CALIFORNIA PUBLIC UTILITIES COMMISSION
Water Division

STANDARD PRACTICE FOR

DETERMINATION OF WATER SUPPLY REQUIREMENTS

OF WATER SYSTEMS

Standard Practice U-22

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DETERMINATION OF WATER SUPPLY REQUIREMENTS OF WATER UTILITY SYSTEMS

A - GENERAL

1. This standard practice has been prepared to assist engineers and analysts (staff) of the Water Division in the determination of the water supply requirements of water utility systems[1]. This practice will be useful to analysts in their determination of the adequacy of the water supply sources and facilities of water utilities requesting certificates of public convenience and necessity, for formal and informal complaint proceedings where storage or supply facilities are in question and for better evaluation of the water supply supplemental questionnaire for subdivisions.

B - PURPOSE AND SCOPE

2. The purpose of this standard practice is to set forth more definitive water supply requirement criteria for the various geographical areas and varying usage characteristics of service in California. To more completely accomplish this objective this practice includes definitions and requirements of water systems designed primarily to provide pressure by use of hydropneumatic tanks and by utilizing elevated storage. Also included is a chapter on the particular requirements of summer resort situations. A discussion of standby water sources and supply facilities, their economic feasibility and their desirability as a service concept is contained in the last chapter.

C - TOTAL WATER SUPPLY REQUIREMENT

3. The total water supply requirement is that flow which is required to meet the immediate demands of all customers during the time of maximum system usage. This requirement, usually expressed as gallons per minute and related to demand during the maximum hour, can be met from any one or more of the following sources:

a. Gravity flow from springs and steam diversions.
b. Directly from wells delivering at operating pressures.

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[1] This practice, with the exception of Standby Requirements, was prepared by Associate Engineer John D. Reader. Associate Engineer Colin Garrity was responsible for the preparation of Standby Requirements. This practice was prepared under the general supervision of Senior Engineer D. F. LaHue. Doc. Mgmt #267088.

c. Gravity flow from elevated storage tanks and reservoirs.
d. Booster pumped surface storage, stream flow or spring supplies.

4. The term "total water supply requirement" should not be confused with the actual water supply available for any particular water system. A water system having storage facilities which can store in excess of 10% of the maximum day's demand can normally meet its customers' demands with an available water supply which will be appreciably less than the total water supply requirement. Where the available water supply is limited or seasonal, it will be necessary to provide storage facilities with a capacity large enough to store up to one or more maximum months' demand.

D - ESTIMATING MAXIMUM WATER USE FROM AVAILABLE DATA

5. The demand during the maximum hour for commercial (residential and business) customers at meter rates can usually be estimated at between 1 ¾ and 2 times the gallon per minute average on the day of maximum demand[2]. This maximum demand cannot be accurately estimated from the actual use over a period longer than one such day unless it can be confined to the use during two, three or four days of continuous maximum use.

6. Where only the month of maximum system use is known, the maximum hourly requirement can usually be estimated more accurately by using the empirical formula Q = N x c x f., where Q = flow in gallons per minute, N = number of customers, c = a constant ranging from 2 to 5 for metered systems and from 5 to 9 for flat-rate systems and f =a constant to reflect diversity ranging from 1.8 for ten customers to 0.69 for 100 customers to 0.34 for 500 customers, see Chart No. 2 in General Order No. 103.

7. For the average utility serving the commercial class of customer at flat rates, the maximum hourly demand can usually be estimated at about 1 ½ times the average for the maximum day.

8. Higher ratios of maximum demand to average demand on the day of maximum use can be expected on metered water systems (particularly resort systems) where the charges for service

[2] If a local governmental agency (city or county) imposes a higher flow rate, the Commission-designated flow rate from General Order 103 will govern. See D.90306, May 22, 1979.

are relatively high or where there is known to be a limited supply of water. In such cases in warm climates the maximum demand will often exceed twice the average for the maximum day.

