

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

FOR NPS USE ONLY
RECEIVED JUN 26 1979
DATE ENTERED AUG 16 1979

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC Croton Hydroelectric Plant

AND/OR COMMON
Croton Dam

2 LOCATION

STREET & NUMBER
Croton Dam Road, at the Muskegon River NOT FOR PUBLICATION

CITY, TOWN Croton VICINITY OF 9th CONGRESSIONAL DISTRICT

STATE Michigan CODE 026 COUNTY Newaygo CODE 123

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
<input type="checkbox"/> DISTRICT	<input type="checkbox"/> PUBLIC	<input checked="" type="checkbox"/> OCCUPIED	<input type="checkbox"/> AGRICULTURE	<input type="checkbox"/> MUSEUM
<input checked="" type="checkbox"/> BUILDING(S)	<input checked="" type="checkbox"/> PRIVATE	<input type="checkbox"/> UNOCCUPIED	<input type="checkbox"/> COMMERCIAL	<input type="checkbox"/> PARK
<input checked="" type="checkbox"/> STRUCTURE	<input type="checkbox"/> BOTH	<input type="checkbox"/> WORK IN PROGRESS	<input type="checkbox"/> EDUCATIONAL	<input type="checkbox"/> PRIVATE RESIDENCE
<input type="checkbox"/> SITE	PUBLIC ACQUISITION	ACCESSIBLE	<input type="checkbox"/> ENTERTAINMENT	<input type="checkbox"/> RELIGIOUS
<input type="checkbox"/> OBJECT	<input type="checkbox"/> IN PROCESS	<input type="checkbox"/> YES: RESTRICTED	<input type="checkbox"/> GOVERNMENT	<input type="checkbox"/> SCIENTIFIC
	<input type="checkbox"/> BEING CONSIDERED	<input type="checkbox"/> YES: UNRESTRICTED	<input checked="" type="checkbox"/> INDUSTRIAL	<input type="checkbox"/> TRANSPORTATION
		<input checked="" type="checkbox"/> NO	<input type="checkbox"/> MILITARY	<input type="checkbox"/> OTHER:

4 OWNER OF PROPERTY

NAME Consumers Power Company

STREET & NUMBER
212 West Michigan Avenue

CITY, TOWN Jackson VICINITY OF STATE Michigan

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC. Newaygo County Courthouse

STREET & NUMBER
CITY, TOWN White Cloud STATE Michigan

6 REPRESENTATION IN EXISTING SURVEYS

TITLE Historic American Engineering Record

DATE July 15, 1976 FEDERAL STATE COUNTY LOCAL

DEPOSITORY FOR SURVEY RECORDS Historic American Engineering Record, Heritage Conservation and Recreation Service, U. S. Department of the Interior

CITY, TOWN Washington STATE D.C.

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
<input checked="" type="checkbox"/> EXCELLENT	<input type="checkbox"/> DETERIORATED	<input type="checkbox"/> UNALTERED	<input checked="" type="checkbox"/> ORIGINAL SITE
<input type="checkbox"/> GOOD	<input type="checkbox"/> RUINS	<input checked="" type="checkbox"/> ALTERED	<input type="checkbox"/> MOVED DATE _____
<input type="checkbox"/> FAIR	<input type="checkbox"/> UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

Beginning on the east bank of the Muskegon River and proceeding from east to west, the Croton Hydroelectric Plant consists of three distinct structures - an earth embankment, a concrete and brick powerhouse, and a concrete spillway. The embankment section is 200 feet long and 40 to 60 feet high, varying with the depth of the riverbed. It is approximately 200 feet wide at its base, with slopes of 3:1 on the upstream face and 2:1 on the downstream face, culminating in a flat crest 20 feet wide. There is a reinforced concrete corewall, 1 foot wide and 42 feet high running the entire length of the embankment and located 15 feet north (upstream) of the crest of the embankment. The corewall rests on a sheet steel piling cutoff driven 36 feet below the riverbed, which prevents water from undermining the corewall.

The powerhouse, which abuts the west end of the embankment, is a brick ell-shaped building resting on a reinforced concrete foundation which rests on about 3,000 round oak piles. All exterior walls rest on sheet steel pilings which act as cutoffs to prevent water from undermining the foundations. The powerhouse is 60 feet tall, with two gabled roofs supported by steel roof trusses. The easternmost segment, the Turbine Room, was originally 46 feet wide and 100 feet long, but a small addition 10 feet wide and 50 feet long was made to the southeast corner in 1915 when two new generators were installed. The second part of the powerhouse, originally the Generator Room, is 46 feet by 100 feet. Two reinforced concrete retaining walls extend 40 feet upstream from the northeast and northwest corners of this section to form a triangle which also serves as an anchor for a floating trash boom which keeps refuse out of the turbine pits. A similar triangle is formed by two reinforced concrete retaining walls extending 60 feet south from the south (downstream) facade of the Generator Room. A concrete training wall extends an additional 140 feet south from the point of this triangle.

