# USEFUL

# IRRIGATION INFORMATION

# AND

# PUMP DATA




FARM ADVISOR'S OFFICE
COUNTY ADOBE BUILDING
MERCED, CALIFORNIA

by

C. R. Horton

Assistant Farm Advisor

Issued by the

Merced County Office

of the

Agricultural Extension Service

University of California

March 1948

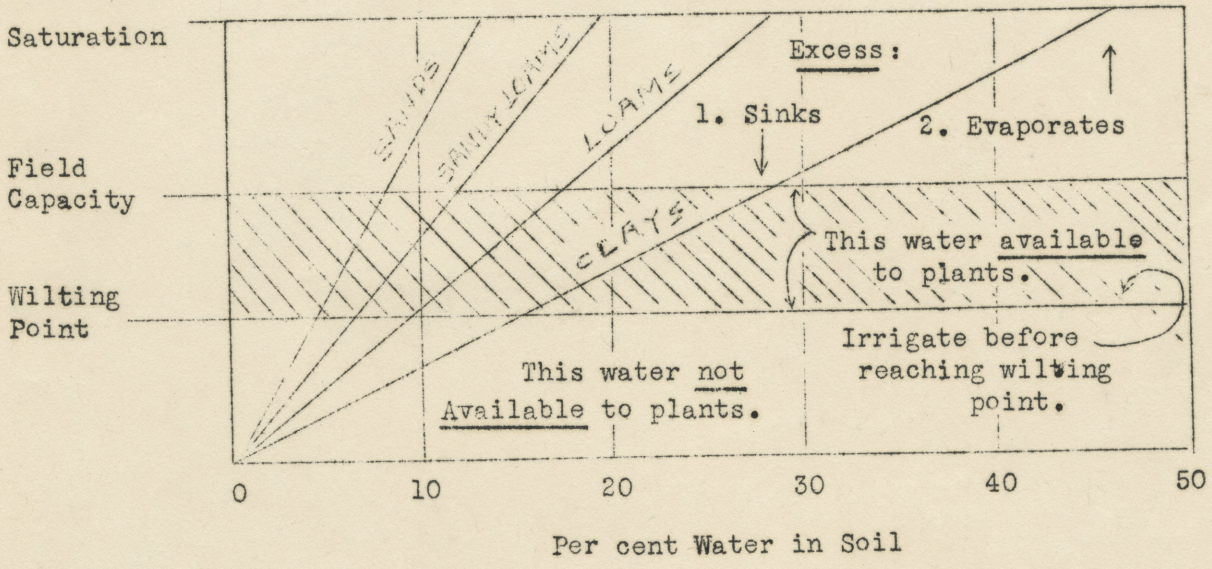
## Depth of Water to be Applied to Bring Soil Moisture from Wilting Point to Field Capacity

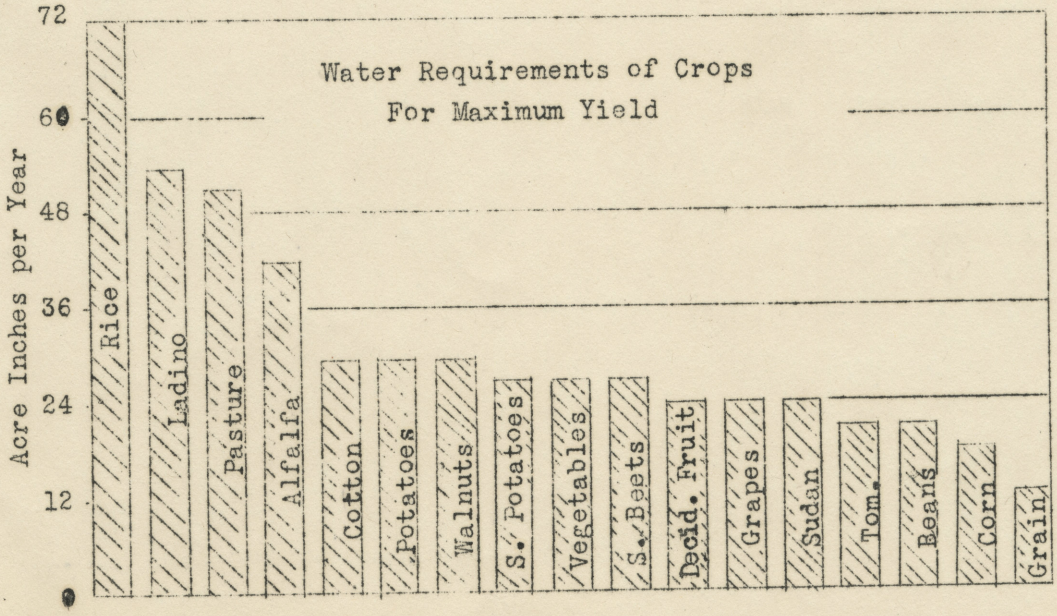
| Root zone | Sandy Soil | Loam Soils | Clay Soils |
|---|---|---|---|
| Less than 2 feet | 1 - 2 inches | 2 - 3 inches | 3 - 4 inches |
| 2 - 4 feet | 2 - 3 " | 4 - 6 " | 6 - 9 " |
| 4 - 8 feet | 4 - 6 " | 8 - 10 " | 10 - 14 " |

