The 1913 Dayton Flood and the Birth of Modern Flood Control Engineering in the United States

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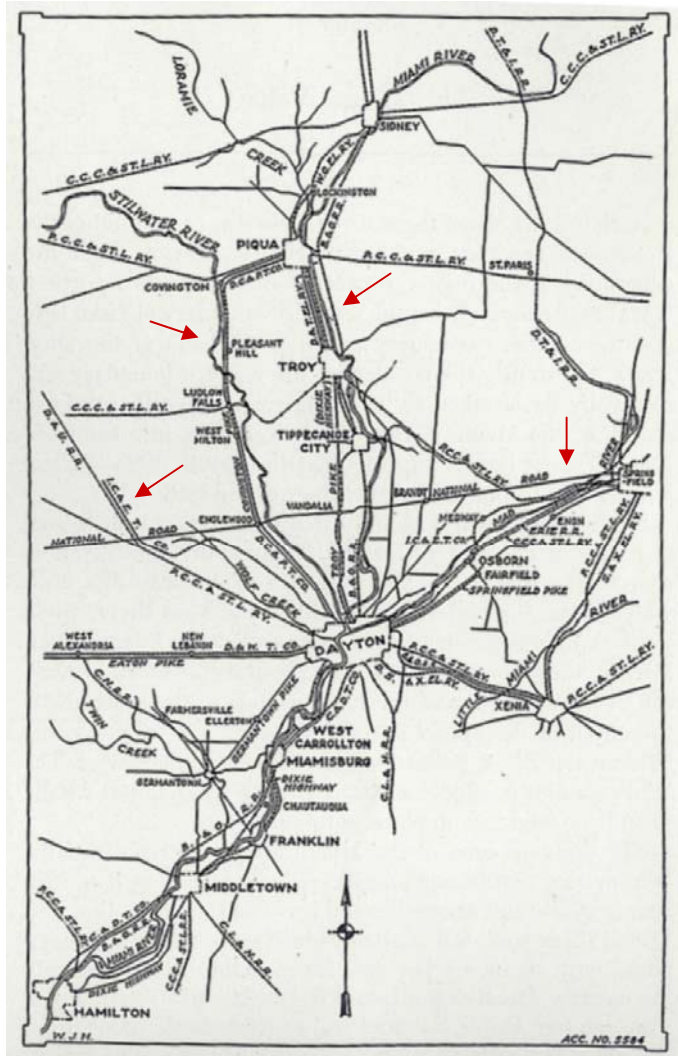
Overview of the Dayton Area

- 4 rivers converge in Dayton within one mile of each other
- The Dayton area averaged one major flood every decade
- Miami River watershed covers 3,937 square miles and 115 miles of channel; feeds into the Ohio River



A map of Miami River watershed with towns, highways, and railroads.

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Timeline of Flood Events (1 of 7)

- 21 March 1913 – 60 degrees, freak windstorm begins
- 22 March – sunny day, temperatures fall into the 20s
- 23 March – Easter Sunday, rain begins falling on Ohio and nearby states
- 24 March – heavy rains, at 0700 river reaches high stage for the year at 11.6 ft and continues to rise

Rainfall map of March, 1913, storm.

Timeline of Flood Events (2 of 7)

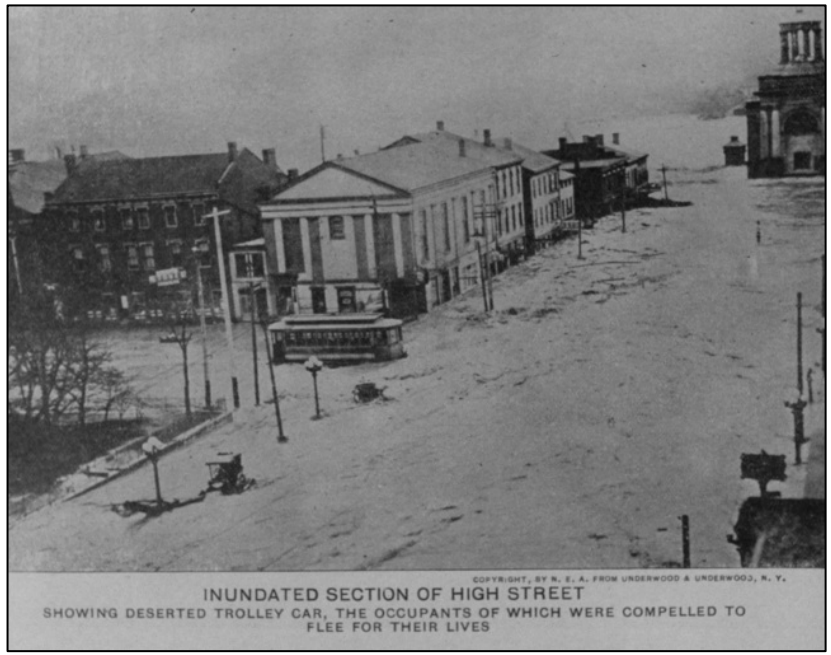
25 March –

- **0000: A.M. Fox contacts police after discovering weakening in Herman street levee; Dayton Police start warning sirens and alarms**
- **0530: City Engineer Gaylord Cummin discovers water at top of levees and flowing at an unprecedented 100,000 cubic feet per second**

Timeline of Flood Events (3 of 7)

25 March –

- **0600: water appears in Dayton streets after levees begin to overtop**
- **0800: levees on south side fail, begin flooding downtown business district**



Timeline of Flood Events (4 of 7)

25 March – water levels continue to rise throughout Dayton

At the edge of the flood. From high land in southeast Dayton, looking toward the center of the city.

Timeline of Flood Events (5 of 7)

26 March - flood waters reach their crest at 0130

High Street, Hamilton, at daybreak, March 26, 1913, taken when flood was near crest. The depth may be judged from the street lamps which just clear the water surface.

Timeline of Flood Events (6 of 7)

26 March – early morning gas explosion at 5th and Wilkinson (photos taken after water receded)

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SCENE IN THE HEART OF THE BUSINESS SECTION OF DAYTON, SHOWING HOUSES DESTROYED BY FLOOD AND FIRE

The burned section of the Dayton business district. Fire added to the havoc wrought by the flood and destroyed much valuable property. This view of St. Clair Street shows how the asphalt pavement was torn up by the swiftly flowing water.

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Timeline of Flood Events (7 of 7)

26 March – panoramic image of Dayton along the swollen Miami River at 1030

(looking North)

Flood Destruction- Casualties

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STREET IN DAYTON AFTER THE FLOOD RECEDED

SCENE IN THE BUSINESS SECTION, SHOWING DEAD HORSES DROWNED IN THE FLOOD. HORSES WERE DROWNED IN THEIR STALLS IN MANY CITIES.

- 700 people died in storm event (467 in Ohio and about 300 from Dayton)
- 1400 horses and 2000 other domestic animals died in flood.

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Wood Frame Houses Decimated; lifted off foundations and Tumbled About

Houses piled together.

Flotsam punctures structures

Houses were moved off their foundations. People trapped in the upper stories of their homes chopped holes in the attic walls and roofs in order to escape. The debris on the roofs was left by the water near the crest of the flood.

