Memorandum

Files

Denver, Colorado
March 19, 1952

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Preliminary model studies to determine if the air-lift pump principle could be used to obtain a small increase in the running level of large volumes of water flowing in a canal

Tests were made during the period between October 28, and November 5, 1949, using an existing 2-foot wide flume with a glass window in one side which permitted observation of the flow in the vicinity of the pump. An air manifold 1 inch high, 24 inches wide, and 12 inches long was placed on the flume floor (Figures 1 and 2). Air was supplied to this manifold under pressure and, after passing an orifice through which the flow was measured, discharged from the top of the manifold through 253 No. 60 holes spaced on 1-inch centers. A baffle, consisting of a 90° segment of a 12-inch radius cylinder, was placed immediately downstream from the manifold (Figure 2). A flat second baffle was placed on a slope over the manifold with the upstream edge submerged and with the downstream edge or top, considerably above the normal upstream water surface.

The sequence of events through the pump area was as follows: Water, flowing at a depth of about 18 inches, passed over the air manifold, then between the upper baffle and the curved downstream baffle, and on down the flume to a check gate which was fixed at a given elevation for a given discharge. If no air was being discharged by the manifold the water surface elevation at a point well downstream from the baffle was nearly the same as the elevation of the water surface upstream from the manifold, differing only by the grade drop due to friction. However, if air was being discharged by the manifold, a drawdown occurred upstream from the upper baffle so that a head differential existed across the pump (Figure 2). The water surface elevation well downstream from the pump remained fixed because the check gate remained fixed during a given test. The same head differential could have been obtained if the check gate had been raised when the pump was started, thereby maintaining the upstream water surface elevation constant. The amount of lift and the attendant air requirements are shown in Figure 3.

The test program was limited to determining if the air-lift pump principle could be applied to obtain small increases in water surface elevations where large quantities of water are flowing in a canal. As soon as it was found that the required lift could be obtained, the program was terminated and no attempts were made to perfect any parts of the system or to improve the poor efficiency. The limited tests were sufficient, however, to permit the following general observations:

a. The lift increases as the quantity of air is increased

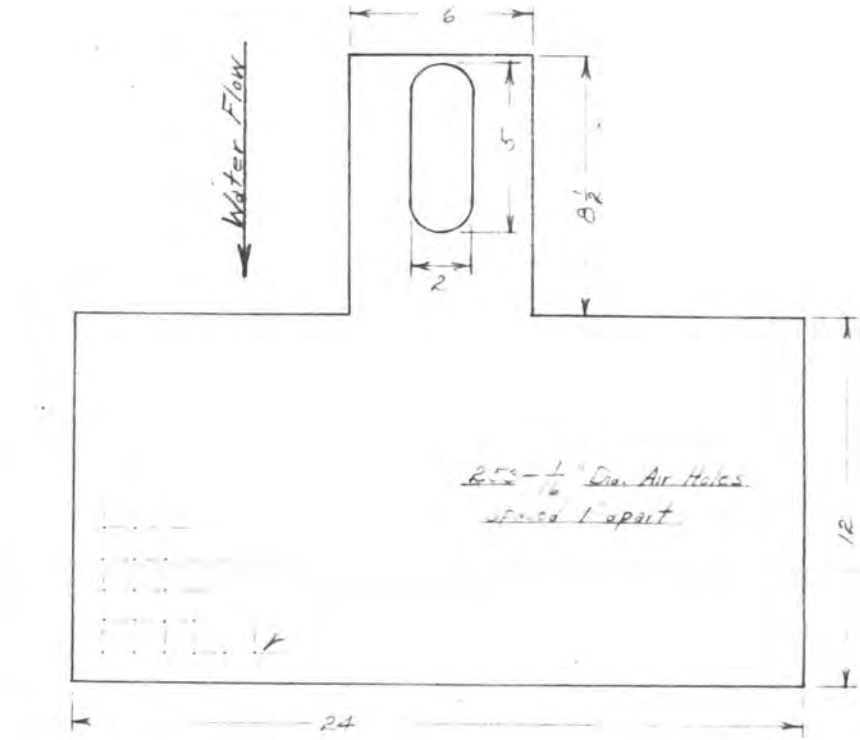
b. The shape and the height of the downstream baffle are very important. The shape shown in Figure 2 produces bad eddies which probably reduce the lift. The height of the baffle affects the lift, with crest elevations either too high or too low resulting in decreased lift

