INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

PONDS 1 & 2, JR WHITING PLANT
ERIE, MICHIGAN

OCTOBER 13, 2016

PREPARED FOR:
CONSUMERS ENERGY COMPANY

Mannik Smith GROUP

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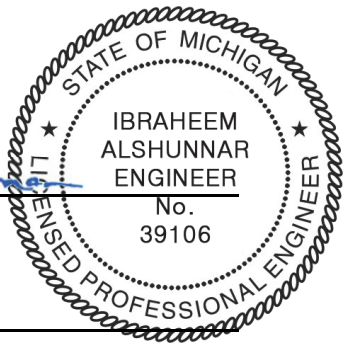
Certification

Professional Engineer Certification Statement [40 CFR 257.82(c)(5)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations 40 CFR Part 257.82(c)(5), I attest that this Inflow Design Flood Control System is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257. 82(c)(5).

The Mannik Smith Group, Inc.



Signature

October 13, 2016
Date of Report Certification

Ibraheem Shunnar, PE
Name

6201039106
Professional Engineer Certification Number

1.0 INTRODUCTION

1.1 Background

JR Whiting Generating Facility (JR Whiting) is a coal-fired power generation facility located in Erie, Michigan as presented on Figure 1 – Site Location Map. JR Whiting formerly operated coal-burning baseload units but ceased electrical generation on April 15, 2016. Prior to stopping electrical generation, Ponds 1 & 2 served two primary functions:

- Received outflow from the Bottom Ash Pond for secondary detention and settlement of bottom ash
- Received intermittent sluiced fly ash and low-volume waste water from the generating facility for detention and settlement

The two ponds are no longer receiving coal combustion residuals (CCRs) from an active power generating plant. The ponds are contained by a perimeter dike which has, generally, a 20-foot wide crest and a crest elevation of about 590.1 (NAVD88). The perimeter dikes are built of CCR materials and the crest area is graded to allow flow of stormwater from the crest area into the ponds. The elevation of water in the Ponds is approximately 584 ft. (NAVD88).

Ponds 1 & 2 are interconnected by subsurface pipes. Flow from both ponds is combined and discharged through a common outfall into the forebay in accordance with a National Pollutant Discharge Elimination System (NPDES) Permit. The discharge pipe to the forebay has been grouted. As such there is no discharge from the pond at this time. Since there are no outlet pipes, the Ponds 1 & 2 levels are impacted only by precipitation and evaporation. During closure operations, discharge may be needed to facilitate subgrade preparation. Future discharges from Ponds 1 & 2 will be performed in accordance with the active NPDES permit.

There are three sources of inflow into the pond: precipitation; stormwater from the dike crest; and flow from the Boiler Treatment Ponds located south of the ponds as shown on Figure 1. The flow from the Boiler Treatment Ponds is transferred through a pipe that discharges at the southeast corner of Pond 2.

1.2 Purpose

The purpose of the Inflow Design Flood Control System Plan (Plan) is to provide a basis for the certification required by 40 CFR 257.82(c)(5) (Hydrologic and Hydraulic Capacity Requirements for CCR Surface Impoundments). Ponds 1 & 2 have been rated a significant hazard potential as determined under 40 CFR 257.73(a)(2). 40 CFR 257.82(a) requires the owner or operator of the significant hazard potential CCR surface impoundment to design, construct, operate, and maintain an inflow flood control system that meets the following requirements:

- Adequately manage the flow into the CCR unit during and following the peak discharge of the inflow of the 1000-year flood event
- Adequately manage the flow from the CCR unit to collect and control the peak discharge resulting from the 1000-year flood event
- Handle discharge from the CCR unit in accordance with the surface water requirements under 40 CFR 257.3-3

2.0 FLOOD CONTROL SYSTEM

The existing flood control system for Ponds 1 & 2 consists of the existing perimeter dikes with a top elevation of 590.1 ft. (NAVD88.) There are two mechanisms that may occur and result in flooding of the Ponds 1 & 2. The first

includes rise of water levels in Lake Erie to a level above the Ponds 1 & 2 dike and flooding of the ponds. The second mechanism includes rising of water levels within the ponds above the top of dike elevation from precipitation.

Based on the US Army Corps of Engineers, the 100 and 500 year flood elevations for Lake Erie in the vicinity of the JR Whiting Plants are 577.5 ft. and 578.4 ft. (NAVD88), respectively. The top of dike elevation for these ponds is about 590.1 ft. (NAVD88). On that basis, the 1,000 year flood elevation is estimated at about 579.5 ft. On that basis, it is anticipated that a 1000 year flood elevation in Lake Erie will not cause flooding of the ponds.

Based on recent surveys, the water elevation in the ponds is currently about 584 ft. (NAVD 88). On that basis, the ponds have currently 6.1 feet of free board. As discussed before, the inflow into the pond include precipitation, run on from the perimeter dike crest and flow from the Chemical Ponds. The Chemical Ponds ceased operations and the only flow into these ponds is precipitation. The capacity of Ponds 1 & 2 is considered adequate if it can handle a 1000 year storm event and it can store stormwater within its watershed.

To determine whether or not Ponds 1 & 2 meet requirements for 40 CFR 257.82, the hydraulic capacity of Ponds 1 & 2 was estimated. The water balance (inflow vs outflow) for the ponds was studied and evaluated. Inflow refers to the precipitation that falls on the watershed which drains to the two ponds. Since there are no outlet pipes for Ponds 1 & 2, the only outflow considered in the stormwater balance evaluation was evaporation from the ponds. Once inflow and outflow volumes were calculated on an annual basis, an estimation of available storage space in Ponds 1 & 2 was made. By comparing net inflow to available capacity, estimations were made to determine how long until Ponds 1 & 2 overtop, and whether or not the ponds can handle the required design flood described in 40 CFR 257.82.

The watershed for Ponds 1 & 2 was determined using contours from survey data. The drainage area for the ponds was determined to consist of Ponds 1 & 2 themselves, including the perimeter dike crest area, as well as the drainage from the two chemical ponds to the south. The total drainage area was determined to be 20.88 acres. Of the total drainage area, 16.59 acres of this is open surface water, including the chemical ponds. The remaining acreage consists of 0.04 acres of rooftop for a building located near the chemical ponds, 1.08 acres of uncovered land which surrounds the chemical ponds, and 3.17 acres of land which consists of perimeter dike crest area. Appropriate runoff coefficients and runoff curve numbers were used to get a weighted average of 0.95 for a runoff coefficient and 95 for a hydraulic flow curve number.

To estimate total inflow and outflow to Ponds 1 & 2, annual rainfall data was taken from the National Oceanic and Atmospheric Administration (NOAA). The closest NOAA station recording precipitation is located at the Monroe Wastewater Treatment Plant. Using data, ranging from the year 2003 to 2015, from this weather station, an average annual precipitation value was calculated to be 34.88 inches (Reference 1). The average evaporation rate was needed to calculate the outflow. This value was taken from the Michigan Land and Water Management Division. Based on their figures, evaporation from May to October in the area is approximately 25 inches (Reference 2).

Using the average annual rainfall, the total acreage of the watershed, and the runoff coefficient, calculations were made to estimate the inflow into Ponds 1 & 2. By multiplying these three values together, an estimated 2,511,523 cubic feet of stormwater per year is estimated to flow into Ponds 1 & 2. For the outflow volume, the annual average evaporation rate is multiplied by the area of surface water, 16.59 acres. This outflow volume is estimated to be 1,365,225 cubic feet per year. Comparing inflow to outflow on an annual basis, each year 1,146,298 cubic feet of stormwater will be stored in the pond system. According to 40 CFR 257.82, there must also be enough available volume for a 24 hour / 1,000 year storm. NOAA ATLAS 14 Point Precipitation frequency estimates give a value of 7.63 inches for a 24 hour / 1,000 year storm in the area of the ponds. The SCS runoff curve number method was used to create a hydrograph using a curve number of 95 for the site. The volume of the 1,000 year storm is 533,049 cubic feet.

In order to evaluate whether or not Ponds 1 & 2 can handle a 1000 year storm flood, the available capacity of both ponds needed to be calculated. Using contours taken from survey data from March 2015, the available storage capacity of both ponds could be determined. Since a pipe connects the two ponds together, they act as a singular pond. The water elevation is assumed to be 584.7 and the max elevation water can reach before it spills out onto the crest is 590.1. Using these minimum and maximum elevations the pond was determined to have 3,269,521 cubic feet of available storage.

Based on these assumptions and calculations stated above, Ponds 1 & 2 has adequate capacity to handle the 1,000 year/24 hour storm. In addition, Ponds 1 & 2 have capacity to store estimated inflow for the next 2 years with a remaining available storage volume of 976,925 cubic feet. After 2 years of average inflow, the ponds will still be able to handle the 24 hour / 1,000 year storm.

On that basis, we recommend that within two years of the certification of this report, or other appropriate fixed date either a permitted discharge from Ponds 1 & 2 is conducted or closure is initiated. In addition, we recommend this plan is updated every two years until the ponds are closed. On that basis, we conclude that:

- The inflow design flood control system adequately manages flow into the CCR unit during and following the peak discharge of the inflow design flood (1000-year flood)
- The inflow design flood control system adequately manages flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood (1000-year 24-hour storm event)

3.0 PLAN REVISION AND RECORDKEEPING

Per 40 CFR 257.82(c)(4), the Plan will be revised and updated every five years. However, as described above, we recommend that the plan is updated within two years until the closure of Ponds 1 & 2. The Plan is considered complete on the date it has been placed in the facility's operating record as required by 40 CFR 257.105(g)(4).

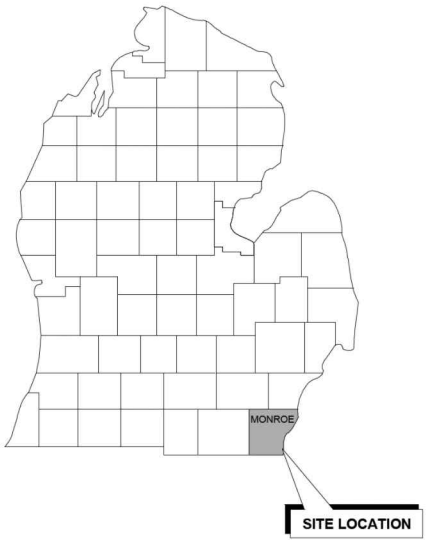
Per 40 CFR 257.82(c)(2), amendment of the Plan must occur whenever there is a change in conditions that would substantially affect the written Plan in effect. This amended Plan must be placed in the facility's operating record as required by 40 CFR 257.105(g)(4).

