STUDY OF TWO WATER PLANTS

TARAWA TERRACE - MONTFORD POINT

Camp Lejeune, North Carolina

APRIL 1979

HENRY VON OESEN AND ASSOCIATES, INC.
Consulting Engineers & Planners
Wilmington, North Carolina

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I. INTRODUCTION

The water treatment plants serving Montford Point and Tarawa Terrace are in poor condition and are experiencing operating difficulties. The purpose of this study is to analyze the status of the two plants and to make recommendations regarding eliminating the problems.

II. EXISTING PLANTS

A. Tarawa Terrace

1. General description. The present plant is a lime softening process, using a catalytic precipitation lime contact tank and pressure filters. The lime feed equipment consists of two batch type mixing tanks using bagged lime and hand mixing, and two positive displacement lime pumps. The lime contact tank is enclosed and has a capacity of 700 GPM. There are six nine-foot diameter pressure filters having a maximum instantaneous capacity of 1140 GPM and maximum daily capacity of 1,099,000 GPD. There is a 750,000 gallon finished water reservoir with four vertical turbine type high service pumps - the largest of which has a gasoline standby engine. Pump capacities are 500 GPM, 750 GPM, 1000 GPM and 1250 GPM. Control and operation of the well system and treatment plant is manual. Control and operation of the high service pumps is automatic. The plant was originally built in 1952 and was expanded in 1962. The rated capacity is 1,000,000 gallons per day.

2. Operation and condition. The lime contact tank and filters are enclosed, making it impossible for the operator to observe the water during the treatment process. It is very important for the water to be observed at various stages during the treatment to enable the operator to make

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2. Operation and condition. The lime contact tank and filters are enclosed, making it impossible for the operator to observe the water during the treatment process. It is very important for the water to be observed at various stages during the treatment to enable the operator to make

adjustments as necessary to maintain optimum conditions and efficient operation. Further, the water should be exposed to the atmosphere during treatment to allow oxidation of iron, which is inherent at the high pH values occurring during lime treatment. Serious operating problems have been experienced at Tarawa Terrace due to inability to properly control the process, including cementing of filter sands, structural damage to the filter bed supports, and short filter runs. Filter sand is replaced regularly. Large access ports have had to be cut into the filters to allow this. The filter tanks themselves are extensively pitted and should be replaced.

The lime feed system has no provision for pacing to match the incoming flow. Lime is received in bags and batch mixed by hand, which is laborious and time consuming. Difficulties are experienced in obtaining desired softening without exceeding pH limitations. This can be corrected by recarbonation.

The existing reservoir has a wood roof which was constructed about 25 years ago. There is some deterioration due to rotting and a new roof will be needed in the near future.

The filter backwash is presently discharged into the storm drainage system without treatment. It is anticipated that treatment for removal of suspended matter will be required in the near future.

The plant is located in a closely developed area and there is little space available for expansion or construction of new facilities at the existing site. The plant cannot be taken out of service for renovation or rebuilding on the existing site, as there is no other acceptable source of water for the Tarawa Terrace area.

The plant building appears structurally sound and in reasonably good condition. There are sufficient supporting facilities, storage,

laboratory, office, and other space for operation of the plant, although space utilization is not very efficient. The building was originally designed for use as a fire station, and has been expanded and/or modified twice for use as a water plant.

The piping system, high service pumps, lime pumps, fluoridation system and chlorinators appear to be in acceptable condition and could be reused in a renovated plant, if properly located.

B. Montford Point

1. General description. The present plant is an ion exchange softening system, using zeolite softeners. There are two six-foot diameter softeners having a calculated total maximum capacity of 565 GPM. A portion of the water is bypassed around the softeners to leave a residual hardness. Salt is received in bulk in a wet salt storage tank. There is a 400,000 gallon concrete finished water reservoir. There are three horizontal double suction centrifugal high service pumps with capacities of 500, 1000 and 1250 GPM, the largest of which is dual driven with electric motor and gasoline standby engine. Control of the wellfield and high service pumps is automatic, using pressure controls. The rated plant capacity is 750,000 gallons per day. The plant was built in 1957.

2. Operation and condition. The treatment process presently being used is not adequate for the raw water due to the presence of iron in excess of 2 ppm. The iron in the bypassed water is not removed, and the ion exchange process is not recommended for iron concentrations exceeding 2 ppm. Serious problems are occurring in the distribution system due to iron content in the finished water.

