THE HOGBACK DAM AND DEVELOPMENT *

By Warren A. Gentner, M-CSCE
Chief Engineer of Metropolitan District Water Bureau, Hartford, Conn.

PUBLIC water supply service operations in the Hartford area were inaugurated one hundred years ago this coming October 23rd. Hartford was then a city of some 20 to 25 thousand people and the original water supply system consisted primarily of a pumping station on the west bank of the Connecticut River about 1000 feet north of the Bulkeley Bridge from which Connecticut River water was pumped through a 16-inch cast iron water main to a 7-million-gallon reservoir on Lord's Hill (Garden Street), then the western outskirts of the city, and some 125 feet higher than and about one mile west of, the river. From this reservoir, water was distributed by gravity through a network of street mains to consumers.

Less than ten years later the growing city was faced with the necessity of increasing its water supply facilities. In a spirited election in October 1864, the electorate wisely decided to develop a new surface source of water supply on the eastern slope of Talcott Mountain in the town of West Hartford rather than to increase the capacity of the Connecticut River pumping facilities and continue the use of river water.

In accordance with this decision, six small reservoirs were subsequently built on the Talcott Mountain watershed and put into service at varying intervals from 1867 to 1895.

By the early 1900s increasing demands for water again forced the city to seek additional sources of supply and after thorough investigations and studies of several watersheds, the Farmington River was chosen as the one offering the greatest advantages and possibilities. Since making this choice, two water supply reservoirs have been constructed on tributaries of the Farmington River: Nepaug Reservoir, (9.5 billion gallons capacity) constructed during the 1914-1918 period on the Nepaug River, and Barkhamsted Reservoir (32 billion gallons capacity) constructed during the 1932-1940 period on the East Branch of Farmington River. Now a third development is proposed, the so-called Hogback Reservoir on the West Branch of Farmington River in the Town of Colebrook.

When the Nepaug development was first projected considerable opposition was voiced by industries and power developments scattered along the lower Farmington River because of the proposed permanent diversion of

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the flow of water from the 32 square miles of Nepaug watershed and the consequent loss of use of this water to them.

As compensation for the loss of this water, the City of Hartford agreed to build, operate and maintain a 3-billion-gallon storage reservoir with approximately 62.7 square miles of free tributary drainage area on the East Branch of the Farmington River and further agreed never again to divert Farmington River water for water supply purposes.

There thus was established a policy of compensation in kind which has had a significant bearing on each subsequent water supply development on the Farmington River watershed.

Thus, through the construction of The Saville Dam and the impounding of some 32 billion gallons of water in the Barkhamsted Reservoir at the very headwaters of the East Branch Compensating Reservoir, flow from 53.8 of the 62.7 square miles of free drainage area promised under the Nepaug agreement was taken away from the downstream mill owners.

To compensate for this loss, The Metropolitan District, successor to the City of Hartford as owner of the water supply system, agreed to build and have ready for operation for the mill owners' benefit not later than January 1, 1955 additional compensation reservoirs on the West Branch of the Farmington River (Hogback). The January 1, 1955 date has since been changed to January 1, 1959. The legislative bill authorizing the Hogback project stipulates that the natural flow of the West Branch of the Farmington River shall not be held back at the dam except such flows as shall be in excess of 150 cubic feet per second above the dam site and the minimum flow through the dam shall not be allowed to fall below 50 second feet regardless of the actual natural flow.

Pending completion of the Hogback Reservoir, the District further agreed to discharge 13.6 billion gallons of water (37.3 m.g.d.) each year from the Barkhamsted Reservoir as temporary compensation.

The completion and servicing of the proposed Hogback Reservoir will therefore restore to the Barkhamsted Reservoir for water supply purposes its present 37.3 m.g.d compensation commitment thereby increasing the 95% year yield of the reservoir from 17.7 to 55 m.g.d. and the combined Nepaug and Barkhamsted yields from 44.7 to 82 m.g.d., which is more than double the 1954 use of water (37 m.g.d.).

The foregoing somewhat lengthy explanation of District water supply developments on the Farmington River has been presented to give a clearer conception of the function of the Hogback Reservoir in the District's water supply setup.