Per 40 CFR 257.82(d), Consumers Energy Company (CEC) must comply with the recordkeeping requirements specified in 40 CFR 257.105(g), the notification requirements specified in 40 CFR 257.106(g), and the internet requirements specified in 40 CFR 257.107(g).

4.0 REFERENCES

1. http://www.ncdc.noaa.gov/cdo-web/datasets/ANNUAL/stations/COOP:205563/detail
2. http://www.michigan.gov/documents/deq/lwm-waterbudget_202791_7.pdf

FIGURES



MONROE COUNTY

NOT TO SCALE

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FIGURE 1

SITE LOCATION MAP

PONDS 1 & 2
JR Whiting Generating Facility
Erie, Monroe County, Michigan

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FIGURE 2

GENERAL SITE PLAN

PONDS 1 & 2
JR Whiting Generating Facility
Erie, Monroe County, Michigan

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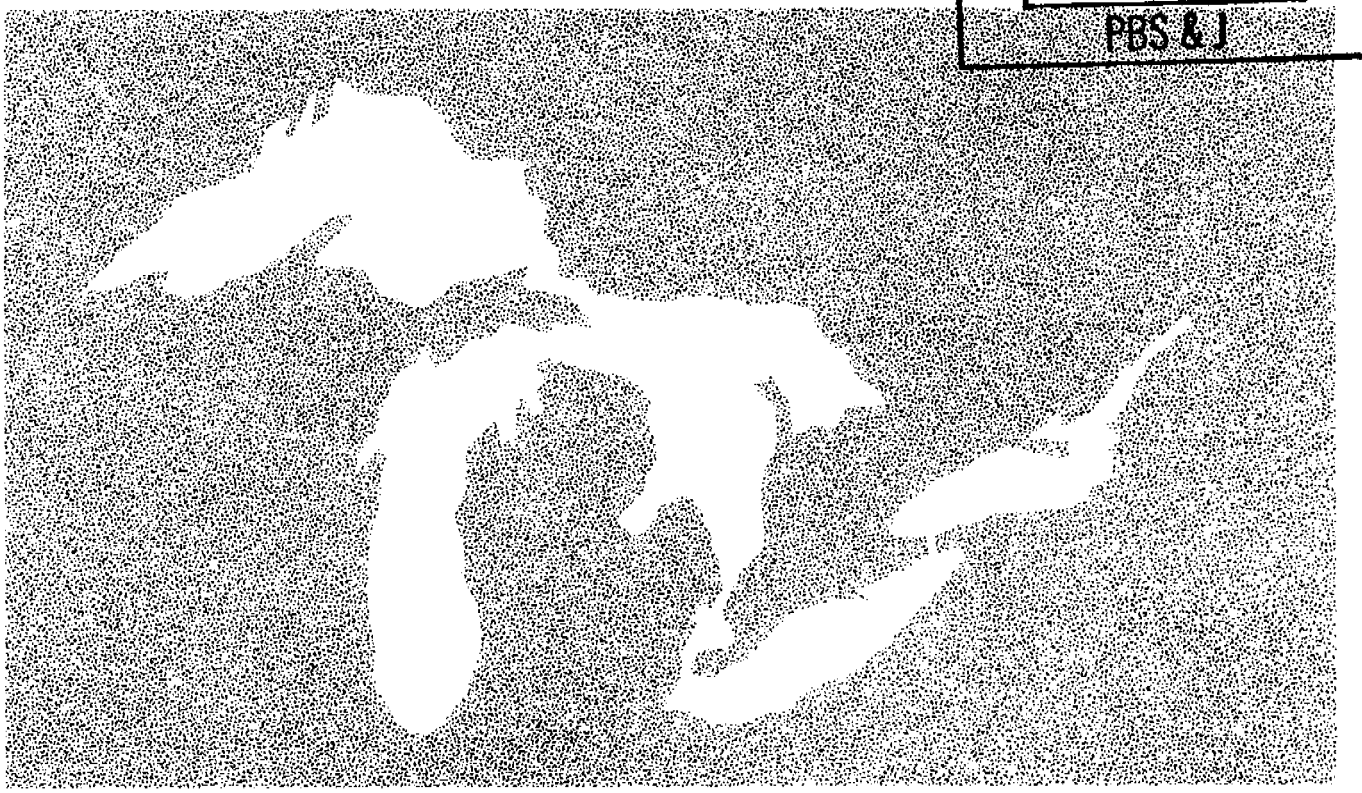
APPENDIX A

REVISED REPORT ON GREAT LAKES OPEN COST FLOOD LEVELS, US CORP OF ENGINEERS, APRIL 1988

PHASE I

REVISED REPORT ON GREAT LAKES OPEN-COAST FLOOD LEVELS



Prepared by the U.S. Army Corps of Engineers
for the Federal Emergency Management Agency

Detroit, Michigan
April 1988

PHASE I
REVISED REPORT
ON
GREAT LAKES
OPEN-COAST FLOOD LEVELS

PREPARED BY THE U.S. ARMY CORPS OF ENGINEERS
FOR THE FEDERAL EMERGENCY MANAGEMENT AGENCY

DETROIT, MICHIGAN
APRIL 1988

PHASE I

REVISED REPORT
ON
GREAT LAKES OPEN-COAST FLOOD LEVELS

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ACKNOWLEDGEMENTS

The people involved in the preparation of the Revised Report on Great Lakes Open-Coast Flood Levels as of December, 1987 were:

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PHASE I

REVISED REPORT

ON

GREAT LAKES OPEN-COAST FLOOD LEVELS

INTRODUCTION

GENERAL

The Federal Emergency Management Agency (FEMA) has adopted the 100-year flood level as the standard for identification of flood hazard areas in conjunction with the National Flood Insurance Program. Often the 10, 50, and 500-year flood levels are also of concern in dealing with flood control and sound flood plain management strategies. A study was performed using water level information through 1974 to develop these flood levels for the Great Lakes. It was published in three booklets in 1977 and 1978; Phase I, Phase II, and Appendices A and B of the "Report on the Great Lakes Open-Coast Flood Levels". In 1987, due to the additional data collected since the original study was completed, and the extreme high water levels experienced in the Great Lakes since that time, FEMA requested an update of the previous study. The basic tenet of this update effort was to retain the approach utilized in the 1977 report. The original study methodology was

followed, except where analysis of the data indicated variations were appropriate.

The results of the updated study have been published as three reports with the same format as used in the original Phase I, Phase II, and Appendices. The updated reports are entitled "Revised Report on Great Lakes Open-Coast Flood Levels". The Phase I report documents the statistical technique employed in determining the frequency curves, and details where the updated study methodology varies from the original report. The Phase I report also presents on Plates 1 through 5 the open-coast flood levels determined for each reach of the United States shoreline of the Great Lakes. Open-coast flood levels are defined in this report as the flood levels occurring along a lake shoreline which is unprotected by the presence of islands and which is uninterrupted by bays subject to additional wind setup. The areas excluded from the open-coast study are also indicated on Plates 1 through 5. Comparison of the results of the revised study from the 1977 study are also indicated on Table 2.

In the Phase II report, methods for determining the frequency of flood levels are presented for locations not included in the Phase I report. An analysis of the gage data on the connecting channels is given, along with general guidelines for the application and interpolation of the results. Methods are also

included for simulating or deriving flood level data for gages with a short period of record, and for developing flood level frequencies at locations where records of water level data are not available.

Appendices A, B, C, D, and E contain documentation of the updated study which is too detailed to include in the Phase I or Phase II report. Appendix A includes tables of adjustment factors which were applied to recorded water levels to establish a common base which reflects a fixed regimen in the Great Lakes-St. Lawrence River system. The frequency curves from which the various return period flood levels were derived are included in Appendix B. Summary tables of the revised study results, in comparison to the 1977 report, and the water levels for the 10, 50, 100, and 500-year return period at each gage, are presented in Appendix C. Appendix D contains copies of all correspondence pertaining to the development and review of the various drafts of the Phase I and Phase II reports. Examples of flood level frequency determination using short period gage records for Phase II areas are contained in Appendix E.

The various State and Federal agencies concerned with flood insurance studies on the Great Lakes were provided copies of the Phase I and Phase II draft reports in mid-January, 1988 and the

end of January, 1988, respectively. The comments that were received have been considered and where appropriate have been incorporated in the updated study.

DATA

RECORDED WATER LEVELS

Official monthly mean and hourly instantaneous water level data, published by the National Ocean Service of the U. S. Department of Commerce, and the Canadian Hydrographic Service of the Canadian Department of Environment, as recorded at 65 stations throughout the Great Lakes and their connecting channels, were used to derive the maximum annual flood levels. The stations and their periods of record are listed in Table 1. Recording gages were continuously operated at these stations for periods ranging from 22 to 86 years, as of 1986. Four additional gages, not included in the original report, were incorporated. They were Port Inland on Lake Michigan, Little Current and Point Edward on Lake Huron, and Port Lambton on the St. Clair River. The Black Rock Canal gage on the Niagara River is no longer functional and was excluded from the new study. The American Falls gage was also excluded from the new study. In 1976, the gage was relocated 400 feet upstream of the original site. Because of the steep slope of the Niagara River between these locations, the data from the two locations could not be used as

TABLE 1 - WATER LEVEL STATIONS

Water Level Gaging Station	Gage No.	Period of Record
Lake Superior		
Point Iroquois	9004	1933-1986
Marquette	9016	1903-1986
Ontonagon	9044	1960-1986
Duluth	9064	1950-1986
Two Harbors	9070	1942-1986
Thunder Bay (C)	02AB018	1915-1986
Michipicoten (C)	02BD004	1915-1986
Lake Huron		
Fort Gratiot	4098	1938-1986
Lakeport	5002	1956-1986
Harbor Beach	5014	1902-1986
Essexville	5035	1953-1986
Harrisville	5059	1963-1986
Detour	5098	1955-1986
Thessalon (C)	02CA006	1926-1986
Tobermory (C)	02FA003	1962-1986
Parrysound (C)	02EA014	1960-1986
Collingwood (C)	02ED012	1915-1986
Goderich (C)	02FE012	1915-1986
Little Current (C)	02CG002	1959-1986
Point Edward (C)	02GG010	1927-1986
Lake Michigan		
Ludington	7023	1951-1986
Holland	7031	1960-1986
Calumet Harbor	7044	1903-1986
Milwaukee	7057	1906-1986
Green Bay	7079	1954-1986
Sturgeon Bay	7072	1946-1986
Mackinaw City	5080	1900-1986
Port Inland	7096	1965-1986
Lake Ontario		
Oswego	2030	1935-1986
Rochester	2058	1956-1986
Cape Vincent	2000	1916-1986
Port Weller (C)	02HA018	1930-1986
Toronto (C)	02HC048	1915-1986
Cobourg (C)	02HD015	1956-1986
Kingston (C)	02HM008	1963-1986