## Period Between Irrigations

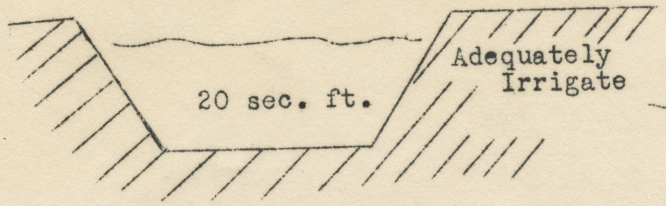
| Crop Type | Depth of Available Water Retained in Root Zone | | | |
|---|---|---|---|---|
| | 1 inch | 3 inches | 6 inches | 12 inches |
| Heavy user | 3 - 6 days | 9 - 18 days | 18 - 36 days | 36 - 72 days |
| Medium user | 4 - 8 " | 12 - 24 " | 24 - 48 " | 48 - 96 " |
| Light user | 6 - 12 " | 18 - 36 " | 36 - 72 " | 72 - 144 " |

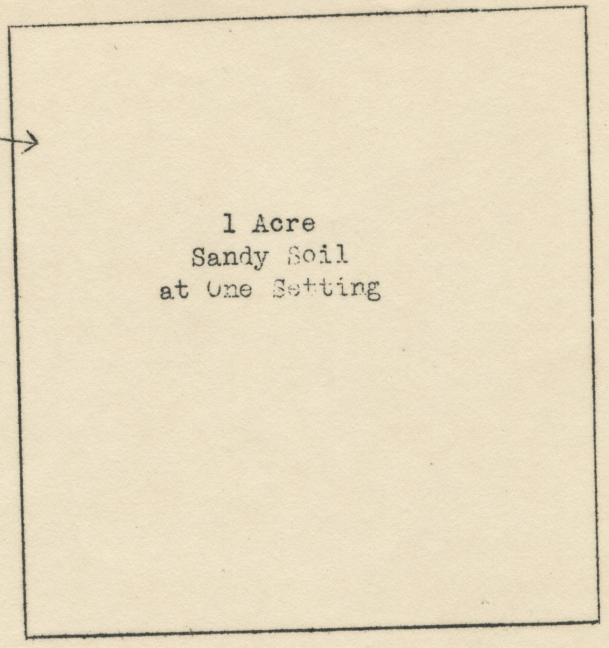
ONE ACRE INCH OF WATER EQUALS 27,154 GALLONS



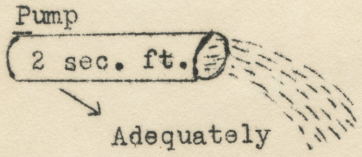
## EFFECT OF REDUCING HEAD



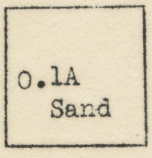



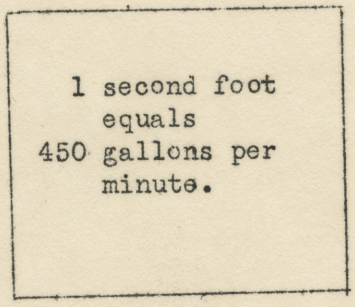

Ratios to Remember

| Soil | Sec. ft. | Irrigates : | Acres/Setting |
|---|---|---|---|
| Sand | 20 | : | 1 |
| Loam | 10 | : | 1 |
| Clay | 2 | : | 1 |