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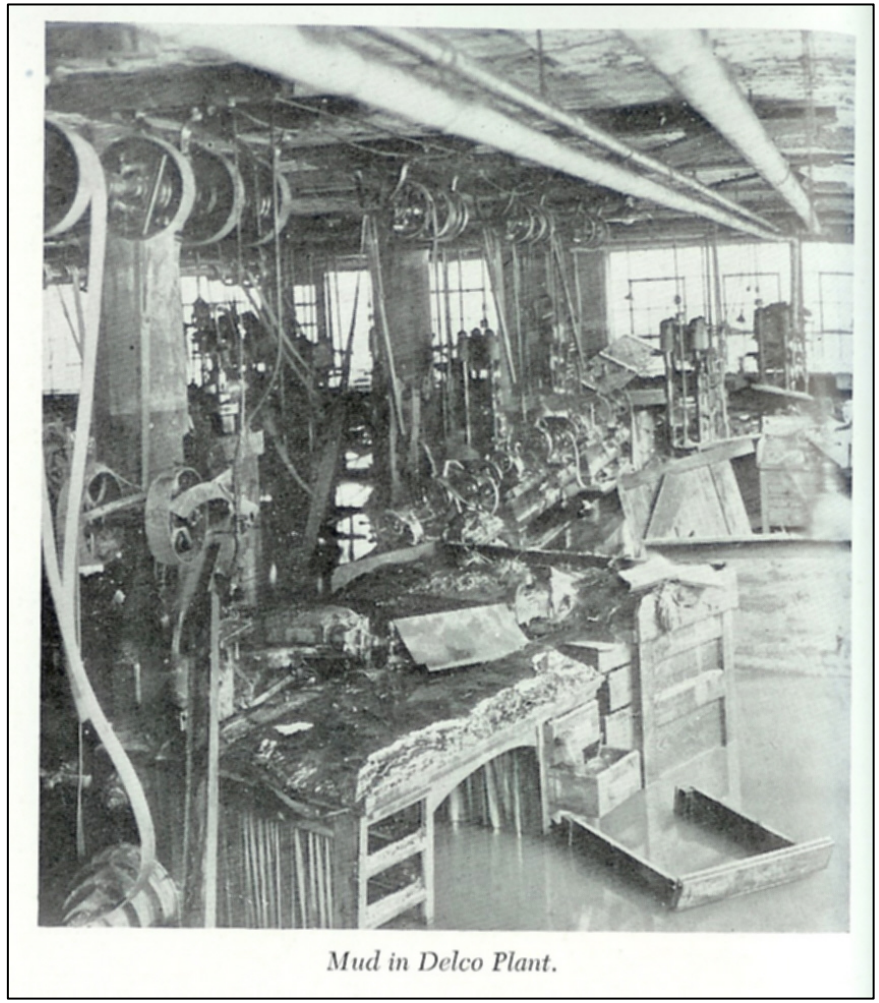
Impacts on downtown industrial area

TROLLEY CAR AT DAYTON, OHIO, SWEPT THREE BLOCKS BY THE FLOOD AND OVERTURNED IN THE STREET



Mud in Delco Plant.

Flood Recovery - 1

In business again.

Flatcars being used to move debris from Jefferson Street, Dayton.

- **The physical recovery took about a year; but the business recovery took about 10 years**

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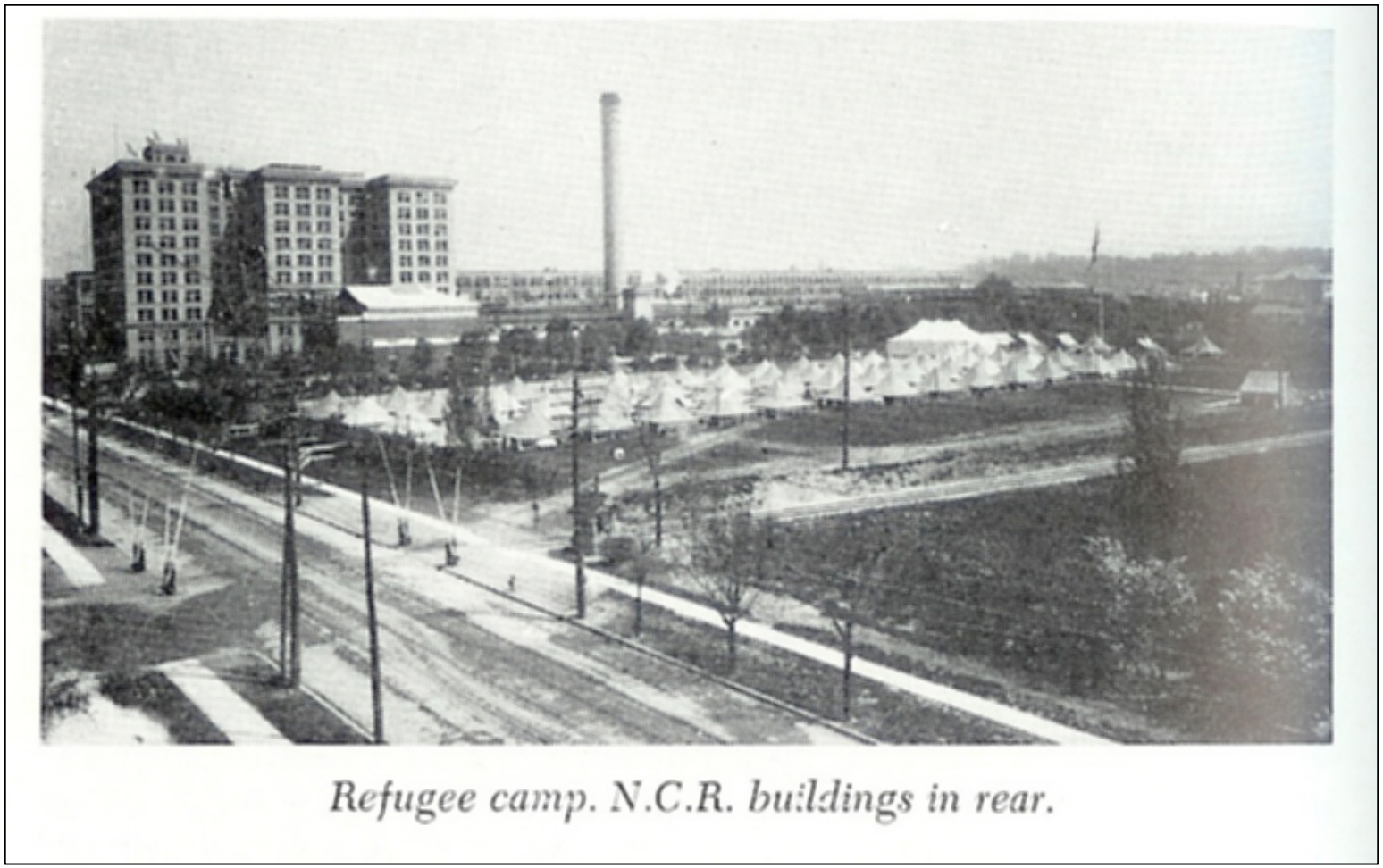
Flood Recovery - 2



Refugee camp. N.C.R. buildings in rear.

The Ohio National Guard constructed refugee camps until people could be resettled or relocated.