The extant equipment includes the two original Westinghouse horizontal generators in the Generator Room, each rated at 3,750 K.V.A., 7,500 Volts, operating at 225 R.P.M. They are each driven by a pair of Allis-Chalmers quadriplex horizontal turbines with 44 inch Francis runners set in pairs, installed in 1915. Each pair of turbines is rated at 4,000 Horsepower when operated at 225 R.P.M. with a hydraulic head of 39½ feet. They have direct-connected exciters. The generators were originally operated at 6,600 volts and the line voltage was stepped up to 100,000 volts with three delta-connected transformers of 3,000 kilowatts capacity. When the generator voltage was increased to 7,200 in early 1909, the result was approximately 110,000 volts on the high tops of the transformers. There are also a pair of vertical generators and the turbines which drive them, installed in 1915 at the east end of the Turbine Room. The generators are Allis-Chalmers units, rated at 1,610 K.V.A., 7,500 Volts, operating at 150 R.P.M. and are driven by Allis-Chalmers vertical turbines rated at 1,750 B.P.H. when run at 150 R.P.M. with a head of 39 feet.

The third major section of this plant is a reinforced concrete spillway which abuts the western end of the powerhouse and extends 242 feet to the

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

FOR NPS USE ONLY	
RECEIVED	JUN 26 1979
DATE ENTERED	AUG 16 1979

CONTINUATION SHEET

ITEM NUMBER 7 PAGE 2

west bank of the Muskegon River. It is 90 feet wide and rests on round timber pilings, with sheet steel piling cutoffs at the upstream and downstream faces. There is a steel shutter gate 40 feet wide in the middle of the spillway, with four steel tainter (radial) gates, each 20 feet wide and 13 feet high on either side. The shutter gate is flanked by two reinforced concrete piers 110 feet long and $4\frac{1}{2}$ feet wide, while the tainter gates are supported by piers of the same width, 35 feet long and 42 feet high. South of each set of four tainter gates is a concrete-lined tumble bay 30 feet wide and 90 feet long. South of the tumble bay is an inclined, reinforced concrete apron 250 feet wide and 200 feet long, varying from $4\frac{1}{2}$ to $2\frac{1}{2}$ feet thick.

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
<input type="checkbox"/> PREHISTORIC	<input type="checkbox"/> ARCHEOLOGY-PREHISTORIC	<input type="checkbox"/> COMMUNITY PLANNING	<input type="checkbox"/> LANDSCAPE ARCHITECTURE	<input type="checkbox"/> RELIGION
<input type="checkbox"/> 1400-1499	<input type="checkbox"/> ARCHEOLOGY-HISTORIC	<input type="checkbox"/> CONSERVATION	<input type="checkbox"/> LAW	<input type="checkbox"/> SCIENCE
<input type="checkbox"/> 1500-1599	<input type="checkbox"/> AGRICULTURE	<input type="checkbox"/> ECONOMICS	<input type="checkbox"/> LITERATURE	<input type="checkbox"/> SCULPTURE
<input type="checkbox"/> 1600-1699	<input type="checkbox"/> ARCHITECTURE	<input type="checkbox"/> EDUCATION	<input type="checkbox"/> MILITARY	<input type="checkbox"/> SOCIAL/HUMANITARIAN
<input type="checkbox"/> 1700-1799	<input type="checkbox"/> ART	<input checked="" type="checkbox"/> ENGINEERING	<input type="checkbox"/> MUSIC	<input type="checkbox"/> THEATER
<input type="checkbox"/> 1800-1899	<input type="checkbox"/> COMMERCE	<input type="checkbox"/> EXPLORATION/SETTLEMENT	<input type="checkbox"/> PHILOSOPHY	<input type="checkbox"/> TRANSPORTATION
<input checked="" type="checkbox"/> 1900-	<input type="checkbox"/> COMMUNICATIONS	<input checked="" type="checkbox"/> INDUSTRY	<input type="checkbox"/> POLITICS/GOVERNMENT	<input type="checkbox"/> OTHER (SPECIFY)
		<input checked="" type="checkbox"/> INVENTION		

SPECIFIC DATES 1908, 1915

BUILDER/ARCHITECT William G. Fargo

STATEMENT OF SIGNIFICANCE

The Croton Hydroelectric Plant on the Muskegon River was one of Michigan's first large-scale electrical generating plants and was the site of significant innovations in engineering, both in the construction of the plant and in the transmission of the electrical power generated there. Because of its importance to civil and electrical engineering, dozens of engineers from all over the world visited Croton during and after its construction.

This plant was the product of a long-term alliance of three talented Michiganians- William Augustus Foote, an Adrian native active in the electric power industry since 1886, chiefly as an entrepreneur and financier; his brother, James Berry Foote, an electrical engineering genius; and William G. Fargo, a civil engineer from Jackson who began building hydroelectric plants for the Footes in 1898. W. A. Foote was heavily involved in electrical utilities in Jackson, Battle Creek, Kalamazoo and Grand Rapids beginning in the early 1890's and in 1904 bought a one-third interest in the Grand Rapids-Muskegon Water Power Electric Company, which acquired virtually all the lands and the riparian rights on the Muskegon River in June 1905. The enterprise had to be reorganized and refinanced in April 1906, when a new company was established, the Grand Rapids-Muskegon Power Company. In March 1906, the company opened the Rogers Hydroelectric Plant which developed 6,000 horsepower and supplied electricity to Grand Rapids, 55 miles away, and to Muskegon over a transmission line extending 68 miles. As the Rogers Dam was completed, construction began at Croton, located about seventeen miles downstream from Rogers.