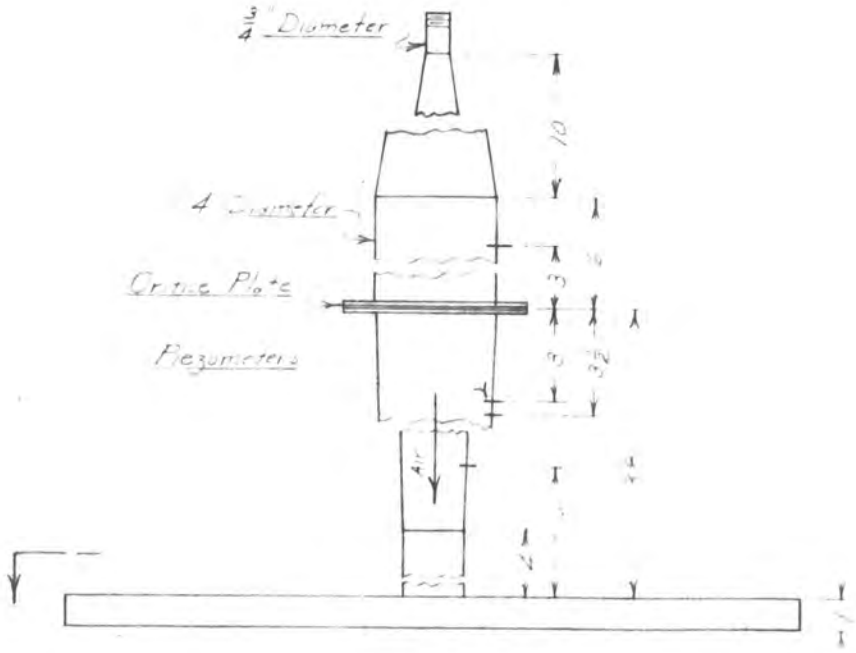
c. At low water discharges some of the air escaped upstream from the upper baffles without producing useful work

d. The design of the upper baffle was less critical than the downstream one. It should, however, be high enough so that it is not overtopped, and the upstream edge should be low enough to prevent bubbles from escaping upstream. Care must be taken to not put the upstream edge so low that the flow is appreciably obstructed

e. It may be possible to use many fewer air holes than were used in the manifold tested. Many of the individual air bubbles from this manifold gathered together into large bubbles before reaching the water surface.