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Flood Protection Campaign -1

- Some part of the Ohio flooded every year from 1873 to 1913
- Engineers did not have an accepted methodology for predicting the maximum probable flood
- Levees were the primary form of flood control up to 1913
- Dams scared people after the 1889 Johnstown Dam disaster
- Flood control was still considered a local or state problem
- Most of downtown Dayton was built on the Miami River's natural floodplain

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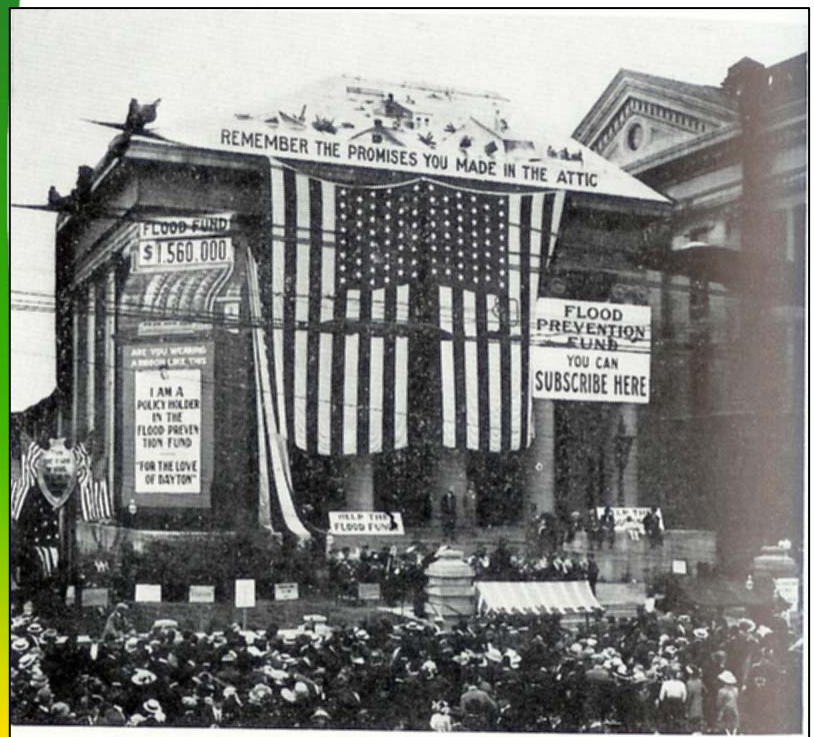
Flood Protection Campaign - 2



Flood Prevention Fund signs at the Courthouse. A giant replica of a cash register was built on the Courthouse platform, and each day the amount subscribed up to that time was "rung up" on the register.

- The City of Dayton vowed that their city would never flood again
- On 27 March, Governor James Cox appointed a Citizens' Relief Commission
- On 2 May, the Commission began a 10 day fundraiser which raised over $2 million (1913 dollars) from 23,000 subscribers
- The Commission hired Arthur E. Morgan to head the flood control program

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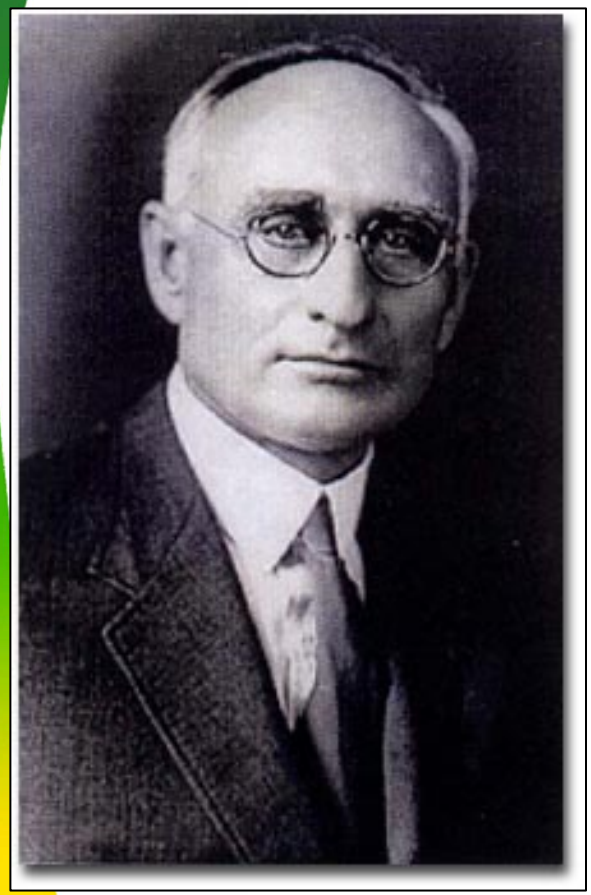
Arthur E. Morgan, C.E.



Arthur E. Morgan
(1878-1975)

- Born Cincinnati, OH; grew up in St. Cloud, MN
- Worked various jobs out west and attended the University of Colorado for 6 weeks
- Worked for his father's engineering practice; drafted engineering code for the State of Minnesota
- Married twice; 2 sons and 3 daughters
- Moved to Dayton, OH in 1913
- President of Antioch College, 1921-33
- Oversaw creation of the Pueblo (Colorado) Conservation District after 1921 Pueblo flood
- First Chairman of the Tennessee Valley Authority (1933-38)
- Committed to social reform and scientific methods
- Lifelong critic of the Corps of Engineers; wrote book *Dams and Disasters* (1973)
- Lived to be 97

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Morgan's Flood Protection Plan - 1

- **Morgan was literally given *carte blanche: "The valley has suffered a calamity that must never be allowed to occur again. Find a way out."***
- **He hires 50 engineers to determine the size the Miami Valley watershed and determine the flood volume.**
- **Used historical data from Europe to estimate that 1000 year recurrence frequency floods are 20% larger than 100 or 200 year frequency events.**
- **03 October 1913, Morgan presents eight different plans to the city.**

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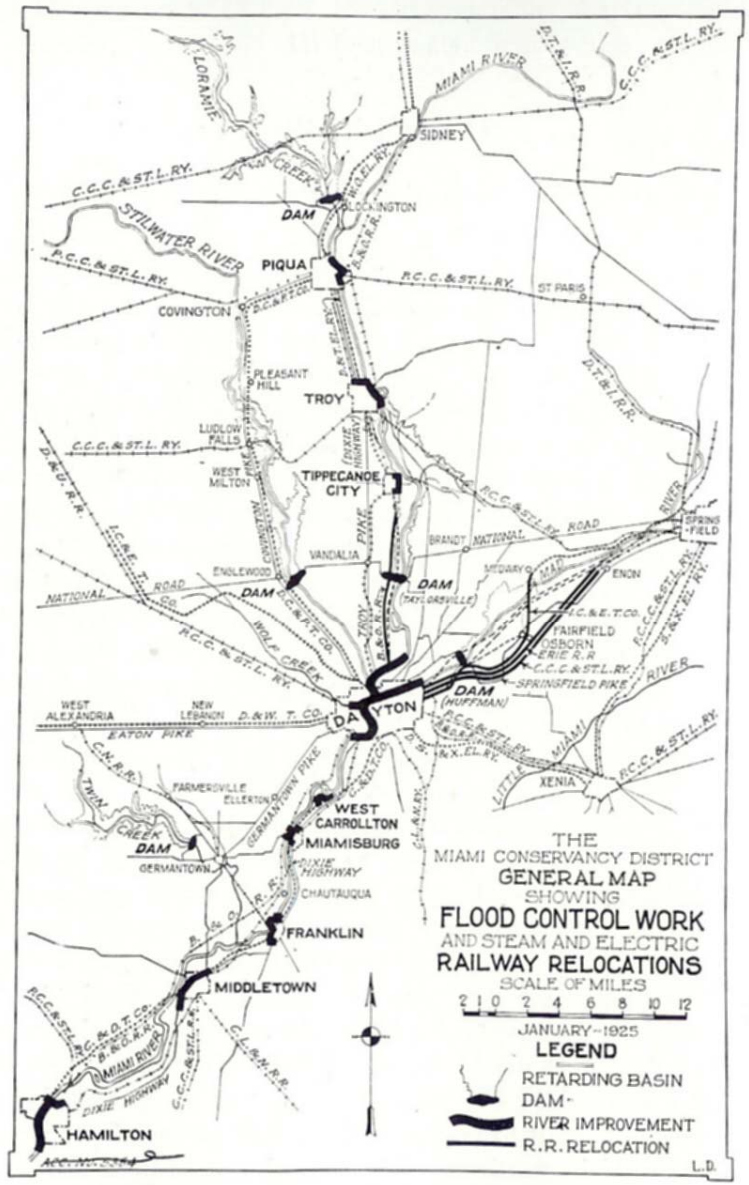
Flood Protection Plan - 2

- After much debate, the City of Dayton decided on building a system of dry reservoirs citing its precedence in France's Loire Valley.
- Morgan's Plan:
  - Instream Storage: Five earthen dams with conduits or slots to meter out a limited amount of water
  - Training levees: Widening channel substantially through the Dayton area and constructing large levees.
  - Flood storage areas to be used as farmland between brief periods of flooding
- The New channel could convey 40% more volume than 1913 flood!

