Marco Island Reverse Osmosis Water Treatment Plant Expansion Preliminary Design

For:

Southern States Utilities, Inc.
1000 Color Place
Apopka, FL 32703

By:

Boyle Engineering Corporation

Project Manager — Steven J. Duranceau, PhD, PE
Florida Registration No. 46583

Steven J Duranceau 26 MAY 95

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BOYLE — 320 E. South Street, Orlando, FL 32801

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Southern States Utilities, Inc.
Marco Island R.O. Expansion

TECHNICAL MEMORANDUM No. ES-1

Subject: Executive Summary

Overview

Southern States Utilities, Inc. (SSU) owns and operates a 4.0 mgd reverse osmosis (RO) water treatment plant (WTP) located on Marco Island, Florida. In February 1995, SSU authorized Boyle Engineering Corporation (Boyle) to provide professional engineering services related to expanding the RO facilities' capacity to 6.0 mgd of permeate water. Specifically, Boyle was authorized to evaluate the existing pre-treatment and post-treatment systems, instrumentation and electrical systems for adequacy after the expansion of the facility. Also, Boyle was authorized to evaluate the preliminary design requirements for new systems (skids, etc.) for the expansion.

Technical Memoranda

The Technical Memoranda (TMs) are divided into 18 TMs, with ES-1 serving as the Executive Summary. TMs G-1 through G-3 provide a brief overview of the Construction Planning and Schedule, Construction Permits and Opinion of Probable Construction Cost. TMs P-1 through P-11 provide an overview of the existing process equipment and evaluates the equipment required for the expansion of the facility. TMs E-1 and E-2 evaluate the existing electrical equipment in the facility and make recommendations on the electrical components required for the expansion of the facility. TM I-1 provides a brief overview of the existing control and instrumentation of the existing facility and makes recommendations on the control and instrumentation for the expansion of the facility.

General Project

Problem's with Existing wells.

The expansion of the Marco Island R.O. facility will increase the design permeate water capacity from 4 mgd to 6 mgd. A raw water flow of approximately 9.2 mgd is necessary to produce 6 mgd of permeate water at the expected process recovery rate of 65 percent. To provide 9.2 mgd, the construction of five new wells and transmission piping will be required for this expansion. The the wells and transmission main will be designed and constructed under another contract.

The expansion will include a second sand separator, two new pre-treatment cartridge filters, two new membrane feed pumps and two new membrane skids. The new RO membrane skids will be housed in the existing Process Building. In addition, two of the transfer pumps will be converted from a constant-speed control to a variable frequency drive system. One vertical turbine pump with a variable frequency drive unit will be added to the concentrate pumping transfer station.

The expansion to the RO plant will be designed to add 2 mgd of permeate for a total capacity of 6 mgd. The new RO skids will be designed to produce a permeate water that will meet SSU's finished water goals that are presented in Table 1.

TABLE 1

Finished Water Target Range Goals

Constituent	Finished Water Standard (mg/L)	Finished Water Target Range (mg/L)
Chloride	250	125-189
Sodium	160	80-120
TDS	500	250-375
Hardness, Total (ppm as $CaCO_3$)	---	20-50

The preliminary design presented in these TMs have used existing data that was provided by SSU.

Based on preliminary Technical Memorandums, the estimated probable construction cost for the Marco Island RO expansion is approximately $1.043 million dollars for a 1 MGD process expansion and $1.969 million for a 2 MGD process expansion.

TECHNICAL MEMORANDUM No. G-1

Subject: Construction Planning and Schedule

Purpose and Scope

Technical Memorandum (TM) No. G-1 has been prepared to present a preliminary schedule for the proposed Marco Island RO facilities expansion from bidding phase through final completion. The project's overall schedule is preliminary in nature and could vary following final design.

If a project of this size and complexity is divided up into separate construction contracts, experience has shown that ease of management and coordination are a direct benefit. It allows contractors to bid on separate portions of a project for which they have individual areas of specialization and expertise. It also facilitates phased construction by an individual contractor rather than relying on one general contractor to complete large and varied tasks within short time frames. This should result in a higher quality, timely, and more cost-effective product for Southern States Utilities, Inc.