The zeolite softeners themselves are in poor condition and must be replaced. The tanks have corroded to such an extent that extra plates have been welded to the outside to stop leaks. Also, the concrete floor of

the treatment area has settled a few inches, requiring equipment and piping to be blocked up. Settlement appears to be continuing as gaps under equipment supports are still developing.

Much of the steel in the building (windows, doors, piping, etc.) is severely corroded, probably due to the brine tanks in the building. The brine measuring tanks were recently replaced with fiberglass and one of the brine pumps has been removed. Otherwise, the building appears to be in satisfactory structural condition. The finish water pumps, while old, appear to be in good operating condition. The instrumentation (meters, recorders, control) and chlorination system appear to be in satisfactory condition. The fluoridation system is obviously a temporary set-up which needs to be replaced with a permanent installation.

There is adequate space for supporting facilities, laboratory, storage for the present facility, and there is ample space in the general area to allow expansion of the plant.

C. Other Facilities

1. Distribution systems. The two distribution systems are connected by an 8" water line through Knox Trailer Park. However, the elevated tank at Tarawa Terrace is at an elevation about fifty feet higher than at Montford Point. Normally a valve on the connecting line is kept closed because of the pressure differential. A booster station is provided in the Knox Park area to allow the Montford Point plant to supply Tarawa Terrace in an emergency. Water will flow by gravity from Tarawa Terrace to Montford Point.

The 8" connecting line between the two systems is not large enough to provide service between the two areas on a normal basis. Such a line would need to be at least 12" size. Also, some provision would be required to handle the different tank elevations.

2. Holcomb Boulevard Plant (Building 670). The existing Holcomb Boulevard water plant is a modern 2 MGD cold lime softening plant serving the Paradise Point area. The plant was built in 1971 and was designed for expansion to 5 MGD. It is in excellent condition and has experienced only minor routine operating problems. It is close enough to serve Montford Point and Tarawa Terrace by construction of a transmission main, plant expansion and other appurtenances.

III. WATER DEMAND

Flow records obtained from the Base Utility Department for the year 1978 are included as Appendix B and are summarized as follows:

	Average Day	Peak Day
Tarawa Terrace	896,000 GPD	1,128,000 GPD
Montford Point	425,000 GPD	661,000 GPD

Data obtained from the Planning Department of the Public Works Department at Camp Lejeune indicates no expected increase in population or demand at either plant. DM-5 recommends a 25% reserve for systems over 6,000 population (900,000 GPD) and a 50% reserve for systems under 6,000 population. Using this data, the following design capacities are suggested:

	Avg. Daily Flow	Reserve	Suggested Design Cap.
Tarawa Terrace	1,000,000	25%	1,250,000
Montford Point	500,000	50%	750,000
Combined System	1,500,000	25%	2,000,000

IV. WELL FIELD

A. Flow Capacity

The present wells have capacities as follows:

Tarawa Terrace:	TT-26	175 GPM
	TT-30	70
	TT-31	125
	TT-52	200
	TT-53	75
	TT-54	170
	TT-67	140
	Total	955 GPM

Montford Point:	M-142	70 GPM
	M-168	50
	M-197	130
	M-628	80
	M-629	140
	M-630	140
	Total	610 GPM

The State of North Carolina criteria for wellfields requires that the combined yield of all wells be sufficient to provide the average daily demand in not less than 12 hours' pumping time. On this basis, the required total well capacity at Tarawa Terrace is 1388 GPM. Since 955 GPM is presently available, an additional 433 GPM is needed, which will require three new wells. The required total well capacity at Montford Point is 833 GPM. Since 620 GPM is presently available, an additional 213 GPM is needed, which will require two new wells. The required total well capacity for a combined system is 2,222 GPM. Since 1,575 GPM is presently available, an additional 647 GPM is needed, which will require five new wells.

	Required Capacity	Existing Capacity	Additional	Number of New Wells
Tarawa Terrace	1388	955	433	3
Montford Point	833	620	213	2
Combined	2222	1575	647	5

B. Raw Water Quality

Recent analyses of the water from each well presently in use were obtained from the Base Utility Division. In addition, complete analyses of the composite raw water at each plant were made. These analyses were compared to the applicable requirements of the Safe Drinking Water Act, Bureau of Medicine and Surgery, and the State of North Carolina.

