# FLUORIDE REDUCTION
# in
# COMMUNITY WATER SUPPLIES

prepared for the :

## STATE OF SOUTH CAROLINA
## DEPARTMENT OF HEALTH & ENVIRONMENTAL CONTROL
### WATER SUPPLY DIVISION

A JOINT VENTURE

**J. E. SIRRINE COMPANY & AWARE, INC.**

Summerville, South Carolina Brentwood, Tennessee

volume TWO

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# AMERICAN HERITAGE MOBILE HOME PARK

# LEXINGTON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of American Heritage Mobile Home Park. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The American Heritage Mobile Home Park water system has two wells. One well is 425 feet deep, yields 45 GPM, and has a fluoride concentration of approximately 3.3 mg/l.[1] The second well is 385 feet deep, yields 28 GPM, and has a fluoride concentration of approximately 1.9 mg/l.[1] The water system has a 5,000 gallon pneumatic tank for water storage. The system serves 165 mobile home sites. When visited during this study, approximately 40% of the trailer sites were occupied. The system has no water meters with which water use can be determined.

### ESTIMATED WATER DEMAND

Assuming two persons per mobile home and a water use of 70 GPD per person, it was estimated that the average daily water demand would be 23,100 GPD. If it is assumed that the peak day water demand is 180% of the average day water use,[2] the water demand would be 41,580 GPD.

With that demand, the desirable minimum pumping rate would then be 43.4 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[3] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 249 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated[4] that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[3] of checking pneumatic tank size indicates that a well capacity of at least 155.8 GPM would be needed with the existing 5,000 gallon of pneumatic water storage. However, an additional 7,500 gallons of pneuwater use of 231 GPD per consumer, the future average day water demands were estimated to be 86,625 GPD by 1990 and 98,175 by the year 2000.

Using the peak month record as a guide, it is estimated that the peak day water use is approximately twice the average day water use. Therefore, the peak day water demands are estimated to be 173,250 GPD for 1990 and 196,350 GPD for the year 2000.

The below listed supply requirements were calculated utilizing a regulatory criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period. Those values are as follows:

- 1979 - 132 GPM;
- 1990 - 180 GPM;
- 2000 - 204 GPM.

Based on the above estimates, a pumping capacity of 150 GPM was selected as the capacity for the ensuing evaluations.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative should include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

### Method

The alternative would involve the drilling of a new well or wells to replace or blend with one of the existing high fluoride wells. For the blending alternative, it will be assumed that an existing well's pump will be replaced with a smaller unit to achieve an acceptable blend. It should be noted that this alternative is dependent upon the quantity and quality of low fluoride water available, both of which are unknown. Therefore, for this to be a viable solution, a test and water

INTRODUCTION

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Central Mobile Home Village. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Central Mobile Home Village water system has two wells in use. One is 340 feet deep and yields 90 GPM and one is 270 feet deep and yields 30 GPM for a total yield of 120 GPM.[1] The system's fluoride concentration is approximately 3.5 mg/l.[2] The water system has a 745 gallon pressure tank for water storage. The system served approximately 70 persons in 36 mobile homes during 1979. The number of trailers and the population is expected to remain stable. There are no meters in use and, therefore, water use must be estimated from use in similar systems.

### ESTIMATED WATER DEMAND

Assuming two persons per mobile home and a water use of approximately 100 GPD per person, it is estimated that the average daily water demand would be approximately 7,200 GPD. If it is assumed that the peak day water demand is 180% of the average day water use,[3] the water demand would be 12,960 GPD.

With that demand, the desirable minimum pumping rate would be 13.5 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[4] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 36 resd. x 3.56 GPM/resd. = 128 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated[5] that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[4] of

# FLUORIDE REDUCTION

# IN

# COMMUNITY WATER SUPPLIES

Prepared For

STATE OF SOUTH CAROLINA

DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

WATER SUPPLY DIVISION

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

Summerville, S. C.     Brentwood, TN

VOLUME TWO

# NOTICE

This volume contains one copy each of forty-three reports which were bound separately and transmitted to communities throughout the eastern section of South Carolina. As an adjunct to the reports, three Appendices were prepared to address items of common interest to many of the communities included in the study. All such appendices have been printed at the end of this Document, but have been omitted from the individual reports to avoid redundancy. To determine which appendices were included in the separately bound reports, the reader should consult the appropriate Table of Contents.

# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Aynor. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## EXISTING CONDITIONS

The Aynor water system presently has two wells in use.[1] Well No. 1, located near the Town's 100,000 gallon elevated water tank, is pumped at approximately 150[1] gallons per minute (GPM), has a fluoride concentration of approximately 5.0 milligrams per liter (mg/l) and an iron concentration of less than 0.1 mg/l.[2] Well #2, located near the corner of North Main Street and Sixth Avenue is also reported[1] to be pumped at approximately 150 GPM. Both wells are constructed to the same depth; therefore, the chemical quality of water from the two wells is expected to be approximately the same.

The Town's water use[3] during the peak month for three past years is tabulated below.

| TOWN OF AYNOR<br>PEAK MONTH WATER DEMAND | | | |
|---|---|---|---|
| Period (month/year) | Average Demand (gal/day) | Consumers | Consumer Average (gal/day) |
| 9/77 | 132,000 | 310 | 426 |
| 9/78 | 139,000 | 318 | 437 |
| 9/79 | 127,000 | 325 | 391 |

The average water use for 1979 was estimated to be 75,000 GPD.[4] The combined yield of the Town's two wells is approximately 288,000 GPD with 16 hours of pumping.

## FUTURE CONDITIONS

The estimates by the Town[3] of the future number of water service customers are 375 customers by the year 1990 and 425 by the year 2000. Using the current average checking pressure tank size indicates that a well capacity of at least 93.2 would be needed if the existing 745 gallon tank is all the storage available. However, an additional 6,500 gallons of pneumatic tank capacity would allow the use of a 13.5 GPM well, which is estimated to be sufficient to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 36 residential connections assumed as design condition.
2. Existing pneumatic tank size is 745 gallons.
3. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 36 residences x 3.56 GPM/res. x 0.8 = 102.5 GPM instantaneous demand.
2. Usable pneumatic tank volume = 745 ÷ 4 - 186.25 gallons.
3. Tank contribution for 20 minutes = 186.25 gallons.
4. Minimum new well size to meet instantaneous supply demand = 102.5 GPM - 9.3 GPM = 93.2 GPM.
5. Minimum pneumatic tank capacity with 13.5 GPM well = (102.5 GPM - 13.5 GPM) x 20 minutes x 4 = 7,120 gallons.
6. Additional pneumatic tank capacity needed = 7,120 gal. - 745 gal. = 6,375 gallons. Use a 6,500 gallon tank.

# FLUORIDE REDUCTION

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## METHOD

The viable alternatives for this system appear to be quite limited. One possible alternative would be to connect to the City of Conway's proposed water main extension out Highway 701 to a proposed industrial site. However, the end of the water main would be approximately 2.9 miles from the Central Mobile Home Village. With a construction cost of $4.00 per foot for a 4" diameter PVC pipe installation, the cost would be over $60,000. Other costs would include design costs, a master meter installation, drive and roadway repairs, etc. Due to the high cost per residence, this possible alternative has been eliminated by the writer. Treatment for fluoride reduction has also been eliminated for the same reason.

The only viable alternative for this system appears to be the drilling of a new well to tap a more acceptable water source. With a fluoride concentration of zone sampling well must be drilled near one of the existing wells and sufficient, satisfactory water located to replace or blend with the existing well water.

Assuming the test well process locates blend water with a fluoride concentration of 0.2 mg/l or less, a blended water fluoride concentration of approximately 1.4 mg/l can be achieved by using 38 GPM of existing well water with 112 GPM of low fluoride water. One problem which could occur in trying to achieve this much low fluoride water is that the blend water may have a high iron concentration. In that event, either sequestering of the iron to keep it in solution or iron removal treatment would be required.

For this alternative, it will be assumed that one test and sampling well, followed by two production wells, will be needed to achieve the 112 GPM required for blending with one existing well only. It will also be assumed that an iron sequestering and a gas chlorination unit will be needed at the selected existing well site and that one new well will be installed near the existing well and one will have to be piped to the existing well site. To indicate the impact of excessively high iron content in the new wells, the cost of iron removal treatment has also been estimated. However, it is beyond the scope of this study to predict whether or not iron removal treatment would be necessary.

<u>Cost Estimate with Iron Sequestering</u>

| | |
|---|---|
| • Capital cost estimate for project design and construction | $90,000 |
| • Annual added debt service assuming 12% loan for 30 years | $11,174 |
| • Annual added operation cost using 1979 estimated water use | $ 826 |
| • Total estimated added annual cost | $12,000 |

Cost Estimate with Iron Removal

- Capital cost estimate for project design and construction $230,000
- Annual added debt service assuming 12% loan for 30 years $ 28,555
- Annual added operation cost using 1979 estimated water use $ 16,125
- Total estimated added annual cost $ 44,680

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendum, rate structure studies, funding procurement, etc., provided only iron sequestering is required. It is estimated that the time would increase to 42 months if iron removal treatment is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative, if only iron sequestering is required. However, if iron removal treatment is necessary, it is anticipated that an additional water system operator may be required. Therefore, the expense of an operator has been added to the estimated operating cost.

ALTERNATIVE NO. 2: TREAT EXISTING WELLS

Method

This solution would involve the treatment of well water from either of the two existing wells. To provide back-up protection, the cost of piping to allow either existing well to be used is included in the cost estimate. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from the well being used and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the nearest sanitary sewer system. The Town would have to incur cost to pipe to that sewer and pay for treating it. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

## Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $340,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 42,208 |
| • Annual added operation cost using 1979 estimated water use | $ 27,000 |
| • Total estimated added annual cost | $ 69,208 |

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed A operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| AYNOR ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 150 | $11,174 | $ 826 | $ 36.92 |
| No. 2: Treatment | 150 | $42,208 | $27,000 | $212.95 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Implementation of that alternative would result in the following water rate increase:

- Existing monthly rate[5] — $ 9.40
- Estimated monthly increase — 3.08

Adjusted Monthly Water Rate — $12.48/consumer

REFERENCES


[1]Meeting and discussion with Aynor's Mayor, Hoyt Johnson, and Water Superintendent, Benny Andrews, on January 31, 1980.

[2]DHEC Water Analysis, from Aynor Well #1, dated April 3, 1980.

[3]Written data received from Town personnel following January 31, 1980 meeting.

[4]Telephone communication with Ms. Graham on April 24, 1980.

[5]DHEC Staff Study on Fluoride for Aynor, South Carolina, dated May 15, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# BELMONT SUBDIVISION

# DORCHESTER COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

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# IN
# PUBLIC WATER SUPPLY
# OF
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# HORRY COUNTY, SOUTH CAROLINA

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Belmont Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

Belmont Subdivision is an established residential community. It is located in Dorchester County and lies to the west of the Town of Summerville. The water system serving Belmont Subdivision provided water to 32 consumers, approximately 100 people, as of July, 1978.[1]

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 160 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand 5,120 gallons
- Maximum Daily Demand 9,216 gallons

### Supply Requirement

The domestic supply requirement for this community was assumed to be 6 GPM, the average flow during a period of maximum demand.

## EXISTING SUPPLY

The existing water supply consists of one well of unreported capacity.[1] The water produced by the well contains 2.9 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.[2]

## FLUORIDE REDUCTION

### METHOD

Based upon available information, the most practical and least expensive method of effecting a fluoride reduction in this community is to abandon the existing supply and purchase water from the Town of Summerville. Belmont Subdivision is located approximately 4,200 feet from the nearest Summerville main; therefore, construction of a new 6" line will be required as shown on Figure No. 1. It should be noted that the proposed installation includes four hydrants spaced at 1,000 foot intervals along Sweatman Road.

### COST

Due to the lack of fire hydrants within the subdivision, it was determined that a 2" master meter would meet the requirements of this community. The cost of a 2" connection including the meter has been estimated at $1,200.[3] It will be the owner's responsibility to obtain the necessary permits, to design the waterline, and to subsequently install it.

The estimated construction cost of the complete line including 6" pipe, hydrants, tap, meter, engineering, and project contingency expenses is $35,200. Annual debt service expense on that amount calculated at 12% for 30 years is $4,369. The increase in annual expenses attributable to this change was calculated as follows:

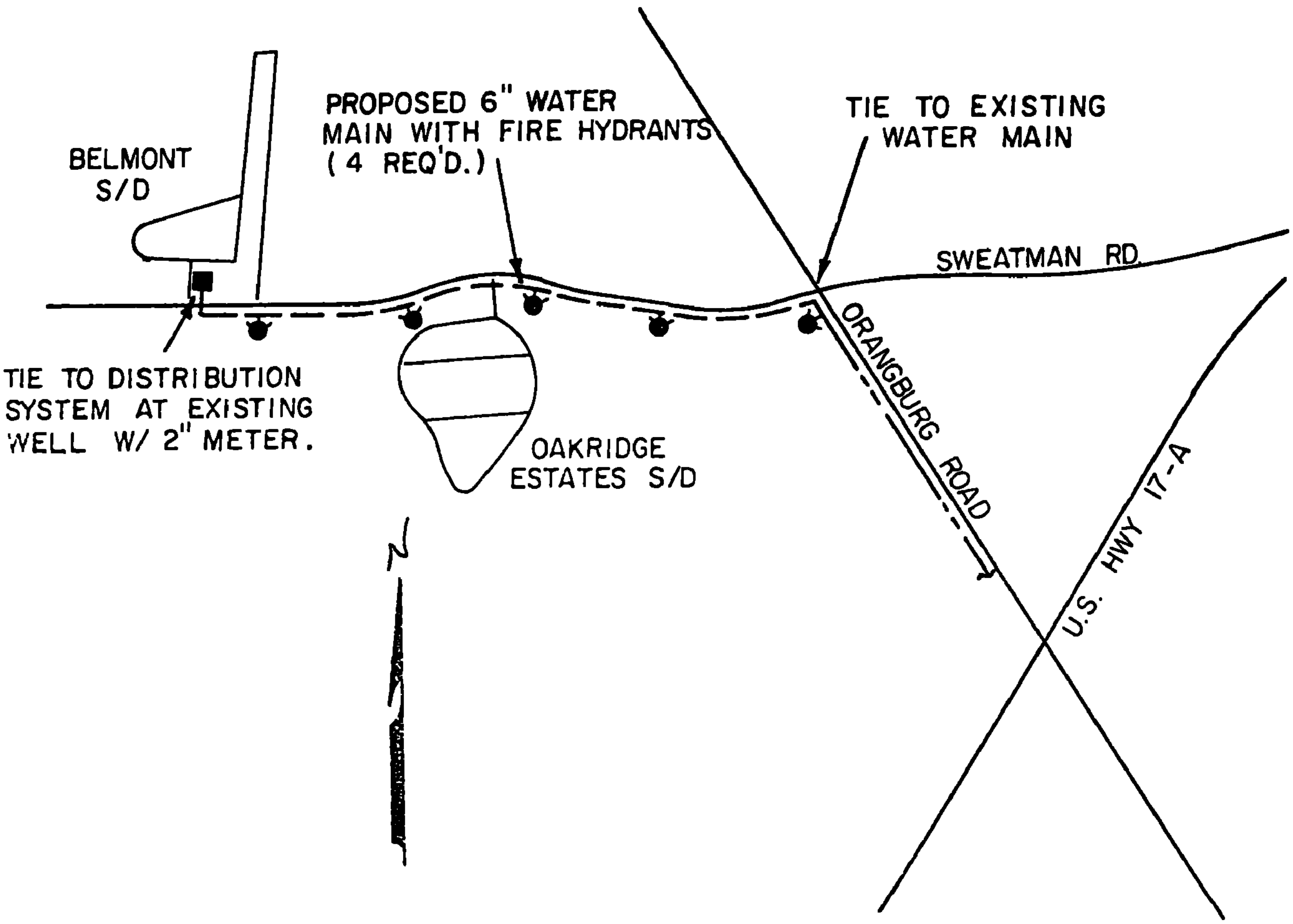


Figure 1

SCHEMATIC DIAGRAM OF PROPOSED

WATER SUPPLY ADDITIONS
at

BELMONT SUBDIVISION

| | | |
|---|---|---|
| • | Debt Service | $4,369 |
| • | Plus Water Purchase | 1,754 |
| | Subtotal | $6,123 |
| • | Less Power Cost | 123 |
| | Total Annual Increase | $6,000 |

Presuming that the increase calculated above will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $187.50 per consumer ($15.63/month).

IMPLEMENTATION

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of the above-described facilities can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

OPERATOR REQUIREMENTS

Operator requirements for this system will not change as a consequence of fluoride reduction in the water supply.

## REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for Belmont Subdivision, Dorchester County, April 25, 1978."

[2]South Carolina Department of Health and Environmental Control, Water Analysis Report on Laboratory Sample No. R06208-1602, June 29, 1978.

[3]Personal communication, Mr. Roy Winey, Town of Summerville, March 27, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# BRIARCLIFFE SUBDIVISION
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Briarcliffe Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Briarcliffe Subdivision water system has two wells in use and a third well which is not used because it has a high iron concentration.[1] The system has a 50,000 gallon elevated tank which is used for water storage.[2] Data on record with DHEC or from the Owner on the existing wells is tabulated below.

| BRIARCLIFFE SUBDIVISION EXISTING WELL DATA | | | |
|---|---|---|---|
| Well | Capacity (Gal/Min) | Fluoride[4] (mg/l) | Iron[4] (mg/l) |
| #1 (Deep) | 300 | 5.0 | 0.20 |
| #2 (Shallow) | 70 | 0.1 | 0.7 |
| #3 (Shallow) | 60 | | |

### FUTURE CONDITIONS

The Briarcliffe Subdivision has a planned ultimate development lot and multifamily unit layout which would have a total of approximately 773 residential units.[3] Using their current average water use of 289 GPD per dwelling, their future average water use would be 0.223 MGD. Using their current estimated peak day factor, their future peak day would be approximately 0.37 MGD. It should be noted that the 300 GPM well alone could meet this estimated demand in approximately 20.6 hours of pumping. Therefore, for the purposes of this report, the alternatives to solve the fluoride reduction problem will be sized to provide at least 300 GPM of acceptable water.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: DRILL WELL(S) FOR BLENDING

### Method

The alternative would involve the drilling of an additional shallow well or wells to blend with the existing high fluoride well. This alternative is heavily dependent upon the quantity and quality of low fluoride ground water available, which, lacking other data, will be assumed to be similar to the existing shallow well presently in use. Using the fluoride concentration of the two wells presently used, it has been calculated that a blended water fluoride concentration of 1.4 mg/l can be achieved by blending 80 GPM of the high fluoride water with 220 GPM of the low fluoride, shallow well water. The 1.4 mg/l blend concentration was selected to cover variations which occur in fluoride concentrations and well pumping rates. This yield and blend could possibly be achieved by adding an additional shallow well or wells, tying these to the three existing wells and replacing the existing deep well pump with an 80 GPM unit.

One known problem with blending at the above-described rate is that the blend water iron concentration is estimated to be 0.57 mg/l which is well above the accepted aesthetic limit of 0.3 mg/l. However, since this limit is a Secondary Standard with DHEC, the high iron concentration can be accepted, provided it can be kept in solution, by sequestering and the users accept this water without complaint. Also, it is important that the water from the two wells be tested at the prescribed blend to see if any other problems occur.

It should be mentioned that, although it does not appear that iron removal treatment will be required, this possibility does exist.

The components of the basic well blending solution are (1) the installation of two additional shallow wells on properly spaced new well sites, (2) the piping of these wells to the main deep well and the blending of new wells with the three existing wells, (3) the installation of an iron sequestering unit with a small enclosure building, and (4) the replacement of the deep well pumps with an 80 GPM pump.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $110,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 13,657 |
| • Annual added operation cost using 1979 water use | $ 1,200 |
| • Total estimated added annual cost | $ 14,857 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of rate structure studies, required referendum, funding procurement, etc., provided only iron sequestering is required. It is estimated that the time would increase to 42 months if iron removal treatment is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative, if only iron sequestering is required. However, if iron removal treatment is necessary, it is anticipated that an additional water system operator may be required.

ALTERNATIVE NO. 2: PURCHASE WATER FROM MYRTLE BEACH

Method

The alternative would involve the installation of approximately 3,500 feet of not less than 6 inch diameter water main and a master meter assembly and vault.[5] Myrtle Beach has indicated[5] that a 12 inch water main would be the smallest size that they would like to have installed. The details of exactly what size water main and how it would be paid for would obviously have to be worked out with Myrtle Beach.

For this report, costs will be estimated on the basis of a 6 inch water main and meter installation. The 6 inch meter installation fee was estimated[5] to be $9,000 plus a $625 deposit for an out-of-town customer and $4,500 plus a $325 deposit for an in-town customer. The actual water use costs would be $1.14 per 1,000 gallons for an out-of-town customer and $0.57 per 1,000 gallons for an in-town customer. Since Briarcliffe could be annexed into the City of Myrtle Beach to save costs, it will be assumed for this report that the in-town fees will be in effect. Also, since Myrtle Beach will need to increase their rates to cover the cost of reducing the fluoride in their system, the water rate increase due to their least expensive alternative must be added to their current $0.57 per 1,000 gallon rate. This would add approximately $1.07 per 1,000 gallons to the cost of the water.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $35,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 4,345 |
| • Annual added water cost, less power cost, using 1979 water use | $70,261 |
| • Total estimated added annual cost | $74,606 |

Implementation

It has been estimated that securing an agreement, design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of rate structure studies, required referendum, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

## ALTERNATIVE NO. 3: FLUORIDE REMOVAL TREATMENT

### Method

This solution would involve the treatment of the 300 GPM flow from Well #1. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the sanitary sewer system. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

### Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $397,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 49,284 |
| • Annual added operation cost using 1979 water use | $ 38,500 |
| • Total estimated added annual cost | $ 87,784 |

### Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of completion of required referendum, rate structure studies, funding procurement, etc.

### Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| BRIARCLIFFE SUBDIVISION<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 300 | $13,657 | $ 1,200 | $ 35.63 |
| No. 2: Purchase | N/A | $ 4,345 | $70,261 | $178.91 |
| No. 3: Treatment | 300 | $49,284 | $38,500 | $210.51 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[2] — $20.05
- Estimated monthly increase — 2.97

Adjusted Monthly Water Rate — $23.02/consumer

REFERENCES

[1]Meeting and discussion with Mr. Sing, Briarcliffe water system operator for Carolina Water Services, Inc., Owner, on January 24, 1980.

[2]DHEC Staff Study on Fluoride for Briarcliffe Subdivision, dated May 15, 1978.

[3]Telephone communication with Mr. Sing, on May 1, 1980.

[4]Telephone communication with Mr. Fred Soland of DHEC on May 2, 1980.

[5]Telephone communication with Mr. Bill Bull, Superintendent of Water & Sewer Department for Myrtle Beach, South Carolina, on April 21, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# BUCKSPORT WATER COMPANY

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


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J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Bucksport Water Company. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The Bucksport Water Company provided service to 303 consumers, approximately 1,060 people, as of February, 1978.[1]

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 200 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand — 60,600 Gallons
- Maximum Daily Demand — 109,080 Gallons

### Supply Requirement

Utilizing an assumed criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period, the present supply requirement was calculated to be 113 GPM.

### Existing Supply

The existing supply consists of two deep well installations. One is located along U.S. Highway 701 and consists of one 175 GPM well and one 10,000 gallon pneumatic storage tank. The other is located along S. C. Route 237 and consists of one 90

GPM well and one 5,000 gallon pneumatic storage tank.[2] Water supplied by the existing wells contain 2.6 mg/l fluoride and 3.0 mg/l fluoride respectively.[2]

## FLUORIDE REDUCTION

Preliminary investigative efforts identified five viable fluoride reduction alternatives for the Bucksport Water Company. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

It should be noted that the scope of this study was limited and therefore assumed that the existing distribution system has sufficient hydraulic capacity to accomodate changes in the location and/or input in the point of supply.

### ALTERNATIVE NO. 1: BLENDING

#### Method

Fluoride reduction can be achieved by drilling a series of shallow wells and blending their yield with that of the existing deep wells. Assuming a fluoride concentration of 0.1 mg/l in the proposed shallow wells, a shallow/deep mix of 1.00 GPM/ 0.92 GPM will result in a blend having a fluoride concentration of 1.4 mg/l.

This alternative addresses construction of shallow blending wells at Well #1 (175 GPM). Well #2 (90 GPM) was not considered because increased capacity (shallow plus deep) of Well #1 will exceed the existing capacity of both deep wells. Utilizing a blend ratio of 1 shallow/0.92 deep, the required shallow well capacity was determined to be 161 GPM. Lacking accurate data on the quantity of shallow ground water available in the Bucksport area, yield was conservatively estimated at 60 GPM per well, requiring construction of three wells.

The capacity of the system as proposed herein should accommodate a consumer population of 600 residential connections, 2,100 people. That capacity was verified as follows:

- Well capacity based upon a 16-hour operating period

  Required

  $$\frac{(600 \text{ taps})(200 \text{ GPD})(1.8)}{(16 \text{ hr})(60 \text{ min/hr})} = \underline{\underline{225 \text{ GPM}}}$$

  Available

  175 GPM + 180 GPM = 355 GPM

- Pneumatic storage capacity required.[3]

  Total Instantaneous Demand

  *(0.8 GPM)(600 homes) = 480 GPM

  Instantaneous Supply Demand

  (480 GPM)(20 min) = 9,600 GPM

  Available Pumping Capacity

  (355)(20 min) = 7,100 Gallons

*The instantaneous demand for a system with 600 homes connected to it is 0.8 GPM/ connection.

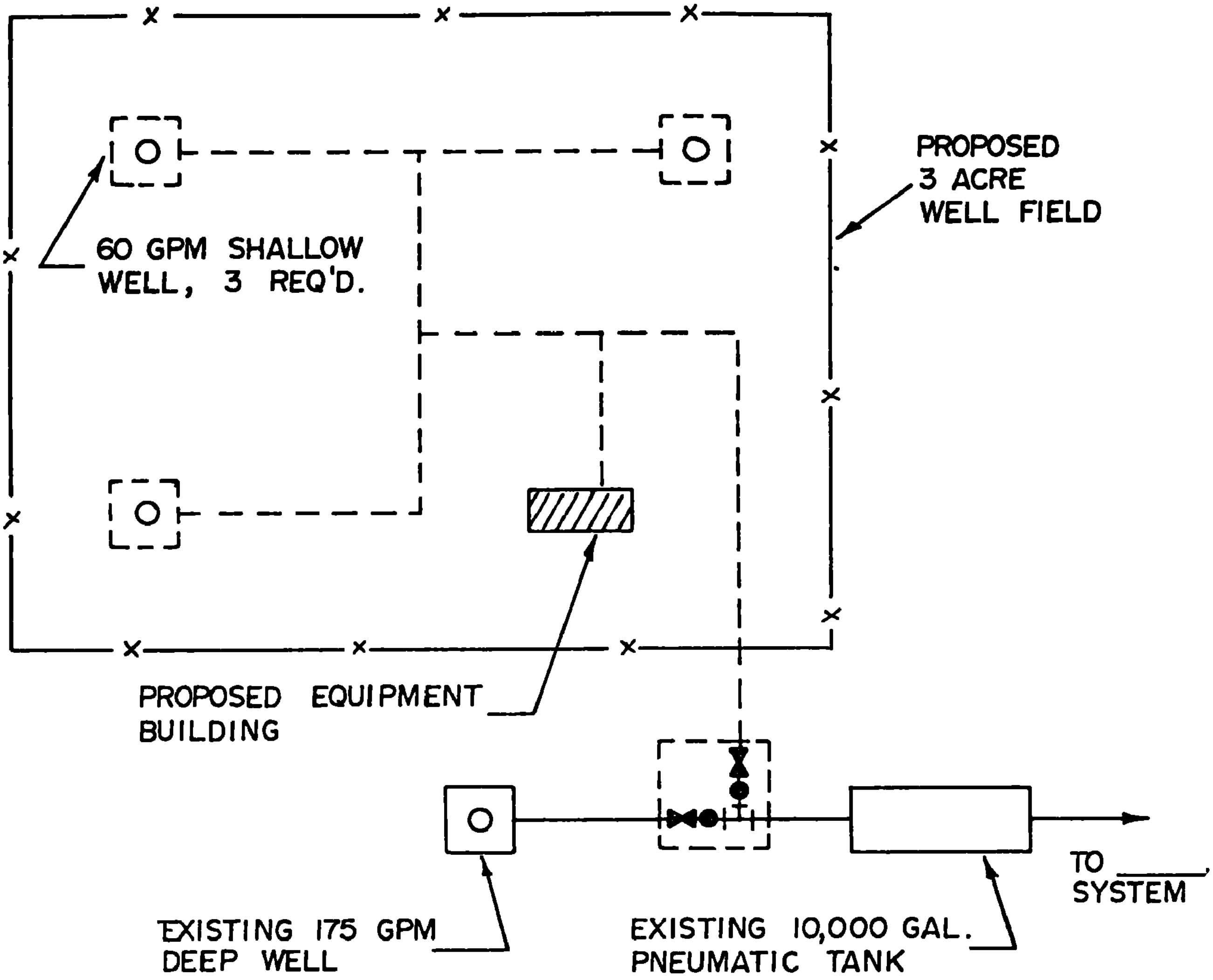


FIGURE 1

SCHEMATIC DIAGRAM OF

PROPOSED WATER SUPPLY ADDITIONS

AT

BUCKSPORT WATER COMPANY

Pneumatic Storage Requirement

$$\frac{9{,}600 \text{ gal} - 7{,}100 \text{ gal}}{**0.25} = 10{,}000 \text{ Gallons}$$

Sufficient iron to cause aesthetic problems, such as staining of plumbing fixtures, should be expected in the proposed shallow wells. With the favorable ratio of deep/shallow well water that will be utilized in this system, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow wells will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump.

A schematic diagram of the proposed water supply additions is presented in Figure 1. A complete list of the facilities recommended is as follows:

- Three 60 GPM shallow wells. Each well should be equipped with a vertical turbine pump set up to operate simultaneously with the deep well pump.
- One concrete valve pit constructed at the intersection of the deep and shallow well lines. The pit should contain meters and valves on both supply lines. The chlorine injection point should be in the tee or the line leaving the pit.
- Polyphosphate mixing and feed facilities. The concept presented herein utilizes a single chemical feed point in the common main leading from the shallow wells. However, it should be noted that iron must be in a soluble form for sequestering to be effective, and that pumping and/or conveyance may cause the iron to precipitate. Should that situation occur, the chemical feed point may have to be moved or iron treatment may become necessary.

**Pneumatic tanks ideally satisfy a given water storage requirement by utilizing 25% of the available tank volume for water storage and 75% for air storage.

Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $180,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $22,345 |
| • Operations and Maintenance | 500 |
| Total Estimated Annual Cost | $22,845 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: PURCHASE

Method

This alternative addresses abandonment of the existing deep well supply and replacing same with water purchased from the City of Conway. The connection would be effected by constructing a short section of main in the right-of-way of U.S. Highway 707 and installing a master meter.

Cost

The estimated construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $100,000. Annual costs are summarized below.

| | | |
|---|---|---|
| • | Debt Service on a 30-Year Loan at 12% | $12,414 |
| • | Water Purchase | 29,151 |
| | Subtotal | $41,565 |
| • | Less Power Cost | 2,565 |
| | Total Estimated Annual Cost Increase | $39,000 |

The water purchase expense listed above was calculated at a minimum rate of $5.00/month/consumer for the first 2000 gallons and $0.75 for each additional 1000 gallons,[4] the prevailing service charge rendered by the City of Conway. It should be noted that City was included in this study and it, too, will incur additional expenses as a result of reducing the fluoride concentration of the water supply. Assuming a uniform amortization of the cost associated with the least expensive alternative developed for Conway, water rates would increase by $0.64 per 1000 gallons. Utilizing the higher rate, Bucksport's water purchase expense was recalculated to be $43,307, bringing the total estimated annual cost increase for Alternative No. 2 to $53,156.

## Implementation

The implementation of this alternative is solely dependent on the availability of water from the City of Conway. Assuming immediate availability, this alternative could be implemented 24 months after completion of required referendums, rate structure studies, funding procurement, contract negotiations, etc.

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 3: REGIONAL SYSTEM

Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River at Bucksport. Distribution mains convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system will be $2.95 per 1000 gallons. At the current average daily demand of 60,600 gallons, Bucksport's annual cost will be $62,251.

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 60 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

## ALTERNATIVE NO. 4: TREATMENT

### Method

This alternative addresses treatment of a portion of the flow from the existing 175 GPM well utilizing activated alumina. The system would be sized to treat 110 GPM, the remaining 65 GPM would bypass treatment and be blended with the defluoridated water. A liquid waste stream from the unit would be discharged to a wastewater equalization tank. Periodically, the contents of said tank would be trucked to the Pee Dee River for disposal. Due to the limited amount of water storage capacity available on this system, a regeneration tank and pump were included in the cost estimate.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

### Cost

The construction cost of Alternative No. 3 including engineering and project contingency expenses has been estimated at $470,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $58,346 |
| • Operations and Maintenance | 46,654 |
| Total Estimated Annual Cost Increase | $105,000 |

### Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 36 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an A operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## ALTERNATIVE NO. 5: PEE DEE RIVER

### Method

This alternative addresses the construction of an 0.25 MGD package water treatment plant which would process water drawn from the Pee Dee River. The proposed capacity (175 GPM) was selected for comparison purposes with the other alternatives. In actuality, a more complete assessment of future water demand might dictate design and construction of a facility of different capacity.

### Cost

The construction cost of Alternative No. 5 including engineering and project contingency expenses has been estimated at $500,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $62,070 |
| • Operations and Maintenance | 80,430 |
| Subtotal | $142,500 |
| • Less Power Cost (abandoned wells) | 2,500 |
| Total Estimated Annual Cost | $140,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 48 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Construction of the treatment facility described in this alternative will require that a minimum of two water plant operators be added to the existing staff. Under present regulations, one class "C" operator living within one hours travel time of the plant and one class "D" operator will be required.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| BUCKSPORT WATER COMPANY<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 355 | $22,345 | $ 500 | $ 75.39 |
| No. 2: Purchase | N/A | $12,414 | $40,742 | $ 175.43 |
| No. 3: Regional | 150 | $56,226 | $ 6,025 | $ 205.00 |
| No. 4: Treatment | 175 | $58,346 | $46,654 | $ 346.53 |
| No. 5: Pee Dee | 175 | $62,070 | $77,930 | $ 462.05 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative will result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[1] | $15.70 |
| • Estimated monthly increase | 6.13 |
| Adjusted Monthly Water Rate | $21.83/consumer |

REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for Bucksport Water Company, Horry County, undated."

[2]South Carolina Department of Health and Environmental Control, Water Analyses Reports on Laboratory Samples numbered P 1782 and P 1783, April 3, 1980.

[3]Joseph S. Ameen, "Community Water Systems", Technical Proceedings, High Point, North Carolina, 1971.

[4]Personal communication, Mr. Winfield, City of Conway, April 14, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# BULLS BAY RURAL COMMUNITY WATER DISTRICT

# CHARLESTON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

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J. E. SIRRINE COMPANY and AWARE, INC.

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## INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Bulls Bay Rural Community Water District. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The Bulls Bay Rural Community Water District provided service to 856 consumers, approximately 3,167 people, as of January, 1980.[1]

Population projections for the unincorporated areas of Charleston County lying east of the Cooper River were obtained from the Berkeley Charleston Dorchester Council of Governments. Those projections were utilized to develop consumer projections for the district. It was deemed unrealistic to convert the entire unincorporated area population directly to consumers because the district does not serve the entire area. It was however, reasoned that the growth percentages could be applied to the existing consumer population to develop projected system growth. The computations that were made are summarized in the following table.

| BULLS BAY RURAL COMMUNITY WATER DISTRICT CONSUMER POPULATION PROJECTIONS | | | |
|---|---|---|---|
| Year | Population* Projection | % CHANGE | Consumers |
| 1980 | 14,942 | -0- | 856 |
| 1985 | 18,477 | 23.7 | 1,059 |
| 1990 | 21,226 | 14.9 | 1,217 |
| 1995 | 23,866 | 12.4 | 1,368 |

* Population projection for the entire unincorporated area of Charleston County lying east of the Cooper River.