The Croton plant was designed to develop 14,400 horsepower with a hydraulic head of 40 feet. It had more than twice the capacity of the Rogers plant, which was the largest in Michigan when it opened. By contrast, the immense Niagara Falls generating plant developed 50,000 horsepower. Approximately two-thirds of the Croton plant was constructed of reinforced concrete, following typical contemporary engineering practices. However, in building the earth embankment dam, 300 feet long and containing 104,000 cubic yards, Fargo moved the sand and gravel used for fill from a nearby hill by means of hydraulic sluicing. This was the first large-scale use of this technique east of the Mississippi.

Fargo built a pumping plant at the river, using a total of seven rotary pumps of different manufacture, all driven by electric motors, to move water up a ten inch pipeline to a bluff about 110 feet above the river.

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

FOR NPS USE ONLY

RECEIVED
JUN 26 1979

DATE ENTERED

AUG 16 1979

CONTINUATION SHEET

ITEM NUMBER 8 PAGE 2

At the bluff, the line was reduced to four inches and water was fed into nozzles by means of four inch rubber hoses. The pressure of the water, about 80 pounds per square inch at the nozzles, broke up the soil and the intermixed water and soil was diverted into sheet metal troughs which extended about 850 feet at grades of 6-8% to the point on the embankment where the material was deposited. The embankment was filled in sections to permit the water to drain off slowly, thus compacting the fill.

The chief advantage of the hydraulic sluicing method was its cost. The total expenses of constructing the embankment, including depreciation of equipment, was only \$7,076 or about seven cents per cubic yard of material moved. As part of the Croton project, Fargo also constructed a fill of 20,000 cubic yards for a highway bridge approach downstream from the dam, utilizing hydraulic sluicing at approximately the same costs.

Croton was also the site of significant breakthroughs in the transmission of electricity at high voltages. The Foote brothers wanted to reduce the power loss that resulted from long distance transmission by increasing the line voltage from the 72,000 volts used on the Rogers line to the unprecedented pressure of 110,000 volts. The Rogers line used pin-insulators 14 inches in diameter, the largest size that could be economically produced, mounted on wooden poles. These insulators were the best the electrical industry had developed up to this time, but they were not adequate to carry the projected voltage from Croton. While visiting the General Electric plant in Schenectady, New York, J. B. Foote discovered that E. M. Hewlett and Harold W. Buck were experimenting with a new insulator. The Hewlett-Buck system utilized five porcelain discs or "bells", each ten inches in diameter, suspended from one another by wire and attached to the transmission tower. The Footes tried this system but found that the hardware connecting the insulators tended to break the porcelain discs. J. B. Foote solved this problem by annealing pieces of line wire, threading it through the insulators, and attaching it to the discs with Crosby clips.

The insulator innovation was critical but there were other significant innovations as well. For the transmission line, they used three-legged steel towers which rose to a point, commonly called "windmill" towers because they were originally designed to support farm windmills. The Footes preferred to use Number 2 stranded medium-hard copper wire for the conductor on this line, but because wire manufactureres were not equipped to produce this size, they instead used six strands of Number 10 medium-hard copper wire cabled around a hemp center. When considered as an interrelated cluster of innovations, these developments in the design of insulators, towers, and conductors were not only immediately significant

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

FOR NPS USE ONLY	
RECEIVED	JUN 26 1979
DATE ENTERED	AUG 16 1979

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

CONTINUATION SHEET

ITEM NUMBER 8 PAGE 3

in permitting the Croton transmission line to operate at unprecedented high voltages, but they also paved the way for further increases in transmission pressures. Three years after Croton was completed, the Foote interests opened a 140,000 volt transmission line from Cooke Dam on the AuSable River to Bay City, a distance of 125 miles.

The Croton plant went into full service in July 1908 and aroused international interest. Dozens of foreign visitors including engineers from England, Russia, France, Italy, Japan, and India came to view the plant. Dr. Charles P. Steinmetz, the "wizard" of General Electric, conducted corona tests on the Croton transmission line in the fall of 1908. Croton not only attracted the attention of the international engineering community, but it also appealed to the imagination of the general public. In September 1907, when the plant was still under construction, the Footes promoted three railroad excursions from Grand Rapids to the dam location, involving more than 500 guests in all, including bankers, manufacturers, government officials and ordinary citizens. They were given a grand tour of the dam and powerhouse, as well as an elaborate dinner followed by expensive cigars. At the conclusion of the last dinner on September 11th, a group of fifty citizens from Holland, Michigan sang the "Song of Croton Dam," composed for the occasion by H. VanderPloeg of Holland and sung to the tune of "Marching Through Georgia." The lyrics reflect the enthusiasm generated by Croton:

Sing a song of Croton Dam
The biggest in the State.
Where the water sizzles thru
And things are up to date.
Sing it with a hearty cheer
As long as you can make.
While we are riding to Croton.