(C) indicates a Canadian station

TABLE 1 - WATER LEVEL STATIONS (Cont'd)

Water Level Gaging Station	Gage No.	Period of Record
Lake Erie		
Buffalo	3020	1900-1986
Barcelona	3032	1961-1986
Erie	3038	1959-1986
Cleveland	3063	1904-1986
Marblehead	3079	1960-1986
Toledo	3085	1941-1986
Fermi	3090	1964-1986
Gibraltar	4020	1941-1986
Kingsville (C)	02GH070	1962-1986
Erieau (C)	02FG002	1957-1986
Port Stanley (C)	02GC027	1926-1986
Port Dover (C)	02GC028	1958-1986
Port Colborne (C)	02HA017	1911-1986
Lake St. Clair		
St. Clair Shores	4052	1953-1986
Belle River (C)	020M005	1961-1986
St. Marys River		
Southwest Pier	6070	1934-1986
U.S. Slip	6060	1934-1986
St. Clair River		
Dunn Paper	4096	1955-1986
Mouth of Black River	4090	1955-1986
Dry Dock	4087	1928-1986
Marysville	4084	1955-1986
St. Clair	4080	1953-1986
Port Lambton (C)	02GG011	1931-1986
Algonac	4070	1953-1986
Detroit River		
Windmill Point	4049	1952-1986
Fort Wayne	4036	1915-1986
Wyandotte	4030	1960-1986
Niagara River		
Niagara Intake	3012	1963-1986
Ashland Avenue	3007	1958-1986
St. Lawrence River		
Ogdensburg	1030	1935-1986

a continuous record. Ten years of record are available at the new location, however, this is too short of a period to develop a frequency curve. The American Falls gage can be included in future studies when the period of record is greater.

MAXIMUM ANNUAL FLOOD LEVELS

The maximum annual flood level at a station is considered to be the highest instantaneous level recorded by a gage during the year at that station. This level is comparable to the storm water level which results from a wind setup superimposed on the undisturbed water level of the lake. Figure 1 illustrates wind effects on lake levels. Short-period fluctuations of water levels, such as created by wave action, are almost completely dampened by the stilling wells in which the gage floats operate. Consequently, flood levels in this report do not include wave runup caused by the waves rushing up a beach or a structure.

There are two types of gages, digital and analog. An analog gage makes a continuous graph of water levels over time. The maximum instantaneous level is readily discernible on analog gage records. A digital gage records water levels at prescribed time intervals, for example, the water level may be measured every hour. Since a maximum instantaneous level cannot be measured by a digital gage, the maximum hourly water level is used. This is usually acceptable, as maximum hourly data published from

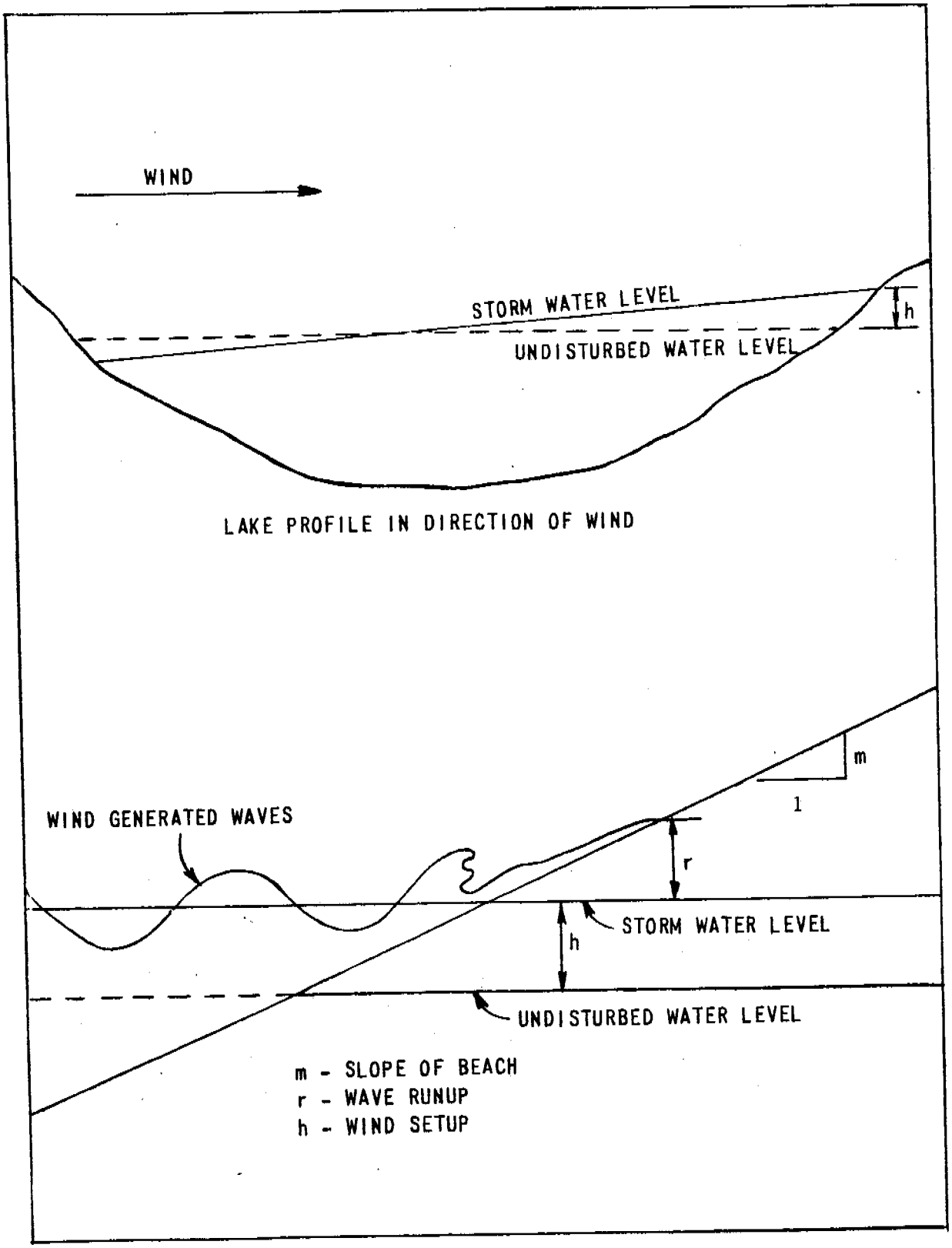


FIGURE 1. WIND EFFECTS ON LAKE LEVELS

digital gages are not significantly different from the maximum instantaneous levels derived from analog gages. However, there are exceptions, as for example at Buffalo, New York, where the water level during storms may rise or fall more than five feet in an hour. In such cases, instantaneous water levels are derived from the recorder of a second analog gage operating in the same well along with the digital gage.

ADJUSTMENT FACTORS

Over the period of record, the levels of the lakes have been significantly affected by changes in the amount of diversions into and out of the Great Lakes Basin, changes in the outflow conditions resulting from regulation of Lakes Superior and Ontario, and dredging within the connecting channels. To account for the effects of these changes on historical levels, the recorded levels were adjusted to present conditions. Adjustments were derived from monthly mean lake levels obtained by routing the 1900-1986 net basin supplies through the Great Lakes under present diversion and outlet conditions. Since the previous study, a revised Lake Erie outlet rating equation has been incorporated, the Long Lac and Ogoki Diversions have been increased from 5,000 cubic feet per second (cfs) to 5,600 cfs, and the Welland Canal Diversion increased from 7,000 cfs to 9,200 cfs. The regulation of Lake Superior has also changed from the 1955 Modified Rule of 1949 to the current plan of operation,

known as Plan 1977. The differences each month between the derived levels and the recorded monthly mean levels at the Master Gage sites (Marquette, Harbor Beach, St. Clair Shores, Cleveland and Oswego) were mathematically smoothed and tables of monthly adjustments were generated for 1900 to 1986. These tables are included in Appendix A. The adjustments to be applied to the annual maximum recorded levels at all sites on each lake were obtained from these tables.

METHOD

STATISTICAL ANALYSIS

The statistical analyses of the data addressed the concerns of appropriate frequency distribution, autocorrelation of the data, and regional skew values. The Hydrologic Engineering Center (HEC), and the Waterways Experiment Station (WES) were consulted, and provided comments to the Detroit District's analysis. HEC's report and WES's summary of conclusions are provided in Appendix D.

In the 1977 study, a log-Pearson Type III frequency distribution was used to analyze the data. For this study update, both the log-Pearson Type III and the Pearson Type III distributions were investigated. Comparison of the two methods, when applied to the adjusted data, showed that the skew

coefficients were almost identical. HEC concluded that the long record gages gave the same flood levels for given return periods using either method. Therefore, the logarithmic transformation was deemed unnecessary, and the Pearson Type III frequency distribution was adopted for this analysis.

In this study, as well as in the previous study, coincident frequency analysis had been suggested by HEC as the procedure to use. Coincident frequency analysis involves generating two separate frequency curves, one for short duration water level rises (wind induced setup), and one for the maximum undisturbed lake levels. These curves are then statistically combined to produce the final frequency curve. The maximum undisturbed lake levels are not directly measured, but estimated by maximum monthly mean lake levels. The short duration water level rises are calculated by subtracting the monthly mean water levels from the recorded instantaneous maximum water levels. However, since the basic tenet of this update was to retain the approach utilized in the 1977 report, the more complex procedure of coincident frequency analysis was not used.

Two other significant concerns had to be addressed during the course of the statistical analysis of the data. These concerns were the autocorrelation of lake levels, and the different skew values exhibited by frequency distributions among gage sites.

Autocorrelation, as related to lake levels, measures the tendency of a lake level to be similar to the previous year's (or following year's) level. Skew measures the distribution of the magnitude of water levels. Skew gives an indication if high levels occur more frequently than low levels, or vice versa. A zero skew indicates that on the average, high levels occur as often as low levels.

Lakes Michigan-Huron showed the greatest autocorrelation in the yearly data. The other Great Lakes exhibited autocorrelation to a lesser degree. The question of whether autocorrelation was significant was answered by constructing two separate frequencies, based on even year data and odd year data from the Harbor Beach gage. This eliminated the strong yearly dependence present in the data. The overall impact of reducing the dependence and re-introducing it in the form of total data did not significantly alter the frequency relationship. Since Lakes Michigan-Huron exhibited the strongest autocorrelation and this dependence did not create significant differences, the effect of autocorrelation on the other lakes was considered insignificant.