WATER SUPPLY REQUIREMENTS

Current Demand

Daily water demand in the service area currently averages 100,000 GPD.[1] That translates to an average of 117 GPD/connection. Maximum daily demand was considered to be approximately 180% of average daily usage.[2] Accordingly, the current water demand placed on the system has been established as follows:

- Average Daily Demand 100,000 Gallons

- Maximum Daily Demand 180,000 Gallons

Projected Demand

The 117 GPD/connection which was utilized in the computation of current demand is unusually low as compared to usage recorded in similar communities. Two factors that conceivably influence the low usage are higher than average water rates and the fact that the system is relatively new. Most homes that are connected to the system obtained water from private wells prior to a public supply being made available to them. Those wells are probably utilized by consumers for non-potable uses such as car washing and lawn watering in an effort to minimize their monthly bills. This practice will presumably be continued by homeowners that presently own a private well. It is however, unlikely that owners of new homes will invest in private wells as a means of avoiding a monthly overage charge of a few dollars. Consequently, per connection water demand can be expected to increase as the system grows. For the purpose of projecting future demand, 160 GPD/connection was assumed as a system average. Those projections have been summarized in the following table.

| BULLS BAY RURAL COMMUNITY WATER DISTRICT PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 100,000 | 180,000 |
| 1985 | 170,000 | 306,000 |
| 1990 | 195,000 | 351,000 |
| 1995 | 219,000 | 394,000 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period. Those values are as follows:

- 1980 - 186 GPM
- 1985 - 319 GPM
- 1990 - 366 GPM
- 1995 - 410 GPM

EXISTING SUPPLY

The existing water supply consists of one deep well having a rated capacity of 500 GPM and eight shallow wells having a combined capacity of 200 GPM. Two of the shallow wells have been abandoned due to the presence of objectionable concentrations of tannic acid. The remaining six are operational and produce approximately 150 GPM. The water produced by the deep well contains 5.0 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.

The shallow wells were constructed to serve as a source of blending water for the deep well. Blending being the method chosen to reduce the fluoride concentration in the water supply to the legal limit or less. To date, the blending process has been ineffective. Operation of the deep well at 500 GPM would require production of approximately 1,250 GPM of fluoride-free water to effect an acceptable mix.

The shallow wells pump into a common six-inch main which terminates through a metered connection to the inlet of an existing 25,000 gallon ground level mixing tank. The deep well is also metered and connected to the inlet side of the mixing tank. Chlorine is injected in the tank inlet thereby disinfecting the combined flow.

PROPOSED FACILITIES

The district has obtained permission from the County of Charleston to construct eight additional shallow wells on county property.[1] The site is presently fenced and is located approximately 0.3 of a mile from the existing field of shallow wells.

## FLUORIDE REDUCTION

### METHOD

Blending deep and shallow well water in the proper proportions will reduce the fluoride concentration in the district's supply to acceptable levels. Maintaining a shallow to deep blend ratio of 2.5/1 will yield a product having a fluoride concentration of 1.4 mg/l.

The success of blending is dependent upon control of the flow from the deep well. At the 2.5/1 ratio given above, the deep well flow with the six existing shallow wells should be 60 GPM. After the eight new wells are constructed, the deep well flow should be increased to 140 GPM. Deep well flows ranging from 50 GPM to 150 GPM are not practically obtainable by throttling the existing 500 GPM vertical turbine pump. Accordingly, we hereby recommend that a new horizontal booster pump be installed in the existing building that houses the deep well. (See Figure 1). Artesian pressure of the existing deep well appears to be sufficient to accommodate the operation of the booster pump without difficulty. However, the residual artesian pressure of the deep well should be checked at pumping rates of 50, 100, 150, 200 and 250 GPM prior to initiating the actual design of the booster pump installation. The proposed pump discharge should be fitted with a globe valve to facilitate adjustment of the flow rate between 40 GPM and 150 GPM. Existing meters in both deep and shallow well discharge lines should be used to monitor the flow rates. Pump controls should remain essentially unchanged providing for simultaneous operation of the proposed booster pump with the shallow wells.

Recognizing that the above-described blending process dictates a shift from deep well water to a blend of predominantly shallow well water, the nuisance problems

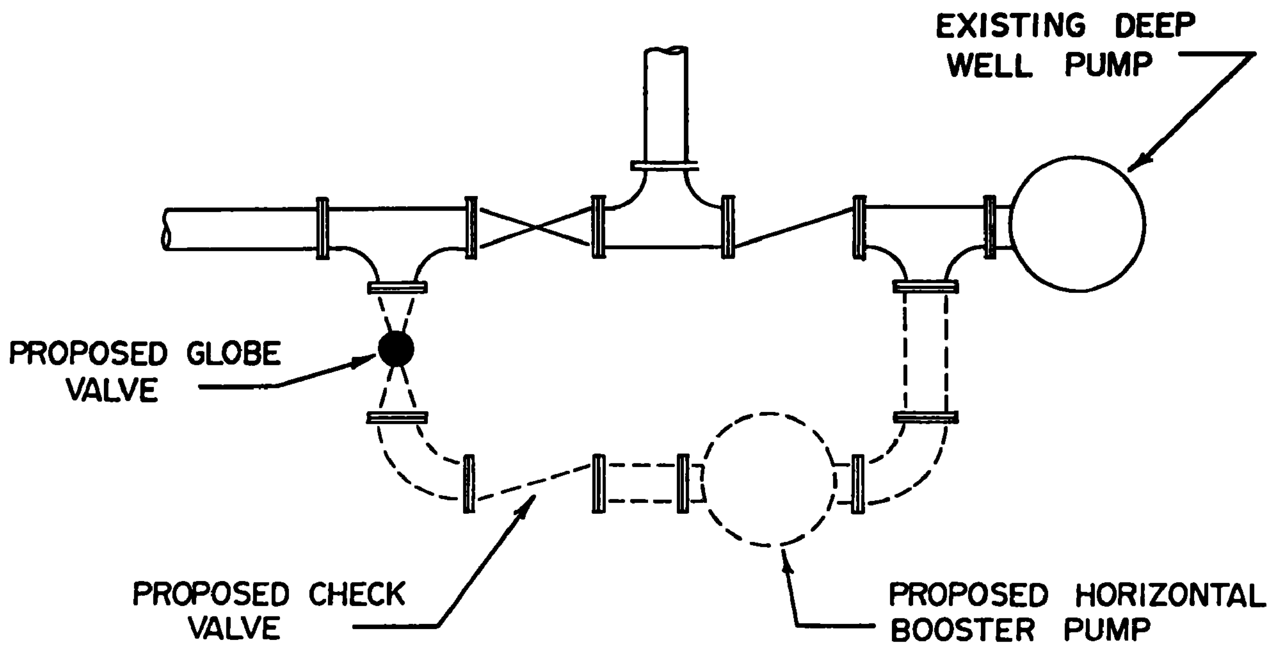


Figure 1

SCHEMATIC DIAGRAM OF PROPOSED

BOOSTER PUMP INSTALLATION

at

BULLS BAY RURAL COMMUNITY WATER DISTRICT associated with iron in the water supply must be considered. The existing shallow wells contain 0.4 PPM iron.[3] At that concentration, iron in its soluble form (water clear, no red coloring apparent) can usually be stabilized or sequestered by adding polyphosphates. Where feasible, sequestering is relatively simple and inexpensive. Unfortunately, the physical arrangement of this system may create some difficulty in locating a suitable feed point for the chemical. Stabilization of the iron requires that it be in a soluble form. Pumping and/or conveyance to the deep well site may cause the iron to precipitate (turn the water red).

It was beyond the scope of this report to determine whether or not sequestering is practical; accordingly, the cost estimates assume the two following extremes:

- The addition of polyphosphates at the deep well site will satisfactorily sequester the iron contained in the shallow well water, and
- Filtration equipment will be installed at the deep well site for the purpose of iron removal from the shallow well water.

COST

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the facilities were constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the estimated annual cost increase is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

Immediate compliance can be achieved by installing the proposed booster pump and utilizing the six existing shallow wells. The installed cost of said pump and a polyphosphate feed system would be approximately $14,000; however, the system capacity would be nearly equal to the existing demand and is therefore, desirable but will only serve as a "STOP-GAP" measure. Full compliance will require the construction of the eight new wells plus the booster pump. Capacities achievable with both existing and proposed shallow wells were calculated as follows:

- Existing Shallow Wells

| | | |
|---|---|---|
| (6 wells)(25 GPM Ea.) | = | 150 GPM |
| Booster Pump | = | 60 GPM |
| System Pumping Rate | = | 210 GPM |
| (210 GPM)(60 min/hr)(16 hr) | = | 201,600 GPD |
| Note: 1980 Demand | = | 180,000 GPD |

- Existing and Proposed Shallow Wells

| | | |
|---|---|---|
| (14 wells)(25 GPM Ea.) | = | 350 GPM |
| Booster Pump | = | 140 GPM |
| | | 490 GPM |
| (490 GPM)(60 min/hr)(16 hr) | = | 470,400 GPD |
| Note: 1995 Demand | = | 394,000 GPD |

Without Iron Removal

The estimated construction cost of the new wells, proposed booster pump, and polyphosphate feed equipment including engineering and project contingency is $290,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $36,000 |
| • Operations and Maintenance (polyphosphates) | 250 |
| Total Estimated Annual Cost Increase | $36,250 |
| • Cost increase per consumer | $ 42.35 |

## With Iron Removal

The estimated construction cost of the new wells, proposed booster pump, iron removal filters, including engineering and project contingency expenses is $580,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $72,001 |
| • Operations and Maintenance | 17,999 |
| Total Estimated Annual Cost Increase | $90,000 |
| • Cost Increase Per Consumer | $105.14 |

## Water Rates

As of May, 1978, the average monthly water bill rendered for service from this system was $28.20.[4] Assuming that the increased annual cost will be amortized uniformly, the average water bill will increase to the following:

| | |
|---|---|
| • Without iron removal | $31.73 |
| • With iron removal | $36.96 |

## OPERATOR REQUIREMENTS

### Without Iron Removal

Operator requirements will not change as a consequence of fluoride removal.

### With Iron Removal

The additional level of effort required to operate and maintain the filters will create one additional staff position for a water system operator.

## IMPLEMENTATION

Design and construction of the wells and booster pump can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc. Should the filters be necessary, eighteen additional months should be added for a project total of 42 months.

# FLUORIDE REDUCTION IN PUBLIC WATER SUPPLY OF CENTRAL MOBILE HOME VILLAGE HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture of

J. E. SIRRINE COMPANY and AWARE, INC.

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## REFERENCES


[1]Personal Communication, John Jacques, Bulls Bay Community Water District, January, 1980.

[2]Clark, J. W., et al. Water Supply and Pollution Control, 1971, International Textbook Company, Scranton, Pennsylvania.

[3]Parker Laboratory, Inc., Analysis Report Number 19871, dated September 20, 1976.

[4]South Carolina Department of Health and Environmental Control, "Staff Study for Bulls Bay Rural Community District", May 1, 1978.

Discussions with United States Geological Survey personnel and representatives of South Carolina Water Resources Commission indicate that subsurface conditions conducive to producing a low fluoride water source improve as the distance from the ocean increases. Consequently, this alternative addresses construction of low-fluoride blending wells in close proximity to the Jamestown Well (#5) and the Caropines Well (#7). The remaining existing wells would be abandoned.

The WRC representative predicted that an average yield of 60 GPM should be possible per shallow well. Therefore, multiple shallow wells and well lots with connecting piping will be required to serve the two existing wells. Also, assuming a shallow well fluoride concentration of approximately 0.2 mg/l, the pumping rate of the two existing wells would be reduced to achieve an acceptable blend while maintaining a total yield of 1580 GPM.

The following table lists the amount of existing and low fluoride blend water required for an acceptable fluoride blend and the maximum blend water iron concentration to achieve a 1.0 mg/l iron blend. The 1.0 mg/l iron concentration is somewhat arbitrary. Additionally, the critical factor for this alternative is that the iron in the blended water must be less than 0.3 mg/l, which appears unlikely, or be suitable for sequestering to achieve an acceptable supply. To allow a safety factor, a 1.4 mg/l fluoride concentration has been used as the acceptable concentration in the blended water.

GARDEN CITY BEACH
BLENDING REQUIREMENTS

| Existing Wells | | | Proposed Wells | | |
|---|---|---|---|---|---|
| Well | Fluoride (mg/l) | Iron (mg/l) | Reduced Capacity | Capacity | Iron (mg/l) |
| #5 | 3.2 | 0.07 | 280 GPM | 420 GPM | 1.62 |
| #7 | 4.0 | 1.30 | 280 GPM | 600 GPM | 0.86 |

Iron sequestering units were assumed to be necessary at each main well site. To indicate the impact of excessively high iron content in the new wells, the cost of iron removal treatment has also been estimated and was included in the cost section as a separate project estimate. It was beyond the scope of this study to determine whether iron sequestering or removal treatment will be required.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $1,000,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 124,150 |
| • Annual added operation cost using 1979 water use | $ 4,000 |
| • Total estimated added annual cost | $ 128,150 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $2,000,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 248,300 |
| • Annual added operation cost using 1979 water use | $ 20,000 |
| • Total estimated added annual cost | $ 268,300 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 30 months of the completion of required referendums, rate structure studies, funding procurement, etc. If iron removal becomes necessary, implementation time will increase to 54 months.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative, if iron sequestering is required. However, if iron removal

REFERENCES

[1]Meeting and discussion with Mr. Sing, water system operator for Carolina Water Services, Inc., Owner, on January 24, 1980.

[2]Letter to DHEC's Fred Soland from Carolina Water Service, Inc. dated October 9, 1979.

[3]Meeting and discussion with Mr. Allen Zack of the U.S. Geological Survey (USGS) on February 5, 1980 and Mr. Larry West of the S.C. Water Resources Commission (WRC) by phone on April 8, 1980.

[4]DHEC Staff Study on Fluoride for Garden City, dated May 8, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# PAWLEY'S ISLAND/MURRELL'S INLET COMBINED WATER SYSTEM

GEORGETOWN COUNTY WATER AND SEWER AUTHORITY

GEORGETOWN COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

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J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Pawley's Island/Murrell's Inlet Combined Water System. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

Georgetown County Water and Sewer Authority (GCWSA) is planning to connect their Pawley's Island-Litchfield Beach water system with their Murrell's Inlet water system within the next couple of years.[1] This report will evaluate both communities as one system, the Pawley's Island/Murrell's Inlet Combined System.

Data relative to the existing in-service wells was obtained from SC DHEC. That information is tabulated below.

| PAWLEY'S ISLAND/MURRELL'S INLET EXISTING WELL DATA | | | |
|---|---|---|---|
| Well | Capacity[1] (Gal/Min) | Fluoride[2] (mg/l) | Iron[2] (mg/l) |
| #1 S. Pawley's | Not in Use | 3.8 | 0.40 |
| #2 N. Pawley's | 225 | 4.2 | 0.10 |
| #3 S. Litchfield | 250 | 4.7 | 0.10 |
| #4 N. Litchfield | 225 | 5.7 | 0.10 |
| #6 Mid Litchfield | 275 | 4.4 | 0.10 |
| #11 Murrell's Inlet | 235 | 4.0 | 0.04 |
| #12 Hagley | 100 | 1.1 | 0.01 |
| #13 Litch. Plant. | 500 | 3.0 | 0.01 |

As indicated above, only Well #12 is known to have an acceptable fluoride concentration.

From data provided by GCWSA, the combined system served an average of approximately 2,555 residential equivalent customer connections in 1979, the actual number of customers being approximately 1,165.[1] The average water use for 1979 was approximately 0.273 MGD and the peak day was estimated to be approximately 1.73 MGD.

The combined system has in service one 250,000 gallon elevated tank at Murrell's Inlet, one 300,000 gallon elevated tank at Well #6, one 250,000 gallon elevated tank near S.C. Road #46 and Road #450, and one 20,000 gallon pneumatic tank at Well #12.[1] The storage has sufficient capacity to meet the average flow on a peak day for approximately 12 hours.

FUTURE CONDITIONS

The following table gives past and projected residential equivalent customer connections and water demands.[1]

| PAWLEY'S ISLAND/MURRELL'S INLET WATER DEMAND ESTIMATES | | | |
|---|---|---|---|
| Year | Connections | Maximum Month (MGD) | Maximum Day (MGD) |
| 1978 | 2270* | 0.93* | |
| 1979 | 2555* | 1.01* | 1.73 |
| 1990 | 6100 | 2.40 | 3.82 |
| 2000 | 8350 | 3.18 | 4.87 |
| * Historical Data | | | |

Utilizing a regulatory design criterion requiring that water wells be capable of meeting the maximum daily demand during a 16-hour pumping period, this system operated at design capacity (1810 GPM) on at least one occasion in 1979.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

The existing supply capacity of 1810 GPM will be utilized as a basis for evaluating the alternatives presented in the remainder of this report.

### ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

Method

This alternative would involve the drilling of wells to replace or blend with the existing high fluoride wells. This alternative is heavily dependent upon the quantity and quality of low fluoride ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used for blending and sufficient, satisfactory water located to replace or blend with the existing well water.

Based upon discussions with U.S. Geological Survey (USGS) personnel, it is anticipated that higher yields of good quality water are more likely to be found by drilling near the Intracoastal Waterway as opposed to wells drilled closer to the ocean.[3] One example is the Brookgreen Gardens ticket stand well which yields approximately 150 GPM, has a fluoride concentration of 0.2 mg/l and an iron concentration of less than 0.1 mg/l.[4] Discussions with the S.C. Water Resources Commission indicate that 75 to 100 GPM could be expected from shallow wells in the area.[5]

It appears that the best location for blending wells would be near the Litchfield Plantation well due to its proximity with the Intracoastal Waterway. This alternative assumes that all <u>other</u> high fluoride wells will be abandoned. The 100 GPM Hagley well can be used without any treatment, the blended water would provide the remaining 1710 GPM. The Litchfield Plantation well has a fluoride concentration of 3.0 mg/l and produces 500 GPM. To achieve a blend of 1710 GPM with a fluoride concentration of 1.4 mg/l, it would be necessary to construct 14 shallow wells with a combined fluoride concentration of 0.75 mg/l or less.

In addition to the blending wells, the estimated cost of this alternative includes iron sequestering equipment.

<u>Cost Estimate</u>

| | |
|---|---|
| • Capital cost estimate for project design and construction | $900,000 |
| • Annual added debt service assuming 12% loan for 30 years | $111,735 |
| • Annual added operation cost using 1979 water use | $ 2,730 |
| • Total estimated added annual cost | $114,465 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 30 months of the completion of required referendum, rate structure studies, funding procurement, etc., provided only iron sequestering is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

ALTERNATIVE NO. 2: FLUORIDE REMOVAL TREATMENT

Method

This solution would involve the treatment of the water from all existing high fluoride wells. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the proposed sanitary sewer system. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $2,255,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 279,936 |
| • Annual added operation cost | $ 208,000 |
| • Total estimated added annual cost | $ 487,936 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 48 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

ALTERNATIVE NO. 3: REGIONAL WATER SYSTEM

Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1000 gallons. At your current average daily demand of 273,000 gallons, your annual cost would be $293,953.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| GCWSA PAWLEY'S ISLAND/MURRELL'S INLET COMBINED SYSTEM ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Capital | Annual Cost Data | |
| | | | Operating | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 1810 | $111,735 | $ 2,730 | $ 44.80 |
| No. 2: Regional | 2653 | $265,504 | $ 28,449 | $115.05 |
| No. 3: Treatment | 1810 | $279,936 | $208,000 | $190.97 |

*Equivalent Residential Consumer

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[6] | $17.85 |
| • Estimated monthly increase | 3.73 |
| Adjusted Monthly Water Rate | $21.58/consumer |

REFERENCES

[1]Meeting and discussions with Bob Barker, Director of GCWSA, and Barry Green, Engineer with GCWSA, on January 23 and 24, 1980.

[2]DHEC Water Analyses: Well #1 dated October 4, 1976; Well #2 dated October 27, 1975; Wells #3, 4 & 6 dated July 19, 1976; Well #12 dated April 2, 1980. Parker Laboratory, Inc., Analysis, on Well #11 dated June 28, 1977.

[3]Meeting and discussion with Allen Zack of USGS Conway Office, on February 5, 1980.

[4]DHEC Water Analysis on Brookgreen Gardens Ticket Stand well, taken April 2, 1980.

[5]Telephone communication with Larry West of S. C. WRC Conway Office, on April 8, 1980.

[6]DHEC Staff Study on Fluoride for Murrell's Inlet and Pawley's Island systems, both dated April 17, 1978.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# GRAND STRAND WATER AND SEWER AUTHORITY
# GARDEN CITY AREA COMBINED WATER SYSTEM
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Garden City Area Combined Water System. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## EXISTING CONDITIONS

Grand Strand Water and Sewer Authority (GSWSA) is planning, or has already entered into agreement, to purchase three existing water systems in the Garden City area within a year and to interconnect those systems with GSWSA's Windjammer water system.[1] The three systems to be purchased are Jensen's Trailer Park, Green Lakes Mobile Home Park, and Mt. Gilead Water Company. For this report, the four water systems will be treated as one system and will be referred to as the Garden City Area Combined Water System of GSWSA.

Data on record with DHEC[2] relative to the existing wells which presently serve the individual systems are listed in the following table.

| GARDEN CITY AREA COMBINED WATER SYSTEM EXISTING WELL DATA | | | | |
|---|---|---|---|---|
| Well | Capacity (Gal/Min) | Fluoride (mg/l) | Iron (mg/l) | Storage (Gallon) |
| Green Lakes | 90 | 5.4 | 0.10 | 15,000 |
| Jensen's | 150 | 5.0 | 0.08 | 13,600 |
| Mt. Gilead #1 | 75 | 5.0 | | 2,500 |
| Mt. Gilead #2 | 125 | 5.0 | | |
| Windjammer | 200 | 5.1 | 0.10 | 10,000 |

Data received from present system owners[3] and from the DHEC staff studies on fluoride indicate that the present number of total customers served is approximately 800 of which 700 are mobile homes. Of these, the Green Lakes system's 250 trailers are occupied primarily during the summer months. The present annual average water use for the combined system is estimated to be 135,000 GPD.

FUTURE CONDITIONS

The future total number of customers is estimated to be 1,000. Using the present average water use per dwelling, the future average water use is estimated to be approximately 180,000 GPD.

If it is assumed that the peak day water demand will be 180%[4] of the average future water use during the summer, the future water demand would be approximately 0.385 MGD. With that demand, the desirable minimum pumping rate would be 400 GPM, which would allow the estimate peak day water demand to be pumped in 16 hours. If Ameen's method[5] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 600 GPM. Using this as the instantaneous water supply demand, Ameen's method[5] of checking pressure tank capacity indicates that a well capacity of 400 GPM should be adequate with the existing 41,100 gallons of pneumatic tank capacity.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 1,000 residential connections assumed as design condition.
2. Yield of new well is assumed to be 400 GPM.
3. Existing pressure tank size is 41,100 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on Pages 50 through 55.

Calculations:

1. 1,000 residences x 0.6 GPM/resd. = 600 GPM.
2. 600 GPM - 400 GPM well yield = 200 GPM tank demand.

3. 200 GPM x 20 minute demand = 4,000 gallons of stored water needed.

4. Minimum pressure tank size = 4,000 x 4 = 16,000 gallons.

5. Existing tank capacity is 41,100 gallons; therefore, existing tanks are adequate.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for this water system. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

### Method

The alternative would involve the drilling of new wells to replace or blend with the existing high fluoride wells. This alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used and sufficient, satisfactory water located to replace or blend with the existing well water.

Since the desirable future peak day pumping rate is 400 GPM and the present total pumping rate is 640 GPM, it will only be necessary to produce 400 GPM of blended water. Therefore, for this study it will be assumed that the total rate of blended water flow at each existing well site will have to be only 62.5% of the existing well capacity to achieve a total pumping rate of 400 GPM. The proper blend will be achieved by replacing the existing pumps with smaller pumps of the desired pumping rate. This will reduce the amount of low fluoride water required.

Assuming that the shallow ground water will have a fluoride concentration of 0.2 mg/l or less, the blend ratio graph in the Appendix can be used to determine the required quantity of low fluoride water needed to blend with existing high fluoride well water. The following table gives the amount of low fluoride water required for an acceptable fluoride blend and the maximum blend water iron concentration to achieve a 1.0 mg/l iron blend. The 1.0 mg/l iron concentration is somewhat arbitrary since the critical factor for this alternative to be a low cost solution is that the iron in the blended water must either be less than 0.3 mg/l, which appears unlikely, or be suitable for sequestering to achieve an acceptable water. To allow a safety factor, a 1.4 mg/l fluoride concentration has been used as the acceptable concentration.

GARDEN CITY AREA COMBINED WATER SYSTEM
BLENDING DATA

| Well | Fluoride (mg/l) | Iron (mg/l) | Reduced Capacity | Capacity | Iron (mg/l) |
|---|---|---|---|---|---|
| Green Lakes | 5.4 | 0.10 | 13 GPM | 43 GPM | 1.27 |
| Jensens | 5.0 | 0.08 | 24 GPM | 70 GPM | 1.31 |
| Mt. Gilead #1 | 5.0 | 0.10 | 12 GPM | 35 GPM | 1.31 |
| Mt. Gilead #2 | 5.0 | 0.00 | 20 GPM | 58 GPM | 1.31 |
| Windjammer | 5.1 | 0.10 | 30 GPM | 95 GPM | 1.29 |

Based on estimates received from private contractors[6] and a discussion with South Carolina Water Resources Commission personnel[7], it was assumed that shallow wells would produce 60 GPM of low fluoride water on the average. Therefore, multiple wells and well lots with connecting piping would be required to serve each deep well. It was also assumed that iron sequestering units would be required at each main well site. To indicate the impact of excessively high iron content in the new wells, the cost of iron removal treatment has also been estimated. However, it is beyond the scope of this study to predict whether or not iron removal treatment would be necessary.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $310,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 38,487 |
| • Annual added operation cost using estimated existing water use | $ 1,436 |
| • Total estimated added annual cost | $ 39,923 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $770,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 95,596 |
| • Annual added operation cost using estimated existing water use | $ 16,890 |
| • Total estimated added annual cost | $112,486 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendum, rate structure studies, funding procurement, etc. Should iron removal treatment become necessary, the time would increase to 48 months.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative. However, if iron removal treatment is necessary, it is anticipated that at least one additional staff position for water system operator would be created.

## ALTERNATIVE NO. 2: REGIONAL WATER SYSTEM

### Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

### Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1000 gallons. At the current average daily demand of

135,000 gallons, the annual cost for this system would be $145,361.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

ALTERNATIVE NO. 3: TREAT EXISTING WELLS

Method

This solution would involve the treatment of existing well water to reduce the fluoride concentration. To be consistent with the previous alternative, it was assumed that 400 GPM would be treated. Therefore, the two Mt. Gilead wells would be piped together and treated and the one well at Windjammer will be treated.

The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the proposed sanitary sewer system. Since stored water is limited in this community, it has been assumed that a regeneration tank and variable speed pump would be required at each treatment unit. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

## Cost Estimate

- Capital cost estimate for project design and construction — $840,000
- Annual added debt service assuming 12% loan for 30 years — $104,278
- Annual added operation cost using estimated existing water use — $ 62,000
- Total estimated added annual cost — $166,278

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 42 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| GSWSA GARDEN CITY AREA COMBINED SYSTEM ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 400 | $38,487 | $ 1,436 | $ 49.90 |
| No. 2: Regional | 267 | $131,293 | $14,068 | $181.70 |
| No. 3: Treatment | 400 | $104,278 | $62,000 | $207.85 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Assuming that the increased annual cost for the selected alternative will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $49.90 per consumer ($4.16/month).

## REFERENCES

[1] Telephone communication with Bob Barker, Director of GSWSA, on April 9, 1980.

[2] DHEC Staff Studies on Fluoride for:
Green Lakes Mobile Home Park, dated April 17, 1978;
Jensen's Trailer Park, dated March 30, 1978;
Mt. Gilead Water Company, dated April 19, 1978;
Windjammer Mobile Home Park, dated April 17, 1978.

[3] Meetings and discussions with system owners:
Green Lakes Mobile Home Park, on February 12, 1980;
Jensen's Trailer Park on February 6, 1980;
Mt. Gilead Water Company on February 5, 1980;
Windjammer Mobile Home Park on January 30, 1980.

[4] Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[5] Ameen, Joseph S., Community Water Systems, pages 50 through 55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[6] Well yields, chemical quality, and costs estimated by Robert B. Heater, President of Heater Well Company.

[7] Telephone communication with Larry West of the South Carolina Water Resources Commission, Conway Office, on April 8, 1980.

# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Crystal Lakes Mobile Home Park. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The Crystal Lakes Mobile Home Park water system provided service to 200 consumers, approximately 600 people, as of April, 1978.[1]

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 200 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand — 40,000 Gallons
- Maximum Daily Demand — 72,000 Gallons

### Supply Requirement

Utilizing a regulatory criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period, the present supply requirement was calculated to be 75 GPM.

### Existing Supply

The existing supply is obtained from two deep well installations. The larger consists of one 125 GPM well and one 16,000 gallon pneumatic storage tank. The other consists of one 75 GPM well and one 10,000 gallon pneumatic storage tank.[1] Water supplied by the existing wells contains 4.08 mg/l fluoride.[2]

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for the Crystal Lakes Mobile Home Park. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: WATER PURCHASE

### Method

This alternative addresses purchasing water from the City of Myrtle Beach. The connection would be made along U.S. Highway 17 in close proximity to Long Bay Estates. A distribution main, constructed at the expense of the mobile home park owner, would convey water from the city system to the mobile home park.

## Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $30,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $ 3,724 |
| • Water Purchase | 8,322 |
| Subtotal | $12,046 |
| • Less Power Cost (Abandoned Wells) | 1,046 |
| Total Estimated Annual Cost Increase | $11,000 |

The water purchase expense listed above was calculated at $0.57 per 1000 gallon, the prevailing bulk rate charged by the City of Myrtle Beach. It should be noted that the City was included in this study and that they too, will incur additional expenses as a result of reducing the fluoride concentration of their water supply. Assuming a uniform amortization of the cost associated with the least expensive alternative developed for Myrtle Beach, their bulk rate would increase from $0.57/1000 gallon to $1.64/1000 gallon. Utilizing the higher rate, Crystal Lakes' water purchase expense was recalculated to be $23,944, bringing the total estimated annual cost of Alternative No. 1 to $26,622.

## Implementation

The implementation of this alternative is solely dependent on the availability of water from Myrtle Beach. As of this writing, the minimum time required is estimated at 36-60 months.[3]

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: TREATMENT

Method

This alternative addresses treatment of a portion of the flow from the existing 125 GPM well utilizing activated alumina. The system would be sized to treat 85 GPM, the remaining 40 GPM would bypass treatment and be blended with the defluoridated water. A liquid waste stream from the treatment unit would be discharged directly to the sanitary sewer. Due to the limited amount of water storage capacity available on this system, a regeneration tank and pump were included in the estimated cost.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $355,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 30% | $ 44,070 |
| • Operations and Maintenance | 65,000 |
| Subtotal | $109,070 |
| • Less Power Cost (Abandoned Wells) | 1,070 |
| Total Estimated Annual Cost Increase | $108,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 36 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| CRYSTAL LAKES MOBILE HOME PARK ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Purchase | N/A | $ 3,724 | $22,898 | $133.11 |
| No. 2: Treatment | 125 | $44,070 | $63,930 | $540.00 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the incremental increase was calculated to be $133.11 per consumer ($11.09/month).

REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for Crystal Lakes Mobile Home Park, Horry County, April 17, 1978."

[2]South Carolina Department of Health and Environmental Control, Water Analysis Report on Laboratory Sample No. 626023, August 17, 1977.

[3]Personal communication, Jay Hood, Myrtle Beach, April 25, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# TOWN OF EDISTO BEACH

# COLLETON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Edisto Beach. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The water system serving the Town of Edisto Beach provided water to 750 consumers as of January 29, 1980.[1]

### WATER SUPPLY REQUIREMENTS

The Town of Edisto Beach is a resort community with several miles of public beach. Consequently, water demand fluctuates significantly in response to seasonal changes and day to day variations in weather conditions.

Accurate data relative to actual water demand is not readily available. Therefore, the following data will be utilized to determine present and future water demand:

- The existing supply, 360 GPM, operates approximately 20 hours to satisfy peak day demand.
- The incorporated section of Edisto Beach is subdivided into 1700 residential lots, of which 750 contain permanent dwellings.

#### Current Demand

Maximum daily demand was assumed to be 432,000 GPD. (360 GPM x 20 hr x 60 min/hr = 432,000 GPD). That translates to 576 GPD/connection.

#### Projected Demand

Based upon the current situation, maximum future daily demand was calculated as follows:

- (1700 lots)(576 GPD) = 979,200 gal/day
- Miscellaneous Usage = 220,800 gal/day

Total = 1,200,000 gal/day

EXISTING SUPPLY

The existing supply consists of three ± 600 feet wells that have a combined capacity of 360 GPM. The yield from the operating wells contains approximately 4.0 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.

The Town also has one abandoned well that is ± 1800 feet deep. Said well is brackish with a total dissolved solids (TDS) concentration of 5500 mg/l. Fluoride in the deep well is 2.2 mg/l, iron is reported to be 8.0 mg/l.[2] It should be noted that the sample which was analyzed to obtain the iron concentration was drawn after the well sat idle for several years. Therefore, it is quite possible that deterioration of the well casing and pump column piping contributed to the high iron reading.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for the Town of Edisto Beach. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: FLUORIDE TREATMENT

### Method

This solution requires the construction of three separate activated alumina treatment facilities, one at each existing well site. Each facility would treat a portion of the existing flow which would subsequently be blended with the remaining portion. The capacities of the three facilities are tabulated below.

| EDISTO BEACH<br>ACTIVATED ALUMINA TREATMENT CAPACITY | | | |
|---|---|---|---|
| Facility | Treated | Untreated | Blend |
| Plant #1 | 100 GPM | 30 GPM | 130 GPM |
| Plant #2 | 55 GPM | 25 GPM | 80 GPM |
| Plant #3 | 115 GPM | 35 GPM | 150 GPM |

The waste streams generated by each facility would be collected in an equalization tank. After each regeneration, the contents of said tanks would be neutralized (pH adjusted) and discharged to a storm sewer. A regeneration tank and pump will not be required at these facilities.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $1,077,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $133,698 |
| • Operations and Maintenance | 71,302 |
| Total Estimated Annual Cost Increase | $205,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 42 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an A operating license. Approximately 120 hours of formal training should be adequate to upgrade opertor skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## ALTERNATIVE NO. 2: DESALTING TREATMENT

### Method

This solution requires the installation of a reverse osmosis (R/O) treatment facility in close proximity to the existing elevated water storage tank. The plant would treat brackish water drawn from the abandoned well which is located at the base of the tank. For the purpose of comparing treatment alternatives, the R/O unit would be sized at 480 GPM. Assuming that 25% of the raw water flow will become waste (brine), the output of the plant will be 360 GPM. It was also assumed that regulatory agencies will permit the brine to be discharged to the ocean without treatment.

See the Appendix entitled "Fluoride Treatment" for a description of the reverse osmosis process.

It should be noted that this evaluation assumes that the brackish well is in good condition. As a first step in any planning effort, the actual condition of the well should be ascertained.

Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $1,100,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $136,554 |
| • Operating Cost | 185,446 |
| Total Estimated Annual Cost Increase | $322,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 36 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements are identical to those discussed under Alternative No. 1.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| TOWN OF EDISTO BEACH ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Treatment Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Alumina | 360 | $133,698 | $ 71,302 | $273.33 |
| No. 2: Reverse Osmosis | 360 | $136,554 | $185,446 | $429.33 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

As of January, 1980, the average annual water bill rendered for service from this system was $109.00.[1] Assuming that the increased annual cost for the selected alternative will be amortized uniformly, the average annual water bill will increase to $382.33 ($31.86 per month).

Brackish water treatment, while being more expensive, offers the advantage of utilizing two aquifers as a source of supply in lieu of one. Discussions with town officials and various state agencies indicate that the aquifer presently in use is very limited in capacity potential. If the ultimate demand of 1,200,000 GPD (1250 GPM) is to be met, a combination of waters from both 600 and 1800 foot levels may have to be utilized.

## REFERENCES

[1]Personal communication, Mayor Winston Brooks, Town of Edisto Beach, January 29, 1980.

[2]South Carolina Department of Health and Environmental Control, Water Analysis Report on Laboratory Sample No. P-1735, April 14, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# FOREST ACRES TRAILER PARK

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Forest Acres Trailer Park. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Forest Acres Trailer Park water system is served by one 50 ± GPM[1] well which has a fluoride concentration of approximately 5.1 mg/l.[2] One 500 gallon pneumatic tank[2] is used for water storage.

