began in 1975. As of 1999, TARP was 85 percent complete (Schein 2004).

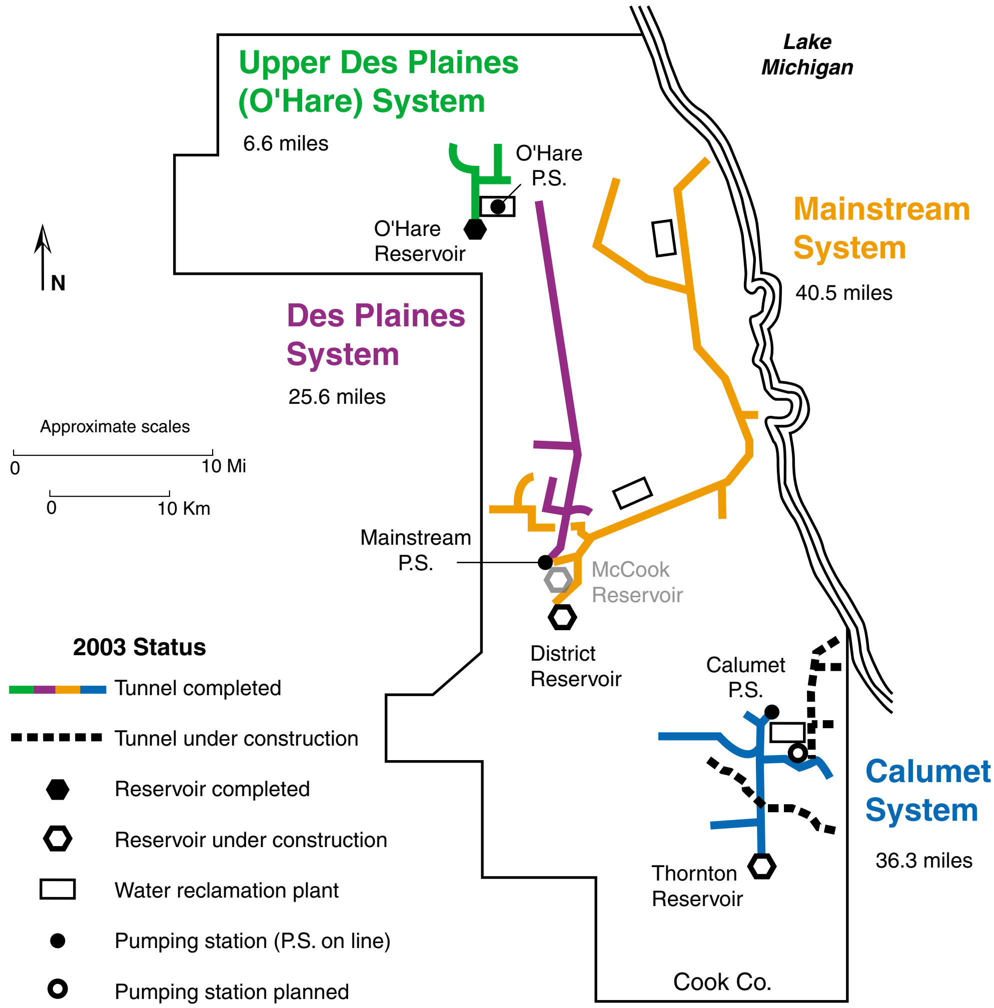
The reason for TARP is that Chicago and 52 of the older municipalities in Cook County have combined storm water and sanitary sewers. During times of extreme precipitation and runoff, the increased volume of water can require a bypass of the sewage treatment facilities and the discharge of storm water and untreated sewage into the Chicago River system and Lake Michigan.

TARP is intended to intercept, transport, and temporarily store the combined storm water and sewage. Once conditions allow, the water in the TARP system can be pumped to treatment plants and then discharged to the rivers and waterways that drain Cook County westward to the Illinois River. Drop shafts provide the means to send the water to the tunnels. The tunnels are pathways to transport water to former quarries, which will be used as temporary storage reservoirs. When completed, TARP will have 109 miles of tunnel capable of holding 1.8 billion gallons. The reservoirs are planned to hold at least 15 billion gallons (Metropolitan Water Reclamation District of Greater Chicago 2003, 2004).

The tunnels, which are up to 35 feet in diameter, are nearly all cut through Silurian dolomitic limestone. To minimize blasting, the tunnels were cut using tunnel boring machines (TBMs). Once the TBM is backed out, a concrete lining is cast in place to form a smooth tunnel wall. The tunnel boring technology used for TARP was also used in constructing the Chunnel beneath the English Channel.

A person provides scale within an unlined tunnel segment in Silurian dolomite. This photo is from a tunnel system similar to TARP being built in Milwaukee County, Wisconsin (photo by Robert Bauer, ISGS).

TARP is managed by the Metropolitan Water Reclamation District of Greater Chicago, a regional government agency separate from the City of Chicago and Cook County. The U.S. Environmental Protection Agency has provided 75 percent of the cost for the project. Completed segments of TARP are in use and have already contributed to improved water quality in the region's rivers and waterways.



TARP consists of four distinct tunnel systems each with branch tunnels. The tunnels are positioned beneath public rights-of-way, primarily beneath the region's rivers and waterways.

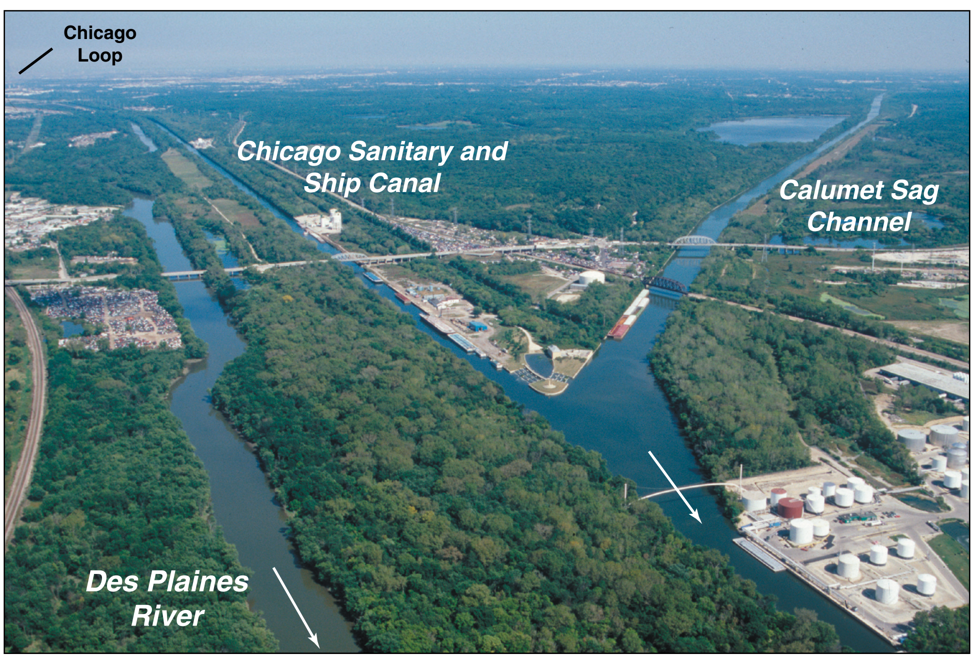
Mined-out quarries will be used as TARP reservoirs. The McCook quarry, shown here, was part of the original plan, but will be replaced by a new quarry/reservoir on nearby Metropolitan Water Reclamation District property (September 2002; photo by M. Chrzastowski, ISGS).

6 Des Plaines River and Watershed

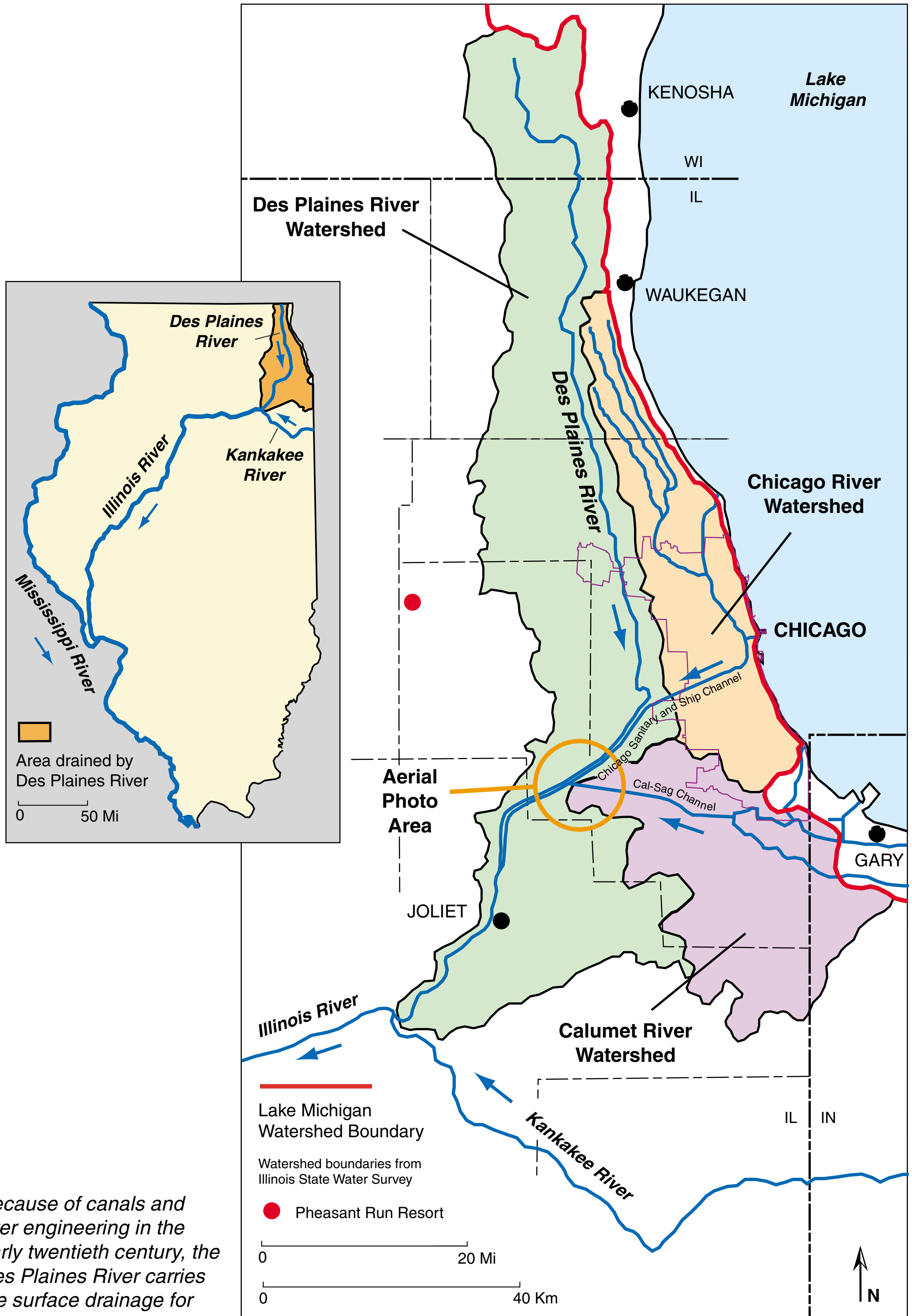
The Des Plaines River plays a major role in the surface water drainage of nearly the entire Chicagoland area. The Des Plaines originates in southern Wisconsin 12 miles north of the Illinois-Wisconsin state line. Along most of its northern reach, the river flows in the topographic low between morainal ridges. As the river passes the vicinity of O'Hare International Airport and continues southward, it traverses the western and upper part of the Chicago Lake Plain. A subtle topographic rise east of the river is sufficient to keep it directed southward rather than turning east across the plain and flowing to Lake Michigan.

About 10 miles south of O'Hare International Airport, the river turns southwest to flow through the Chicago Outlet Valley. From here onward, the river occupies the channel eroded by discharge of glacial Lake Chicago and ancestral Lake Michigan. About 25 miles southwest of downtown Chicago, the confluence of the Des Plaines and Kankakee Rivers forms the Illinois River. The total length of the Des Plaines River is 156 miles (Illinois Department of Natural Resources).

The total land area now drained by the Des Plaines River has nearly doubled since the 1800s. This increase resulted from canal construction and river engineering. In their natural settings, both the Chicago River watershed and the Calumet River watershed flowed to Lake Michigan. In 1900, completion of the Chicago Sanitary and Ship Canal redirected the Chicago River flow away from the lake and westward to the Des Plaines River. The canal joins the Des Plaines River near Joliet. In 1922, the Calumet Sag (or Cal-Sag) Channel was completed. This channel redirects the flow of the Little Calumet River away from Lake Michigan. The Cal-Sag intercepts the Chicago Sanitary and Ship Canal in the Chicago Outlet Valley.



View looking east showing the three waterways that flow through the Chicago Outlet Valley (Sept 2002; photo by M. Chrzastowski, ISGS).



Because of canals and river engineering in the early twentieth century, the Des Plaines River carries the surface drainage for nearly all of Chicagoland.

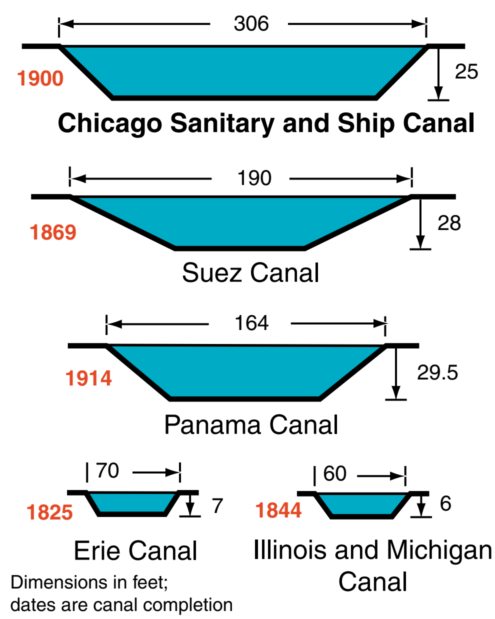
7 Headwaters of the Chicago River

After leaving the Tri-State Tollway, the excursion route is about 35 miles north of downtown Chicago and within an area that is the headwaters of the Chicago River. The Chicago River consists of the North Branch, South Branch, and a short segment (about 2 miles long) called the Main Stem, which provides a link between the two branches and Lake Michigan. The tributaries, canals, and channels that make up the Chicago River system have a combined length of more than 150 miles through Chicago and several of the north suburbs (Solzman 1998). Of the two branches, the North Branch has the significantly greater length and larger watershed.

In the early history of Chicago, the Chicago River discharged to Lake Michigan and functioned as the city's sewer main. The resulting lake pollution was at odds with the use of the lake as the primary source of drinking water. Cholera outbreaks in the mid- to late-1800s were severe. The proposed solution was construction of a canal to link the South Branch Chicago River with the Des Plaines River and to reverse the river flow in the Main Stem and South Branch away from the lake (Chicago Public Library 2004, Hill 2000).

The reversal of the Chicago River occurred in 1900 with the completion of the Chicago Sanitary and Ship Canal. Much of the canal route required cutting into bedrock. The canal's construction was comparable to building the Suez and Panama Canals.