9. A rule of thumb in general use states that the maximum demand for domestic service is two to three times the average daily demand in gallons per minute. Whenever used, the average daily demand should be based upon the maximum month, and most water systems in California require about three times such average. This method of estimating maximum demand is not recommended where any degree of accuracy is required.

10. The use of "c" factors between 2 and 5 for fully metered systems and between 5 and 9 for flat rate systems should not be too rigidly applied as the field data indicates that the demands of metered systems may require the use of a "c" factor in excess of 5 and the demands of flat rate systems may require the use of a very low "c" factor. The latter is particularly true of resort water systems. The demands on metered systems and on flat rate systems are not too different, as the customers on either system use their facilities to capacity during certain peak use hours. The tendency of using more water on a flat rate system is more likely to extend the duration of the period of peak demand than to increase the peak demand itself very measurably.

E - THE PRESSURE SYSTEM

11. The term pressure system as used here, and in the water works field generally, refers to the distribution system which maintains pressure in the system by means of pumps. These pumps can be well pumps, booster pumps or a combination thereof.

12. Usually the pressure system has one or more steel pressure tanks containing an air cushion varying from about one half to one quarter of the tank capacity. This air cushion prevents the pump or pumps from having to operate continuously or from turning on and off too frequently. Some systems having numerous well or booster pumps have been designed to operate without using pressure tanks by having one or more pumps run constantly to maintain pressure during periods of minimum use and automatic controls on other pumps to activate them as necessary to maintain the system pressure as the demand increases.

13. Where hydropneumatic tanks (pressure tanks with air cushions) are to be used some means

of replenishing the air must be provided to replace the air absorbed. Where this cannot be accomplished with well pumps by utilizing the air in the pump column it is usually necessary to install an air compressor or air charger for each hydropneumatic tank.

14. The supply of water to be made available for a pressure system should be designed to meet the requirements for the maximum hourly demands. The well or other source of supply must be capable of delivering continuously this maximum demand for at least two hours. The water supply and related facilities must be adequate to deliver the total water supply requirement of the system. This requirement can usually be determined from the formula Q = N x c x f. or taken directly from Chart 2 in General Order 103. If additional demands of large users are known to exist these should be added to the total demand obtained from the formula or chart.

F - GENERAL RULES FOR DESIGN

15. The system pumping capacity should usually be about 1 ¼ times the total water supply requirement in order to permit the pumps to restore water and pressure in the tanks at the same time as it is meeting the maximum system demand. This usually results in providing a reasonable safety factor because any centrifugal pump will deliver more water at the lower end of the pressure range than it will average within the pressure range.

16. The size of pressure tanks can normally be determined from two informal rules using the larger tank capacity obtained therefrom. These rules are applicable to systems that operate approximately between 30 and 60 pounds per square inch. For systems (or tanks) operating at higher pressures, the tanks and their capacities should be carefully designed, particularly where the allowable pressure range is small. These rules are as follows:

a. Allow 40 gallons per average domestic water customer.
b. Multiply the pumping capacity in gallons per minute by 15 to obtain the tank size in gallons.

17. As a general rule, a pressure system should not be designed to operate for more than one year with a single well facility. Any pressure system should be able to meet its average daily summertime demand when its largest pumping facility is out of service.

G - EXAMPLE OF DESIGN

18. The following is an example of the design of the water supply, pumping and pressure tank requirements for a pressure system to serve 500 customers within the next five year period in an area where the climatic and water use experience indicates that a "c" factor of 6 should be applied to the formula shown on Chart 2 of General Order 103.

Example - Pressure System Design

Step 1 - Determine the total water supply requirement necessary to meet the maximum demand.

$Q = Ncf = (500)(6)(.35) = 1{,}050$ gallons per minute

Therefore: Average daily maximum demand - $\frac{1{,}050}{1.75} = 600$ gpm

Step 2 - Determine the number of wells or supply sources.

As this system may have to serve this area for five or more years, there should be a minimum of two pumping facilities.