Although complete analyses of each individual well was not available, there is sufficient overlapping and data from other sources to give indications of water quality in the area. Copies of the available analyses are attached as Appendix A.

The maximum contaminant level for inorganic chemicals of the Safe Drinking Water Act are as follows:

Arsenic	0.05 mg/l
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Fluoride	1.4 to 2.4 (depending on temperature)
Nitrate	10.0

The State of North Carolina has the following additional maximum contaminant levels for other chemicals and requires treatment to remove amounts in excess:

Iron	0.3
Manganese	0.05

The State also has the following recommended limits for other chemical substances:

Chloride	250.0
Copper	1.0
Phenols	0.001
Sulfate	250.0
Total dissolved solids	500.0
Zinc	5.0

All of the wells presently in use meet the Safe Drinking Water Act requirements. They also meet the state recommended limits for other chemical substances. However, the iron content in every well is significantly in excess of the state maximum. Manganese is also slightly high in three wells. Although there are no state or federal limits for hardness, DM-5 recommends treatment of water with hardness in excess of 150. Hardness of the present wells ranges from 164 to 320, and it is the present practice at Camp Lejeune to soften the water. The hardness is virtually all calcium bicarbonate.

Therefore, the water needs treatment for removal of significant amounts of iron and calcium bicarbonate hardness.

V. PROPOSED IMPROVEMENTS

A. New Plant Processes

There are two basic processes that would be appropriate for the raw water at both Tarawa Terrace and Montford Point.

1. Cold lime and filtration. A lime slurry is injected into the raw water from the wells as it enters a catalytic precipitation type contact tank. The tank is conical in shape and is about half-filled with an inert catalyst such as sand. As the water rises through the tank, the hardness precipitates as calcium carbonate and coats the grains of the catalyst. When the grains become too large, they are drawn off and disposed of in landfill. The effluent from the tank is recarbonated by addition of carbon dioxide or sulfuric acid, lowering the pH to 8-8.5, and flows to rapid sand filters where any residual calcium carbonate or iron floc is removed. Provision for disinfection by chlorine and addition of fluoride will be made. The filter backwash water will flow to a holding lagoon and then be pumped at a slow rate into the sanitary sewer system for disposal.

2. Aeration, filtration and zeolite softening. The raw water from the wells is pumped through an aerator where the iron is oxidized into a detention tank of about 15 minutes storage, where an iron floc is allowed to form. The water than flows through filters, removing the suspended matter. The water then will pass through zeolite water softeners where calcium and magnesium are removed. A blending system will bypass a portion of the hard water around the softeners and blend the two streams to provide a finished water hardness of about 50 ppm. Provision for disinfection by chlorine and addition of fluoride will be made. The filter backwash water and softener regeneration water will flow to a holding lagoon and then be pumped at a slow rate into the sanitary sewer system for disposal.

B. General Comments

Experience at Camp Lejeune indicates that the cold lime/filtration process gives better results and is less expensive to operate. Therefore, it is recommended that any new plant be of that process. The aeration/filtration/ion exchange process is recommended only for renovation of the Montford Point plant. It is apparent that there will be serious problems involved with renovation of the Tarawa Terrace plant in its present location, for the following reasons:

1. The plant must remain in operation during the renovation because there is no other adequate source of water.

2. There is little, if any, space (land area) available for new and/or expanded facilities.

3. Significant changes in the process and types of equipment are needed, and will require replacement of most of the major items of equipment.

It is therefore recommended that a new plant be constructed to serve the Tarawa Terrace area.

The Montford Point plant may be expanded and/or upgraded in its present location by replacing existing equipment and adding additional equipment. Careful scheduling will be required to avoid interruption of service to the system and some problems may occur due to poor water quality during softener replacement. These problems would be of concern but should not be insurmountable.

C. Suggested Alternatives

Three basic approaches to the project are proposed as follows:

Alternate A: Build new plant to serve the Tarawa Terrace area, and renovate the existing Montford Point plant to serve Montford Point. Provide new wells and raw water system extensions as required. The two distribution systems will remain essentially as presently existing. The new plant would be of the lime softening/filtration type and the renovated Montford Point plant would be of the aeration/filtration/ion exchange type.

Alternate B: Build a new treatment plant in the Knox Park area and connect to supply both systems from the new plant. Abandon both existing plants. Provide new wells and raw water system extensions to connect new and existing wells to the new plant. Provide a new water connection from the new plant to both distribution systems. The new plant would be of the lime softening/filtration type.

