Columbus' New Water Supply Dam and Reservoir

By C. B. Cornell, *Ex.* '02, *Assoc. Mem. Amer. Soc., C. E. Field Engineer, Bureau of Water Works Extension*

O'SHAUGNESSY DAM

By resolution of the Council of the City of Columbus, adopted February 7, 1921, this dam was named and designated the 'O'Shaugnessy Dam' in honor of the late Jerry O'Shaugnessy, who so faithfully and well served the City as Superintendent of its Water Works for many years.

A BRONZE tablet inscribed as above will be placed on the wall of the Outlet Gate House at the center of the new Water Works Dam now under construction across the Scioto river about 4 miles north of Dublin. Let us pause long enough to consider the grandeur of a testimonial such as this. May those who read, may we as engineers "so faithfully and well serve" the demands of our respective callings in life that in the end we may deserve as lasting a tribute to our service.

WHY A NEW DAM WAS NEEDED

The first question asked by those unfamiliar with Columbus' Water Works system is, "Why are such a dam and reservoir needed by the City?"

The first answer to this question is found in the fact that, while Columbus is located on a stream which, with the exception of the Miami river, has established the highest flood flow record for streams with corresponding watershed conditions, this same stream, with 1053 square miles of watershed above the present Storage Dam, has also a record of low flow in dry seasons which approaches the lowest recorded figures for similarly situated watercourses.

Additional reasons for the necessary extensions may be cited: population increase amounting to 57,000 people between the 1910 and 1920 census; a fluctuating increase in per capita consumption water which is difficult to predict in advance, as following figures will indicate: 1909—71.4 gals. per cap., 1914—87.5 G. P. C., 1915—80.5 G. P. C., 1918—99.7 G. P. C., 1921—82.3 G. P. C.; the supplying of surrounding suburbs with city water; and, the small capacity of the present Storage Reservoir, which, as a measure of expediency and in order to meet the urgent needs of the City without further delay, was cut down from a recommended capacity of 5,681 million gals. to 1,487 million gals. as actually constructed. The latter condition has been bettered to some extent by the addition of four foot flash boards placed on the crest of the present dam which has increased the available storage capacity 503 million gals.

SOME CHARACTERISTICS OF THE SCIOTO RIVER

The wide variation in the discharge of the Scioto river is quickly indicated by citing 8 cu. ft. per sec. as the approximate low daily flow record and 75,000 C. F. S. the maximum rate of discharge at the Storage Dam during the 1913 flood. Estimated average total discharge of the river at the Storage Dam, based on a rainfall of 35 inches and a run off of 30% of the rainfall, would equal about 192 billion gals. annually, or about 23 times the present requirements for water supply. The minimum annual yield of the 1053 sq. mi. of watershed above the dam was estimated in the preliminary report covering the present structure as about 110 billion gals.

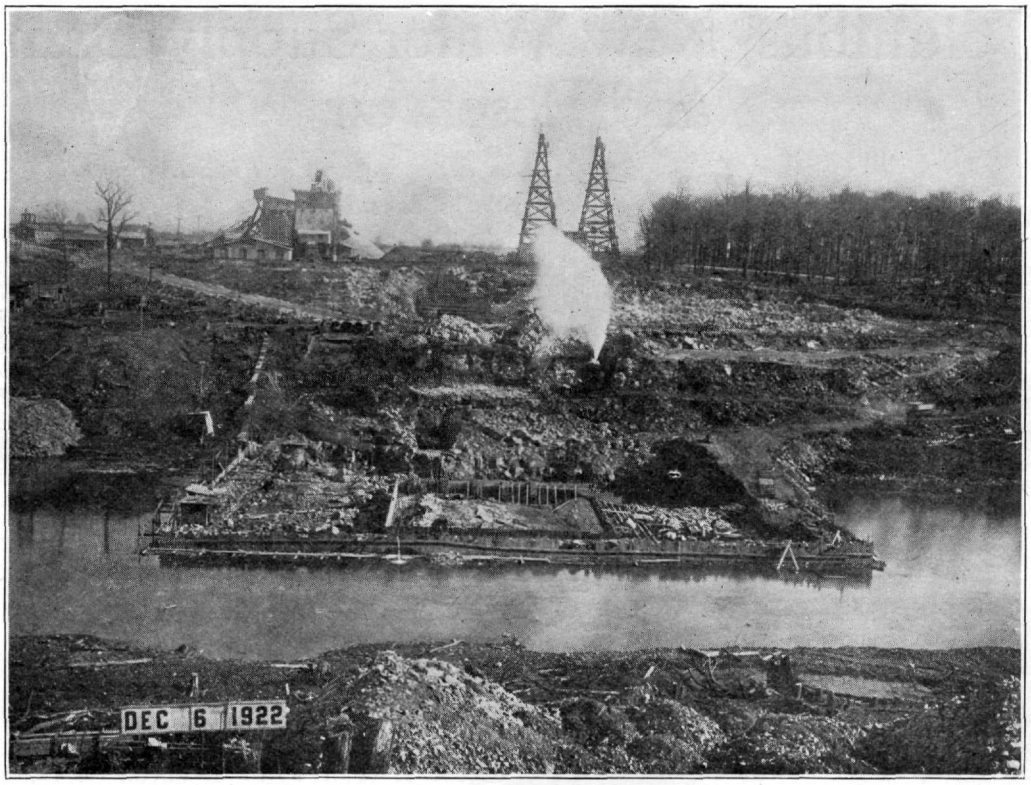
River gaugings or other authentic data on the flow of Central Ohio streams are notably meager. Fairly good continuous gauge readings of the Scioto are available since 1898 only. In 1914 the Scioto River Reservoir was drawn down to the crest level of the dam in the latter part of May and failed to again reach crest level until the early part of the following December. The accumulated flow of the river into the reservoir was less than the total water drawn for use, plus a small amount of wastage, for a continuous period of 191 days. The estimated minimum yield of the watershed as originally estimated for the same period would have amounted in 191 days to a total of 11 billion gals. The actual yield for the period in question totaled only 4 billion, 620 million gals., or about 40% of the estimated figure.