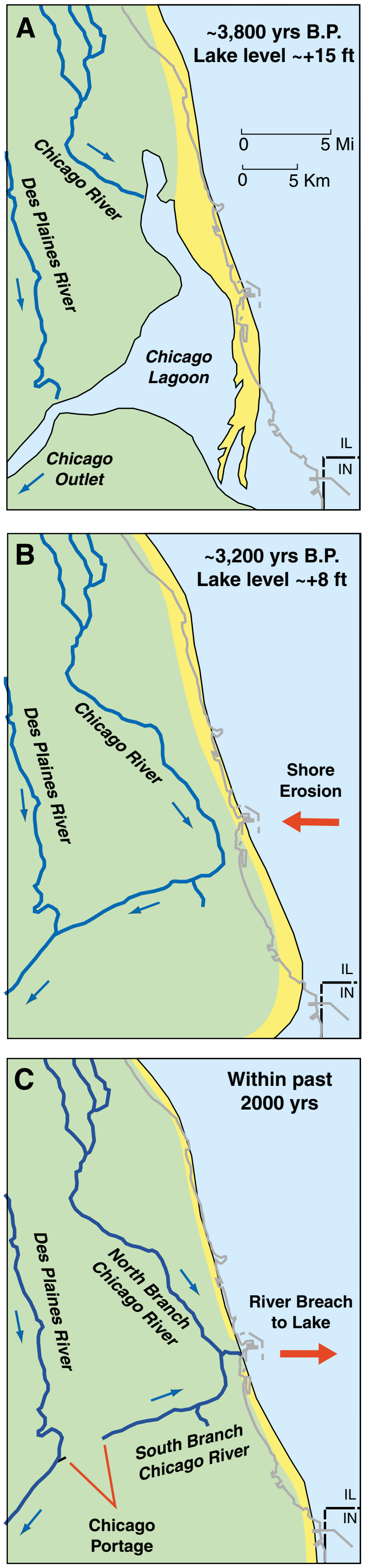
After the river reversal, times of high river level or low lake level could result in the river again flowing into the lake. By 1938, bulkheads were in place to separate the river and lake and the Chicago Lock was constructed to maintain this separation but allow boat passage.



Schematic comparison of Chicago Sanitary and Ship Canal and other major canals (modified from chipublib.org).

The reversal of flow direction in the South Branch was a major engineering achievement, but it reestablished the flow direction that existed earlier in the geologic evolution of the Chicago River. The river engineering also contributed to the Chicago River essentially having three distinct source areas:

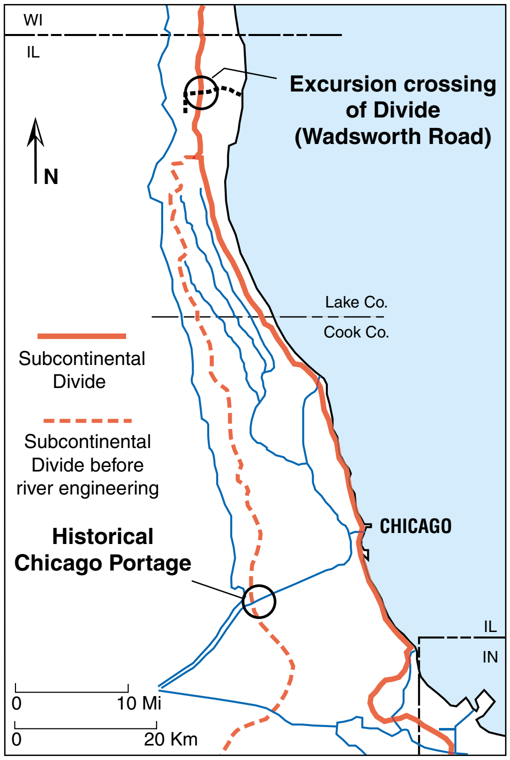
1. the naturally occurring headwaters of the North Branch
2. inflow of lake water at the Chicago Lock
3. inflow of lake water into the North Shore Channel, which was built to intercept storm water and improve flow rates in the North Branch (see Feature 15).



Geography of the present-day Chicago River system.

Geologic evolution of the Chicago River:
(A) Chicago River flows to Chicago Lagoon,
(B) Chicago River flows to Des Plains River,
(C) Chicago River breaches a channel to Lake Michigan
(modified from Chrzastowski and Thompson 1992).

8 Crossing the Subcontinental Divide



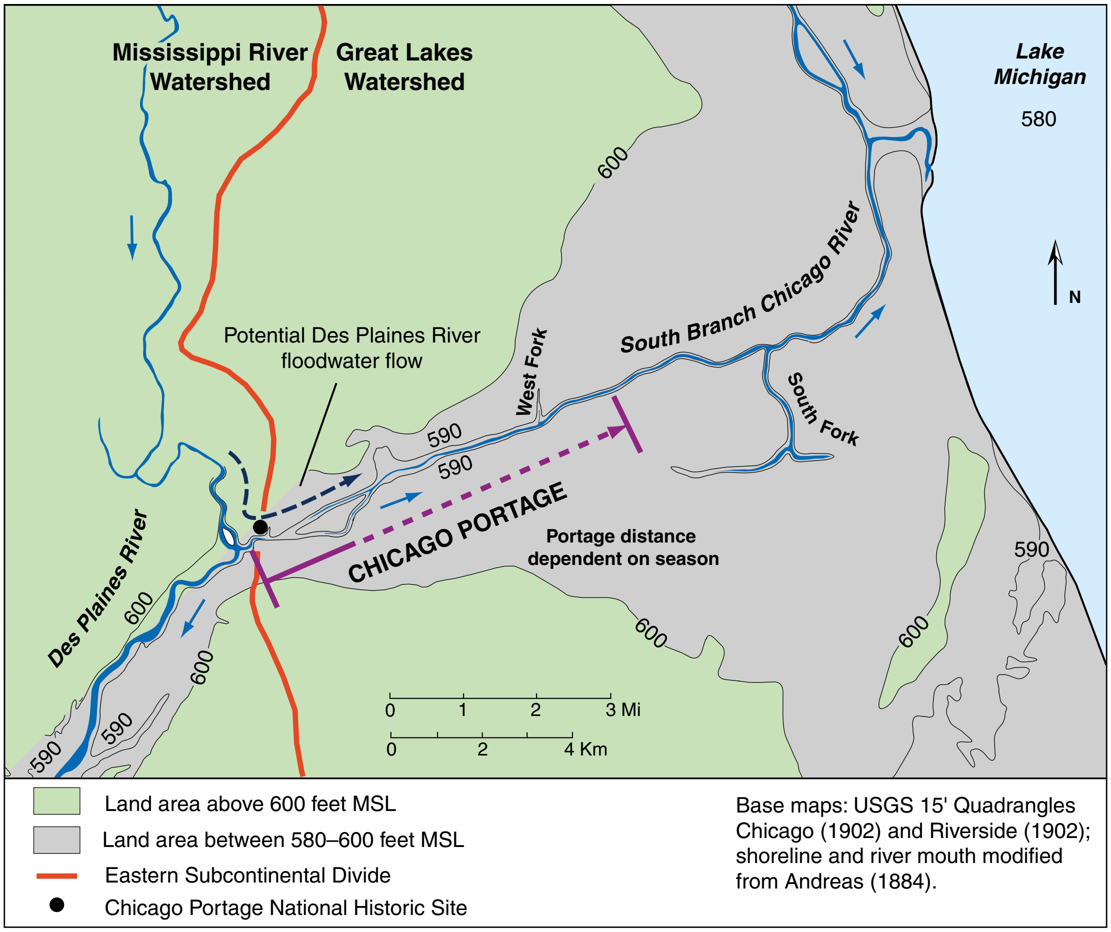
Present and historical trace of the Subcontinental Divide at Chicago.

Chicago's location on the Eastern Subcontinental Divide.

The Eastern Subcontinental Divide crosses Chicagoland and here separates the watershed of the Mississippi River system from the Great Lakes/St. Lawrence River system. The excursion crosses the Divide on the crest of the Highland Park Moraine along Wadsworth Road adjacent to the Waukegan Regional Airport. The elevation at this crossing is about 730 ft MSL, which is 150 ft above the mean level of Lake Michigan (580 ft MSL).

In Chicago, the Divide is essentially along the Chicago shoreline as a result of engineering the Chicago River and the urban storm-sewer network. The natural occurrence of the Divide was 12 miles west of present downtown Chicago at the historical Chicago Portage. Here the minimum land elevation was no more than 10 feet above the mean level of Lake Michigan. The significance of this watershed crossing was apparent to the first European explorers (Marquette and Joliet) who passed here in 1673. They noted in their journals that a short canal would provide the link for a navigable passage across the eastern half of the continent (Chicago Public Library). This vision was 175 years before the completion of the Illinois and Michigan Canal.

Seasonal conditions could significantly alter the portage distance. During dry seasons, a portage of three to four miles might be necessary. During wet seasons, the portage could be less than a mile, and there were even times when a continuous water passage occurred and no canoe portage was necessary. High water on the Des Plaines River could cross the Divide and flow into the West Fork South Branch. Historical accounts reported such a Divide-crossing flood in the spring of 1849 (Hill 2000). An ice jam on the Des Plaines River sent a surge of floodwater eastward to Lake Michigan, causing extensive damage to docks and vessels moored along the South Branch and main stem of the Chicago River.



This map reconstructs the river patterns prior to the 1830s when river engineering began. The South Branch Chicago River was originally known as the Portage River because of its use in passage between the Des Plaines River and Lake Michigan.

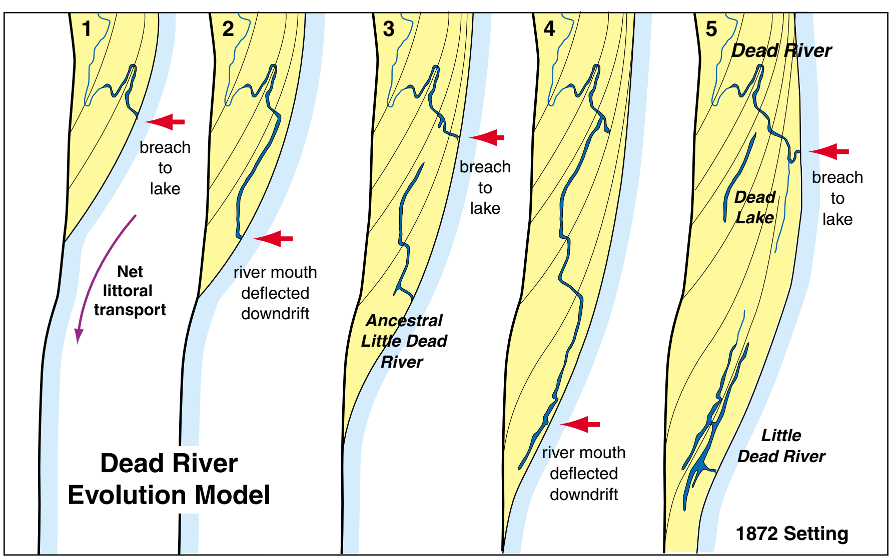
A larger-than-life steel sculpture at Chicago Portage National Historic Site commemorates the first European crossing of the Chicago Portage in 1673 by Father Jacques Marquette, Louis Joliet, and an Indian guide (October 2004; photo by M. Chrzastowski, ISGS).

Stop 1 Dead River and Illinois Beach State Park

The North and South Units of Illinois Beach State Park together occupy 4,160 acres on the Zion Beach-Ridge Plain. The plain is a distinctive coastal landform that extends nearly 18 miles from Kenosha, Wisconsin, southward to North Chicago, Illinois. The plain is up to one mile wide in the vicinity of the state park lodge. A subaqueous continuation of this coastal feature extends at least 5,000 feet offshore. In cross section, this feature is seen to be a lenticular body of littoral sand and gravelly sand up to 30 feet thick over till (Hester and Fraser 1973, Fraser and Hester 1974, Chrzastowski and Frankie 2000).

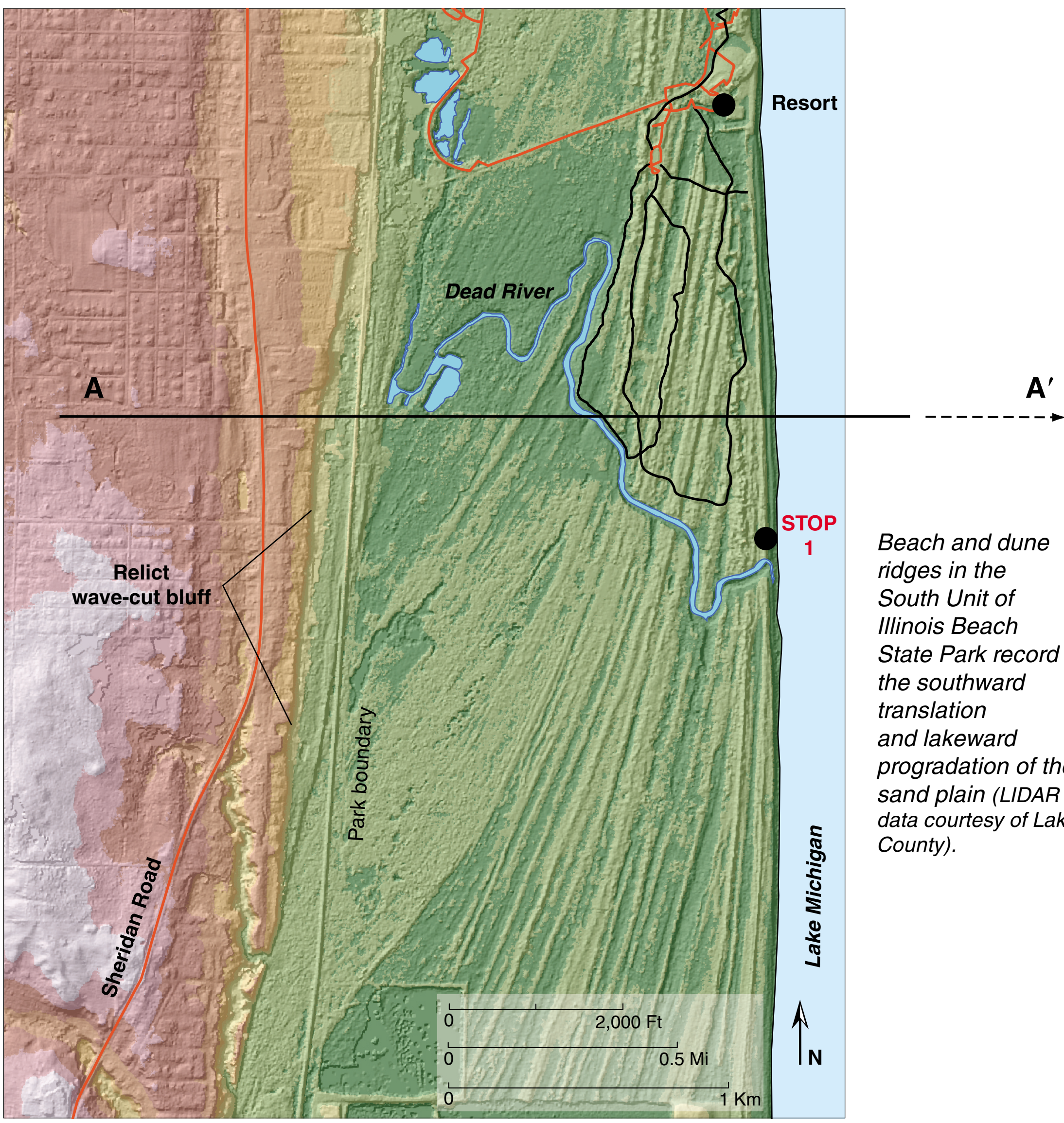
The Zion Beach-Ridge Plain is a migratory coastal landform that has been translating southward for the past 5,500 years. The source of the sand and gravelly sand was possibly a glacial-fluvial deposit along the coast north of Kenosha (Chrzastowski 2001). The translation has involved erosion along the northern shore of the sand body and redeposition along the southern shore. Dating of basal peat indicates the plain first advanced southward across the Wisconsin-Illinois state line about 3,700 years B.P. (Larsen 1985). A relict wave-cut bluff formed prior to the translation of the plain remains near the western margin of the state park sand plain. The null zone between net erosion and net accretion has shifted southward with the sand body translation. Through historical time, this zone has been centered near the mouth of Dead River.