Chorus.

Hurrah! Hurrah! we shout for Croton Dam.
Hurrah! Hurrah! the biggest dam what am.
And so we shout the chorus of the dam
That given us light.
As we are riding to Croton.

How the water dashed o'er
The dam that fills the creek.
How it surges through the gates
That sends it on its work.
How the wheels are turning as
The water rushes through

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

FOR NPS USE ONLY

RECEIVED JUN 26 1979

DATE ENTERED

AUG 16 1979

CONTINUATION SHEET

ITEM NUMBER 8 PAGE 4

While we are riding to Croton.

Chorus.

Oh, the power, the light, the heat
That dam does furnish us.
Oh, the industries that hum
That feel the electric touch.
Oh, the cities that are built
Where'er that power is used
While we are marching to Croton.

Chorus.

The Croton Hydroelectric Plant is still in constant service and is kept in excellent condition by the Consumers Power Company.

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

FOR NPS USE ONLY

RECEIVED

JUN 26 1979

DATE ENTERED

AUG 16 1979

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

CONTINUATION SHEET

ITEM NUMBER 9 PAGE 2

Item 9

Bush, George. Future Builders: The Story of Michigan's Consumers Power Company. New York, 1973.

Fargo, William G. "Hydraulic Excavation and Dam Building at the Croton and Lyons Dams in Michigan," Engineering News, Volume 58, Number 17 (October 24, 1907), pp. 429-431.

Foote, J. B. "The History of the Evolution of the High Voltage Tower Transmission Lines of the Consumers Power Company," Au Sable News, (September 1921), pp. 1-15.

Grand Rapids Herald. Unsigned articles, 8 September 1907, pp. 2,5; 10 September 1907, p. 6; and 11 September 1907, p. 7.

Luther, E. Hardy. "Early Developments in High Voltage Transmission," Michigan History, LI (Summer 1967), pp. 102-105.

Schuyler, James Dix. Reservoirs for Irrigation, Water-Power and Domestic Water Supply. New York, 1909.

Property

Croton Hydroelectric Plant

State

Michigan Newaygo

Working Number

6.26.79.1538

TECHNICAL

Photos

3

Maps

1

CONTROL

OK C. 26.79

HISTORIAN

Early 20th c. hydro plant with surviving original features. See HAER comments - Boundary is sufficient to protect resource.

ACCEPT
DUBIE 8/15/79

Powerhouse has interesting architectural detailing in gable ends, reflecting influence of late 19th c. styling. Needs HAER review.

ARCHITECTURAL HISTORIAN

ACCEPT
Saxe 8-8-79

ARCHEOLOGIST

OTHER

a fine nomination ~~for~~ a significant hydroelectric plant. It is crisply written and to the point. In many ways it is a model industrial nomination.