The second concern involved different skew values among gages on the same lake and from lake to lake, and required study to arrive at a satisfactory solution. The Hydrologic Engineering

Center (HEC) performed an extensive analysis on the regional skew characteristics of the data and recommended the following:

	Skew
Lake Superior	0.2
Lake Michigan-Huron	0.2
Lake Erie	0.2
Lake Ontario	0.4

The Waterways Experiment Station (WES) was also consulted and their general findings supported the analysis of HEC. Both reports found that the length of the data record consistently influences computed skews. Gages with longer records gave skews which were less variable and closer to zero. Both reports found regional skew variations between the Lakes, with Lake Ontario being significantly different from the rest. To determine the effect on the frequency curves of using a zero skew or a regional skew, a comparison was made. With the use of HEC's regional skew values, the generated water levels were 0.1 foot to 0.2 foot higher for all of the Lakes, in comparison to the use of zero skew. Based on HEC's extensive review, and WES's recommendation for using a regional skew for Lake Ontario, the regional skew values provided by the Hydrologic Engineering Center were adopted.

RESULTS

OPEN-COAST LEVELS

The open-coast flood levels were derived from the 10, 50, 100, and 500-year flood levels computed for each station taking into consideration such factors as the number of years of record, physical environment of the gage, levels at other gages on the lake and the configuration of the adjoining shoreline. The open-coast levels between gaging stations were interpolated, taking all these factors into consideration, for a smooth transition to avoid showing sudden rises and falls in the levels. The derivation of open-coast levels at the stations and between stations in some cases is judgmental rather than mathematical in nature. Although the flood levels at all current Canadian and U. S. stations were considered in determining the open-coast flood levels, more weight was given to the levels at the stations with the longer periods of record. However, where a gage exists within a reach, the derived open-coast level for that reach is within the 5% and 95% confidence limit interval for the gage's frequency curve.

The updated open-coast flood levels are shown on Plates 1-5. These plates are produced from navigation charts, and show the U.S. shoreline divided into reaches. The delineation of the

reaches is unchanged from the 1977 report. The updated 10, 50, 100, and 500-year open-coast flood levels which apply to the reaches are shown in tables located on the Plates, with elevations in feet on both International Great Lakes Datum (1955) and Mean Sea Level Datum (Mean Sea Level Datum is equivalent to the National Geodetic Vertical Datum of 1929).

COMPARISON OF RESULTS

A comparison between the findings of the 1977 report and the updated study generally shows higher expected flood elevations for each of the reported reaches. The higher elevations are mainly due to the fact that extreme high water levels occurred during the added period (1975-1986). A portion of the difference in elevation (0.1 to 0.2 foot) can be attributed to the use of regional skew values as discussed earlier in this report. The average and maximum differences between water levels from each study for each Lake and return period, are listed in Table 2. A detailed comparison of the 1977 study to the revised study, in tabular form, is included in Appendix C. This table compares the 1977 study's 10, 50, 100, and 500-year flood levels for each reach to the results of the updated study.

FUTURE UPDATES

Because the period of record of some stations used in this report is so short, the flood levels reported herein should be

TABLE 2 - COMPARISON OF RESULTS

The Average and Maximum Differences Found in Comparing the Revised Study to the 1977 Study, (Feet)

	Return Period							
	10-Year		50-Year		100-Year		500-Year	
Lake	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.
Lake Superior	0.0	0.2 (C)	0.1	0.3 (C)	0.1	0.3 (C)	0.2	0.4 (C)
Lake Huron	0.0	0.0	0.2	0.2	0.3	0.3	0.6	0.6
Lake Michigan	0.5	0.9 (K)	0.7	1.1 (K)	0.8	1.2 (K)	1.1	1.5 (K)
Lake St. Clair	0.7	0.7 (AA)	1.0	1.0 (AA)	1.1	1.1 (AA)	1.5	1.5 (AA)
Lake Erie	0.2	0.6 (Z)	0.3	0.7 (A,Z)	0.4	0.9 (A)	0.7	1.1 (A,Z)
Lake Ontario	0.0	0.0	0.3	0.3	0.3	0.3	0.6	0.6

The average difference was calculated by (1) subtracting the 1977 study results from the revised study results for each reach in a lake, and then (2) averaging the differences on each lake.

The maximum difference was the maximum value found on a lake at a specific reach when the 1977 study results were subtracted from the revised study results. The letter in parentheses indicates the reach at which the maximum difference occurred. If no letter follows the maximum value, this indicates that the difference was the same for all reaches on a lake.

reviewed in about 15 years (2000-2005). At that time, the longer record will provide data of greater statistical significance.

Note: See the Phase II report of the Revised Report on Great Lakes Open-Coast Flood Levels for those areas not covered in this Phase I report.

LAKE SUPERIOR TABLE

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*								
	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
REACH	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	602.8	603.7	603.3	604.2	603.5	604.4	603.9	604.8
B	602.7	603.7	603.2	604.2	603.4	604.4	603.8	604.8
C	602.8	603.9	603.3	604.4	603.5	604.6	603.9	605.0
D	602.7	603.9	603.2	604.4	603.4	604.6	603.8	605.0
E	602.6	603.8	603.1	604.3	603.3	604.5	603.7	604.9

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

OPEN-COAST FLOOD LEVELS ARE APPLICABLE FOR ALL LAKE SUPERIOR SHORELINES EXCEPT IN THE FOLLOWING PHASE II AREAS:

REACH A-WHITEFISH BAY
REACH B-GRAND ISLAND
REACH B-HURON BAY
REACH B-KEWEENAW BAY
REACH C-CHEQUAMEGON BAY
REACH C-APOSTLE ISLANDS

THUNDER BAY (1915–1986)

MICHIPICOTEN (1915–1986)

TWO HARBORS (1942–1986)

ONTONAGON (1960–1986)

DULUTH (1950–1986)

MARQUETTE (1903–1986)

POINT IROQUOIS (1933–1986)

LAKE SUPERIOR REVISED OPEN-COAST FLOOD LEVELS

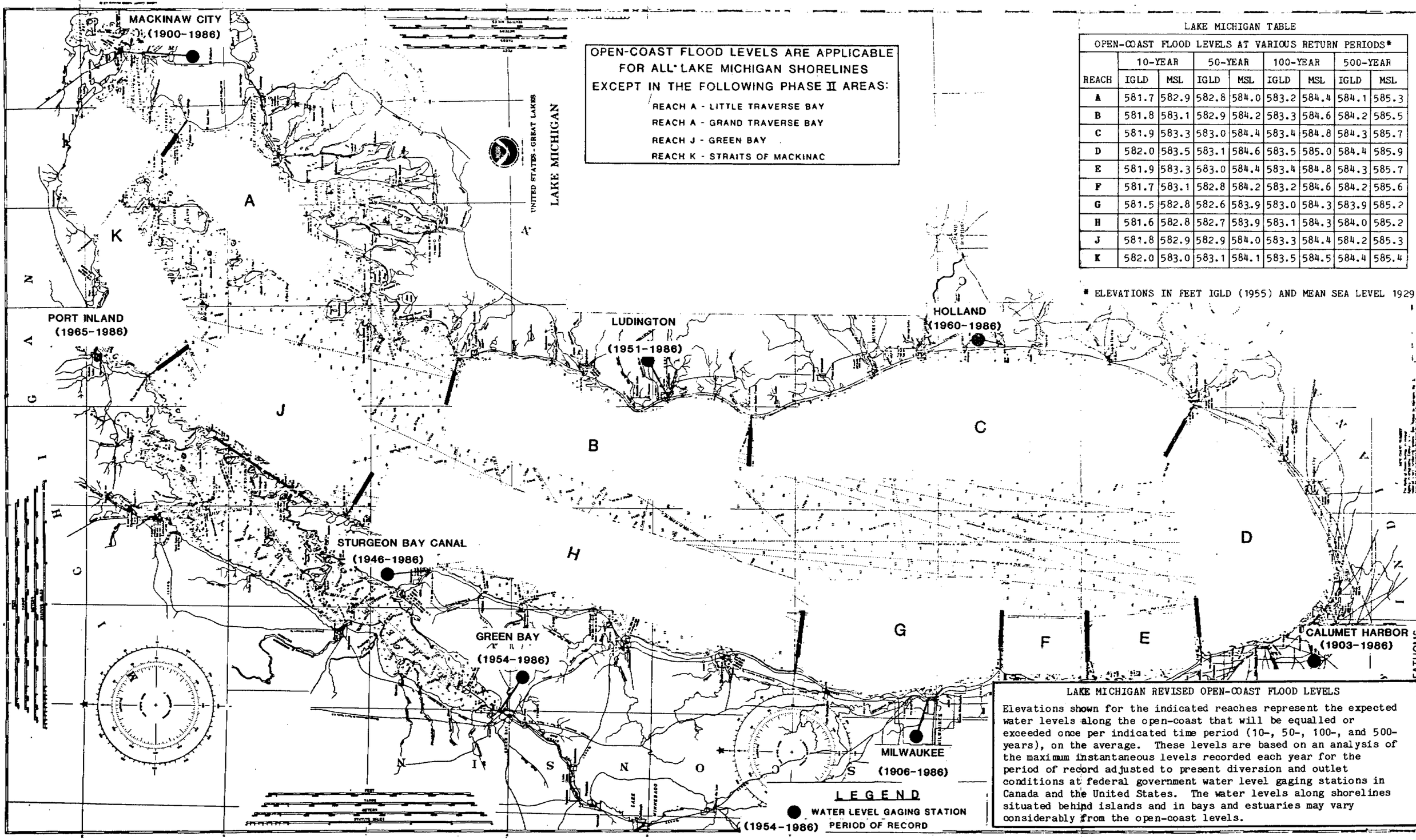
Elevations shown for the indicated reaches represent the expected water levels along the open-coast that will be equalled or exceeded once per indicated time period (10-, 50-, 100-, and 500-years), on the average. These levels are based on an analysis of the maximum instantaneous levels recorded each year for the period of record adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines situated behind islands and in bays and estuaries may vary considerably from the open-coast levels.