The system serves one single family house, a four-unit apartment, and 11 mobile home sites, nine of which were occupied when the system was visited.[3] In addition to serving the above-mentioned 14 families, the system owners hope to furnish water to 6 other families in the future. If it is assumed that each dwelling will use an average of 200 GPD, the existing water use would be 2,800 GPD and the future water use would be 4,000 GPD.

### ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[4] the future water demand would be 7,200 GPD. With that demand, the desirable minimum pumping rate would be 7.5 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[5] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 86 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated[7] that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[5] of checking pressure tank size indicates that a well capacity of at least 63 GPM will be needed if the existing 500 gallon tank is all the storage to be provided. However, a 4,864 gallon pneumatic tank capacity would be required if an 8.0 GPM well was achieved, which is estimated to be sufficient to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 20 residential connections assumed as design condition.
2. Existing pneumatic tank size is 500 gallons.
3. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 20 residences x 4.3 GPM/resd. x 0.8 = 68.8 GPM instantaneous demand.
2. Usable pneumatic tank volume = 500 ÷ 4 = 125 gallons.
3. Tank contribution for 20 minutes = 125 ÷ 20 minutes = 6.25 GPM.
4. Minimum new well size to meet instantaneous supply demand = 68.8 GPM - 6.25 = 62.55 GPM.
5. Minimum pneumatic tank capacity with 8 GPM well = (68.8 - 8) x 20 minutes x 4= 4,864 gallons.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: PURCHASE WATER FROM GSWSA

### Method

This solution would involve the installation of a master water meter and approximately 0.4 of a mile of connection water main between the Forest Acres system and Grand Strand Water and Sewer Authority's (GSWSA) water main in the Smalls Hud Project area. It should be noted that connection to GSWSA will not eliminate the high fluoride problem until GSWSA corrects their own problem.

The cost of this installation was estimated by GSWSA in February, 1979 to be approximately $17,000.[1] This cost would be at least $20,000 at today's prices.

Based on communication with GSWSA,[6] it appears that the rate charged for water will be in the range of $0.50 to $0.65 per 1,000 gallons. The higher rate will be used for cost estimating purposes. To this rate, an increase of $0.93 per 1000 gallons must be added to cover the minimum cost which GSWSA is expected to incur in solving their fluoride problem.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $20,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 2,483 |
| • Annual added water cost, deleting power, etc. | $ 1,578 |
| • Total estimated added annual cost | $ 4,061 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 18 months of the completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

ALTERNATIVE NO. 2: DRILL NEW WELL

Method

This alternative would involve the drilling of a new well to replace or blend with the existing high fluoride well. This alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled near the existing well and sufficient, satisfactory water located to replace or blend with the existing well water.

Assuming a shallow well fluoride concentration of 0.2 mg/l, a shallow/deep blending ratio of 3.1/1 would be required to maintain a fluoride concentration of 1.4 mg/l in the combined flow. Accordingly, a blend of 48 GPM shallow to 15 GPM deep would provide the 63 GPM required to meet the peak day demand utilizing the existing storage tank. It should be noted that a smaller pump would be required to reduce the deep well flow from 50 GPM to 15 GPM.

This alternative will assume that one 8 GPM well and one new 5,000 gallon pneumatic water storage tank will be installed. Due to the uncertainty associated with the quality of shallow ground water, it will be assumed for cost estimation purposes that iron sequestering and chlorination equipment with enclosures will be required with the installation of a new well.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $45,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 5,587 |
| • Annual added operation cost using estimated existing water use | $ 50 |
| • Total estimated added annual cost | $ 5,637 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of funding procurement, etc.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| FOREST ACRES TRAILER PARK<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Purchase Water | N/A | $2,483 | $1,578 | $290.07 |
| No. 2: New Well | 8 | $5,587 | $ 50 | $402.64 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Presuming that the increased annual cost for the primary alternative will be amortized uniformly, the annual incremental increase was calculated to be $290.07 per consumer ($24.17/month).

## REFERENCES


[1]Memo from Fred H. Soland, Jr., P. E., on Forest Acres Trailer Park, Horry County, dated February 14, 1979.

[2]DHEC Staff Study on Fluoride completed in 1978.

[3]Meeting and discussion with Mr. Bellamy on February 12, 1980.

[4]Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[5]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[6]Telephone communication with Bob Barker, Director of GSWSA, on April 9, 1980.

[7]Letter from Fred H. Soland of DHEC to Joe Willson of JESCO dated May 5, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# GARDEN CITY BEACH
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Garden City Beach. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## EXISTING CONDITIONS

The Garden City water system has seven wells and approximately 88,000 gallons of pneumatic tank capacity in service. Data on record with DHEC or from the Owner on the existing wells is tabulated below.

| GARDEN CITY BEACH EXISTING WELL DATA | | | |
|---|---|---|---|
| Designation | Capacity (GPM) | Fluoride (mg/l) | Iron (mg/l) |
| #1 Central | 300 | 5.0 | 0.10 |
| #2 | 200 | 5.0 | 0.10 |
| #3 | 250 | 3.0 | 0.40 |
| #4 | 95 | 3.8 | 0.23 |
| #5 Jamestown | 300 | 3.2 | 0.07 |
| #6 Huntsburger | 135 | 4.0 | 0.10 |
| #7 Caropines | 300 | 4.0 | 1.30 |

The Garden City water system served approximately 1319[2] water service customers in 1979 who used an annual average of 0.40 MGD. The peak three-month period average for 1979 was 0.63 MGD and the peak day water use was estimated to be 0.98 MGD.[1] The present total well capacity is 1580 GPM.

## FUTURE CONDITIONS

The Garden City water system has experienced limited growth during the last few years. Estimates are that 100 single family residential equivalents have been added since 1977 raising the total residential equivalents to 1990 in 1979.[1] However, it has been predicted that an additional 2500 residential equivalents may be added by the year 1990,[1] due to the installation of sanitary sewers. Using the present water demands as a guide, it was estimated that peak day water use in 1990 would be approximately 2.2 MGD. The present pumping capacity could conceivably meet that demand; accordingly, treatment or replacement of the present pumping capacity has been selected as the sizing criterion for this report.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

#### Method

This alternative would involve the drilling of wells to replace or blend with the existing high fluoride wells. This alternative is heavily dependent upon the quantity and quality of low fluoride ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used for blending and sufficient, satisfactory water located to replace or blend with the existing well water.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# GRAND STRAND WATER AND SEWER AUTHORITY
# SOCASTEE AREA COMBINED WATER SYSTEM
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY AND AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Socastee Area Combined Water System. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Socastee Area combined water system includes the following individual water systems: Green Acres, Cimarron Plantation, Watson's Riverside and HUD projects, Watergate, Small's HUD project, Highway 707 project, Highway 544, and the Forest Brook - Cypress Creek Subdivisions. The Highway 544 system presently and/or formerly obtained its water from the Conway Rural water system which has a fluoride concentration of approximately 4.0 mg/l.[1] All other systems were originally served by their own wells which now supply the combined water system. The approximate pumping rates,[2] hydropneumatic water tank sizes,[2] fluoride and iron concentrations[1] of the wells are listed in the following table.

SOCASTEE AREA COMBINED WATER SYSTEM
EXISTING SUPPLY DATA

| Well | Capacity (Gal/Min) | Fluoride (mg/l) | Iron (mg/l) | Storage (Gallon) |
|---|---|---|---|---|
| #1 Booster Pump at C.R. | 200 | 4.0 | 0.1 | None |
| #2 Watson's Riverside | 55 | 4.0 | 0.3 | 10,000 |
| #3 Green Acres | 300 | 3.9 | 0.1 | 10,000 |
| #4 Cimarron | 50 | 4.0 | 0.1 | 10,000 |
| #5 Watson's HUD | 500 | 3.0 | 0.1 | |
| #6 Watergate | 40 | 5.1 | 0.1 | 10,000 |
| #7 Forest Brook | 500 | 4.7 | 0.2 | 20,000 |
| #8 Small's HUD | 200 | 5.0 | 0.2 | 10,000 |

The combined system served an average of approximately 1,571 water service connections in 1979, of which over 98% were residential connections.[3] Average demand in

1979 was approximately 338,200 GPD and a peak monthly average of 387,700 GPD occurred in July.

FUTURE CONDITIONS

Future water demand estimates were obtained from a consulting engineer's report dated May 2, 1979.[1] A substantial growth in population and service connections was predicted in that report. The average day water demand for the combined systems was predicted to be approximately 1.65 MGD for 1990 and 2.69 MGD for the year 2000. The peak day water demand for the combined system was predicted to be double the average day water demand which would be 3.30 MGD for 1990 and 5.375 MGD for the year 2000. Water main installations to interconnect the previously listed systems are planned and expected to be in service by 1982. Also, a 250,000 gallon elevated water storage tank has been proposed for installation by 1982 for the Forest Brook/Highway 544 system service area.

Another water system proposed by GSWSA would be along Highway 90 from the junction of Highway 501 near Conway to an area approximately one and one half miles to the west of Nixonville. Since this is a proposed system, it was not included in this study.

FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for the subject water system. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

Method

This alternative would involve the drilling of wells to replace or blend with the existing high fluoride wells. This alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used and sufficient, satisfactory water located to replace or blend with the existing well water.

Assuming that the shallow ground water will have a fluoride concentration of 0.2 mg/l or less, the blend ratio graph in the Appendix can be used to determine the required quantity of shallow well water needed to blend with existing high fluoride well water. The facilities proposed in this alternative would, if constructed, provide a 1500 GPM supply which would be approximately equal to the existing high yield well capacity.

The following table indicates the amounts of shallow well water (0.2 mg/l fluoride) that can be blended with selected deep wells to maintain a blended fluoride concentration of 1.4 mg/l. It should also be noted that the capacity of the existing wells would be reduced and that a maximum shallow well iron concentration is listed. The capacity reduction would be effected by replacing the existing pumps. The maximum iron concentration would provide a blended supply having an iron level of 1.0 mg/l which can usually be sequestered by adding polyphosphates (chemicals). Iron concentrations in excess of 1.0 mg/l should be expected to require treatment.

SOCASTEE AREA COMBINED WATER SYSTEM
BLENDING DATA

| Well | Fluoride (mg/l) | Iron (mg/l) | Reduced Capacity (Gal/Min) | Capacity (Gal/Min) | Iron (mg/l) |
|---|---|---|---|---|---|
| #3 | 3.9 | 0.10 | 98 | 202 | 1.44 |
| #5 | 3.0 | 0.10 | 216 | 284 | 1.68 |
| #7 | 4.7 | 0.20 | 134 | 366 | 1.29 |
| #8 | 5.0 | 0.20 | 50 | 150 | 1.27 |

Iron sequestering units were assumed to be needed at each main well site. Based on estimates received from private contractors[4] and a discussion with the South Carolina Water Resources Commission[5], it was assumed that shallow wells produce 75 GPM each;

therefore, multiple wells and well lots with connecting piping would be required to serve each deep well. Cost data for systems with and without iron removal treatment have been prepared and are presented below. It is beyond the scope of the study to determine whether or not iron removal treatment would be needed.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $900,000 |
| • Annual added debt service assuming 12% loan for 30 years | $111,735 |
| • Annual added operation cost using 1979 water use | $ 3,382 |
| • Total estimated added annual cost | $115,117 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $1,900,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 235,885 |
| • Annual added operation cost using 1979 water use | $ 18,441 |
| • Total estimated added annual cost | $ 239,326 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 30 months of the completion of required referendum, rate structure studies, funding procurement, etc. It is estimated that the total time would increase to 54 months if iron removal treatment is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative. However, if iron removal treatment is necessary, it is anticipated that a staff position for at least one additional water system operator would be created.

ALTERNATIVE NO. 2: TREAT EXISTING WELLS

Method

This solution would involve the treatment of existing well water to reduce the fluoride concentration. To be consistent with the previous alternative, it will be assumed that only the high yielding wells, Wells #3, 5, 7 and 8 will be treated. Each well would have its own treatment unit. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the sanitary sewer system which has been proposed. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

- Capital cost estimate for project design and construction $1,590,000
- Annual added debt service assuming 12% loan for 30 years $ 197,383
- Annual added operation cost using 1979 water use $ 156,000
- Total estimated added annual cost $ 353,383

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 48 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an A operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

ALTERNATIVE NO. 3: REGIONAL WATER SYSTEM

Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains would convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1000 gallons. At the current average daily demand of 338,200 gallons, the annual cost for this system would be $364,157.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| GSWSA SOCASTEE AREA COMBINED WATER SYSTEM ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating. | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 1,500 | $111,735 | $ 3,382 | $ 73.28 |
| No. 2: Treatment | 1,500 | $197,383 | $156,000 | $224.94 |
| No. 3: Regional | 2,292 | $328,914 | $ 35,243 | $231.80 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Assuming that the increased annual cost for the selected alternative will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $73.28 per consumer ($6.11/month).

REFERENCES

[1]Preliminary Engineering Report on GSWSA's water systems between Conway and Myrtle Beach, by CH2M Hill, dated May 2, 1979.

[2]DHEC Staff Studies on Fluoride for the various individual water systems, dated March 2 and 6, 1978 and July 11, 1978.

[3]Data sheets provided by GSWSA listing actual billing records from November 20, 1977 through January 11, 1980.

[4]Well yields, chemical quality, and costs estimated by Robert B. Heater, President of Heater Well Company.

[5]Telephone communication with Larry West of the South Carolina Water Resources Commission, Conway Office, on April 8, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# TOWN OF HEMMINGWAY
# WILLIAMSBURG COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980. a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Hemmingway. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The water system serving the Town of Hemmingway provided water to 532 consumers, approximately 1700 people, as of April, 1978.[1]

Williamsburg County is expected to experience continued industrial growth during the forseeable future. As a consequence of that growth, the consumer population of the Hemmingway water system is expected to grow. In lieu of actual planning data which is not readily available, an annual growth rate of 5% will be assumed in the ensuing sections of this report.

## WATER SUPPLY REQUIREMENTS

### Current Demand

The average daily water usage for calendar 1979 was estimated at 212,500 GPD.[2] That translates to an average of 400 GPD/connection. Maximum average daily demand was considered to be approximately 180% of average daily usage.[3] Accordingly, the current water demand placed on the system has been established as follows:

- Average Daily Demand 212,500 Gallons
- Maximum Daily Demand 382,500 Gallons

### Projected Demand

Utilizing the previously assumed 5% annual growth rate in consumer population, projected water demand has been estimated and is presented in the following table.

| TOWN OF HEMMINGWAY<br>PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 212,500 | 382,500 |
| 1985 | 271,100 | 488,000 |
| 1990 | 345,900 | 622,600 |
| 1995 | 441,368 | 794,500 |
| 2000 | 563,200 | 1,013,700 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing a regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period. Said values are as follows:

- 1980 - 398 GPM
- 1985 - 508 GPM
- 1990 - 648 GPM
- 1995 - 828 GPM
- 2000 - 1,056 GPM

EXISTING SUPPLY

The existing water supply consists of two deep wells having a combined rated capacity of 785 GPM. As of February 4, 1980, the #2 well, which is rated at 235 GPM, was not in use.[2] Based upon the present requirement of 398 GPM, the existing production capability of the #1 well (550 GPM) is adequate. It is noted, however, that water produced by the existing wells contains 1.8 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.[4]

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for the Town of Hemmingway. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: BLENDING

Method

Fluoride reduction can be achieved by drilling a series of shallow wells and blending their yield with that of the existing deep wells. Assuming a fluoride concentration of 0.1 mg/l in the proposed shallow wells, a shallow/deep mix of 1.00 GPM/ 2.33 GPM will result in a blend having a fluoride concentration of 1.4 mg/l.

This alternative addresses construction of shallow blending wells at Well #1. Well #2 was not considered because it is out of service and usage projections indicate that the increased capacity (shallow plus deep) of Well #1 will satisfy community requirements through the year 2000. Utilizing a blend ratio of 1 shallow/2.33 deep, the required shallow well capacity was determined to be 235 GPM.

Lacking accurate data on the quantity of shallow ground water available in the Hemmingway area, quantity was conservatively estimated at 50 GPM per well, requiring construction of five wells.

Sufficient iron to cause aesthetic problems, such as staining of plumbing fixtures, should be expected in the proposed shallow wells. With the favorable ratio of deep/shallow well water that will be utilized in this system, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow wells will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump.

A schematic diagram of the proposed water supply additions is presented in Figure 1. A complete list of the facilities recommended is as follows:

- Five 50 GPM shallow wells. Each well should be equipped with a vertical turbine pump set up to operate simultaneously with the deep well pump.
- One concrete valve pit constructed at the intersection of the deep and shallow well lines. The pit should contain meters and valves on both supply lines. The chlorine injection point should be in the tee or the line leaving the pit.

- Polyphosphate mixing and feed facilities. The concept presented herein utilizes a single chemical feed point in the common main leading from the shallow wells. However, it should be noted that iron must be in a soluble form for sequestering to be effective, and that pumping and/or conveyance may cause the iron to precipitate. Should that situation occur, the chemical feed point may have to be moved or iron treatment may become necessary.

Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $205,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $25,449 |
| • Chemical Cost | 251 |
| Total Estimated Annual Cost Increase | $25,700 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: TREATMENT

Method

This alternative addresses treatment of a portion of the flow from the existing 500 GPM well utilizing activated alumina. The system would be sized to treat

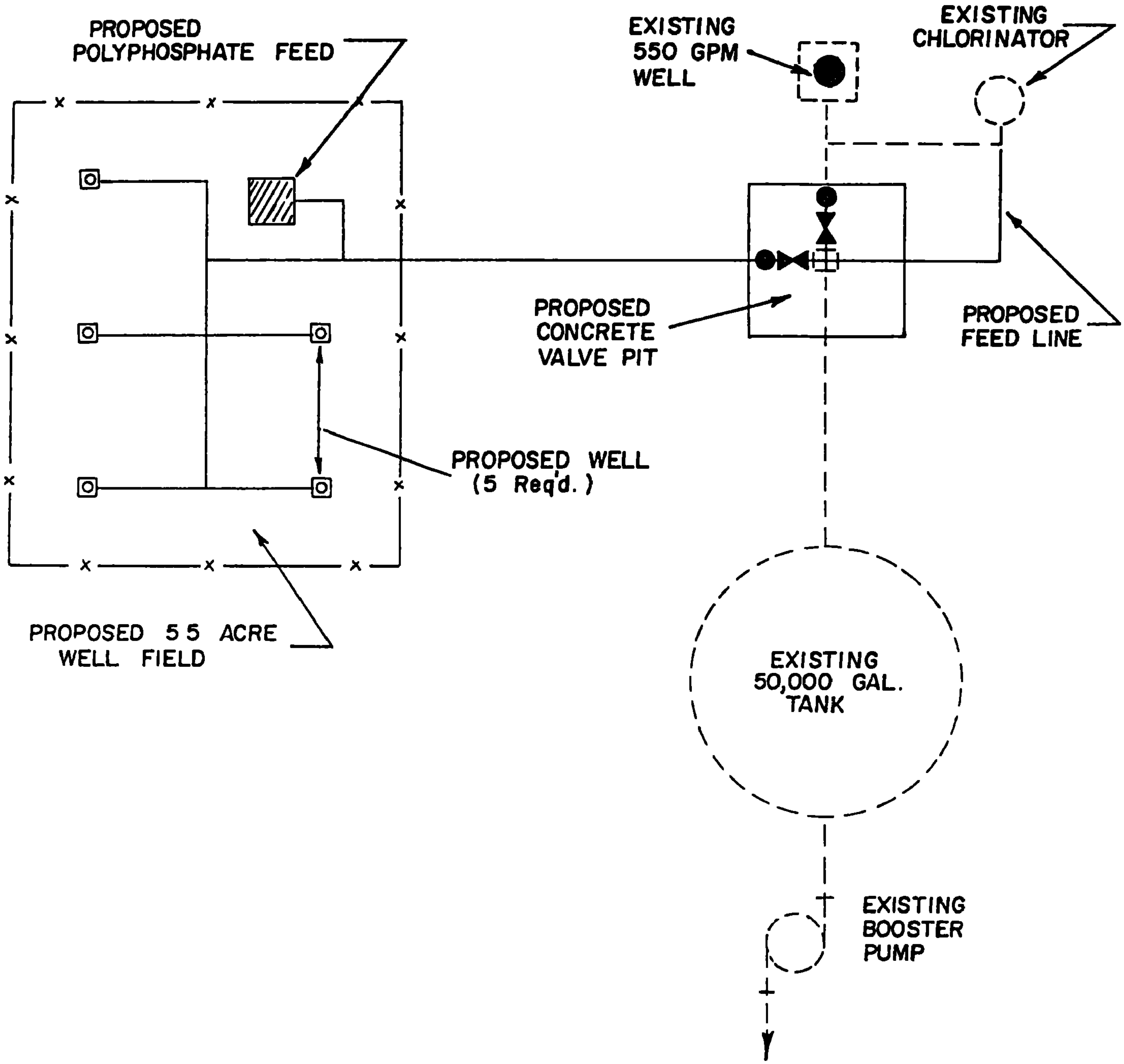


FIGURE 1

SCHEMATIC DIAGRAM OF

PROPOSED WATER SUPPLY ADDITIONS

AT

TOWN OF HEMMINGWAY

125 GPM, the remaining 375 GPM would bypass treatment and be blended with the defluoridated water. A liquid waste stream from the unit would be discharged to a waste equalization tank. Periodically the contents of said tank would be trucked to the Pee Dee River or one of its tributaries for disposal.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $435,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $ 54,000 |
| • Operations and Maintenance | 52,000 |
| Total Estimated Annual Cost Increase | $106,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 36 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an A operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| TOWN OF HEMMINGWAY<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 785 | $25,449 | $ 251 | $ 48.30 |
| No. 2: Treatment | 500 | $54,000 | $52,000 | $199.25 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[1] $9.60
- Estimated monthly increase 4.03

Adjusted Monthly Water Rate $13.63/consumer

REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for The Town of Hemmingway, Williamsburg County", April 17, 1978.

[2]Personal communication, Mr. Cecil Kimery, Town of Hemmingway, February 4, 1980.

[3]South Carolina Department of Health and Environmental Control, Water Analysis Report on Laboratory Sample number R06148-1566, June 6, 1978.

[4]Clark, J. W., et al., Water Supply and Pollution Control, 1971, International Textbook Company, Scranton, Pennsylvania.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# INLET OAKS VILLAGE
# GEORGETOWN COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Inlet Oaks Village. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Inlet Oaks Village water system has one 200 GPM well and one 10,000 gallon pneumatic water storage tank in service. The well is reported fluoride concentration of approximately 6.0 mg/l. The water system is approximately 1,800 feet away from a water line owned by the Georgetown County Water and Sewer Authority's Murrell's Inlet system.

Water use in this system is not metered. The system has 100 approved mobile home sites 90 to 95% of which were filled when the park was visited. The owner advised that the trailers were owned primarily by retired couples. Assuming the trailer park is full and average use during the summer is 200 GPD per trailer, the estimated average daily water demand would be 20,000 GPD.

### ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[3] the water demand would be 36,000 GPD. With that demand, the desirable minimum pumping rate would be 37.5 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[4] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 200 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated[6] that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[4] of checking pneumatic tank size indicates that a well capacity of 37.5 GPM, the minimum peak day pumping rate, should be adequate with the existing 10,000 gallon tank.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 100 residential connections assumed as design condition.
2. Yield of new well is assumed to be 37.5 GPM.
3. Existing pressure tank size is 10,000 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 100 residences x 2.0 GPM/resd. x 0.8 = 160 GPM.
2. 160 GPM - 37.5 GPM well yield = 122.5 GPM tank demand.
3. 122.5 GPM x 20 minute demand = 2450 gallons of stored water needed.
4. Minimum pressure tank size = 2450 x 4 = 9800 gallons.
5. Existing tank size is 10,000 gallons; therefore, tank is adequate.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL NEW WELL

#### Method

This alternative would involve the drilling of a new well or wells to replace or blend with the existing high fluoride well. Since the existing well has such a high fluoride concentration, from 3.2 to 3.8 gallons of low fluoride water would be needed for blending to achieve a safe, acceptable fluoride concentration. A replacement well would be more acceptable if sufficient and suitable water can be located. If the new well yields less than 37.5 GPM but more than 29 GPM, then blending by replacement of the existing wells pump could be used. Obviously, this alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled and sufficient, satisfactory water located.

For this alternative, it will be assumed that one new 29 GPM well with iron sequestering equipment and a replacement pump for the existing well will be required to achieve an acceptable water.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $40,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 4,966 |
| • Annual added operation cost using 1979 estimated water use | $ 200 |
| • Total estimated added annual cost | $ 5,166 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

ALTERNATIVE NO. 2: PURCHASE WATER FROM GCWSA

Method

This alternative would involve the installation of a master water meter and roughly 1800 feet of connection main between the Inlet Oaks system and the Georgetown County Water and Sewer Authority's (GCWSA) Murrell's Inlet system. It should be noted that connection to GCWSA will not eliminate the high fluoride problem until GCWSA corrects their own problem.

GCWSA has advised[5] that they should have the following service connection and water rates in effect by the end of June, 1980:

| | |
|---|---|
| • 3/4" residential connection fee | $320 |
| • Minimum residential service rate | $6.47/month |
| • Charge for all water used | $0.97/1000 gallons |
| • 3" commercial tap and meter installation fee | $2,000 |

- Commercial water service rates are assumed to be basically the same as the residential rates.

In addition to the above, an increase of approximately $1.15 per 1000 gallons must be added to cover the minimum cost which GCWSA is expected to incur in solving their fluoride problem.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $25,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 3,104 |
| • Annual added water cost, less power cost, with existing use | $21,800 |
| • Total estimated added annual cost | $24,904 |

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of funding procurement, etc.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| INLET OAKS<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 37.5 | $4,966 | $ 200 | $ 54.38 |
| No. 2: Purchase Water | N/A | $3,104 | $21,800 | $262.15 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $54.38 per consumer ($4.53/month).

## REFERENCES


[1]DHEC Staff Study on fluoride problem in Inlet Oaks Village, completed in 1978.

[2]Meeting and discussion with Henry Burrough, Jr. on February 7, 1980.

[3]Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[4]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[5]Telephone conversation with Barry Green of Georgetown County Water and Sewer Authority, on April 15, 1980.

[6]Letter from Fred H. Soland of DHEC to Joe Willson of JESCO dated May 5, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# ISLE OF PALMS

# CHARLESTON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Isle of Palms. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The water system serving the Isle of Palms community provided water to 1,439 consumers, approximately 5,000 people, as of January 28, 1980.[1]

### WATER SUPPLY REQUIREMENTS

The Isle of Palms is a resort community with several miles of public beach. Consequently, water demand fluctuates significantly in response to seasonal changes and day to day variations in weather conditions.

Accurate data relative to actual water demand is not readily available. Therefore, the remainder of this report will be premised on the assumption that the existing capacity of 1,700,000 gallon/day must be maintained.[2]

### EXISTING SUPPLY

The water supply for the Isle of Palms presently consists of 14 shallow well stations and one deep well. Four of the shallow well systems are chlorinated and pumped directly into the distribution system. Those four shallow well systems are generally located on the eastern end of the island. The ten remaining shallow well stations pump into one common transmission main which conveys the shallow well water to the site of the deep well where the two supplies are blended and discharged into two ground level storage tanks. The ground level storage tanks, which have a combined capacity of 870,000 gallons, act as a suction reservoir for several booster pumps that feed the distribution system. Also constructed on the site of the ground storage reservoirs, is one 150,000 gallon elevated water storage tank which rides on the system.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for the Isle of Palms Water Company. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: BLENDING

### Method

Blending deep and shallow well water in the proper proportions will reduce the fluoride concentration in the community's water supply to acceptable levels. Based upon a deep well fluoride concentration of 4.7 mg/l and a shallow well concentration of 0.8 mg/l, blending ratios were calculated and are presented in the following table.

| ISLE OF PALMS DEEP/SHALLOW BLENDING RATIOS | | |
|---|---|---|
| Blend Ratio (deep/shallow) | Flow Ratio (deep/shallow) | Fluoride Concentration |
| 1.0/5.5 | 153 GPM/847 GPM | 1.4 mg/l |
| 1.0/4.6 | 179 GPM/821 GPM | 1.5 mg/l |
| 1.0/3.9 | 204 GPM/796 GPM | 1.6 mg/l |

The existing supply capacity of 1,700,000 gallons of water per day translates to approximately 1200 GPM. The water company presently discharges approximately 200 GPM, the yield of four shallow well stations, directly into the distribution system. The remaining 1000 GPM must be generated by blending a portion of the deep well capacity with a series of shallow wells. Based upon a blended fluoride concentration of 1.4 mg/l, the required shallow well capacity is 847 GPM. (See Table above). Accordingly, this alternative mandates the construction of 7 additional shallow well stations.

The success of blending is dependent upon control of the flow from the deep well. Existing meters and valves can be utilized to throttle the deep well to provide a flow that is properly proportioned to the shallow well yield. However, it should be noted that the adaptability of the existing deep well pump to function in a throttled mode of operation is questionable. It is beyond the limited scope of this study to fully evaluate the effect of the significantly reduced pump output. The reader is therefore cautioned that it may become necessary to modify or replace the existing unit to consistently maintain flow rates less than 200 GPM.

Cost

Facilities included in the estimated capital cost of this alternative are the addition of seven shallow well stations and modification of the existing deep well pump. The estimated construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $340,000. Annual debt service expense on that amount calculated at 12% for 30 years is $42,207. Total system operating costs would remain approximately the same.

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: TREATMENT

Method

This alternative addresses treatment of a portion of the flow from the existing deep well utilizing activated alumina. The system will be sized to treat 800 GPM, the remaining 200 GPM will bypass treatment and be blended with the defluoridated water. A liquid waste stream from the unit will be discharged to a wastewater equalization tank. The contents of said tank will be slowly drained to the sanitary sewer system.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $665,000. Annual costs are summarized below.

- Debt Service on a 30-Year Loan at 12% $82,553
- Operations and Maintenance 72,447

Total Estimated Annual Cost $155,000

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 36 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an A operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

ISLE OF PALMS
ALTERNATIVE SUMMARY

| Alternative | Capacity (GPM) | Annual Cost Data | | |
|---|---|---|---|---|
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 1000 | $42,207 | - | $ 29.33 |
| No. 2: Treatment | 1000 | $82,553 | $72,447 | $107.71 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[1] | $6.50 |
| • Estimated monthly increase | 2.46 |
| Adjusted Monthly Water Rate | $8.96/consumer |

REFERENCES


[1]Personal communication, William Connelly, Isle of Palms Water Company, January 28, 1980.

[2]South Carolina Department of Health and Environmental Control, "Staff Study for Isle of Palms, Charleston County," undated.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# JAMESTOWN
# BERKELEY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Jamestown. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The water system serving the Town of Jamestown provided water to 90 consumers, approximately 315 people, as of March, 1978.[1]

Population projections for the Planning District 204, of which Jamestown is a part, were obtained from the Berkeley Charleston Dorchester Council of Governments. Said projections were utilized to develop consumer projections for the Town. Recognizing that the Town is the most densely populated area in the district, the district growth percentages were applied to the existing consumer population to develop projected system growth. The computations that were made are summarized in the following table.

| TOWN OF JAMESTOWN<br>CONSUMER POPULATION PROJECTIONS | | | |
|---|---|---|---|
| Year | Population* Projection | % Change | Consumers |
| 1980 | 5,197 | -0- | 90 |
| 1985 | 5,472 | 5.3 | 95 |
| 1990 | 5,424 | 0.9 | 94 |
| 1995 | 5,324 | 1.8 | 92 |

*Population projection for the entire 204 Planning District

### WATER SUPPLY REQUIREMENTS

#### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 160 gallons per connection, a maximum daily demand factor of 180%, and the above listed consumer population, were used to establish system demand data which is summarized in the following table.

| TOWN OF JAMESTOWN PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 14,400 | 25,900 |
| 1985 | 15,200 | 27,400 |
| 1990 | 15,000 | 27,000 |
| 1995 | 14,700 | 26,500 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period.

- 1980 - 27 GPM
- 1985 - 29 GPM
- 1990 - 28 GPM
- 1995 - 28 GPM

EXISTING SUPPLY

The existing water supply consists of one deep well having a rated capacity of 120 GPM. Based upon the present requirement of 27 GPM, the existing production capability is adequate. It is noted, however, that water produced by the existing well contains 2.1 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.[1]

# FLUORIDE REDUCTION

## METHOD

Based upon available information, the most practical and least expensive method of effecting a fluoride reduction in the town's water supply is to blend water from a shallow aquifer with that of the existing deep well. Assuming a fluoride concentration of 0.1 mg/l in the shallow well, a shallow/deep mix of 60 GPM/120 GPM will result in a blend having a fluoride concentration of 1.4 mg/l. The Town presently owns a shallow well which served as a source of drilling water during the construction of the deep well.[2] It is quite possible that said shallow well can be equipped with a pump and utilized as a source of blending water. With the operation of a shallow well, disinfection and iron content require consideration.

Shallow wells are generally more susceptible to bacterial contamination than are deep wells. Consequently, the chlorinated shallow well water should be detained in a pressure contact tank for 30 minutes prior to being blended with the deep well water.

Sufficient iron to cause aesthetic problems, such as staining of plumbing fixtures, should be expected in the proposed shallow wells. With the favorable ratio of deep/shallow well water that will be utilized in this system, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow wells will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump.

A schematic diagram of the proposed water supply additions is presented in Figure 1. A complete list of the facilities recommended is as follows:

- Ground level improvements to the existing well which will accommodate the installation of a pump.
- One 60 GPM submersible pump including electrical controls.
- One concrete valve pit constructed at the intersection of the deep and shallow well discharge lines. The pit should contain meters and valves on both lines.
- One 2000 gallon ground level pressurized chlorine contact tank.
- One gas chlorinator.
- One polyphosphate mixing and feed system.
- One equipment building.

COST

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the facilities were constructed and became operational during the 1980 calendar year. By utilizing current data, the estimated annual cost increase is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

The construction cost of the above-described facilities including engineering and project contingency expenses has been estimated at $28,000. Annual costs are summarized below.

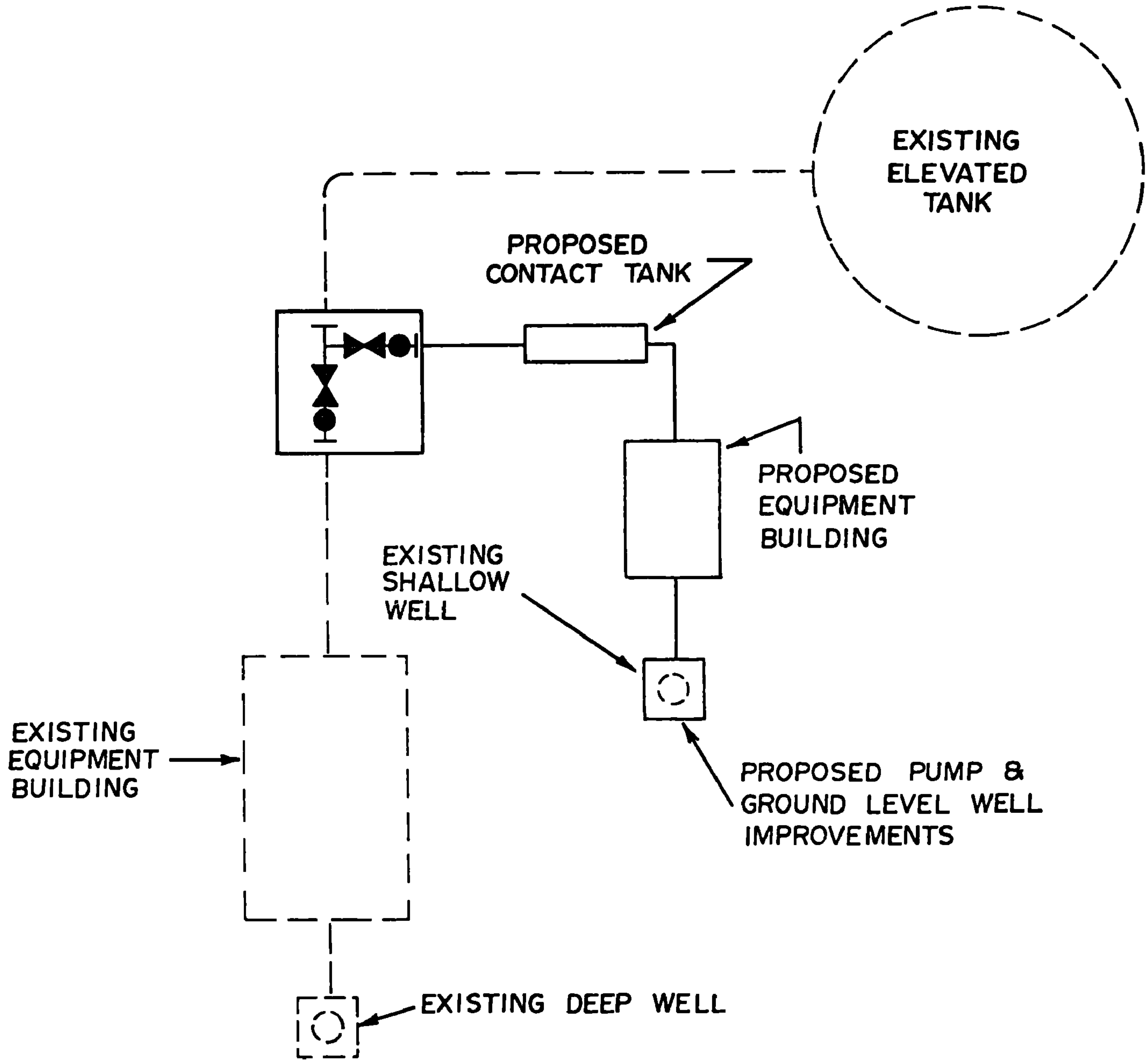


FIGURE 1

SCHEMATIC DIAGRAM OF PROPOSED

WATER SUPPLY ADDITIONS

AT

TOWN OF JAMESTOWN

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $3,476 |
| • Operations and Maintenance | 54 |
| Total Estimated Annual Cost Increase | $3,530 |

Assuming a uniform amortization of the estimated annual cost increase over the entire consumer population, each consumer would be required to pay an additional $39.22 per year. It should be noted that the above listed costs are premised on the existing shallow well being satisfactory for use. Should a new well be required, the annual per consumer cost increase will rise from $39.22 to $59.87.