CONDITIONS MAKING ADDITIONAL STORAGE CAPACITY NECESSARY

In 1918 the high per capita consumption and the natural increase in population, together with the other factors previously referred to, resulted in the greatest daily average consumption that had yet been experienced since the present system was put in service in 1908, namely, 22,534,000 gals. per day. It was apparent that, with the normal increase in population, a 5% increase over the yearly average consumption which is likely to occur during the six months of low flow, and, with a repetition of dry weather conditions as experienced in 1914, the dry weather capacity of the present works would have been reached by the end of the time required to plan and construct additional storage works. Further than this there was no assurance that per capita consumption would remain stationary nor that the low flood record of 1914 might not be still further decreased, a combination which would certainly result in a serious water shortage.

RECOMMENDATIONS

During the latter part of 1918 Mr. John H. Gregory, Mem. Amer. Soc. C. E., was retained by the City to investigate and report on the whole water works system. His report and recommendations were submitted in March, 1919, and covered extensions to the distribution system, additions to the filtration plant, additions to the pumping equipment, the raising of the intake dam at the pumping station, and, the extension of the system of supply.



VIEW FROM THE WEST BANK OF THE RIVER. MOVABLE TOWERS AND CONCRETE PLANT IN THE BACKGROUND

The last recommendation, with which we are more directly concerned called for increasing the height of the present Storage Dam or the Julian Griggs Dam, as it was recently designated by resolution of the City Council, and, the construction of a new dam and reservoir at some point upstream from the Griggs Dam. The new reservoir as recommended was to have storage capacity sufficient to supply the difference between the capacity of the enlarged Griggs Reservoir and that required to furnish the City with 55 million gals. of water per day through a dry season such as had been experienced in 1914, or, as Mr. Gregory estimated, until about 1950 to 1958.

In the preparation of the report the possibilities of the Olentangy river, Big Darby creek, Alum creek and Big Walnut creek as sources of additional water supply were considered but were found to be less desirable in many respects than the recommended extensions on the Scioto.

The recommendations as submitted were endorsed by the Chamber of Commerce, a committee of engineers from the Engineers' Club of Columbus and numerous other civic and social organizations, with the single exception that the increasing of the height of the Griggs Dam, by a six foot addition, as recommended, was not endorsed by the Engineers' Club, their recommendation being that the increase in storage capacity thereby obtained be secured by increasing the height of the proposed new dam a sufficient amount to secure equivalent storage. This recommendation was subsequeently adopted and followed in the designing of the new structure.

After an extensive educational campaign the question of issuing bonds to the amount of $3,000,000 to pay for the proposed extensions was placed before the citizens of Columbus in November, 1919, and was given a safe margin of favorable votes.