HAER

Inventory

Review 8/9/79

Don Jackson

The significance of the resource is clearly established - accept

REVIEW UNIT CHIEF

ACCEPT

DUBIE for Saxe 8/15/79

BRANCH CHIEF

KEEPER

National Register Write-up

9-4-79

Send-back

Re-submit

Entered

AUG 16 1979

Federal Register Entry



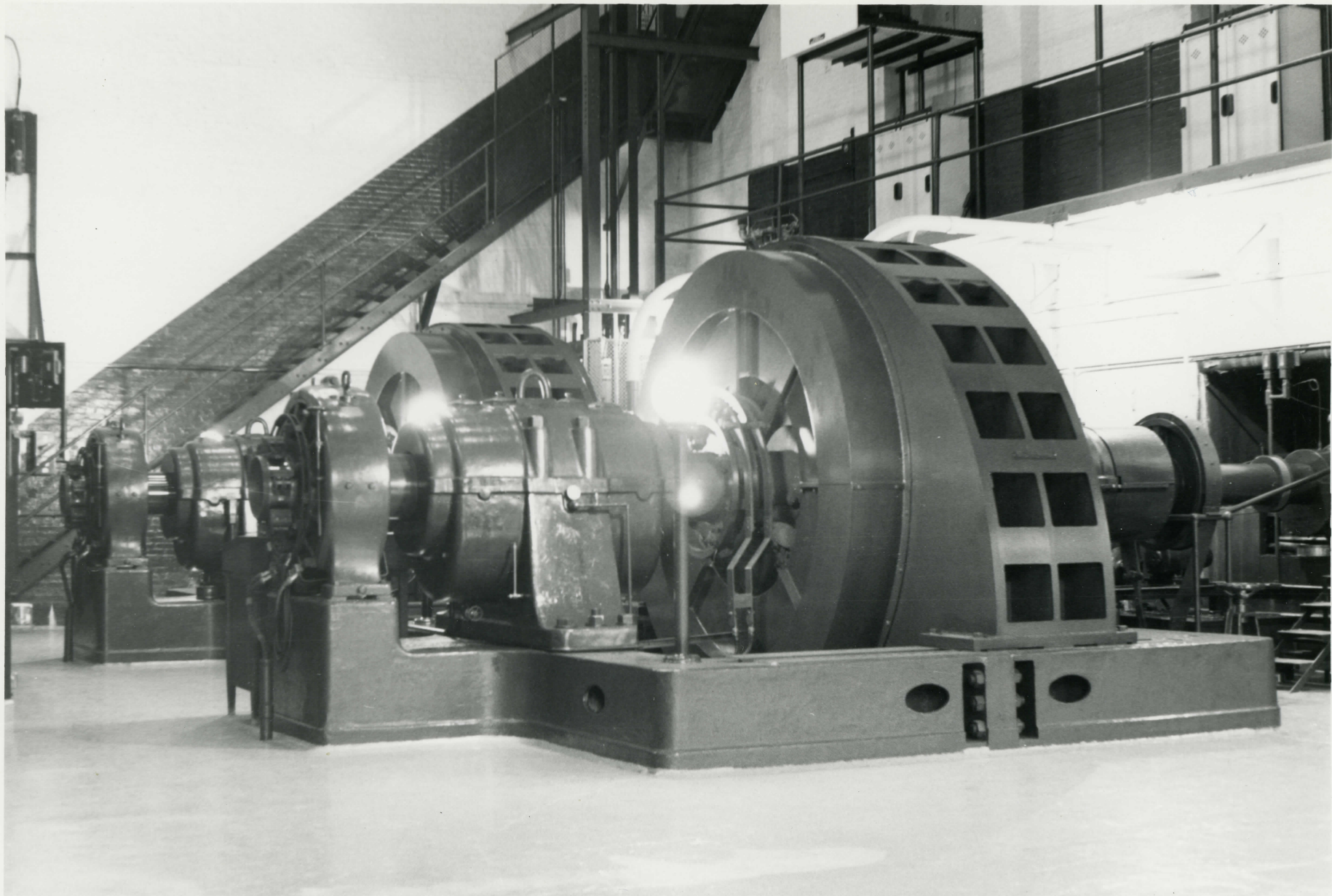
Newaygo County

Croton Hydroelectric Plant, Croton,
Michigan, Charles K. Hyde, 6-2-1978,
Michigan History Division, view from
the southwest.

1 of 5

^{DOE}
AUG 16 1979

JUN 26 1979



Croton Hydroelectric Plant, *Newaygo Co.*
Generator Room, Croton, Michigan,
Charles K. Hyde, 6-2-1978, Michigan
History Division, view from the
southwest.