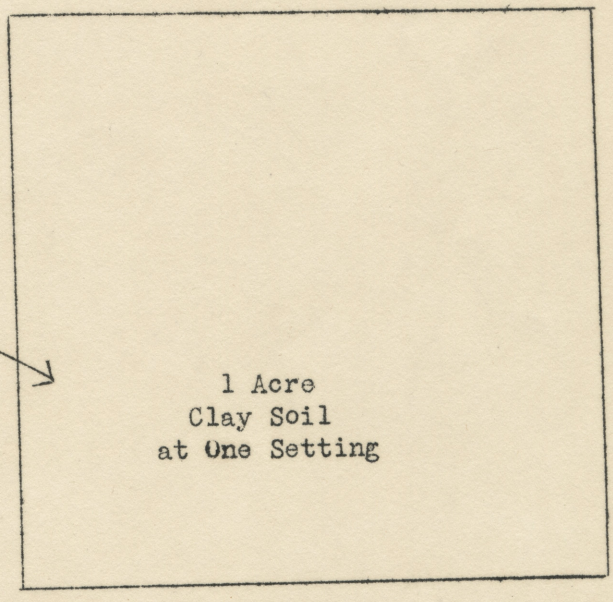



Adequately
Irrigates
Only




BUT

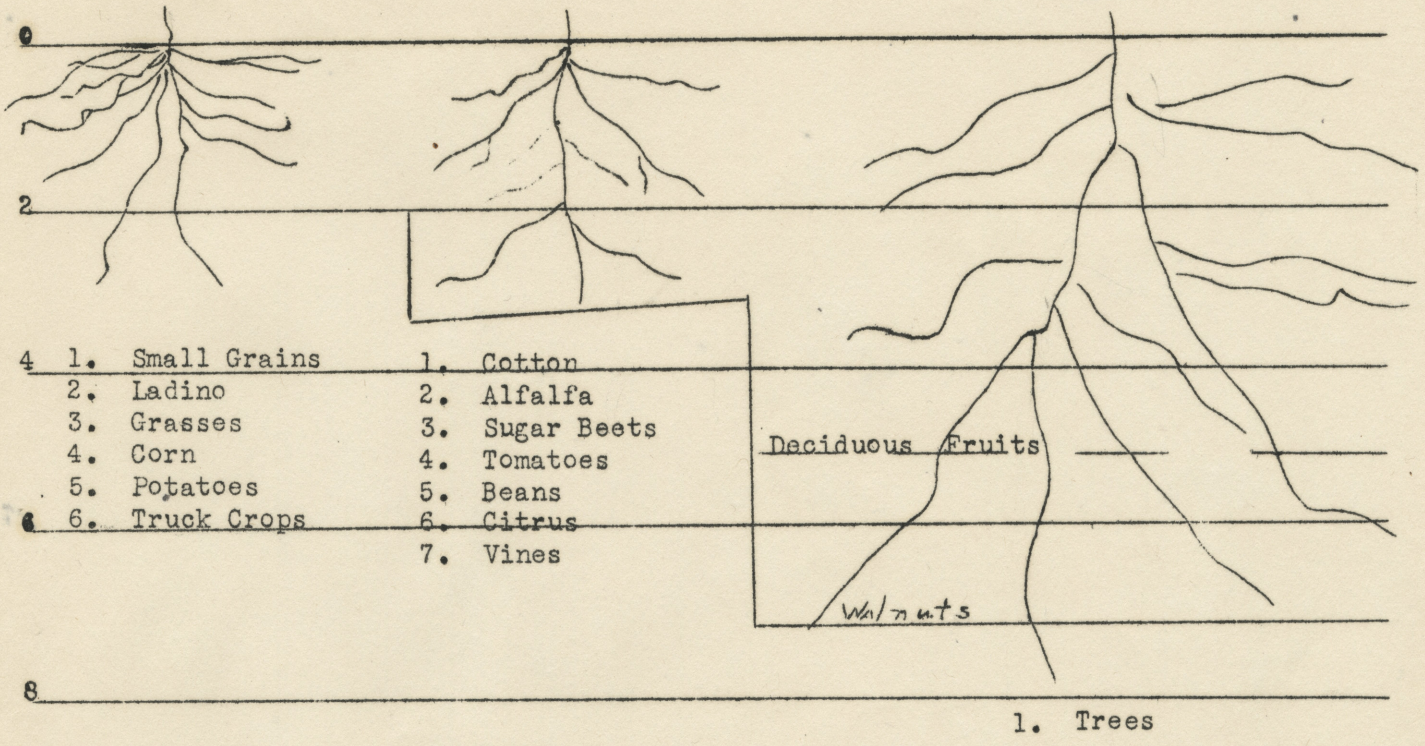


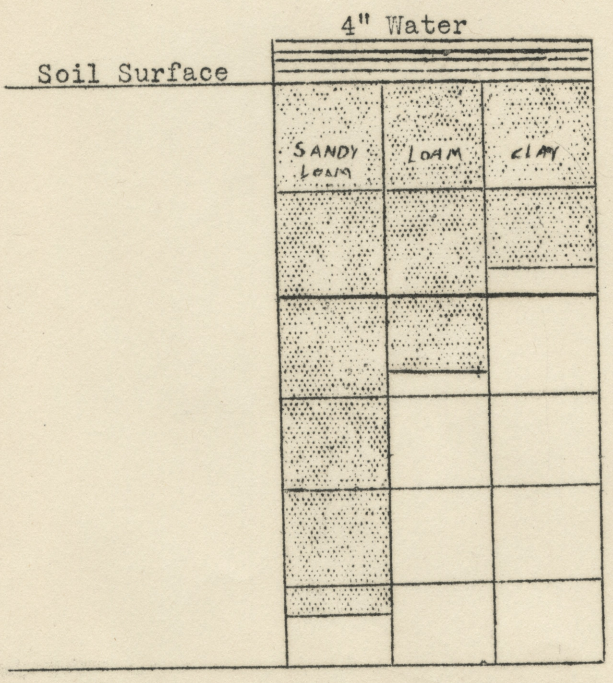

If checks are too large for smaller head of water, they should be made smaller by shortening or narrowing, or both.

If furrows are too long, shorten them if possible. If not increase unit flow per furrow, or cut down number of furrows irrigated at one time.

## ROOT TYPES

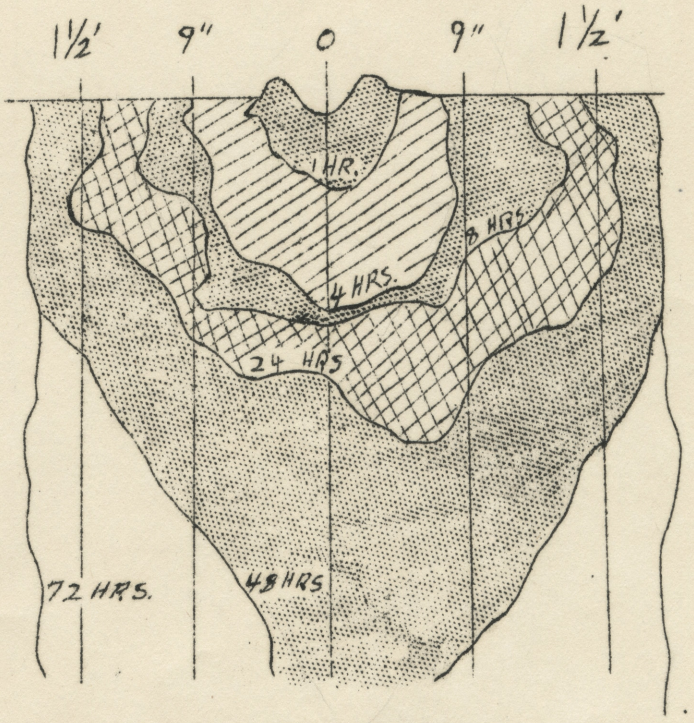
Effective Depths from Which Roots Absorb Water