In light of these advantages, the project will be broken into three contracts:

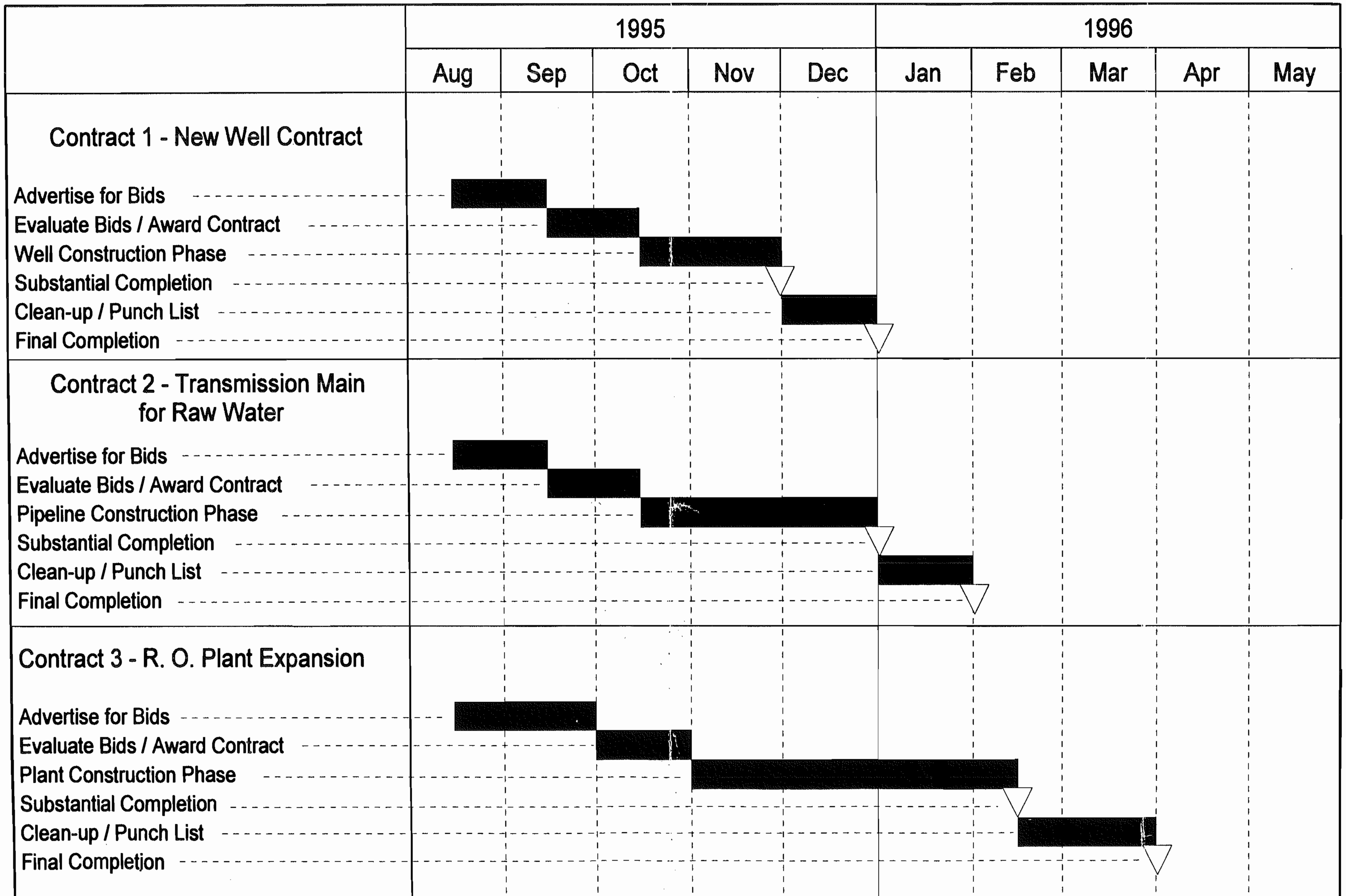
- Contract 1 - Well Construction
- Contract 2 - Transmission Main for Raw Water
- Contract 3 - RO Plant Expansion

The estimated construction schedule is presented in Drawing G-1.