The succession of alternating beach and dune ridges and inter-ridge swales has formed a "washboard" topography that is particularly well preserved in the state park's South Unit. The evolution of Dead River is also closely tied to the accretion history of the sand plain. The river has lengthened with time as the plain prograded. There has also been a dynamic interplay between the river attempting to breach and maintain a channel to the lake and littoral transport closing such channels and deflecting the river mouth farther downdrift. The river derives its name from the tendency to have no significant flow because of beach accretion blocking the river mouth. Numerous characteristics of the Dead River provide an analog for the natural state of the Main Stem Chicago River. The landscape near the mouth of the Dead River has numerous similarities to the natural setting of what is now the Chicago Loop (see Guidebook Feature 18).

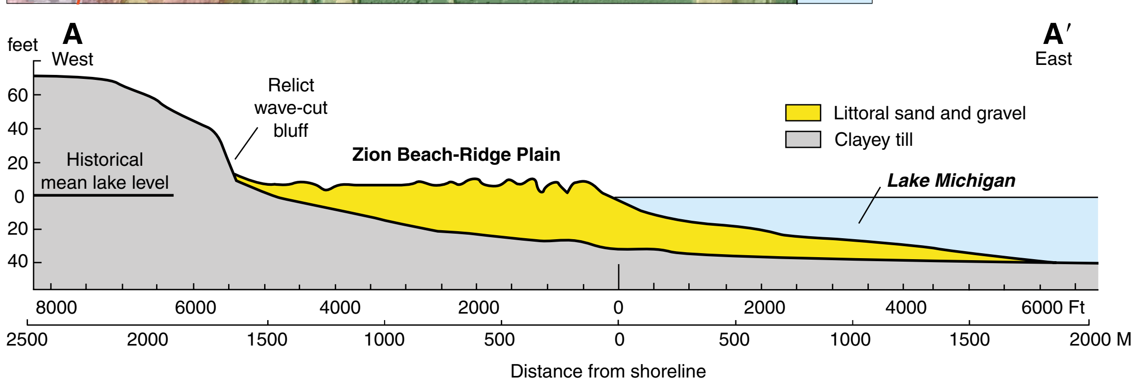


(After Chrzastowski 2001.)

Stop 1



Beach and dune ridges in the South Unit of Illinois Beach State Park record the southward translation and lakeward progradation of the sand plain (LIDAR data courtesy of Lake County).



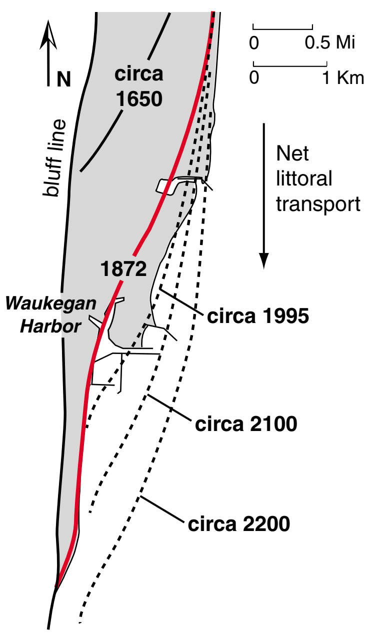
Generalized cross section showing the beach ridge sediments overlying a relict nearshore profile eroded in till (modified from Chrzastowski and Trask 1995).

9 Waukegan Harbor

Waukegan Harbor is a federal harbor built and maintained by the U.S. Army Corps of Engineers Chicago District. The U.S. Army Engineers first became involved in building a harbor here in 1852. The present harbor mainly results from construction between 1902 and 1906. Improvements occurred from 1930 through 1932 (Bottin 1988). Waukegan Marina was completed in 1984.

The MV Buffalo delivers gypsum to a U.S. Gypsum facility in Waukegan Harbor. Here the freighter is in transit through the harbor entrance channel (September 2004; photo by M. Chrzastowski, ISGS).

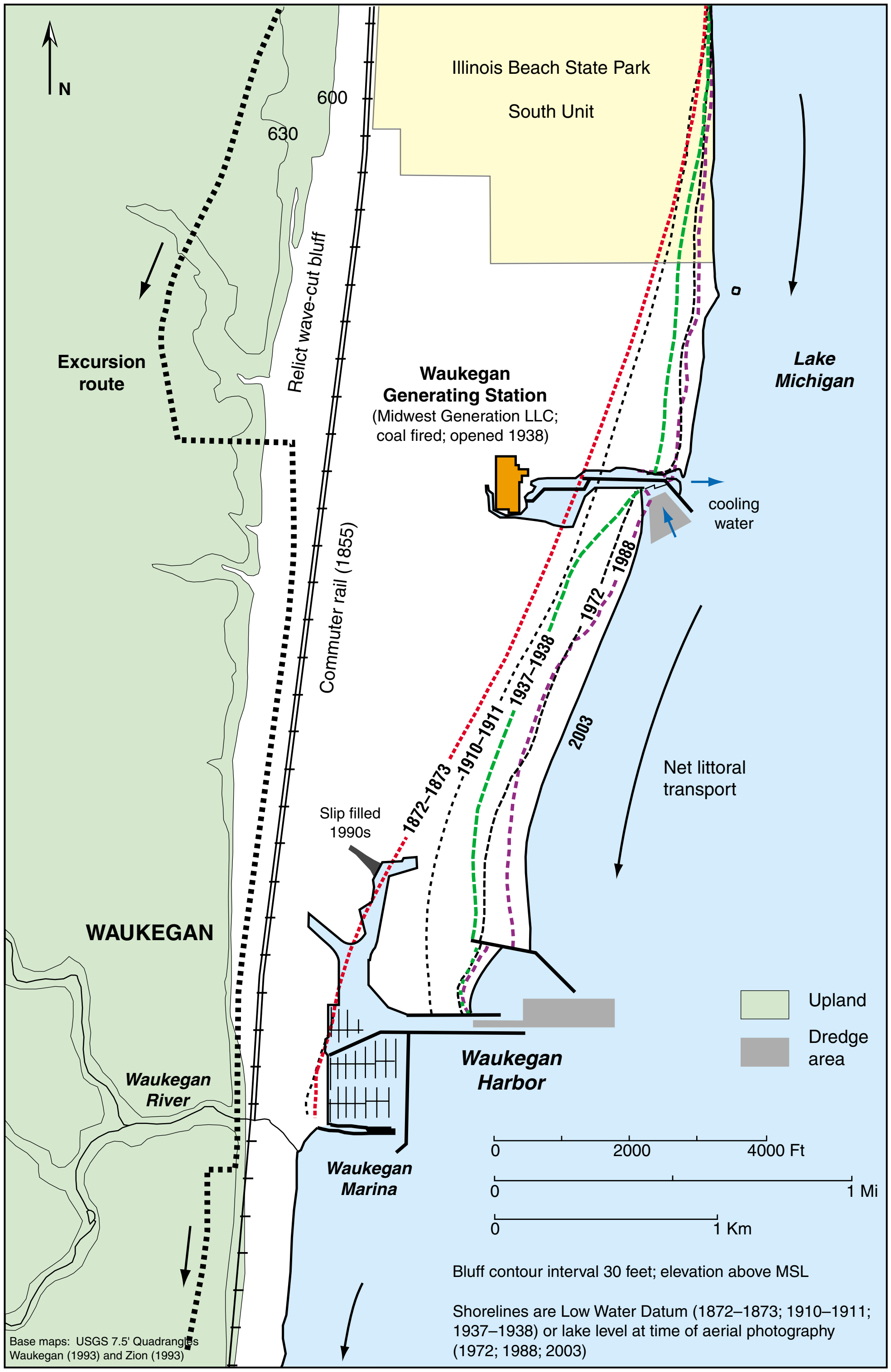
Dredging is necessary to remove littoral sand that accumulates in the entrance channel and the channel approach. The average annual accretion is approximately 40,000 cubic yards (Chrzastowski and Trask 1995). The dredged sand is typically transported northward by barge to nourish the state park nearshore.



Projected shoreline change if Waukegan Harbor had not been built (modified from Chrzastowski and Trask 1995).

No natural harbor existed here, but the shoreline curvature at this southern end of the Zion Beach-Ridge Plain provided some protection from northerly waves. This limited protection apparently led explorers Marquette and Joliet to land their canoe in this area in 1673 on their return journey to Québec after passing through the Chicago Portage. The French later established a fort atop the nearby coastal bluff. The name *Waukegan* is Potawatomi for “Little Fort,” which was the name for the original settlement (Wikipedia 2004).

Considerable shore accretion has occurred north of Waukegan Harbor. Although typical of the sand entrapment updrift of harbor jetties and breakwaters, this accretion would have occurred even if the harbor structures were not built. The naturally occurring southward migration of the beach-ridge plain would have resulted in shoreline progradation in this area.



Beach accretion since 1872 updrift of Waukegan Harbor has formed approximately 420 acres of coastal land (after Chrzastowski and Trask 1995).

10 Great Lakes Navel Training Center

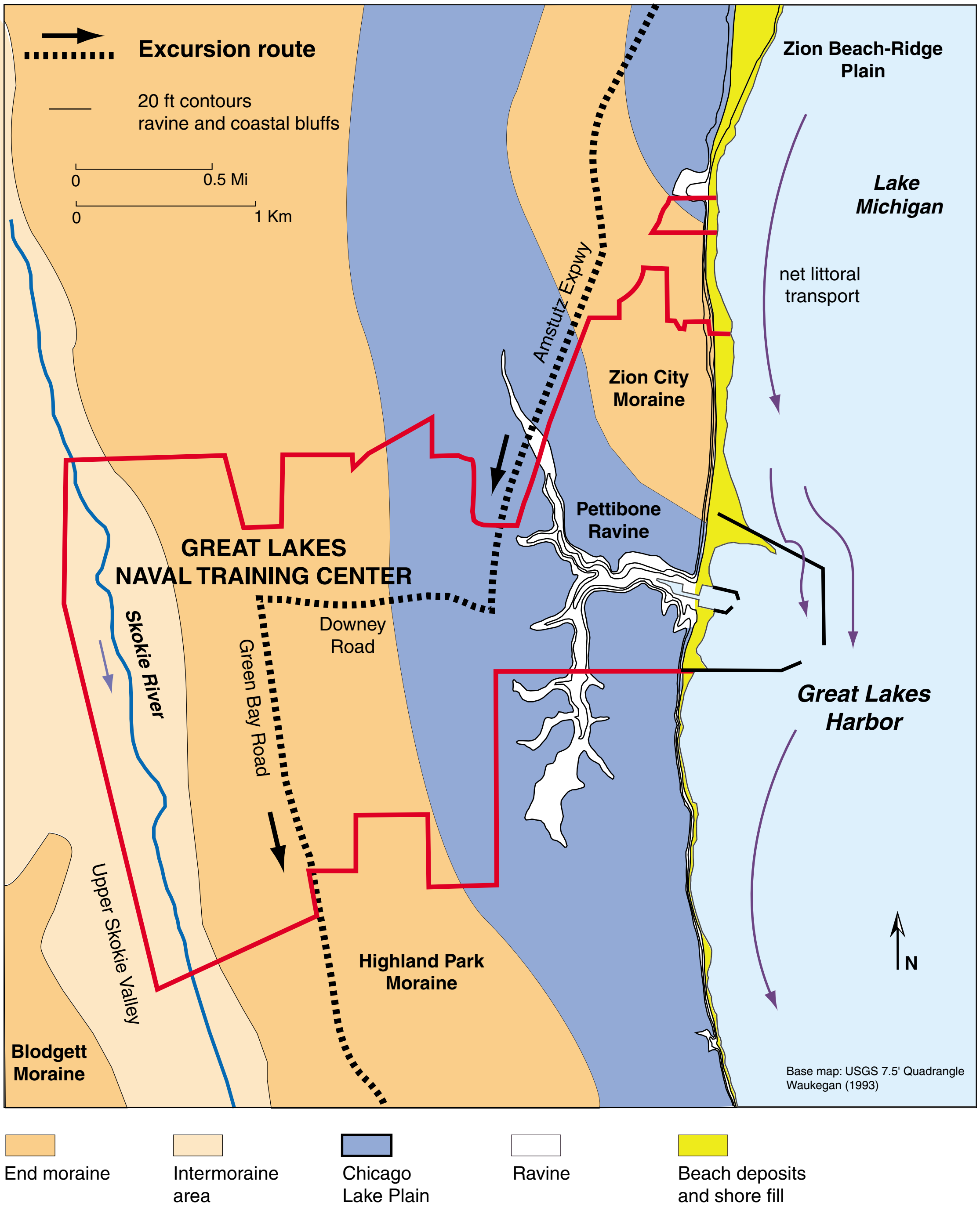
The Navy career of over 3.5 million men and women who enlisted in the U.S. Navy began at Great Lakes Naval Training Center. This base covers approximately 1,600 acres, making it the largest naval training center in the world. The base is a city unto itself with its own fire, police, and public works departments. Approximately 29,000 military and civilian staff are employed here to provide training and services for an additional 50,000 navy personnel (Global Security.org 2004).

Construction of the Naval Training Center began in 1905, and the base was commissioned in 1911. Selection of this site for a training center within the Great Lakes region primarily resulted from lobbying efforts by the Chicago Merchant Club. The Club acquired the initial land area in 1904 and offered it to the U.S. government for the base (Ebner 1988). The main part of the base is perched above Lake Michigan atop a glacial lake plain and the Zion City and Highland Park Moraines.

Great Lakes Harbor encloses an area of about 104 acres making it the largest breakwater-defended harbor north of Chicago. By comparison, the combined Waukegan Harbor and Marina total 80 acres. Construction or breakwaters to form a small harbor at the mouth of Pettibone Creek was completed by 1910. More extensive breakwaters were completed in 1923. The harbor has never been used to the extent originally envisioned. Instead, it has become a major trap for littoral sand moving southward along the shore. A low crest elevation along the breakwater has allowed storm waves to transport sand over the north breakwater and into the harbor basin. Limited harbor dredging occurred in 1952 and 1970. Over recent decades, the rate of harbor accretion has diminished as more littoral sand has been able to bypass the harbor along the lakeward side of the north breakwater (Chrzastowski and Trask 1995). Accretion of littoral sand within Great Lakes Harbor precludes use of most of the northern half of the harbor area.

Vertical aerial photo of harbor
(May 12, 1994; photo by Illinois Department of Transportation).

Oblique aerial photo of northern half of harbor viewed from the east showing close-up of sand accretion (May 3, 2000; photo by M. Chrzastowski, ISGS).



(Surficial geology from Willman and Lineback 1970.)

Land for the Great Lakes Naval Training Center was originally centered on Pettibone Ravine and with time expanded northward and westward. The ravine provided a site for the early (inner) harbor as well as access between the upland plain and the harbor. The elevation difference ranges from 60 to 80 feet.