IMPLEMENTATION

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of the proposed water system addition can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

OPERATOR REQUIREMENTS

Operator requirements will not change as a consequence of this fluoride reduction alternative.

REFERENCES


[1]South Carolina Department of Health and Environmental Control, "Staff Study for the Town of Jamestown, Berkeley County", March 16, 1978.

[2]Personal Communication, Mayor Clark, Town of Jamestown, February 18, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# KINGSTREE
# WILLIAMSBURG COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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## INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Kingstree. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING SUPPLY

The existing supply consists of four deep wells with a combined capacity of 1750 GPM.[1] Of the four, only the Highway 377 well produces water with a fluoride concentration in excess of the legal limit. Said well has a rated capacity of 500 GPM and was constructed in 1978 at an approximate cost of $200,000.

The Highway 377 well presently pumps directly into a common distribution system that is supplied by all four operating wells. Due to its location along a single 12" main at the southeastern extremity of the system, little or no fluoride attenuation is accomplished by in-system blending with the product from the other wells.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for the Highway 377 well. Both alternatives were subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: WELL ISOLATION

#### Method

The Highway 377 well is located in close proximity to five major consumers that are exempt from the fluoride limitation.[2] Accordingly, this alternative calls for the construction of a separate distribution main and elevated tank which will serve the exempt users exclusively. The proposed mini-system would be supplied

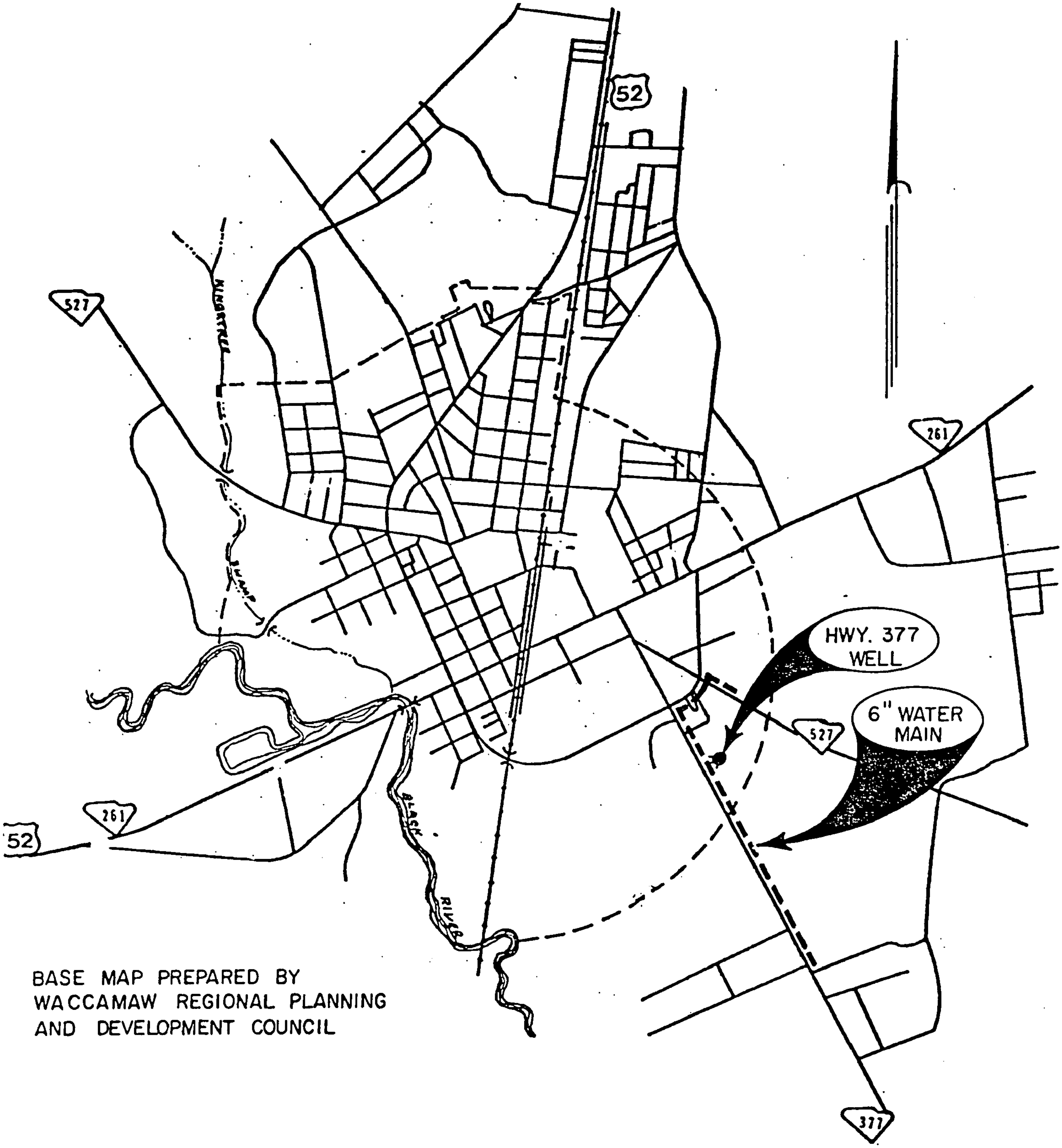


FIGURE 1

LOCATION MAP OF PROPOSED

MINI-SYSTEM

AT KINGSTREE, SOUTH CAROLINA

by the Highway 377 well, and would be isolated from the main system by appropriate valves. The general location of the proposed mini-system is shown by Figure No. 1.

The daily water use for the exempt facilities was estimated from information provided by the Town and/or the respective user. Said usage is tabulated below:

| | |
|---|---|
| • Warsaw Manufacturing | 2,000 GPD |
| • Kingstree Manufacturing | 285,000 GPD |
| • Williamsburg Technical College | 50,000 GPD |
| • Kingstree Senior High School | 20,000 GPD |
| • Williamsburg County Hospital | 31,000 GPD |
| Total | 388,000 GPD |

Utilizing a 16-hour operating period for the Highway 377 well, total production will be 480,000 GPD. That amount exceeds the estimated mini-system demand by 92,000 GPD (approximately 24%). Recognizing that the proposed water main will parallel the Town's existing system, it was assumed that fire flows would be provided by the existing system. Consequently, fire flows were not included in the following computation of storage requirements.

- Criteria: Provide average daily demand during any given 12-hour period.
- Well Capacity

  (12 hr)(60 min)(500 GPM) = 360,000 gallons
- Storage Capacity

  388,000 gallons - 360,000 gallons = 28,000 gallons

  Use 50,000 gallons

The mini-system storage tank should consist of the elevated type with an overflow elevation equal to that of the existing tanks presently maintaining pressure on the Town's distribution system. Tank piping should include an emergency fill line connected to the main system via a check valve.

## Cost

The estimated construction cost of the mini-system including engineering and project contingency expenses has been estimated at $230,000. Annual debt service expense on that amount calculated at 12% for 30 years is $28,552. Total system operating costs would remain the same.

## Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 30 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

# ALTERNATIVE NO. 2: BLENDING

## Method

Fluoride reduction in the Highway 377 well can be achieved by drilling a series of shallow wells and blending their yield with that of the deep well. Assuming a fluoride concentration of 0.1 mg/l in the proposed shallow wells, a shallow/deep mix of 285 GPM/500 GPM will result in a blend having a fluoride concentration of 1.4 mg/l.

Lacking accurate data on the quantity or quality of shallow ground water available in the Kingstree area, quantity was conservatively estimated at 50 GPM per well,

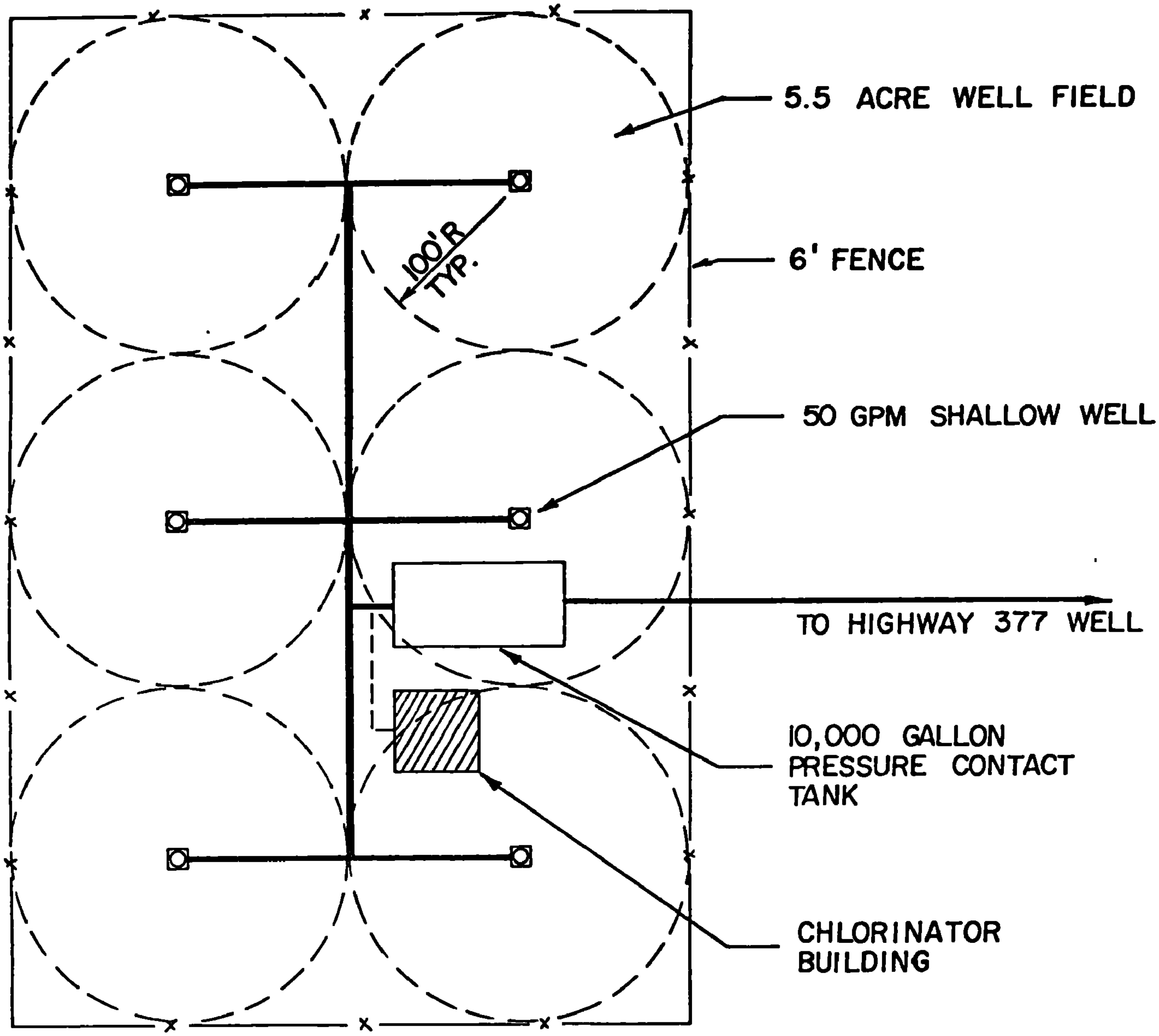


FIGURE 2

SCHEMATIC DIAGRAM OF

PROPOSED WATER SUPPLY ADDITIONS

AT

KINGSTREE, SOUTH CAROLINA

requiring construction of six wells. Iron content was one aspect of quality that was considered, disinfection was the other.

Sufficient iron to cause aesthetic problems, such as staining of plumbing fixtures, should be expected in the proposed shallow wells. With the favorable ratio of deep/shallow well water that will be utilized in this system, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow wells will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump.

Shallow wells are generally more susceptible to bacterial contamination than are deep wells. Consequently, chlorination should be effected with a gas machine. The chlorinated water should subsequently be detained in a pressure contact tank for 30 minutes prior to being blended with the deep well water.

A schematic drawing of the proposed water supply additions is presented in Figure 2.

Cost

The estimated construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $250,000. Annual debt service expense on that amount calculated at 12% for 30 years is $31,035. Total system operating costs would increase by approximately $500 per year due to the polyphosphate addition bringing the total annual increase to $31,535.

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| TOWN OF KINGSTREE ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Well Isolation | 500 | $28,552 | -0- | $15.86 |
| No. 2: Blending | 785 | $31,035 | $500 | $17.52 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[3] — $11.10
- Estimated monthly increase — 1.32

Adjusted Monthly Water Rate — $12.42/consumer

REFERENCES

[1]Personal communication, Mike Tisdale, Town of Kingstree, March 18, 1980.

[2]Personal communication, Fred Soland, South Carolina Department of Health and Environmental Control, April 1, 1980.

[3]South Carolina Department of Health and Environmental Control, "Staff Study for the Town of Kingstree, Williamsburg County," undated.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# THE TOWN OF LANE

# WILLIAMSBURG COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Lane. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The water system serving the Town of Lane provided water to 135 consumers, approximately 500 people, as of February, 1978.[1]

Williamsburg County is expected to experience continued industrial growth during the forseeable future. As a consequence of that growth, the consumer population of the Lane water system is expected to grow. In lieu of actual planning data which is not readily available, an annual growth rate of 5% will be assumed in the ensuing sections of this report.

## WATER SUPPLY REQUIREMENTS

### Current Demand

The average daily water usage for calendar 1979 was 22,000 gallons.[2] That translates to an average of 165 GPD/connection. Maximum average daily demand was considered to be approximately 180% of average daily usage.[3] Accordingly, the current water demand placed on the system has been established as follows:

- Average Daily Demand — 22,000 Gallons
- Maximum Daily Demand — 39,600 Gallons

### Projected Demand

Utilizing the previously assumed 5% annual growth rate in consumer population, projected water demand has been estimated and is presented in the following table.

| TOWN OF LANE<br>PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 22,000 | 39,600 |
| 1985 | 28,000 | 50,400 |
| 1990 | 36,000 | 64,800 |
| 1995 | 46,000 | 82,800 |
| 2000 | 58,000 | 104,400 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing a regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period.

- 1980 - 41 GPM
- 1985 - 53 GPM
- 1990 - 68 GPM
- 1995 - 86 GPM
- 2000 - 109 GPM

EXISTING SUPPLY

The existing water supply consists of one deep well having a rated capacity of 100 GPM. Based upon the present requirement of 41 GPM, the existing production capability is adequate. It is noted, however, that water produced by the existing well contains 2.0 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.

## FLUORIDE REDUCTION

### METHOD

Based upon available information, the most practical and least expensive method of effecting a fluoride reduction in the town's water supply is to drill a shallow well and blend its yield with that of the existing deep well. Assuming a fluoride concentration of 0.1 mg/l in the proposed shallow well, a shallow/deep mix of 45 GPM/100 GPM will result in a blend having a fluoride concentration of 1.4 mg/l.

With the construction and operation of a shallow well, two aspects of water quality that were of little or no concern before will require consideration. One is disinfection, the other is iron content.

Disinfection should be effected in the blended supply with a gas chlorinator. The new chlorinator should be equipped with a device designed to automatically alternate from an empty gas bottle to a full one. The gas system requires that the operator exercise greater care in handling the chlorine, but the system itself is highly reliable and requires very little maintenance. It is also recommended that the chlorinated water be detained in a pressure contact tank for a minimum of 30 minutes before being discharged to the distribution system. The existing water mains are capable of conveying water from the well to the taps of several consumers almost immediately. Should a problem exist, the short contact time presently possible would be inadequate for disinfection to take place.

Sufficient iron to cause aesthetic problems, such as staining of plumbing fixtures, should be expected in the proposed shallow well. With the favorable ratio of deep/shallow well water that will be utilized in this system, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow well will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump. It is possible that the existing hypochlorination equipment can be rebuilt and used.

A schematic drawing of the proposed water supply additions is presented in Figure 1. A complete list of the facilities recommended is as follows:

- One 45 GPM shallow well approximately 100 feet deep. The well should be equipped with a vertical turbine pump set up to operate simultaneously with the deep well pump.
- One concrete valve pit constructed at the intersection of the deep and shallow well discharge lines. The pit should contain meters and valves on both supply lines and should also serve as an injection point for the chlorine solution.
- One 5,000 gallon ground level pressurized chlorine contact tank.
- A pump house addition to accommodate the installation of a gas chlorinator.

The above-described facilities will bring the Lane water supply into compliance with the fluoride standard. It will also increase the total system capacity to 145 GPM which should satisfy community requirements beyond the projection for year 2000.

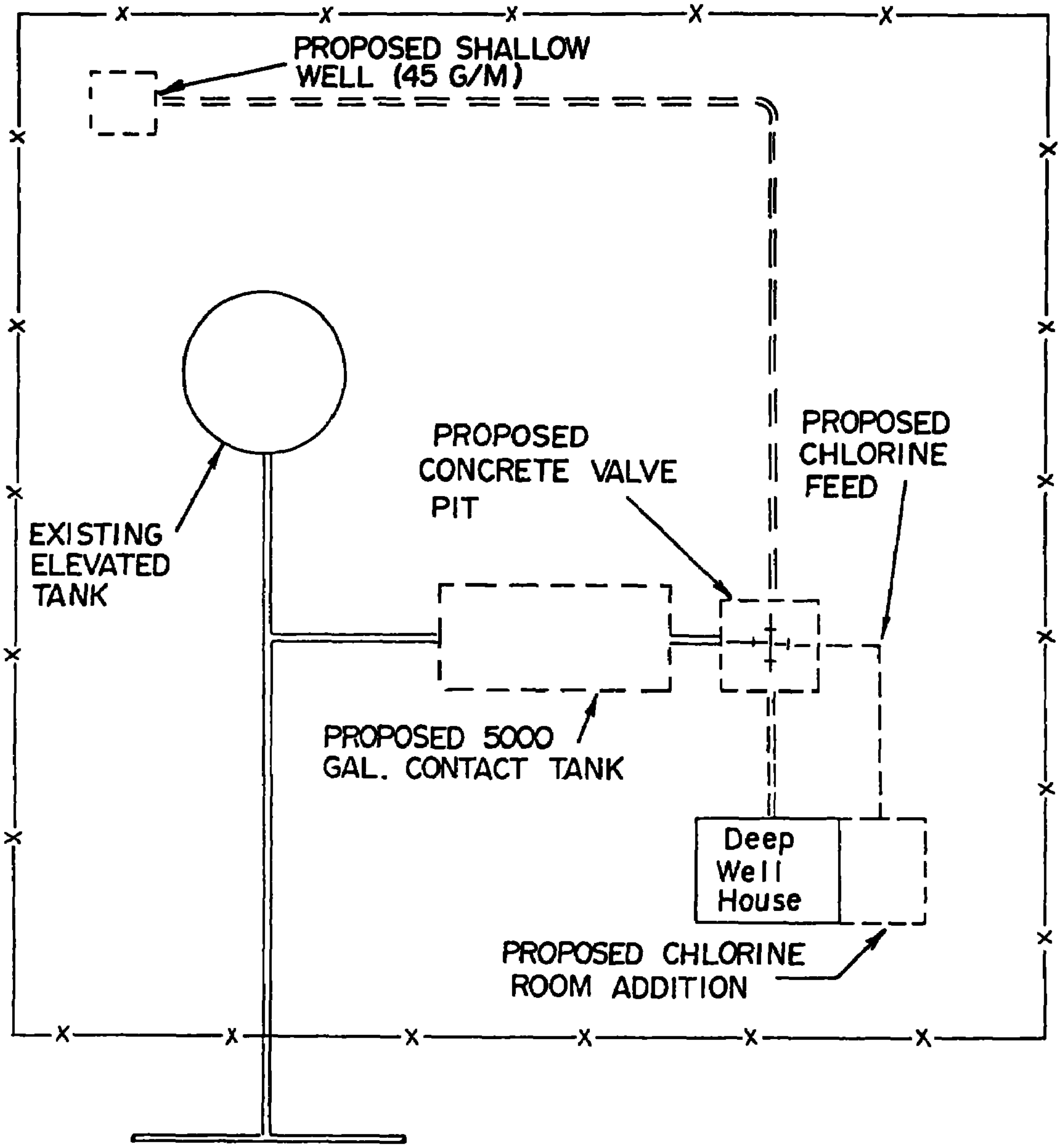


Figure 1

SCHEMATIC DIAGRAM OF PROPOSED
WATER SUPPLY ADDITIONS

AT

TOWN OF LANE

## COST

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the facilities were constructed and became operational during the 1980 calendar year. By utilizing current data, the estimated annual cost increase is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

The construction cost of the proposed facilities including engineering and project contingency expenses has been estimated at $60,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $7,448 |
| • Operations and Maintenance | 102 |
| Total Estimated Annual Cost Increase | $7,550 |
| • Annual Cost Increase per Consumer | $55.93 |

Construction of the facilities described in this report would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[1] | $10.98 |
| • Estimated monthly increase | 4.66 |
| Adjusted Monthly Water Rate | $15.64/consumer |

## IMPLEMENTATION

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of the above-described facilities can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

## OPERATOR REQUIREMENTS

Operator requirements for this system will not change as a consequence of fluoride reduction in the water supply.

## REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for the Town of Lane, Williamsburg County", February 27, 1978.

[2]Personal Communication, Lois Martin, Town of Lane, February 4, 1980.

[3]Clark, J. W., et al., Water Supply and Pollution Control, 1971, International Textbook Company, Scranton, Pennsylvania.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# THE TOWN OF LITTLE RIVER
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Little River. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## EXISTING CONDITIONS

The Little River water system presently has three wells in service. According to the system operator, Mr. Baldwin, all three are within 2500 to 3000 feet of each other. Well #1 is presently pumped at approximately 125 gallons per minute (GPM), is relatively deep, has a fluoride concentration of approximately 2.7 mg/l and an iron concentration of 0.1 mg/l.[1] Well #2 is pumped at approximately 75 GPM, taps shallower water zones than Well #1, has a fluoride concentration of approximately 2.5 mg/l, and an iron concentration of approximately 0.8 mg/l.[2] Well #2 is pumped directly to Well #1 where the flows are mixed, chlorinated, and piped into a 10,000 gallon pressure tank which is connected to the distribution system. Well #3 serves the Bay Tree Condominium and Golf Course system and has recently been connected to the Little River system. Its pumping rate is approximately 200 GPM, its screen is set from 460 feet to 500 feet deep, fluoride and iron concentrations are reported to be approximately 5.0 mg/l and 0.1 mg/l[3], respectively. The Little River system has a 75,000 gallon elevated tank in Town and a 125,000 gallon elevated tank at the Bay Tree well which should provide adequate peak day storage.

The Little River system presently serves approximately 275 residental service connections, a school, a golf club house and pro shop, one industrial user, and various small commercial users. The average water demand of the new completed system is estimated to be 100,000 GPD.[5] The summer average water demand is estimated by Waccamaw Regional Planning and Development Council (WRPDC) to be approximately 0.12 million gallons per day (MGD) and the peak day, approximately 0.16 MGD.

FUTURE CONDITIONS

WRPDC has estimated the future average summer water demands to be 0.24 MGD in 1990 and 0.35 MGD in the year 2000. Assuming the peak day factor remains fairly constant, the peak day flows would be 0.32 MGD in 1990 and 0.47 in the year 2000.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

#### Method

The alternative would involve the drilling of new wells to replace or blend with the two existing high fluoride wells that have an acceptable iron concentration. This alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used and sufficient, satisfactory water located to replace or blend with the existing well water.

Assuming that the shallow ground water will have a fluoride concentration of 0.2 mg/l or less, the blend ratio graph in the Appendix can be used to determine the required quantity of shallow well water needed to blend with existing high fluoride well water. The following table gives the amount of shallow well water required for an acceptable fluoride blend and the maximum shallow well iron concentration to achieve a 1.0 mg/l iron blend. The 1.0 mg/l iron concentration is somewhat arbitrary since the critical factor for this alternative to be a low cost solution is that the iron in the blended water must either be less than 0.3 mg/l, which appears unlikely, or be suitable for sequestering to achieve an acceptable water. To allow a safety factor, a 1.4 mg/l fluoride concentration has been used as the acceptable concentration.

| TOWN OF LITTLE RIVER BLENDING DATA | | | | | |
|---|---|---|---|---|---|
| Existing Wells | | | | Proposed Wells | |
| Well | Fluoride (mg/l) | Iron (mg/l) | Reduced Capacity (Gal/Min) | Capacity (Gal/Min) | Iron (mg/l) |
| #1 | 2.7 | 0.1 | 125 | 134 | 1.84 |
| #2 | 2.5 | 0.8 | 75 | 68 | 1.22 |
| #3 | 5.0 | 0.1 | 200 | 600 | 1.30 |

Since Well #3 requires considerably more water for blending than is needed for the entire water system in the future, blending would only be practical if a much smaller pump is installed in this well. However, if blending is achieved with Well #1 alone, the yield would be 259 GPM. Therefore, for this alternative, the selected design capacity is 259 GPM. Based on discussions with representatives of the USGS and South Carolina Water Resources Commission (WRC), it will be assumed that one test and sampling well, followed by two production wells, will be needed to achieve the 134 GPM required for blending. It will be assumed that an iron sequestering unit will be needed at the existing well site and that one blending well will be piped to the existing well site. To indicate the impact of excessively high iron content in the new wells, the cost of iron removal treatment has also been estimated. However, it is beyond the scope of this study to predict whether or not iron removal treatment would be required.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $110,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 13,657 |
| • Annual added operation cost using 1979 water use | $ 1,000 |
| • Total estimated added annual cost | $ 14,657 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $250,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 31,038 |
| • Annual added operation cost using 1979 water use | $ 15,728 |
| • Total estimated added annual cost | $ 46,766 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendum, rate structure studies, funding procurement, etc. It is estimated that the time would increase to 42 months if iron removal treatment is required.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative. However, if iron removal treatment is necessary, it is anticipated that one additional water system operator may be required.

## ALTERNATIVE NO. 2: PURCHASE WATER FROM GSWSA

### Method

This solution would involve the purchase of water from Grand Strand Water and Sewer Authority's (GSWSA) Wampee system. This system is presently connected to the Little River system and a master water meter is included at the connection. This solution is reported to be unacceptable to the Little River Water Company and, therefore, has the lowest rating of the alternatives. The Wampee well, which is reported to pump 300 GPM, is estimated to be adequate for approximately five years, if it were to serve both the Wampee and Little River service areas.

### Cost Estimate

To the writer's knowledge, no capital cost would be required to implement this solution, at least for the first few years. Beyond that time, some rate increase might be necessary to pay for a new well. This should be considered when comparing the costs of the various alternatives.

Based on communication with GSWSA,[4] the rate charged for water from the Wampee system might range from $0.50 to $0.65 per 1000 gallons. The estimated added annual operation cost using the $0.65 per 1000 gallon rate and deleting the cost of pumping water from the existing wells would be $21,377.

Implementation

It has been estimated that the time required to achieve an acceptable agreement between Little River and GSWSA concerning the method, rate, etc., of purchasing water might take from 6 to 12 months.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

ALTERNATIVE NO. 3: TREAT EXISTING WELLS

Method

This solution would involve the treatment of well water from Wells #1 and #3 to reduce the fluoride concentration. Well #2 would not be used since it has a high iron concentration. The combined yield of Wells #1 and #3 would be 325 GPM or 0.468 which is just slightly less than the estimated peak day water demand for the year 2000. Because Wells #1 and #3 are not far apart, it will be assumed that the treatment system will be at one site with piping connections to the other well.

The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from the wells and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the Town's proposed sanitary sewer system. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

- Capital cost estimate for project design and construction $331,000
- Annual added debt service assuming 12% loan for 30 years $ 41,090
- Annual added operation cost using 1979 water use $ 26,000
- Total estimated added annual cost $ 67,090

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| LITTLE RIVER ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron sequestering) | 259 | $13,657 | $ 1,000 | $ 50.54 |
| No. 2: Purchase | N/A | -0- | $21,377 | $ 73.71 |
| No. 3: Treatment | 325 | $41,090 | $26,000 | $231.34 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[6] | $14.50 |
| • Estimated monthly increase | 4.21 |
| Adjusted monthly water rate | $18.71/consumer |

## REFERENCES

[1] DHEC Water Analysis Report, Little River, Sample #P-1599, dated March 13, 1980.

[2] DHEC Water Analysis Report, Little River, Sample #P-1601, dated March 13, 1980.

[3] DHEC Water Analysis Report, Little River, Sample #P-1600, dated March 13, 1980.

[4] Telephone communication with Bob Barker, Director of GSWSA, on April 9, 1980.

[5] Telephone communication with Steve Hutchinson of Leon Campbell and Associates, Engineers for Little River, on March 20, 1980.

[6] DHEC Staff Study on Fluoride completed in 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# THE TOWN OF LORIS

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Loris. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Loris water system presently has five wells, with the largest (Well #2) being the only one normally in service.[1] The other four wells have iron concentrations which are generally from three to seventeen times the maximum recommended in the Secondary Drinking Water Standard, and therefore are only used as backup wells during a fire or other water shortage emergency. Well #2 is the only well known to have a high fluoride concentration. The approximate pumping rates and fluoride and iron concentrations of the wells are listed in the following table.

THE TOWN OF LORIS
EXISTING WELL DATA

| Well | Capacity (Gal/Min) | Fluoride (mg/l) | Iron (mg/l) | Hardness (mg/l) |
|---|---|---|---|---|
| #1 Walnut St. | 150 | 1.3 | 1.30 | 36 |
| #2 Spring St. | 400 | 3.8 | 0.01 | 16 |
| #3 Liberty St. | 300 | | (High) | |
| #4 Carolina Furn. | 300 | 0.3 | 1.00 | 150 |
| #5 Carolina Furn. | 50 | 0.2 | 5.00 | 150 |

The Town has a 300,000 gallon and a 75,000 gallon elevated tank which are used for water storage. These tanks provide more than one day's storage of water at current water use rates which is quite adequate to meet their storage needs.

During calendar 1979, the Town used approximately 250,000 GPD on the average and served approximately 870 customers.[5] However, increased consumption by a local industry has recently boosted the daily average to 300,000 GPD.[5]

## FUTURE CONDITIONS

The Town has experienced limited growth for several years. Waccamaw Regional Planning and Development Council (WRPDC) has estimated that water supply needs in Loris would increase from its present 300,000 GPD to 400,000 GPD by 1990 and to 500,000 GPD by the year 2000.

WRPDC estimated that the current maximum day water demand for Loris is approximately 400,000 GPD. This would be a 1.33 peak day factor which appears to be realistic. In terms of pumping capacity, the present estimated peak day water demand would require 16 hours of pumping at 416 GPM.

The alternatives evaluated in the ensuing pages of this study will be predicated on maintaining the existing supply capacity of 400 GPM.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is present in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: BLEND EXISTING WELL WATER

#### Method

This alternative would involve the piping of Well #2, the high fluoride well, to Well #4, the replacement of Well #2 pump with a smaller pump to achieve an acceptable blend, and the addition of an iron sequestering unit at the Well #4 blending point. The best connection piping route would need to be selected after a careful study of all field conditions. However, for this report it will be assumed that 6" piping would be installed from Well #2 north along Spring Street to Church

Street, then east along Church Street to the railroad, then south along Meeting Street to Holly Street, then east along Holly Street crossing under the railroad to Broad Street, then south along Broad Street to Walnut Street, then east along Walnut Street to the site of Well #4. That route would be approximately 6,900 feet in length.

The existing pump in the #2 well should be replaced with a 140 GPM unit. That flow would be mixed with the 300 GPM from Well #4 to produce a blended water having a fluoride concentration of approximately 1.4 mg/l. That concentration should allow sufficient safety factor to stay within the 1.6 mg/l limit established by law.

Blending the #2 well yield with that of Well #4 would result in an iron concentration of approximately 0.7 mg/l, which is 0.4 mg/l above the accepted aesthetic limit. In addition, the hardness of the combined supply would be approximately 107 mg/l as $CaCO_3$, which would cause some laundering problems and promote scale build-up in water heaters.

The iron problem may be overcome to a degree by sequestering (keeping it in solution) with a chemical solution addition of sodium hexametaphosphate. However, the water must be tested to determine whether or not the iron content is amenable to sequestering.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $100,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 12,415 |
| • Annual added operation cost using current estimated water use | $ 3,300 |
| • Total estimated added annual cost | $ 15,715 |

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

## ALTERNATIVE NO. 2: IRON REMOVAL TREATMENT

## Method

This alternative would involve iron removal treatment of water from two existing wells which have low fluoride but high iron concentrations. The sources selected for the purposes of this study are Wells #1 and #4.

The project would include installing connection piping from Well #1, east along Walnut Street, crossing the railroad and Broad Street, and into Well #4 site, the tentatively selected treatment plant site. This connecting route would be approximately 2,000 feet long.

The iron removal treatment system selected for cost estimation purposes was a Ferrosand filtration system with continuous potassium permanganate regeneration. Hardness treatment is not included as a part of this alternative. Utilizing Wells #1 and #4, the treatment unit capacity would be 450 GPM.

## Cost Estimate

- Capital cost estimate for project design and construction — $400,000
- Annual added debt service assuming 12% loan for 30 years — $ 49,660

- Annual added operation cost using estimated current water use $19,500
- Total estimated added annual cost $69,160

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 30 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## Operator Requirements

Operator requirements for this system are expected to increase as a consequence of implementing this alternative. It is anticipated that at least one additional water system operator may be required. Therefore, an operator's salary was estimated and included in the estimated operating cost.

## ALTERNATIVE NO. 3: FLUORIDE REMOVAL TREATMENT

### Method

This solution would involve the treatment of the water from Well #2. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the Town's sanitary sewer system. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Well #2 is the only well requiring no iron treatment but containing excessive fluoride concentrations; accordingly, it will serve as the proposed source of supply for this evaluation.

## Cost Estimate

- Capital cost estimate for project design and construction $405,000
- Annual added debt service assuming 12% loan for 30 years $ 50,277
- Annual added operation cost using estimated existing water use $ 40,500
- Total estimated added annual cost $ 90,777

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| LORIS ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 440 | $12,415 | $ 3,300 | $ 18.06 |
| No. 2: Iron Treatment | 450 | $49,660 | $19,500 | $ 79.49 |
| No. 3: Fluoride Treatment | 400 | $50,277 | $40,500 | $104.34 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[3] — $9.75
- Estimated monthly increase — 1.51

Adjusted Monthly Water Rate — $11.26/consumer

## REFERENCES

[1]Meeting and discussion with Mr. Rodney Hardee, water superintendent, on January 30, 1980.

[2]DHEC Water Analyses Reports for Loris, South Carolina
Sample Point: Well #1, Police Station, taken April 3, 1980.
Sample Point: Well #4, small well, taken April 3, 1980.
Sample Point: Well #5, large well, taken April 3, 1980.

[3]DHEC Staff Study on Fluoride for Town of Loris, dated April 19, 1978.

[4]Water Analysis by Froehling and Robertson, Inc. for Sydnor Hydrodynamics Inc., for Town of Loris, (Well #2), dated August 16, 1973.