AVERAGE WATER PENETRATION

After 4"
Irrigation

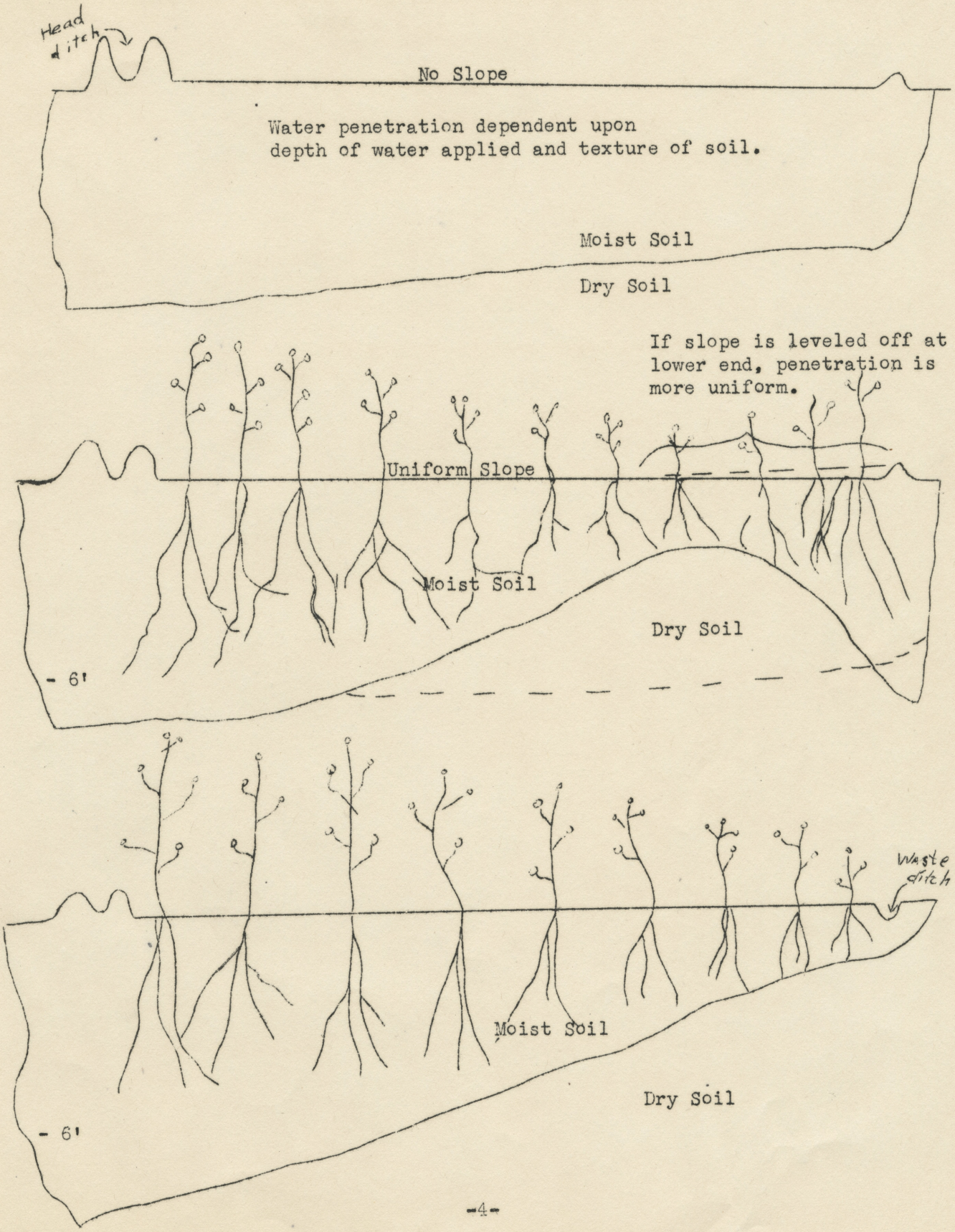



DISTRIBUTION OF WATER

In a well drained clay loam soil, under continuous water application.

## PENETRATION OF WATER

Penetration of water is roughly proportioned to time water is on surface. Here is shown relative root and top growth of cotton on long borders. (Would be similar for furrows.)



## CENTRIFUGAL PUMP FACTS

1. The quantity a centrifugal pump will deliver varies approximately as the speed.
   The head it will deliver varies as the square of the speed.
   The horse power needed varies as the cube of the speed.

   EXAMPLE: At a normal speed of 1750 rpm a pump is designed to deliver 1000 gpm at a total head (suction - lift) of 100' using 40 hp. What will be the result if the pump speed is increased to 1785 rpm?