LOCATION OF DAM

No extensive preliminary surveys were made in connection with the preparation of the preliminary report of 1919 because of urgent need for speed in getting the necessary extensions under way. Two factors lent material assistance to such a course of procedure: First, Mr. Gregory's familiarity with Columbus conditions, gained through his connection as Engineer in Charge of the design and construction of the present system; Second, the availability of surveys, maps, etc., prepared by the Franklin County Conservancy Commission in its studies of flood prevention dams and reservoirs on three of the streams considered in Mr. Gregory's report. The entire collection of data, maps, survey notes and the remaining equipment of the Commission have since been purchased by the City and have been used for many purposes with considerable saving to the City in both time and expense.

The site proposed for a flood prevention dam about two and one-half miles north of Dublin was used in making preliminary studies and estimates for the proposed new storage dam because complete data on this location were available, and for the additional reason that, if a dam and reservoir in this location proved desirable, there still remained the possibility of locating a better site at some other point on the same stream. Subsequent results have demonstrated the wisdom of the course of procedure adopted.

The first problem encountered in starting the new work was the checking up of the site of the proposed Conservancy Dam and the comparison of this site with other possible locations, this work being started in June, 1920. Likely sites were selected on the available topographical maps, located on the ground, profiles across the valley surveyed, plotted and compared, new lines selected by a rough reconnaissance made from the original profiles were run, plotted and compared. Cross sections of ground

adjacent to the best profiles were then taken and plotted and the contour lines of the surface drawn on large scale maps. Twenty-seven profiles were actually run and numerous others were prepared from the large scale maps. Four areas covering from one to seven of the best profiles each were cross sectioned, mapped and drilled to determine the location of the underlying rock.

SUBSURFACE INVESTIGATIONS

The location and to some extent the character of the rock underlying the various sites were investigated by hand drilling, with bars and sledge, where earth cover was less than seven or eight feet, and with two ordinary well drilling machines where cover in excess of these figures occurred. Approximately 1,000 hand drilled holes were made and 400 machine drilled holes were put down of varying depths up to 75 feet. The results of drilling operations were plotted on the large maps and the contours of the rock surface drawn on the maps in colors. The site finally selected was also core bored, this work being taken up later on.

By a process of comparing profiles all but about seven of the sites were eliminated. Estimates of cost of a tentative design of dam on the various sites eliminated all but three of the seven, and complete estimates of dam and reservoir costs resulted in the selection of the site on which construction work is now under way.

Complete investigations were made covering the 4½ mile stretch of the river from a few hundred feet north of the Dublin bridge to about a quarter of a mile north of the Powell Road bridge. A study of maps and an inspection of ground conditions at possible sites was made below Dublin and as far north as White Sulphur in Delaware County, above which no river gorge exists. The three best sites were found between a point 2½ miles north of Dublin and the upper site one-fourth mile north of the Powell Road bridge.

CORE BORINGS

With the choice reduced to three sites the core boring of the best site was done during the summer of 1921. Twenty holes of sufficient diameter to produce a two-inch core were drilled to depths ranging from 15 to 62 feet at points under and close to the proposed structure. The holes were also tested under hydraulic pressure to determine the existence of open seams or other objectionable conditions in the rock. No serious rock conditions were develped. The cores produced, the site and the geological horizon of the site were studied and reported upon favorably by Prof. Bownaker, State Geologist.

Before the preliminary work was completed the detailed design of the dam was started. The general considerations decided upon called for a gravity type overflow dam of O-G section and of height sufficient to form a reservoir of about 5½ billion gals. available storage capacity, surmounted by a concrete bridge to replace the Powell Road bridge now located about 2,300 feet above the site. A gate house with equipment to release the stored water, provision for future hydro-electric development, and a broad concrete apron to prevent erosion from the overfalling water, as has occurred at the Griggs Dam, were decided upon.

As fitted to the site the final plans call for a length of 879 feet between abutments with a maximum spillway section 70 feet in height from the lowest point in the apron to the crest, and with the crown of the roadway of the bridge 21′ 3″ above the crest. This located the crest 64.5 feet above the low water level at the site. The maximum width across the base including the apron is 110 feet. The outlet gate house is at the center of the dam, being located on the ground at the east edge of the present river bed. Its location is due to the abrupt rise in the bed rock of the west bank to crest height and the gentler slope in the higher lying portions of the east bank. Half of the water passing over the crest will therefore have to flow over the present east bank, it being desirable from many viewpoints to make the overflow section as long as the site will permit. This condition led to a departure from the ordinary design in that the bottom of the structure was planned as a series of steps fitting the elevation of bed rock as developed by the borings. The steps on the steeper slopes are shorter along the length of the dam and of greater height and the reverse on the flatter areas. The same stepped effect is followed in excavating the material away from in front of the concrete apron except that, from a point a little distance downstream from the apron, the rock face risers of all steps are curved toward the river bed on concentric circular curves, the tread of each step being also excavated with a slight grade downstream. Water flowing over the easterly or westerly section of the dam will flow across the apron and continue in the same direction over the tread of the upper step until deflected toward the river by the riser of the upper step, eventually reaching the river, in the case of the easterly step, some 600 feet downstream from the dam. Advantages gained by the step treatment are: the elimination of the destructive erosion along the downstream toe of the apron, the furnishing of sufficient stone for concrete, slope paving, roads, etc., the confining of quarrying operations to an area where same will serve a useful purpose, and betterment in the appearance of the whole structure.