Construction Schedule - Preliminary Draft

(For Discussion Purposes Only)

4/12/1995



SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

BEC PROJECT NO. OR-S25-103-00

CONSTRUCTION SCHEDULE
PRELIMINARY DRAFT

DRAWING G-1

TECHNICAL MEMORANDUM No. G-2

Subject: Construction Permits

Purpose and Scope

Technical Memorandum (TM) No. G-2 addresses most of the permitting requirements for the construction of the plant expansion.

The basic assumptions in this Technical Memorandum are as follows:

A. Expansion of the facility will be located within the existing structure located east of South Heathwood Drive.

B. Building permits for the modification and construction on the expansion of the facility must be obtained from Collier County.

C. Concentrate from the expansion R.O. membrane processes will be disposed of via an injection well, which has a permitted disposal capacity of 4,000 gpm (5.76 mgd) with a maximum injection pressure of 127.6 psi.

Permits Required

The County and state permit requirements for the Marco Island R.O. Expansion are identified in this Technical Memorandum. The following text describes some of the permits and their review process.

<u>Florida Department of Environmental Protection (FDEP) Construction Permit</u>. Modifications of the existing treatment plant and construction of a new raw water source will require an FDEP Permit to Construct a Public Drinking Water System.

<u>Collier County Building Permit</u>. Collier County building permits are issued for building construction and can be issued only after Site Development Plan approval. For the Marco Island R.O. Expansion, this permit will be applied for and obtained by the contractor awarded the project.

TECHNICAL MEMORANDUM No. G-3

Subject: Opinion of Probable Construction Cost

Purpose and Scope

Technical Memorandum (TM) No. G-3 addresses the opinion of probable construction cost of the R.O. plant expansion.

Cost estimates were obtained from Boyle disciplines for the process, electrical, and instrumentation portions of the Marco Island R.O. plant expansion project, which included the following major elements:

- Equipment and materials of construction.
- Construction labor expenses.
- Contingency factor.

The project's overall opinion of probable cost is preliminary in nature and could vary following final design. A summary of the estimate of probable construction cost for the expansion of the Marco Island R.O. plant is presented in Table 1.

Equipment, Materials and Labor

Costs for equipment purchase, installation and calibration were based on prices obtained from equipment manufacturers, their representatives or data collected during similar past projects. These costs are subject to change due to variable factors such as the economy, energy costs and raw material availability. Actual equipment selection is also subject to change during final project design. Operating warranties from equipment manufacturers have a non-assignable cost benefit. These beneficial costs were not included in the project's construction cost estimate.

Some cost estimates for material and labor were based on the most current edition of the Means Building Construction Cost Data. Similar to equipment costs, material and labor costs are also subject to changes in the economy and energy costs.

TABLE 1

Preliminary
Opinion of Probable Cost

Item	1 MGD Process Expansion	2 MGD Process Expansion	Existing Process/ Well Field Enhancements
Mobilization	$30,000	$50,000	
Pre-treatment			
Sand Separator	$30,000	$30,000	
Cartridge Filters	30,000	60,000	
Piping and Valves	25,000	50,000	
Pretreatment Subtotal	$85,000	$140,000	
Cleaning and Chemical Systems	$25,000	$25,000	
Membrane Process			
Membrane Feed Pumps	$80,000	$160,000	
Membrane Pressure Vessels	110,000	220,000	
Membrane Elements	218,000	435,000	
Piping and Valves	18,000	35,000	
Membrane Process Subtotal	$426,000	$850,000	
Concentrate Pumping Station			
Pump	$25,000	$25,000	$19,000
Piping and Valves	9,000	9,000	2,000
Concentrate Pumping Station Subtotal	$34,000	$34,000	$21,000
Electrical	$135,000	$270,000	$33,000
Instrumentation	$145,000	$290,000	$170,000
Subtotal	$880,000	$1,659,000	$224,000
Construction Contingency @ 15%	$132,000	$253,000	$ 34,000
Subtotal	$1,012,000	$1,912,000	
Escolation Factor to 11/95 @ 3%	$ 31,000	$ 57,000	
Total Opinion of Probable Cost	$1,043,000	$1,969,000	$258,000

Contingency Factor

Since the project construction cost estimates for each discipline were based on preliminary design drawings, a contingency factor of 15 percent was included in the estimated construction cost.