   ANSWER:
   Speed ratio = 1785 ÷ 1750 = 1.02
   gpm = 1.02 x 1000 = 1020
   Head = $(1.02)^2$ x 100 = 104'
   H.P. = $(1.02)^3$ x 40 = 42.4

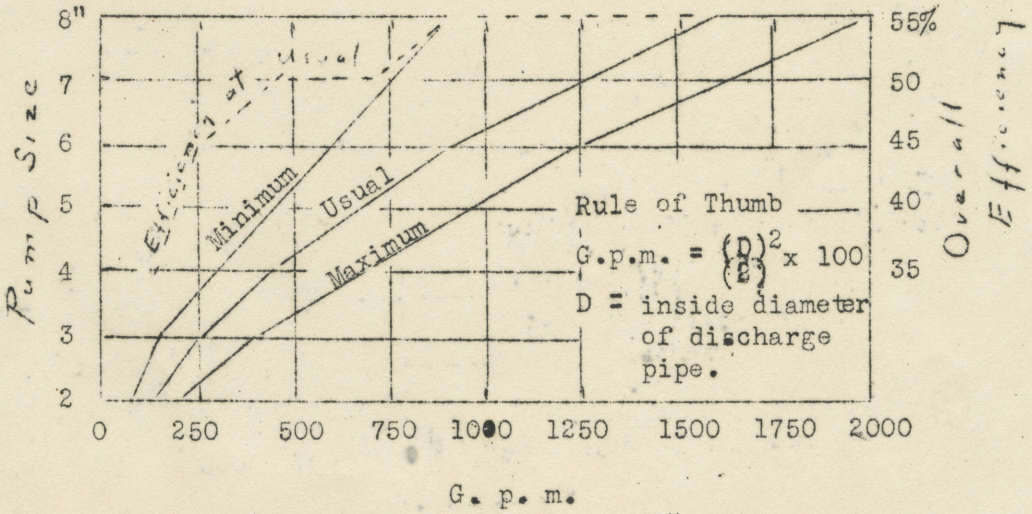
2. Centrifugal pumps must be primed to start.

3. At the time a pump is installed it would probably be most economical to dig a pit as deeply as possible and lower the pump. This would save having to lower it later on during the pumping season when the water table is sure to go down.

4. Under most conditions the pump is best placed at the water table level, the drawdown then becoming the suction lift.

5. Suction lifts as great as 33' at sea level are theoretically possible. However, suction lifts greater than 15' result in decreased efficiency.

6. The greatest efficiency is obtained at the head for which the pump is designed. When operated at same speed, the pump will deliver water at both greater and lesser heads but at a reduced efficiency.




Capacities of Centrifugal Pumps
(Approximate)

## SOME CENTRIFUGAL PUMP "IFS"

If after starting the pump it throws a little water at the first few revolutions, and then churns and fails to discharge more, it is just evidence that the air was not all out of the pump and pipes, or the suction lift too great, or a leaky pipe, or a long suction and insufficient discharge head.

If when first started the pump throws a full stream for a few minutes, and then fails, it is caused by failure of supply, or water receeding in the well below the suction limit, which in a well is best determined by a vacuum gauge placed on the suction elbow of the pump. The remedy for this is to lower the pump, thus reducing the suction lift.

If the pump delivers a full stream of water at the surface, or level of the pump, but fails to pump at a higher discharge point, the speed of the pump is too low.

If the pump starts a full stream, and then the discharge decreases very slowly until the pump fails to deliver any water, it is caused by an air leak at the packing gland.

If the pump delivers a full quantity for a few hours and fails, the speed and water supply being unchanged, the suction pipe or impeller is obstructed.

If when running there is a heavy vibration, the shaft has been sprung, the pump is out of alignment or an obstruction has lodged in one side of the impeller.

If the bearings heat unduly, the belt is unnecessarily tight, the bearings lack oil, or there is an end thrust.

The last "If" is, that if the pump is properly installed, and operating, it will positively operate successfully, as the centrifugal is the most simple, most efficient and long-lived water lifting device manufactured.

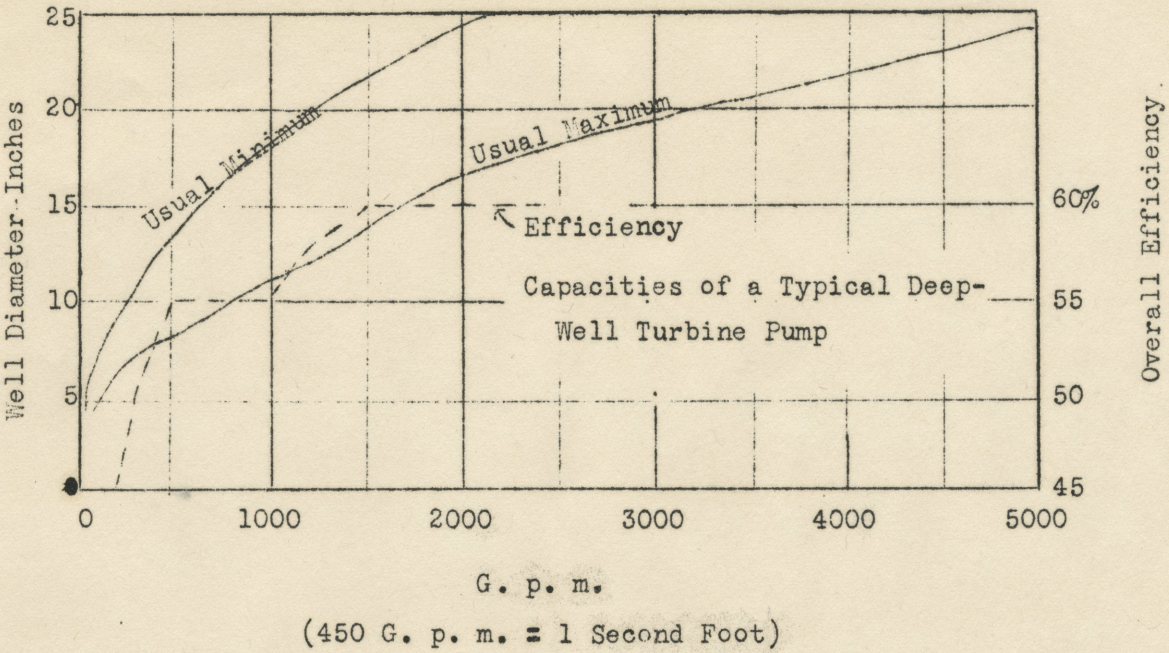
Water should not discharge into a sump or tank near the end of the suction pipe, as there is danger of carrying air down, and into the suction pipe.

