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THE SUBSURFACE GLACIAL GEOLOGY AT PROPOSED EFFINGHAM DAMSITE AND ITS ENGINEERING IMPLICATIONS

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For several years the City of Effingham has been concerned with the sufficiency of its municipal water-supply, which is derived from a small lake two miles southwest of the city, in turn maintained by supplemental pumpage from the adjacent Little Wabash River. Investigations of both subsurface groundwater and surface-reservoir possibilities for replacement or additional supplies have been made at various times.

In 1955 Warren and Van Praag, Inc., consulting engineers for the newly created Effingham Water Authority, completed preliminary investigations for a reservoir in the valley of Blue Point Creek with a damsite in the SE. ¼ sec. 22, T. 8 N., R. 5 E., about 4 miles west of Effingham (Fig. 1).

In general the geologic materials in the region consist of a downward succession of: 1) a thin mantle of loessial silt of Wisconsin age, in which the surficial topsoil has been principally developed; 2) an irregular layer of sand and gravel of Illinoian age, of which at least the upper part has been more or less weathered and consequently is more or less clayey; 3) an irregular deposit of clay till of Illinoian age; 4) another irregular layer of clay till of Kansan age, of which the upper part was weathered during the Yarmouth interglacial stage preceding the advent of the Illinoian glacier; and 5) bedrock formations belonging to the Pennsylvanian system. Silty sand and gravel, in part deposited directly from the Illinoian glacier and in part deposited by present streams reworking the Illinoian outwash, occur in the bottoms of the principal valleys.

Before making their studies the engineers had informed themselves about the geologic conditions and were aware that the Illinoian sand and gravel deposits, somewhat unusual in Illinoian drift, required special attention. Consequently they included in their investigations an adequate program of test-boring at the damsite and obtained good sets of samples which were referred to us for identification and interpretation.

As shown on the accompanying diagrammatic cross-section (Fig. 2) the materials encountered in the test-borings are in accord with and generally confirm the regional sequence. The Wisconsin loess is represented by noncalcareous silty soil in the top 4 to 5 feet of borings 9 and 10. (Boring 10, not shown on diagram, is in spillway section to left of diagram.) The original Illinoian upland outwash, now noncalcareous, is represented in the

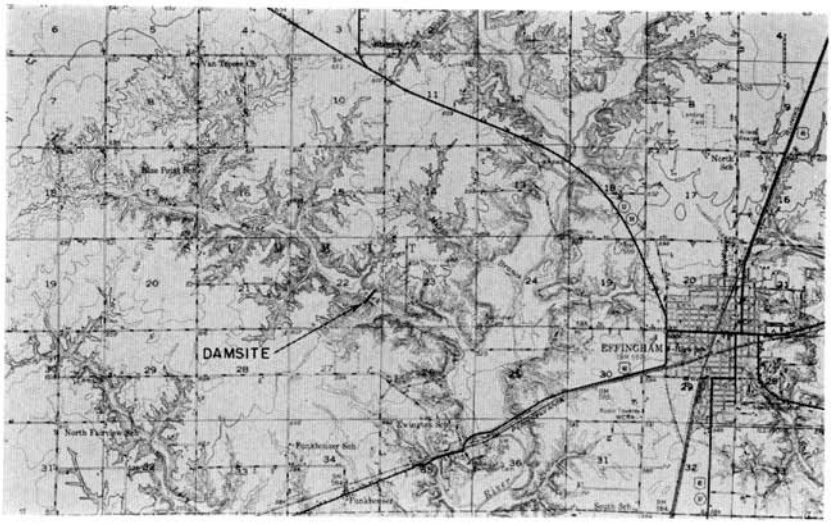

FIG. 1.—Location of proposed damsite on central part of Effingham quadrangle topographic map.

same borings, down to depths of 15 and 17 feet, respectively. The reworked (?) Illinoian outwash in the valley extends practically from the surface down to depths of 11 feet in boring 1, 21 feet in boring 6, 30 feet in boring 2, 13 feet in boring 7, 8 feet in boring 3, and 4.5 feet in boring 4 but is absent in boring 8. It is probably mantled by alluvial silt, but no such material appears in any sample. It is noncalcareous except for the bottom eight feet in boring 2 and is oxidized throughout.

Illinoian till occurs between depths of 0 and 52 feet in boring 5, 11 and 19 feet in boring 1, 19 and 21 feet in boring 7, 4.5 and 6 feet in boring 4, 0 and 15 feet in boring 8, 15 and 22 feet in boring 9, and 17 and 22 feet in boring 10 but is absent in borings 2, 3 and 6. The upper nine feet of the till in boring 5 is leached, but all the rest is calcareous. It is oxidized to a depth of more than 8 feet in boring 8, more than 12 feet in borings 1 and 5, and more than 16 feet in borings 9 and 10. It is not oxidized in boring 7, at a depth of 19 feet. In boring 7 the Illinoian till is overlain by six feet of faintly laminated fine-grained silt (B in Fig. 2) which is also probably of Illinoian or immediate post-Illinoian age, as it is in turn overlain by the reworked (?) sand and gravel.