Flood Protection Plan - 3

QUANTITIES OF WORK, BY FEATURES

Feature	Excavation	Embankment	Concrete	Steel
Channel Improvement				
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Tons
Piqua	260,315	338,252	1,298	2.40
Troy	343,822	180,664	5,494	132.43
Tippecanoe City	43,773	171,776	4,161	33.95
Dayton	2,195,779	869,537	35,715	570.72
West Carrollton	2,962	34,697	286	.....
Miamisburg	26,533	232,298	4,601	46.38
Franklin	107,330	143,026	4,638	120.34
Middletown	84,174	186,602	1,345	19.03
Hamilton	2,265,716	407,782	31,615	885.64
Subtotals	5,330,404	2,564,634	89,153	1,810.89
Dams				
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Tons
Lockington	267,691	1,022,868	32,062	29.30
Englewood	339,225	3,642,600	27,391	147.16
Taylorsville	818,390	1,301,262	47,934	80.26
Huffman	318,515	1,402,490	37,822	188.23
Germantown	189,554	844,577	17,381	46.72
Subtotals	1,933,375	8,213,797	162,590	491.67
Totals	7,263,779	10,778,431	251,743	2,302.56

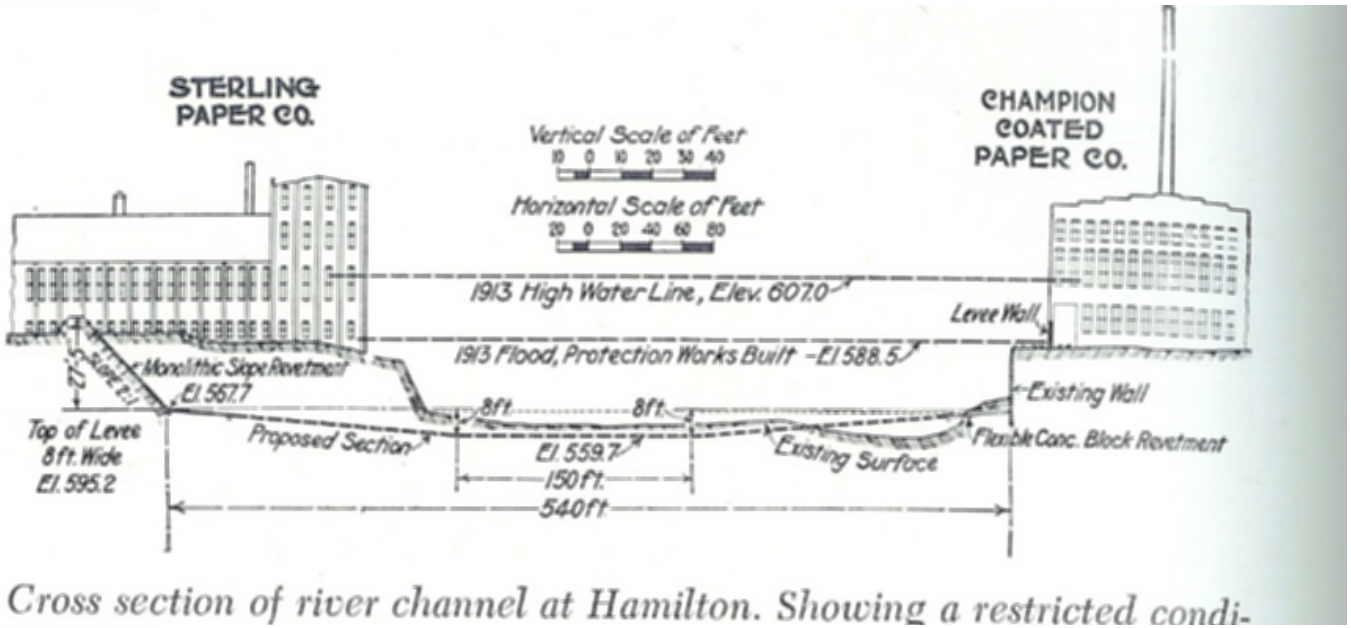


Location of works included in the Official Plan.

Creation of the Miami Conservancy District

- In 1914, Morgan drafted the Ohio Conservancy Act which was quickly passed and signed into law
- The Act allowed local governments to establish “conservancy districts” for flood control (called flood control districts today)
- After much debate regarding the act’s constitutionality, the Miami Conservancy District (MCD) was established on June 1915 and appointed Morgan as its first president; work immediately began on his Dayton flood control system

Project Construction - 1



Cross section of river channel at Hamilton. Showing a restricted condi-

Entire factories were removed where such features had encroached the natural river channel

The Miami River channel at Dayton before Conservancy improvements.

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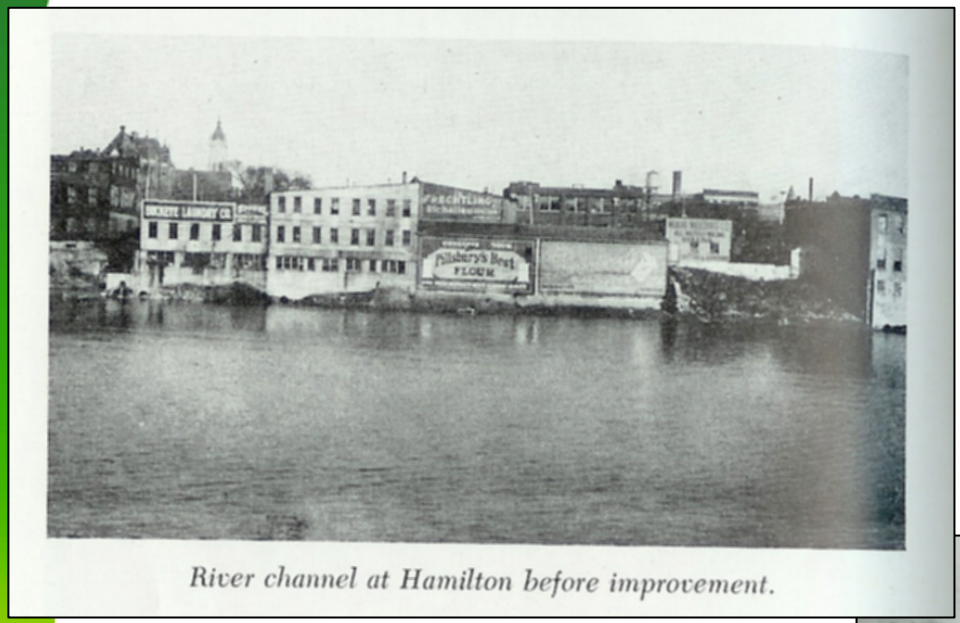
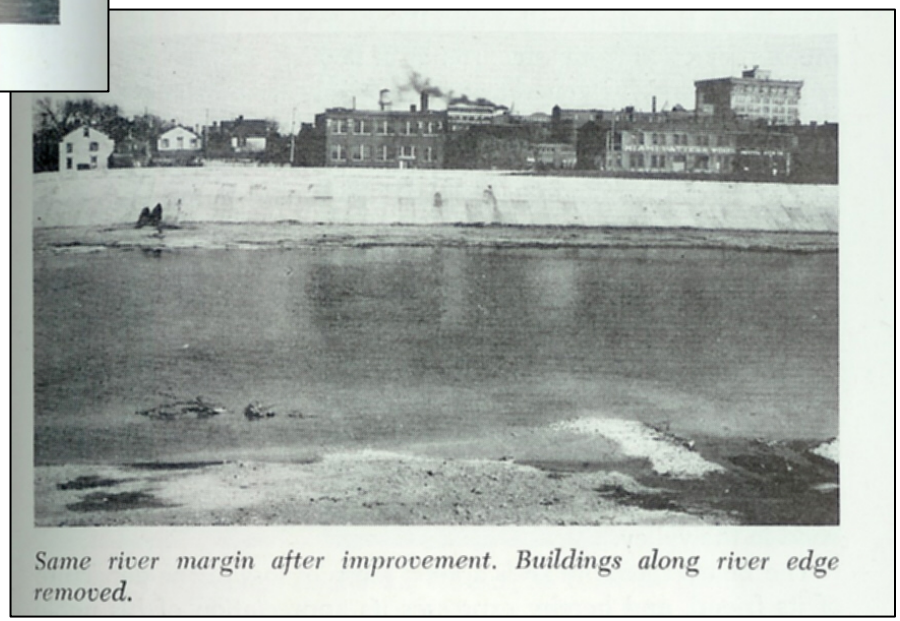
Project Construction - 2