Step 3 - Determination of required pump capacity.

Using two sources of supply and two pumping facilities each well and pump should be capable of producing the following.

$$\left(\frac{1{,}050}{2}\right)(1.25) = 657 \text{ gpm each}$$

This capacity would also be adequate to meet the average daily maximum demand if one pump were out of service.

Step 4 - Determination of required pressure tank capacity.

Using two equal pumping facilities and assuming that each serves half of the customers, each tank should have the following capacity.

Rule (a) $40\,(250) = 10{,}000$ gallons

Rule (b) $15\,(657) = 9{,}850$ gallons

Use 10,000 gallons as the required capacity of each tank.

Step 5 - Check pumping frequency during maximum demand.

If pressures at the tank are set to operate between 40 and 60 psi and the pressure tanks are adjusted to be 40% full of water at 40 psi, the quantity of water available to the system from the tanks between these pressure limits is:

From $P_1V_1 = P_2V_2$ (Assumes constant temperature)

Where:

$P_1 = 40 + 15 = 55$ psia

$P_2 = 60 + 15 = 75$ psia

$V_1 = 6{,}000$ gals. (air)

$$V_2 = \frac{P_1}{P_2}(V_1) = \frac{55}{75}(6{,}000) = 4{,}400 \text{ gallons (air)}$$

Therefore: Water available to system.

2 (6,000-4,400) = 3,200 gallons

Period pump off during maximum demand.

$$\frac{3{,}200}{1{,}050} = 3.0 + \text{minutes}$$

Period pump on during maximum demand.

$$x = \frac{3{,}200}{2(657)} + \frac{1{,}050x}{2(657)}$$

$0.2x = 2.44$

Therefore: $x = 12.2$ minutes

H - SYSTEMS WITH ELEVATED STORAGE

19. As used here, elevated storage includes only those portions of the storage facilities of a system which are located such that water will flow by gravity from such reservoirs or tanks to the customers' premises and provide not less than minimum operating pressures at their respective service connections.

20. The quantity of elevated storage may vary from negligible storage to help meet the maximum hour demand to storage capable of meeting the requirements for several days or months.

21. In determining the quantity of elevated storage available to a system, only storage directly connected to the distribution system should be considered. If collection storage is directly connected to the distribution system by means of a long or small diameter transmission main, this is normally considered to be the supply available to the system and, therefore, it is given no value as distribution storage. Where the collection storage and its related pipeline facilities are adequate to meet the maximum hourly system demands, such storage should be considered as distribution storage.

22. Where a system has elevated storage of 5% or less of its maximum day requirement, the water supply should be designed to meet the total water supply requirements of the system just as though it were a pressure system, and provision should be made for standby sources of water supply.

23. For systems having storage exceeding 5% of the maximum day requirement, such storage is useful in meeting a portion of the maximum hourly demand of the system. The rate of flow available from storage is usually determined by dividing the storage in gallons by 240 minutes which represents the flow available from storage for four hours at the maximum demand. Four hours have been used under the assumption that most systems have two 2-hour periods of peak or near peak use on a maximum use day and that usually it is not possible for the storage to be replenished during the time interval between these two peaks.

24. The size and length of pipeline facilities from storage and the allowable pressure drop should be checked to determine the pipeline capacity available and if found to be less than that available from storage for four hours of maximum use the lesser figure should be used.

25. It is also necessary to determine or estimate the average use on the maximum use day and to be careful not to reduce the size of pumping facilities below the minimum necessary to provide for the maximum day and any growth anticipated within the next few years.

I - EXAMPLE OF DESIGN

26. Shown following is an example of the design of the water supply and storage facilities for a water system having elevated storage adequate to store approximately one fourth of the maximum day's use to serve 500 customers in an area where the climatic and water use experience indicates that a "c" factor of 4.5 should be applied to the formula shown on Chart 2 of General Order 103. The pipeline from the storage tank in this example is 1,000 feet of 6-inch pipe. A maximum daily water use of 1,200 gallons per customer has been used.