The Hogback Project

Briefly, the Hogback project involves the construction of a dam on the West Branch of the Farmington River in the Town of Hartland about

two miles upstream from the village of Riverton to form a 6½-billion-gallon storage reservoir.

Incidental to the construction of the reservoir, it will be necessary to relocate a 3½-mile section of State Highway Route 8 in Connecticut and Massachusetts and four small cemeteries presently located within the area to be flooded.

Ultimately a 3-mile tunnel will be built through the ridge separating the valleys of the East and West Branches of the Farmington River to permit diversion of flood waters from the proposed Hogback Reservoir into the Barkhamsted Reservoir for general water supply use.

Preliminary Surveys and Investigations

Preliminary work on the Hogback project was begun in 1931 with the aerial mapping of the West Branch valley from New Hartford northerly to the Massachusetts state line by The Fairchild Company of New York City and an accompanying ground survey by The R. H. Randall & Company of Toledo, Ohio, consisting of a traverse and line of levels extending from the East Branch Compensating Reservoir in New Hartford up the West Branch valley to the State line with several connecting traverses to the East Branch surveys previously made. The Randall Company was also commissioned to contour the aerial copy prints of the Fairchild Company, locating contours at ten-foot intervals below 650, over an area of approximately 5000 acres.

Also in 1931, The Schlumberger Electrical Prospecting Methods, New York City, made a series of 26 electrical observations at the dam site to determine by measurement of electrical resistances through the overburden, the depth to rock and the character of the overburden.

To obtain more extensive and precise information on rock foundation conditions, some 65 core bearings, averaging 24 feet into rock, were made in 1946 under a contract awarded to Sprague and Henwood, Inc., of Scranton, Pennsylvania.

As a result of these investigations, the underlying rock at the dam site was found to be schist with an average depth of overburden of 7 feet (principally sand and gravel), ranging from no cover to a maximum of about 25 feet.

To determine the availability and suitability of materials for an earth fill dam, numerous samples of material from areas upstream from the dam site were collected and laboratory tested. From the data thus obtained it was found than an ample supply of material both for the pervious portion of the dam and for the soil core could be obtained within 2 to 3 miles of the dam site but that suitable material for use as concrete aggregate would require considerable processing to make it acceptable.

Dr. Charles P. Berkey, former geologist at Columbia University, acted as consultant geologist and Drs. Karl Terzaghi and Leo Casagrande of Harvard University were consultants on soils and materials of construction.

Site and Type of Dam

The site of the dam is at a prominent constriction in the narrow river valley, having rugged steep rock slopes from the river level to about Elevation 600, above which the slopes are much more gentle and smooth.

Foundation investigations outlined above all indicate that the site is favorable for either a masonry or an earth fill dam.

The decision to build an earth dam was based on the indicated saving in cost and the availability of suitable material for this type of structure within easy access of the dam site.

The principal dimensions of the dam as planned are as follows:

Length	800 feet
Maximum height above stream bed	125 " (above rock 135)
Maximum base thickness	700 "
Thickness at flow line	140 "
Top width	62.5 "
Freeboard	15 "
Total volume of embankment	650,000 cu. yds.

The reservoir to be impounded by this dam will have the following features:

Extreme length	4.0 miles
Maximum width	0.4 "
Area of water surface	560 acres
Maximum depth (at dam)	110 feet
Average depth	36 "
Flow line elevation	641.0 (m.s.l.)
Total capacity	6.5 billion gallons
Length of shore line	12.0 miles