River channel at Hamilton before improvement.

Business and industries which encroached the 1000 year flow channel were razed and relocated

The channel of the Miami River was restored to its maximum cross section



Same river margin after improvement. Buildings along river edge removed.

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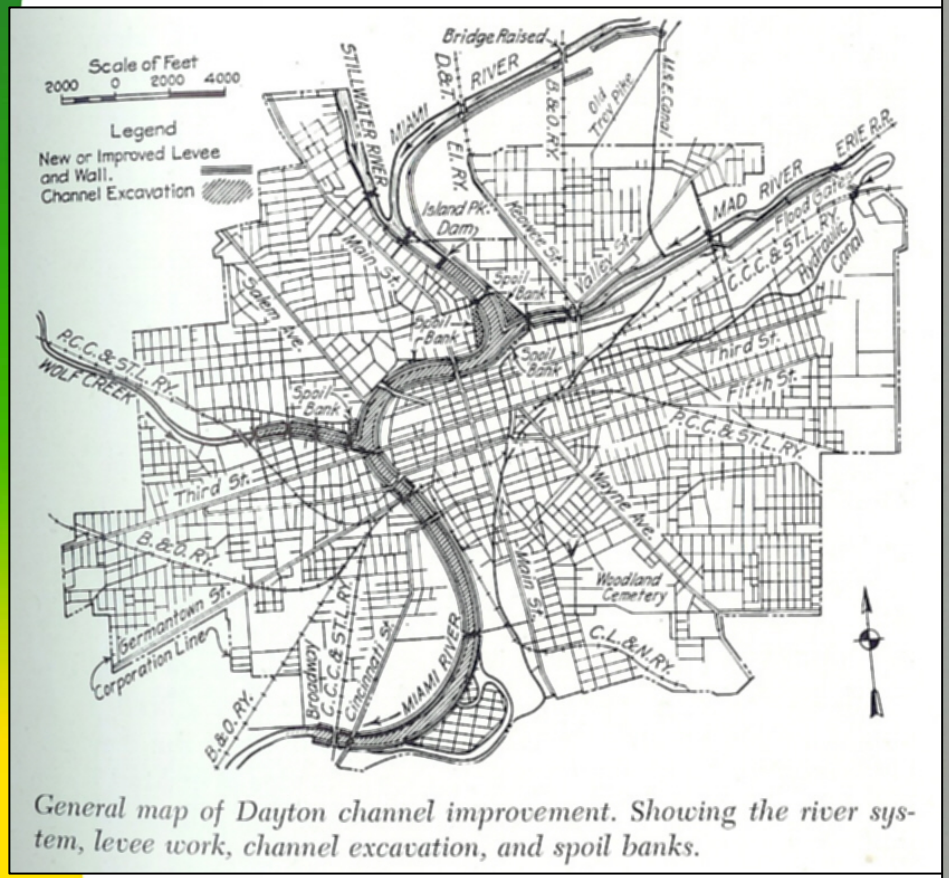
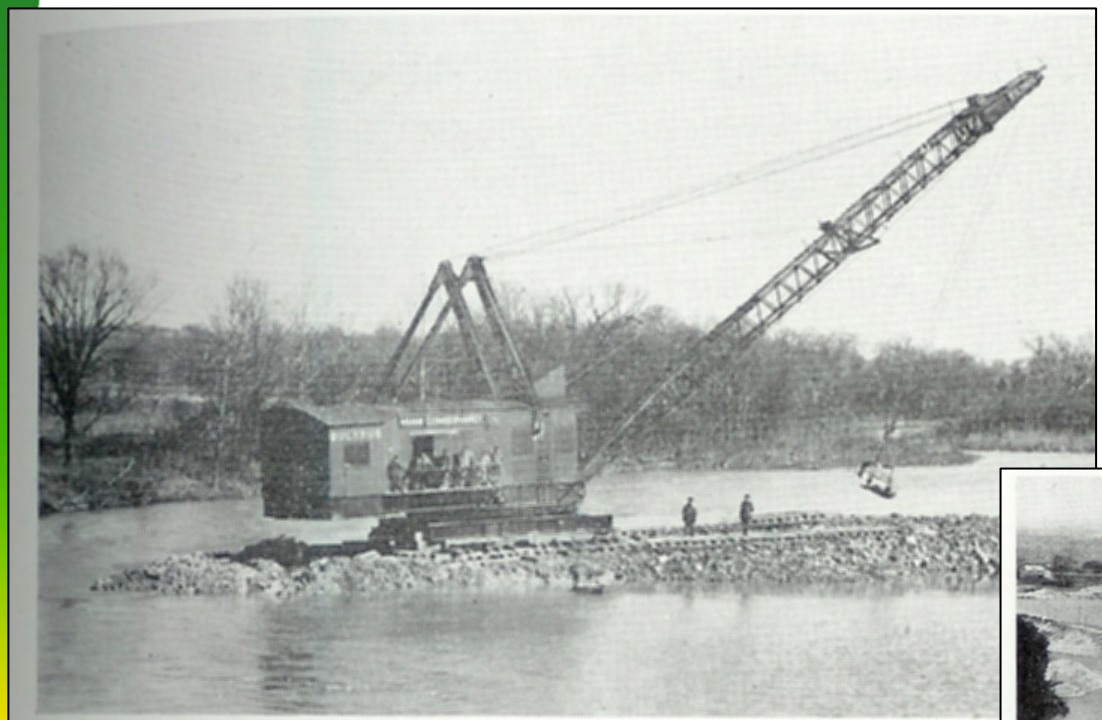
Project Construction - 3