Alternate C: Expand the existing Holcomb Boulevard plant from 2 MGD to at least 4 MGD and construct a transmission main from the expanded plant to the existing Tarawa Terrace and Montford Point plants. The water would be delivered into the existing Tarawa Terrace reservoir and pumped into the distribution systems using the present high service pumps and one additional 2000 GPM pump. A new 12" water supply line and altitude valve will be needed to connect the Tarawa Terrace system to the Montford Point

system. The Holcomb Boulevard plant was designed to allow expansion to 5 MGD. For the expansion to 4 MGD, two new lime contact tanks and two new filters will be required. Approximately seven new wells, associated raw water extensions, a new finished water reservoir, and pumping station will be required. The plant has sufficient supporting facilities, controls, laboratory, lime storage, etc., for the expanded capacity. New backwash water settling facilities will be required. Note: While the plant is being expanded, it would probably be appropriate to expand to 5 MGD, as it is approaching capacity. However, only the 2 MGD applicable to Tarawa Terrace and Montford Point will be considered in this report.

VI. CONSTRUCTION COST ESTIMATE

A. Alternate A: New plant for Tarawa Terrace and renovate Montford Point plant.

Wells - Five required

Site work	$ 2,500	
Well	20,000	
Building	7,000	
Pump	6,500	
Piping	3,500	
Electrical	2,500	
Total	$ 42,000 x 5	$ 210,000

Raw Water Lines

8" (3,700 lf @ $10.00)	$ 37,000	
Valves (5 ea @ $600.00)	3,000	
Total		40,000

Distribution Lines

12" (2,000 lf @ $15.00)	$ 30,000	
Valves (2 ea @ $1,000.00)	2,000	
Total		32,000

Montford Point Treatment Plant

Demolition	$ 15,000	
Site work	15,000	
Aerator and clear well	7,000	
Building addition	45,000	
New softeners and accessories	52,000	
Filter equipment	65,000	
Piping and pumps	40,000	
Electrical	33,000	
Controls and instrumentation	15,000	
Total		287,000

Tarawa Terrace Treatment Plant and Reservoir

Site work	$ 95,000	
Building	520,000	
Piling	135,000	
Reservoir	150,000	
Treatment equipment and pumps	160,000	
Filter equipment	120,000	
Piping and mechanical	150,000	
Electrical	166,000	
Controls and instrumentation	65,000	
Total		1,561,000

Total Construction	$2,130,000
SIOH (5.5%)	117,000
Contingency (5%)	112,000
Total CWE	$2,359,000
Design (6%)	142,000
TOTAL: ALTERNATE A	$2,501,000

B. Alternate B: New plant to serve Tarawa Terrace and Montford Point.

Wells - Five required

Site work	$ 2,500	
Well	20,000	
Building	7,000	
Pump	6,500	
Piping	3,500	
Electrical	2,500	
Total	$ 42,000 x 5	$ 210,000

Raw Water Lines

12" (6,500 lf @ $15.00)	$ 97,500	
10" (4,750 lf @ $12.00)	57,000	
Valves (8 ea $600.00)	7,500	
Creek crossing (200 lf @ $50.00)	10,000	
Total		172,000

Distribution Lines

12" (9,800 lf @ $15.00)	$147,000	
Valves (6 ea @ $1,000)	6,000	
Altitude valve and pit	11,000	
Creek crossing (200 lf @ $50.00)	10,000	
Total		174,000

Treatment Plant and Reservoir

Site work	$105,000	
Building	650,000	
Piling	180,000	
Reservoir	225,000	
Treatment equipment and pumps	185,000	
Filter equipment	137,000	
Piping and mechanical	205,000	
Electrical	222,000	
Controls and instrumentation	75,000	
Total		1,984,000

Total Construction	$2,540,000
SIOH (5.5%)	140,000
Contingency (5%)	134,000
Total CWE	$2,814,000
Design (6%)	169,000
TOTAL: ALTERNATE B	$2,983,000

C. Alternate C: Expand Holcomb Boulevard plant to serve Tarawa Terrace and Montford Point.

Wells - Seven required

Site work	$ 2,500	
Well	20,000	
Building	7,000	
Pump	6,500	
Piping	3,500	
Electrical	2,500	
Total	$ 42,000 x 7	$ 294,000