Pro-Illinoian Loveland loess is represented by 6 inches of gray calcareous silt between depths of 19 and 19.5 feet in boring 1 and one foot of light-tan, noncalcareous silt between depths of 21 and 22 feet in boring 6 (C in Fig. 2). Because boring 6 was stopped at 22 feet it did not reveal the thickness of the Loveland loess at that spot.

Kansan till occurs at depths of 19.5 feet in boring 1, 21 feet in boring 7, 12 feet in boring 3, 6 feet in boring 4, and 15 feet in boring 8. It is absent in boring 2, but is prob-

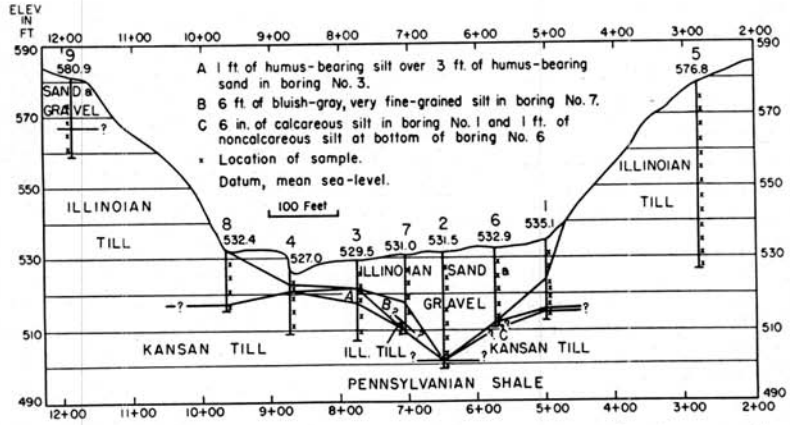

FIG. 2.—Diagrammatic cross-section of geologic materials at proposed Effingham damsite, based on samples from test-borings.

ably not far below the bottom depth of 22 feet in boring 6, and is doubtless present at undetermined depths under borings 5, 9, and 10. The top surface of the Kansan till is irregular, due to weathering and erosion during the Yarmouth interglacial stage, and all of the till represented in the samples is noncalcareous and brown or greenish. The greenish color occurs in borings 1 and 7, in which the top of the till is lower than in borings 3, 4, and 8, and may indicate the presence of a Yarmouth valley. The humus-bearing silt and sand between depths of 8 and 12 feet in boring 3 (A in Fig. 2) are probably alluvial deposits of Yarmouth age.

Formations of Pennsylvanian age underlie the entire area, but only boring 2 was drilled deep enough to encounter weathered shale of this age.

Practically all of the material represented by the samples will provide satisfactory foundation for the dam. The humus-bearing material between depths of 8 and 12 feet in boring 3 is so sandy and gravelly and contains so little humus that its bearing-power is not seriously affected. The only material that may have relatively low bearing-power is the silt between depths 13 and 19 feet in boring 7, but as it is not recorded in the adjacent borings it appears to be so localized that it can be disregarded unless for some reason the material over it is excavated.

However, the reworked (?) Illinoian sand and gravel in the valley is sufficiently permeable that considerable and possibly dangerous leakage under the dam may occur unless adequate preventive measures, such as sheet-piling, are incorporated in the design of the dam. The sheet-piling should be driven through both the humus-bearing material in boring 3 and the silt in boring 7, to the underlying till. Because sheet-piling is not always wholly effective, there should probably also be incorporated in the dam design an adequate drainage section in the downstream toe of the dam, and, for safety's sake, it would be desirable

to install piezometers in this drainage section.

The outwash sand and gravel on the uplands is also permeable, and thus, unless there is some way of cutting it off, the dam should probably be constructed so that the water-level in the reservoir is little if any above the bottom of the outwash.

The effects of this layer of outwash must also be considered in designing the spillway that will be cut through it. Possibly potential seepage can be cut off by sheet-piling, but this may build up excessive hydraulic pressures on the bottom and sides of the spillway, and consequently it may be preferable to install drains under and along the sides of the spillway where it cuts through the outwash and to discharge these drains into the spillway itself.

One of the most serious problems that seems to be present is an adequate source of satisfactory material for the dam. As the upper material on the uplands is principally silt, sand, and gravel, it is hardly suitable material for a dam, except for a drainage section in the downstream part. It can be used in the main section of the dam only if it is mixed with an adequate amount of clay, and this will require careful measurements of the proper compaction of such a mixture. This precaution will have to be carefully exercised if it is planned to use in the dam the material excavated from the spillway. The only source of clay is the till underlying the sand and gravel. Inasmuch as the till is satisfactory material for the dam, it may be desirable to plan to obtain the material for the dam from excavations in the till in the lower parts of the valley-walls upstream from the dam. Such excavation would also increase the capacity of the reservoir.

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