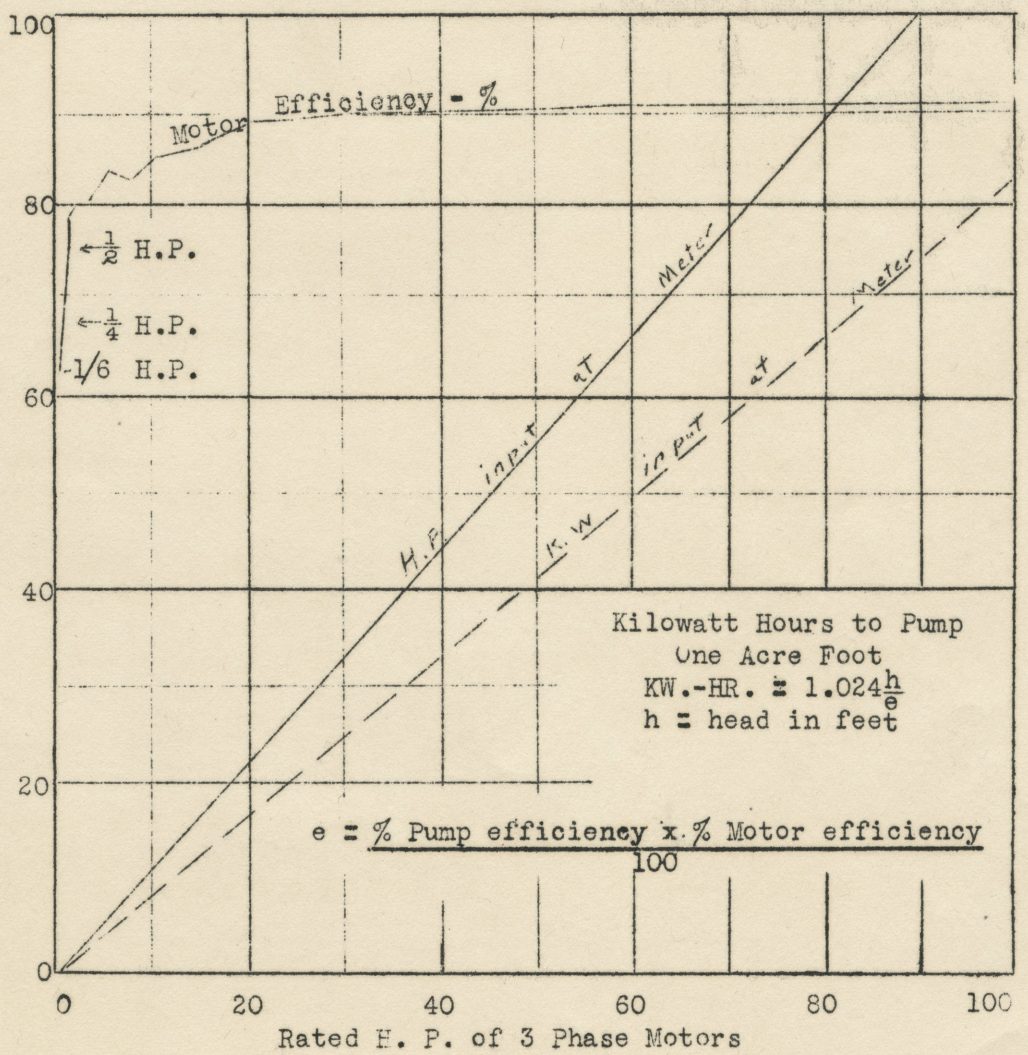
Do not attempt to pump more than the maximum catalog rating of the pump, as that will cause waste of power.

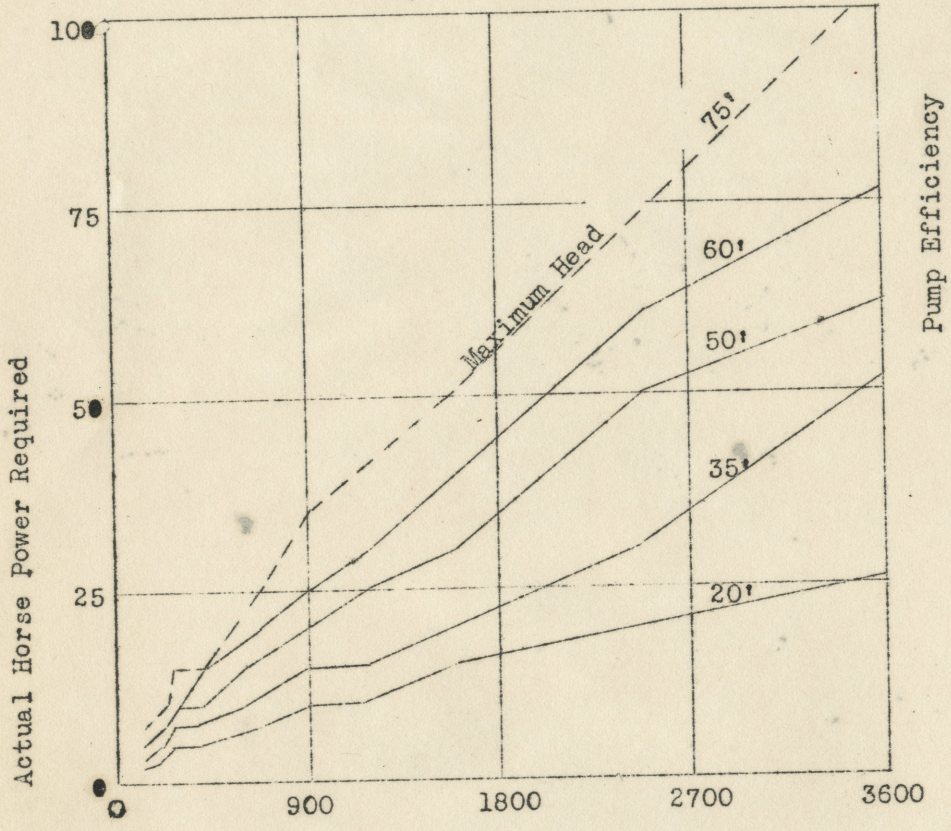
Do not call for help until you are sure none of the above "Ifs" are present.