11 Highland Park Moraine

The Highland Park Moraine extends 60 miles from southern Wisconsin in the north to the city of Wilmette in the south. This end moraine is notable for several reasons:

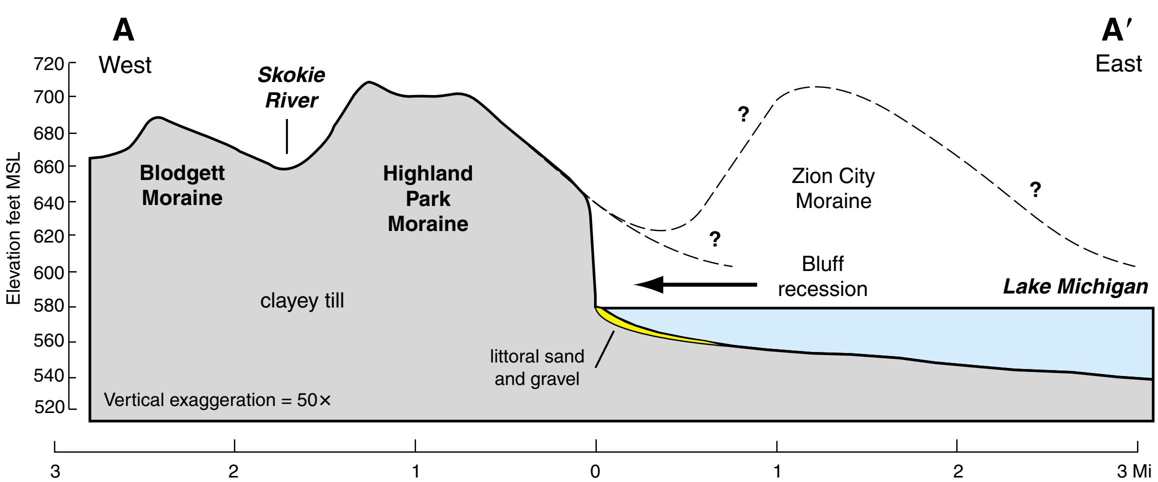
- The Lake Michigan shore intercepts the Highland Park Moraine, and coastal erosion has resulted in a bluff coast. Bluff heights are as much as 90 feet at Highland Park. Shore protection has now halted bluff recession, but the long-term historical bluff recession prior to shore protection averaged 0.6 to 0.8 feet annually (Jibson et al. 1994)

- The lakeward side of the moraine is incised by a series of V-shaped ravines. These have a dendritic pattern and reach as much as one mile inland from the lakeshore. Intermittent streams flow through the ravines.

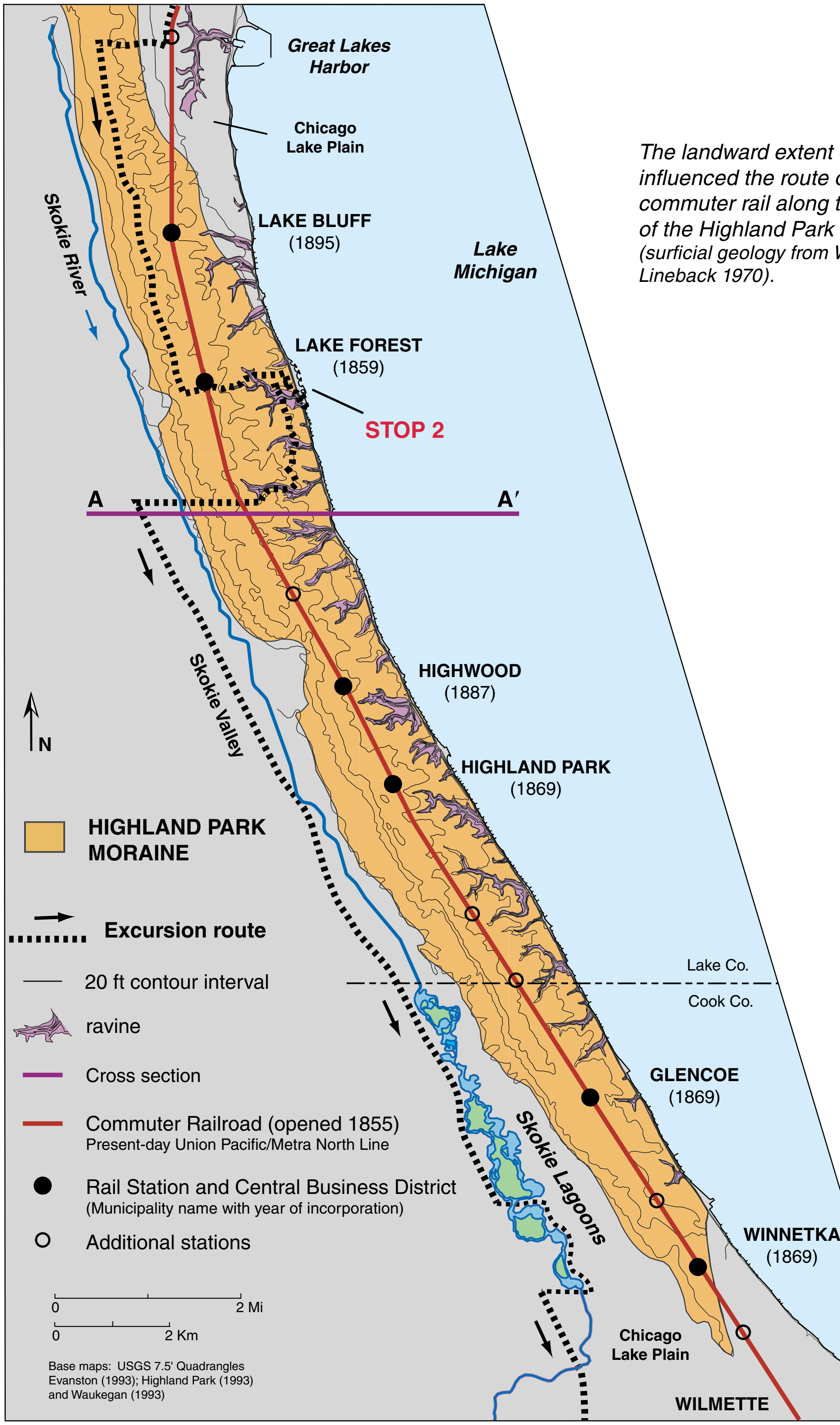
- Built atop the moraine are several of the wealthiest communities in Illinois and the nation. The bluff tops with their lakeward vistas contain Chicagoland's greatest concentration of mansions and estates.

The municipalities along the moraine are the major part of the string of lakeshore cities north of Chicago collectively called "The North Shore." Settlement and incorporation of these municipalities was spurred by the 1855 completion of a passenger rail route between Chicago and Kenosha, Wisconsin, that followed the crest of the moraine (Ebner 1988). Originally the Chicago and North Western Railroad, this is now the Union Pacific/Metra North Line. The route for the railroad was located just landward of the headwalls at the landward limit of the ravines. This route avoided the need to build bridges across these impediments. The ravine topography thus influenced the railroad right-of-way, which in turn influenced location of the stations and the central business districts.

Ravines are limited to the lakeward side of the moraine. The origin of the ravines likely relates to headward erosion of streams that drained across the emergent lake bed during the Chippewa phase (10,000 to 5,500 yrs B.P.) when lake level fell to as much as 260 feet below the historical mean (see lake level curve, page 9).



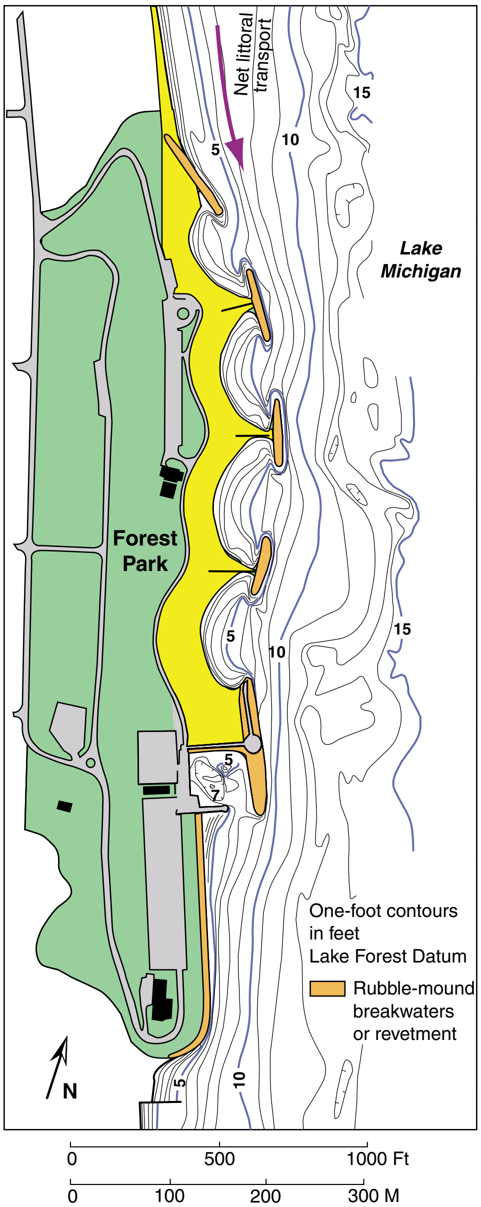
Coastal erosion has formed the Illinois bluff coast.



The landward extent of ravines influenced the route of the commuter rail along the crest of the Highland Park Moraine (surficial geology from Willman and Lineback 1970).

Stop 2 Forest Park Beach at City of Lake Forest

Forest Park Beach is the municipal beach along the Lake Michigan shore at the city of Lake Forest. This 22-acre lakeshore facility was constructed in 1987 by Lake Forest at a cost of about $9 million dollars. The project was built to provide both shore protection and recreation (Anglin et al. 1987).



Nearshore bathymetry (1995) at Forest Park Beach (modified from Chrzastowski and Trask 1996).

The coastal engineering at Forest Park Beach uses rubble-mound breakwaters to form restricted openings into beach cells. As waves enter the breakwater gap, they are refracted so that they have a perpendicular approach to the crescent-shaped shoreline of the beach cell. Predominant sediment transport within the beach cells is therefore onshore-offshore; alongshore transport is limited. The result is sand conservation within each beach cell.

Although beach nourishment has not been necessary, the boat-launch basin at the south end of the complex is a trap for littoral sediment and requires maintenance dredging. Littoral sand transported southward on the lake bottom around the lakeward side of the breakwaters by northerly waves is moved into the boat-launch basin by southeasterly waves (Chrzastowski and Trask 1996, 1997). Annual maintenance dredging removes on average about 6,000 cubic yards, which is transported and dumped in the nearshore south of the park property. The dredging allows continued southward net transport.

Forest Park Beach is the largest of numerous beach-cell systems constructed along the Illinois bluff coast in recent decades along both municipal and private properties. This design to contain placed sand is becoming necessary because of reduced volume of littoral sand in transport. Bluff erosion was once the primary source of beach sediment supply. The volume of sediment in the littoral transport stream has diminished as more of the bluff coast has been armored, and bluff erosion has nearly been eliminated (Shabica and Pranschke 1994). Beach-cell systems may represent the future for beaches along much of the Illinois bluff coast from Waukegan south to Evanston.

Above: View of Forest Park Beach from the north (July 1994).

Left: The park's preexisting groin field and narrow beaches are visible in this July 1986 view from the south. Construction is under way on the third rubble-mound breakwater counting from the north. The southern breakwater and its shore attachment define the small boat basin (photos courtesy of City of Lake Forest).

Example of beach cells built along private lakeshore in Lake Forest (May 3, 2000; photo by M. Chrzastowski, ISGS).

12 Skokie Valley

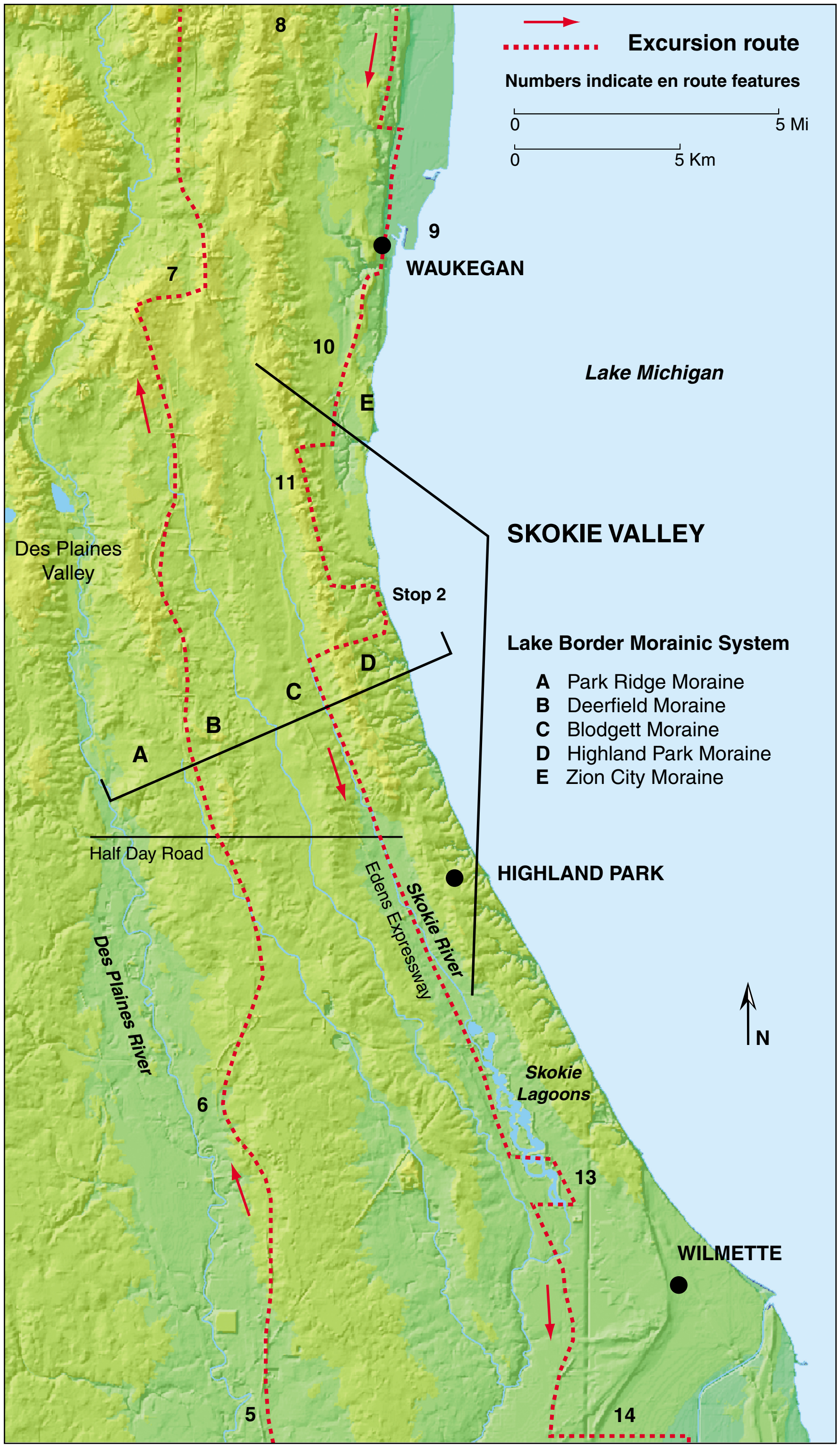
Skokie Valley is an 18-mile-long intermoraine lowland between the Blodgett Moraine to the west and the Highland Park Moraine to the east. The morphology of the two bounding moraines gives Skokie Valley a nearly linear trend and makes it the best defined of the three sub-parallel intermoraine lowlands within the Lake Border Morainic System. At most, the valley floor is 70 feet lower than the crest of the nearby moraine. This maximum relief occurs in the valley's central section in the vicinity of Highland Park. The length of the valley is traversed by the Skokie River.

