INTERIM REPORT OF GROUND WATER CONDITIONS at TARAWA TERRACE CAMP LEJEUNE, N. C.

by

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Resident Officer in Charge of Construction
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Camp Lejeune, N. C.

Dear Sir:

This report is submitted at your request and is related to Contract NBy-7595, dated September 11, 1958.

It is an interim report that summarizes the results of recent test drilling in relation to raw-water supply in the Tarawa Terrace area. The report embodies much material that is to be included in the final report under the above contract.

Sincerely yours,

Harry E. LeGrand
Consulting Geologist

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Encls. - in triplicate

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TARAWA TERRACE AREA

General Comments

The first wells were drilled at Tarawa Terrace in 1951, and since that time seven wells have been in operation intermittently. Some driller's logs and other records are available, but these records have only limited use for the following reasons. Three sets of well numbers have been used - the driller's numbers, the site numbers, and the present numbers. Thus far, it has not been possible to relate these numbers so that a specific well record can be identified with a particular well. Before the test-drilling program started, less was known about the ground-water situation than at other places on the Base. Knowledge has improved with the drilling of three test holes, but information is still not adequate to clearly state the type of additional wells that would be most suitable and the expected yield from each.

The character of the rock materials and their water-bearing properties along Lejeune Boulevard may be summed up as follows:

(1) From the land surface to a depth of about 50 to 60 feet a white to light gray medium-grained sand is the chief material.

(2) Between depths of about 50 to 85 feet one or more limestone beds occur. The limestone varies in degree of hardness and is commonly less than 20 feet thick.

(3) Sand underlies the limestone zone and extends to a depth of more than 200 feet. The sand varies from fine to very fine in grain size.

Of the five wells along Lejeune Boulevard, only well No. 1 now furnishes more than 100 gallons a minute. Most of the water from the five wells comes from depths varying from 50 to 100 feet. The water is typically hard and contains moderate amounts of iron and hydrogen sulfide. Wells Nos. 6 and 7 on the Bell Fork Road need separate consideration. It is thought that these two wells draw much of their water from depths between 150 and 200 feet. At any rate, the yields are relatively good, but the chemical quality is very poor. Water from both wells contains more than 4 parts per million of hydrogen sulfide. Moreover, well No. 6 has nearly 200 parts per million of chloride and well No. 7 nearly 50 parts. Water from these two wells is not suited for present treatment facilities, and in no case can this water be treated economically.

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Well Construction

The type of well most suitable for use is known for most areas, but this is not the case at Tarawa Terrace. In fact, it is proper to give serious thought to each of the following types of wells:

(1) well points

(2) gravel-wall wells

(3) regular screened wells

(4) open-end tubular wells

Although water supplies are not commonly developed from well points in the Coastal Plain, the shallow, medium-to-coarse sands that occur at Tarawa Terrace are well suited to this type of well construction. Shallow, thirty or thirty-five foot wells, extending along existing raw-water lines on Lejeune Boulevard and Bell Fork Road, can furnish much more than the total anticipated supply at Tarawa Terrace. Advantages of this type of well supply include low initial cost and water that is soft, low in dissolved mineral matter, and free from salt-water encroachment. Disadvantages include frequent maintenance inspections and repairs and all problems that result from the corrosiveness of the water. The pH of the shallow water may vary between 5.5 and 6.5, and its corrosive tendency is certain. The well points would deteriorate within several years. Raw-water lines would be subject to corrosion, and the pick-up of iron before reaching the treatment plant might be significant. The present treatment facilities would have little use. Some consideration should be given to the use of shallow wells for furnishing part of the supply. By interspersing well points with deeper wells, the blended water could be treated very simply.