Example - Water System With Elevated Storage

Step 1 - Determine the total water supply requirement to meet the maximum demand:

(a) By using formula Q = Ncf:

$$Q = (500)\ (4.5)\ (.35) = 790 \text{ gallons per minute}$$

(b) From recorded maximum day use;

$$\text{Max. Hr. Rate} = \frac{\text{Max. Day}}{1{,}440} \text{ (Demand factor)}$$

$$= \frac{600{,}000}{1{,}440} (1.75) = 730 \text{ gallons per minute}$$

Use 750 gallons per minute.

Step 2 - Determine the portion of the total demand available from storage:

(a) Storage available for four hours of peak usage.

$$\frac{150{,}000}{240} = 625 \text{ gallons per minute (gpm)}$$

(b) Water available at 30 psi.

Through 1,000 feet of 6-inch steel pipe and limiting the pressure loss to approximately 10 psi;

From friction loss table,

500 to 600 gpm

Use 550 gpm.

Take lesser of figures from (a) and (b) for Third step.

Step 3 - Determine required pump capacity:

Min. pump capacity to meet maximum day = $\frac{750}{1.75}$ = 430 gpm

Portion of maximum demand necessary directly from source of supply = 750-550 = 200 gpm

Conclusion - Two pumping units, one of 200 gpm and the other of 300 gpm capacity, would be adequate as the larger unit in conjunction with storage could meet the maximum demand and still provide some additional capacity for growth while the smaller unit could be used when the demands on the system are low as well as being of adequate capacity to maintain water service on a standby basis if the larger unit should fail. Both of these pumps would have to be available to meet the maximum day requirements. Provision for growth should be studied separately in those cases where it is possible to enlarge the pumping facilities in order to avoid the necessity of early pump replacement.

J - THE SUMMER RESORT WATER SYSTEM

27. A summer resort water system is one which serves the majority of its customers during the summer season and would include any water system which has its maximum demands on the long summer weekends such as result from the Fourth of July and Labor Day holidays. Some such systems may also operate during the winter season but they should be designed primarily to meet summer demands as such usage is controlling.

28. Because most resort systems have great fluctuations in daily demands and are often situated where water supplies are limited, it is usually most economical to provide relatively large storage facilities to collect water during periods of low water use to meet the demands of long holiday weekends.

29. The water use and the maximum demands of summer resort systems are generally less than those of permanent communities located in comparable areas. This is largely due to the fact that garden irrigation is usually very limited in resort areas and there is greater diversity of use.

30. In addition to meeting its maximum hourly demand, the resort system must meet a series of maximum daily demands. When a holiday such as the Fourth of July falls on a Thursday or a Tuesday, a four-day period of maximum daily demands will often result. In the case of such a four-day period ending on a Tuesday, the supply will have to be adequate to meet the weekday requirements and replenish the storage for the next weekend in the 70 to 75 hours intervening. On a metered resort water system, the maximum daily water use is usually only about one half of the water use in a permanent community under the same climatic conditions. As a general guide this maximum daily water use per customer seems to vary between 300 and 600 gallons.

K - REQUIRED WATER SUPPLY

31. The supply of water to be made available for a summer resort water system adequate to serve 100 customers whose maximum daily water use is 500 gallons per customer under climatic and other conditions which warrant the use of a "c" factor of 3.0 are developed for several representative situations in the following paragraphs in this section.

32. If the resort is served by means of a pressure system the maximum demand must be met directly from the available water supply. From the formula Q = Ncf, the total water supply requirement would be (100)(3)(0.7) = 210 gallons per minute. The use of 1 ½ to 2 times the maximum day's consumption is not accurate here because it does not give consideration to diversity when applied to a small system.