Raw Water Lines

14" (6,000 lf @ $20.00)	$120,000	
12" (5,800 lf @ $15.00)	87,000	
8" (1,500 lf @ $10.00)	15,000	
Valves and appurtenances	9,000	
Total		231,000

Transmission Main

16" (13,000 lf @ $25.00)	$325,000	
Creek crossing (1,000 lf @ $75)	75,000	
Valves and appurtenances	12,000	
Air relief valves (6 ea @ $1,000)	6,000	
Total		418,000

Treatment Plant Expansion

Site work	$ 10,000	
Building	210,000	
Piling	140,000	
Reservoir	225,000	
Treatment equipment and pumps	170,000	
Filter equipment	137,000	
Piping and mechanical	50,000	
Electrical	60,000	
Controls and instrumentation	30,000	
Total		1,032,000

Modifications at Tarawa Terrace

Connection at existing reservoir	$ 15,000	
New high speed pump	17,000	
Electrical	5,000	
Total		$ 37,000

Distribution

12" main (9,800 lf @ $15.00)	$147,000	
Valves (6 ea @ $1,000.00)	6,000	
Altitude valve and pit	11,000	
Creek crossing (200 lf @ $50.00)	10,000	
Total		174,000
Total Construction		$2,186,000
SIOH (5.5%)		120,000
Contingency (5%)		115,000
Total CWE		$2,421,000
Design (6%)		145,000
TOTAL: ALTERNATE C		$2,566,000

VII. OPERATING AND MAINTENANCE COSTS

Records for FY 78 indicate the following operating costs for the existing plants:

	Labor	Supplies	Total
Montford Point	$ 44,899	$ 13,766	$ 58,665
Tarawa Terrace	82,647	22,125	104,772
Holcomb Boulevard	105,533	13,961	119,494

The Tarawa Terrace plant and the Holcomb Boulevard plant are manned 24 hours per day. Montford Point is manned only one shift, but is supported from Tarawa Terrace during other shifts. It is assumed this policy would be continued. Maintenance and repairs vary widely due to differences in age and condition of the plants. However, since this project would renovate or replace the plants, it is assumed that repairs and maintenance would be

the same for all alternates.

The Holcomb Boulevard plant is similar in size and type to the new plant proposed in Alternate B to serve both Montford Point and Tarawa Terrace. It is therefore used as a guide for anticipated operation costs for the new plant.

Operating Costs - Base Year FY78

	Labor	Supplies	Total
Alternate A			
Renovated Montford Point Plant	$ 45,000	$ 14,000	$ 59,000
New Tarawa Terrace Plant	80,000	7,000	87,000
Total			$146,000
Alternate B			
New Montford Point/ Tarawa Terrace Plant	$100,000	$ 14,000	$114,000
Alternate C (Note: Costs listed are the additional costs of operation due to expansion of the Holcomb Boulevard plant)			
Holcomb Boulevard Plant	$ 40,000	$ 14,000	$ 54,000

VIII. ECONOMIC ANALYSIS

The construction costs and operation costs were analysed using discount factors and procedures set out in the LANTDIV PED instruction for preparation of economic analyses. This data is attached as Appendix C. A project life of 25 years was assumed.

The uniform annual cost of each alternate is as follows:

Alternate A	$408,600
Alternate B	427,208
Alternate C	323,425

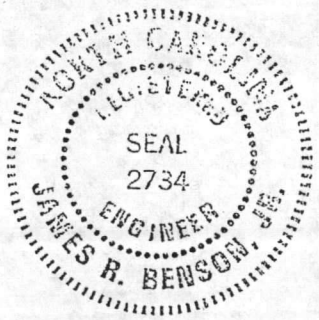
IX. CONCLUSIONS AND RECOMMENDATIONS

It is apparent that Alternate C is the most cost effective alternative for alleviating the problems presently being experienced at the existing Montford Point and Tarawa Terrace plants. This is due almost totally to the savings in operating costs resulting from operating one plant instead of three plants. It is therefore recommended that the two existing treatment plants be abandoned and the Holcomb Boulevard plant be expanded and a transmission main be constructed to serve Tarawa Terrace and Montford Point.