Six 71′ 6″ concrete arch spans on each side of the outlet gate chamber section connect with a reinforced hollow abutment section at each end of the bridge, about 60 feet long carrying the 18 foot roadway and 4 foot sidewalks from the end of the last span to connection with the earth embankment sec-

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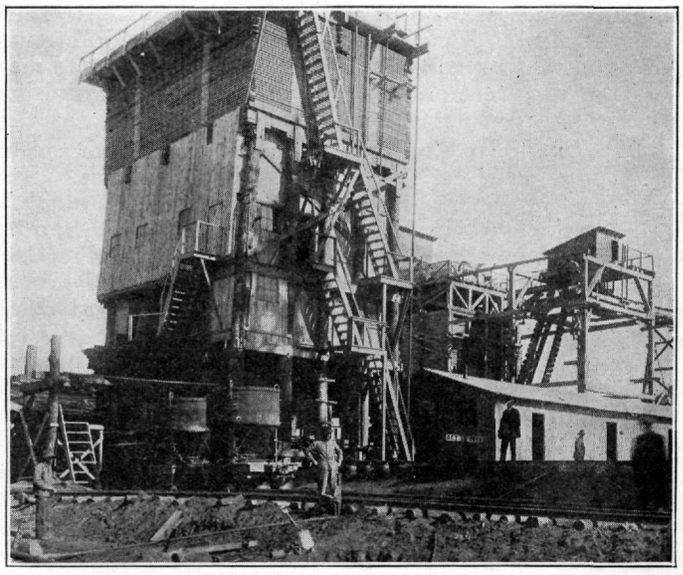

THE CONCRETE PLANT, SHOWING A PORTION OF THE CRUSHING PLANT ON THE RIGHT

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tions. The latter are constructed with a concrete core wall which extends for about 350 feet on the east end of the dam and 150 feet on the west end beyond the abutment section. The embankment section is extended for short distances beyond the ends of the core walls to connect with ground at the elevation of the roadway. The overall length from end to end of core walls is approximately 1510 feet.

ARCHITECTURAL TREATMENT

In contrast to the Griggs Dam, which was constructed with the idea of increasing the height at some future date, the new dam is to be a finished structure and it was early decided to give the entire structure as pleasing an appearance as reasonable expenditures would permit. The outlet gate

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chamber and the power gate chamber, at the west abutment section, project upstream from the main part of the dam and offer opportunity for pleasing treatment. An open pavilion on the upstream side of the east abutment was added to balance the structure and circular balconies on the downstream side of the abutments were also included. The gate houses, pavilion and balustrades on both sides of the bridge and abutments are to be constructed of Indiana limestone. Tile roofs on the buildings, the pannelling of the piers and ornamental treatment of the arch spans and bridge floor will produce a pleasing appearance. The Frank L. Packard Co. handled this part of the design.

CONSTRUCTION

The actual construction work was started in July, 1922, and about 18% of the work has been completed to date, the Thompson Starret Co. of New York being the contractors. It is their policy to provide their jobs with ample up-to-date equipment. They have provided and set up two 1100 foot span, 10 ton cableways, both having movable towers 103 feet high at both ends, by means of which it is possible to directly reach all of the concrete work except the core walls.

Excavation is handled with a 1-yard Osgood shovel on caterpillar truck delivering to White trucks which in turn haul the excavated material to the crushing plant or point of disposal. Rock drilling is done altogether with jack hammers supplied with compressed air from a stationary plant having two motor driven compressors. The handling of excavated material by trucks has not proven very satisfactory and arrangements are being made to replace the present method by handling the bulk of the material with the cable ways to a grizzly located on the east bank and thence by industrial railroad to the crushing plant.