33. If the system has storage equal to one maximum day's use, the available water supply must be large enough to replenish this storage during the nighttime hours. If it is assumed that no water is used during the nighttime hours, that there are 10 such nighttime hours and that the storage were depleted by 10 p.m., this resort system would require the following water supply:

Maximum daily requirement = (100 customers)(500 gallons per customer) = 50,000 gallons
Storage capacity = 50,000 gallons
Water supply necessary to fill storage tanks in 10 hours - $\frac{50{,}000 \text{ gallons}}{(10 \text{ hours})(60 \text{ minutes per hour})}$ = 83 gpm

Therefore: Required water supply is 83 gallons per minute.

34. If the system has storage equal to three maximum days' use, the supply need only be large enough to meet the average day requirement during the maximum use month. The average day requirement during the maximum use month is usually 60 to 80% of the maximum day requirement unless the resort is not greatly affected by the usual influx of weekend vacationers. If the resort operates to capacity for several weeks during the summer, the average day during the maximum use month may be 80 to 90% of the maximum day requirement. This system could successfully meet a four-day maximum use weekend with a

continuous water supply of 28 gpm as follows:

Maximum daily requirement = (100)(500) = 50,000 gallons
Storage capacity = (3)(50,000) = 150,000 gallons
Average day requirement during maximum month
(0.8)(50,000) = 40,000 gallons per day
or, $\frac{40,000}{1,440}$ = 28 gallons per minute.

During the first three days of the four-day weekend the entire storage would be used except that this supply would replenish the storage as follows:

(3)(40,000) = 120,000 gallons

35. In those cases where the storage is larger than necessary to meet daily and weekend demands but not large enough to provide seasonal storage, the supply must be checked very carefully. Such situations will normally occur when water systems have storage capacities which fall between those necessary to meet the needs of three maximum days' use and three maximum months' use. The following is an example for such a water system assuming it had storage capacity equal to one maximum month's use.

Maximum daily requirement = (100)(500) = 50,000 gallons
Storage capacity = (0.8)(30)(50,000) = 1,200,000 gallons
Average daily requirement during maximum months
(0.8)(50,000) = 40,000 gallons per day

As we know from the previous example that 28 gallons per minute will meet the needs of the average day during the maximum month assuming no seepage or evaporation losses are incurred, we can assume that any additional storage will reduce the water required from the source of supply. If this storage capacity is applied to the requirements of five summer months, by reducing this storage to gallons per minute and allowing 10% for seepage and evaporation losses, the 28-gpm requirement is reduced as follows:

$$28 - \frac{(1{,}200{,}000)(0.90)}{(5)(1{,}440)(30)} = 28 - 5 = 23 \text{ gpm}$$

36. If the system has storage equal to the requirements of four maximum use months, the supply need only be large enough to meet the average daily requirement. Unless this were a resort operated without weekend peak demands, the average day is approximately one fourth to one third of the maximum day. However, where a system has such large storage facilities some provision may have to be made for water losses by seepage and evaporation. Such a system can be checked as follows:

Maximum daily requirement = (100) (500) = 50,000
Average daily requirement during maximum months
(0.8)(50,000) = 40,000 gallons per day
Storage capacity = (4)(30)(40,000) = 4,800,000 gallons
Average daily requirement

$$\frac{50{,}000}{3} = 16{,}600 \text{ gallons per day}$$

Allowing 10% for losses from seepage and evaporation, the water supply requirement would be as follows:

$$\frac{(16{,}600)(1.10)}{1{,}440} = 12.8 \text{ gallons per minute.}$$

37. This supply of approximately 13 gallons per minute for a typical summer distribution of the monthly requirements can be checked as follows:

Month	May	June	July	August	Sept.	Oct.
% of Max. Month	38%	72%	100%	96%	58%	23%
(Use in M. gallon increased 10% to allow for losses)						
Storage Full 4,800 M.G.		"	"	"	"	"
Storage 4,800 - 500 + 560 = 4,470 M.G.	"	"	"	"	"	"
Storage 4,800 - 950 + 560 = 4,470 M.G.	"	"	"	"	"	"
Storage 4,470 - 1,320 + 560 = 3,710 M.G.	"	"	"	"	"	"
Storage 3.710 - 1,270 + 560 = 3,000 M.G.	"	"	"	"	"	"
Storage 3,000 - 770 + 560 = 2,790 M.G.	"	"	"	"	"	"

38. The examples previously outlined should assist staff engineers in evaluating the water supplies of existing or proposed water systems. It is of particular interest to point out that the water supply necessary to serve 100 customers under the same climatic conditions for the water systems outlined above vary from about 15 to 210 gallons per minute depending upon the amount of storage on the system.