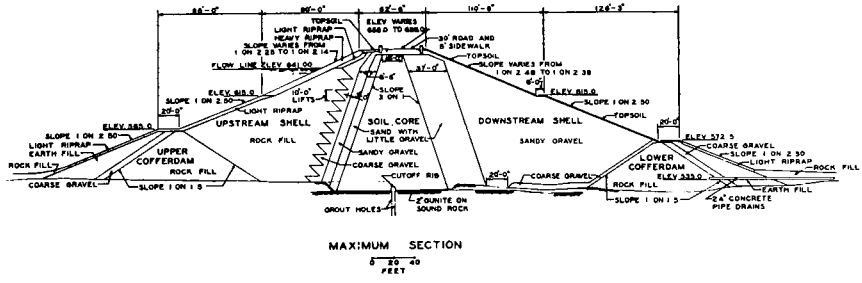

FIGURE 1

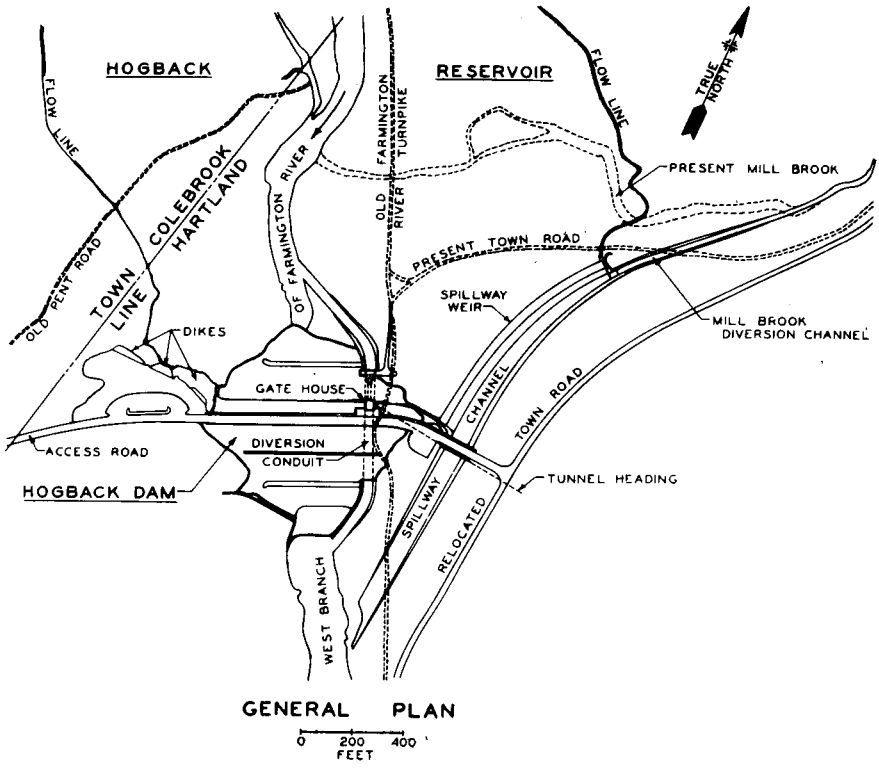

FIGURE 2

SECTION OF DAM

The section of dam finally selected is a combination of an earth fill and rock fill dam. The soil core and downstream portion of the embankment follow conventional lines of an earth fill dam and the upstream shell, that of a rock fill dam.

The substitution of a soil core for a concrete core wall and rock fill in the upstream shell for gravelly material material represents a distinct departure in design from other earth dams of our system.

For water tightness the dam depends primarily on an impervious soil core centered along the center line of the dam, 18 feet wide, at the top which is 12 feet above the normal reservoir flow line, with 3 on 1 side slopes both upstream and down, and resting on a gunited surfacing of original sound rock.

To overcome the danger of uneven settlement in the soil core, on the steep, rugged lower rock slopes of the valley with consequent opening of tension cracks in the soil core through which water might pass, all such

slopes will be cut down to a maximum slope of 1 on 1 except for small local areas where slopes steeper than 1 on 1 will be permitted for rises less than 4 feet. Local depressions in the rock will be filled with concrete and concrete fill will be placed over the diversion conduit up to the top of the rock cut made for the construction of the conduit.

To prevent any appreciable leakage underneath the core, the entire underlying surface of rock will be covered with a 2-inch thickness of gunite and a small concrete cut-off rib, four feet high will underlie the soil core throughout its length.

Seams in the underlying foundation will be thoroughly grouted through two lines of grout holes, 25 to 30 feet deep, located under the cut-off rib, 21 inches on either side of its center line. Grout holes will be spaced not more than 15 feet center to center on each line and staggered. Supplementary grout holes will be provided if and where conditions warrant.