It would be advisable to study the area presently being served by the Holcomb Boulevard plant and its existing demand to determine if the proposed expansion should include additional capacity for its existing area. Preliminary discussions indicate that some additional facilities may be planned within the area served by the plant, and expansion in the near future may be needed, regardless of the Montford Point/Tarawa Terrace expansion. Obviously, any expansions should be done concurrently as one project.

Respectfully submitted,

HENRY VON OESEN AND ASSOCIATES, INC.
Consulting Engineers & Planners



James R. Benson, Jr., P. E.

19 April 1979

LAW & COMPANY
OF WILMINGTON, INCORPORATED
CONSULTING AND ANALYTICAL CHEMISTS
P. O. BOX 629 WILMINGTON, N.C. 28402
(919) 762-7082 (919) 762-8956

APPENDIX A

3/19/79

Chemical Report

Number 13-11-144 Sample of

Received 3/9/79

For #788
Henry von Oesen & Associates
Marks 611 Princess St.
Wilm.,NC 28401

RECEIVED
MAR 30 1979
HENRY VON OESEN & ASSOC

Description
Well Water

	Montford Pt. #1	Tarawa Terrace #2
Arsenic, mg/l	<.01	<.01
Barium, mg/l	<.04	<.04
Cadmium, mg/l	<.01	<.01
Chromium, mg/l	<.01	<.01
Lead, mg/l	<.01	<.01
Mercury, mg/l	<.002	<.002
Selenium, mg/l	<0.01	<0.01
Silver, mg/l	<.01	<.01
Fluoride, mg/l	0.26	0.36
Nitrate-Nitrogen, mg/l	0.04	0.04
Iron, mg/l	2.10	1.00
Manganese, mg/l	.02	.02
Chloride, mg/l	38.7	7.4
Copper, mg/l	<.01	<.01
Phenol, mg/l	<.0.01	<.001
Sulfate, mg/l	5.3	3.5
Zinc, mg/l	.03	.01

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(919) 762-7082 (919) 762-8956

Chemical Report

Number Page 2 Sample of Received

For #788
Henry von Osesen & Associates

Marks

Description

	Montford Pt. #1	Tarawa Terrace #2
Total Dissolved Solids, mg/l	324	220.
Hardness, mg/l as $CaCO_3$	242	210
Ph	7.2	7.3
Calcium, mg/l	90	100
Magnesium, mg/l	2.0	2.5
Phen. Alkalinity, mg/l as CaCO3	0	0
M.O. Alkalinity, mg/l as $CaCO_3$	213	211

Chemist Judy Watkins

CHEMICAL ANALYSIS - WATER
MCBCL 11330/3 (REV 8-74)

MONTFORD POINT

Date 2-7-79

Parameter	M-142	M-168	M-197	M-628	M-629	M-630	RIFLE RANGE	HOLCOMB BLVD	NEW RIVER
PH	7.4	7.3	7.3	7.4	7.3	7.4			
PHENOLTHALEIN ALKALINITY	0	0	0	0	0	0			
METHYL ORANGE ALKALINITY	204	230	250	228	178	212			
HARDNESS CARBONATES AS $CaCO_3$	190	220	320	220	180	308			
BICARBONATES AS $CaCO_3$									
CHLORIDES AS Cl	8	14	162	10	12	108			
HARDNESS AS $CaCO_3$									
IRON AS Fe	.83	.99	2.05	.85	4.50	1.16			
MANGANESE	.03	.03	.04	.03	.06	.03			
CALCIUM ORTHO PHOSPHATE	85	87	125	88	65	115			
MAGNESIUM META PHOSPHATE	1.22	2.31	4.16	1.92	1.68	2.35			
FLUORIDE									
CHLORINE RESIDUAL									

REMARKS:

NOTE: All results reported in parts per million unless otherwise noted except for pH, temperature, and specific conductance. One liter of potable water is assumed to weigh one kilogram.