39. Every system should be designed to allow for growth or some other factor of safety. Unless the area is growing very rapidly a safety factor of 20% is usually adequate.

40. As the type of system to be built is usually determined by the supply available, the following examples may be helpful in determining the storage necessary when the quantity of water available is known.

41. The following are examples of the design of summer resort water systems to serve 100 customers having maximum daily water requirements of 500 gallons per customer with three different water supplies available.

Example A:

With 50 gpm available

Total water supply requirement

Q = Ncf = (100)(3)(0.7) = 210 gpm

Water supply necessary from storage

210-50 = 160 gpm

Maximum daily water requirements

(100)(500) = 50,000 gallons

Minimum supply necessary for maximum day

$$\frac{50{,}000}{1{,}400} = 35 \text{ gpm}$$

Thus, the 50 gpm are adequate to permit less than one maximum day's storage.

Storage necessary to meet four peak use hours

(160)(240) = 38,400 gallons.

Therefore storage necessary to meet four peak use hours and a 20%

growth or safety factor.

[1.2(210) - 50][240] = (202)(240) = 48,500 gallons

Use 50,000 gallons.

Example B:

With 100 gpm available

Total water supply requirement = 210 gpm.

Therefore storage necessary to meet four peak use hours and a 20% growth or safety factor.

[1.2(210) – 100][240] = (152)(240) = 36,500 gallons

Use 40,000 gallons.

Example C:

With 150 gpm available

Total water supply requirement = 210 gpm.

Therefore storage necessary to meet four peak use hours and a 20% growth or safety factor.

[1.2(210) - 150][240] = (102)(240) = 24,500 gallons

Use 25,000 gallons.

42. If the same system were being designed to serve 500 summer resort customers, the total water supply requirement could be checked by using two methods as follows:

Total water supply requirement

a. From Q = Ncf,

$= (500)(3)^{1}(0.35) - 525$ gpm.

b. From maximum day requirement,

$\frac{(250,000)}{1,440}(3.0)^{2} = 520$ gpm

Note 1. "c" factor for resort systems one half of 6 for permanent residents.

Note 2. See ratio of maximum hour to average hour on maximum day from tabulation in Chapter 2.

L - CONCLUSIONS

43. The maximum hourly demands of flat rate domestic water systems in permanent communities can be fairly accurately estimated at 1 ½ times the average demand on the maximum day. The use of this method requires some means of recording the total use on the maximum day.

44. The maximum hourly demand of metered domestic water systems in permanent communities is normally 1 ¾ to 2 times the average demand on the maximum day.

45. Low daily and hourly maximum demands appear to be caused as much, or more, by high tariff quantity rates as by climatic conditions.

46. The maximum hourly and daily demands of water systems in resort or seasonal communities can usually be estimated at about one half of the demands of a similar system for a permanent community under the same climatic conditions.

47. It does not appear to be practical to try to accurately estimate the maximum hourly demand of resort systems from the maximum day's use as this fluctuates due to variations in the intensity and duration of the maximum demands. From the limited data obtained, it would appear that for flat rate resort systems the maximum hourly demand might be roughly 2 to 2 ½ times the average demand on the maximum day and for metered resort systems the maximum hourly demand might be roughly 2 ¾ to 4 times the average demand on the maximum day.

48. Unless some consideration is given to the reduced daily and hourly maximum demands of the usual resort water system, the requirements of Chart 2 in General Order No. 103 will be greater than necessary to provide adequate service.