The contingency factor is generally added to a construction cost estimate to account for unknown factors which may not have been taken into account during the design activities. An example of an unknown factor may include such items as valves, pressure gauges, etc. In addition, contingency factors should help to cover slight design changes which may occur during final design.

Preliminary design drawings include less detailed information than final design drawings. Therefore, the contingency value for preliminary design cost estimates should be higher than the expected contingency value for final design cost estimates.

TECHNICAL MEMORANDUM No. P-1

Subject: Process Schematic and Water Quality, Raw and Finished

Purpose and Scope

Technical Memorandum (TM) No. P-1 has been prepared to: 1) set forth the raw and finished water quality standards based on available information provided by the client; 2) to provide an overview of the processes that will be used in the expansion of the Marco Island R.O. plant; and 3) describe the interrelationship between the processes.

Raw Water Quality

SSU proposes that the raw water source for the expansion of the Marco Island Water Treatment Plant will potentially come from three different supplies: 1) existing wells, 2) new wells, and 3) proposed surface water. The existing wells are discussed in TM G-1. The water quality in many of the ten existing wells has been changing. SSU has only limited water quality information on these wells. The new wells that will provide the additional raw water supply for the expansion have not yet been drilled. When these wells are developed, a complete raw water analysis should be performed to establish the blended raw water quality of the existing and new wells.

The consideration of blending a surface water with the wells is discussed in TM P-11. As explained in TM P-11, the concept of blending surface water is a relatively new concept, it has not been fully evaluated as yet and the potential of this source and the effect on the membrane design are unknown. For the purpose of this TM, the design raw water quality will be based on the limited historical data from the existing wells and recent data collected on chloride, conductivity and total dissolved solids from all of the production wells.

Table 1 presents the limited historical raw water quality data provided by Southern States Utilities, Inc. (SSU) for wells CO-2112 (Well No. 4), CO-2123 (Well No. 5), and CO-2111 (Well No. 8). The data in Table 1 was developed from information generated by Thornton Laboratories, Inc. (1145 East Cass Street, Tampa, FL 32514), Laboratory number 805310. This information was provided to SSU on February 4, 1992. Between February 1992 and March 1995, there has been an increase in chlorides, conductivity, total dissolved solids and sodium. These wells have changed to a point where the raw water quality is in some cases marginal for the feedwater source to the R.O. skids.

TABLE 1

Historical Raw Water Quality Data
Wells 4, 5 and 8 (average)
(February 1992)

Constituent	Raw Water (mg/l) as the ion
Barium	0.02
Bicarbonate	167.19
Calcium	210
Chloride	4,447.4
Fluoride	0.99
Iron	ND
Magnesium	210
Nitrate	0
Potassium	93
Silica	14
Sodium	2,500
Strontium	24
Sulfate	535
TDS	8,201.6
pH	7.47
Temperature (° C)	25
Alkalinity, Bicarbonate (ppm $CaCO_3$)	136
Hardness, Total (ppm $CaCO_3$)	1,387.9

Conductivity in umhoscm what is it
ND = Non-Detectable

Presently, the raw water for the R.O. facility is supplied by existing Wells 1, 2, 7 and 10. The range of chlorides and total dissolved solids data provided by SSU on these wells for the period January 1994 through March 1995 is presented in Table 2.

TABLE 2

Historical Raw Water Quality Data
Wells 1, 2, 7 and 10
(January 1994 through March 1995)

Constituent	Raw Water (mg/l) as the ion
Chloride	3,761 - 5,400
Total Dissolved Solids	7,408 - 10,500

In order to develop a raw water quality basis-of-design, and because of the limited available historic water quality data, Boyle used the following methodology:

- Use the 14 month average data for chlorides and TDS from Wells 1, 2, 7 and 10.
- Use the other parameters from Wells 4, 5 and 8, adjusted to maintain ionic balance.
- Adjust the calcium, magnesium and sulfate to reflect the high TDS raw water.

Based on the above methodology, the parameters listed in Table 3 are recommended for the basis-of-design. It is recommended that SSU and SSU's hydrogeologist involved in developing the new wells, review Table 3 for appropriateness in regard to either the expected water quality for the new wells, actual new wells water quality when it is available, and blended water quality for the expansion. This review should be completed prior to Boyle proceeding with the final design selection of the membrane element and array of the membrane skid.