LEGEND

● WATER LEVEL GAGING STATION

(1960–1986) PERIOD OF RECORD

PLATE 1



OPEN-COAST FLOOD LEVELS ARE APPLICABLE FOR ALL LAKE MICHIGAN SHORELINES EXCEPT IN THE FOLLOWING PHASE II AREAS:

- REACH A - LITTLE TRAVERSE BAY
- REACH A - GRAND TRAVERSE BAY
- REACH J - GREEN BAY
- REACH K - STRAITS OF MACKINAC

LAKE MICHIGAN TABLE

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*

REACH	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	581.7	582.9	582.8	584.0	583.2	584.4	584.1	585.3
B	581.8	583.1	582.9	584.2	583.3	584.6	584.2	585.5
C	581.9	583.3	583.0	584.4	583.4	584.8	584.3	585.7
D	582.0	583.5	583.1	584.6	583.5	585.0	584.4	585.9
E	581.9	583.3	583.0	584.4	583.4	584.8	584.3	585.7
F	581.7	583.1	582.8	584.2	583.2	584.6	584.2	585.6
G	581.5	582.8	582.6	583.9	583.0	584.3	583.9	585.2
H	581.6	582.8	582.7	583.9	583.1	584.3	584.0	585.2
J	581.8	582.9	582.9	584.0	583.3	584.4	584.2	585.3
K	582.0	583.0	583.1	584.1	583.5	584.5	584.4	585.4

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

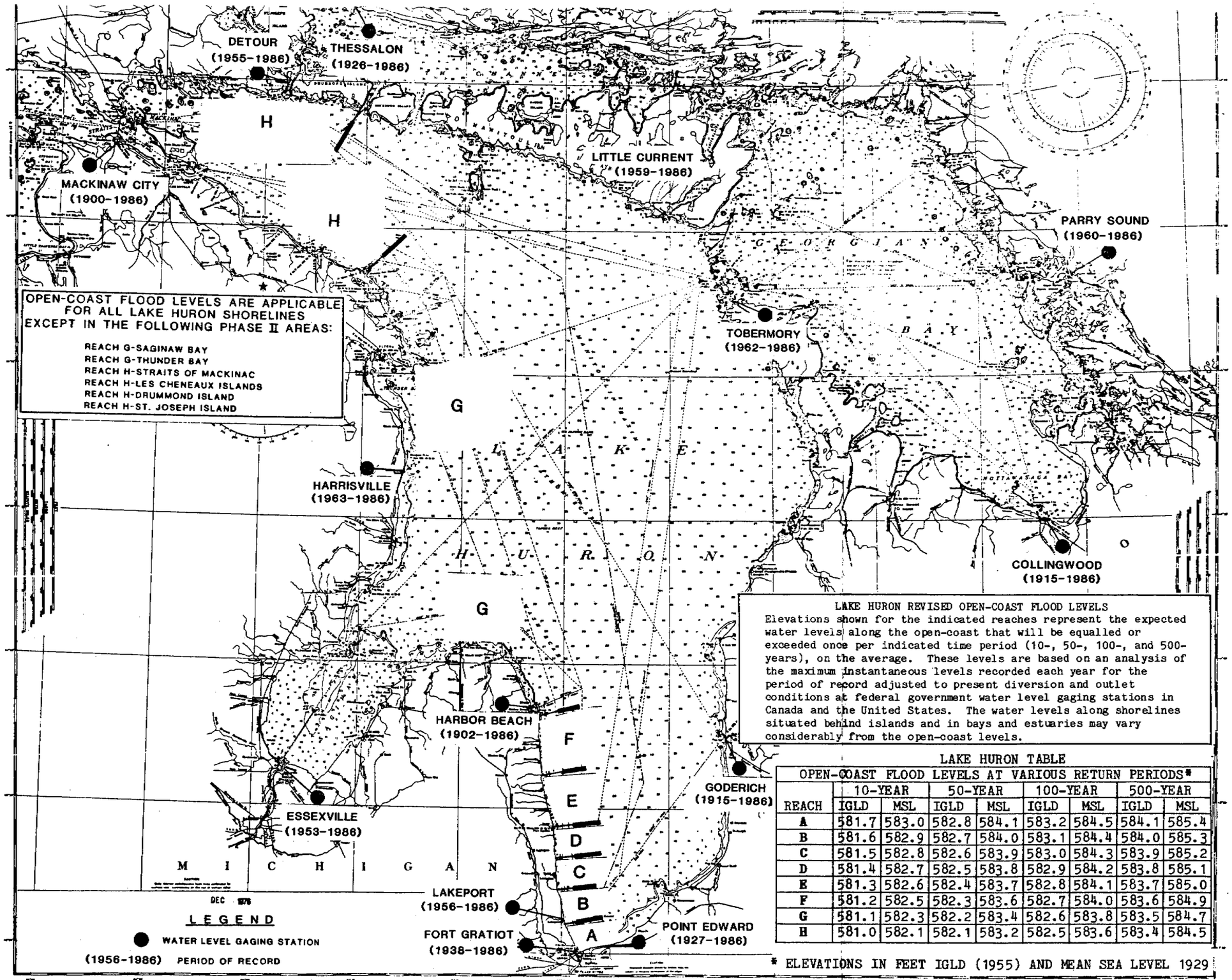
LEGEND

● WATER LEVEL GAGING STATION
(1954-1986) PERIOD OF RECORD

LAKE MICHIGAN REVISED OPEN-COAST FLOOD LEVELS

Elevations shown for the indicated reaches represent the expected water levels along the open-coast that will be equalled or exceeded once per indicated time period (10-, 50-, 100-, and 500-years), on the average. These levels are based on an analysis of the maximum instantaneous levels recorded each year for the period of record adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines situated behind islands and in bays and estuaries may vary considerably from the open-coast levels.

PLATE 2



LAKE HURON REVISED OPEN-COAST FLOOD LEVELS

Elevations shown for the indicated reaches represent the expected water levels along the open-coast that will be equalled or exceeded once per indicated time period (10-, 50-, 100-, and 500-years), on the average. These levels are based on an analysis of the maximum instantaneous levels recorded each year for the period of record adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines situated behind islands and in bays and estuaries may vary considerably from the open-coast levels.

LAKE HURON TABLE

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*

	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
REACH	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	581.7	583.0	582.8	584.1	583.2	584.5	584.1	585.4
B	581.6	582.9	582.7	584.0	583.1	584.4	584.0	585.3
C	581.5	582.8	582.6	583.9	583.0	584.3	583.9	585.2
D	581.4	582.7	582.5	583.8	582.9	584.2	583.8	585.1
E	581.3	582.6	582.4	583.7	582.8	584.1	583.7	585.0
F	581.2	582.5	582.3	583.6	582.7	584.0	583.6	584.9
G	581.1	582.3	582.2	583.4	582.6	583.8	583.5	584.7
H	581.0	582.1	582.1	583.2	582.5	583.6	583.4	584.5

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

PLATE 3

OPEN-COAST FLOOD LEVELS ARE APPLICABLE FOR ALL LAKE ERIE SHORELINES EXCEPT IN THE FOLLOWING PHASE II AREAS:

REACH K - ERIE HARBOR
REACH W - SANDUSKY BAY
REACH Z - MAUMEE BAY

LAKE HURON

LAKE ONTARIO

ALGONAC (1953-1986)

PORT LAMBTON (1931-1986)

ST. CLAIR SHORES (1953-1986)

WINDMILL POINT (1952-1986)

BELLE RIVER (1961-1986)

ERIEAU (1957-1986)

PORT STANLEY (1926-1986)

PORT DOVER (1958-1986)

PORT COLBURNE (1911-1986)

BUFFALO (1900-1986)

GIBRALTAR (1941-1986)

KINGSVILLE (1962-1986)

FERMI (1964-1986)

TOLEDO (1941-1986)

MARBLEHEAD (1960-1986)

CLEVELAND (1904-1986)

BARCELONA (1961-1986)

ERIE (1959-1986)

AA Z Y X W V U T S R Q P N M L K J H G F E D C B A

PENNSYLVANIA

NEW YORK

LAKE ERIE REVISED OPEN-COAST FLOOD LEVELS

Elevations shown for the indicated reaches represent the expected water levels along the open-coast that will be equalled or exceeded once per indicated time period (10-, 50-, 100-, and 500-years), on the average. These levels are based on an analysis of the maximum instantaneous levels recorded each year for the period of record adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines situated behind islands and in bays and estuaries may vary considerably from the open-coast levels.

LEGEND

WATER LEVEL GAGING STATION

(1961-1986) PERIOD OF RECORD

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*								
	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
REACH	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	578.4	579.7	579.8	581.1	580.3	581.6	581.4	582.7
B	577.8	579.1	579.2	580.5	579.6	580.9	580.7	582.0
C	577.3	578.6	578.6	579.9	578.9	580.2	580.0	581.3
D	576.8	578.1	578.1	579.4	578.3	579.6	579.4	580.7
E	576.3	577.6	577.6	578.9	577.8	579.1	578.9	580.2
F	575.9	577.3	577.1	578.5	577.3	578.7	578.4	579.8
G	575.5	576.9	576.6	578.0	576.9	578.3	577.9	579.3
H	575.2	576.7	576.2	577.7	576.5	578.0	577.4	578.9
J	574.9	576.4	575.8	577.3	576.2	577.7	577.0	578.5
K	574.6	576.1	575.5	577.0	575.9	577.4	576.7	578.2
L	574.4	575.9	575.2	576.7	575.6	577.1	576.4	577.9
M	574.2	575.7	575.0	576.5	575.4	576.9	576.1	577.6
N	574.1	575.6	574.8	576.3	575.2	576.7	575.9	577.4
P	573.9	575.4	574.7	576.2	575.1	576.6	575.7	577.2
Q	573.8	575.4	574.6	576.2	575.0	576.6	575.6	577.2
R	573.9	575.5	574.7	576.3	575.1	576.7	575.8	577.4
S	574.1	575.7	574.9	576.5	575.3	576.9	576.1	577.7
T	574.3	575.9	575.1	576.7	575.5	577.1	576.4	578.0
U	574.5	576.1	575.4	577.0	575.8	577.4	576.7	578.3
V	574.7	576.3	575.7	577.3	576.1	577.7	577.1	578.7
W	574.9	576.4	576.0	577.5	576.4	577.9	577.5	579.0
X	575.1	576.6	576.2	577.7	576.7	578.2	577.7	579.2
Y	575.4	576.9	576.5	578.0	577.0	578.5	577.9	579.4
Z	575.7	577.2	576.8	578.3	577.3	578.8	578.2	579.7
AA	576.6	578.0	577.8	579.2	578.2	579.6	579.2	580.6