Upstream from the soil core will be two 8½-foot (horizontal measurement) filter belts, the first of sand with little gravel and the second of sandy gravel followed by a 3-foot minimum belt of coarse gravel; the purpose of these graded belts being to prevent loss of material from the soil core due to drawdown of the reservoir.

The balance of the upstream shell will be principally rock fill to be obtained as rock spoil from the diversion conduit and spillway channel excavations.

Immediately downstream from the soil core there will be a 37-foot (horizontal measurement) filter belt of sand with little gravel and the balance of the downstream shell will be of sandy, gravel material.

Coffer-dams at the upstream and downstream toes of the dam will keep the central portion of the dam unwatered during the early construction period and subsequently become a portion of the dam itself.

The upstream face of the dam will be built on a 1 on 2.143 to 2.25 slope above Elevation 615 and 1 on 2.5, below. The upstream face will be surfaced with roughly graded, light riprap below Elevation 615, and heavy riprap above that elevation where wave action will be more severe. The top of the upstream coffer-dam will form a 20-foot berm in the upstream face of the dam.

The downstream face will be broken by two berms, one of 8-foot width at Elevation 615 and the other of 20-foot width, being the top of the downstream coffer-dam at Elevation 572.5. Slope of the downstream face below Elevation 615 is 1 on 2.5 and above that elevation it will vary from 1 on 2.384 to 1 on 2.48.

Except for the downstream coffer-dam slope which will be riprapped, the entire downstream face of the dam will be covered with 12 inches of topsoil and grassed. Permanent drainage pipes will be installed in the downstream portion of the dam.

A 30-foot service road with a 5-foot sidewalk area on the upstream side of the roadway paralleled by rubble parapet walls will traverse the dam to provide access to work areas on the west side of the river.

Diversion Conduit

The diversion conduit's function is to handle normal and flood flows of the stream during the construction period and to deliver regulated discharge of water for the benefit of downstream users following completion of the dam and supply of flood waters to tunnel for Barkhamsted storage.

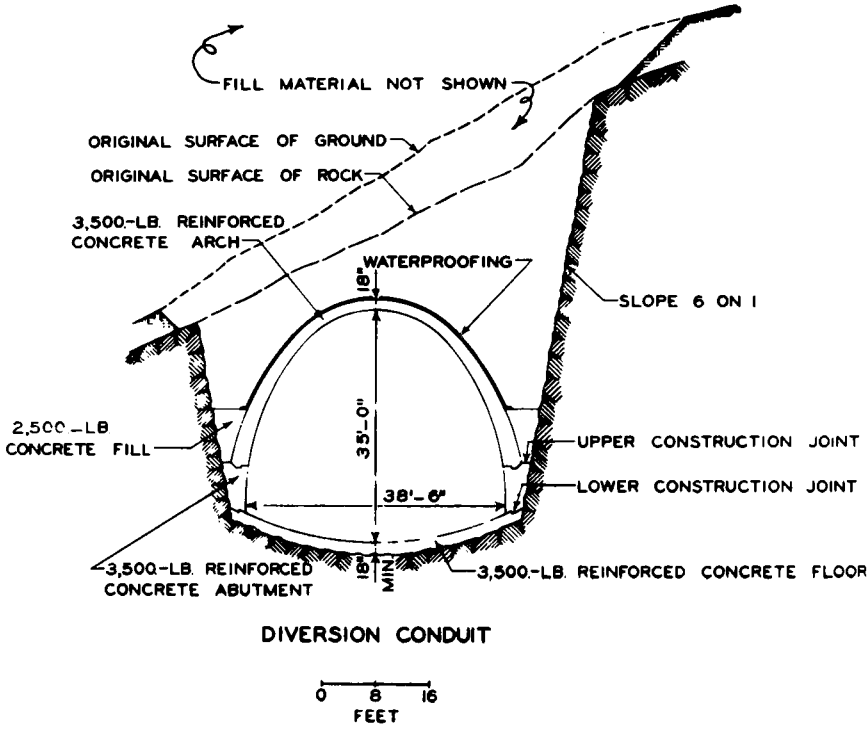

Figure 3

The Hogback diversion conduit will be located in rock on the east side of the valley. It will be a reinforced concrete horseshoe shaped structure, 428 feet long, 38 feet 6 inches wide and 35 feet high, with walls 18 inches thick at the crown and a 1% invert slope. Its construction will involve about 75,000 cubic yards of rock excavation.