The Skokie Valley has been a natural transportation corridor since the earliest settlement in the area. An inter-urban electric passenger railroad was built along the western margin of the valley in 1925. This right-of-way is now used for commercial rail as well as high-tension transmission lines. The valley provides for the route of U.S. Highway 41 (Skokie Highway), which has a long history as a highway link between Chicago and Milwaukee. In the southern part of the valley is a segment of the Edens Expressway, which is part of I-94. Completed in 1951 and originally called Edens Parkway (also Edens Superhighway), this expressway is one of the first built in Chicagoland. It is named for William G. Edens, who was an Illinois banker and early advocate of paved roads. In 1918, he sponsored the state's first highway bond issue and is credited with "taking Illinois out of the mud" (Chicago Area Transportation Study 2001).

Skokie Valley is divisible into northern and southern reaches based on morphology and geologic history. The transition occurs in the vicinity of Half Day Road. North of the road, the valley floor is narrow and beyond the maximum extent of submergence by waters from glacial Lake Chicago. To the south, a broader valley floor with a gentle and persistent southward slope occurs. This southern part of Skokie Valley was once a finger-like inlet of early glacial Lake Chicago (see Features 13 and 14).

The Skokie Swift, an electric commuter train, still operates along the southern part of the former inter-urban railway that once extended along the entire length of Skokie Valley (April 2005; photo by M. Chrzastowski, ISGS).

Restored circa 1920s inter-urban station at the Dempster Street station of the Skokie Swift (April 2005; photo by M. Chrzastowski, ISGS).



Skokie Valley is the best defined of the series of intermorainal lowlands in the Lake Border Morainic System (DEM generated by Curtis Abert, ISGS).

13 Skokie Lagoons

Skokie Lagoons are a man-made series of connected basins located in the southern part of Skokie Valley. The lagoons have 190 acres of water area and a maximum depth of about 16 feet. The lagoons and the surrounding forested land are owned and managed by the Forest Preserve District of Cook County (Forest Preserve District of Cook County 1961).

The natural setting in this area was an extensive marsh and peat deposit up to four feet thick that was crossed but poorly drained by a small river. *Skokie* is a Pottawatomi word for marsh, and the Pottawatomi called this area *Chewab Skokie* (great marsh). Early settlers, not being particularly concerned by redundancy, called the place Skokie Marsh. The Pottawatomi's marsh, thus, is the origin of the name for the river, the valley, and a suburb two miles to the south.

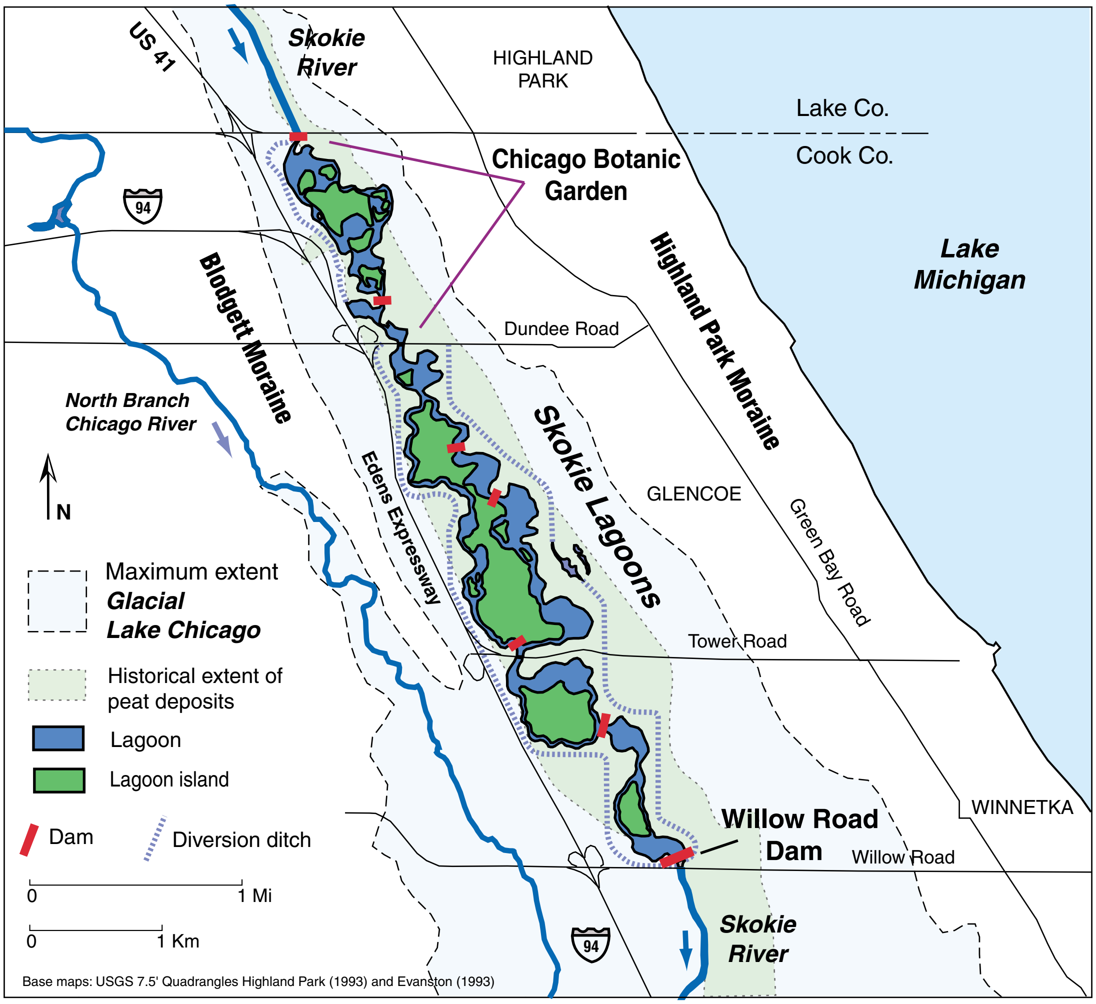
Seasonal flooding of Skokie Marsh was a problem for early farming in the area, and poor drainage and mosquitoes were health concerns. In the late 1800s, there were limited efforts toward land draining and flood control. However, the area was also recognized for its recreational potential for fishing and picnicking and as a natural area.

In the 1920s, the Forest Preserve District of Cook County acquired much of the marsh area for forest preserve development. No significant improvements were made until 1933 when President Franklin D. Roosevelt appointed local Wilmette resident Harold L. Ickes as Secretary of the Interior. Ickes made flood control and recreational enhancement of the Skokie Marsh a priority project of the Civilian Conservation Corps (CCC). Work began in May 1933 and continued until 1942. At the peak of the project, more than 1,000 men were stationed here, making this one of the largest CCC camps in the nation (Hill 2000, *Chicago Daily News* 1935).

The CCC project involved digging the basins, channels, and diversion ditches; building a series of dams and dikes; using fill to make elevated land for roadways and uplands; and landscaping the newly created uplands. The largest of the dams is Willow Road Dam at the south end of the lagoons. An estimated four million cubic yards of earth was moved in the project (Forest Preserve District of Cook County 1961). Although mechanized means were used in most of the earth moving, a considerable amount of excavating was done by hand. The excavations to create Skokie Lagoons contrast with the filling and grade raising that were done to eliminate marsh areas in what is now the Chicago Loop (Guidebook Feature 18).

Chicago Botanic Garden

Beginning in the 1960s, additional lagoons, islands, and uplands were constructed north of Skokie Lagoons for the 385-acre Chicago Botanic Garden. This facility is owned by the Forest Preserve District of Cook County and is operated by the Chicago Horticultural Society. The Chicago Botanic Garden contains more than one million plants and includes restorations of historic Midwest landscapes (Chicago Botanic Garden 2004).



Skokie Lagoons were constructed within the extent of historical peat deposits along the Skokie Valley (surficial geology modified from Bretz 1930-1932a, b, Willman and Lineback 1970).

Willow Road Dam at the south end of Skokie Lagoons is the main control dam for the lagoon system (June 2004; photo by M. Chrzastowski, ISGS).

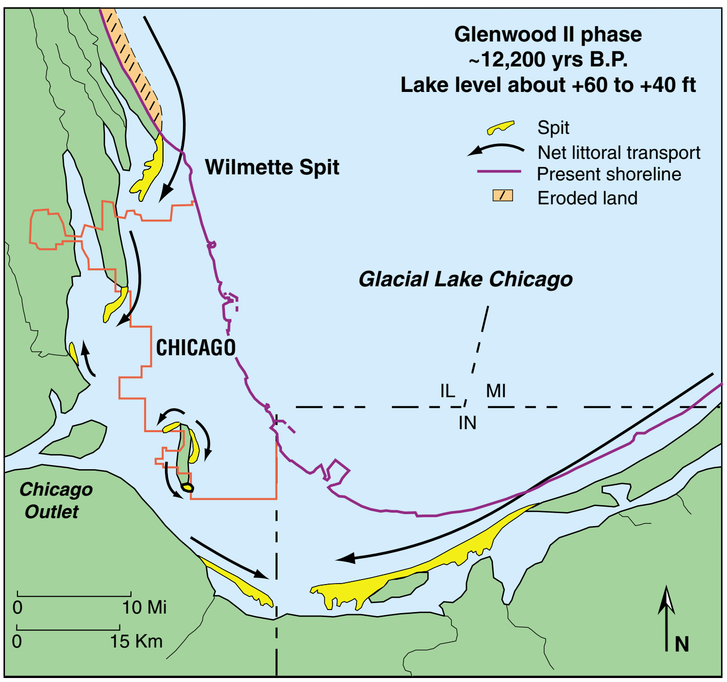
14 Wilmette Spit

The geologic history of lake submergence of the Chicago Lake Plain is recorded by relict shorelines and spits. These features consist of sand and gravelly sand eroded from the morainal uplands on the lake margin and moved alongshore by littoral transport. The progressively lower lake levels of successive high lake phases formed a series of spits on the Chicago Lake Plain that are sequentially younger and lower in elevation.

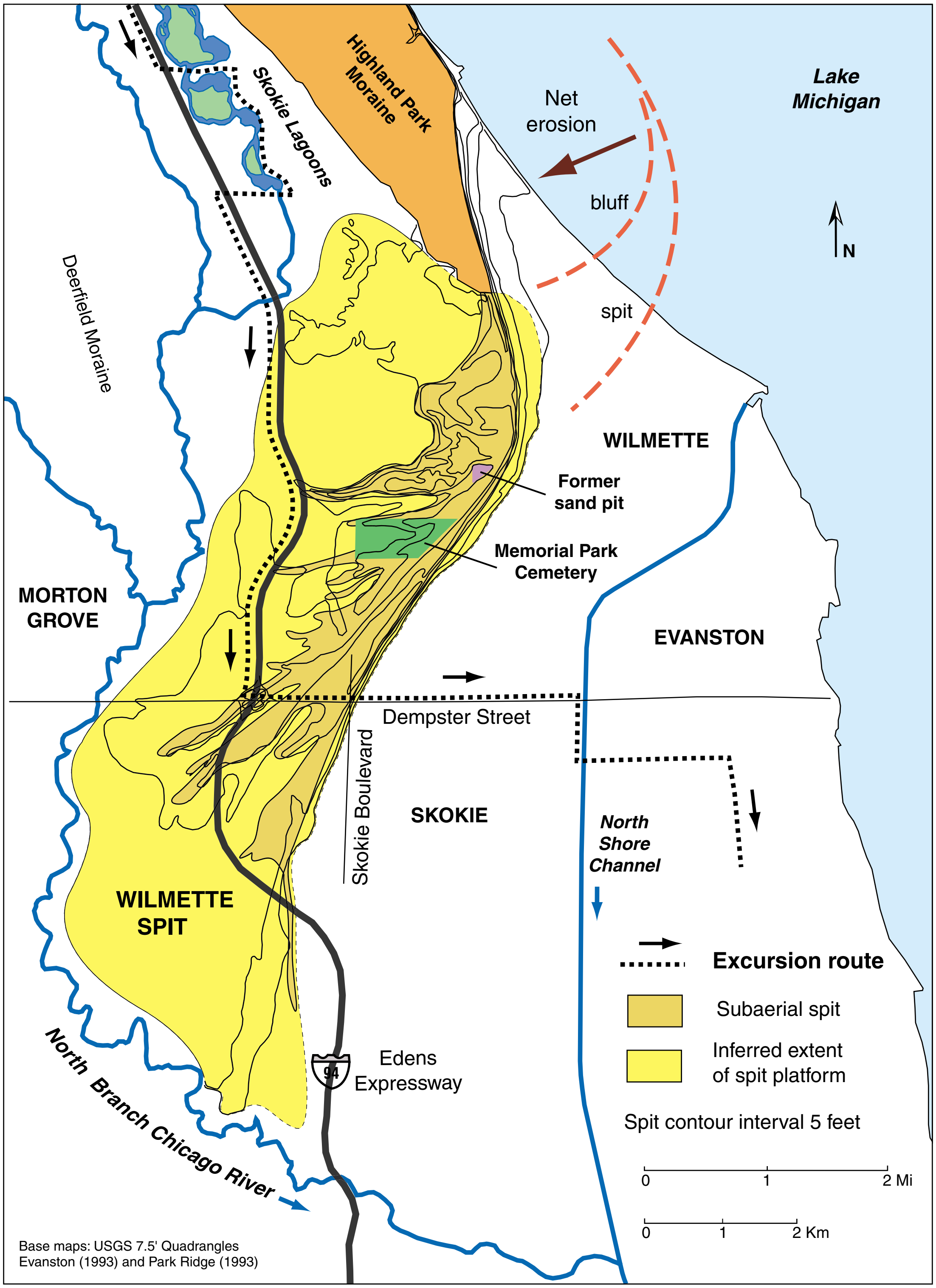
Wilmette Spit is one among the group of oldest spits formed during the Glenwood phases of ancestral Lake Michigan (see lake level curve, page 9). During this time, lake level was as much as 60 feet above the historical mean level. A gradual decline in lake level possibly occurred through the Glenwood phases, as demonstrated by a series of progressively lower ridge crest on the Wilmette Spit (Chrzastowski and Thompson 1992). When the highest lake level occurred in the Glenwood phases, most of the present Chicago land area was submerged.

The relict spits on the Chicago Lake Plain are prominent topographic features that rise 15 to 20 feet above the plain. The relief is best seen on the lakeward (eastward) side of the spit, which corresponds to the shoreface slope. The excursion route descends the lakeward slope of Wilmette Spit on Dempster Street after crossing the intersection with Skokie Boulevard.

During early urban development, some of the spits were mined for sand and gravel. However, a more common land use was for cemeteries. The excellent drainage of the sand deposits was better suited for cemeteries than the poorly drained clay soils across much of the lake plain. Several of the spits are named after a cemetery on the spit where cemetery digs aided the early geologic study of these landforms.



Paleogeography of the Chicago area during formation of Wilmette Spit (modified from Chrzastowski and Thompson 1992).



The Wilmette Spit extends across approximately 12 square miles of Chicago's near-north suburbs. The relief of the spit influenced the course of the North Branch Chicago River (surficial geology from Bretz 1930-1932b, c, Willman and Lineback 1970).

15 North Shore Channel

The North Shore Channel is an integral part of the Chicago River system. The channel originates on the Lake Michigan shore at Wilmette Harbor and flows southward about eight miles to meet the North Branch Chicago River. Wilmette Harbor is a recreational boat basin in the approach to the North Shore Channel. A dam, sluice gate, and lock separate water in the lake and channel. The sluice gate and pumps are used to regulate the flow of Lake Michigan water into the channel.