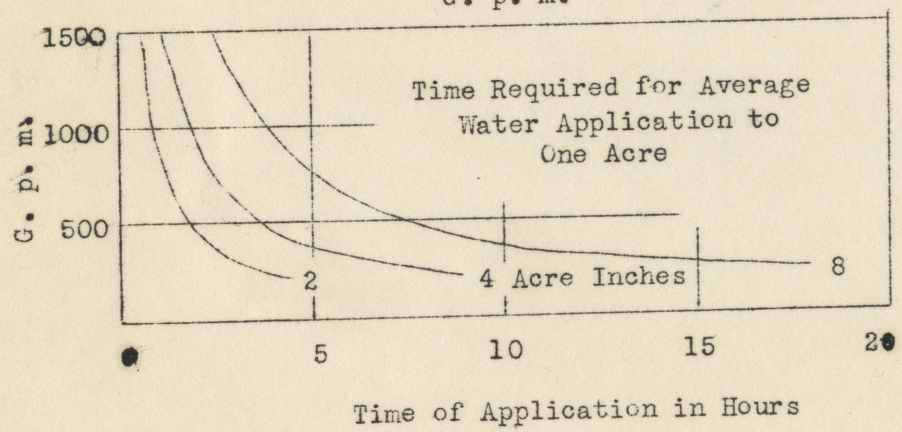
* * * * * *

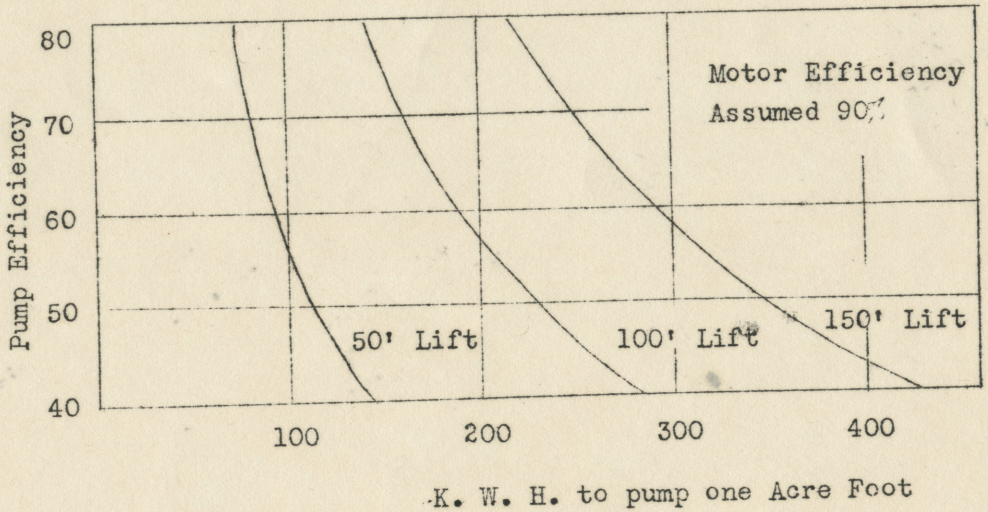
**Discharge**--The discharge of a centrifugal pump is fixed by the speed and the design, and not by the service. At a given speed and head, the discharge is fixed by the design. To change the discharge, either the head must change or the speed must change.


Well Diameter-Inches
25
20
15
10
5
0
1000
2000
3000
4000
5000
Usual Minimum
Usual Maximum
Efficiency
Capacities of a Typical Deep-Well Turbine Pump
60%
55
50
45
Overall Efficiency
G. p. m.
(450 G. p. m. = 1 Second Foot)


100
80
60
40
20
0
Motor Efficiency - %
← 1/2 H.P.
← 1/4 H.P.
1/6 H.P.
H.P. input at Meter
K.W. input at Meter
Kilowatt Hours to Pump One Acre Foot
KW.-HR. = 1.024 h/e
h = head in feet
e = % Pump efficiency x % Motor efficiency / 100
0
20
40
60
80
100
Rated H. P. of 3 Phase Motors