LABORATORY ANALYSIS BY:

DATE OF ANALYSIS:

APPENDIX A

CHEMICAL ANALYSIS - WATER
MCBCL 11330/3 (REV 8-74)

TARAWA TERRACE

Date 2-7-79

Parameter	TT-26 HADNOT POINT	TT-30 MONTFORD POINT	TT-52 CAMP GEIGER	TT-53 TARAWA TERRACE	TT-54 ONSLOW BEACH	TT-67 COURTHOUSE BAY	RUFFLEX RANGE	HOLCOMB BLVD	NEW RIVER
PH	7.4	7.3	7.2	7.4	7.5	7.7			
PHENOLTHALEIN ALKALINITY	0	0	0	0	0	0			
METHYL ORANGE ALKALINITY	228	224	204	198	180	172			
HARDNESS CARBONATES AS $CaCO_3$	220	220	256	216	200	164			
BICARBONATES AS $CaCO_3$									
CHLORIDES AS Cl	14	16	12	8	12	2			
HARDNESS AS $CaCO_3$									
IRON AS Fe	.93	12.0	5.20	1.0	.53	1.25			
MANGANESE TOTAL PHOSPHATE	.02	.10	.06	.03	.01	.03			
CALCIUM ORTHO PHOSPHATE	103	85	106	80	81	67			
MAGNESIUM META PHOSPHATE	2.26	2.2	2.72	1.82	1.40	1.79			
FLUORIDE									
CHLORINE RESIDUAL									

REMARKS:

NOTE: All results reported in parts per million unless otherwise noted except for pH, temperature, and specific conductance. One liter of potable water is assumed to weigh one kilogram.

LABORATORY ANALYSIS BY:

DATE OF ANALYSIS:

APPENDIX A

FLOW RECORDS

TT-38 WATER TREATMENT PLANT

DELIVERED WATER FLOW FOR 12 MONTH PERIOD

	(X 1000)		(Gals/Day)
JANUARY	27,750 GALS.	HIGH DAY	950,000 GALS.
FEBRUARY	28,480	"	981,000
MARCH	25,187	"	988,000
APRIL	26,832	"	1,072,000
MAY	26,138	"	977,000
JUNE	29,561	"	1,056,000
JULY	29,786	"	1,128,000
AUGUST	27,866	"	954,000
SEPTEMBER	26,915	"	1,083,000
OCTOBER	31,320	"	1,012,000
NOVEMBER	23,174	"	986,000
DECEMBER	24,080	"	892,000

M-178 WATER TREATMENT PLANT

	(X 1000)		(Gals/Day)
JANUARY	12,878	"	498,000
FEBRUARY	13,304	"	488,000
MARCH	12,322	"	488,000
APRIL	12,278	"	527,000
MAY	14,279	"	596,000
JUNE	13,774	"	554,000
JULY	12,301	"	604,000
AUGUST	13,884	"	623,000
SEPTEMBER	14,651	"	539,000
OCTOBER	12,466	"	529,000
NOVEMBER	11,749	"	661,000
DECEMBER	11,065	"	432,000

WELL CAPACITY AT THE WELL

WELL #	ORIGINAL g.p.m.	PRESENT g.p.m.
TT-26	200	175
TT-30	100	70
TT-31	145	125
TT-52	300	200
TT-53	350	75
TT-54	200	170
TT-67	168	140
TOTAL	1463	955
M-142	100	70
M-168	100	50
M-197	155	130
M-243	150	CAVED
M-628	130	80
M-629	150	140
M-630	150	140
TOTAL	935	620

ECONOMIC ANALYSIS OF SHORE FACILITY

APPENDIX C

DATE: 19 April 1979

ACTIVITY (Name and Location)
Marine Corps Base, Camp Lejeune, North Carolina

PROJECT TITLE
Study of Two Water Plants

P NO.

DESCRIPTION OF ALTERNATIVES

A. Renovate Montford Point Plant and new Tarawa Terrace Plant.
B. New plant to serve Montford Point and Tarawa Terrace.
C. Expand Holcomb Boulevard plant to serve Montford Point and Tarawa Terrace.

ALTERNATIVE A Renovate Montford Point, New Tarawa Terrace — ECONOMIC LIFE 25 YRS.

DESCRIPTION AND YEAR	COSTS ($) ONE TIME	COSTS ($) RECURRING	DISCOUNT FACTOR	PRESENT VALUE ($)
INVESTMENT	2,501,000			2,501,000
OPERATIONS		146,000	9.524	1,390,504

TOTAL PRESENT VALUE ALTERNATIVE A - $ 3,891,504 ÷ DISCOUNT FACTOR 9.524 = UNIFORM ANNUAL COST 408,600

ALTERNATIVE B New Montford Point and Tarawa Terrace Plants — ECONOMIC LIFE 25 YRS.