[5]Telephone communication with Mr. Rodney Hardee, water superintendent, on April 23, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# THE MIKE WILLIAMSON MOBILE HOME PARK

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

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# INTRODUCTION

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Mike Williamson Mobile Home Park. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## EXISTING CONDITIONS

The Mike Williamson Mobile Home Park water system is reported[1] to consist of what was at one time three very small water systems, each with its own well. The system has one 1,500 gallon and one 1,550 gallon pneumatic tank[2] for water storage. The system's water has a fluoride concentration of approximately 3.2 mg/l.[2] The system's water use is not metered. There are 40 mobile home sites presently being served.[1]

Assuming an average water use of 200 GPD per mobile home, it is estimated that the average daily water demand would be 8,000 GPD.

## ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[3] the water demand would be 14,400 GPD. With that demand, the desirable minimum pumping rate would be 15 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[4] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 136 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated[7] that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[4] of checking pneumatic tank size indicates that a well capacity of at least 71 GPM will be needed if the existing 3,050 gallons of pneumatic tankage is all the water storage available. However, an additional 5,000 gallons of pneumatic tank capacity would allow the use of a 15 GPM well, which is estimated to be sufficient to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 40 residential connections is design condition.
2. Existing pressure tank sizes are 1500 and 1550 gallons.
3. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 40 residences x 3.4 GPM/resd. x 0.8 = 108.8 GPM instantaneous demand.
2. Usable pressure tank volume = 3050 ÷ 4 = 762.5 gallons.
3. Tank contribution for 20 minutes = 762.5 ÷ 20 minutes = 38.1 GPM.
4. Minimum new well size to meet instantaneous supply demand = 109 GPM - 38 GPM = 71 GPM.
5. Minimum pneumatic tank capacity with 15 GPM well = (109 GPM - 15 GPM) x 20 minutes x 4 = 7,520 gallons
6. Additional pneumatic tank capacity needed = 7,520 gal. = 3,050 gal. = 4,470 gallons. Use 5,000 gallon tank.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: PURCHASE WATER FROM CONWAY

Method

This alternative would involve the installation of a master water meter and approximately 150 yards of connection water main between the Mike Williamson Mobile Home Park and a proposed extension of the Conway water system. Conway plans to extend a water main along Highway 905 past this community by the end of 1981.[5] It should be noted that connection to the Conway system will not eliminate the high fluoride problem until Conway corrects their own problem.

Conway has advised that they presently charge $2,600 for a 3" water meter installation, which would probably be required for this mobile home park. The City's proposed water rates, which are likely to be in effect by the end of June, 1980, are $5.00 minimum per dwelling per month for the first 2,000 gallons plus $0.75 per each 1,000 gallons used in addition to the first 2,000 gallons.[6] To this rate, an increase of $0.64 per 1,000 gallons must be added to cover the minimum cost which Conway is expected to incur in solving their fluoride problem.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for connection installation | $5,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 621 |
| • Annual added water cost, less power cost, using estimated water use | $5,634 |
| • Total estimated added annual cost | $6,255 |

Implementation

It has been estimated that securing of approvals and a water service contract, and construction of this alternative can be accomplished within 24 months of the completion of funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

ALTERNATIVE NO. 2: DRILL NEW WELL

Method

This alternative would involve the drilling of a new well to replace or blend with the existing high fluoride wells. Since it has been estimated that 15 GPM would be needed to meet the peak water demand with additional storage, a replacement well appears to be a more practical solution than the operation of two wells. It should be noted that this alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled and sufficient, satisfactory water located.

For cost estimating purposes, it will be assumed that a 15 GPM replacement well, a 5,000 gallon pneumatic tank, and an iron sequestering unit is to be installed.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $45,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 5,587 |
| • Annual added operation cost using estimated water use | $ 100 |
| • Total estimated added annual cost | $ 5,687 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required rate structure studies, funding procurement, etc., provided only iron sequestering is required. It is estimated that the time would increase to 42 months if iron removal treatment is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| MIKE WILLIAMSON MOBILE HOME PARK ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Purchase Water | N/A | $ 621 | $5,634 | $156.38 |
| No. 2: New Well | 15 | $5,587 | $ 100 | $142.18 |

Based upon the above listed information, Alternative No. 2 is the least expensive method of effecting a solution to the fluoride problem in this community. However, purchasing water from the City of Conway would provide this community with a more reliable municipal water supply. Accordingly, we recommend that Alternative No. 1 be implemented.

Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $156.38 per consumer ($13.03/month).

## REFERENCES


[1]Meeting and discussion with Mike Williamson on February 5, 1980.

[2]DHEC Staff Study on Fluoride, dated May 15, 1978.

[3]Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pennsylvania.

[4]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[5]Telephone conversation with Mr. Winfield, Director of Public Works for Conway, South Carolina, on March 7, 1980.

[6]Telephone conversation with Mr. Winfield, Director of Public Works for Conway, South Carolina on April 14, 1980.

[7]Letter from Fred H. Soland of DHEC to Joe Willson of JESCO dated May 5, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# TOWN OF MT. PLEASANT
# CHARLESTON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Mt. Pleasant. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The Town of Mt. Pleasant provided service to 5,200 consumers (approximately 14,000 people) as of January, 1980.[1]

Population projections for the entire geographical area served by the Mt. Pleasant water system were obtained from the Berkeley Charleston Dorchester Council of Governments. Recognizing that Bulls Bay Rural Community Water District serves a portion of that geographical area and that some residents do not have access to a public water supply, the population projections were not converted directly to water demand. Instead, they served as a basis for establishing growth factors which were applied to the existing consumer inventory. Consumer projections determined in accordance with the above-described methodology are summarized in the following table.

| TOWN OF MT. PLEASANT<br>CONSUMER POPULATION PROJECTIONS | | | |
|---|---|---|---|
| Year | *Geographical Area Population | % Increase | No. Consumers |
| 1980 | 20524 | -0- | 5200 |
| 1985 | 24036 | 17% | 6084 |
| 1990 | 26789 | 11% | 6753 |
| 1995 | 29454 | 10% | 7428 |

*Geographical area population includes people residing in the old section of town plus those living in unincorporated areas lying east of the Cooper River.

WATER SUPPLY REQUIREMENTS

Current Demand

Daily water demand in the three service areas comprising the town's water system during calendar 1979 are listed in the following table.[2]

| TOWN OF MT. PLEASANT AVERAGE DAILY WATER DEMAND IN GALLONS | | | | |
|---|---|---|---|---|
| Month | Plant #1 | Plant #2 | Plant #3 | System |
| January | 524,929 | 239,487 | 308,842 | 1,073,258 |
| February | 439,321 | 240,286 | 336,343 | 1,015,950 |
| March | 453,635 | 277,488 | 271,700 | *1,102,823 |
| April | Unknown | ***282,633 | ***221,743 | |
| May | 643,825 | 282,181 | 241,039 | 1,167,045 |
| June | 669,317 | 228,836 | 266,833 | 1,164,986 |
| July | 606,913 | 379,065 | 246,132 | 1,232,110 |
| August | 574,210 | 439,548 | 258,948 | **1,272,706 |
| September | 481,540 | 358,497 | 262,243 | 1,102,280 |
| October | 318,107 | 384,451 | 390,994 | 1,093,552 |
| November | 328,367 | 422,231 | 332,870 | 1,083,468 |
| December | 294,258 | 442,677 | 422,503 | 1,159,438 |
| Average | 485,000 | 335,000 | 305,000 | 1,125,000 |

*Low month
**High month
***Not included in averages

Maximum daily demand was considered to be approximately 180% of average daily usage.[3] Those maximums are as follows:

- Plant #1 873,000 GPD
- Plant #2 603,000 GPD
- Plant #3 549,000 GPD
- System 2,025,000 GPD

Projected Demand

Translating current system data to individual consumer demand, the average daily usage per connection was placed at 216 gallon per day/consumer. Utilizing that value future water demand was calculated and is summarized in the following table.

| TOWN OF MT. PLEASANT PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 1,125,000 | 2,025,000 |
| 1985 | 1,314,000 | 2,365,000 |
| 1990 | 1,459,000 | 2,626,000 |
| 1995 | 1,604,000 | 2,888,000 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing a SC DHEC design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 22-hour operating period.

- 1980 - 2109 GPM
- 1985 - 2453 GPM
- 1990 - 2735 GPM
- 1995 - 3008 GPM

EXISTING SUPPLY

The Mt. Pleasant water supply consists of three separate plants all of which pump into a common distribution system. Each of the three supplies consist of one deep well and a series of shallow wells. The installed well capacity of each plant is as follows:

- Plant #1 (Simmons St.)

| | |
|---|---|
| Deep Well | 900 GPM |
| Eleven Shallow Wells | 275 GPM |

- Plant #2 (Mathis Ferry Road)

| | |
|---|---|
| Deep Well | 900 GPM |
| Twelve Shallow Wells | 300 GPM |

- Plant #3 (Snee Farm)

| | |
|---|---|
| Deep Well | 250 GPM |
| Eleven Shallow Wells | 275 GPM |

FLUORIDE REDUCTION

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ALTERNATIVE NO. 1: BLENDING

Method

To achieve a blend of deep and shallow well water having a combined fluoride content of 1.4 mg/l, the deep/shallow blend ratio must be maintained at 1 GPM/2.22 GPM. Utilizing the total combined shallow well capacity of 850 GPM, the deep well production would be limited to 385 GPM. It should be noted that during a

16-hour pumping day the resulting supply of 1235 GPM would be 42% deficient in 1980 and 50% deficient by 1985. The computation of those deficiencies was made as follows:

- 1980

| | |
|---|---|
| Required | 2109 GPM |
| Available | 1235 GPM |
| Deficiency | 874 GPM |

$$\frac{874 \text{ GPM}}{2109 \text{ GPM}} = 42\%$$

- 1985

| | |
|---|---|
| Required | 2463 GPM |
| Available | 1235 GPM |
| Deficiency | 1228 GPM |

$$\frac{1228 \text{ GPM}}{2463 \text{ GPM}} = 50\%$$

Consequently, this alternative will require the construction of additional shallow wells. The initial phase will be sized to accommodate 1985 flow requirements. Beyond that, nine shallow wells will have to be constructed for each 100 GPM increase in deep well capacity that is utilized.

One other item noted during the study was that the Town's booster pumping facilities are operating at or near capacity. Due to the limited scope of this study, an in-depth evaluation was not possible. However, the following cursory computations are presented for the information of the reader.

- Capacity Data

Plant #1 (measured capacity)

| | | |
|---|---|---|
| One Pump | = | 450 GPM |
| One Pump | = | 480 GPM |
| Combined Capacity | = | 650 GPM |

Plant #2 (rated capacity)

| | | |
|---|---|---|
| Two pumps @ 500 GPM each | | |
| Assumed combined capacity | = | 650 GPM |

Plant #3 (rated capacity)

Two pumps @ 500 GPM each
Assumed combined capacity = 650 GPM

- Available Capacity with One Pump

480 + 500 + 500 = 1,480 GPM
(1480 GPM)(24 hr)(60 min/hr) = 2,131,200 GPD

- 1980 Adequacy

Average Day

$\frac{1,125,000 \text{ gal}}{2,131,200 \text{ gal}}$ = 53% Run Time (12 hrs, 43 min)

Maximum Day

$\frac{2,025,000 \text{ gal}}{2,131,200 \text{ gal}}$ = 95% Run Time (22 hrs, 48 min)

- 1985 Adequacy

Average Day

$\frac{1,314,000 \text{ gal}}{2,131,200 \text{ gal}}$ = 62% Run Time (14 hrs, 52 min)

Maximum Day

$\frac{2,365,000 \text{ gal}}{2,131,200 \text{ gal}}$ = 111% Run Time Inadequate

Based upon visual inspections of the three water plant sites, the plants were ranked according to the apparent availability of new shallow well sites. The site selected as most suited to shallow well additions was Plant #3 (Snee Farm). The second was Plant #2, and the third, or least desirable was Plant #1. Consequently, the required 1985 capacity of 2463 GPM will be met by maximizing the use of deep Well #3, maximizing the use of the shallow wells at Plant #1, and providing the remaining capacity at Plant #2. The modifications and/or additions required to achieve that end are described in the following paragraphs. One other item that should be noted is that the following scenarios assume that the existing distri-

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# THE CITY OF CONWAY

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

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## BACKGROUND

### EXISTING CONDITIONS

The Conway and Conway Rural water systems are both operated by the City of Conway and presently have six and two wells, respectively, which are spread throughout their service areas. All wells are rated at 500 gallons per minute (GPM)[1] and are reported by DHEC[2] to have fluoride concentrations in excess of the 1.6 milligrams per liter (mg/l) limit set by EPA. The shallow ground water from ground level down 100 to 200 feet in the area is generally reported to have quite high iron concentrations, in the range of 2.0 to 3.0 mg/l, but relatively low fluoride concentrations, generally in the neighborhood of 0.1 to 0.2 mg/l.[3] Below the iron laden water zones, the water is quite high in fluoride, in the 3.5 to 5.0 mg/l range, but the concentration decreases with depth until the salty zones are reached at a depth somewhere below 770 feet below mean sea level (MSL). The fluoride concentration in the water zones from 585 to 762 feet below MSL are reported by DHEC to have an average fluoride concentration of 2.2 mg/l[2] and, by independent laboratory analyses, to have an iron concentration of from 0.01 to 0.25 mg/l.[1]

The City system has three 200,000 gallon elevated water tanks and the Conway Rural system has one 200,000 gallon elevated water tank. As for sanitary sewers which might be used for disposal of treatment wastewater, presently Wells #1 through #4 have sewers within a reasonable distance. Sewers are planned for the areas near the Conway Rural wells and should be in service within a couple of years.

The City water system had 3,584 connections[1] in 1979 which served a population of approximately 10,000. The Conway Rural system had 346 connections[1] which served to a population of approximately 1,000. The average and peak day water demands[1] for 1979 were 0.955 million gallons per day (MGD) and 1.125 MGD, respectively for the City system, and 0.376 MGD and 0.476 MGD, respectively, for the Conway Rural system.

FUTURE CONDITIONS

The City has estimated the average and peak day water demands[1] for 1985 to be 1.8 MGD and 2.5 MGD, respectively, for the City system and 0.75 MGD and 1.0 MGD, respectively, for the Conway Rural system. The Waccamaw Regional Planning and Development Council (WRPDC) had estimated that the average day water demand would be 2.0 MGD for 1990 and 2.5 MGD for the year 2000 for the combined City and Conway Rural systems. Since the City has estimated a larger growth than WRPDC, the writer has increased the WRPDC predictions and estimated that the average and peak day water demands might be 3.0 MGD and 4.0 MGD, respectively, for 1990 and 3.5 MGD and 4.66 MGD, respectively, for the year 2000.

The City also advised that one new 500 GPM well is being planned for installation in 1980 for the City system, and also one new 500 GPM well for the Conway Rural system was being planned. The City prefers to have at least twice as much pumping capacity as the peak day water demand.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified several viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

#### Method

This alternative is heavily dependent upon the quantity and quality of shallow ground water actually available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used and sufficient, satisfactory water located to achieve an acceptable blend. The water located must have a relatively low fluoride and iron concentration. Using the water analyses provided by DHEC[2] and assuming that the shallow water will have a fluoride concentration of 0.2 mg/l or less, the blend ratio graph in the Appendix can be used to determine the required quantity of shallow well water needed to blend with the deep well water. To choose a reasonable design flow for this solution, this alternative will involve blending at six of the City's eight deep wells to achieve 3000 GPM yield of acceptable water. To allow a safety factor, a 1.4 mg/l fluoride concentration will be used as the acceptable concentration. Wells #1, 2, 3, 4, 6 and Conway Rural #2 will be used for this alternative since they have a lower fluoride concentration than the other two wells in the system. The following table gives the amount of deep and shallow water required for an acceptable fluoride blend and the shallow well iron concentration to give a 1.0 mg/l iron blend. The 1.0 mg/l iron concentration is somewhat arbitrary since the critical factor for this alternative to be a low cost solution is that the iron in the blended water must either be less than 0.3 mg/l, which appears unlikely, or be suitable for sequestering to achieve an acceptable water.

CITY OF CONWAY
BLENDING REQUIREMENTS

| Existing Well Data | | | | Proposed Well Data | |
|---|---|---|---|---|---|
| Well | Fluoride[2] (mg/l) | Iron[1] (mg/l) | Reduced Capacity | Capacity | Iron (mg/l) |
| #1 | 2.2 | 0.01* | 303 GPM | 197 GPM | 2.52 |
| #2 | 2.1 | 0.25* | 318 GPM | 182 GPM | 2.31 |
| #3 | 2.3 | 0.01* | 289 GPM | 211 GPM | 2.36 |
| #4 | 2.1 | 0.01* | 318 GPM | 182 GPM | 2.73 |
| #6 | 2.2 | 0.03* | 303 GPM | 197 GPM | 2.49 |
| R-#2 | 3.0* | 0.06* | 215 GPM | 285 GPM | 1.71 |

*Not from SC DHEC analysis.

As can be seen by the table, this alternative is based on the assumption that the existing deep well pumps will be replaced with smaller pumps to achieve the desired blend. Also, it will be assumed that shallow wells will produce 75 GPM and therefore, multiple wells and well lots with connecting piping will be required to serve each deep well. With limited data on the shallow ground water, it appears that iron sequestering would be marginally possible. However, costs have been estimated on such a system for comparison purposes. This alternative assumed that iron removal treatment will be required.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $1,090,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 135,324 |
| • Annual added operation cost using 1979 water use | $ 13,310 |
| • Total estimated added annual cost | $ 148,634 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $2,340,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 290,511 |
| • Annual added operation cost using 1979 water use | $ 22,789 |
| • Total estimated added annual cost | $ 313,300 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 30 months of the completion of required referendum, rate structure studies, funding procurements, etc., provided only iron sequestering is required. It is estimated that the time would increase to 54 months if iron removal treatment is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative, if iron sequestering is required. However, if iron removal treatment is necessary, it is anticipated that an additional water system operator may be required.

ALTERNATIVE NO. 2: TREAT EXISTING WELLS

Method

This solution would involve the treatment of existing well water to reduce the fluoride concentration. To be consistent with the previous alternative, it will be assumed that only six of the wells will be treated. Wells #1, 2, 3, 4 and CR1 and CR2 would be the most likely candidates since they either have a sewer nearby now or sewers are planned. Each well would have its own treatment unit. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to a nearby sanitary sewer. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $2,270,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 281,798 |
| • Annual added operation cost using 1979 water use | $ 207,000 |
| • Total estimated added annual cost | $ 488,798 |

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed A operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## ALTERNATIVE NO. 3: REGIONAL WATER SYSTEM

## Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1000 gallons. At the current average daily demand of 1,331,000 gallons, the annual cost would be $1,433,154.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementation of this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| CONWAY AND CONWAY RURAL ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron treatment) | 3,000 | $290,511 | $ 22,789 | $ 79.72 |
| No. 2: Treatment | 3,000 | $281,798 | $207,000 | $124.38 |
| No. 3: Regional | 2,778 | $1,294,454 | $138,700 | $364.67 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative will result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[4] | $7.55 |
| • Estimated monthly increase | 6.64 |
| Adjusted monthly water rate | $14.19/consumer |

## REFERENCES


[1]Data personally received from Mr. Winfield, Public Works Director of Conway, at meeting held February 6, 1980.

[2]DHEC Water Analysis Reports as follows:
City Well #1, Sample #P080, dated July 19, 1979, F = 2.2 mg/l
City Well #2, Sample #P081, dated July 19, 1979, F = 2.1 mg/l
City Well #3, Sample #P082, dated July 19, 1979, F = 2.3 mg/l
City Well #4, Sample #P083, dated July 19, 1979, F = 2.1 mg/l
City Well #5, Sample #P076, dated July 19, 1979, F = 2.5 mg/l
City Well #6, Sample #P077, dated July 19, 1979, F = 2.2 mg/l
Conway Rural #1
Conway Rural #7

[3]Meeting and discussion with Al Zack of U.S. Geologic Survey and Larry West of South Carolina Water Resources Commission, on February 5, 1980.

[4]DHEC Staff Study on Fluoride for Conway, dated May 4, 1978 and for Conway Rural, dated May 8, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# CRYSTAL LAKES MOBILE HOME PARK

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture Of

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June 21, 1978 DHEC memorandum,[1] it appears possible to find low fluoride water at a shallower depth than the two existing American Heritage wells. Shallow wells at nearby Taylor Lumber Company, Inman and Associates, and Wesco Steel were reported to have fluoride concentrations of less than 0.1 mg/l. Water samples from the nearby Moose Lodge and Airport Skateland wells had 1.4 mg/l and 1.1 mg/l of fluoride, respectively. The Moose Lodge well was reported to be 405 feet deep.

If blending of existing well water with that of a new well is proposed, the existing 45 GPM well would require 72 GPM of low fluoride (0.2 mg/l or less) water, while the existing 28 GPM well would require only 12 GPM to achieve a safe, acceptable blended fluoride concentration of 1.4 mg/l. Since a combined yield of 28 GPM and 12 GPM would be less than the 43.4 GPM needed for the peak day, a yield of at least 15.4 GPM would actually be the predicted minimum desirable pumping rate of a new well. Due to the uncertainty associated with the quality of shallow ground water, it will be assumed for cost estimation purposes that iron sequestering and chlorination equipment with an enclosure will be required with the installation of a new well. Also, as discussed previously, a 7,500 gallon pneumatic tank must be added to the system with a total well capacity of 43.4 GPM.

COST ESTIMATE

| | |
|---|---|
| • Capital cost estimate for project design and construction | $50,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 6,208 |
| • Annual added operation cost using 1979 estimated water use | $ 100 |
| • Total estimated added annual cost | $ 6,308 |

IMPLEMENTATION

It has been estimated that design, securing of approvals, advertisement, contract execution, and construction on this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

## OPERATOR REQUIREMENTS

Operator requirements for this system are not expected to change as a consequence of implementation of this alternative.

## SUMMARY

Based upon available information, the most practical and least expensive method of solving the fluoride problem for the American Heritage Mobile Home Park appears to be to construct the well project described above. Presuming that the increased annual cost will be amortized uniformly over the existing customer population of 65, the annual incremental increase is calculated to be $97.05 per consumer ($8.09/month).

REFERENCES

[1]DHEC Memorandum, Subject: American Heritage Mobile Home Park, Lexington County; From: Fred H. Soland, Jr., P. E.; To: File; dated June 21, 1978.

[2]Clark, J. W., et al. Water Supply and Pollution Central, page 35, 1971, International Textbook Company, Scranton, Pennsylvania.

[3]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[4]Letter from Fred H. Soland of DHEC to Joe Willson of JESCO dated May 5, 1980.

matic tank capacity would allow the use of a 43.4 GPM well, which is estimated to be sufficient to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 165 residential connections assumed as design condition.
2. Combined yield of new and existing well is assumed to be 43.4 GPM.
3. Existing pressure tank size is 5,000 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on Pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 165 residences x 1.5. GPM/resd. x 0.8 = 199.2 instantaneous demand.
2. Usable pneumatic tank volume = 5,000 ÷ 4 = 1,250 gallons.
3. Tank contribution for 20 minutes = 1,250 ÷ 20 minutes = 62.5 GPM
4. Minimum new well size to meet instantaneous supply demand = 199.2 GPM - 43.4 GPM = 155.8 GPM.
5. Minimum pneumatic tank capacity with a 43.4 GPM well = (199.2 GPM - 43.4 GPM) x 20 minutes x 4 = 12,464 gallons.
6. Additional pneumatic tank capacity needed = 12,464 gal. - 5,000 gal. = 7,464 gallons. Use 7,500 gallon tank.

## FLUORIDE REDUCTION

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative should include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### METHOD

The viable alternatives for this system appear to be quite limited. One possible alternative would be to connect to the City of Cayce's water system. However, the end of the Cayce water system is approximately 1.8 miles from the American Heritage Mobile Home Park. Utilizing an estimated construction cost of $6.00 per foot for a 6" diameter PVC pipe installation, the cost would be over $57,000. Other costs would include a possible $10,000 tap fee, a master meter installation, drive and roadway repairs, highway borings, etc. Due to the high cost per residence, this possible alternative has been eliminated by the writer. Treatment for fluoride reduction has also been eliminated for the same reason. It is, however, the system owner's prerogative to investigate and select any alternative that will bring this supply into compliance with the law.

The only viable alternative for this system appears to be the drilling of a new well to tap a more acceptable water source. Based on information contained in a

3.5 mg/l, it would take approximately 53 GPM of low (0.2 mg/l or less) fluoride well water to blend with the existing 30 GPM well to achieve a safe, acceptable blended fluoride concentration of approximately 1.4 mg/l. Since it has been estimated that only 14 GPM will be needed to meet the peak day demand with additional storage, it is more practical to assume that a new well can be constructed to meet the peak day water demand, rather than to achieve sufficient water to blend with either existing well. Therefore, for cost estimating purposes, installation of a 14 GPM well with a 6,500 gallon pneumatic tank will be assumed.

Excessive iron, requiring iron removal treatment, might be encountered. However, it appears reasonable to assume that 14 GPM of relatively low iron, low fluoride water can be located. Therefore, for cost estimating purposes, it will be assumed that iron sequestering will be required.

COST ESTIMATE

| | |
|---|---|
| • Capital cost estimate for project design and construction | $45,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 5,587 |
| • Annual added operation cost using 1979 estimated water use | $ 50 |
| • Total estimated added annual cost | $ 5,637 |

IMPLEMENTATION

It has been estimated that design, securing of approval, advertisement, contract execution, and construction on this alternative can be accomplished within 24 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## OPERATOR REQUIREMENTS

Operator requirements for this system are not expected to change as a consequence of implementation of this alternative.

## SUMMARY

Based upon available information, the most practical and least expensive method of solving the fluoride problem for the Central Mobile Home Village appears to be to construct the well project described above. Presuming that the increased annual cost will be amortized uniformly over the existing customer population, the annual incremental increase is calculated to be $156.58 per consumer ($13.05/month).

## REFERENCES

[1]DHEC Memorandum, Subject: Central Mobile Home Village, Horry County: From: Fred H. Soland, Jr., P. E.; to: File; dated August 11, 1978.

[2]DHEC Analysis Report, Station Code 626012, Laboratory Sample No. P071660070, FDW-51, dated July 13, 1976.

[3]Clark, J. W., et al. Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pennsylvania.

[4]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[5]Letter from Fred H. Soland of DHEC to Joe Willson of JESCO dated May 5, 1980.

bution system has sufficient hydraulic capacity to accommodate the required shift in the physical location of production capacity.

Plant #3 has a deep well capacity of 250 GPM. The desired blend will require that the shallow well capacity be increased from 275 GPM to 550 GPM. That increase will necessitate the construction of eleven additional shallow wells. The total combined capacity of the expanded supply will be 800 GPM, approximately 32% of the required total.

Plant #1 has a combined shallow well yield of 275 GPM. The desired blend will allow the use of 125 GPM of deep well water. Based upon available information, it appears that the artesian flow from the deep well will provide the required amount of water. The existing electric operated valve will start and stop the flow simultaneous with the operating of the shallow wells, the deep well discharge valve can be utilized to accomplish any required throttling. The resulting capacity of this facility will be reduced to 400 GPM, approximately 16% of the required total.

Plant #2 will be utilized to provide the remaining 1263 GPM necessary to meet the maximum daily demand in the year 1985 with a 16-hour pumping day. The desired blend at this facility will require an increase in shallow well capacity from 300 GPM to 900 GPM. Said increase can be accomplished by drilling 24 new wells. The deep well capacity that can be utilized is 400 GPM. The existing pump should be replaced with a smaller unit or modified by removing one or more of the existing bowl assemblies to facilitate operation of the well at that capacity.

Cost

The facilities to be constructed under this alternative include: thirty-five shallow wells and one pump replacement or modification. The estimated construction cost of said facilities including engineering and project contingency expenses has been estimated at $1,470,000. Annual debt service expense on that amount calculated at 12% for 30 years is $182,485. Other annual costs such as power and chlorine are approximately proportional to usage and would not change noticeably as a result of the above-described facility additions.

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 48 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: TREATMENT

Method

This solution would involve the treatment of a portion of water produced at each of the three existing wells utilizing the activated alumina process. Plants numbered 1 and 2 will be served by two 700 GPM treatment systems. The 250 GPM well at Plant #3 will be served by a 170 GPM system. The remainder of the flow will be blended yielding a combined system capacity of 2250 GPM. The system will also include a wastewater equalization brine tank to minimize hydraulic impact on the sanitary sewer system.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

## Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $1,650,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $204,831 |
| • Operations and Maintenance | 167,169 |
| Total Estimated Annual Cost Increase | $372,000 |

## Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 42 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| TOWN OF MT. PLEASANT<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 2,460 | $182,485 | - | $35.09 |
| No. 2: Treatment | 2,250 | $204,831 | $167,169 | $71.54 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[1] $8.50
- Estimated monthly increase 2.92

Adjusted Monthly Water Rate $11.42/consumer

## REFERENCES

[1]Personal communication, Ron Bycroft, Town of Mt. Pleasant, January 23, 1980.

[2]Personal communication, Ron Bycroft, Town of Mt. Pleasant, February 1, 1980.

[3]Clark, J. W., et al., Water Supply and Pollution Control, 1971, International Textbook Company, Scranton, Pennsylvania.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# THE CITY OF MYRTLE BEACH
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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## INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the City of Myrtle Beach. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Myrtle Beach water system presently has 21 wells in service.[1] These are distributed throughout its very linear distribution system which parallels the Atlantic Ocean. Two more wells are being drilled as of this writing. The wells generally have a pumping capacity of from 200 to 460 gallons per minute (GPM). These wells generally have multiple screens located from 300 to 710 feet deep which are opposite what is known as the Black Creek aquifer. This aquifer is generally located from a depth of 200 feet down to a depth of 1,000 feet in the Myrtle Beach area, but the lower 200 feet is salty (chloride concentration above 250 mg/l). The waters from these wells are reported to have fluoride concentrations which range from 3.5 up to 5.2 mg/l depending on the location of screens and local conditions. The Conway office of the U. S. Geological Survey (USGS) has indicated that, to their knowledge, all waters from the Black Creek aquifer in the area have fluoride concentrations which are typically twice to four times greater than the legal limit of 1.6 mg/l.

A test well program is currently being conducted by the USGS to determine the quantity and quality of shallow ground water in the Myrtle Beach area. The results of this testing could indicate that the use of shallow ground water is practical. However, previous and current testing indicates that variable and relatively low yields should be expected from shallow aquifers in the area. Therefore, to date no data exists to encourage the belief that sufficient, good quality, or even treatable iron laden, shallow ground water exists to meet the City's current maximum water demand which occurs during the tourist season.

The Myrtle Beach water system contains 6500 metered connections, many of which serve multi-family housing units and commercial establishments. Utilizing the average residential water bill,[4] it was estimated that service is provided to the equivalent of 10,000 single family users. Accordingly, that estimated consumer population will be utilized to assess the financial impact that fluoride reduction will have on this community. (See page 7 of this report)

During the 1979 summer season, Myrtle Beach was able to pump approximately 10 million gallons per day (MGD)[1] or 6,945 GPM which just met the peak day demand. For the peak month (July), billed water consumption averaged 8.232 MGD.[2] The billed water consumption[2] plus the estimated leakage for 1979 averaged approximately 5.7 MGD.

FUTURE CONDITIONS

Future water supply needs have been estimated by Consoer, Townsend & Associates, Ltd., engineers for Myrtle Beach, to be 13.33 MGD for 1990 and 15.0 MGD for the year 2000.[1] The intermediate plan to meet the increasing water demand is to rehabilitate a selected few wells each year and install new wells as needed to stay ahead of the demand. This plan would be followed until a more permanent solution to the quantity and quality deficiencies can be achieved.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

One possible solution to the fluoride problem which will not be discussed herein is the use of the Intracoastal Waterway as a source of supply for a surface water treatment facility. Myrtle Beach has contracted with USGS to study this possibility in detail. However, the results of that study will not be available for an indeterminate period of time. Accordingly, SC DHEC personnel elected to forego the evaluation of the waterway source due to insufficient data on the quality and quantity of raw water.[5]

ALTERNATIVE NO. 1: TREAT EXISTING WELLS

Method

This solution would involve the treatment of the 23 existing wells plus those wells which are added in the future. For this study, it will be assumed that 27 wells will be in service.

The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the City's sanitary sewer system. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $9,395,000 |
| • Annual added debt service assuming 12% loan for 30 years | $1,166,295 |
| • Annual added operation cost using 1979 water use | $1,056,500 |
| • Total estimated added annual cost | $2,222,795 |

Implementation

It has been estimated that design, securing of permits and apprvoals, advertisement, contract execution, and construction of this alternative can be accomplished within 54 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an A operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

ALTERNATIVE NO. 2: REGIONAL WATER SYSTEM

Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains would convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1000 gallons. At the current average daily demand of 5,700,000 gallons, annual cost to this community would be $6,137,475.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| MYRTLE BEACH ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Eq. Resd. Consumer |
| No. 1: Treatment | 9460 | $1,166,295 | $1,056,500 | $222.28 |
| No. 2: Regional | 9257 | $5,543,490 | $ 593,985 | $613.75 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[4] $8.60
- Estimated monthly increase 18.52

Adjusted Monthly Water Rate $27.12/consumer

## REFERENCES

[1] Interim Water and Sewer Report for City of Myrtle Beach, by Consoer, Townsend & Associates, Ltd., dated October, 1979, and revised December, 1979 and January, 1980.

[2] Typed data on past water consumption received from Bill Bull, Superintendent of Water and Wastewater Division of Myrtle Beach, during January 29, 1980 meeting.

[3] Meeting and discussion with Fred Soland of DHEC on March 4 and 5, 1980.

[4] DHEC Staff Study on Fluoride for Myrtle Beach, dated March 1, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# MYRTLE BEACH AIR FORCE BASE

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Myrtle Beach Air Force Base. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The family housing area at Myrtle Beach Air Force Base contains 865 single family dwelling units.[1]

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 200 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand 173,000 Gallons
- Maximum Daily Demand 311,400 Gallons

### Supply Requirement

Utilizing a regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period, the present supply requirement was calculated to be 325 GPM.

### Existing Supply

The housing area is connected to a central system that serves the entire air base. That system is supplied by three operating deep wells each having an approximate capacity of 400 GPM. Two elevated storage tanks ride on the system. One 300,000 gallon tank is located in the housing area, the other, a 200,000 gallon structure, is located in the cantonement area.[2]

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: BLENDING

Method

Blending deep and shallow well water in the proper portions will reduce the fluoride concentration in the water supply to acceptable levels. This alternative will address dividing the existing water system into two separate piping networks each having its own supply and storage facilities.

One network would serve the base housing area exclusively. The source of supply would consist of one existing deep well and a series of eight new shallow wells.

The water would be blended in a shallow/deep ratio of 225 GPM/100 GPM yielding a supply with a fluoride concentration of 1.4 mg/l. The blended water would be disinfected with chlorine and receive an injection of polyphosphates to sequester iron. Storage would be provided by an existing 300,000 gallon elevated storage tank.

The other network would serve the cantonement area exclusively. The source of supply would consist of one operating deep well that is presently located in the cantonement area and the yield from one of the existing deep wells situated in the base housing area. Storage will be provided by an existing 200,000 gallon elevated storage tank.

The success of blending in the base housing area is dependent upon control of the flow from the deep well. This can be accomplished by throttling the deep well to provide a flow that is properly proportioned to the shallow well yield. It should be noted that the adaptability of the existing deep well pump to function in a throttled mode of operation is questionable. It is beyond the limited scope of this study to fully evaluate the effect of the significantly reduced pump output. The reader is therefore cautioned that it may become necessary to modify or replace the existing unit to consistently maintain flow rates less than 200 GPM.