Gravel-wall wells have been traditional at Camp Lejeune, and their success is not disputed. However, many wells, both at Hadnot Point and Tarawa Terrace, have pumped sand. In order to free the water of sand, the pumping rate must be reduced. The cause of the sand pumping is clear. Almost all the sand below 50 feet throughout Onslow County is surprisingly even grained. The sand is medium to fine and rarely of a coarse texture. The screen size selected is invariably large--commonly 60 slot (slot opening 0.06-inch). Gravel is selected to fit the screen opening instead of the formational sand. Therefore, the gravel is commonly too coarse and allows the fine to medium sand to be drawn through the screen. The pore space between the gravel becomes clogged with fine sand, resulting also in poor well yields. A smaller screen opening would result in less sand pumping but would also result in a poorer yield. If a larger percent of the sand were coarser, the natural development of a well would result in the fine sand being drawn through during the initial period of development; the coarser sand would be arranged around the gravel wall, and the efficiency of the well would be increased.

Regular screened wells are not inferior, and may be superior, to gravel-wall wells in yield and performance if they are properly constructed. Great care must be taken to select the correct screen size and to place the screens at precisely the correct depth. If the slots are too large, the well will pump sand. If the slots are too small and the screens are not placed opposite the best sand, the yield of the well will be poor. Very few drillers in the Southeastern states are competent to install screen wells properly. Therefore, under the system of competitive bidding on well installations the risk of having improperly screened wells installed is too great to take.

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Open-end tubular wells are conventional in the Tertiary limestone unit that extends from North Carolina to Florida, and only at Camp Lejeune have other types of wells been used on a large scale. At Hadnott Point, Tarawa Terrace, and Montford Point the limestone, or shellrock, is so thin that the development of sand-free water from open-end tubular wells is not a certainty. There is a very good chance that open-end wells could be successful at Tarawa Terrace. Neither the samples nor the electric log clearly indicate how much of the shellrock zone is hard, consolidated rock. The depth zones in the wells are: T-9 (71 - 97 feet), T-10 (66 - 77), and T-11 (57 - 66). The proper method of construction is to drive the casing into the top of the rock, extend the well as an open hole a few feet deeper, and stop the hole before it passes through the rock into underlying sand. Development of the well should follow the course of alternately pumping the well at a great rate and resting it. After several days of developing the well in this manner, it is presumed to be acceptable if it has not previously filled with sand or collapsed. If sand-free rock wells can be developed, they will have better specific capacities than screened or gravel-wall wells; individual well yields of 200 gallons a minute could be expected.

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Findings and Recommendations

1. No wells should be developed along Lejeune Boulevard below the shellrock zone, the bottom of which is less than 100 feet below the ground. Only fine sand lies below the shellrock, and its contribution to the yield of a well is not great. Moreover, the fine sand tends to move through the screens into the wells and into the distribution system.

2. Although not a simple relation, the hydrogen sulfide content of the water tends to increase with depth. Water shallower than 100 feet contains no objectionable quantity of hydrogen sulfide, whereas that below 150 feet contains an objectionable amount.

3. Below a depth of 175 feet the chloride, or salt, content of the water increases significantly. Wells drawing water between depths of 100 and 200 feet need to be watched for possible salt-water encroachment. On the other hand, wells drawing water at depths shallower than 100 feet will not draw in salt water.

4. Freedom from salt-water encroachment, insofar as wells shallower than 100 feet are concerned, permits a greater tolerance of drawdown of the water levels than would be the case in the development of deeper water.

5. The spacing and drawdown of wells are not a primary concern until two or more development wells are completed. To reduce mutual interference from pumping to a minimum and tolerable allowance, a spacing of 600 feet or more between wells is tentatively recommended.

6. The anticipated average yield for new wells cannot be estimated within narrow limits until at least one new development well is installed. It is safe to assume that gravel-wall wells, screening the best water-bearing materials between 40 and 100 feet, will average more than 125 gallons a minute--perhaps more than 150 gallons a minute. It is suggested that an attempt be made to develop an open-end well in the shellrock. The cheapness of this type of well and its great potential yield merit consideration. It would be inadvisable for a well contractor who specializes in screened and gravel-wall wells to install this type of well.