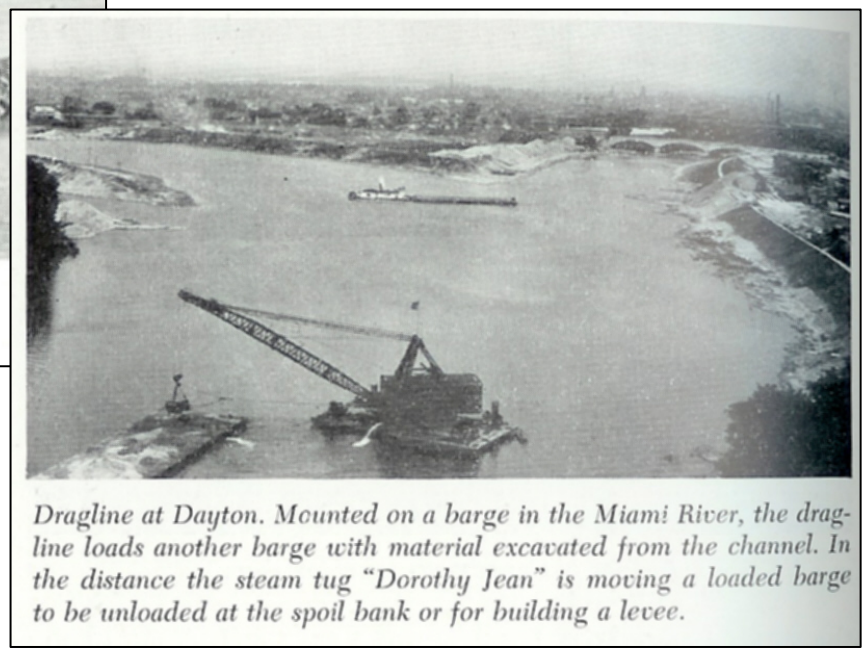
General map of Dayton channel improvement. Showing the river system, levee work, channel excavation, and spoil banks.

Air view of improved river channel at Dayton.

Project Construction - 4



Dragline at Englewood Dam.



Dragline at Dayton. Mounted on a barge in the Miami River, the dragline loads another barge with material excavated from the channel. In the distance the steam tug "Dorothy Jean" is moving a loaded barge to be unloaded at the spoil bank or for building a levee.

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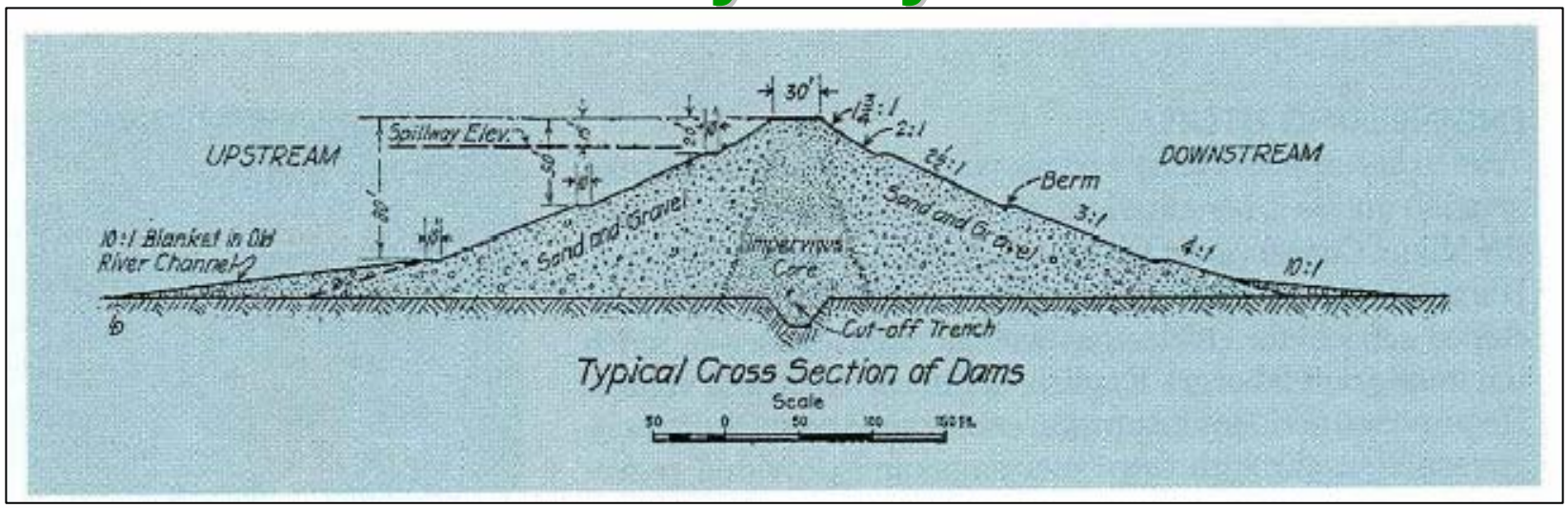
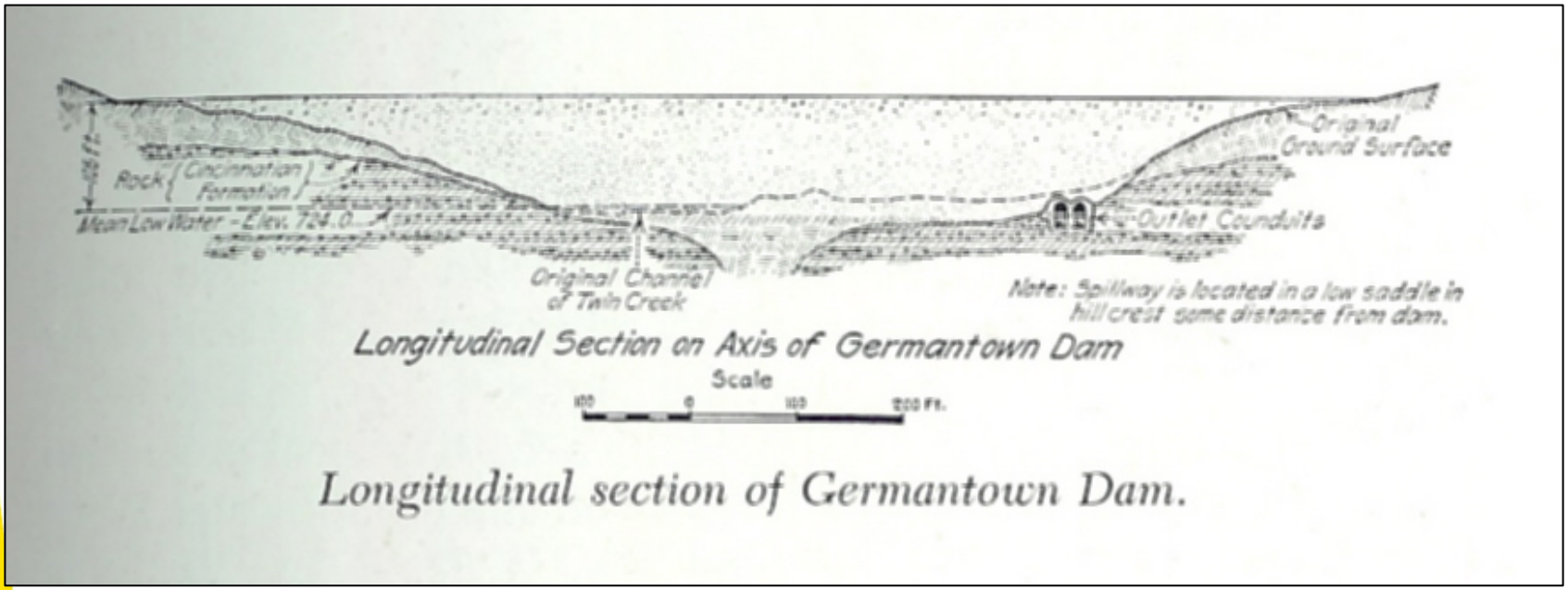
Embankment Flood Storage Basins – basically “dry dams”