A schematic drawing of the proposed water supply additions is presented in Figure 1. A complete list of the facilities recommended is as follows:

- Eight shallow wells each having a capacity of 30 GPM.
- One equipment building to house chemical feed and level control mechanisms.
- One gas chlorinator.
- One 10,000 gallon pressurized chlorine contact tank.
- One concrete valve pit constructed at the intersection of the deep and

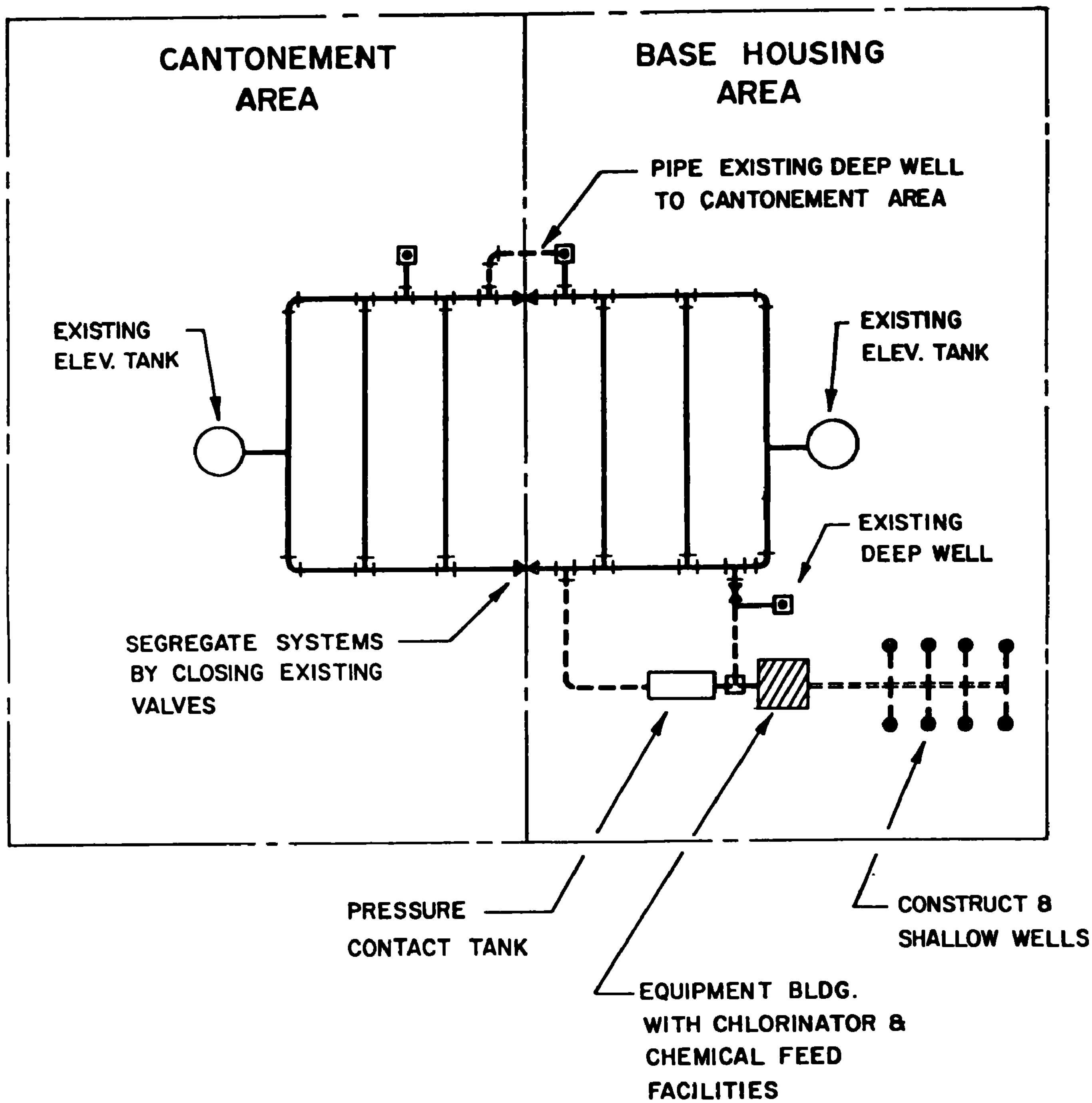


FIGURE 1

SCHEMATIC DIAGRAM OF PROPOSED

WATER SYSTEM ADDITIONS

AT

MYRTLE BEACH AIR FORCE BASE

shallow well lines. The pit should contain meters and valves on both supply lines.

- Polyphosphate mixing and feed facilities. The concept presented herein utilizes a single chemical feed point in the common main leading from the shallow wells. However, it should be noted that iron must be in a soluble form for sequestering to be effective, and that pumping and/or conveyance may cause the iron to precipitate. Should that situation occur, the chemical feed point may have to be moved or iron treatment may become necessary.

Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $380,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $47,173 |
| • Operations and Maintenance | 177 |
| Total Estimated Annual Cost | $47,350 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: WATER PURCHASE

Method

As is discussed in Alternative No. 1, the base distribution system would be divided and the existing deep wells utilized as a source of supply for the cantonement area. The base housing area would be served through a metered connection from the municipal system serving Myrtle Beach.

Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $45,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $ 5,586 |
| • Water Purchase | 35,992 |
| Subtotal | $41,578 |
| • Less Power Cost | 1,578 |
| Total Estimated Annual Cost Increase | $40,000 |

The water purchase expense listed above was calculated at $0.57 per 1000 gallon, the prevailing bulk rate charged by the City of Myrtle Beach. It should be noted that the City was included in this study and that it, too, will incur additional expenses as a result of reducing the fluoride concentration in the water supply. Assuming a uniform amortization of the cost associated with the least expensive alternative developed for Myrtle Beach, the bulk rate would increase from $0.57/1000 gallon to $1.64/1000 gallon. Utilizing the higher rate, the above listed water purchase expense was recalculated to be $103,558, bringing the total estimated annual cost of Alternative No. 2 to $107,566.

## Implementation

The implementation of this alternative is solely dependent on the availability of water from Myrtle Beach. As of this writing, the minimum time required is estimated at 36-60 months.[3]

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| MYRTLE BEACH AIR FORCE BASE ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 325 | $47,173 | $ 177 | $ 54.74 |
| No. 2: Purchase | N/A | $ 5,586 | $101,980 | $124.35 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $54.74 per consumer ($4.56/month).

## REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for Myrtle Beach Air Force Base, Horry County," undated.

[2]Personal communication, Dan Bender, Myrtle Beach Air Force Base, April 24, 1980.

[3]Personal communication, Jay Hood, Myrtle Beach, April 25, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# SURFSIDE BEACH

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Surfside Beach. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## EXISTING CONDITIONS

The Surfside Beach water system presently has two wells in service. The larger of the two, which is pumped at 550 GPM, is used almost exclusively with the smaller well, which is pumped at 190 GPM, used as a back-up supply only.[1] The larger well has a measured fluoride concentration of approximately 3.0 mg/l and an iron concentration of less than 0.1 mg/l.[2] The larger well has screens located from 419 to 469 feet and from 596 to 616 feet deep. The fluoride concentration of the smaller well is reported to be approximately 2.6 mg/l[3], its iron concentration is not known.

The system has a 300,000 gallon elevated tank which serves as the Town's water storage. To the system operator's knowledge,[1] the shallower ground water contains iron in unacceptable concentrations. Therefore, it has typically not been used and little is known about the water's quality or quantity.

In 1979, Surfside had approximately 1485 water service connections which used on the average for the year approximately 0.336 MGD. The average water use for the peak two-month period during 1979 was approximately 0.463 MGD and the peak day water use was approximately 0.865 MGD.

## FUTURE CONDITIONS

The following table gives past and projected customer connections and water demands.[1]

SURFSIDE BEACH
EXISTING AND PROJECTED CONSUMER DATA

| Year | Connections | Peak Month (MGD) | Peak Day (MGD) |
|---|---|---|---|
| 1976 | 1310 | 0.389 | 0.739 |
| 1977 | 1374 | 0.551 | 0.698 |
| 1978 | 1432 | 0.546 | 0.834 |
| 1979 | 1485 | 0.463 | 0.865 |
| 1990 | 2500 | 0.800 | 1.40 |
| 2000 | 3400 | 1.105 | 1.88 |

As can be seen above, the present pumping capacity of 740 GPM or 1.065 MGD is adequate to meet the current demand in approximately 20 hours of pumping. However, additional pumping capacity will be needed in the near future. Recognizing this, the Town is seeking funds at this time to construct a new well and elevated tank.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for the subject water system. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1890 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

#### Method

This alternative would involve the drilling of new wells to replace or blend with the existing high fluoride wells. This alternative is heavily dependent upon the quantity and quality of low fluoride ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used and sufficient, satisfactory water located to replace or blend with the existing well water.

Since it is desirable to plan for future conditions, the 1985 peak day water demand of 1.15 MGD has been selected as the design condition for this alternative. Also, a 16 hour pumping period has been selected to meet this demand which would require 1200 GPM of pumping capacity. To achieve this capacity, it appears only marginally practical to assume that sufficient, acceptable low fluoride ground water can be located to blend with, let alone to replace, the existing well water. Therefore, it will be assumed that blending is necessary and that the proper blend can be achieved by replacing an existing pump with a smaller pump of the desired pumping rate where required.

Assuming that the available blend water will have a fluoride concentration of 0.2 mg/l or less, the following table gives the amount of blend water required for an acceptable fluoride blend and the maximum blend water iron concentration which will give a 1.0 mg/l iron blend. The 1.0 mg/l iron concentration is somewhat arbitrary since one critical factor for this alternative to be a relatively low cost solution is that the iron in the blended water must either be less than 0.3 mg/l, which appears unlikely, or be suitable for sequestering to achieve an acceptable water. To allow a safety factor, a 1.4 mg/l fluoride concentration has been used as the acceptable concentration.

SURFSIDE BEACH
BLENDING DATA

| Existing Wells | | | | Proposed Wells | |
|---|---|---|---|---|---|
| Well | Fluoride (mg/l) | Iron (mg/l) | Reduced Capacity (Gal/Min) | Capacity (Gal/Min) | Iron (mg/l) |
| #2 | 2.6 | | 190 | 190 | |
| #3 | 3.0 | 0.10 | 353 | 467 | 1.68 |

Based on estimates received from a representative of the South Carolina Water Resources Commission (WRC)[4], it will be assumed that shallow wells will produce approximately 60 GPM of low fluoride water on the average. Therefore, multiple wells and well lots with connecting piping will be required to serve the two existing wells. It will also be assumed that iron sequestering units will be required at existing well site. To indicate the impact of excessively high iron content in the new wells, the cost of iron removal treatment has also been estimated. However, it is beyond the scope of the study to predict whether or not sufficient, acceptable water will be located or whether iron removal treatment would be required.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $700,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 86,905 |
| • Annual added operation cost using 1979 water use | $ 3,360 |
| • Total estimated added annual cost | $ 90,265 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $1,200,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 148,980 |
| • Annual added operation cost using 1979 water use | $ 20,000 |
| • Total estimated added annual cost | $ 168,980 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendum, rate structure studies, funding procurement, etc., provided only iron sequestering is required. It is estimated that the time would increase to 42 months if iron removal treatment is required.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative. Should iron removal treatment become necessary, it is anticipated that one or more additional water system operators may be required. Therefore, the cost of one operator has been added to the estimated operating cost.

ALTERNATIVE NO. 2: FLUORIDE REMOVAL TREATMENT

Method

This solution would involve the treatment of the water from the two existing wells plus the proposed well, which will be assumed to be a 460 GPM well. This will make the treated water yield approximately equal with that of the previous alternative. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. This process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the proposed sanitary sewer system. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

- Capital cost estimate for project design and construction $1,115,000
- Annual added debt service assuming 12% loan for 30 years $ 138,416
- Annual added operation cost using 1979 water use $ 102,750
- Total estimated added annual cost $ 241,166

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of the completion of required referendum, rate structure studies, funding procurement, etc.

## Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

## ALTERNATIVE NO. 3: REGIONAL WATER SYSTEM

### Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains would convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1000 gallon. At the current average daily demand of 336,000 gallons, the annual cost for Surfside Beach would be $361,788.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| SURFSIDE BEACH<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 1,167 | $ 86,905 | $ 3,360 | $ 60.78 |
| No. 2: Treatment | 1,170 | $138,416 | $102,750 | $162.40 |
| No. 3: Regional | 972 | $326,774 | $ 35,014 | $243.63 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[5] | $12.00 |
| • Estimated monthly increase | 5.07 |
| Adjusted Monthly Water Rate | $17.07/consumer |

REFERENCES


[1]Meeting and discussion with Mr. J. D. Felix, Water Superintendent for Surfside Beach, on January 28, 1980.

[2]DHEC Water Analysis on Surfside Beach Well #3, dated April 2, 1980.

[3]Water analysis on Surfside Beach well water, dated June 7, 1978.

[4]Telephone communication with Larry West of the S. C. Water Resources Commission, Conway Office, on April 8, 1980.

[5]DHEC Staff Study on Fluoride for the Town of Surfside Beach, dated April 19, 1978.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# SYCAMORE ACRES SUBDIVISION
# LEXINGTON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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## INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Sycamore Acres Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Sycamore Acres water system presently has two wells in use. Well #1, which is on Maple Road, is reported[1] to have an approximate pumping rate of 47 GPM under system pressure and Well #2, which is on Sycamore Drive, is reported[1] to have an approximate pumping rate of 50 GPM under system pressure.

Well data reports indicate that Well #1 is 310 feet deep and Well #2 is 290 feet deep. The South Carolina Department of Health and Environmental Control (DHEC) Staff Study on Fluoride[2] indicates that the average fluoride concentration in the system is 1.9 mg/l. The system has two 5,000 gallon pneumatic tanks for water storage, one at each well site.

The Sycamore Acres water system is connected to, but presently valved off from, four adjoining, interconnected subdivisions which have an acceptable fluoride concentration in their water. The four systems are operated by the same water company which operates the Sycamore Acres system, Carolina Water Services, Inc. The systems are Grayland Forest, Spring Hill, Spring Lake, and Laurel Meadows.

The Sycamore Acres system served an average of 91 customers[3] during 1979, although it has been reported that 96 taps exist.[2] Of the 91 customers, 89 were single family residences with an estimated 3.5 persons per residence and two were stores. The metered water use of the customers during 1979 averaged 18,332 GPD[3] which is approximately 202 GPD per customer. This subdivision has not grown at all during the last few years and is not expected to grow in the near future.

ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[4] and that 96 customers exist, the water demand would be 34,811 GPD. With that demand, the desirable minimum pumping rate would be 36.3 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. Therefore, the existing 97 GPM supply capacity is quite adequate.

If Ameen's method[5] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 96 resd. x 2.04 GPM/resd. = 195.8 GPM. However, this estimate is based on each residence using from 400 to 500 GPD and may need to be verified in the field. Using this instantaneous water supply demand, Ameen's method[5] of checking pneumatic tank capacity indicates that an additional 2,760 gallons of pneumatic tank capacity would be needed if a new well capacity of 36.3 GPM, to meet the peak day demand, were used.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 96 customers assumed as design condition.
2. Yield of a new well is assumed to be 36.3 GPM.
3. Existing pressure tank capacity is 10,000 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55.

Calculations:

1. 96 residences x 2.04 GPM/resd. = 195.8 GPM.
2. 195.8 GPM - 36.3 GPM well yield = 159.5 GPM tank demand.

3. 159.5 GPM x 20 minute demand = 3,190 gallons of stored water needed.

4. Minimum pneumatic tank size = 3,190 x 4 = 12,760 gallons.

5. Additional pneumatic tank capacity needed = 12,760 gallons - 10,000 gallons = 2,760 gallons. Use 3,000 gallon tank.

## FLUORIDE REDUCTION

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### METHOD

One alternative which might appear to have some possibilities would be the installation of a new well of at least 36.3 GPM which would tap a lower fluoride water zone. However, the well log data available does not give much encouragement that other water zones exist. Also, if another water zone does exist, it could just as easily have a high fluoride concentration as not.

The most viable alternative for Sycamore Acres appears to be blending their existing well water with water from the adjoining systems. The adjoining water systems are reported[1] to have an average fluoride concentration of 1.2 mg/l, but their system elevation and pressure is inadequate to properly serve Sycamore Acres without a booster pump.

The blended flow would be considerably greater than that needed to meet the system's estimated instantaneous water supply demand. Therefore, one of the existing wells would be utilized as the high fluoride source; the other well would be abandoned. Blending the yield from Well #2 (50 GPM) with 125 GPM from an adjoining system would result in a fluoride concentration of 1.4 mg/l.

The booster pumping station would be located near the intersection of Maple Road and Mineral Springs Road near the Spring Hill Subdivision.[1] That site is approximately 61 feet lower in elevation and 4,200 linear feet from the Well #2 site.[1] The booster pump installation would consist of the following:

- A ground storage suction tank (6,000 gallons ±) with automatic water level control valve;
- A 125 GPM booster pump wired to operate simultaneously with the Well #2 pump, and;
- 6" piping from the booster pump to Well #2.

COST ESTIMATE

- Capital cost estimate for project design and construction $50,000
- Annual added debt service assuming 12% loan for 30 years $ 6,208

IMPLEMENTATION

It has been estimated that design, securing of approval, advertisement, contract execution, and construction on this alternative can be accomplished within 18 months of the completion of required referendums, rate structure studies, funding procurement, etc.

OPERATOR REQUIREMENTS

Operator requirements for this system are not expected to change as a consequence of this alternative.

## SUMMARY

Based upon available information, the most practical and least expensive method of solving the fluoride problem for the Sycamore Acres Subdivision appears to be to construct the blending project described above. Presuming that the increased annual cost will be amortized uniformly over the existing customer population of approximately 91, the annual incremental increase is calculated to be $68.22 per consumer ($5.69/month).

REFERENCES

[1]Personal communication with Mr. Rob Burgun of Johnny T. Johnson and Associates, Inc., Columbia, South Carolina on March 31 and April 1, 1980.

[2]DHEC Staff Study for Sycamore Acres, Lexington County, dated March 22, 1978.

[3]Personal communication with Dolly Lewis of Carolina Water Services, Inc., W. Columbia, South Carolina on March 31, 1980.

[4]Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pennsylvania.

[5]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# WAGON WHEEL FARMS SUBDIVISION

# GEORGETOWN COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. Sirrine Company and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Wagon Wheel Farms Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Wagon Wheel Farms Subdivision water system has one 60 GPM well and a 500 gallon pneumatic water storage tank in service. The well is reported to have a fluoride concentration of approximately 4.4 mg/l and an iron concentration of less than 0.1 mg/l. The water system is approximately 300 feet away from a water line owned by the Georgetown County Water and Sewer Authority's Murrell's Inlet system.

Water use in this system is not metered. The owner has advised that the 40 existing mobile home trailers are occupied only during the summer.[2] The system has 50 approved taps. Assuming the trailer park is full and average use during the summer is 200 GPD per trailer, the estimated average daily water demand would be 10,000 GPD.

### ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[3] the water demand would be 18,000 GPD. With that demand, the desirable minimum pumping rate would be 18.8 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[4] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 150 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated[6] that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[4] of checking pneumatic tank size indicates that a well capacity of at least 113.7 GPM would be needed if the existing 500 gallon tank is all the storage available. However, since the 60 GPM well with the 50 gallon tank has evidently met the demand in the past, it appears that the instantaneous demand is not more than 60 GPM plus the tank contribution for 20 minutes. Using this demand, an additional 4,000 gallons of pneumatic tank capacity should allow the use of a new 18.8 GPM well, which should be able to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 50 residential connections assumed as design condition.
2. Existing pressure tank size is 500 gallons.
3. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 50 residences x 3.0 GPM/resd. x 0.8 = 120 GPM instantaneous demand.
2. Usable pressure tank volume = 500 ÷ 4 = 125 gallons.
3. Tank contribution for 20 minutes = 125 ÷ 20 minutes = 6.3 GPM.
4. Minimum new well size to meet Ameen's instantaneous supply demand = 120 GPM - 6.3 GPM = 113.7 GPM.
5. Instantaneous demand = 60 GPM (well) + 6.3 GPM (tank) = 66.3 GPM
6. Minimum storage with 18.8 GPM well = (66.3 - 18.8) x 20 minutes = 950 gallons.
7. Minimum pneumatic tank capacity = 950 x 4 = 3,800 gallons.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL NEW WELL

#### Method

This alternative would involve the drilling of a new well to replace or blend with the existing high fluoride well. It has been estimated that 18.8 GPM would be needed to meet the peak water demand; therefore, a replacement well appears to be more practical than operating two wells. It should be noted that this alternative is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled and sufficient, satisfactory water located.

This alternative assumes that one new 19 GPM well with iron sequestering and chlorine equipment would be constructed. In addition, a new 4,000 gallon pneumatic water storage tank would be included. It should be noted that if excessive or non-sequesterable iron exists in the new well, iron removal treatment would become necessary.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $45,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 5,587 |
| • Annual added operation cost using estimated water use | $ 22 |
| • Total estimated added annual cost | $ 5,609 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

ALTERNATIVE NO. 2: PURCHASE WATER FROM GCWSA

Method

This alternative would involve the installation of a master water meter and approximately 300 feet of connection main between the Wagon Wheel Farms system and Georgetown County Water and Sewer Authority's (GCWSA) Murrell's Inlet system. It should be noted that connection to GCWSA will not eliminate the high fluoride problem until GCWSA corrects their own problem.

GCWSA has advised[5] that they should have the following service connection and water rates in effect by the end of June, 1980:

- 3/4" residential connection fee would be $320
- Minimum residential service rate would be $6.47/month
- Charge for all water used would be $0.97/1000 gallons
- 2" commercial tap and meter installation fee would be $1,000
- 3" commercial tap and meter installation fee would be $2,000
- Commercial water service rates are assumed to be basically the same as the residential rates.

In addition to the above, an increase of approximately $1.15 per 1000 gallons must be added to cover the minimum cost which GCWSA is expected to incur in solving their fluoride problem.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for connection installation | $4,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 497 |
| • Annual added water cost, less power cost, with estimated use | $5,420 |
| • Total estimated added annual cost | $5,917 |

Implementation

It has been estimated that securing of approvals and a water service contract, and construction of this alternative can be accomplished within 18 months of the completion of funding procurement, etc.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| WAGON WHEEL FARMS<br>ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: New Well (assuming iron sequestering) | 19 | $5,587 | $ 22 | $140.23 |
| No. 2: Purchase Water | N/A | $ 497 | $5,420 | $147.93 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $140.23 per consumer ($11.69/month).

## REFERENCES

[1]DHEC Water Analysis, Sampling Point: Wagon Wheels Farms, Station Code 422001, Laboratory Sample No. 9100850055, dated October 28, 1975.

[2]Meeting and discussion with Mr. Welch, the owner, on February 7, 1980.

[3]Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[4]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[5]Telephone conversation with Barry Green of Georgetown County Water and Sewer Authority, on April 15, 1980.

[6]Letter from Fred H. Soland of DHEC to Joe Willson of JESCO dated May 5, 1980.

# APPENDIX

# REGIONAL WATER SYSTEM

# REGIONAL WATER SYSTEM

A regional water system which would serve the major coastal communities in Horry and Georgetown Counties was evaluated during the course of this study. The system would be supplied by a 35 MGD conventional surface water treatment facility located on the northeastern bank of the Pee Dee River at the U.S. Highway 701 crossing.

It was assumed that all water systems within reasonable proximity of the proposed transmission mains would be connected. A list of the water systems involved is included at the end of this narrative. The list also contains current and projected water use data.

The transmission lines were sized to maintain a 2.0 to 3.0 foot per second velocity in the mains at the peak day water demand estimated for 1990. At these velocities, pressure losses would be small enough to preclude the use of booster pumping stations. Service pumps located at the treatment facility would maintain pressure gradients above the overflow elevations of existing water tanks located on the user systems. Connections to those tanks would require the use of altitude valves.

The capital cost of the regional water system was estimated to be $85,000,000. The transmission mains accounted for approximately 70% of that cost. Calendar 1980 operation, maintenance and equipment replacement costs were estimated to be $1,143,000. Each user system served would purchase water through a master meter at a uniform rate. Utilizing current usage data and assuming that the plant operated during calendar 1980, the unit price would be $2.95 per 1000 gallons.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# THE CITY OF NORTH MYRTLE BEACH
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the City of North Myrtle Beach. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The North Myrtle Beach water system includes, at the time of this writing, eight wells, four elevated water storage tanks, and a generally linear distribution system which parallels the Atlantic Ocean. The water tanks have a combined capacity of 650,000 gallon. Chlorination is the only treatment utilized at the wells. The design pumping rates and approximate fluoride concentrations of each well are listed in the following table.

| NORTH MYRTLE BEACH EXISTING WELL DATA | | |
|---|---|---|
| Well | Capacity[1] (Gal/Min) | Fluoride[2] (mg/l) |
| #1 41st Ave. S. | 350 | 5.4 |
| #2 Stuckeys 27th Ave. S. | 300 | |
| #3 Possum Trot 13th Ave. S. | 500 | 5.0 |
| #4 Hillside & 9th Ave. S. | 250 | 4.7 |
| #5 Fire Station | 500 | 4.7 |
| #6 Vereen | 500 | 5.2 |
| #7 Sea Mountain | 500 | |
| #8 White Point | 500 | 5.2 |

The system served approximately 4700[1] consumers in 1979 and delivered an estimated 1.6 MGD[1] as an average for the year. The average water consumption for the three summer months was estimated to be approximately 2.5 MGD and the peak day water demand for 1979 was approximately 3.5 MGD.[3]

### FUTURE CONDITIONS

Future water supply needs have been estimated by the City's consulting engineer to be 4.8 MGD for 1985 and 5.4 MGD for 1995.[1] Using those rates, the maximum water supply rate needed for 1990 was estimated to be 5.1 MGD. The Waccamaw Regional

Planning and Development Council furnished an estimate of 6.0 MGD for the water supply needed in the year 2000, which appears to be in line with the Harwood Beebe Company estimates.

As of this writing, two additional wells and two additional elevated water storage tanks are under construction.[1] It is anticipated that these wells will yield water of basically the same quality as the existing facilities. The proposed yields were given as 500 GPM each.[1] If this yield is achieved, North Myrtle Beach will have a pumping capacity of 6.336 MGD which would be greater than the estimated supply requirement for the year 2000.

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: DRILL WELLS FOR BLENDING

### Method

This alternative addresses construction of new wells to blend with the existing high fluoride wells. Blending is heavily dependent upon the quantity and quality of shallow ground water available, both of which are unknown. Therefore, for this to be a viable solution, test and water zone sampling wells must be drilled near each existing well to be used and sufficient, satisfactory water located to blend with the existing well water. There is no assurance that sufficient, satisfactory water exists until testing is completed.

Assuming that the shallow water will have a fluoride concentration of 0.2 mg/l or less, the blend ratio graph in the Appendix can be used to determine the required well capacity. The average quality of the existing wells was used to estimate the quality of water which may be expected from the two wells being constructed. For this alternative, the design flow will be 4400 GPM which is equal to the existing well capacity plus the estimated pump rates of the two wells under construction.

The following table gives the amount of deep and shallow water required for an acceptable fluoride blend, and the maximum shallow well water iron concentration to achieve a 1.0 mg/l iron blend assuming all deep wells have an iron concentration of 0.1 mg/l. The 1.0 mg/l iron concentration is somewhat arbitrary since the critical factor for this alternative to be a low cost solution is that the iron in the blended water must either be less than 0.3 mg/l, which appears unlikely, or be suitable for sequestering to achieve an acceptable water. To allow a safety factor, a 1.4 mg/l fluoride concentration has been used as the acceptable blend concentration.

CITY OF NORTH MYRTLE BEACH
BLENDING DATA

| Existing Wells | | | Proposed Wells | |
|---|---|---|---|---|
| Well | Fluoride (mg/l) | Reduced Capacity (Gal/Min) | Capacity (Gal/Min) | Iron (mg/l) |
| #1 | 5.4 | 81 | 269 | 1.27 |
| #2 | 5.0* | 75 | 225 | 1.30 |
| #3 | 5.0 | 125 | 375 | 1.30 |
| #4 | 4.7 | 67 | 183 | 1.33 |
| #5 | 4.7 | 133 | 367 | 1.33 |
| #6 | 5.2 | 120 | 380 | 1.28 |
| #7 | 5.0* | 125 | 375 | 1.30 |
| #8 | 5.2 | 120 | 380 | 1.28 |
| #9 | 5.0* | 125 | 375 | 1.30 |
| #10 | 5.0* | 125 | 375 | 1.30 |

*Assumed to be the average fluoride concentration in the existing wells

As indicated in the table, this alternative would require that the existing deep well pumps will be replaced with smaller pumps to achieve the desired blend. As a minimum, iron sequestering units are assumed to be needed at each main well site. Based on estimates received from private contractors[4] and discussions with South Carolina Water Resources Commission[5], shallow well yields were estimated between 75 and 100 GPM. Therefore, multiple wells and well lots with connecting piping will be required to serve each deep well. At an average yield of 85 GPM approximately 40 shallow wells will be required.

Due to the large quantity of shallow well water required for blending, a good possibility exists that iron removal treatment would be necessary. Accordingly, the estimated cost of blending with and without iron treatment are presented below.

Cost Estimate with Iron Sequestering

| | |
|---|---|
| • Capital cost estimate for project design and construction | $2,300,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 285,545 |
| • Annual added operation cost using estimated 1979 water use | $ 16,000 |
| • Total estimated added annual cost | $ 301,545 |

Cost Estimate with Iron Removal

| | |
|---|---|
| • Capital cost estimate for project design and construction | $5,100,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 633,165 |
| • Annual added operation cost using estimated 1979 water use | $ 32,000 |
| • Total estimated added annual cost | $ 665,165 |

## Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 36 months of the completion of required referendum, rate structure studies, funding procurement, etc., provided only iron sequestering is required. It is estimated that the time would increase to 54 months if iron removal treatment is required.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative. However, if iron removal treatment becomes necessary, it is anticipated that at least one additional staff position for a water system operator would be created. The estimated salary of one operator has been included in the operating cost estimate.

## ALTERNATIVE NO. 2: TREAT EXISTING WELLS

## Method

This solution would involve the treatment of the water from the eight existing wells plus the two proposed wells, which would yield an approximate total of 4400 GPM. The treatment process which appears to be the least expensive to reduce the fluoride concentration is the activated alumina process. That process would involve treatment of a portion of the flow from each well and the blending of the bypassed portion with the defluoridated water. When the treatment capacity is exhausted, the unit must be regenerated and the backwash discharged to the City's sanitary sewer system. This alternative includes a wastewater equalization tank at the seven largest wells to reduce the hydraulic impact on the City's sanitary sewer during the regeneration process. For a description of the activated alumina process, see the Appendix entitled "Fluoride Treatment".

Cost Estimate

- Capital cost estimate for project design and construction $4,915,000
- Annual added debt service assuming 12% loan for 30 years $ 610,148
- Annual added operation cost using estimated 1979 water use $ 461,000
- Total estimated added annual cost $1,071,148

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 48 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

ALTERNATIVE NO. 3: REGIONAL WATER SYSTEM

Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River near Bucksport. Distribution mains convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisions involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

Cost

The estimated bulk purchase rate for water drawn from the proposed regional system is approximately $2.95 per 1,000 gallons. At the current average daily demand of 1,600,000 gallons, the annual cost would be $1,722,800.

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 60 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| NORTH MYRTLE BEACH ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending (assuming iron removal) | 4,400 | $633,165 | $ 32,000 | $141.52 |
| No. 2: Treatment | 4,400 | $610,148 | $461,000 | $227.90 |
| No. 3: Regional | 3,542 | $1,556,067 | $166,733 | $366.55 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

- Existing monthly rate[6] $ 6.84
- Estimated monthly increase 11.79

Adjusted Monthly Water Rate $18.63/consumer

REFERENCES

[1]Data provided by: Harwood Beebe Company with letter dated March 7, 1980 and also by phone conversation with Mr. Hugh Miley, Jr. on March 6, 1980.

[2]Chemical analyses "Laboratory Report" by Palmer & Mallard on seven wells, dated December 16, 1977.

[3]Telephone communication with Mr. Smith of North Myrtle Beach water department on April 8, 1980.

[4]Well yields, chemical quality, and costs estimated by Robert B. Heater, President of Heater Well Company.

[5]Telephone communication with Larry West of the S. C. Water Resources Commission, Conway Office, on April 8, 1980.

[6]DHEC Staff Study on Fluoride for North Myrtle Beach, dated April 18, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# NORTH TRANQUIL ACRES SUBDIVISION

# DORCHESTER COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of North Tranquil Acres Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

North Tranquil Acres is an established residential subdivision. It is located in Dorchester County and lies to the south of the Town of Summerville. The water system serving North Tranquil Acres provided water to 175 consumers, approximately 500 people, as of July, 1978.[1]

Most building lots in the subdivision are occupied; therefore, the population is expected to remain static.

### WATER SUPPLY REQUIREMENTS

#### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 160 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand 28,000 gallons
- Maximum Daily Demand 50,400 gallons

#### Supply Requirement

The domestic supply requirement for this community was assumed to be the average flow during a period of maximum demand. Said requirement was computed to be 35 GPM.

A windshield survey of this community confirmed the existence of fire hydrants. Therefore, it was determined that the supply must have the capacity to meet both domestic and fire flow requirements.

EXISTING SUPPLY

The existing water supply consists of 3 wells having a combined rated capacity of 270 GPM.[1] The water produced by the wells contains 2.6 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.[2]

## FLUORIDE REDUCTION

### METHOD

Based upon available information, the most practical and least expensive method of effecting a fluoride reduction in this community is to abandon the existing supply and purchase water from the Town of Summerville. The Town owns and operates an existing 10" main that traverses the entire length of North Tranquil Acres along the western side of Ladson Road. The connection can be made at any point along the above-described main.

### COST

The fire flow requirement will dictate the installation of a six-inch connection and meter. The tap and meter have been estimated to cost $6,000.[3] It will be the owner's responsibility to obtain a permit from the State Highway Department to construct a waterline across Ladson Road and to subsequently install said crossing. For the purpose of estimating the capital cost of this system, it has been assumed that the conditions of the Highway Department permit will specify installation of the crossing by boring under the paved portion of the road.

The estimated construction cost of the complete connection including tap, meter, bored crossing, engineering and project contingency expenses is $12,600. Annual debt service expense on that amount calculated at 12% for 30 years is $1,564. The <u>increase</u> in annual operating expenses for this system attributable to this change was calculated as follows:

| | | |
|---|---|---|
| • | Debt Service | $1,564 |
| • | Plus Water Purchase | 7,569 |
| | Subtotal | $9,133 |
| • | Less Power Cost | 433 |
| | Total Annual Increase | $8,700 |

At the current consumer population the annual increase in cost per consumer will be $49.71 ($4.14/month).

IMPLEMENTATION

Design and construction of the above-described facilities can be accomplished within 18 months of the completion of required referendums, rate structure studies, funding procurement, etc.

OPERATOR REQUIREMENTS

Operator requirements for this system will not change as a consequence of fluoride reduction in the water supply.

## REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for North Tranquil Acres Subdivision, Dorchester County, April 17, 1978."

[2]South Carolina Department of Health and Environmental Control, Water Analysis Report on Laboratory Sample No. R06208-1603, June 29, 1978.

[3]Personal communication, Mr. Roy Winey, Town of Summerville, March 27, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# OAKEY SWAMP TRAILER PARK
# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Oakey Swamp Trailer Park. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Oakey Swamp Trailer Park water system is reported to have two wells and four pneumatic water storage tanks in service. Well #1 yields approximately 37 GPM, has a 20 foot screen located between 80 and 100 feet deep,[1] and has a fluoride concentration of approximately 1.8 mg/l.[2] Well #2 yields approximately 18 GPM, has a 20 foot screen located between 280 and 300 feet deep,[1] and has a fluoride concentration of approximately 3.6 mg/l.[2] The blended water should have a fluoride concentration of approximately 2.4 mg/l. Well #1 has a 5,000 gallon pneumatic tank and Well #2 has two 100 gallon and one 175 gallon pneumatic tanks in service.[3]

Water use in this system is not metered. The system is permitted for a maximum of 40 trailers.[3] However, the park was less than half full when visited. Assuming the park is full and average water use is 200 GPD per trailer, the estimated average daily water demand would be 8,000 GPD.

### ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[4] the water demand would be 14,400 GPD. With that demand, the desirable minimum pumping rate would be 15 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[5] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 136 GPM. However, this estimate is based on each residence having four persons who use a total of from 400 to 500 GPD. Since this system serves a trailer park, DHEC has indicated that 80% of Ameen's instantaneous demand can be used as the estimated demand. Using this instantaneous water supply demand, Ameen's method[5] of checking pneumatic tank size indicates that a well capacity of 41.6 GPM would be needed with the existing 5,375 gallons of tank capacity. However, an additional 2,500 gallons of pneumatic tank capacity would allow the use of a 15 GPM well, which is estimated to be sufficient to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 40 residential connections assumed as design condition.
2. Yield of new well is assumed to be 15 GPM.
3. Existing pneumatic tank capacity is 5,375 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on Pages 50 through 55, except that instantaneous demand is reduced to 80% of Ameen's estimate.