The conduit was designed to discharge a flow equivalent to the maximum West Branch flood of record (27,000 sec. ft.) without overtopping the upstream coffer-dam.

Spillway and Spillway Channel

The spillway of an earth dam and its capacity to discharge flood flows without overtopping of the dam is the safety valve upon which the integrity of the structure depends.

The Hogback Dam spillway weir has been designed to discharge a flow of 92,000 second feet (765 sec. ft. per square mile) with reservoir at Elevation 650 (9.0 feet above normal flow line), and spillway channel 104,000 second feet to include Mill Brook diversion. This discharge is equivalent to 3½ times the maximum West Branch flood of record (247 second feet on 75 square miles). The design inflow rate of 800 second feet per square mile compares with 500 second feet per square mile used in the Barkhamsted Reservoir which, reduced by pondage, produces a maximum weir discharge at Hogback of 765 second feet per square mile compared with 280 second feet per square mile at Barkhamsted.

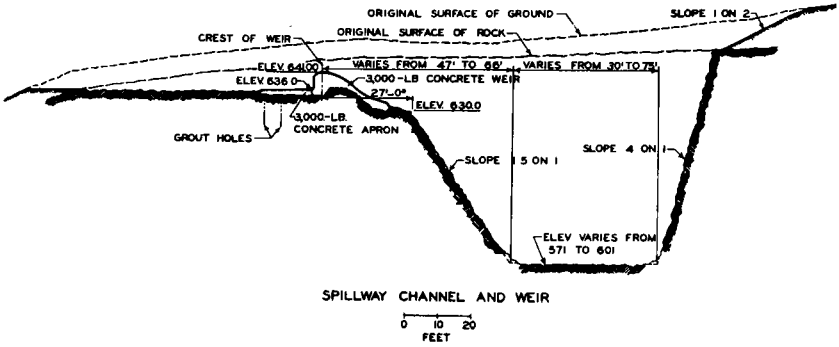

FIGURE 4

The 900-foot concrete spillway is an ogee shaped structure with a 15-foot concrete apron on the reservoir side. It will be securely anchored to the rock on which it will be founded, to counteract ice pressure, and seams in the underlying rock will be grouted using the same grouting procedure as under the soil core.

The spillway channel, almost wholly in rock, will deliver water passing over the spillway back into the river downstream from the dam. It will be some 1840 feet long, about 900 feet of which is opposite the weir. The channel will have an invert width of 72 feet, invert slope of 1 to 7% and side wall slopes of 4 on 1. The maximum depth from invert to original rock surface will be about 80 feet and its construction will involve about 330,000 cubic yards of rock excavation. The spillway channel will be spanned by a reinforced concrete arch bridge to carry the service road which crosses the dam.

For sanitary reasons, Mill Brook, which drains some 55 square miles of the Pinehurst Lakes cottage resort area, will be permanently diverted from

the reservoir into which it would naturally discharge and will discharge into the upper end of the spillway channel.

Model Tests

To test the adequacy of design of the spillway, spillway channel and diversion conduit, a 1 to 50 scale model of the dam with appurtenant control works was built and tested at the Alden Hydraulic Laboratory of Worcester Polytechnic Institute.

The model tests not only met all the design requirements (27,000 sec. ft. for the diversion conduit and 92,000 sec. ft. for the spillway weir) with very satisfactory flow performance but further tests indicated that a spillway flow of 143,000 second feet (about 5¼ times the maximum West Branch flood of record) could be handled leaving a 2¼-foot freeboard below the top of the dam embankment and that the spillway channel would safely discharge this flow plus an additional assumed 12,000 second feet from Mill Brook.