The channel, excavated between 1907 and 1909 by the Sanitary District of Chicago, was built for two purposes:

1. to intercept combined storm water and sewage from the north shore communities of Evanston and Wilmette, preventing sewage from entering Lake Michigan, and

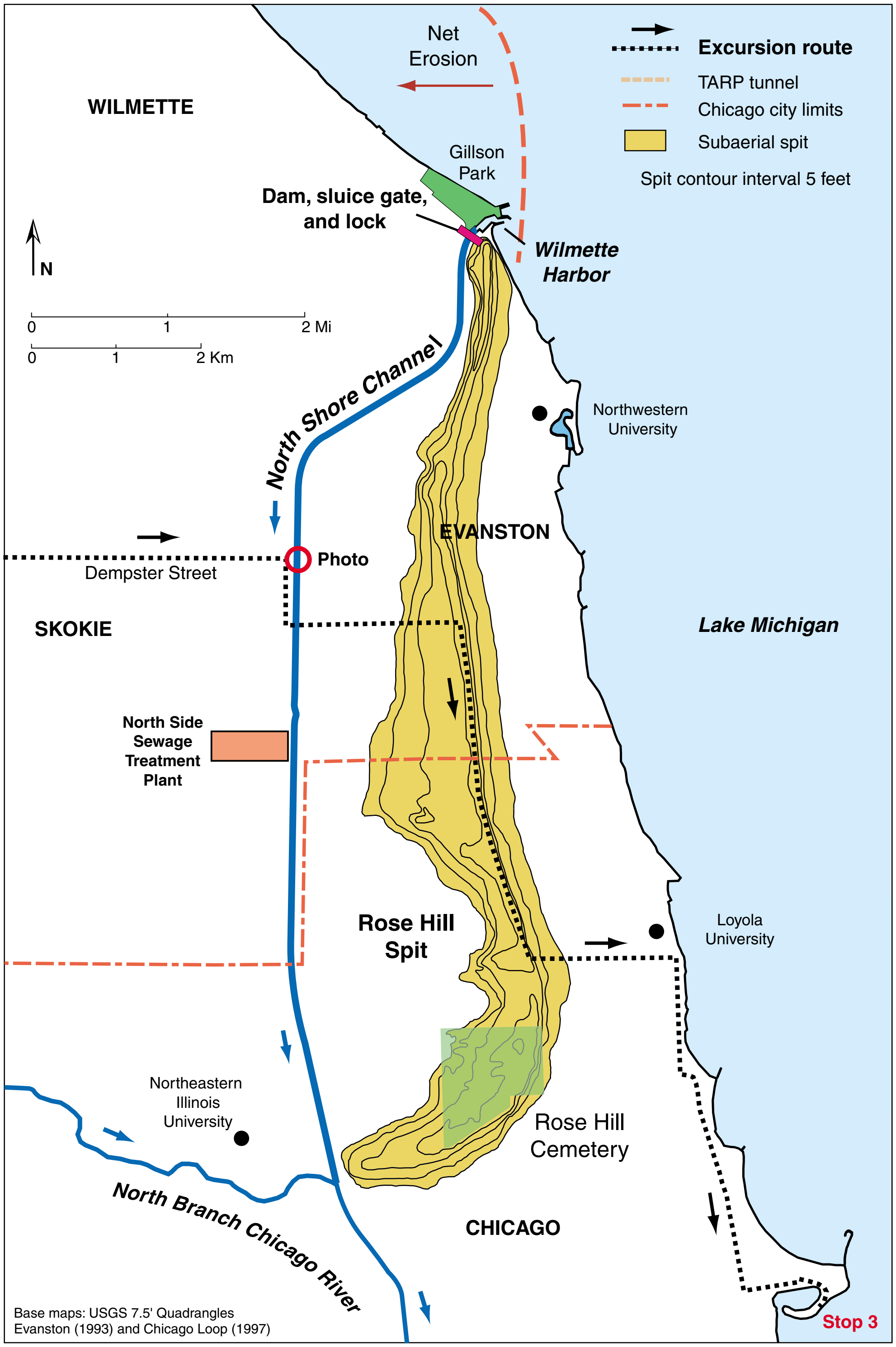
2. to use Lake Michigan water to create a hydraulic head and increased flow to flush water southward in the North Branch Chicago River.

The channel is about 30 feet wide at water level and was originally dredged to depths of 11 to 13 feet (Hill 2000). Siltation has since reduced depths to about 7 feet (NOAA 1999). The channel is in a cut that averages 15 feet below the surrounding ground level. Much of the excavation was into clay. Slumping and slope stability were continual problems during construction. Excavated clay was used to create about 30 acres of land for Gillson Park on the Wilmette shore. Other uses included fill for park land along the Evanston shore (Hill 2000, Solzman 1998).

View of the North Shore Channel looking north from Dempster Street Bridge (December 4, 2004; photo by M. Chrzastowski, ISGS).

TARP and the North Shore Channel

With the rapid suburban growth of the 1950s, severe storms could bring sufficient storm water flow into the North Shore Channel to raise its water level and threaten to back up the storm sewers. Lowering the channel's water level involved opening the lock gates at Wilmette Harbor, which allowed discharge of storm water and untreated sewage into the lake. Subsequent beach closings could persist for days. TARP is making such lake discharge a thing of the past. One of the legs of the TARP Mainstream System is operational about 200 feet below the right-of-way of the North Shore Channel.



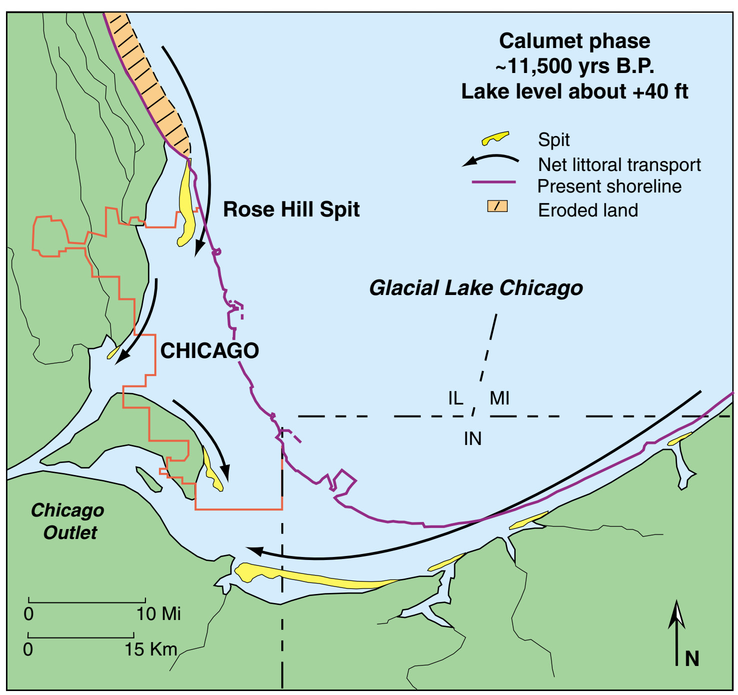
The North Shore Channel and Rose Hill Spit are major landscape features in Evanston and the far north side of Chicago (surficial geology from Bretz 1930–1932c, d).

16 Rose Hill Spit

Rose Hill Spit formed within glacial Lake Chicago from about 11,800 to 11,200 years B.P. (Schneider and Hansel 1990) during the Calumet phase of lake-level history when lake level was as much as 40 feet above the historical mean. Rose Hill Spit extends nearly north-south for about seven miles. It lacks the series of arcuate ridges of Wilmette Spit, but has a distinct hook at its distal end. This relict spit is the highest land across the central part of the city of Evanston and forms a drainage divide within the city. The morainal upland from which Rose Hill Spit extended has been entirely removed by coastal erosion. The proximal end of the spit has likely also been removed by coastal erosion.

The high and well-drained land along the spit made it a favored site for trails during early settlement and for the siting of Rose Hill Cemetery for which the spit is named. Ridge Avenue in Evanston and northern Chicago is aligned along the crest of the spit. Street intersections along Ridge Avenue provide the opportunity to look east (lakeward) down the slope of the spit's shoreface. About 15 feet of relief occurs along the east side of the spit. A more gradual slope occurs on the west side, which was the wave-protected bay-side of the spit.

After the formation of Rose Hill Spit, recession of glacial ice from the Lake Michigan basin opened northern lake outlets that were isostatically depressed. Lake level fell dramatically and was below the historical mean for at least 5,000 years (Chippewa phase; see lake-level curve page 9). Lake level subsequently rose with the isostatic rebound of these northern outlets. About 5,500 yrs B.P., the Chicago Outlet was reactivated, and lake level was as much as 20 feet above the historical mean (Nipissing phase). Again, littoral transport resulted in spit development on the Chicago Lake Plain. Graceland Spit formed during this time. Graceland Spit is parallel to Rose Hill Spit, and its crest is about one-third mile to the east. In Chicago, Clark Street runs along the crest of the Graceland Spit.



Paleogeography of the Chicago area during formation of Rose Hill Spit (modified from Chrzastowski and Thompson 1992).

The Wilmette, Rose Hill, and Graceland Spits are prominent landscape features near Chicago's north city limits (DEM generated by Curtis Abert, ISGS).

View of the lakeward (shoreface) slope of Rose Hill Spit. The excursion route along Ridge Avenue is atop the hill (November 15, 2001; photo by M. Chrzastowski, ISGS).

17 Crossing Howard Street—Welcome to Chicago

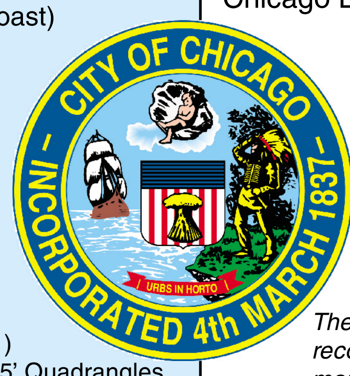
Chicago is officially divisible into 77 community areas (Chicago Area Geographic Information Study 2005). The O'Hare community was crossed early in the excursion. The remaining excursion route crosses or touches on 13 additional areas. Landscape features or topography defines the community area boundaries in parts of the city. One example is Ridge Avenue, which follows the crest of Rose Hill Spit and divides the West Ridge and Rogers Park communities. A rather prominent topographic boundary for several community areas is the course of the North Branch, South Branch, and Main Stem Chicago River.

The Chicago municipal flag has symbolism that recognizes the geographic division of the city, the importance of water features in Chicago's setting, and four select events in the city history. The flag consists of three white stripes, two blue stripes, and four red stars. Three of the stars indirectly relate to Chicago's water setting. Fort Dearborn, the World's Columbian Exposition, and the Century of Progress World's Fair were all located along the Lake Michigan shore.

Origin of city name: ***Checagou***—a Native American word for which the etymology is uncertain. It likely meant *wild onion (leek),* but possibly *skunk,* or even *strong* or *great.* The word is generally assumed to be a reference to the wild onion that grew near the mouth of the Chicago River across an extensive marsh at what is now the Chicago Loop.

Chicago Facts

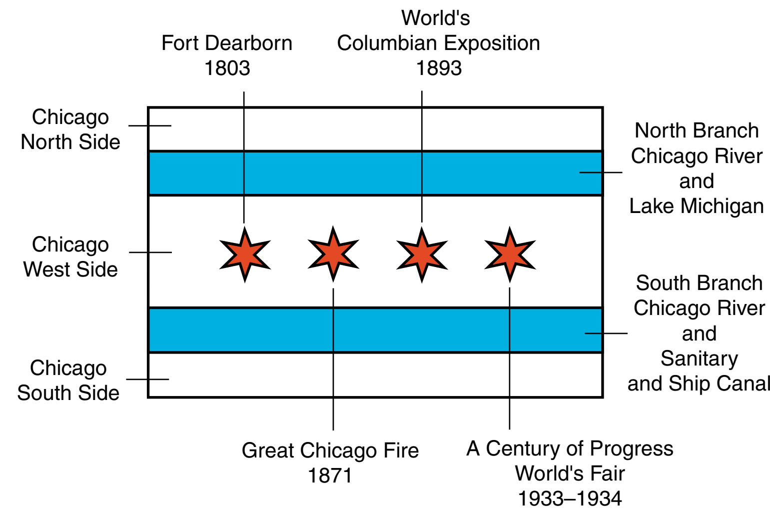
Incorporation:	Town of Chicago August 12, 1833 City of Chicago March 4, 1837
City Motto:	Urbs in Horto (City in a Garden)
Area:	228 square miles
Population:	2.89 million (23% of Illinois population) (2000 census)
Highest elevation:	~672 ft MSL—Blue Island morainal ridge
Lowest elevation:	~578 ft MSL—Lake Michigan shoreline
Relief:	~94 ft
Shoreline length:	23 miles (38% of Illinois coast)
Daily average water pumpage:	970 million gallons
Water supply tunnels under lake and land:	63 miles
Water mains:	4,230 miles
Sewer mains:	~4,300 miles
Sources:	Chicago Public Library (2001) Elevation data from USGS 7.5' Quadrangles Chicago Loop (1997) and Blue Island (1997)

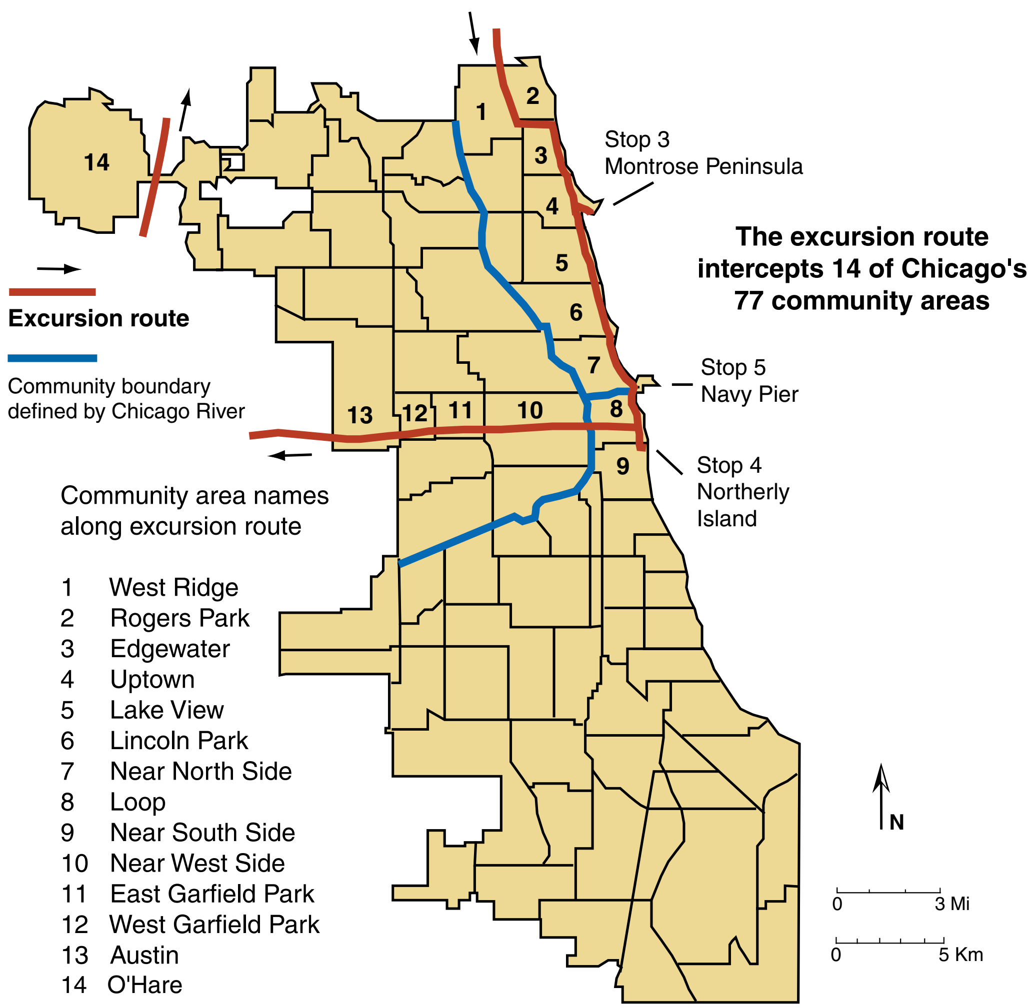


The Chicago seal recognizes the city's maritime and Native American heritage.