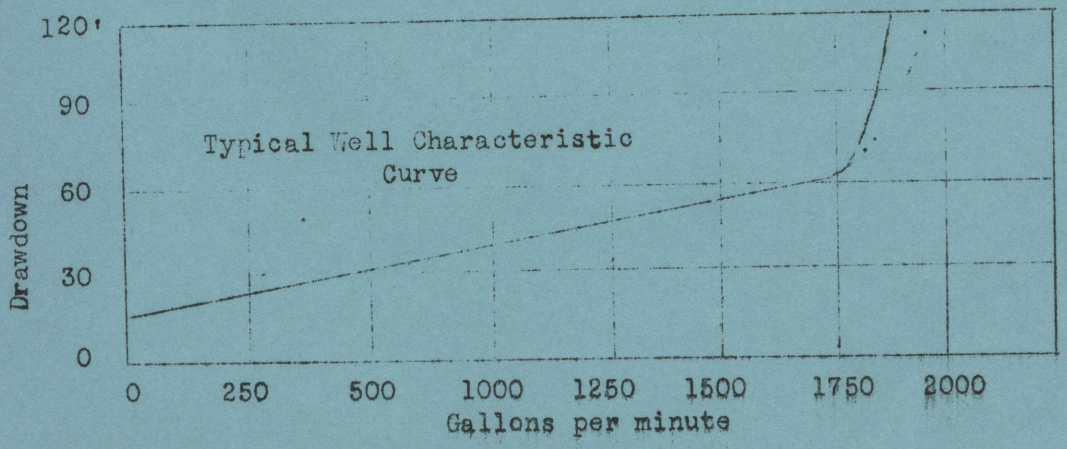

| Pump size | Ave. gpm | R.P.M. of Motor Maximum Head 20' | 35' | 50' | 60' | 75' |
|---|---|---|---|---|---|---|
| 2 | 100 | 1740 | | | 1740 | |
| 2½ | 150 | 1120 | 1120 | 1740 | 1740 | 1740 |
| 3 | 225 | 850 | 1120 | 1740 | 1740 | 1740 |
| 3½ | 300 | 850 | 1120 | 1740 | 1740 | 1740 |
| 4 | 400 | 850 | 1120 | 1120 | 1120 | 1120 |
| 5 | 700 | 850 | | | 1120 | 1120 |
| | 600 | | 1120 | 1120 | | |
| 6 | 900 | 850 | 1120 | 1120 | 1120 | 1120 |
| 7 | 1200 | 695 | 850 | 850 | 850 | 850 |
| 8 | 1600 | 695 | 695 | 850 | 850 | 850 |
| 10 | 2500 | 565 | 695 | 695 | 695 | 850 |
| 12 | 3500 | 565 | 565 | 695 | 695 | 850 |

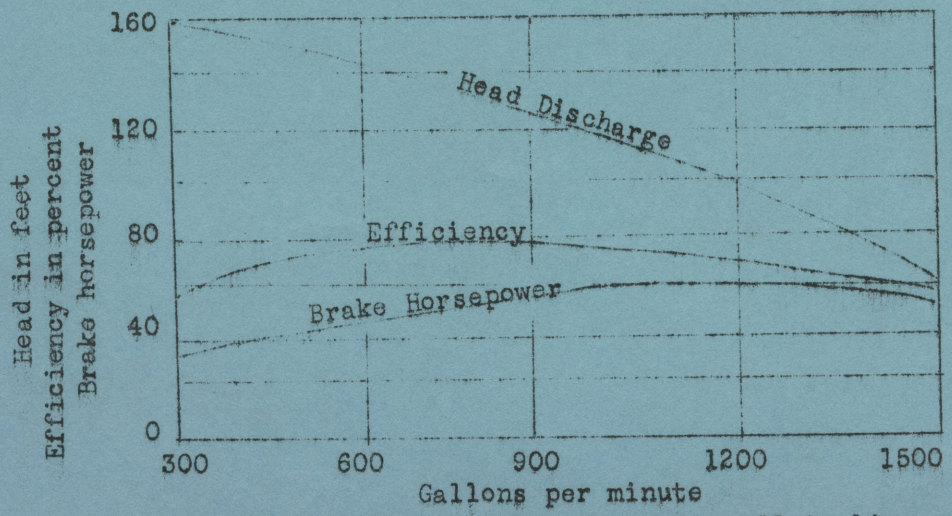
## DEEP-WELL TURBINE PUMPS

For every 15-30 feet of lift, add one stage or bowl.

APPROXIMATE PUMP SIZES AND CAPACITIES

| Outside Diameter of Bowls | Range of Capacity in Gallons per Minute | Minimum Diameter of Well Which Pump Will Enter | Preferred Minimum Diameter of Well |
|---|---|---|---|
| | (Conventional Semi-Enclosed Type of Impeller) | | |
| 5½" | 40 - 200 | 6" | 7" |
| 7¼" | 125 - 500 | 8" | 10" |
| 9¾" | 150 - 750 | 10" | 12" |
| 9 15/16" | 200 - 900 | 11" | 12" |
| 11¼" | 250 - 1350 | 12" | 14" |
| 13¾" | 400 - 2200 | 14" | 16" |
| 15¾" | 300 - 3300 | 16" | 18" |
| 17 3/8" | 600 - 4000 | 18" | 20" |
| 19 3/8" | 750 - 5200 | 20" | [illegible]" |
| 22 3/4" | 1000 - 7000 | 24" | 26" |
| | (Screw or Propeller Type) | | |
| 6 3/8" | 175 - 475 | 7" | 8" |
| 6 3/8" | 200 - 625 | 7" | 10" |
| 7 1/4" | 300 - 1100 | 8" | 10" |
| 9 1/4" | 500 - 2100 | 10" | 12" |
| 11 1/4" | 1000 - 4300 | 12" | 14" |
| 13 1/4" | 1400 - 6500 | 14" | 16" |




Typical characteristic curves for deep-well turbine pump operating at a constant speed.