M - STANDBY REQUIREMENTS

49. Continuity of service is a requisite of good water service and therefore should be given serious consideration. The matter of degree of continuity, and how to achieve this, is the concern of this chapter. Generally, the larger utilities (1,000 customers or more) will not be concerned with this problem because such a utility generally will have at least three sources of supply and, therefore, will ordinarily be able to provide continuous service although possibly at reduced pressures or limited usage. Even for such systems, however, consideration should be given to an alternate source of power supply to assure continuity of service.

50. This section will not be concerned with the standby requirements of special customers, such as hospitals, dairies or food processing plants, other than to point out that such customers do exist and that in determining the adequacy of standby equipment of a system, a determination of the effect of such special customers should be made.

a. Minimum service during an emergency should be maintained at a level that will at least afford some household domestic service. It may not always be economically feasible to do this, but a careful study should be made before rejecting this possibility.

b. The type of system most critical in the furnishing of continuous service is that system which uses one well as a source of supply. As the number of wells increase, the situation becomes less critical, especially if more than one source of power supply is used to pump water from the wells. A system having only one well is generally very small, supplying service to no more than 300 customers and possibly as few as 25 customers. To provide standby on such a system, special consideration should be given to the most economical means.

N - TYPES OF WATER SYSTEM FACILITIES

51. The following are types of water system facilities which may provide some reasonable degree of standby protection if properly designated. Comments relative to the merits of each are listed.

a. Inter-connection with another water system of source of supply approved by

the State Department of Public Health:

(1) Possibly, the most economical method of furnishing standby initially.

(2) Requires the least maintenance.

(3) Can often be readily arranged because of the mutual assistance aspects as between utilities.

(4) If not reciprocal arrangement, it can be equipped with a pressure regulating valve so that the supply is automatically available.

b. Surface storage with booster:

(1) Sizing of well pump may be reduced since peaking can be done with water in tank and booster pump.

(2) Allows water from another source to be used in system by pumping such water into surface storage tanks.

(3) Can be readily equipped with an alternate source of power, such as a portable gasoline power booster pump.

c. Elevated storage:

(1) Sizing of well pump may be reduced since peaking can be done with water in such tank.

d. Additional well and related pumping equipment:

(1) If primarily provided for standby purposes and when situated close to the main well supply, only one pressure tank is necessary and the operation can be made automatic by using lower turn-on pressure limit for standby well.

(2) If initial well is to be utilized to near its capacity to supply the system requirements, an additional well provided could probably be powered by gas, diesel or natural gas engine, thereby affording the greatest degree of continuity.

52. The inter-connection arrangement of providing continuity of service will be ignored in the following discussion because most of the factors influencing the cost of such installations are indeterminate when discussion is as general as here attempted.

53. Of the various alternatives mentioned in Paragraph 5, the most reliable and most

economical method to provide limited standby is elevated storage if the terrain is such as to allow this type of storage to be built without the necessity of a tank tower. The additional cost for a minimum standby service would only be approximately $3,500 for a 100-customer system over that required for a well pump and pressure tank installation, since for the former the pressure tank is unnecessary and the well pump size may be reduced because the storage would aid in meeting the peaking requirements of such a system. The probability is that there would be no additional maintenance and operation expense because the demand charge for the power would be lower and would offset additional maintenance expense on the larger tank. It is estimated that the increase in the unit revenue requirement for this example would be approximately 35 cents per customer per month.

54. The surface storage method is considered to be the next most economical. The cost of additional plant is not much more than for the elevated storage arrangement, discussed above, approximately $4,000 for the same size system but operating and maintenance costs would definitely be increased due to the necessity of two pumps.

55. The final method discussed in Paragraph 5, the utilization of an additional well, is the most adequate method of insuring continuity of service, especially when equipped with an alternate source of power. However, it may turn out to be the most expensive, depending upon the availability of surface water. The use of the alternate power source would definitely make it so.