A complete crushing and screening plant having a No. 6 and No. 25 crusher, revolving screen, with storage bins beneath and the necessary elevator and belt conveyor equipment to deliver the crushed rock either to trucks or to the storage piles, has been furnishing all of the stone used in all parts of the work. The stone is delivered to the storage piles in three grades: ¼" to ¾", ¾" to 1½", and 1½" to 3", the three grades being kept separate until combined in known proportions in the concrete. Delivery to storage piles is made from an elevated trestle carrying a belt conyevor. A tunnel under the storage piles is equipped with a belt conveyor which loads from gates in the tunnel roof and delivers the material to an elevator which lifts it up into the bins over the concrete plant. The tunnel and conveyor extend beyond the stone piles and trestle and under the sand storage space.

Sand containing 80% silica is required for all concrete work, that being used at the present time being obtained at Dresden, O. The sand, cement and other materials shipped to the work are hauled by truck from Powell on the Hocking Valley Railroad, a distance of 2½ miles.

Practically all of the machinery on the work except the cable ways and steam shovel are operated by electricity, a special transmission line operating at 12,000 volts having been constructed from the C. D. & M. Traction Co's. lines about five miles north of Worthington.

Perhaps the most unique portion of the equipment is the concrete plant (a picture of which is shown). It is all housed in one building having four floors. The upper floor is divided into four compartments, three for stone and one for sand; the third floor contains the proportioning apparatus, the second floor houses two 1-yard Smith tilting mixers and the ground floor is used for a pipe shop. The proportioning apparatus consists of four electrically operated scale pans, each of which weighs out one of the three grades of stone or sand to any weight to which the scale beams are set. The whole apparatus is started by pressing an electric button switch. When the scale pans have received their full weight of material the supply is automatically stopped and the contents of all four pans can then be dumped into either of the mixers by pulling a lever. A measured quantity of water is added by operators who also control the dumping of the mixers. Cement is handled in bags by hand. The mixers dump into a large hopper which in turn discharges into 5-yard Haines buckets carried on flat cars running on a narrow gauge track in front of the plant. The track extends the full length of and parallel to the tracks carrying the cable way towers and the concrete buckets are spotted under the cable way, picked up and carried out to the point where the concrete is to be placed in the work.

All of the work to date has been in the easterly two-thirds of the river channel, which is surrounded by a crib and earth cofferdam, and on the sections of the dam east of the river. The work in the present cofferdam was about two-thirds complete when high water and cold weather prevented further progress. The work in the present cofferdam will be completed early in the spring and includes the gate house substructure and outlet pipes. As soon as the concrete work is above ordinary water levels the river flow will be turned through the pipes and the cofferdam in the westerly third of the river constructed. Flood flows in excess of the capacity of the four 48-inch pipes will be allowed to flow over the partially completed work, some sections being left lower than the others when any probability of flood flows exist.

RESERVOIR WORK

The reservoir formed by the dam will flood about 820 acres of land at crest level and about 400 acres more will be required to contain maximum flood heights and for park space from the water's edge to the new road to be constructed along the entire east side of the reservoir from the dam to Bellepoint. Flood provisions for a discharge fifty per cent. in excess of the 1913 flood are being made. Other work includes six and a half miles of new roads replacing flooded or abandoned roads; a 1040 foot steel bridge with a maximum pier height of 58 feet, a new power house, laundry, sewage treatment plant and water supply system for the Girl's Industrial School; a new bridge and long earth fill carrying the road west of the river across the Eversole Run valley in which the water is raised about 14 feet at the road; the clearing and grubbing of the reservoir area to two feet above the crest level; the removal of buildings including one church; the re-location of a portion of a cemetery and the re-burial of the bodies now contained in same, and numerous smaller items.

The date set for the completion of the dam is

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November, 1924, and the other contracts are timed accordingly. The greatest delay to progress, to date, has been the exceedingly slow delivery of materials by the railroads. If conditions are not bettered during the remaining period some of the work is almost certain to fall behind. Those portions of the work which are located in the lower lying portions of the reservoir area will of course be pushed first and if it should appear desirable some storage capacity can be utilized in the spring of 1924.

ORGANIZATION

The work is being handled by the Bureau of Water Works Extension, which was organized for the purpose. Mr. C. B. Hoover, Superintendent of Water Works, is also Engineer in Charge, John H. Gregory is Consulting Engineer and A. R. Holbrook is Office Engineer in charge of design. Quite a force of Ohio State men have been connected with the work to date and more are expected before it is complete.

With the completion of the work the question of supply will be settled for a longer period in the future than has ever been the case since 1871, when the first Columbus Water Works was put in service.