TABLE 3

Basis-of-Design
Raw Water Quality Parameters
Wells 1, 2, 7 and 10 (average)

Constituent	Raw Water (mg/l) as the ion
Barium	0.02
Bicarbonate	167.19
Calcium	232
Chloride	5,381.6
Fluoride	0.99
Iron	ND
Magnesium	331
Nitrate	0
Potassium	93
Silica	14
Sodium	3116.3
Strontium	24
Sulfate	1,086.6
TDS	10,446.6
pH	7.47
Temperature (° C)	25
Alkalinity, Bicarbonate (ppm $CaCO_3$)	136
Hardness, Total (ppm $CaCO_3$)	1,940.7

Conductivity in umhoscm
ND = Non-Detectable

Finish Water Goals

The finished water goals for the RO permeate stream are presented in Table 4. These goals were developed in conjunction with SSU staff.

TABLE 4

Finished Water Goals

Constituent	Finished Water Standard (mg/L)	Finished Water Target Range (mg/L)
Chloride	250	125-189
Sodium	160	80-120
TDS	500	250-375
Hardness, Total (ppm as $CaCO_3$)	---	20-50

Design Criteria

The expansion of the R.O. plant will require improvements to several processes. These processes are grouped into three basic categories: pre-treatment, membrane treatment and post treatment.

The expansion of the pretreatment process will consist of sand separation and filtration of the raw water prior to entering the R.O. units. Sand separation will use a centrifugal separator with no-moving parts. Filtration in the form of cartridge filters with 5 micron cartridges will be provided to remove particles larger than five microns. The function of the sand separators and filters is to protect the membranes from plugging and possible irreparable damage. The pretreatment processes are further discussed in TM No. P-3.

The membrane treatment process expansion will consist of feed pumps and R.O. units. The design raw water quality presented in Table 3 was used to evaluate the selection of membrane elements and the configuration of the pressure vessels. Three different membrane manufacturers computer software programs were used for the selection of membrane elements and the array of the skid. The feed pumps and membrane processes are further discussed in TM No. P-4.

The post-treatment process will consist of degasification for the removal of hydrogen sulfide and carbon dioxide, the addition of sodium hydroxide for final pH adjustment, and the addition of chlorine for disinfection. Further details of the post-treatment processes are presented in TM No. P-5.

Recommendations

The following are a list of recommendations from this technical memorandum:

- When new wells are developed, SSU should obtain raw water quality data and compare the parameters to those assumed in Table 3 of this TM.
- SSU and the firm retained by SSU to develop new wells should review this TM related to the design raw water quality parameters and render an opinion as to the appropriateness of the parameters recommended for the design period.
- SSU should implement a program to regularly collect water quality data on existing wells.

TECHNICAL MEMORANDUM No. P-2

Subject: Pre-treatment

Purpose and Scope

Technical Memorandum (TM) No. P-2 has been prepared to evaluate the existing pre-treatment system and expand the system with additional pre-treatment components. The TM is based on the present operating data, layout and configuration of the pretreatment system.

Design Criteria

The pretreatment of the raw water prior to the R.O. membranes depend on the physical and chemical characteristics of the raw water. Based on the expected raw water quality presented in TM No. 1, the pre-treatment system will include a second sand separator and two additional horizontal cartridge filters. In addition, the existing turbidity analyzer will be replaced with a new turbidity analyzer and transmitter.

Sand Separator

The existing sand separator has been in service since December 1993. The system was designed and laid out to accommodate a second sand separator to operate in parallel when the plant is expanded to 6 mgd permeate production.

The separator will remove particles larger than 74 microns in size prior to application of the feed water to the cartridge filters. The sand separator will be equipped with an automatic discharge system for removal of solids collected during operation. The control of the discharge valve will be accommodated by the existing control panel and timer system. The accumulator tank will be constructed of 316 stainless steel (SST). The vortex finder, cone section, inlet and overflow flange connections will be lined with elastomer.

The design of the sand separator will be based on providing an additional unit to operate in parallel with the existing sand separator in service.