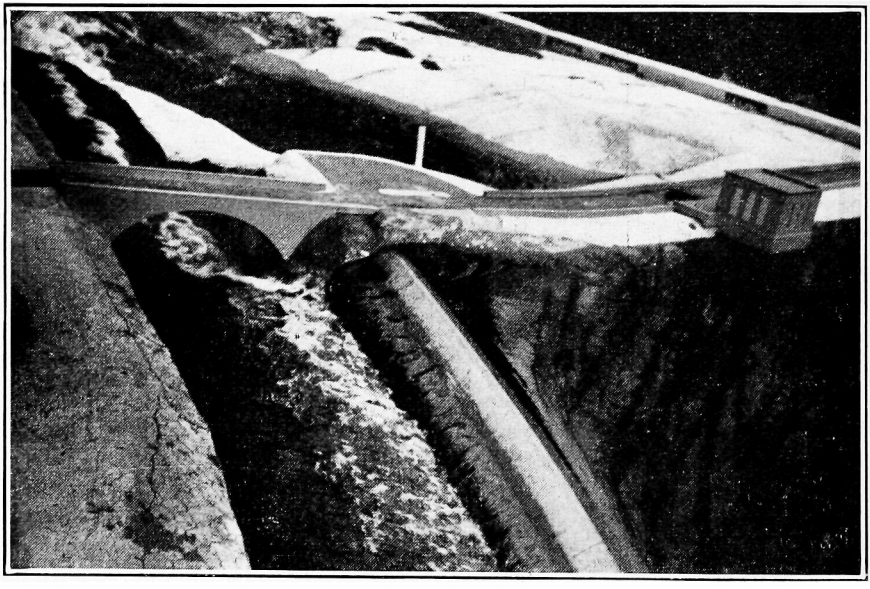

Figure 5 — Scale Model

Gate House

The reinforced concrete gate house structure 45-foot square rises from the diversion conduit to the top of the dam. All exposed concrete surfaces on the gate house will be faced with granite.

The structure will house the various gates, stop planks, traveling crane, generator set and appurtenant electrical equipment necessary for regulating

the delivery of water to Barkhamsted Reservoir and downstream users. Intake arrangements at the gate house will permit taking of water from reservoir bottom for river discharge. The intakes to the proposed tunnel to Barkhamsted Reservoir will be a part of the structure, one at about 20 feet above reservoir bottom and one about 70 feet above.

Water Supply Tunnel to Barkhamsted Reservoir

The first 675 feet of the tunnel which will ultimately extend to Barkhamsted Reservoir will be built under the Hogback Dam contract.

The tunnel is horseshoe shaped, 7′ 3″ wide and 8′ 2″ high with 6 to 8-inch concrete lining. When placed in operation, it will deliver 500 million gallons of water per day into the Barkhamsted Reservoir.

Town and Service Roads

Also to be included in the Hogback Dam contract is the relocation and construction of a 4,800 feet section of town highway in Hartland, as replacement for an existing road crossing the dam site, and the construction of about 6,200 feet of a service road extending from the relocated Hartland road westerly across the dam to connect with an existing town road

Present Status of Hogback Project

The District has acquired about 6,000 acres of land, leaving only one or two small, minor parcels to be purchased.

The construction of the Connecticut relocation of State Highway Route 8 has been completed and work on the Massachusetts section is in progress and will be completed this fall.

The four cemetaries formerly located within the area to be flooded, have been moved to a new site off the watershed.

Personnel and Organization

In addition to the consultants previously mentioned, Mr. Karl R. Kennison, Chief Engineer of the New York Board of Water Supply and Mr. Thomas H. Wiggin, Consulting Engineer of New York have served as consultants on the review of the design and plans for the dam.

Mr. Manning W. Heard is Chairman of the Metropolitan District Commission of Hartford County, Mr. John T. Wells is Chairman of the Water Bureau and Mr. William A. D. Wurts is District Manager.

The general conduct of the work is under the direction of Mr. Warren A. Gentner, Deputy Manager and Chief Engineer of the Water Bureau and the work of design and specifications has been done under the supervision of Mr. William Dorenbaum, Chief Designing Engineer.