7. By developing wells along existing raw-water lines on Lejeune Boulevard and on Tarawa Boulevard into the water plant, a perennially dependable supply of more than 1½ million gallons a day is available. This amount does not exceed the rate of recharge. Additional water can be had from wells shallower than 100 feet along Bell Fork Road, although the character of materials and their water-yielding properties are not clearly known along this road.

8. If all water to be treated at Tarawa Terrace comes from a depth of 50 to 100 feet the water should be treated for hardness and iron content. The hardness of the composite water is less than 180 parts per million but more than 100 parts per million. The amount of iron in the composite water cannot be determined at this time and may be as low as .2 or as high as 1.0 part per million. The possibility exists that the iron content may be so slight that no treatment for it would be necessary.

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T-9 - TARAWA TERRACE

Log

0 - 7	Dark gray clayey sand
7 - 52	Coarse white sand
52 - 71	Medium white sand with small amount of clay
71 - 97	Interlayered shellrock and medium sand
97 - 115	Very fine gray sand and some disseminated clay
115 - 142	Fine gray sand
142 - 158	Very fine gray sand
158 - 177	Fine gray sand
177 - 202	Dark gray clay

Chemical Quality
(parts per million except pH)

	Depths Sampled	
	125 feet	175 feet
Total Hardness	146	108
Chloride	12	12
Iron	4.0	0.2
Hydrogen Sulfide	0.6	0.1
pH	7.2	7.8

Tentative recommendations for well at site of T-9:

Depth: 88 feet
Gravel-wall well with screen settings at the following depth intervals:

37 - 42
50 - 60
68 - 72
83 - 88

Estimated yield: 175 gallons a minute.
After treatment for hardness and iron content, water will be of good quality.

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T-10 - TARAWA TERRACE

Log

0 - 7	White to gray sandy clay
7 - 27	Medium to coarse light gray sand
27 - 47	Medium to fine gray sand
47 - 66	Medium to fine gray sand and shells
66 - 77	Shellrock and fine sand in streaks
77 - 90	Very fine gray sand and clay
90 - 123	Fine gray sand
123 - 137	Very fine gray sand
137 - 156	Fine gray sand
156 - 177	Very fine gray sand, a little clay matrix
177 - 207	Very fine gray sand and clay mixed
207 - 220	Very fine sand
220 - 247	Very fine gray sand and clay mixed
247 - 250	Fine sand and sandstone

Chemical Quality
(parts per million except pH)

	Depths Sampled		
	50 feet	125 feet	250 feet
Total Hardness	36	168	44
Chloride	10	22	182
Iron	-	0.6	0.2
Hydrogen Sulfide	0.1	0.6	0.9
pH	6.0	8.0	8.2

Tentative recommendations for well at site of T-10:

Depth: 77 feet
Gravel-wall well with screen settings at the following depth intervals:

47 - 57
67 - 77

Estimated yield: 150 gallons a minute.
After treatment for hardness and iron content, water will be of good quality.

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T-11 - TARAWA TERRACE

Log

0	- 8	Yellow clay
8	- 17	Fine pink sand
17	- 57	Fine to medium white sand
57	- 62	Shellrock
62	- 66	Medium gray sand and shellrock
66	- 98	Fine gray sand
98	- 110	Very fine gray sand
110	- 132	Fine gray sand
132	- 182	Very fine gray sand and sandy clay
182	- 202	Very fine gray sand

Chemical Quality
(parts per million except pH)

	Depths Sampled	
	85 feet	125 feet
Total Hardness	182	188
Chloride	10	14
Iron	0.2	1.3
Hydrogen Sulfide	0.4	0.5

Tentative recommendations for well at site of T-11:

Depth: 70 feet
Gravel-wall well with screen settings at the following depth intervals:

47 - 57
57 - 62
68 - 73

Estimated yield: 150 gallons a minute.
After treatment for hardness and iron content, water will be of good quality.