The Chicago flag and its symbolism

(Modified from Chicago Public Library 2003.)





(Modified from Chicago Area Geographic Information Study 2005.)

Stop 3 Montrose Peninsula

Montrose Peninsula refers to the entire landmass that protrudes lakeward at Montrose Avenue. The peninsula is made land and is the most lakeward protrusion of park lakefill along the Chicago lakeshore. Filling extended this land nearly three-quarters of a mile from the natural shoreline and into water as much as 20 feet deep. Montrose Harbor was formed by leaving a void in the filled area. To the south, Belmont and Diversey Harbors were similarly formed (Chrzastowski 1991).

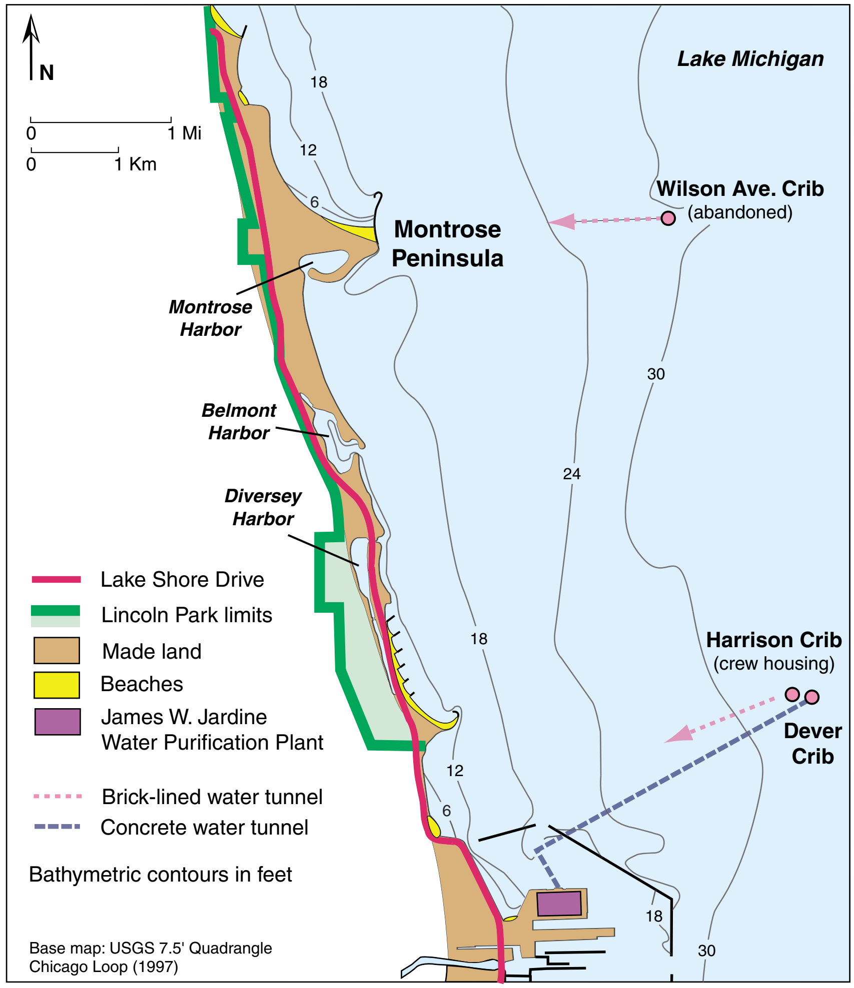
Montrose Peninsula was constructed in the early 1930s. As with most of Chicago's lakeshore filling, the work involved building a line of timber and quarry stone, stepped revetments along the designed shoreline. These structures protected the fill material placed behind them. The fill was primarily sand dredged from the lake bottom off the western Indiana lakeshore and transported to Chicago by hopper-dredge ships. Steel sheetpile was invented in Chicago and had one of its first uses in shoreline construction in the 1931 construction of the hook-shaped Montrose groin (Young 1931, Chrzastowski 2004).

This aerial photo from September 1931 shows the ongoing construction of Montrose Peninsula. Waveland Golf Course is in the foreground. The discharge of fill sand has produced a plume of suspended sediment that clouds the nearshore area (photo courtesy of Great Lakes Dredge and Dock Co., Oakbrook, Illinois).

Since the late 1990s, reconstruction of the Chicago revetments has been under way. Much of this work involves superimposing new stepped revetments over the previous revetments. The new shoreline edge is being built with sheetpile and formed-in-place concrete. The revetment on the south side of Montrose Peninsula was rebuilt in 2003–2004 and provides an example of the work.

Chicago's Water Supply

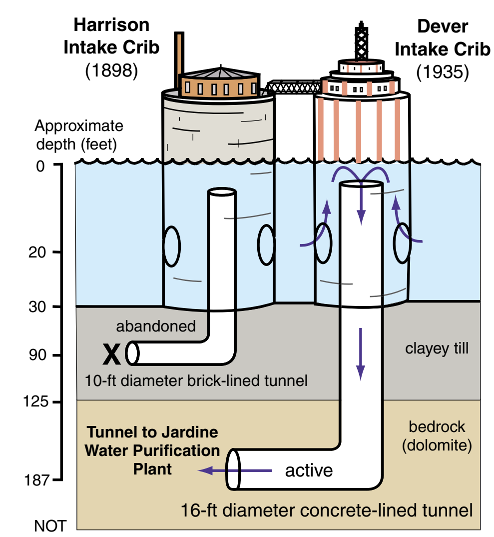
Lake Michigan is the primary water supply for Chicago and for numerous suburbs and outlying communities that buy water from Chicago. The south shoreline at Montrose Peninsula provides a vantage point to view three of Chicago's water-intake cribs. Three additional cribs are out of sight on the south lakeshore. The crib due east of Montrose Peninsula (Wilson Avenue Crib) has been inactive for several decades. Harrison Crib is now used for housing a security crew. The adjacent Dever Crib is the main water intake for the city. A second active intake is on the city's far south lakeshore (68th Street Crib). The water tunnel from Dever Crib leads to the Jardine Water Purification Plant located just north of Navy Pier (Stop 5). Pumping at the Jardine Plant draws water into the crib and through the shaft and tunnel.



(Low Water Datum; NOAA 1999.)

Montrose Peninsula is part of the extensive lake filling for the creation of Lincoln Park.

Harrison and Dever Cribs are located about 2.5 miles offshore in approximately 30 feet of water (May 2000; photo by M. Chrzastowski, ISGS).



Intake crib schematic.

18 Chicago Loop

The name "Chicago Loop" originates from the looping route first made in the late 1800s by a streetcar line and later the loop made by elevated trains. The name "Loop" is now commonly used to refer to all of the downtown area. The official Loop community area is bound by the South Branch Chicago River on the west, the Main Stem Chicago River on the north, Lake Michigan on the east, and Roosevelt Road on the south.

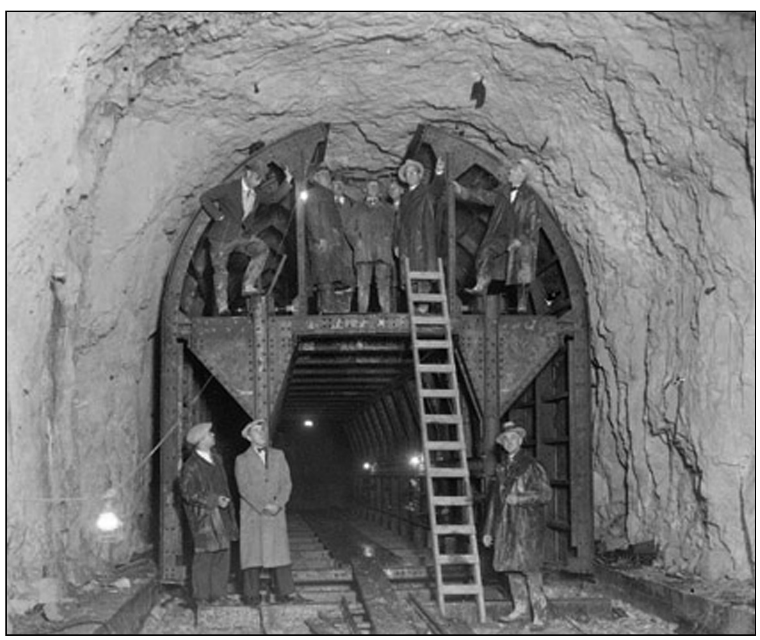
Chicago began its growth in the 1830s within this restricted land area less than one mile square and bounded by water on three sides. Reshaping the landscape for urban development involved filling several sloughs marginal to the river, straightening the river channel, and filling extensively along the Lake Michigan shore. Most important, it was necessary to raise the land elevation across the entire Central Business District.

In the natural setting, much of this land area was only slightly above river level and was subject to flooding. Raising the Central Business District occurred from 1855 to 1856, primarily for sewage management. The city streets were raised as much as eight feet by building retaining walls on the street margins to hold fill for a new street grade. Existing buildings were mechanically lifted or redesigned to accommodate the new street level (Einhorn 2004, Chicago Public Library 2004).

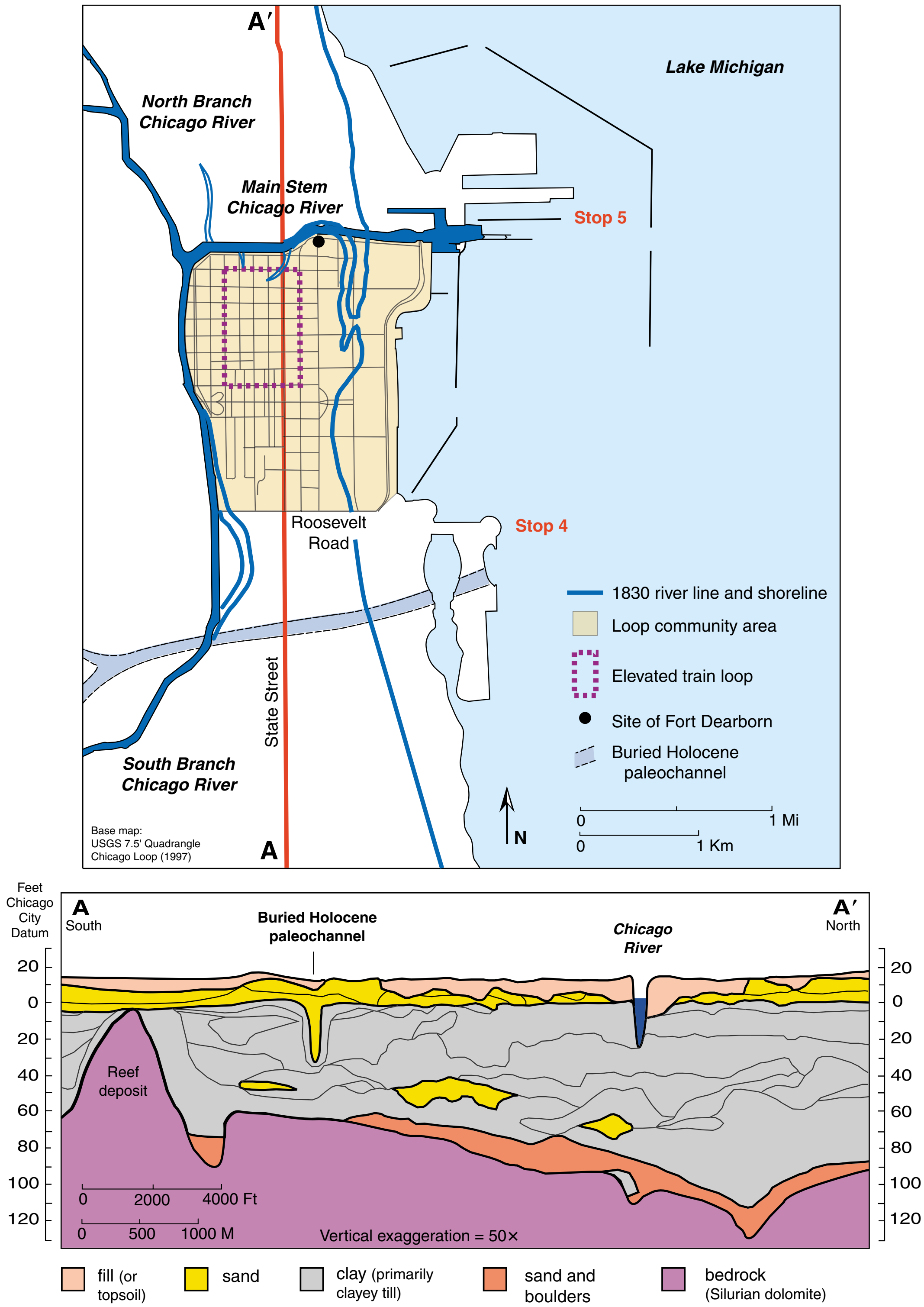
The restricted land area of the Central Business District presented a need for the early city to build taller buildings to provide more business floor space. This need led to the development of steel-skeletal buildings that could be taller than those supported by masonry walls. This new building design—called a "skyscraper"—was invented in Chicago and gave Chicago the world's first skyscraper in 1885 (Heise and Frazel 1987).

Clay deposits 60 to 80 feet thick supported the foundations of early Chicago skyscrapers, but, as skyscraper height increased, it was necessary to have support in the underlying bedrock. The top of bedrock, on average, lies about 100 feet beneath the downtown area.

The clay was advantageous for the late nineteenth and early twentieth century construction of the maze of downtown area tunnels for freight light rail, sewers, water supply, and downtown subways. The tunneling was commonly done with mechanical spades.



Clay exposed in the yet unlined walls of the Chicago Avenue water tunnel (1928; DN-0086862, Chicago Daily News *negatives collection, Chicago Historical Society).*



The Chicago Loop is underlain by fill, lacustrine sand, and a thick sequence of glacial clay over basal sand and boulders (cross section modified from Peck and Reed 1954).

Stop 4 Northerly Island

Northerly Island and the nearby lakeshore to the west and south were the site of the 1933–1934 World's Fair. Called "A Century of Progress International Exposition," the fair commemorated the 100th anniversary of the incorporation of the Town of Chicago as well as the global technological advances over the century. Originally planned to last one year (1933), the popularity of the fair led to its reopening for a second year (1934). Despite the ongoing Great Depression, in its two-year run the fair hosted nearly 49 million visitors (chicagohistory.org).