Figure 1

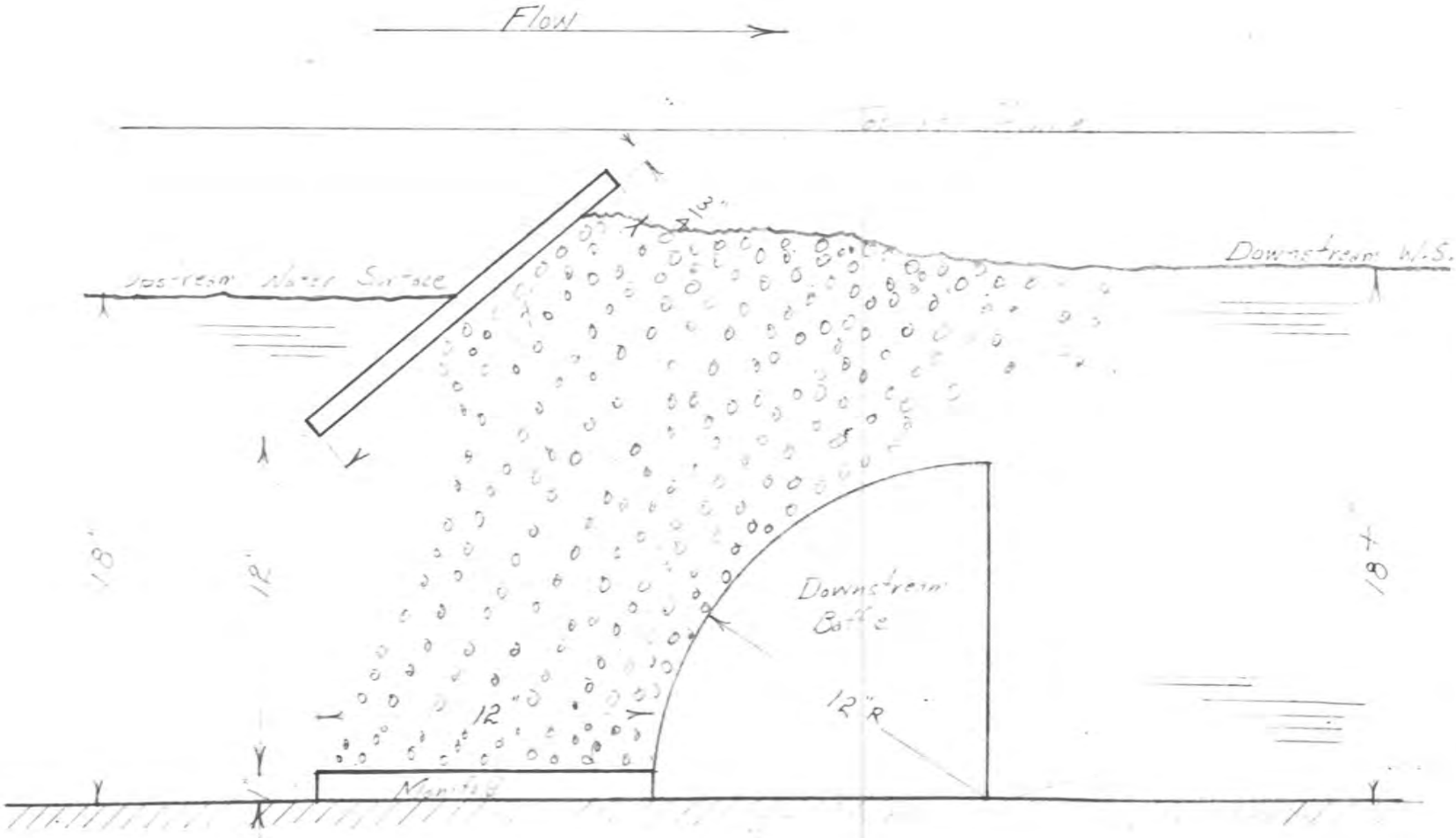




Cutler Air Lift Pump - Laboratory Tests

4" Inlet Manifold

Laboratory Model



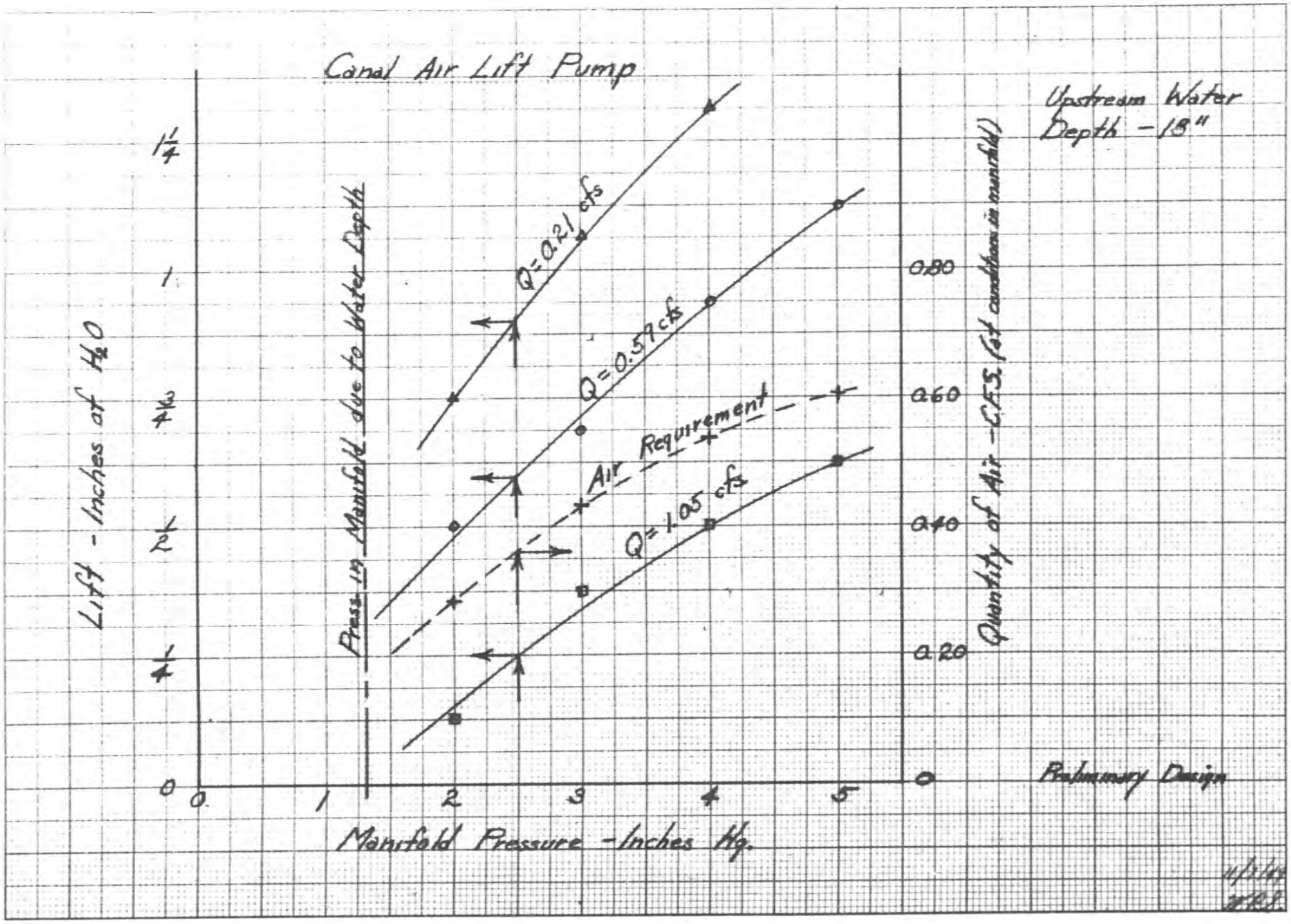
Upstream Water Depth measured 25' U.S. of inner tube
Downstream " " " D.S. of Pipe.

Canal Air Lift Pump
Preliminary Design

11/25/49
W.P.J.

Figure 2

Figure 3


Canal Air Lift Pump
Upstream Water Depth - 18"
Lift - Inches of H_2O
Press. in Manifold due to Water Depth
Q=0.21 cfs
Q=0.57 cfs
Air Requirement
Q=1.05 cfs
Quantity of Air - C.F.S. (at conditions in manifold)
0.80
0.60
0.40
0.20
0
Preliminary Design
Manifold Pressure - Inches Hg.
0
1
2
3
4
5
1/4
1/2
3/4
1
1 1/4