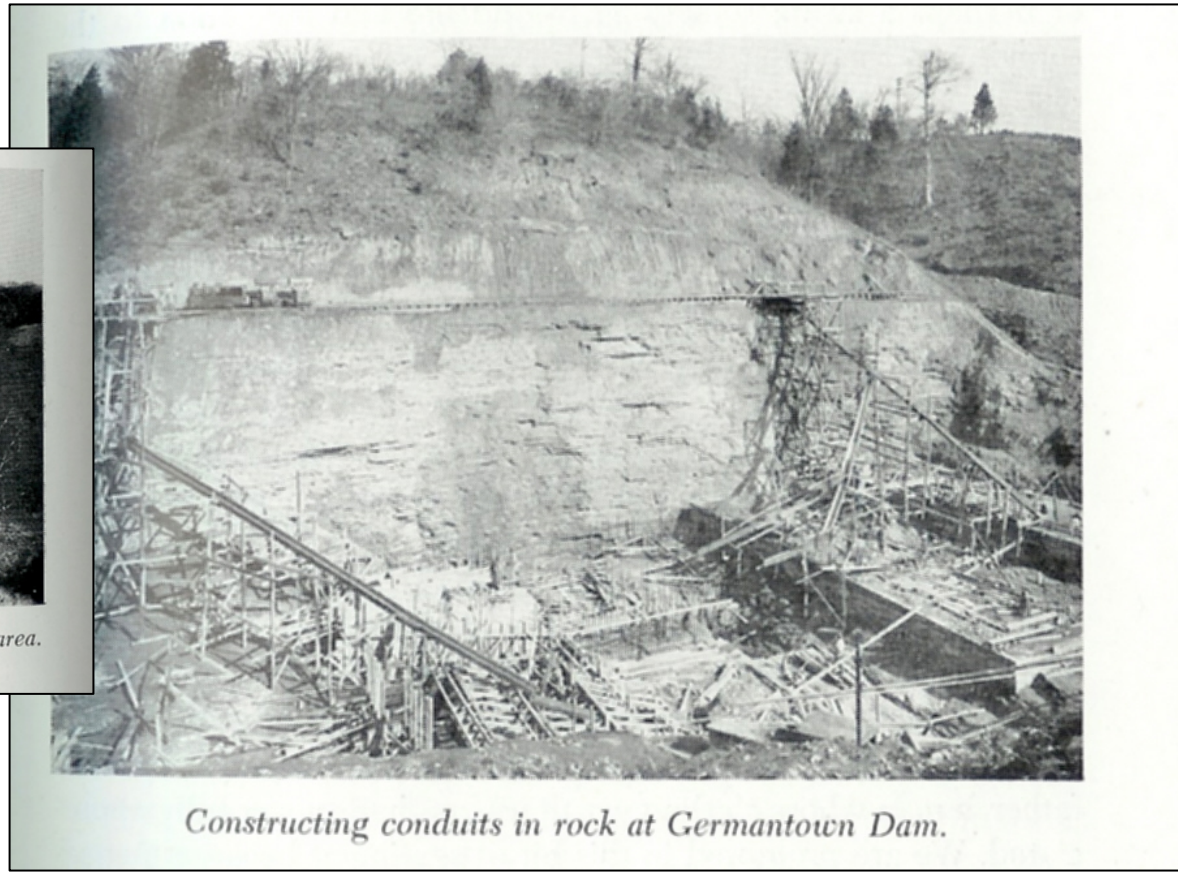




Longitudinal section of Germantown Dam.

GERMANTOWN DAM

Germantown Dam site. Showing valley topography in the Miami area.



Constructing conduits in rock at Germantown Dam.

Germantown Dam was the largest of the five embankment dams constructed as part of the flood control project.

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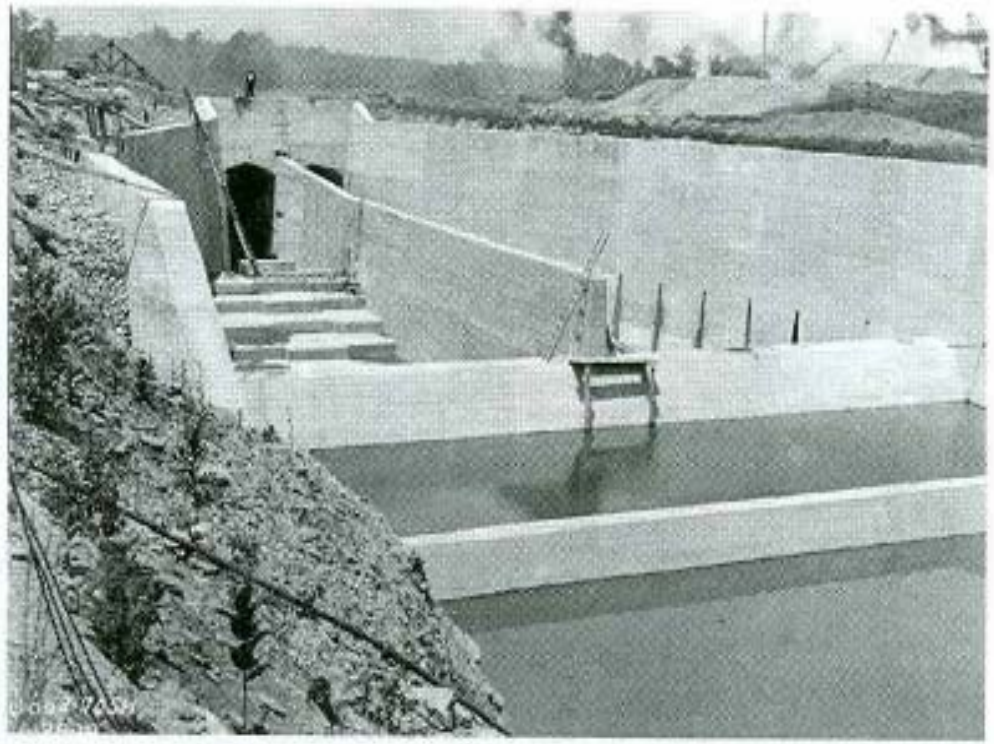
ENGLEWOOD DAM

Rock excavation for outlet conduits at Englewood Dam.



removed just before water was allowed to enter. The finished permanently open outlet conduit at Englewood Dam is shown on June

Morgan employed permanent slots, or openings, in the dams to meter outflow and prohibit between-storm storage; fearing permanent lakes would deter from the primary mission of the dams (flood control).