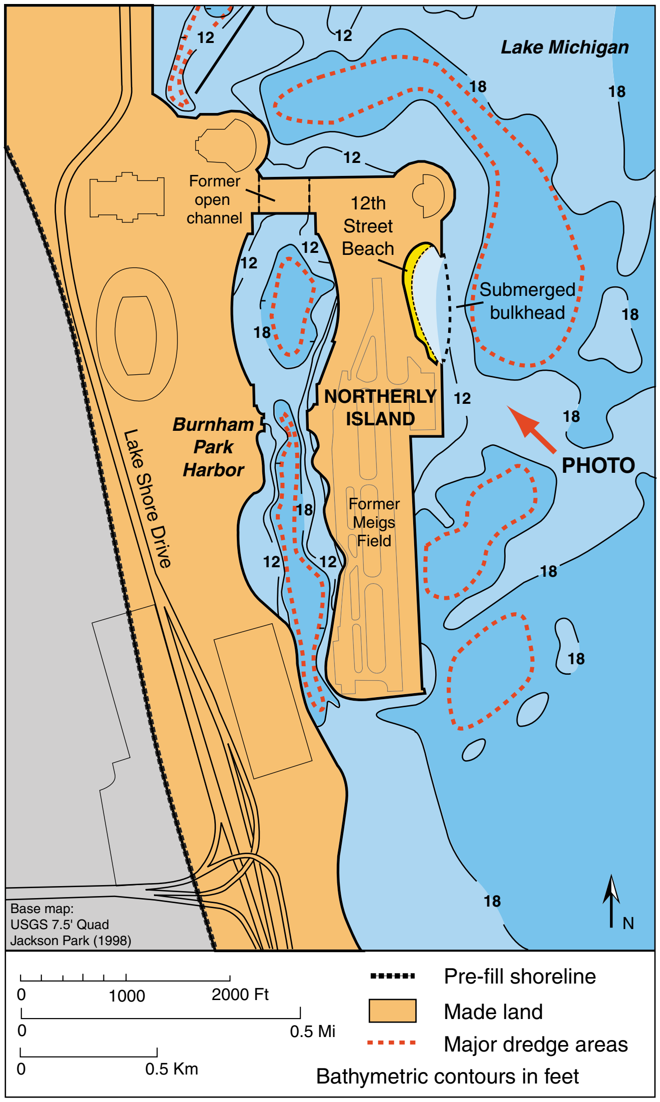
1934 aerial view of A Century of Progress (courtesy of Chicago Park District).

The island and nearby lakeshore are made land constructed in the mid to late 1920s. This made land closely follows the design presented in 1909 by Daniel Burnham and William Bennett in *Plan of Chicago* (Burnham and Bennett 1909). A string of islands and lagoons were proposed for five miles along this south lakeshore. Northerly Island is so named because it is the northernmost of the series of planned islands. World War II was a key factor that prevented completion of the islands and lagoons to the south.

Much of the fill material was sand, mined from the lake bottom off the western Indiana shore and transported to Chicago by hopper-dredge ship (Chrzastowski 1991). However, lake bottom in the vicinity of Northerly Island includes several elongate depressions where clay was dredged for added fill material. Such depressions also occur along the axis of Burnham Park Harbor. Deep water (13 to 18 feet) marginal to 12th Street Beach required that this be a perched beach held by a submerged breakwater. The 12th Street Beach is one of several perched beaches along the Chicago lakeshore made necessary by the water depth along the edge of the lakefill.

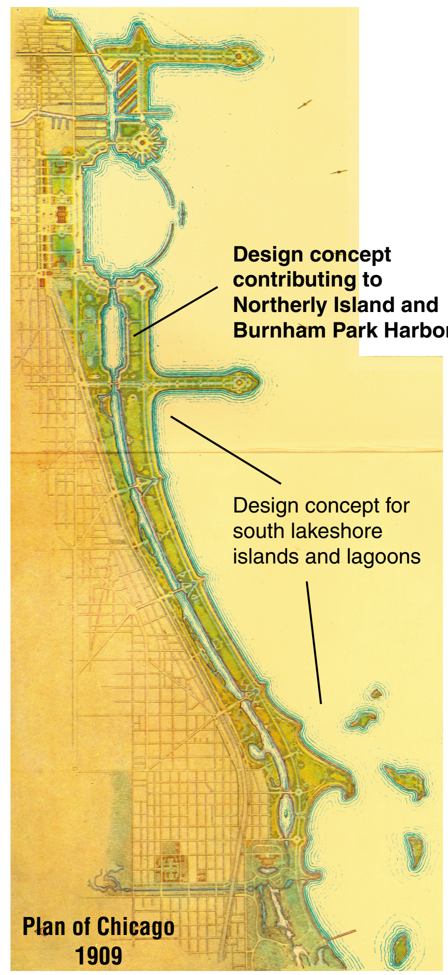
Although Northerly Island was built to be lakeshore park land, after the World's Fair no park development occurred, and then World War II further delayed such development. In 1945, the site was briefly considered for the home of the United Nations. Then, in 1946, the City of Chicago granted a 50-year lease of the island for use as a small airport (Merrill C. Meigs Airfield). Continued use of the airport was hotly disputed after the lease expired in 1996. However, at midnight on March 30, 2003, the runways were blocked and demolition began. As of 2005, Northerly Island is being developed by the City and Chicago Park District as a lakeshore park.

Stop 4



(Low Water Datum; modified from NOAA 1999.)

Northerly Island and Burnham Park Harbor were built similar to the design proposed in the 1909 Plan of Chicago.



(Modified from Burnham and Bennett 1909.)

(May 2000; photo by M. Chrzastowski, ISGS.)

Stop 5 Navy Pier and Chicago Harbor

Chicago had no natural harbor, and the original entrance into the Chicago River was typically restricted by sand accretion. From 1833 until 1834, the U.S. Army Corps worked on jetties to straighten the river entrance and allow the river to be used as the original Chicago Harbor. Updrift accretion and downdrift erosion caused major shoreline changes and led to shore armoring and filling. Between 1874 and 1880, the Corps completed breakwaters for the first "outer" harbor, which is now Monroe Harbor. Between 1889 and 1923 the Corps completed outer breakwaters to form the present Chicago Harbor. Three of the notable features in the harbor are Navy Pier, the Jardine Water Purification Plant, and Chicago Lighthouse.

Navy Pier

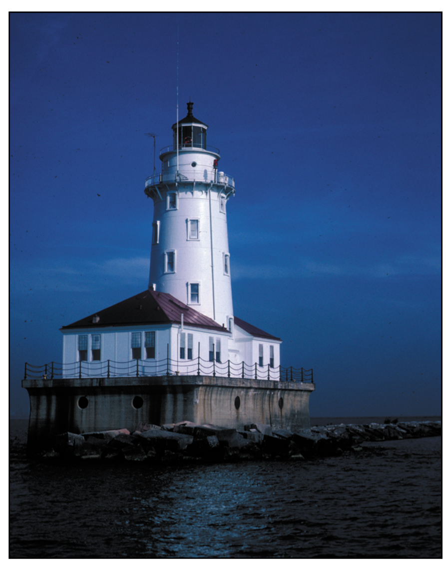
Although called a "pier," Navy Pier is actually filled land. The pier is 3,040 ft long and when completed in 1916, was then the longest pier in the world. It was built by the City of Chicago and originally called Municipal Pier No. 2. The name Navy Pier relates to use during World War II by the U.S. Navy and Marines for training purposes. The pier was used for maritime commerce but never to the degree initially hoped for. From 1946 until 1965, the terminal buildings were used as the campus for University of Illinois at Chicago. The present recreational use dates from the mid 1990s. The pier attracts over one million visitors each year, making this the No. 1 tourist destination in Illinois.

James W. Jardine Water Purification Plant

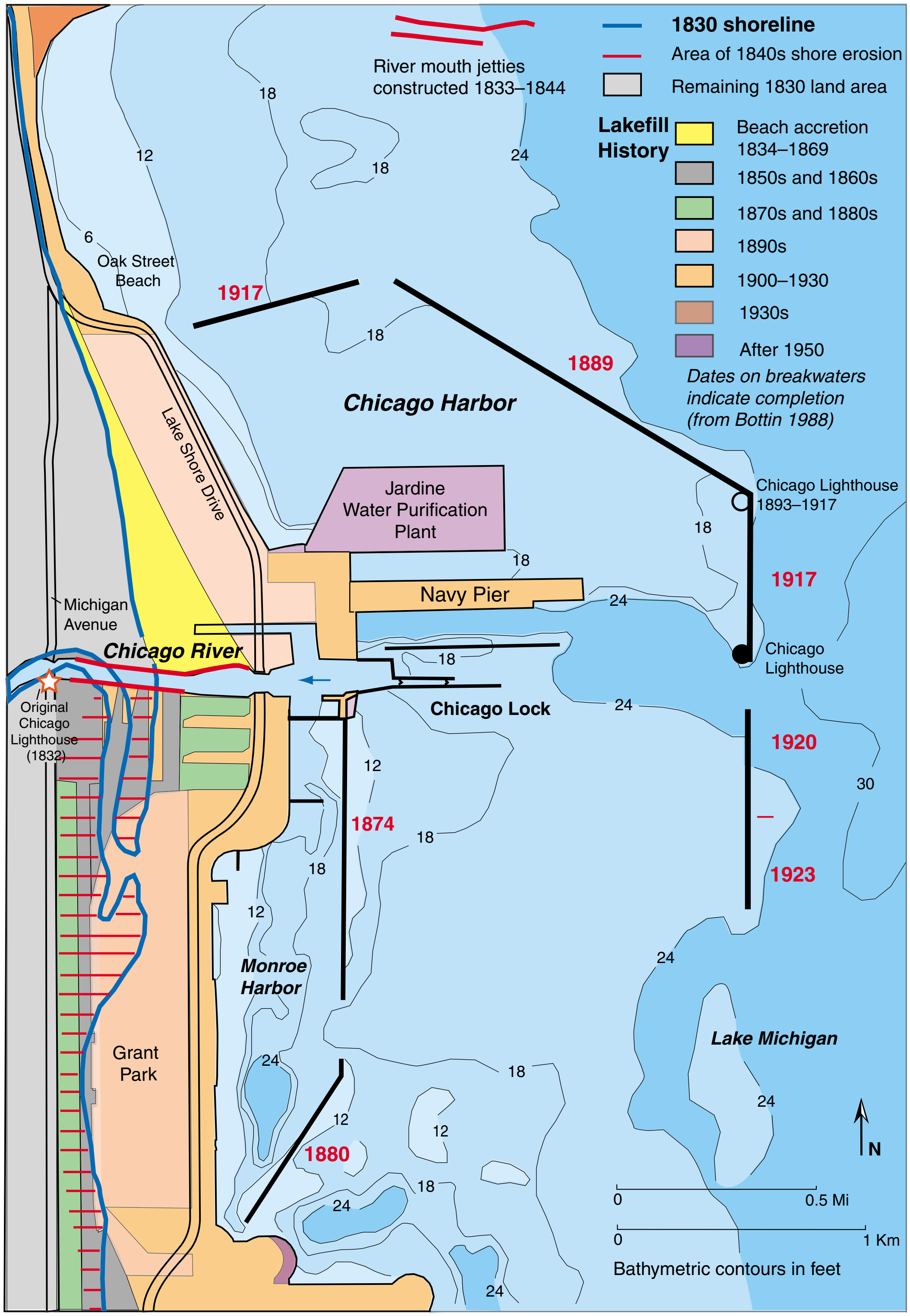
This facility, located on made land filled between 1952 and 1954, is the largest water purification plant in the world. Each day, on average, nearly one billion gallons of water are processed. This plant and a smaller companion plant on Chicago's far south lakeshore serve nearly 5 million consumers in Chicago and 118 outlying suburbs. Water arrives at the plant by tunnels from the Dever Crib (see Stop 3). A seven-hour purification process involves chemical treatment to kill bacteria, remove micro-organisms, and add fluoride (American Society of Mechanical Engineers 2001, ALGOR, Inc. 2004).

Chicago Lighthouse

Chicago's first lighthouse was a stone structure built in 1832 along the banks of the Chicago River near Fort Dearborn. Through the mid- to late 1800s, an eastward-shifting succession of light structures were built at the entrance to Chicago River as jetties and piers were extended farther lakeward. The present Chicago Lighthouse was completed in 1893 and was originally positioned about 1,200 feet to the north. In 1917, the lighthouse was moved to its present location as part of the completion of a southward breakwater extension. The Chicago Lighthouse is now automated. Prior to 1978, it was continually staffed by a team of three lightkeepers.



Chicago Lighthouse, September 1987 (photo by M. Chrzastowski, ISGS).



(Low Water Datum; NOAA 1999.)

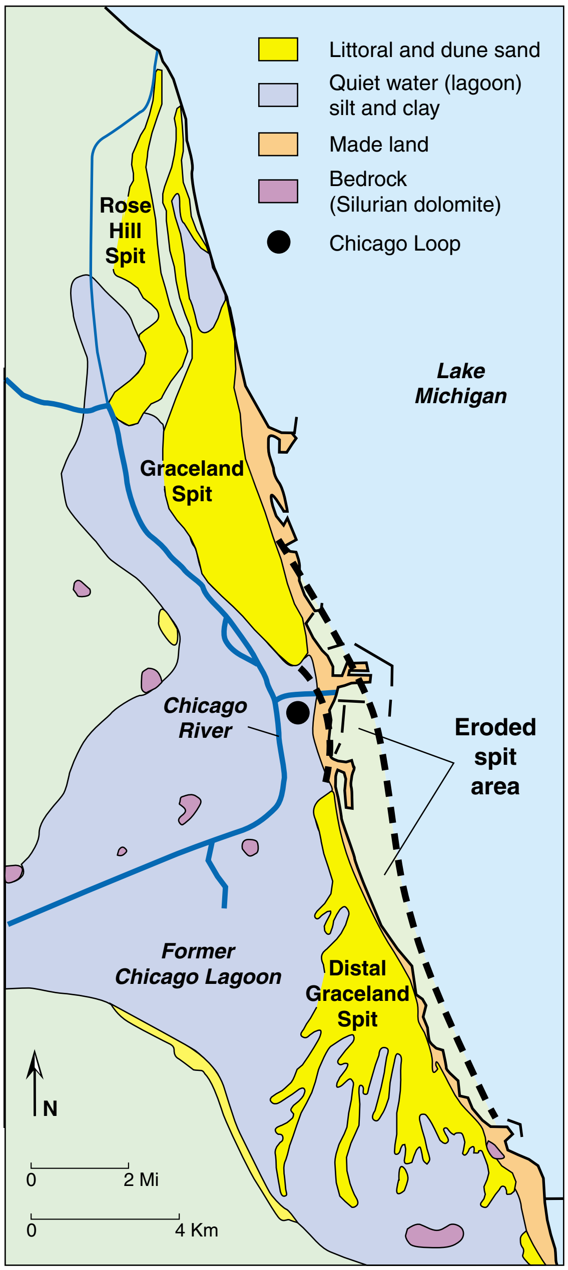
Historical shoreline change and bathymery in the vicinity of Chicago Harbor (after Chrzastowski 1991, 1998).

CONCLUSION

Chicagoland is a product of its unique landscape. This urban area of the Great Lakes region is also an urban area within the watershed of the Mississippi River system. At Chicago and the surrounding area, glacial action and coastal processes have combined to produce a landscape that provides a passageway between two of the great watersheds of the North American continent. This landscape was destined to become the site of the largest metropolis in the middle continent.

The last two stops of this excursion, near the Adler Planetarium on Northerly Island (Stop 4) and at Navy Pier (Stop 5), both provide vantage points to view the dramatic Chicago skyline and the world-class Chicago lakefront, which is a model for urban shoreline design. These last two stops contrast with Stop 1 at Dead River in Illinois Beach State Park. That location is an analog for what this central part of the Chicago lakefront would have looked like in the predevelopment setting.

Chicagoland provides an exceptional opportunity to examine urban geology. Here there is also an exceptional opportunity to learn how to "read" the landscape on which urban growth has occurred. This excursion addresses only a limited number of the unique and interesting geologic features of this metropolis. For any person interested in the geology of Chicagoland, the features and stops presented in this excursion are just a starting point.



Chicago's Missing Piece
Reading the landscape and reconstructing the paleogeogrpahy along Chicago's lakeshore shows that erosion has removed a major segment of former coastal land. This reshaping of the shore in the past 2,000 years played an important role in determining the location of the Chicago River mouth and thus the location of the original settlement of Chicago (modified from Chrzastowski and Thompson 1992).

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