Calculations:

1. 40 residences x 3.4 GPM/res. x 0.8 = 108.8 GPM instantaneous demand.
2. Usable pressure tank volume = 5,375 ÷ 4 = 1,344 gallons.
3. Tank contribution for 20 minutes = 1,344 ÷ 20 minutes = 67.2 GPM
4. Minimum new well size to meet instantaneous supply demand = 108.8 GPM - 67.2 GPM = 41.6 GPM
5. Minimum pneumatic tank capacity with 15 GPM well = (109 GPM - 15 GPM) x 20 minutes x 4 = 7,520 gallons
6. Additional pneumatic tank capacity needed = 7,520 gal. - 5,375 gal. = 2,145 gallons. Use 2,500 gallon tank.

## FLUORIDE REDUCTION

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### METHOD

The viable alternatives for this system appear to be quite limited. Drilling of additional wells for blending has been tried. The results were a reduction in the fluoride concentration from 3.6 mg/l in the deep well to approximately 2.0 mg/l with a shallow well which has a 1.8 mg/l fluoride concentration but a high iron concentration. Another well is reported to have produced a fluoride concentration of 0.2 mg/l, but its iron concentration was an extremely high 10 mg/l.[6] Iron removal treatment would be extremely expensive for this size system, probably costing over $400 annually per customer. Therefore, both the blending and iron treatment solutions have been eliminated as viable alternatives.

The only viable alternative for this system appears to be to connect to the City of Conway's water system when the Conway system is extended to this area. This alternative would involve the installation of a water meter and approximately 140 feet of connection main between the Oakey Swamp system and a water main along Highway 78. Conway has planned to loop a water main out Highway 378, down Highway 78 in front of the Oakey Swamp Trailer Park, and back to Town along Highway 165.[7] This installation is proposed for completion by the end of 1981. It should be noted that connection to the Conway system will not eliminate the high fluoride problem until Conway corrects their own problem.

Conway has advised that they presently charge $2,600 for a 3" water meter installation,[8] which would probably be required for this trailer park. The City's proposed water rates, which are likely to be in use by the end of June, 1980, are $5.00 minimum per dwelling per month for the first 2,000 gallons plus $0.75 per each 1,000 gallons used in addition to the first 2,000 gallons.[8] To this rate, an increase of $0.64 per 1,000 gallons must be added to cover the minimum cost which Conway is expected to incur in solving their fluoride problem.

COST ESTIMATE

| | |
|---|---|
| • Capital cost estimate for connection installation | $3,500 |
| • Annual added debt service assuming 12% loan for 30 years | $ 435 |
| • Annual added water cost, less power cost, using estimated water use | $2,817 |
| • Total estimated added annual cost | $3,252 |

IMPLEMENTATION

It has been estimated that design, securing of approvals and a water service contract, and construction of this alternative can be accomplished within 18 months of the completion of funding procurement, etc.

## OPERATOR REQUIREMENTS

Operator requirements for this system are not expected to change as a consequence of this alternative.

## SUMMARY

Based upon available information, the only viable method of effecting a solution to the fluoride problem in the Oakey Swamp system is to implement the described connection to the Conway system. Presuming that the increased annual cost will be amortized uniformly over the existing customers (assumed to be 20), the annual incremental increase was calculated to be $162.60 per consumer ($13.55/month).

## REFERENCES


[1]Meeting and discussion with Mr. George Bessent on February 5, 1980.

[2]DHEC Staff Study on Fluoride, dated March 16, 1978.

[3]DHEC construction permit #20387 and map of system furnished by the Owner.

[4]Clark, J. W., et al., Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pennsylvania.

[5]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[6]DHEC Water Analysis, Sampling Point: Oakey Swamp Trailer Park, New Well (shallow), Laboratory Sample No. P 08318-465, dated August 29, 1978, F = 0.2 mg/l and Fe = 10 mg/l.

[7]Telephone conversation with Mr. Winfield, Director of Public Works for Conway, South Carolina on March 7, 1980.

[8]Telephone conversation with Mr. Winfield, Director of Public Works for Conway, South Carolina on April 14, 1980.

[9]Letter from Fred H. Soland of DHEC to Joe Willson of Jesco dated May 5, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# PINE RIDGE COMPANY MOBILE HOME PARK

# BERKELEY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop.rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Pine Ridge Company Mobile Home Park. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The water system serving Pine Ridge Company Mobile Home Park provided service to 22 consumers, approximately 70 people, as of May, 1978.[1]

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 160 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand — 3,520 Gallons
- Maximum Daily Demand — 6,336 Gallons

### Supply Requirement

Utilizing a regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period, the supply requirement for this community was calculated to be 7 GPM.

### Existing Supply

The existing water supply consists of two wells of unknown capacity. The fluoride concentration in said wells is 2.5 mg/l which exceeds the limit of 1.6 mg/l established by law.[1]

# FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for the Pine Ridge Mobile Home Park. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

## ALTERNATIVE NO. 1: WATER PURCHASE

### Method

This alternative requires the abandonment of the existing supply and connection to a proposed regional water system. The feasibility of constructing that system is being studied by the Berkeley County Regional Water and Sewer Authority; therefore, no definitive information relative to the availability or cost of water service is presently obtainable.

## ALTERNATIVE NO. 2: BLENDING

### Method

Fluoride reduction can be achieved by drilling one shallow well and blending it with the yield from one of the existing wells. If the existing wells are approximately equal in capacity, their operation can be alternated. If not, one should be taken out of service.

Assuming a fluoride concentration of 0.1 mg/l in the proposed shallow well, a shallow/deep mix of 1 GPM/1.2 GPM will result in a blend having a fluoride concentration of 1.4 mg/l. Based upon the supply requirement previously calculated (7 GPM), a 15 GPM shallow well should be adequate.

The success of blending is dependent upon control of the flow from the deep well. This can be accomplished by throttling the discharge valve to provide the required 18 GPM which will combine with the new well to produce a total flow of 33 GPM.

Sufficient iron to cause aesthetic problems, such as staining of plumbing fixtures, should be expected in the proposed shallow well. With the favorable ratio of deep/shallow well water that will be utilized in this system, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow wells will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump.

Shallow wells are generally more susceptible to bacterial contamination than are deep wells. Consequently, the combined flow should be chlorinated at the inlet side of the existing pneumatic storage tank.

A schematic diagram of the proposed water supply additions is presented in Figure 1. A complete list of the facilities recommended is as follows:

- One 15 GPM shallow well including electrical controls and pump.
- One concrete valve pit constructed at the intersection of the deep and shallow well discharge lines. The pit should contain meters and valves on both lines.
- One chlorinator
- One polyphosphate mixing and feed system
- One equipment building

Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $29,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt service on a 30-Year Loan at 12% | $3,600 |
| • Operations and Maintenance | 25 |
| Total Estimated Annual Cost Increase | $3,625 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

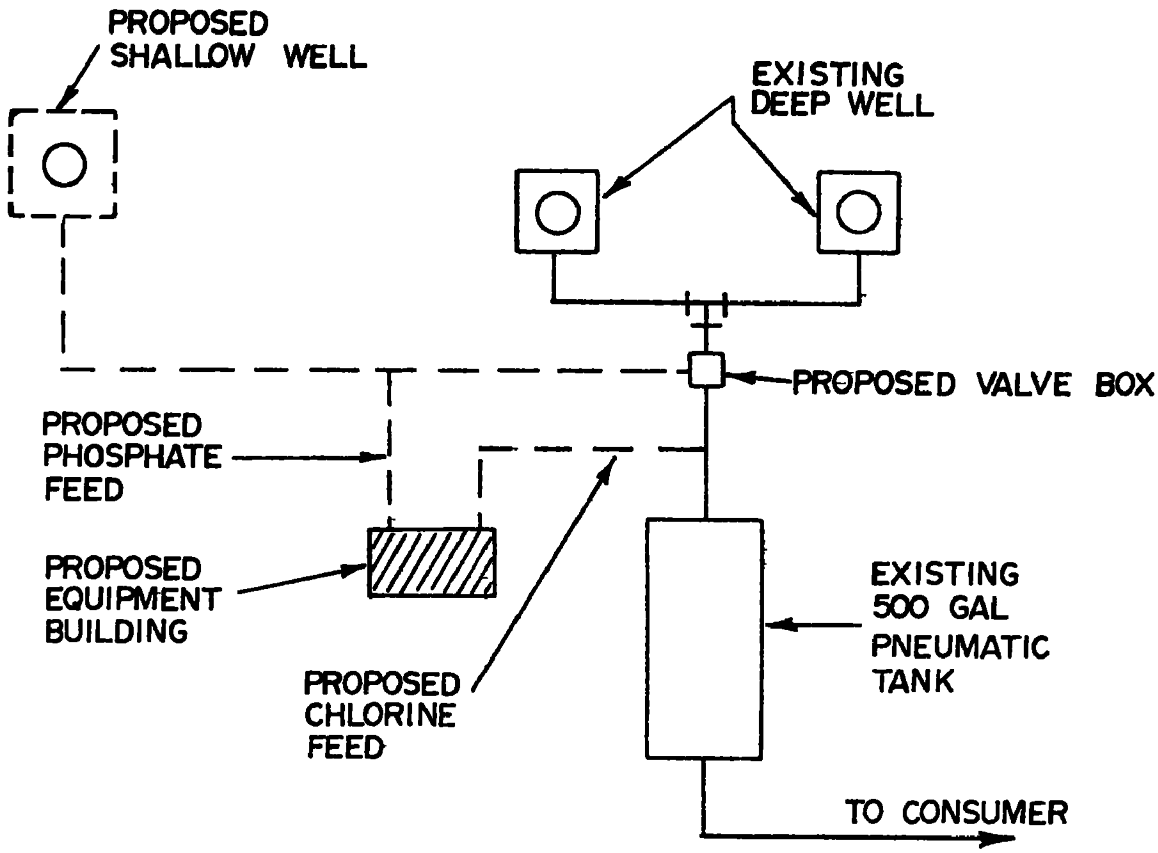


FIGURE 1

SCHEMATIC DIAGRAM OF

PROPOSED WATER SYSTEM ADDITIONS

AT

PINE RIDGE MOBILE HOME PARK

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| PINE RIDGE COMPANY MOBILE HOME PARK ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Consumer |
| No. 1: Purchase | - | - | - | - |
| No. 2: Blending | 33 | $3,600 | $25 | $164.77 |

The superior method of effecting a solution to the fluoride problem in this community is to purchase water from the Berkeley County Regional Water and Sewer Authority. As of this writing, preliminary planning steps have been undertaken by that authority to evaluate the feasibility of constructing a regional water system. We hereby recommend that no action be taken on this system until a firm decision relative to the establishment of a regional system is made. If that decision is unfavorable, Alternative No. 2 should be implemented.

## REFERENCES

[1]South Carolina Department of Health & Environmental Control, "Staff Study for Pine Ridge Company, Berkeley County", May 2, 1978.

# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Plantersville Water System. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Plantersville water system has one well which is pumped at 150 GPM,[1] is thought to have screens located below a depth of 475 feet, and has a fluoride concentration of approximately 5.0 mg/l.[2] The water system has a 75,000 gallon elevated tank[1] for water storage. The system presently serves approximately 240 residential connections which used approximately 60,000 GPD as an average during 1979.[1]

### FUTURE CONDITIONS

During discussions with Mr. Bob Barker,[1] who was at that time Director of the Georgetown County Water & Sewer Authority (GCWSA), he indicated that a reasonable assumption of the growth might be to expect 75 additional connections by 1990 and 50 more by the year 2000. Using the present average water consumption rate of 250 GPD per connection, the future water demand would be 78,750 GPD by 1990 and 91,250 GPD by the year 2000. If it is assumed that the peak day water demand will be 180% of the average day water use,[3] the water demand would be 141,750 GPD by 1990 and 164,250 GPD by the year 2000. With those demands, the desirable minimum pumping rates would be 147.7 GPM for 1990 and 171.1 GPM for the year 2000, which would allow the estimated peak day water demand to be pumped in 16 hours. Since the present well capacity is just slightly greater than the predicted minimum pumping rate for 1990, a design well yield of 150 GPM has been selected for this study.

With 315 water service connections estimated for the year 1990, Ameen's method[4] for predicting instantaneous water demand on the supply system would predict the demand to be 363.8 GPM. Using the 150 GPM well yield, Ameen's method[4] predicts that the 75,000 gallon elevated water storage tank will be more than adequate to meet the instantaneous water supply demand of 364 GPM.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 315 residential connections assumed as design condition.
2. Yield of new well is assumed to be 150 GPM.
3. Existing elevated tank size is 75,000 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55.

Calculations:

1. 315 residences x 1.155 GPM/resd. = 363.8 GPM.
2. 364 GPM - 150 GPM well yield = 214 GPM tank demand.
3. 214 GPM x 20 minute demand = 4,280 gallons of stored water needed.
4. Existing tank size is 75,000 gallons; therefore, tank is more than adequate.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL NEW WELL(S)

#### Method

This alternative would involve the drilling of a new well or wells to replace or blend with the existing high fluoride well. Since the blend ratio has been estimated to be 3.0 gallons of low fluoride (0.2 mg/l) water for each gallon of the existing deep well water to achieve a 1.4 mg/l blended fluoride concentration, it appears more practical for cost estimating purposes to assume that the construction of a replacement well or wells will be required.

It should be noted that the alternative is heavily dependent upon the quantity and quality of shallower water zones, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled and sufficient, satisfactory water located. Once located, a production well could be completed and tested. For this alternative it will be assumed that two wells, one with an iron sequestering system, will be required to achieve the 150 GPM yield desired.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for project design and construction | $55,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 6,828 |
| • Annual added operation cost using 1979 water use | $ 300 |
| • Total estimated added annual cost | $ 7,128 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendum, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

ALTERNATIVE NO. 2: PURCHASE WATER FROM BROWN'S FERRY SYSTEM

Method

This alternative would involve the purchase of water from either Brown's Ferry or

Georgetown Rural water systems. The Plantersville system is already connected to both systems and has in the past sold water to Brown's Ferry. Therefore, no construction would be required, except the reorientation of the meter between the Plantersville and Brown's Ferry systems. A phone conversation with a Georgetown Rural representative revealed that effective April 1, 1980, their bulk water rate will increase from $0.30 to $0.45/1000 gallons of water. Therefore, for this report it has been assumed that purchase of water from Brown's Ferry would be less expensive.

Brown's Ferry is in the process of completing a second well which, assuming the quantity and quality of the water are acceptable, would give Brown's Ferry considerable extra capacity and certainly make sale of water to GCWSA desirable for Brown's Ferry. In the past, Brown's Ferry has purchased water from GCWSA for $0.30/1000 gallons.[6] However, this appears to be too low a rate to expect, considering the current inflation rate. Therefore, for this report, $0.40/1000 gallons has been chosen as being closer to what could actually be negotiated with Brown's Ferry.

Cost Estimate

To the writer's knowledge, the only capital cost which might be required in implementing this alternative would be the reorientation, or possibly, installation of a master water meter. This cost is considered to be negligible and is not included as a significant factor in the cost estimate.

- Added annual water cost, deleting power cost $7,973

Implementation

It has been estimated that the time required to achieve an acceptable agreement between GCWSA and Brown's Ferry concerning the method, rate, etc. of purchasing water might take from 6 to 12 months.

## Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| PLANTERSVILLE ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: New Well(s) | 150 | $6,828 | $ 300 | $29.70 |
| No. 2: Purchase Water | N/A | -0- | $7,973 | $33.22 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $29.70 per consumer ($2.48/month).

## REFERENCES


[1]Meeting and discussion with Bob Barker, Director of GCWSA, January 23 and 24, 1980.

[2]DHEC Water Analysis, Sampling Location: Plantersville Comm., Sample #P 2059 DWCH - 609, dated February 15, 1979, F = 5.0 mg/l.

[3]Clark, J. W., et al., book entitled Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[4]Ameen, Joseph S., book entitled Community Water Systems, pages 50 through 55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[5]Telephone communication with Georgetown Rural Community water system representative, March 17, 1980.

[6]Telephone communication with Brown's Ferry representative, March 17, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# PLATT WATER COMPANY

# HORRY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

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## INTRODUCTION

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Platt Water Company. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The water system serving the Platt Water Company provided service to 450 consumers, approximately 1575 people, as of February, 1978.[1]

In lieu of actual planning data, which is not readily available, an annual growth rate of 10% will be assumed in ensuing sections of this report.

### WATER SUPPLY REQUIREMENTS

#### Current Demand

The average daily water usage for calendar 1979 was 85,000 gallons.[1] That translates to an average of 188 GPD/connection. Maximum average daily demand was considered to be approximately 180% of average daily usage.[2] Accordingly, the current water demand placed on the system has been established as follows:

- Average Daily Demand 85,000 Gallons
- Maximum Daily Demand 153,000 Gallons

#### Projected Demand

Utilizing the previously assumed 10% annual growth rate in consumer population, projected water demand has been estimated and is presented in the following table.

| PLATT WATER COMPANY PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 85,000 | 153,000 |
| 1985 | 137,000 | 247,000 |
| 1990 | 221,000 | 398,000 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing a regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period.

- 1980 - 159 GPM,
- 1985 - 257 GPM,
- 1990 - 415 GPM,

EXISTING SUPPLY

The existing water supply consists of one deep well having a rated capacity of 200 GPM. Based upon the present requirement of 159 GPM, the existing production capability is adequate. It is noted, however, that water produced by the existing well contains 4.0 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law.[3]

## FLUORIDE REDUCTION

Preliminary investigative efforts identified three viable fluoride reduction alternatives for the Platt Water Company. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: BLENDING

#### Method

Fluoride reduction can be achieved by drilling a series of shallow wells and blending their yield with that of the existing deep well. Assuming a fluoride concentration of 0.1 mg/l in the proposed shallow wells, a shallow/deep mix of 2.0 GPM/1.0 GPM will result in a blend having a fluoride concentration of 1.4 mg/l. Based upon that blend and the 1985 projected supply requirement, this alternative will address the development of 180 GPM in shallow well capacity. Lacking accurate data on the quantity of shallow ground water available in the Platt Water Company area, quantity was conservatively estimated at 60 GPM per well, requiring construction of three wells.

The success of blending is dependent upon control of the flow from the deep well. With a shallow well yield of 180 GPM, the deep well pump should be throttled back from 200 GPM to 90 GPM. It should be noted that the adaptability of the existing deep well pump to function in a throttled mode of operation is questionable. It is beyond the limited scope of this study to fully evaluate the effect of the significantly reduced pump output. The reader is therefore cautioned that it may become necessary to modify or replace the existing unit to consistently maintain flow rates less than 100 GPM.

Recognizing that the above-described blending process dictates a shift from deep well water to a blend of predominantly shallow well water, the nuisance problems associated with iron in the water supply must be considered. The existing shallow wells may contain as much as 1.0 mg/l iron. At that concentration, aesthetic problems, such as staining of plumbing fixtures, should be expected. Lacking actual quality data on the shallow aquifer, it was assumed that the iron could be sequestered and then diluted sufficiently to preclude the occurrence of iron related nuisance problems. Feeding a solution of polyphosphates (chemical) to the shallow well will provide an economical means of controlling red water. The chemical is purchased dry in 50 or 100 pound bags and mixed with water to form a solution. The mixture is then injected into the system by a small pump.

One additional consideration is disinfection. Shallow wells are generally more susceptible to bacterial contamination than are deep wells. Consequently, the chlorinated blend of well water should be detained in a pressure contact tank for 30 minutes prior to being discharged to the system.

A schematic drawing of the proposed water supply additions is presented in Figure 1.

1. A complete list of the facilities recommended is as follows:
   - Three shallow wells each having a capacity of 60 GPM.
   - One equipment building to house chemical feed equipment.
   - One 10,000 gallon pressurized chlorine contact tank.
   - One concrete valve pit constructed at the intersection of the deep and shallow well lines. The pit should contain meters and valves on both supply lines.
   - Polyphosphate mixing and feed facilities. The concept presented herein utilizes a single chemical feed point in the common main leading from the shallow wells. However, it should be noted that iron must be in a soluble form for sequestering to be effective, and that pumping and/or conveyance may cause the iron to precipitate. Should that situation occur, the chemical feed point may have to be moved or iron treatment may become necessary.

Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $160,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $19,862 |
| • Chemical Cost | 638 |
| Total Estimated Annual Cost Increase | $20,500 |

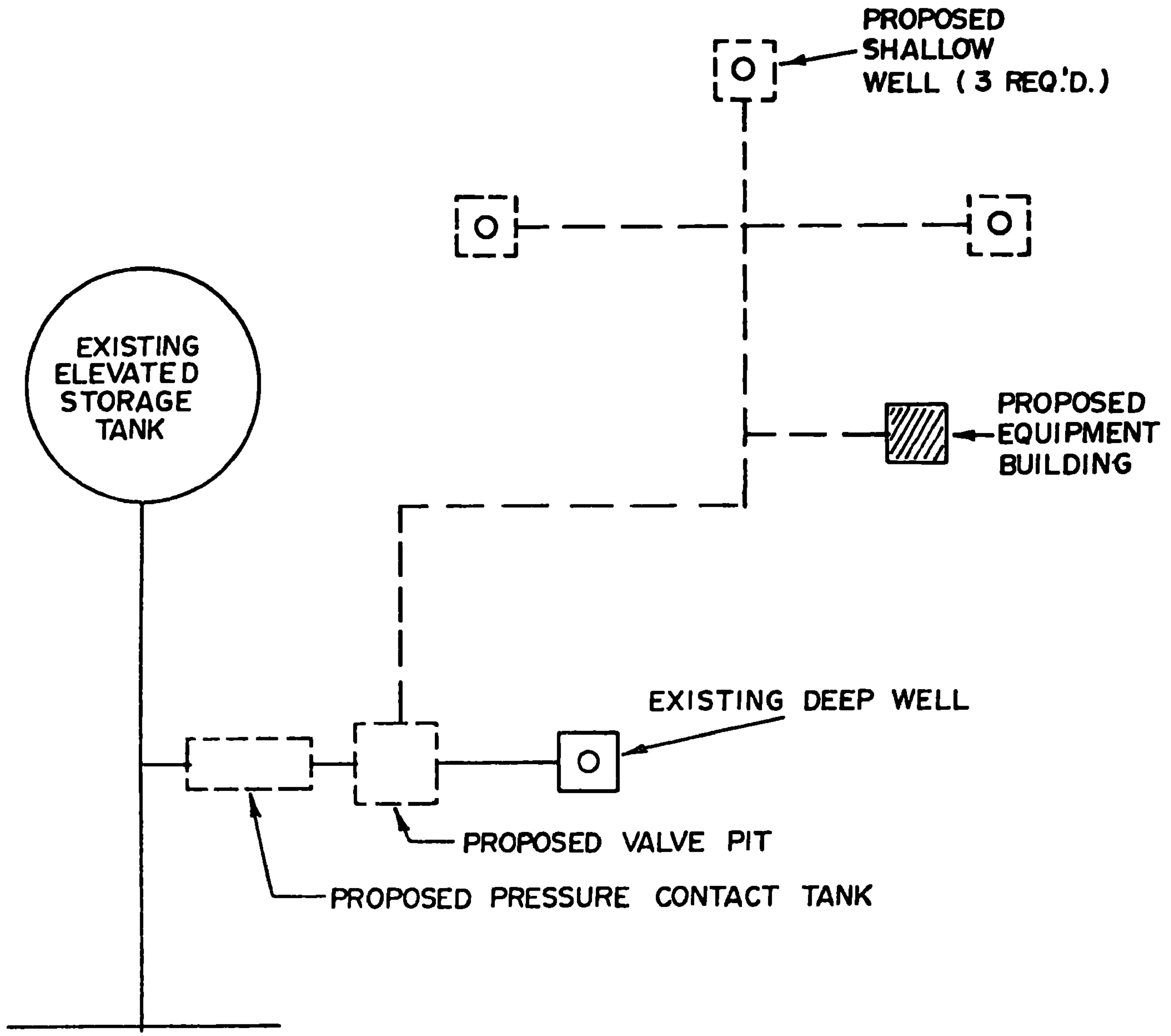


FIGURE 1

SCHEMATIC DIAGRAM OF PROPOSED

WATER SYSTEM ADDITIONS

AT

PLATT WATER COMPANY

## Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

# ALTERNATIVE NO. 2: TREATMENT

## Method

This alternative addresses treatment of a portion of the flow from the existing 200 GPM well utilizing activated alumina. The system would be sized to treat 135 GPM, the remaining 65 GPM would bypass treatment and be blended with the defluoridated water. A liquid waste stream from the treatment unit would be discharged directly to the sanitary sewer.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

## Cost

The construction cost of Alternative No. 2 including engineering and project contingency expenses has been estimated at $350,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $43,449 |
| • Operations and Maintenance | 29,551 |
| Total Estimated Annual Cost Increase | $73,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 36 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

ALTERNATIVE NO. 3: REGIONAL SYSTEM

Method

This alternative addresses the construction of a major water treatment facility on the Great Pee Dee River at Bucksport. Distribution mains would convey the water in a westerly direction as far as Conway, in a southerly direction as far as Pawley's Island, and in a northerly direction as far as North Myrtle Beach.

Management and operation of the proposed system would be effected under a joint agreement of all political subdivisons involved.

Each community system served would purchase water on a bulk basis for resale to its consumers.

See the Appendix entitled "Regional Water System" for a more complete description of the proposed facilities.

## Cost

The estimated bulk purchase rate for water drawn from the proposed regional system will be $2.95 per 1000 gallons. At the current average daily demand of 85,000 gallons, the annual cost will be $91,524.

## Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 60 months of completion of required referendums, rate structure studies, funding procurement, etc.

## Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

## SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| PLATT WATER COMPANY ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 270 | $19,362 | $ 638 | $ 45.56 |
| No. 2: Treatment | 200 | $43,449 | $29,551 | $162.22 |
| No. 3: Regional | 224 | $82,664 | $ 8,860 | $203.39 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

Construction of the primary alternative would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[4] | $13.45 |
| • Estimated monthly increase | 3.80 |
| Adjusted Monthly Water Rate | $17.25/consumer |

## REFERENCES

[1]Personal communication, Mrs. Helen Ellington, Platt Water Company

[2]Clark, J. W., et al., Water Supply and Pollution Control, 1971, International Textbook Company, Scranton, Pennsylvania.

[3]South Carolina Department of Health and Environmental Control, Water Analysis Report on laboratory sample #P10084211, November 27, 1974.

[4]South Carolina Department of Health and Environmental Control, "Staff Study for Platt Water Company, Horry County," April 21, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# RED HILL WATER SYSTEM

GEORGETOWN COUNTY WATER AND SEWER AUTHORITY

GEORGETOWN COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

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In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Red Hill Water System. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Red Hill water system has one well which is pumped at 125 GPM,[1] has screens located between the depths of 880 and 990 feet, and has a fluoride concentration of approximately 3.2 mg/l.[2] The water system has a 60,000 gallon pressure tank[1] for water storage. The system presently serves approximately 40 residential connections which used approximately 10,000 GPD as an average during 1979.[1]

### FUTURE CONDITIONS

Discussion with Mr. Bob Barker,[1] who was at that time Director of the Georgetown County Water and Sewer Authority (GCWSA), revealed that the Red Hill system has not grown very much since its completion nor did Mr. Barker expect it to grow very much in the future. Mr. Barker indicated that a reasonable assumption of the growth might be to expect 15 to 20 new connections within the next thirty years. Therefore, it has been assumed that this system will have an additional 20 residential connections for the system sizing purposes of this report.

With 60 residential connections, Ameen's method[3] predicts that the instantaneous water demand on the supply system would be 60 resd. x 2.7 GPM/resd. = 162 GPM. Peaking the average day water use of 250 GPD per residence by a factor of 1.8[4], the 60 residential connections are estimated to use 0.027 MGD. However, the desirable minimum pumping rate would be 28 GPM, which would allow the estimated peak day demand to be pumped in 16 hours. Using this pumping rate, Ameen's method[3] predicts that the 60,000 gallon pressure storage tank can meet the instantaneous water supply demand of 162 GPM.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 60 residential connections assumed as design condition.
2. Yield of new well is assumed to be 28 GPM.
3. Existing pressure tank size is 60,000 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55.

Calculations:

1. 60 residences x 2.7 GPM/resd. = 162 GPM.
2. 162 GPM - 28 GPM well yield = 134 GPM tank demand.
3. 134 GPM x 20 minute demand = 2680 gallons of stored water needed.
4. Minimum pressure tank size = 2,680 x 4 = 10,720 gallons.
5. Existing tank size is 60,000 gallons; therefore, tank is adequate.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL NEW WELL

#### Method

This alternative would involve the drilling of a new well to replace the existing high fluoride well. Since it has been estimated that only 28 GPM will be needed from a well, it appears more economical to construct a new well rather than blend or treat the existing well.

It should be noted that this alternative is heavily dependent upon the quantity and quality of shallower ground water zones, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled and sufficient, satisfactory water located. Once located, a production well could be completed and connected to the system. For cost estimating purposes, it will be assumed that iron sequestering will be required. The existing well would have to be disconnected.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for well design and construction | $35,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 4,345 |
| • Annual added operation cost using 1979 water use | $ 100 |
| • Total estimated added annual cost | $ 4,445 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of implementing this alternative.

ALTERNATIVE NO. 2: PURCHASE WATER FROM BROWN'S FERRY SYSTEM

Method

This alternative would involve the installation of approximately 1.0 miles of six-inch water main to connect the Red Hill system with the Brown's Ferry system and the purchasing of water by GCWSA from the Brown's Ferry owner. Brown's Ferry is in the process of completing a second well which, assuming the quantity and quality of the water are acceptable, would give Brown's Ferry considerable extra capacity and certainly make sale of water to GCWSA desirable for Brown's Ferry. In the past, Brown's Ferry has purchased water from GCWSA at a price of $0.30/ 1000 gallons.[5] However, this appears to be too low a rate to expect, considering the recent inflation rate. Therefore, for this report, $0.40/1000 gallons has been chosen as being closer to what could actually be negotiated with Brown's Ferry.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for connection design and construction | $45,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 5,587 |
| • Annual added water cost, deleting power costs | $ 1,330 |
| • Total estimated added annual cost | $ 6,917 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| RED HILL<br>ALTERNATIVE SUMMARY | | | | | |
|---|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | | |
| | | Capital | Operating | Per Consumer | |
| No. 1: New Well | 28 | $4,345 | $ 100 | $111.13 | |
| No. 2: Purchase Water | N/A | $5,587 | $1,330 | $172.93 | |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $111.13 per consumer ($9.26/month).

REFERENCES


[1]Meeting and discussion with Bob Barker, Director of GCWSA, January 23 and 24, 1980.

[2]DHEC Water Analysis, Sampling Point: Red Hill Water District, Laboratory Sample No. R 05058-1323, dated May 3, 1978, F = 3.2 mg/l.

[3]Ameen, Joseph S., book entitled Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[4]Clark, J. W., et al., book entitled Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[5]Telephone communication with Brown's Ferry representative, March 17, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# ROCK BLUFF SUBDIVISION
# WILLIAMSBURG COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Rock Bluff Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Rock Bluff water system has one well which is pumped at 75 GPM, has an iron concentration of less than 0.1 mg/l, and has a fluoride concentration of from 1.65 to possibly 2.7 mg/l, depending on which water analysis[1] is accepted. The South Carolina Department of Health and Environmental Control (DHEC) has indicated that the well's fluoride concentration is 1.7 mg/l in their Staff Study on Fluoride. The water system has a 3,000 gallon pneumatic tank for water storage.

The system served approximately 65 people in 21 homes during 1979. Metered water use of the residences during 1979 averaged 4210 GPD and was 4493 GPD during the peak months. This subdivision has not grown at all during the last two years and is not expected to grow in the near future.

### ESTIMATED PEAK WATER DEMAND

If it is assumed that the peak day water demand is 180% of the average day water use,[2] the water demand would be 7,578 GPD. With that demand, the desirable minimum pumping rate would be 7.9 GPM, which would allow the estimated peak day water demand to be pumped in 16 hours. If Ameen's method[3] for predicting instantaneous water demand on the supply system is used, the estimated demand would be 89.3 GPM. Without verification of a lower instantaneous water demand, this demand is accepted as a condition of design. Using this instantaneous water supply demand, Ameen's method[3] of checking pneumatic tank size indicates that a well capacity of at least 51.8 GPM would be needed if the existing 3,000 gallon tank is all the storage available. However, an additional 3,500 gallons of pneumatic tank capacity would allow the use of an 8 GPM well, which is estimated to be sufficient to meet the peak day demand.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 21 residential connections assumed as design condition.
2. Existing pneumatic tank size is 3,000 gallons.
3. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on pages 50 through 55.

Calculations:

1. 21 residences x 4.25 GPM/resd. = 89.3 GPM.
2. Usable pneumatic tank volume = 3000 ÷ 4 = 750 gallons.
3. Tank contribution for 20 minutes = 750 ÷ 20 minutes = 37.5 GPM.
4. Minimum new well size to meet instantaneous supply demand = 89.3 GPM - 37.5 GPM = 51.8 GPM.
5. Minimum pneumatic tank capacity with a 8 GPM well = (89.3 GPM - 8 GPM) x 20 minutes x 4 = 6,504 gallons.
6. Additional pneumatic tank capacity needed = 6,504 gal. - 3,000 gallons = 3,504 gallons. Use 3,500 gallon tank.

## FLUORIDE REDUCTION

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### METHOD

The viable alternatives for this system appear to be quite limited. One possible alternative would be to connect to the City of Kingstree's water system. However, Kingstree's water system is approximately 3.1 miles from Rock Bluff Subdivision. Utilizing an estimated construction cost of $6.00 per foot for a 6" diameter PVC pipe installation, the cost would be over $98,000. Other costs would include design, a master meter installation, drive and roadway repairs, highway borings, etc. Due to the high cost per residence, this alternative has been eliminated.

The only viable alternative for this system appears to be the drilling of a new well to tap a more acceptable water source. Blending with the existing well water is possible since the existing well has a fluoride concentration only slightly above the legal limit of 1.6 mg/l. If the existing well has a fluoride concentration of only 1.7 mg/l as reported in one analysis, then it would take only 19 GPM of low fluoride (0.2 mg/l or less) well water to blend with the existing 75 GPM well to achieve a blended fluoride concentration of approximately 1.4 mg/l. If the existing well's fluoride concentration is actually 2.7 mg/l, as another analysis indicated, then 80 GPM of low fluoride water would be required.

Since it has been estimated that only 8 GPM is needed to meet the peak day water demand and the blend quantity needed is uncertain, it will be assumed for this alternative that a new well of 8 GPM will be installed. Excessive iron could be a problem which would necessitate installing iron removal treatment equipment. However, it appears reasonable to assume that 8 GPM of relatively low iron, low fluoride water can be located. Therefore, for cost estimating purposes, it will be assumed that iron sequestering treatment will be required. In addition to the above, this solution would require the installation of chlorine equipment and a 3,500 gallon pneumatic tank.

COST ESTIMATE

- Capital cost estimate for well design and construction $45,000
- Annual added debt service assuming 12% loan for 30 years $ 5,587
- Annual added operation cost using 1979 average demand $ 46
- Total estimated added annual cost $ 5,633

IMPLEMENTATION

It has been estimated that design, securing of approval, advertisement, contract execution, and construction on this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

## OPERATOR REQUIREMENTS

Operator requirements for this system are not expected to change as a consequence of this alternative.

## SUMMARY

Based upon available information, the most practical and least expensive method of solving the fluoride problem for the Rock Bluff Subdivision appears to be to construct the well project described above. Presuming that the increased annual cost will be amortized uniformly over the existing customer population, the annual incremental increase is calculated to be $268.24 per consumer ($22.35/month).

## REFERENCES

[1]DHEC Analysis Reports identified as follows:

(a) Station Code 545001, Laboratory Sample No. P102760363, DWCH-128, dated October 18, 1976.

(b) Rock Bluff Subdivision, Laboratory Sample No. R06148-1573, dated June 13, 1978.

(c) Station Code 545001, Laboratory Sample No. P1722, DWCH-436, dated January 15, 1976.

(d) Station Code 455001, Laboratory Sample No. P02069-1875, dated February 5, 1979.

(e) Station Code 455001, Laboratory Sample No. P-01259-1757, dated January 24, 1979.

(f) Rock Bluff Subdivision, Laboratory Sample No. P01319-1813, dated January 29, 1979.

[2]Clark, J. W., et al. Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pennsylvania.