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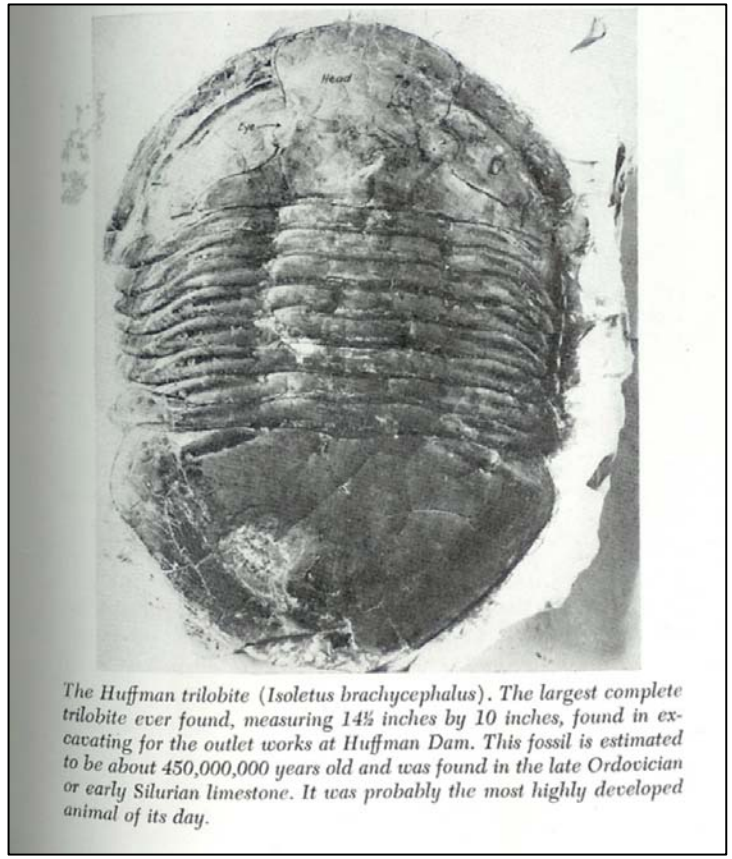
Huffman Dam Outlet Works



The Huffman trilobite (Isoletus brachycephalus). The largest complete trilobite ever found, measuring 14½ inches by 10 inches, found in excavating for the outlet works at Huffman Dam. This fossil is estimated to be about 450,000,000 years old and was found in the late Ordovician or early Silurian limestone. It was probably the most highly developed animal of its day.

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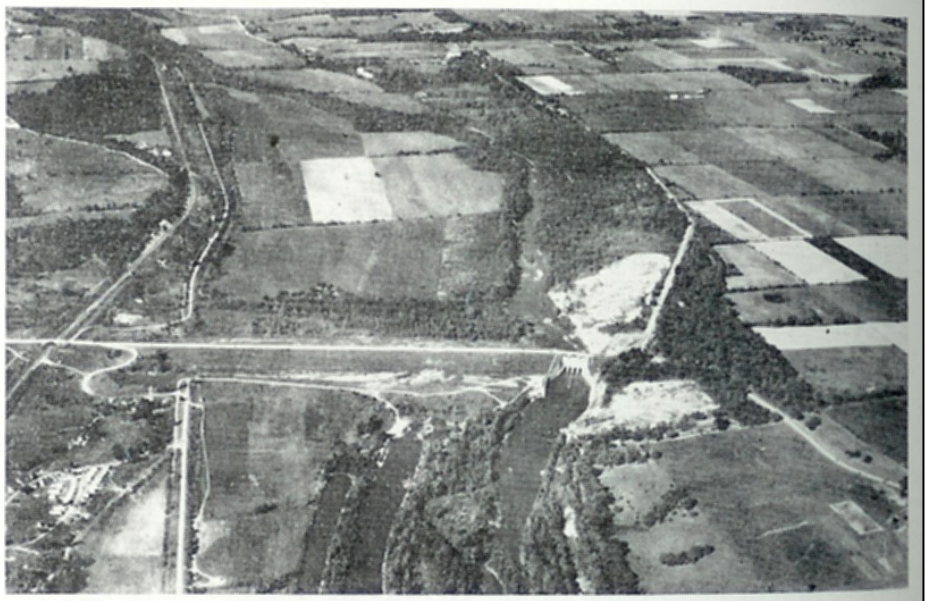
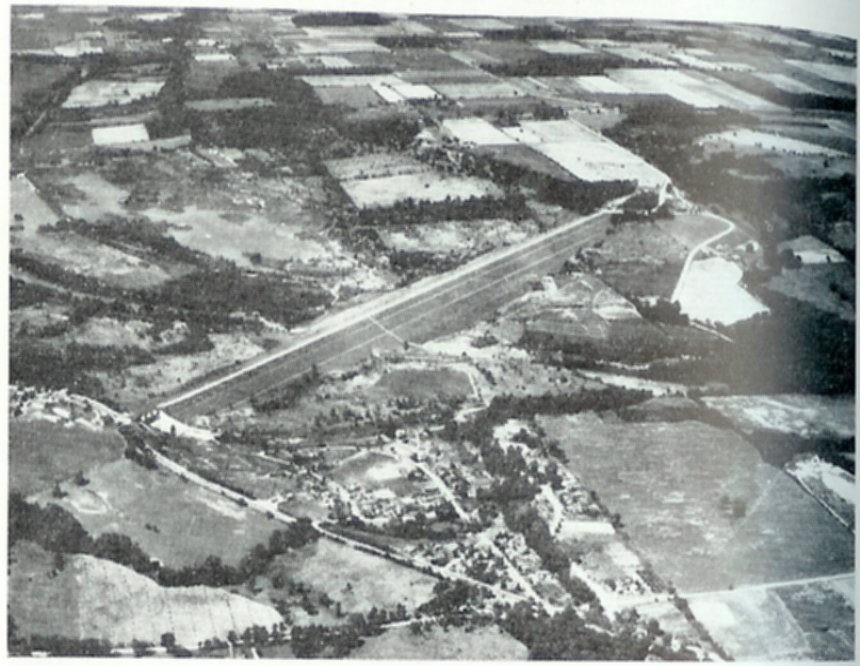
Taylorsville and Englewood Dams



Aerial view of Taylorsville Dam. The Taylorsville Dam on the Miami River above Dayton, and part of the retarding basin, looking upstream. This shows how basin lands are used for agricultural purposes. A recreational area has been developed in the wooded tract east (to right) of the river, in cooperation with the National Park Service.



Aerial view of Englewood Dam and part of retarding basin, looking upstream past the dam. The outlet conduits pierce the dam near the center of the picture, and the spillway is seen at the extreme left. Grasses and honeysuckle protect the slopes against erosion. The ponds above the dam are on the site of the borrow pit from which material was taken for the dam. The agricultural use of lands in the basin is indicated by the cultivated fields above the dam. Englewood is 125 feet in height, the highest of the five dams.

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Englewood Dam in 1993

Aerial photograph taken in 1993 shows Englewood Dam as it appears today under U.S. Route 40. *Source: Miami Conservancy District*

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Current Events in the Miami Conservancy District - 1

Mission: **Healthy watersheds that support sustainable communities and a higher quality of life for our generation and those to come.**

Vision: **Protecting the lives, property, and economic vitality by providing unfailing flood protection, preserving water resources, enhancing river corridors and conserving valuable land within the Great Miami River Watershed.**

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Current Events in the Miami Conservancy District - 2

- Highest water in 2004 occurred on 05 January
- Germantown Basin was 45 feet above normal and at the 8th highest level since the 1913 flood
- All five dams stored water during this event
- 2 to 5 inches of rain fell on the Miami Valley

The Miami Conservancy District maintains an active board of consultants

Members of the larger consulting board. From left to right: E. J. B. Schubring, Morris Knowles, Gaylord Cummins, Arthur E. Morgan, Daniel W. Mead, Gen. Hiram M. Chittenden, James H. Fuertes, Col. J. A. Ockerson, Maj. Gen. O. H. Ernst, T. W. Jaycox, S. M. Woodward.

Original board of consultants

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- www.noaa.gov
- www.miamiconservancy.org
- J. D. Rogers interviews with Dr. Ralph B. Peck

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