275

DOE
AUG

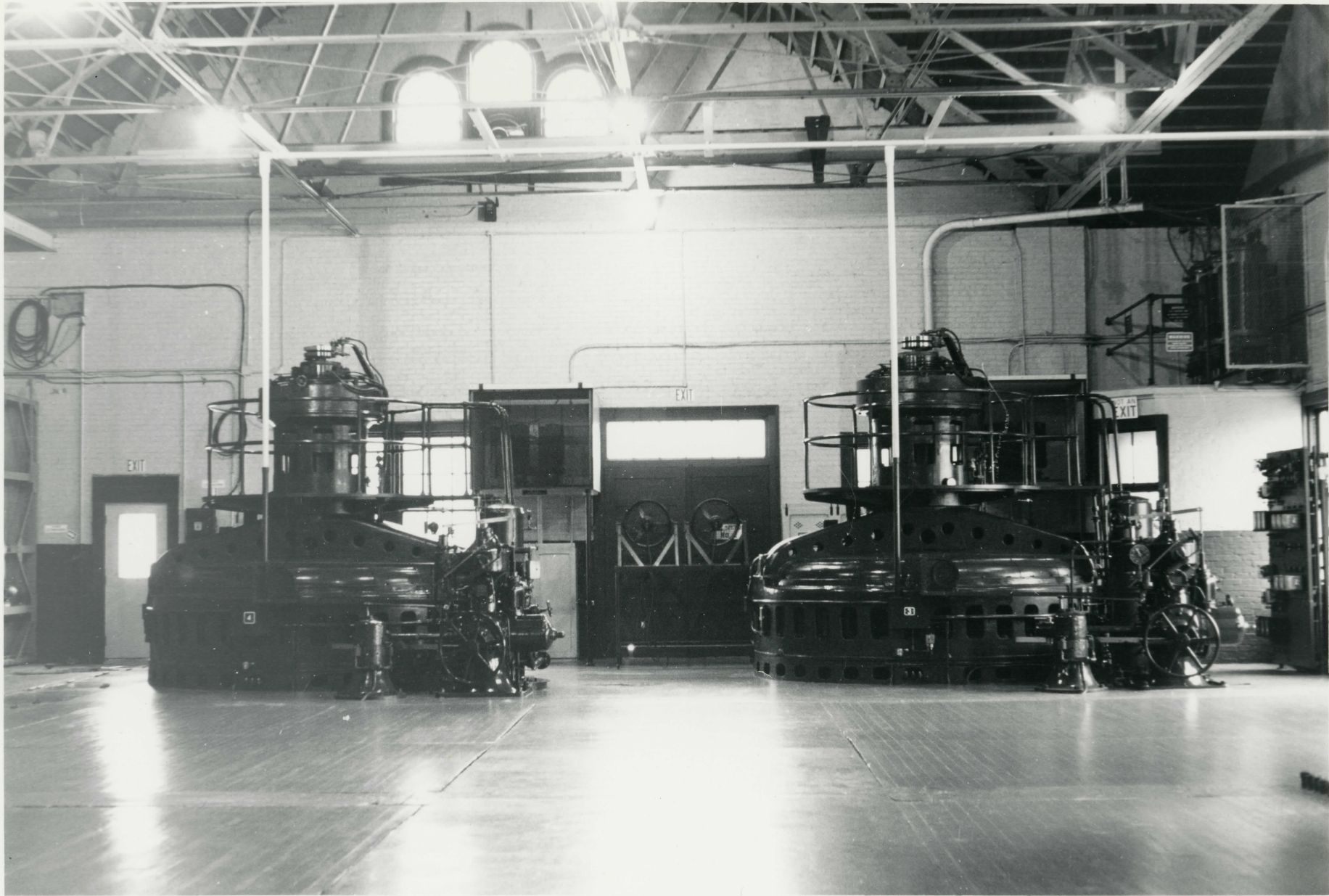
16

1979

JUN

26

1979



Newberry Co.
Croton Hydroelectric Plant, Turbine
Room, Croton, Michigan, Charles K.
Hyde, 6-2-1978, Michigan History
Division, view from the west.

3085 AUG 16 1979

^{DOE}
JUN 26 1979



Newaygo Co.

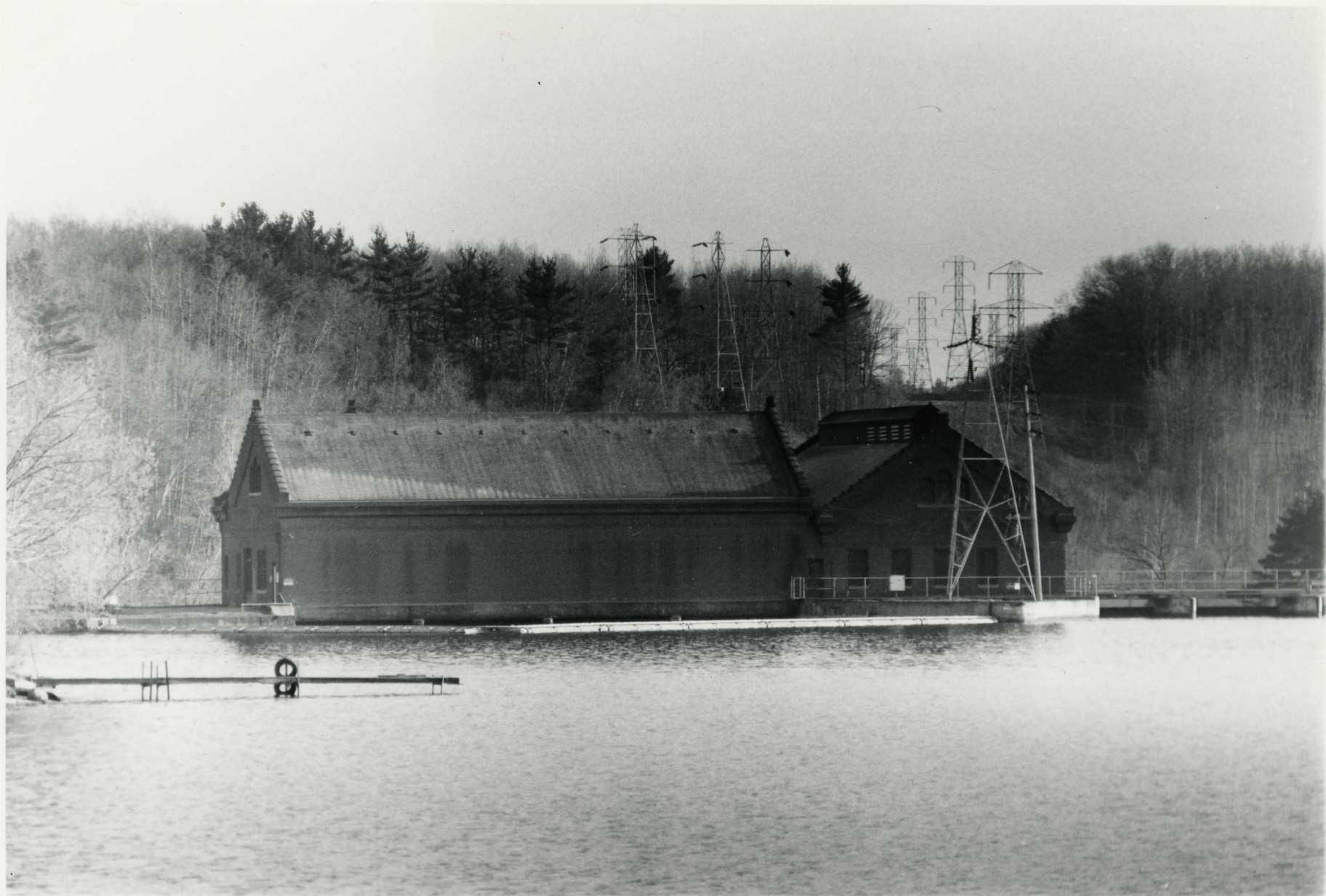
Croton Hydroelectric Plant, Croton,
Michigan, Charles K. Hyde, 6-2-1978,
Michigan History Division, view
from the southeast.