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

NATIONAL OCEAN SURVEY

PLATE 4

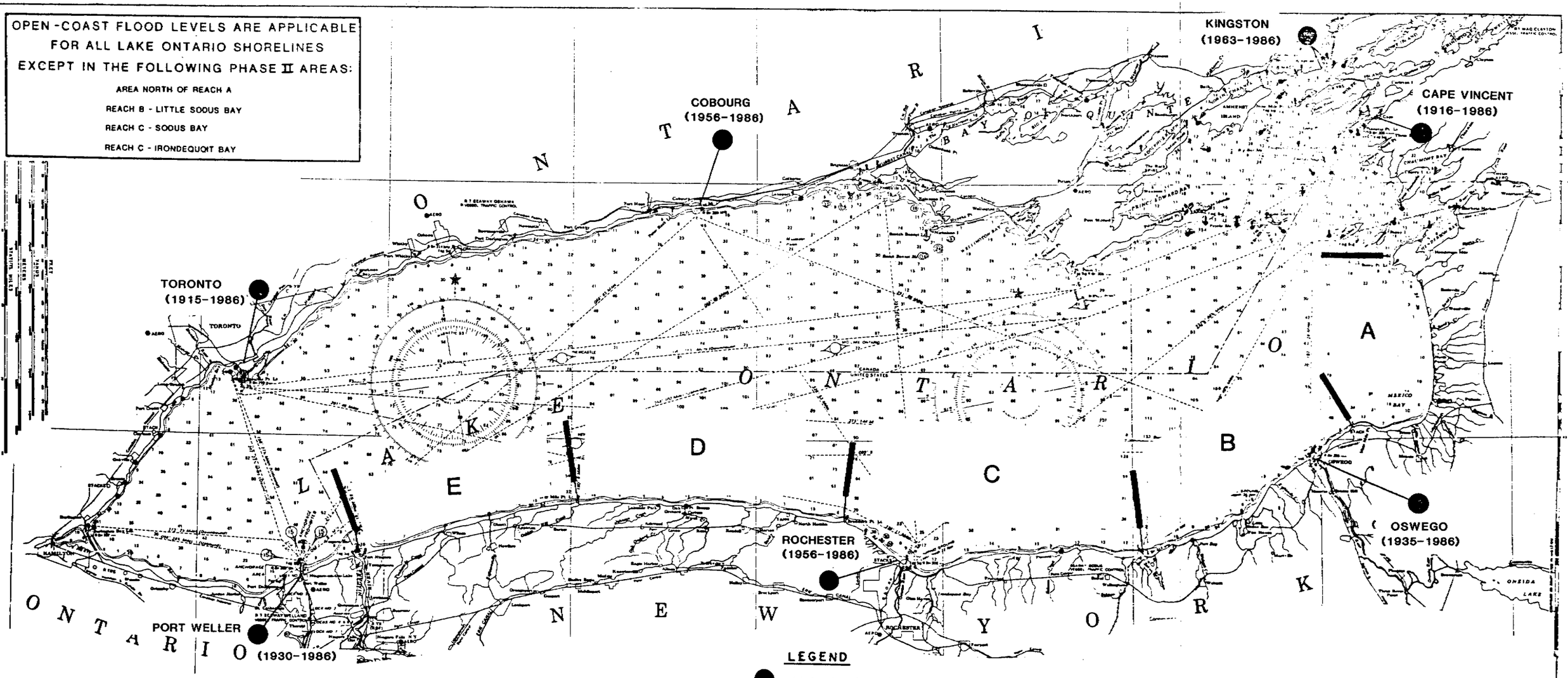
OPEN-COAST FLOOD LEVELS ARE APPLICABLE FOR ALL LAKE ONTARIO SHORELINES EXCEPT IN THE FOLLOWING PHASE II AREAS:

AREA NORTH OF REACH A

REACH B - LITTLE SODUS BAY

REACH C - SODUS BAY

REACH C - IRONDEQUOIT BAY



LEGEND

● Water level gaging station

(1935-1986) PERIOD OF RECORD

LAKE ONTARIO TABLE

OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS*								
	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
REACH	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	247.5	248.7	248.3	249.5	248.5	249.7	249.2	250.4
B	247.4	248.6	248.2	249.4	248.4	249.6	249.1	250.3
C	247.3	248.5	248.1	249.3	248.3	249.5	249.0	250.2
D	247.2	248.4	248.0	249.2	248.2	249.4	248.9	250.1
E	247.1	248.2	247.9	249.0	248.1	249.2	248.8	249.9

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL 1929

LAKE ONTARIO REVISED OPEN-COAST FLOOD LEVELS

Elevations shown for the indicated reaches represent the expected water levels along the open-coast that will be equalled or exceeded once per indicated time period (10-, 50-, 100-, and 500-years), on the average. These levels are based on an analysis of the maximum instantaneous levels recorded each year for the period of record adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines situated behind islands and in bays and estuaries may vary considerably from the open-coast levels.

GLOSSARY

Analog Gage: A recording device where a pen scribes on a continuous graph the water levels obtained at a certain location.

Annual Maximum Instantaneous Water Level: The highest water level that was recorded during a year by a gage with a sampling frequency of an hour or less.

Annual Maximum Monthly Mean Water Level: The highest monthly average water level that occurred at a gage during a year.

Autocorrelation: Tests the tendency of certain numbers to be related to other numbers.

Confidence Limits: Computed values on both sides of an estimate of a parameter that show for a specified probability the range in which the true value of the parameter lies.

Digital Gage: A recording device that registers water levels on punch tape at a certain prescribed interval at a certain location.

Diversion: The transfer of water from one drainage basin to another.

Fetch: The unobstructed distance over water in which waves are generated by a wind of relatively constant direction and speed.

Flood Frequency Curve: A graph relating flood water elevation and the probability of occurrence in any year.

Frequency Distribution: A function describing the relative frequency with which events of various magnitudes occur.

International Great Lakes Datum (IGLD): Common reference datum for the Great Lakes area based on mean water level in the St. Lawrence River at Father Point, Quebec and established in 1955.

International Joint Commission: A single unit commission between the U.S. and Canada, created by the Boundary Waters Treaty of 1909, seeking solutions to the common problems in the joint interest of both countries.

Master Gage: A lake level gage situated as to give an overall representative level of a lake, and usually having a long period of record.

Mean Sea Level (MSL): The datum referenced to the average height of the surface of the sea, found by averaging all stages of the tide over a 19-year period, at 26 stations along the Atlantic and Pacific Oceans, and the Gulf of Mexico. The establishment of the National Geodetic Vertical Datum included the 26 stations, thus referencing NGVD to MSL (See National Geodetic Vertical Datum.)

National Geodetic Vertical Datum of 1929 (NGVD): The nationwide reference surface for elevations throughout the United States. It was established by the National Geodetic Survey in 1929. Mean Sea Level datum is equivalent to NGVD of 1929 (See Mean Sea Level).

One Hundred Year Flood: A flood level that would be equalled or exceeded once in 100 years on average.

Open-Coast: Shoreline which is unprotected by the presence of islands and which is uninterrupted by bays.

Period of Record: The time interval in which data have been collected.

Reach: A section of a lake's shoreline with similar physical characteristics.

Regional Skew: A geographic area which displays similar skewing characteristics (see skew).

Runup: The rush of water up a beach or structure, associated with the breaking of a wave. The amount of runup is measured according to the vertical height above still water level that the rush of water reaches.

Skew Coefficient A numerical measure or index of the lack of symmetry in a frequency distribution. A negative skew indicates that values less than the mean occur more frequently in the sample distribution. A positive skew indicates that values greater than the mean occur more frequently in the sample distribution.

Still Water Level: The elevation that the surface of the water would assume if all wave action were absent.

Storm Water Level: A rise above normal water level on the open-coast due to the action of wind stress on the water surface (see Wind Setup).

Wave Height: The vertical distance between a crest and the preceeding trough.

Wave Setup: Superelevation of the water surface over normal surge elevation due to onshore mass transport of the water by wave action alone.

Wind Setup: Vertical rise in the stillwater level on a body of water caused by piling up of water on the shore due to wind action.

REFERENCES

1. "Report on Great Lakes Open-Coast Flood Levels - Phase I", U.S. Army Corps of Engineers, Detroit District, February 1977.

2. "Report on Great Lakes Open-Coast Flood Levels - Phase II", U.S. Army Corps of Engineers, Detroit District, June 1978.

3. "Revised Report on Great Lakes Open-Coast Flood Levels - Phase II", U.S. Army Corps of Engineers, Detroit District, April 1988.

4. "Appendix to the Report on Great Lakes Open-Coast Flood Levels", U.S. Army Corps of Engineers, Detroit District, July 1977.

5. "Appendices to the Revised Report on Great Lakes Open-Coast Flood Levels", U.S. Army Corps of Engineers, Detroit District, April 1988.

6. "Guidelines for Determining Flood Flow Frequency", Bulletin #17B, U.S. Department of the Interior, Geological Survey, Revised September 1981.

7. "Shore Protection Manual", U.S. Army Corps of Engineers, Coastal Engineering Research Center, Waterways Experiment Station, Vicksburg, Mississippi, 1984.

8. "Historical Water Levels Summary, Ontario - 1985", Inland Waters/Lands Directorate, Water Resources Branch, Water Survey of Canada, Ottawa, Canada, 1987.

9. "Statistical Analysis of Time Series Data (STATS), Users Manual (Preliminary)", U.S. Army Corps of Engineers, The Hydrologic Engineering Center, Davis, California, May 1987.

10. Great Lakes Water Levels, U.S. Department of Commerce, NOAA/NOS, Rockville, Maryland.

11. "Great Lakes Open-Coast Flood Levels - Review of Frequency Analysis Procedures", Project Report 88-1, H. E. Kubik, U.S. Army Corps of Engineers, The Hydrologic Engineering Center, Davis, California, December 1987 (Draft).

APPENDIX B

RAINFALL DATA

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2003)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1																								
2																								
3															2.78X		0.84	31	4.1	8	05	7	2	0
4															3.42		1.45	30	1.0	1	07	4	3	2
5															4.32		0.90	30	0.0	0		9	4	0
6															2.83		1.14	11	0.0	0		6	2	1
7															3.56		0.60	08	0.0	0		10	4	0
8															5.23				0.0	0		7	3	1
9															3.99		1.05	02	0.0	0		8	3	1
10															2.18		1.50	15	0.0	0		5	1	1
11															2.99		0.70	18	0.0	0		9	1	0
12	39.4	25.3	32.4		1005	0	51	01	10	14	0	4	25	0	3.53X				2.9X	1	25	6	2	0
Annual	39.4*	25.3*	32.4*		1005*	0*	51*	Dec*	10*	Dec*	0*	4*	25*	0*	34.83*		1.50*	Oct*	8.0*	8*	Mar*	71*	25*	6*

Notes

(blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will equal zero.

Elem Element types are included to provide cross-reference for users of the NCDC CDO system.

Station Station is identified by: COOP ID, Station Name, State

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value.

* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2004)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	30.6	14.1	22.4		1313	0	60	03	-5	25	0	19	29	2	0.76X		0.29	05	9.6X	5	27	3	0	0
2	37.3X	19.3X	28.3X		1046B	0B	56	29	5	01	0	4	24	0	0.65X		0.37	21	0.0X	5	06	2	0	0
3	48.1	30.6	39.4		789	0	70	06	17	23	0	3	17	0	2.68X		0.65	04	2.8X	2	16	8	1	0
4	61.2	36.1	48.7		497	13	87	18	23	12	0	0	10	0	1.04		0.18	22	0.0	0		5	0	0
5	70.0	49.4	59.7		206	47	85	13	30	04	0	0	2	0	6.66X		1.74	10	0.0	0		13	4	1
6	78.1X	59.4	68.8X		37B	150B	92	08	47	12	3	0	0	0	5.21		1.19	26	0.0	0		8	4	3
7	84.2X	58.7X	71.5X		2B	238B	92	23	45	27	3	0	0	0	3.55		0.63	08	0.0X	0		9	3	0
8	78.0	57.2	67.6		36	122	90	03	48	23	1	0	0	0	2.63		0.59	25	0.0	0		8	1	0
9	77.8	56.2	67.0		51	117	89	02	43	29	0	0	0	0	0.88		0.77	06	0.0	0		2	1	0
10	62.3	42.4	52.4		386	1	80	08	34	04	0	0	0	0	2.51		1.25	15	0.0	0		4	1	1
11	51.8	33.6	42.7		663	0	66	19	19	25	0	0	14	0	4.07		0.97	24	0.0	0		10	3	0
12	36.8	20.3X	28.6X		1133B	0B	59	08	0	25	0	9	27	2	2.62X		1.00	23	8.1	7	26	4	2	1
Annual	59.7*	39.8*	49.8		6159*	688	92	Jul	-5	Jan	7*	35*	123*	4*	33.26*		1.74*	May*	20.5*	7*	Dec*	76*	20*	6*

Notes

(blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will equal zero.

Elem Element types are included to provide cross-reference for users of the NCDC CDO system.

Station Station is identified by: COOP ID, Station Name, State

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value.

* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2005)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	32.8	16.0	24.4		1253	0	58	01	-6	19	0	18	28	3	4.91X		0.89	13	25.0X	8	25	9	4	0
2	36.6	21.1	28.9		1004	0	48	12	9	17	0	9	26	0	2.03X		0.80	21	4.5X	6	03	6	2	0
3	41.6	23.0	32.3		1005	0	63	30	6	07	0	4	26	0	1.04X		0.54	19	8.7	3	11	4	1	0
4	58.3	38.2	48.3		499	6	84	20	28	25	0	0	6	0	3.75		0.90	25	3.0X	3	25	8	3	0
5	65.1	45.7	55.4		297	5	85	10	30	04	0	0	2	0	0.69X		0.22	24	0.0	0		3	0	0
6																								
7																								
8																								
9	79.0	58.1	68.6		22	135	90	14	42	30	1	0	0	0	1.80X		0.70	26	0.0	0		4	1	0
10	65.5	44.4	55.0		337	32	85	06	33	28	0	0	0	0	1.11		0.84	24	0.0	0		2	1	0
11	52.9	35.2X	44.1X		593B	0B	72	05	18	24	0	3	11	0	3.94X		1.02	16	3.0	2	26	10	3	1
12	31.2	18.9	25.1		1232	0	42	24	2	08	0	18	30	0	3.06X		0.90	26	13.4	6	16	7	2	0
Annual	51.4*	33.4*	42.5*		6242*	178*	90*	Sep*	-6	Jan	1*	52*	129*	3*	22.33*		1.02*	Nov*	57.6*	8*	Jan*	53*	17*	1*

Notes

(blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

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Station Station is identified by: COOP ID, Station Name, State

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value.

* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2006)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1		28.3					54	29	10	17	0	2	24	0	4.91X		1.82	18	2.0	2	18	9	3	1
2	38.8	19.4	29.1		998	0	57	16	-2	22	0	7	25	3	2.69		0.90	02	0.5	0		5	2	0
3	48.0	29.0	38.5		811	0	73	14	17	01	0	0	22	0	4.00		1.22	10	0.0	0		6	4	2
4	64.6	42.0	53.3		349	6	82	15	30	09	0	0	3	0	2.09X		0.56	07	0.0	0		9	1	0
5	70.7	51.3	61.0		181	67	93	30	42	23	1	0	0	0	5.96		1.58	11	0.0	0		11	4	1
6	79.9	59.2	69.6		12	154	92	01	49	11	2	0	0	0	2.30		0.99	22	0.0	0		6	2	0
7	85.3	66.2	75.8		0	342	95	17	56	06	6	0	0	0	5.16		1.78	28	0.0	0		6	4	2
8	83.5	63.4	73.5		0	267	97	02	49	16	4	0	0	0	3.91		1.40	29	0.0	0		8	4	1
9	72.8	54.0	63.4		91	51	84	09	38	30	0	0	0	0	2.53		1.10	13	0.0	0		6	1	1
10	60.7	39.6	50.2		454	3	77	04	28	24	0	0	6	0	4.57		1.37	17	0.0	0		10	4	1
11																								
12																								
Annual	67.1*	45.2*	57.2*		2896*	890*	97	Aug	-2*	Feb*	13*	9*	80*	3*	38.12*		1.82*	Jan*	2.5*	2*	Jan*	76*	29*	9*

Notes

(blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will equal zero.

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Station Station is identified by: COOP ID, Station Name, State

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2007)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	37.7	22.4X	30.1X		1080B	0B	56	06	3	26	0	11	23	0	4.53X		1.16	15	3.4	2	31	6	4	3
2	27.4	8.5X	18.0X		1317B	0B	44	21	-10	07	0	21	26	6	0.07X		0.07	26	11.5X	9	15	0	0	0
3	48.5	31.6X	40.1X		758B	8B	80	27	11	08	0	2	14	0	2.05X		0.70	02	2.2	2	07	6	1	0
4	54.7	37.9	46.3		552	0	80	23	20	08	0	1	7	0	2.94		0.75	27	0.0	0		5	3	0
5	70.5	52.3	61.4		171	63	89	16	39	13	0	0	0	0	1.98		0.77	10	0.0	0		5	2	0
6	82.1	62.6	72.4		11	236	95	19	49	06	5	0	0	0	2.57		1.52	04	0.0	0		3	2	1
7	81.7	61.6	71.7		3	217	96	09	52	02	3	0	0	0	2.37		1.16	27	0.0	0		5	2	1
8	83.5	65.1	74.3		2	298	96	02	53	18	9	0	0	0	9.03		1.36	20	0.0	0		11	9	2
9	77.0	56.3	66.7		61	121	88	26	41	16	0	0	0	0	2.61		0.90	27	0.0	0		5	2	0
10	68.5	50.2	59.4		226	62	90	09	34	29	1	0	0	0	2.19		0.85	02	0.0	0		5	2	0
11	49.2	33.0	41.1		711	0	66	01	20	28	0	1	9	0	2.42		1.50	22	0.0	0		5	1	1
12	36.0	23.7	29.9		1080	0	54	03	12	06	0	10	30	0	3.54		1.18	12	11.1	6	18	8	2	1
Annual	59.7*	42.1*	51.0		5972*	1005	96	Aug	-10	Feb	18*	46*	109*	6*	36.30		1.52*	Jun*	28.2*	9*	Feb*	64*	30*	9*

Notes

(blank) Data element not reported or missing.

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B Adjusted total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will equal zero.

Elem Element types are included to provide cross-reference for users of the NCDC CDO system.

Station Station is identified by: COOP ID, Station Name, State

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2008)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	35.6	20.4X	28.0X		1127B	0B	63	09	4	30	0	13	24	0	2.50X		0.90	08	5.8	3	28	6	2	0
2	32.6	16.2	24.4		1171	0	51	18	-3	11	0	12	28	1	3.16X		1.22	06	18.1X	5	13	4	2	1
3	40.8	25.7	33.3		976	0	60	04	12	09	0	5	28	0	1.63X		0.55	19	19.3	6	22	6	1	0
4	60.4	42.1	51.3		411	6	82	26	28	03	0	0	5	0	1.89		0.56	01	0.0	0		6	1	0
5	64.8	47.1	56.0		285	11	85	27	36	01	0	0	0	0	2.29		0.73	12	0.0	0		7	1	0
6	80.9	62.0	71.5		10	210	95	07	51	19	4	0	0	0	5.99		1.28	22	0.0	0		12	7	1
7	84.2	63.5	73.9		3	282	91	19	54	04	4	0	0	0	4.70		2.73	03	0.0	0		4	2	2
8	80.6X	57.9X	69.3X		16B	152B	90	01	44	26	1	0	0	0	0.21		0.07	08	0.0X	0		0	0	0
9																								
10																								
11																								
12																								
Annual	60.0*	41.9*	51.0*		3999*	661*	95*	Jun*	-3*	Feb*	9*	30*	85*	1*	22.37*		2.73*	Jul*	43.2*	6*	Mar*	45*	16*	4*

Notes

(blank) Data element not reported or missing.

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2009)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8	79.7	60.0	69.9		14	173	93	11	47	31	3	0	0	0	4.12		1.82	29	0.0	0		7	3	1
9							83	15	45	20	0	0	0	0	1.54X				0.0	0		4	0	0
10	58.0	39.4	48.7		498	0	75	31	26	18	0	0	5	0	2.72		0.96	10	0.0	0		8	2	0
11	53.1	34.9	44.0		623	0	68	15	24	06	0	0	14	0	0.73X		0.30	30	0.0X	0T	27	2	0	0
12							51	02	12	11	0	5	19	0	2.03X		0.95	09	0.8X	0		2	2	0
Annual	63.6*	44.8*	54.2*		1135*	173*	93*	Aug*	12*	Dec*	3*	5*	38*	0*	11.14*		1.82*	Aug*	0.8*	0*	Dec*	23*	7*	1*

Notes

(blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted total. Monthly value totals based on proportional available data across the entire month.

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X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

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Elem Element types are included to provide cross-reference for users of the NCDC CDO system.

Station Station is identified by: COOP ID, Station Name, State

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value.

* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2010)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	31.0X	19.1X	25.1X		1231B	0B	46	25	2	10	0	14	24	0	0.54X		0.20	24	4.7X	0		1	0	0
2	32.6	21.3	27.0		1060	0	42	22	7	01	0	15	28	0	1.21X							2	0	0
3	50.0	30.0	40.0		765	0	68	19	16	06	0	0	17	0	2.46		0.84	14	0.0	9	01	5	1	0
4							72	22	31	28	0	0	4	0	2.10		1.10	26	0.0	0		2	2	1
5	73.0X	52.4X	62.7X		140B	76B	87	28	31	10	0	0	1	0	5.57X				0.0	0		10	3	1
6	81.2	62.0	71.6		12	219	90	19	47	30	1	0	0	0	3.80		1.22	24	0.0	0		8	2	1
7	88.3X	66.3X	77.3X		0B	391B	95	24	61	30	12	0	0	0	3.90X		1.00	25	0.0	0		8	3	1
8	84.5	62.9	73.7		2	279	92	31	49	27	3	0	0	0	2.18		1.43	01	0.0	0		4	1	1
9	74.0X	52.0X	63.0X		125B	71B	93	02	44	29	3	0	0	0	1.90X		0.50	28	0.0	0		6	1	0
10	65.6	42.5	54.1		337	6	88	11	30	22	0	0	2	0	0.94X		0.40	14	0.0	0		4	0	0
11	50.5	29.2	39.9		748	0	65	23	20	29	0	1	22	0	3.09X		0.86	17	0.0X	0		7	3	0
12	30.8	19.1	25.0		1233	0	56	01	3	14	0	23	30	0	0.89X		0.55	12	4.7X	4	29	2	1	0
Annual	60.1*	41.5*	50.9*		5653*	1042*	95	Jul	2	Jan	19*	53*	128*	0*	28.58*		1.43*	Aug*	9.4*	9*	Mar*	59*	17*	5*

Notes

(blank) Data element not reported or missing.

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A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

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Elem Element types are included to provide cross-reference for users of the NCDC CDO system.

Station Station is identified by: COOP ID, Station Name, State

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2011)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	28.5X	14.0X	21.3X			0	52	02	0	24	0	22	27	1			0.50	25	11.7X	7X	17	3	2	0
2							56	18	-6	10									13.0X	17	12			
3							62	19	15	08					6.13X		4.50	23	0.0X	2	01	5	2	1
4							73	27	32	20									0.0T	0T				
5	67.9	50.8	59.4		216	46	91	31	34	04	1	0	0	0	6.48		1.90	26	0.0			13	4	1
6	79.7X	60.2X	70.0X				96	09	50	14	4	0	0	0	2.02X		0.46	09	0.0			8	0	0
7	90.2X	66.4X	78.3X		0		101	22	54	14	15	0	0	0	3.35A		1.28	28	0.0			4	3	2
8	82.3X	60.0X	71.2X		0		93	01	51	30	1	0	0	0	4.16A		2.22	09	0.0			7	2	1
9	73.0	54.9	64.0		109	86	98	03	39	16	2	0	0	0	6.66		1.06	26	0.0			16	5	1
10	62.5X	42.2X	52.4X			0	78	10	29	31	0	0	5	0	3.23A		1.75	20	0.0			7	1	1
11	54.3X	37.9X	46.1X			0	70	10	23	18	0	0	7	0	8.32A		2.72	23	0.3X	0		8	4	3
12	41.3X	27.8X	34.6X			0	56	15	16	10	0	1	22	0	3.12A		0.73	15	1.6X	2	06	6	1	0
Annual	64.4*	46.0*	10.3		325*	132	101	Jul	-6	Feb	23*	23*	61*	1*	43.47		4.50*	Mar*	26.6*	17*	Feb*	77*	24*	10*

Notes

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2012)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	38.5X	22.3X	30.4X			0	54	07	2	20	0	9	29	0	2.49A		0.87	17	3.4X	2	22	6	1	0
2	40.0X	24.9X	32.5X			0	57	01	10	11	0	3	24	0	1.37A		0.43	29	5.0X	3	15	5	0	0
3	58.5X	37.9X	48.2X			0	78	23	20	10	0	0	8	0	5.45A		2.42	16	0.0T	0T		7	4	1
4	59.1X	36.8X	48.0X				81	16	28	29	0	0	6	0	1.55A		0.48	30	0.0			4	0	0
5	74.3X	51.4X	62.9X				92	26	40	12	1	0	0	0	2.46A		0.93	01	0.0			4	2	0
6	81.7X	58.0X	69.9X				100	29	46	06	4	0	0	0	2.35A		1.21	01	0.0			5	1	1
7	89.4X	65.5X	77.5X		0		102	08	55	21	13	0	0	0	2.13A		0.48	08	0.0			5	0	0
8							92	05	53	22									0.0					
9	74.3	50.3	62.3		145	73	94	01	34	25	1	0	0	0	2.82		0.65	02	0.0			8	1	0
10	60.5X	41.0X	50.8X			0	78	26	29	11	0	0	5	0	2.17A		0.32	18	0.0T	0		6	0	0
11	47.9X	28.4X	38.2X			0	68	13	19	28	0	0	26	0	1.12A		0.46	12	0.0T	0		3	0	0
12	42.2X	28.5X	35.4X			0	62	04	12	28	0	5	17	0	2.18A		0.65	21	5.1X	5X	31	7	1	0
Annual	60.6*	40.5*	5.2		145*	73	102	Jul	2	Jan	19*	17*	115*	0*	26.09		2.42*	Mar*	13.5*	5*	Dec*	60*	10*	2*

Notes

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2013)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	34.8X	19.1X	27.0X	1.7		0	62	30	-1	23	0	12	23	1	4.36A		0.65	11	5.1X	5	02	4	3	0
2	31.9X	19.3X	25.6X	-1.7		0	46	12	2	03	0	12	23	0	2.81A		1.70	27	7.0X	4X	06	4	1	1
3	38.3X	24.5X	31.4X	-5.2		0	65	11	15	21	0	8	22	0	0.77A		0.35	16	1.6X	1X	17	3	0	0
4	55.8X	36.4X	46.1X	-1.6			80	19	18	02	0	0	8	0	4.84A		1.20	11	0.0T	0		10	4	1
5	72.9X	50.5X	61.7X	2.4			90	21	27	13	1	0	1	0	1.87A		0.90	28	0.0			4	1	0
6	77.2X	58.6X	67.9X	-1.9			90	23	44	19	1	0	0	0	8.02A		1.26	13	0.0			9	4	1
7							90	16	50	28	1	0	0	0	6.66A		1.64	02	0.0			5	2	1
8	80.4X	59.5X	70.0X	-1.4			88	27	48	14	0	0	0	0	4.84A		1.90	13	0.0			8	4	1
9	74.4	51.9X	63.1X	-0.7			95	11	39	18	2	0	0	0	2.15		1.04	21	0.0			4	1	1
10	64.3X	43.7X	54.0X	1.8			80	04	28	25	0	0	5	0	1.82A		0.54	07	0.0X	0		4	1	0
11	45.7X	29.3X	37.5X	-3.4		0	66	18	16	29	0	3	15	0	2.13A		0.63	01	0.2X	0T		4	1	0
12	33.5X	20.2X	26.9X	-2.6		0	47	02	-1	16	0	13	23	1	3.29A		1.65	22	12.9X	9	19	5	2	1
Annual	55.4*	37.5*	0.0	-1.1		0	95	Sep	-1	Dec	5*	48*	120*	2*	43.56		1.90*	Aug*	26.8*	9*	Dec*	64*	24*	7*

Notes

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* Annual value missing; summary value computed from available month values.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2014)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	23.6X	4.6X	14.1	-11.2		0	46	14	-15	07	0	21	26	13	2.73A		0.65	06	26.8X	14	10	4	1	0
2	27.8X	8.0X	17.9	-9.4		0	49	21	-8	12	0	18	27	8	3.07A		1.13	21	21.5X	17	18	6	3	1
3	34.5X	15.7X	25.1	-11.5		0	51	28	-3	04	0	9	21	2	0.82X		0.42	12	6.8X	10	14	2	0	0
4	58.3X	37.6X	47.9	0.2			77	22	18	16	0	0	6	0	2.98A		0.85	04	1.7X	2	15	6	3	0
5	69.1X	48.6X	58.8	-0.5			87	28	34	06	0	0	0	0	3.90A		1.18	13	0.0X	0		6	3	1
6	78.8X	60.2X	69.5	-0.3			91	18	44	14	2	0	0	0	2.85A		1.12	19	0.0			6	2	1
7	80.2X	57.8X	69.0	-4.5			91	23	48	29	1	0	0	0	1.83A		0.84	28	0.0			4	1	0
8	79.3X	59.7X	69.5	-1.9			90	27	48	15	1	0	0	0	4.75A		2.25	12	0.0			5	2	2
9	72.3X	50.8X	61.5	-2.3			88	05	40	18	0	0	0	0	5.78X		4.72	11	0.0			6	1	1
10						0	77	28	31	30	0	0	3	0	1.22A		0.20	29	0.0			3	0	0
11	44.0X	28.0X	36.0	-4.9		0	64	12	9	18	0	3	15	0	1.47X		0.95	24	2.2X	2	17	3	1	0
12	40.8X	28.5X	34.7	5.2		0	61	01	11	31	0	5	17	0	1.32X		0.44	25	0.0T	0		5	0	0
Annual	55.3*	36.3*	42.0	-3.7		0	91	Jul	-15	Jan	4*	56*	115*	23*	32.72		4.72*	Sep*	59.0*	17*	Feb*	56*	17*	6*

Notes

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U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Annual Climatological Summary (2015)

Generated on 10/03/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 586 ft. Lat: 41.907° N Lon: 83.416° W
Station: **MONROE WWTP, MI US COOP:205563**

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number Of Days				Total	Depart. from Normal	Greatest Observed		Snow, Sleet			Number Of Days		
											Max >=90	Max <=32	Min <=32	Min <=0			Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	27.8X	13.2X	20.5	-4.8		0	38	20	-4	08	0	16	23	3	1.47A		0.95	04	8.7X	7X	16	3	1	0
2	22.8X	1.5X	12.1	-15.2		0	45	09	-16	20	0	20	24	12	0.57X		0.19	01	16.6X	17	05	4	0	0
3						0	60	17	-3	06	0	4	15	1						11	02			
4	57.7X	35.2X	46.4	-1.3		0	75	14	24	24	0	0	5	0	2.65X		0.55	20		0		7	1	0
5	72.1X	51.3X	61.7	2.4			87	09	36	14	0	0	0	0	5.25X		2.76	31				8	3	1
6	74.3X	57.5X	65.9	-3.9			88	11	43	02	0	0	0	0	11.84X		2.24	23				11	7	6
7	80.6X	60.2X	70.4	-3.1			89	30	51	03	0	0	0	0	3.69A		1.32	09	0.0X	0		9	2	1
8	79.9X	59.6X	69.8	-1.6			91	03	49	28	1	0	0	0	2.64X		1.19	03	0.0	0		4	2	1
9							90	09	46	22	1	0	0	0						0				
10						0	78	13	27	18	0	0	3	0						0				
11							74	06	18	23	0	1	6	0						1	24			
12																								
Annual	59.3*	39.8*	49.5*			0*	91*	Aug*	-16*	Feb*	2*	41*	76*	16*	28.11*		2.76*	May*	25.3*	17*	Feb*	46*	16*	9*

Notes

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