DESCRIPTION AND YEAR	COSTS ($) ONE TIME	COSTS ($) RECURRING	DISCOUNT FACTOR	PRESENT VALUE ($)
INVESTMENT	2,983,000			2,983,000
OPERATIONS		114,000	9.524	1,085,736

TOTAL PRESENT VALUE ALTERNATIVE B - $ 4,068,736 ÷ DISCOUNT FACTOR 9.524 = UNIFORM ANNUAL COST 427,208

ALTERNATIVE C Expand Holcomb Boulevard Plant — ECONOMIC LIFE 25 YRS.

DESCRIPTION AND YEAR	COSTS ($) ONE TIME	COSTS ($) RECURRING	DISCOUNT FACTOR	PRESENT VALUE ($)
INVESTMENT	2,566,000			2,566,000
OPERATIONS		54,000	9.524	514,296

TOTAL PRESENT VALUE ALTERNATIVE C - $ 3,080,296 ÷ DISCOUNT FACTOR 9.524 = UNIFORM ANNUAL COST 323,425

PRELIMINARY EQUIPMENT SIZING

Montford Point Plant Renovation

Design Capacity - 750,000 gpd = 520 gpm.

Coke Tray Aerator Size @ 25 gpm/sf = 20 sf.

Clear Well @ 15 min. Retention = 1,042 cf, use 22' x 8' x 6' deep.

Filters @ 3 gpm/sf = 173 sf, use 3 @ 8' diameter.

Softeners @ 15 grains/gal., 25% bypass, 30,000 grains/cf. and one regeneration/day/tank = 280 cf resin, use 6' sideshell and 50% freeboard, = 2 tanks @ 8' diameter.

New Tarawa Terrace Plant

Design Capacity - 1,250,000 gpd = 870 gpm.

Use 2 Contact Tanks @ 435 gpm each.

Filters @ 2 gpm/sf = 435 sf, use 2 @ 16' x 14'.

Recarbonation Tank @ 20 min. Retention = 2,326 cf, use 16' x 14' x 10' deep.

Reservoir - Distribution Storage and Reservoir to be 1 day capacity 1,250,000 - 250,000 = 1 mg.

High Service Pump Capacity - 150% of ADF = 1,300 gpm. Use 3 pumps, 1,300 gpm, 900 gpm, 500 gpm, space for future pump

New Combined Montford Point Plant/Tarawa Terrace Plant

Design Capacity - 2,000,000 gpd = 1,388 gpm.

Use 2 Contact Tanks @ 700 gpm each.

Filters @ 2 gpm/sf = 694 sf, use 2 @ 20' x 18'.

Recarbonation Tank @ 20 min. Retention = 3,700 cf, use 20' x 18' x 10' deep.

Reservoir - Distribution Storage and Reservoir to be one day capacity - 2,000,000 - 250,000 - 150,000 = 1,600,000 gal.

High Service Pump Capacity - 150% of ADF = 2,080 gpm. Use 3 pumps, 2,100 gpm, 1,500 gpm, 1,000 gpm, space for future pump.

Expanded Holcumb Boulevard Plant

Design Capacity - 2,000,000 gpd - 1,388 gpm.

Use 2 Contact Tanks @ 700 gpm each.

Filters @ 2 gpm/sf - 694 sf, use 2 @ 20' x 18' (match existing filters).

Recarbonation Tank @ 20 min. Retention - 3,700 cf, use 20' x 18' x 10' deep.

Reservoir - Distribution Storage and Reservoir to be 1 day - 2,000,000 - 750,000 - 250,000 - 150,000 = 850,000 gal., use 1,000,000 gal (1/2 day plant capacity).

High Service Pump Capacity - 150% of ADF = 2,080 gpm, use 3 pumps 2,000 gpm, 1,500 gpm, 1,000 gpm, space for future pump.

Transmission Main Size - 2,000 gpm.

Total length 14,000 lf, static head nil.

TDH w/16" main - 36' velocity 3.19 FPS, 25 HP.

TDH w/12" main - 149', volocity 5.68 FPS, 100 HP.

Use 16" main.

Existing Tarawa Terrace Pump Station - Existing pumps are 500 gpm, 750 gpm, 1,000 gpm and 1,250 gpm. Replace 500 gpm pump with 2,000 gpm.

Supply Main to Montford Point - 750,000 gpd @ 150% of ADF = 780 gpm.

Total length - 11,000 lf available head - 54' (Difference in tank heights). Allowable Loss .5 ft/100', use 12".