JUN 26 1979

4885 AUG 16 1979

DVE

21



Newaygo Co.

Croton Hydroelectric Plant, Croton,
Michigan, Charles K. Hyde, 6-2-1978,
Michigan History Division, view from
the northeast.

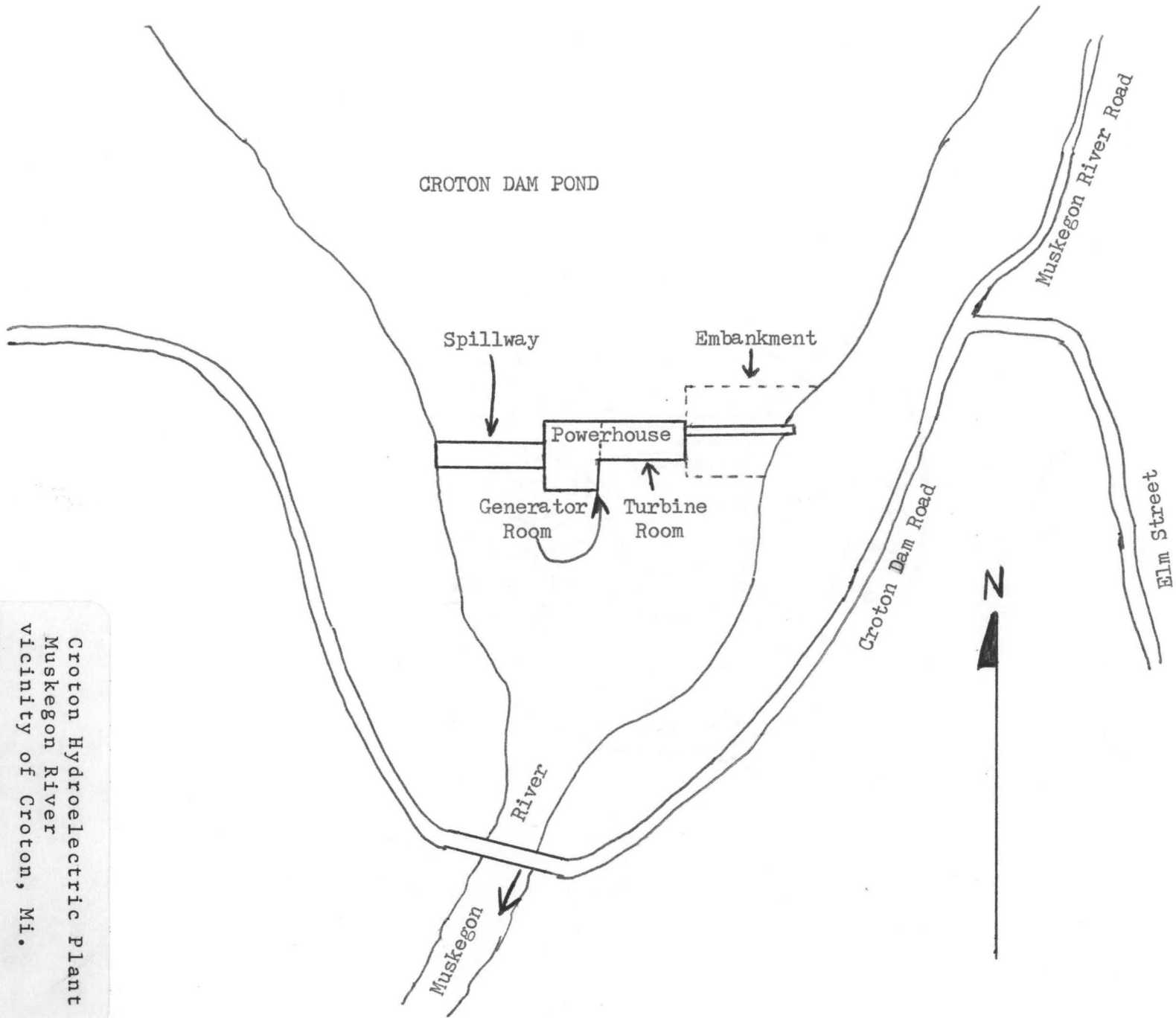
5085

^{DOE}
AUG 16 1979

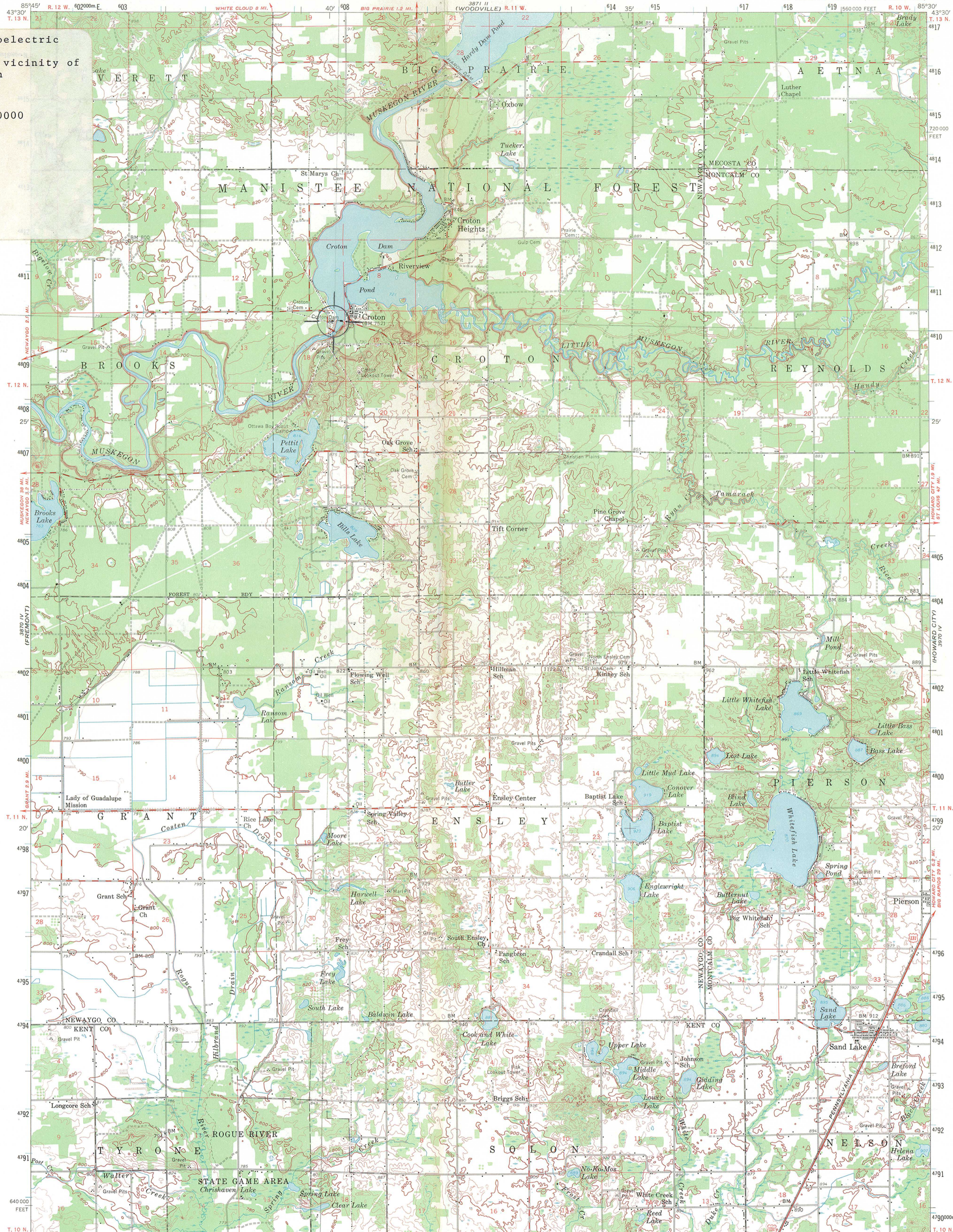
JUN 26 1979

AUG 16 1979 JUN 26 1979

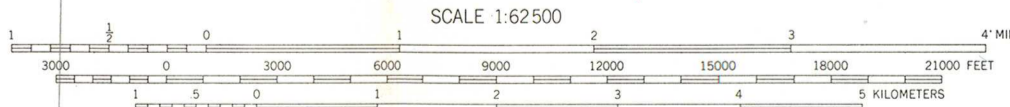
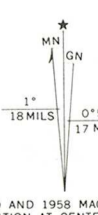
Croton Hydroelectric Plant
Muskegon River
vicinity of Croton, MI.
Newaygo County



Croton Hydroelectric
Plant
Muskegon River, vicinity of
Croton, Michigan
Newaygo County
UTM References:
A 16/608010/4810000



Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1955. Field check 1958
Polyconic projection, 1927 North American datum
10,000-foot grid based on Michigan coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks,
zone 16, shown in blue



SCALE 1:62500
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION
Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U.S. Route — State Route



AUG 16 1979
RECEIVED
JUN 26 1979
NATIONAL REGISTER
SAND LAKE, MICH.
N4315-W8530/15
1958
AMS 3870 I-SERIES V762

ENTRIES IN THE NATIONAL REGISTER

STATE MICHIGAN

Date Entered AUG 1 1979

Name

Location

Croton Hydroelectric Plant

Croton
Newaygo County

Also Notified

Honorable Donald W. Riegler, Jr.

Honorable Carl Levin
Honorable Guy Vander Jagt

State Historic Preservation Officer
Dr. Martha Bigelow
Director
Michigan History Division
Department of State
Lansing, Michigan 48918

NR Byers/bjr 8/20/79

For further information, please call the National Register at (202)343-6401.

Donald -

Are boundaries
sufficient to define
& protect resource?

Emma Jane

HAER

Donald & Emma Jane?