The service conditions for the sand separator are as follows:

- Design Operating Range (gpm): 3,500
- Maximum Surge Pressure (psig): 150
- Maximum Pressure Loss (psig): 12
- Removal Efficiency 90%
- Manufacturers: Krebs Engineers or Lakos Separator USA

Cartridge Filter

The expansion of the plant requires the addition of two new cartridge filters to operate in parallel with the existing four filters in service. The configuration of the new filters will be similar to that of the existing filters. By matching this configuration, the impacts to piping and operation of the system should be reduced.

Cartridge filters are an essential pretreatment process prior to sending raw water to the R.O membranes. The cartridge filter elements will remove particles larger than 5 microns in size prior to application of the feed water to the membranes. The filter vessels will be of horizontal design and constructed of 316 stainless steel (SST). The top closure cover will have 316 SST swing bolts with hex nuts. The internal parts will consist of 316 SST top seat spring assembly with nesting cap, V-post and bottom seat. Cover lift will be a mechanical davit with four tapered cover guide pins for cover alignment. Buna-N O-ring seal will be used for the cover seat. The cartridge filter elements will be constructed of polypropylene on a polypropylene center core. The polypropylene material will be National Sanitation Foundation (NSF) No. 61 that is approved for potable drinking water.

The design of the cartridge filters are based on providing two additional units to operate in parallel with the existing four cartridge filters in service.

The service conditions for the Cartridge Filters are as follows:

- Design Operating Flow/10" Filter Element (gpm): 3.5 - 4.5
- Maximum Clean Pressure Loss (psig): 3
- Maximum Dirty Pressure Loss (psig): 7
- Filtering Particles (micron): 5
- Removal Efficiency (percent): 90
- Manufacturers: Commercial Filter Division
Parker Hannifin or
Cuno Process Filtration Products

The layout of the cartridge filters are shown in drawing P-2.

Turbidity Analyzer

The new turbidity analyzer will be a wall-mounted instruments that monitors the raw water turbidity. The instrument will send output signals to the programmable logic controller (PLC) in the existing control room. The control logic and equipment types will be further explored in Technical Memorandum I-1.

The layout of the turbidity analyzer panel is shown in drawing P-2.

Recommendations

The following are a list of recommendations as a result of this technical memorandum.

- Install one sand separator.
- Install two horizontal cartridge filters.
- Install one wall-mounted turbidity analyzer.

Southern States Utilities, Inc.
Marco Island R.O. Expansion

TECHNICAL MEMORANDUM No. P-3

Subject: Membrane Process

Purpose and Scope

Technical Memorandum (TM) No. P-3 addresses the basis for selecting and sizing the R.O. membrane equipment required to expand the treatment capacity of the Marco Island R.O. plant from 4.0 mgd to 6.0 mgd. A plan overview of the Marco Island site and major equipment components to be added in the expansion are presented in Drawing P-1. The membrane process consists of the following components: 1) feed pumps; 2) membrane skids; and 3) piping and valves. This TM will address the high-pressure feed pumps and R.O. membrane skids.

Design Criteria

The expansion of the R.O. membrane skids will be housed in the existing Process Building. Presently, the building contains four skids, each with a 1.0 mgd capacity for a combined permeate production capacity of 4.0 mgd. Space for the expansion of two additional R.O. membrane skids has been provided, and each skid will be sized to produce 1 mgd of permeate. The addition of these to skids will increase the overall capacity to 6 mgd.