[3]Ameen, Joseph S., Community Water Systems, pages 50-55, 1971, Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# ROSE HILL WATER SYSTEM

# GEORGETOWN COUNTY WATER AND SEWER AUTHORITY

# GEORGETOWN COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Rose Hill Water System. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### EXISTING CONDITIONS

The Rose Hill water system has one well which is pumped at 125 GPM,[1] has screens located between the depths of 769 and 918 feet, and has a fluoride concentration of approximately 4.0 mg/l.[2] The water system has a 20,000 gallon pressure tank[1] for water storage. The system presently serves approximately 42 residential connections which used approximately 11,000 GPD as an average during 1979.[1]

### FUTURE CONDITIONS

Discussion with Mr. Bob Barker,[1] who was at that time Director of the Georgetown County Water and Sewer Authority (GCWSA), revealed that the Rose Hill system has not grown very much since its completion nor did Mr. Barker expect it to grow very much in the future. Mr. Barker indicated that a reasonable assumption of the growth might be to expect 18 to 23 new corrections within the next thirty years. Therefore, it has been assumed that this system will have an additional 23 residential connections for the system sizing purposes of this report.

With 65 residential connections, Ameen's method[3] predicts that the instantaneous water demand on the supply system would be 65 resd. x 2.6 GPM/resd. ≐ 169 GPM. Peaking the average day water use of 262 GPD per residence by a factor of 1.8[4], the 65 residential connections are estimated to use 0.0307 MGD. However, the desirable minimum pumping rate would be 32 GPM which would allow the peak day demand to be pumped in 16 hours. Using this pumping rate, Ameen's method[3] predicts that the 20,000 gallon pressure storage tank can meet the instantaneous water supply demand of 169 GPM.

WATER STORAGE QUANTITY VERIFICATION

Given:

1. 65 residential connections assumed as design condition.
2. Yield of new well is assumed to be 32 GPM.
3. Existing pressure tank size is 20,000 gallons.
4. Peak demand, tank demand, and calculation procedures are as recommended by Joseph S. Ameen in his book entitled "Community Water Systems" on Pages 50 through 55.

Calculations:

1. 65 residences x 2.6 GPM = 169 GPM.
2. 169 GPM - 32 GPM well yield = 137 GPM tank demand.
3. 137 GPM x 20 minute demand = 2740 gallons of stored water needed.
4. Minimum pressure tank size = 2740 x 4 = 10,960 gallons.
5. Existing tank size is 20,000 gallons; therefore, tank is adequate.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for this community. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: DRILL NEW WELL

Method

This alternative would involve the drilling of a new well to replace the existing high fluoride well. Since it has been estimated that only 32 GPM will be needed from a well, it appears more economical to construct a new well rather than blend or treat the existing well.

It should be noted that this alternative is heavily dependent upon the quantity and quality of shallower ground water zones, both of which are unknown. Therefore, for this to be a viable solution, a test and water zone sampling well must be drilled and sufficient, satisfactory water located. Once located, a production well could be completed and connected to the system. For cost estimating purposes, it will be assumed that iron sequestering will be required. The existing well would have to be disconnected.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for well design and construction | $35,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 4,345 |
| • Annual added operation cost using 1979 water use | $ 110 |
| • Total estimated added annual cost | $ 4,455 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

ALTERNATIVE NO. 2: PURCHASE WATER FROM BROWN'S FERRY SYSTEM

Method

This alternative would involve the installation of approximately 0.9 miles of six-inch water main to connect the Rose Hill system with the Brown's Ferry system and the purchasing of water by GCWSA from the Brown's Ferry owners. Brown's Ferry is in the process of completing a second well which, assuming the quantity and quality of the water are acceptable, would give Brown's Ferry considerable extra capacity and certainly make sale of water to GCWSA desirable for Brown's Ferry. In the past, Brown's Ferry has purchased water from GCWSA at a price of $0.30/1000 gallons.[5] However, this appears to be too low a rate to expect, considering the current inflation rate. Therefore, for this report, $0.40/1000 gallons has been chosen as being closer to what could actually be negotiated with Brown's Ferry.

Cost Estimate

| | |
|---|---|
| • Capital cost estimate for connection design and construction | $42,000 |
| • Annual added debt service assuming 12% loan for 30 years | $ 5,214 |
| • Annual added water cost, deleting power cost | $ 1,462 |
| • Total estimated added annual cost | $ 6,676 |

Implementation

It has been estimated that design, securing of permits and approvals, advertisement, contract execution, and construction of this alternative can be accomplished within 24 months of the completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements for this system are not expected to change as a consequence of this alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| ROSE HILL ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: New Well | 32 | $4,345 | $ 110 | $106.07 |
| No. 2: Purchase Water | N/A | $5,214 | $1,462 | $158.95 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community. Presuming that the increased annual cost will be amortized uniformly over the existing consumer population, the annual incremental increase was calculated to be $106.07 per consumer ($8.84/month).

REFERENCES

[1]Meeting and discussion with Bob Barker, Director of GCWSA, January 23 and 24, 1980.

[2]DHEC Water Analysis, Sampling Point: Rose Hill W/D, Laboratory Sample No. R 05058-1322, dated May 3, 1978, F = 4.0 mg/l.

[3]Ameen, Joseph S., book entitled Community Water Systems, pages 50-55, 1971 Technical Proceedings, Post Office Box 5041, High Point, North Carolina.

[4]Clark, J. W., et al., book entitled Water Supply and Pollution Control, page 35, 1971, International Textbook Company, Scranton, Pa.

[5]Telephone communication with Brown's Ferry representative, March 17, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# SANGAREE SUBDIVISION

# BERKELEY COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY AND AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Sangaree Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

The water system serving Sangaree Subdivision provided service to 800 consumers, approximately 2,800 people, as of June, 1979.[1] The system is owned and operated by the Berkeley County Regional Water and Sewer Authority (BCRW&SA). Tramway, an adjacent subdivision which is also owned by BCRW&SA, is interconnected with the Sangaree Facilities and presently serves 15 consumers.

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in these communities is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 200 gallons per connection and a maximum daily demand factor of 180%[2] were used to establish the following system demand data:

- Average Daily Demand — 163,000 Gallons
- Maximum Daily Demand — 293,400 Gallons

### Future Demand

Ultimate development of Sangaree and Tramway Subdivisions will result in a maximum consumer population of 4,300, approximately 15,050 people. Utilizing the data discussed above, future system demand was calculated and is listed below.

- Average Daily Demand — 860,000 Gallons
- Maximum Daily Demand — 1,548,000 Gallons

Existing Supply

The existing supply consists of three wells, two in Sangaree and one in Tramway. The capacity and fluoride concentration of each well is tabulated in the following table.

SANGAREE AND TRAMWAY SUBDIVISION
WATER WELL DATA

| Designation | Capacity (GPM) | Fluoride Concentration |
|---|---|---|
| Sangaree #1 | 250[1] | 2.0 mg/l[3] |
| Sangaree #2 | 140[1] | 2.8 mg/l[4] |
| Tramway #1 | 137[1] | 1.3 mg/l[5] |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing a regulatory criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period. Those values are as follows:

- Current - 305 GPM
- Future (ultimate) - 1615 GPM

## FLUORIDE REDUCTION

Fluoride reduction in this community falls into two categories - short term and long term. Blending the yield from the Tramway well with a portion of the Sangaree supply will provide an immediate, but short-lived, solution to the problem. The two subdivisions are growing rapidly and should be expected to place an increasingly heavy demand on the combined supply for the forseeable future. Accordingly, several long-term solutions that have the potential of meeting the anticipated future demand were evaluated.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative should include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### SHORT TERM SOLUTION

#### Blending

Blending the Tramway and Sangaree water supplies has recently been implemented. The interconnection between the two subdivisions was accomplished by constructing a 10-inch PVC line between the extremities of the two distribution systems. The approximate length of the connector is 6000 linear feet. One directional flow from Tramway to Sangaree is maintained by continuous operation of the Tramway well.

In that mode of operation, approximately 200,000 gallons of low fluoride (1.3 mg $F^-$/l) water is produced each day. Utilizing water from Sangaree #1 (2.0 mg $F^-$/l) as the blending source, a ratio of 1.0 part Tramway: 0.75 part Sangaree will produce a combined flow of 235 GPM having a fluoride concentration of 1.6 mg/l. To achieve the desired mix, the Sangaree well must be throttled from 250 GPM to 100 GPM. During a 24-hour operating period, the maximum available blended capacity of this system is 338,400 gallons.

Based upon the current estimated peak day demand of 293,400 gallons, this water system can achieve immediate compliance with the fluoride standard by making several changes in the operation of the facilities. Those changes should consist of the following:

- Close the necessary valves to ensure a positive one-way flow from Tramway to the base of the elevated storage tank in Sangaree;
- Make piping modifications at the elevated tank site to ensure a positive blend of the two supplies;
- Take Sangaree well No. 2 out of service, and;
- Throttle Sangaree Well No. 1 from 250 GPM to 100 GPM.

It should be noted that the total capacity of this supply must be reduced by 40% to achieve a blend with an acceptable fluoride concentration. Accordingly, meeting the estimated peak day demand will require that the in-service wells be pumped for 21 hours which exceeds the state design criteria of 16 hours. Recognizing that this is an existing condition, it was assumed that regulatory approval of a variance from design criteria could be obtained.

## LONG TERM SOLUTIONS

### Alternative No. 1: Regional System

Method. This alternative requires the abandonment of the existing supply and connection to a proposed regional water system. The feasibility of constructing that system is being studied by the Berkeley County Regional Water and Sewer Authority; therefore, no definitive information relative to the availability or cost of water service is presently obtainable.

### Alternative No. 2: Water Purchase

Method. This alternative requires that the existing ground water supply be abandoned and the Sangaree system be connected to the facilities owned by the Charleston Commissioner of Public Works (CCPW). The connection would be effected by constructing a water main from the intersection of Royal Road with Frontage Road to the intersection of Trestlewood Drive with Woodbridge Boulevard. The installation would require the construction of approximately 4500 linear feet of 12-inch line and a 10" meter vault.

Cost. The estimated construction cost of this alternative is $96,000. That estimate is based on a pipeline installation cost of $20.00 per L.F. and a meter charge of $6,000.[6] The increased annual costs are summarized below.

| | |
|---|---|
| • Debt service on a 30-year loan @ 12% | $11,520 |
| • Water purchase expense | 30,000 |
| Subtotal | $41,520 |
| • Less power cost (abandoned wells) | 2,520 |
| Total Estimated Annual Cost Increase | $39,000 |

Implementation. Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements will not change as a consequence of this fluoride reduction alternative.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

SANGAREE AND TRAMWAY SUBDIVISIONS
ALTERNATIVE SUMMARY

| Alternative | Capacity (GPM) | Annual Cost Data Capital | Operating | Consumer |
|---|---|---|---|---|
| No. 1: Regional | - | - | - | - |
| No. 2: Purchase | - | $11,520 | $27,480 | $47.85 |

The superior method of effecting a solution to the fluoride problem in this community is to construct the proposed regional system. As of this writing, preliminary planning steps have been undertaken by BCRW&SA to evaluate the feasibility of constructing that water system. We hereby recommend that no action be taken on this water supply until a firm decision relative to the establishment of a regional system is made. If that decision is unfavorable, Alternative No. 2 should be implemented. That course of action would result in the following water rate increase.

- Existing monthly rate[7] $12.76
- Estimated monthly increase 3.99

Adjusted monthly water rate $16.75/consumer

## REFERENCES

[1]Personal communication, Arthur Bryngelson, Berkeley County Regional Water and Sewer Authority, June 11, 1980.

[2]Clark, J. W., et al. Water Supply and Pollution Control, 1971, International Textbook Company, Scranton, Pennsylvania.

[3]South Carolina Department of Health and Environmental Control, Water Analysis Report on Sample No. P011470612, February 3, 1977.

[4]South Carolina Department of Health and Environmental Control, Water Analysis Report on Sample No. P011470613, February 3, 1977.

[5]Personal communication, Arthur Bryngelson, Berkeley County Water and Sewer Authority, January 7, 1980.

[6]Personal communication, Steve Kinard, Charleston Commissioners of Public Works, June 12, 1980.

[7]South Carolina Department of Health and Environmental Control, "Staff Study for Sangaree Subdivision, Berkeley County", March 30, 1978.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# SOUTH TRANQUIL ACRES SUBDIVISION

# DORCHESTER COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of South Tranquil Acres Subdivision. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

# BACKGROUND

## CONSUMERS

South Tranquil Acres is an established residential subdivision. It is located in Dorchester County and lies to the south of the Town of Summerville. The water system serving South Tranquil Acres provided water to 100 consumers, approximately 350 people, as of April, 1978.[1]

Most building lots in the subdivision are occupied; therefore, the population is expected to remain static.

## WATER SUPPLY REQUIREMENTS

### Current Demand

Accurate data on actual water use in this community is not readily available. Consequently, system averages developed from records of similar communities were utilized as a basis for establishing assumed values which will be utilized in ensuing sections of this report. An average daily usage of 160 gallons per connection and a maximum daily demand factor of 180% were used to establish the following system demand data:

- Average Daily Demand — 16,000 gallons
- Maximum Daily Demand — 28,800 gallons

### Supply Requirement

The most practical alternative for reducing the fluoride concentration in this water supply is to purchase water from the Town of Summerville. The system owner has expressed a preference for purchasing enough water from the Town to blend with the existing groundwater supply. Another variation of the purchasing alternative is to abandon the existing wells and obtain the entire supply from Summerville. Accordingly, the economics of both variations were analyzed.

Supply Requirements for the Complete Purchase Variation were assumed to be the average daily flow during a period of maximum demand. That requirement was computed as follows:

$$\frac{(28,800 \text{ gal})}{(24 \text{ hrs})(60 \text{ min/hr})} = 20 \text{ GPM}$$

Supply Requirements for the Blending Variation were calculated based upon the following list of assumptions and data:

- The well which is located along Ladson Road will be utilized as the groundwater supply due to its proximity with the Town of Summerville's system.
- The well which is located at the intersection of Lamie Drive and Harrison Road will be abandoned. This capacity will be replaced by water purchased from the Town.
- The water purchased from Summerville will contain 0.2 mg/l fluoride.
- Water drawn from the existing well has a fluoride concentration of 3.0 mg/l.[2]
- A fluoride concentration of 1.4 mg/l can be achieved by maintaining the Summerville flow at 1.33 times the existing well flow.
- The capacity of the existing well is 60 GPM.[1] The blend will require that 80 GPM be obtained from the Town.

- The instantaneous demand for a system with 100 homes connected to it is 2 GPM/connection.[3]

Computation of supply requirements for the blending variation was made as follows:

- Total Instantaneous Demand
  (2 GPM)(100 homes) = 200 GPM

- Instantaneous Supply Demand
  (200 GPM)(20 min) = 4,000 Gallons

- Available Pumping Capacity
  (140 GPM)(20 min) = 2,800 Gallons

- Pneumatic Storage Requirement
  $\frac{4000\ Gal - 2800\ Gal}{*0.25}$ = 4,800 Gallons

As calculated above, <u>the supply requirement of the blend variation is 140 GPM with a pneumatic storage capacity of 4,800 gallons</u>.

* Pneumatic tanks ideally satisfy a given water storage requirement by utilizing 25% of the available tank volume for water storage and 75% for air storage.

## FLUORIDE REDUCTION

### METHOD

As previously discussed, the most practical method of effecting a fluoride reduction in the water supply of South Tranquil Acres is to purchase water from the Town of Summerville. Two variations of a purchasing alternative were evaluated. One addresses abandonment of the two existing wells and the purchase of the entire supply from Summerville; the other requires the purchase of approximately 60% of the supply from the Town and blending that with the production of the Ladson Road well.

<u>Purchasing Variation</u>

The Town of Summerville presently has a distribution main in Ladson Road. The estimated fee for a 2" metered connection is $1,200.[4] Allowing another $800 for piping changes at the well site brings the total estimated capital cost to $2,000.

Annual costs for this system were calculated as follows:

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $ 248.28 |
| • Water Purchase | 4,051.72 |
| Subtotal | $4,300.00 |
| • Less Power Cost[5] | 1,200.00 |
| Total Annual Cost Increase | $3,100.00 |

Blending Variation

The metered connection to the Summerville system required by this variation would also be a 2" and the connection fee is estimated to be $1,200.[4]

To avoid the need for constant superintendence by a skilled operator, a system utilizing a suction tank and booster pump was selected as the means to effect blending in this community. The use of more sophisticated flow proportioning equipment was disregarded in an effort to maintain the operation and maintenance requirements at existing levels. The facilities required are schematically presented in Figure No. 1 and are more fully described in the following list.

- Construct a 5,000 gallon suction tank on a concrete foundation. The tank will be maintained full of Summerville water by an automatic level control valve.
- Install an 80 GPM booster pump which will run simultaneously with the well pump. The pump will be fed by the suction tank described above and will be piped into the inlet side of the pneumatic tank.
- The existing pneumatic tank may have to be replaced due to its obvious lack of capacity. The cost of this work was, however, not included in the estimates because it may not be required by the state.

The construction cost of the pumping system including engineering, project contingency expenses and the connection fee has been estimated at $21,200.

Annual costs for this system were calculated as follows:

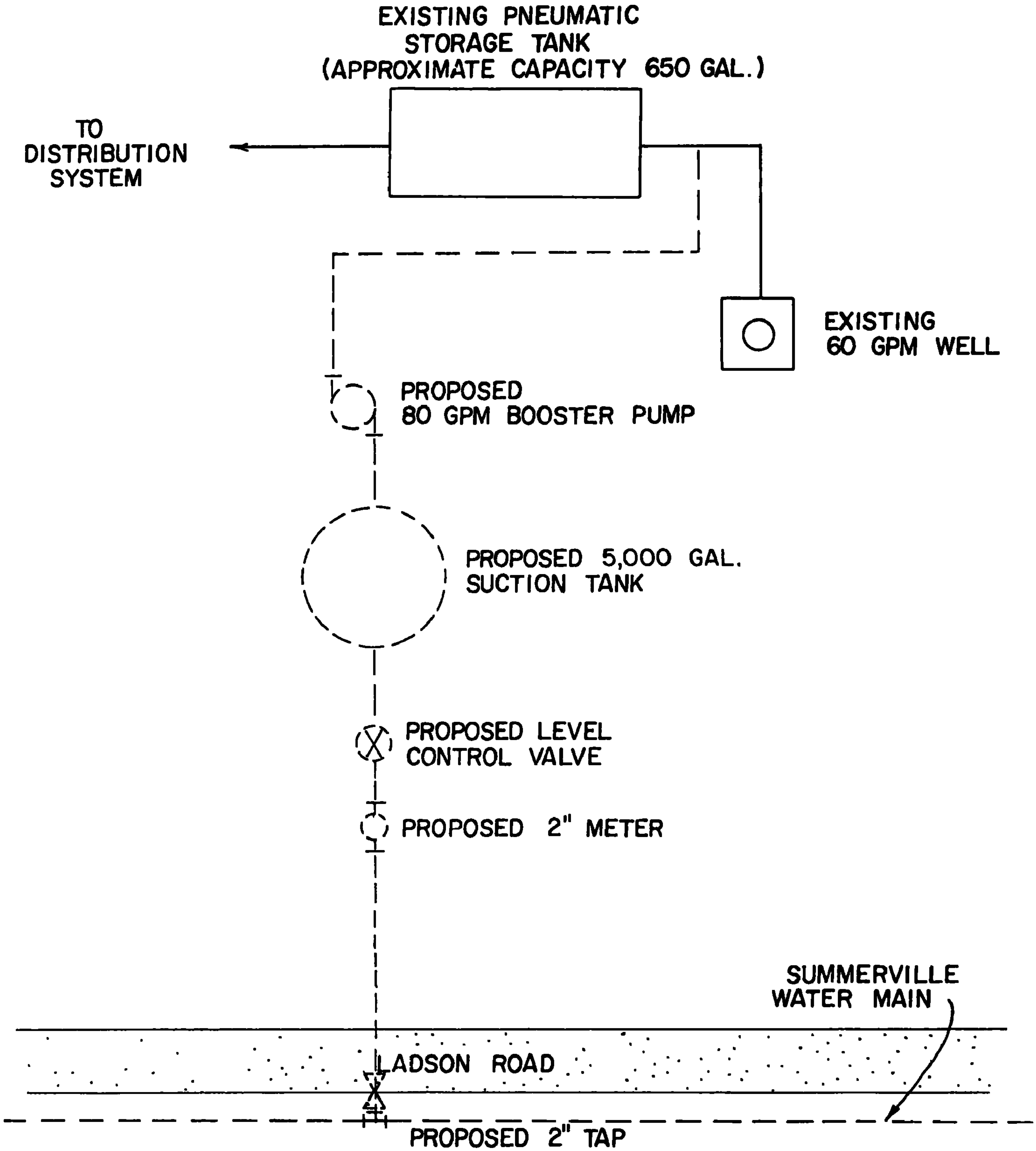


FIGURE 1

SCHEMATIC DIAGRAM OF PROPOSED

WATER SUPPLY ADDITIONS

AT

SOUTH TRANQUIL ACRES SUBDIVISION

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $2,631.76 |
| • Water Purchase | 2,568.24 |
| • Pumping Cost (no change) | -0- |
| Total Annual Cost Increase | $5,200.00 |

COST

The additional incremental annual cost increase per consumer for the two variations of this alternative would be as follows:

- Purchase $31.00 ($2.58/month)
- Blend $52.00 ($4.33/month)

IMPLEMENTATION

Subsequent to the completion of required referendums, rate structure studies, funding procurement, etc., implementation can be achieved as follows:

- Purchase 18 months
- Blend 24 months

OPERATOR REQUIREMENTS

Operator requirements for this system will not change as a consequence of fluoride reduction in the water supply.

REFERENCES


[1]South Carolina Department of Health and Environmental Control, "Staff Study for Tranquil Acres Subdivision, Dorchester County, April 17, 1978."

[2]South Carolina Department of Health and Environmental Control, Water Analysis Report on Laboratory Sample No. P07208-086, July 27, 1978.

[3]Joseph S. Ameen, "Community Water Systems", 1971, Technical Proceedings, High Point, North Carolina.

[4]Personal communication, Mr. Roy Winey, Town of Summerville, March 27, 1980.

[5]Personal communication, Mrs. Wilkins, system owner, March 28, 1980.

# FLUORIDE REDUCTION
# IN
# PUBLIC WATER SUPPLY
# OF
# THE TOWN OF STUCKEY
# WILLIAMSBURG COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL


Prepared By

A Joint Venture Of

J. E. SIRRINE COMPANY and AWARE, INC.

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## INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of the Town of Stuckey. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The water system serving the Town of Stuckey provided water to 66 consumers as of June, 1978.[1] Present plans are to extend the system to serve 20 additional consumers.[2]

Williamsburg County is expected to experience continued industrial growth during the forseeable future. As a consequence of that growth, the consumer population of the Stuckey water system can be expected to grow.

### WATER SUPPLY REQUIREMENTS

Utilizing criteria developed by the Town's consulting engineer, current and projected water supply requirements were calculated as follows.[1]

<u>Current Demand</u>

- People served = (66 + 20)(4) = 344
- Average Daily Demand (in gallons)

| | | |
|---|---|---|
| Domestic (344)(100)(1.5) | = | 51,600 |
| Farming | = | 13,000 |
| Industry | = | -0- |
| Total | = | 64,600 |

- Maximum Daily Demand (in gallons)

| | | |
|---|---|---|
| Domestic (51,600)(1.5) | = | 77,400 |
| Farming | = | 13,000 |
| Industry | = | -0- |
| Total | | 90,400 |

1995 Projected Demand

- Average Daily Demand (in gallons)

| | | | |
|---|---|---|---|
| Domestic | (600)(100)(1.5) | = | 90,000 |
| Farming | | = | 13,000 |
| Industry | (100 GPM)(24 hrs)<br>(60 min) | = | 144,000 |
| | Total | | 247,000 |

- Maximum Daily Demand (in gallons)

| | | | |
|---|---|---|---|
| Domestic | (90,000)(1.5) | = | 135,000 |
| Farming | | = | 13,000 |
| Industry | | = | 144,000 |
| | Total | | 292,000 |

Current and Projected Supply Requirements

- Current $\frac{90,400 \text{ gallons}}{(16 \text{ hrs})(60 \text{ min})}$ = 94 GPM

- Projected $\frac{292,000 \text{ gallons}}{(16 \text{ hrs})(60 \text{ min})}$ = 304 GPM

EXISTING SUPPLY

The existing water supply consists of one deep well having a rated capacity of 150 GPM. Based upon the present requirement of 94 GPM, the existing production capability is adequate. It is noted, however, that water produced by the existing well contains 2.3 mg/l fluoride which exceeds the limit of 1.6 mg/l established by law. In addition to producing water which does not meet the "National Interim Primary Drinking Water Standards" (NIPDWS), the facilities have been in continuous service for approximately 15 years and may therefore require extensive maintenance.

## PROPOSED FACILITIES

Being cognizant of the need for an expanded supply to meet future water demands, the Town of Stuckey is planning the construction of water system improvements. Said improvements are scheduled to include at least one new 200 GPM water well.

## FLUORIDE REDUCTION

### METHOD

Proper construction of the proposed new well should provide a water supply that complies with the fluoride limit established by the NIPDWS. The specifications for the new well should require selective testing of each water bearing strata that is penetrated. Based upon the test results, screen settings for the production well should be selected to accomplish an "in-well" blend that will yield an acceptable fluoride level. Assuming that the water from the deep strata will contain 2.3 mg/l fluoride and the shallow water will contain no fluoride, a shallow/deep mix of 80 GPM/120 GPM will result in a blend having a fluoride concentration of 1.4 mg/l.

### COST

The estimated construction cost of the new well including engineering and project contingency expenses has been estimated at $134,620.[1] Annual debt service expense on that amount calculated at 12% for 30 years is $16,711. Other annual costs, such as power and chemical usage, are approximately proportional to demand and would not increase noticeably if production were shifted from the existing well to the proposed new well. It may be concluded, therefore, that the maximum additional annual expense attributable to the reduction in fluoride is equal to the debt service payment. Accordingly, at a consumer population of 86, the annual cost increase per consumer served would be $194.31 ($16.19/month).

IMPLEMENTATION

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of the above-described facilities can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

OPERATOR REQUIREMENTS

Operator requirements for this system will not change as a consequence of fluoride reduction in the water supply.

REFERENCES

[1]Palmer & Mallard and Associates, Inc., "Town of Stuckey, South Carolina, Williamsburg County Preliminary Engineering Report Water Improvements", June, 1978.

[2]Personal Communication, David Stuckey, Town of Stuckey, February 18, 1980.

# FLUORIDE REDUCTION

# IN

# PUBLIC WATER SUPPLY

# OF

# SULLIVANS ISLAND

# CHARLESTON COUNTY, SOUTH CAROLINA

JULY, 1980

Prepared For

SOUTH CAROLINA DEPARTMENT OF HEALTH

AND ENVIRONMENTAL CONTROL

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# INTRODUCTION

Beginning on June 24, 1977, community water systems throughout the United States were required to comply with the Environmental Protection Agency (EPA) National Interim Primary Drinking Water Standards. Said standards established maximum contaminant levels for ten inorganic chemicals, one of which was fluoride. Enforcement responsibility for the standards was requested by and subsequently granted to the South Carolina Department of Health and Environmental Control (SC DHEC). Investigations conducted by the State revealed that approximately 60 public water supplies exceeded the established fluoride standard. SC DHEC personnel have worked with the affected communities in a concerted effort to develop rational solutions to the problem. This report, which was funded by EPA and prepared under the auspices of SC DHEC, is a direct outgrowth of that effort.

In January, 1980, a study of each community water supply which exceeded the legal limit for fluoride was initiated. The established objective of that investigative effort was to identify one or more viable fluoride reduction alternatives for each community. This report documents that portion of the study which was directed specifically at providing a conceptual solution to the reduction of fluoride in the water supply of Sullivans Island. In addition to addressing the conceptual solution from a technical standpoint, planning-level cost estimates are also presented. It should be noted that all capital costs are presented in 1980 dollars and that all operating expenses were calculated at 1979 water production and consumer levels.

## BACKGROUND

### CONSUMERS

The water system serving the Town of Sullivans Island provided water to 790 consumers as of March 30, 1978.[1]

A population projection for Sullivans Island was obtained from the Berkeley Charleston Dorchester Council of Governments. Said projection was utilized to develop consumer projections for the Town. The computations that were made are summarized in the following table.

| TOWN OF SULLIVANS ISLAND CONSUMER POPULATION PROJECTIONS | | | |
|---|---|---|---|
| Year | Population Projection | % Change | Consumers |
| 1980 | 2,234 | -0- | 790 |
| 1985 | 2,802 | 25% | 988 |
| 1990 | 3,396 | 21% | 1,195 |
| 1995 | 4,000 | 18% | 1,410 |

### WATER SUPPLY REQUIREMENTS

<u>Current Demand</u>

Daily water demand in the service area was tabulated for two sixty-day periods during calendar 1979. One period, January and February, experienced an average daily demand of 177,166 gallons. The other, July and August, was approximately 42% higher with an average daily usage of 252,253.[2] Based upon an annual average of 215,000 GPD, the daily average use per connection was calculated to be 272 gallons.

Projected Demand

Utilizing actual usage data for 1979 and the projected consumer population, average daily water demands were calculated for 3 consecutive 5-year planning periods. Maximum daily demand was also projected at 180% of average daily demand. The results of said calculations are summarized in the following table.

| TOWN OF SULLIVANS ISLAND PROJECTED WATER DEMAND | | |
|---|---|---|
| Year | Average Day (in gallons) | Maximum Day (in gallons) |
| 1980 | 215,000 | 387,000 |
| 1985 | 269,000 | 484,000 |
| 1990 | 325,000 | 585,000 |
| 1995 | 384,000 | 690,000 |

Current and Projected Supply Requirements

The below listed supply requirements were calculated utilizing a regulatory design criterion requiring that the well or wells be capable of meeting the maximum daily demand in a 16-hour operating period.

- 1980 - 403 GPM
- 1985 - 504 GPM
- 1990 - 609 GPM
- 1995 - 719 GPM

EXISTING SUPPLY

The Town has two separate points of supply. The first is located at the intersection of Station 17 and Middle Street. Shallow well water is collected by a series of pump stations. Each pump station houses one (1) six-inch plunger pump and is fed by 8 to 10 shallow (14 to 15 foot deep) well points. The approximate capacity of each station is 50 GPM.[5] The series of pump stations convey water via a 6" pressure main to a small (approximately 3 foot by 4 foot) concrete mixing chamber which is constructed immediately adjacent to the existing deep well. Water flows from the deep well under artesian pressure into the mixing chamber. The blended water then flows a short distance by gravity to a 270,000 gallon concrete ground level storage tank. Booster pumps installed between the ground level reservoir and the distribution system are utilized to maintain system pressure. The water is chlorinated at the pump suction. During periods of maximum demand, the flow from four of eight shallow well stations is blended with the yield from the deep well.[5]

The second water supply is located at the intersection of Station 24 and East Middle Street. This supply consists exclusively of shallow well water which is obtained from a series of pump stations located along East Middle Street. As with the other supply, each pump station houses one (1) six-inch diaphram pump which is fed by 8 to 10 shallow well points. The water is transmitted from the pump stations to a 300,000 gallon ground level steel storage tank which serves as a suction reservoir for the system's booster pumps. Prior to being discharged into the system, the water is chlorinated. As with the other supply, a maximum of four stations pump to this tank during periods of maximum demand.

## FLUORIDE REDUCTION

Preliminary investigative efforts identified two viable fluoride reduction alternatives for Sullivans Island. Each alternative was subsequently evaluated to determine the most practical and least expensive method of effecting a solution to the fluoride problem. The ensuing paragraphs of this report document the results of the evaluations and rank the alternatives in their order of desirability.

Financial information presented in this report is based upon 1979 consumer levels and 1980 planning-level cost data. Consequently, the estimated consumer expense reflects a present day situation. In other words, the assumption was made that the alternative was constructed and became operational during the 1980 calendar year. By utilizing current data, comparison of the various alternatives is placed in a proper perspective with the community's present fiscal position. Recognizing that the cost data is presented in 1980 dollars, it is recommended that initial planning of any alternative include a reevaluation of capital and operating costs with respect to anticipated construction schedules.

### ALTERNATIVE NO. 1: BLENDING

#### Method

Blending deep and shallow well water in the proper proportions on the western end of the island will reduce the fluoride concentration in the Town's water supply to acceptable levels. Based upon a deep well fluoride concentration of 4.7 mg/l and a shallow well concentration of 0.8 mg/l, blending ratios were calculated and are presented in the following table.[3]

| TOWN OF SULLIVANS ISLAND DEEP/SHALLOW BLENDING RATIOS | | |
|---|---|---|
| Blend Ratio (deep/shallow) | Flow Ratio (deep/shallow) | Fluoride Concentration |
| 1.0/5.5 | 36 GPM/200 GPM | 1.4 mg/l |
| 1.0/4.6 | 43 GPM/200 GPM | 1.5 mg/l |
| 1.0/3.9 | 51 GPM/200 GPM | 1.6 mg/l |

The success of blending is dependent upon control of the flow from the deep well. This can be accomplished by installing valves and meters in both the shallow and deep feed lines immediately ahead of the mixing chamber. The flow from the deep well can then be throttled to provide a flow that is properly proportioned to the shallow well yield.

Being cognizant of the marginal capacity of the Town's existing supply and the obvious reduction in deep well yield that will occur as a result of throttling, the construction of one additional shallow well station is included in this alternative.

Cost

The estimated construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $18,000. Annual debt service expense on that amount calculated at 12% for 30 years is $2,234. Total system operating costs would remain approximately the same.

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within 24 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

Operator requirements will not change as a consequence of this fluoride reduction alternative.

ALTERNATIVE NO. 2: TREATMENT

Method

This alternative addresses the construction of one new deep well that will produce 500 GPM. The new facility will replace the existing deep well which is reported to have a deteriorated casing which is leaking badly.[6] Water produced by the proposed well would be treated with activated alumina. The system would be sized to treat 400 GPM, the remaining 100 GPM would bypass treatment and be blended with the defluoridated water. A liquid waste stream from the unit will be discharged to a wastewater equalization tank. The contents of the tank will be drained to the sanitary sewer system at a low rate of flow.

See the Appendix entitled "Fluoride Treatment" for a description of the activated alumina process.

Cost

The construction cost of Alternative No. 1 including engineering and project contingency expenses has been estimated at $865,000. Annual costs are summarized below.

| | |
|---|---|
| • Debt Service on a 30-Year Loan at 12% | $107,381 |
| • Operations and Maintenance | 50,619 |
| Total Estimated Annual Cost Increase | $158,000 |

Implementation

Design, securing permits and approvals, solicitation of proposals, contract negotiation and award, and construction of this alternative can be accomplished within

42 months of completion of required referendums, rate structure studies, funding procurement, etc.

Operator Requirements

The State of South Carolina requires a licensed "A" operator for those systems employing activated alumina fluoride removal technology. The present state license system requires a high school education, four years experience as an operator in a public water treatment plant, and the ability to pass a written examination, in order to obtain an "A" operating license. Approximately 120 hours of formal training should be adequate to upgrade operator skills to the level required by the proposed treatment system. The actual cost to the community for this training is anticipated to be approximately $3,000 plus travel and living expenses.

SUMMARY

The alternatives which were evaluated during the course of this study are summarized in the following table.

| TOWN OF SULLIVANS ISLAND ALTERNATIVE SUMMARY | | | | |
|---|---|---|---|---|
| Alternative | Capacity (GPM) | Annual Cost Data | | |
| | | Capital | Operating | Per Consumer |
| No. 1: Blending | 500 | $ 2,234 | - | $ 2.83 |
| No. 2: Treatment | 500 | $107,381 | $50,619 | $200.00 |

Based upon the above listed information, Alternative No. 1 is the least expensive method of effecting a solution to the fluoride problem in this community.

As of March, 1978, the average monthly water bill rendered for service from this system was $9.84. Assuming that the increased annual cost for the selected alternative will be amortized uniformly, the average water bill will increase to $10.08.

Construction of the primary alternative would result in the following water rate increase.

| | |
|---|---|
| • Existing monthly rate[1] | $9.84 |
| • Estimated monthly increase | .24 |
| Adjusted Monthly Water Rate | $10.08/consumer |

## REFERENCES

[1]South Carolina Department of Health and Environmental Control, "Staff Study for the Town of Sullivans Island, Charleston County," March 30, 1978.

[2]Personal communication, Mrs. Bannister, Town of Sullivans Island, January 28, 1980.

[3]South Carolina Department of Health and Environmental Control, water analyses reports on laboratory samples numbered P06288-1419 and R06288-1654, July 3, 1978.

[4]South Carolina Department of Health and Environmental Control, memorandum from: Fred Soland, to: file, June 29, 1978.

[5]Personal communication, Mr. Truesdale, Town of Sullivans Island, April 23, 1980.

[6]South Carolina Department of Health, Memorandum, From: Fred Soland, To: File, Subject: Sullivans Island Water System, June 29, 1978.