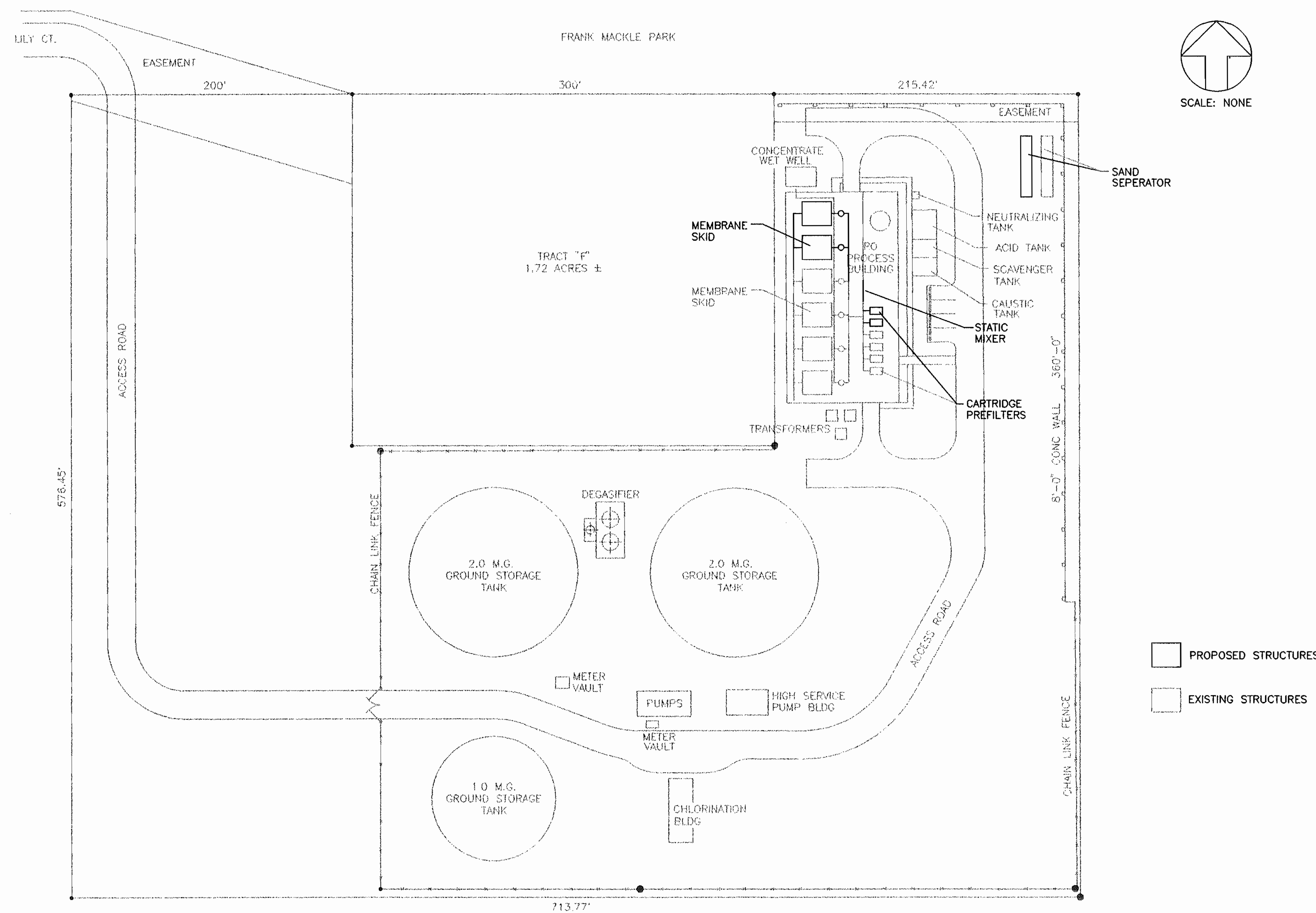
Raw water from the existing and new wells passes through two sand separators prior to entering the building through a 20-inch raw water pipeline. After pretreatment with sulfuric acid and scale inhibitor, the feed water passes through the four existing cartridge filters. Two new cartridge filters will be added with this expansion. The filters remove suspended particles prior to the membrane elements. After the cartridge filters, the feed water enters the 20-inch common header pipe which supplies water to the four existing membrane feed pumps and two new feed pumps. Drawing P-2 presents an overall layout of the proposed expansion of the membrane feed pumps and skids.

Membrane Feed Pumps

The two new membrane skids will each have a dedicated vertical turbine membrane feed pump to drive the treatment process.

The new feed pumps for the expansion will be designed for variable speed operation. The design criteria for the selection of feed pumps are as follows:

- The raw water flow to each of the feed pumps will be 1.53 mgd to compensate for the projected 65 percent recovery of the feed water.
- The expansion will require two additional feed pumps.
- The two new membrane feed pumps will draw feedwater from the common header supplying the existing feed pumps. No backup pump will be installed. However, a backup pump and motor for operation on all skids will be purchased and placed in storage. OK!



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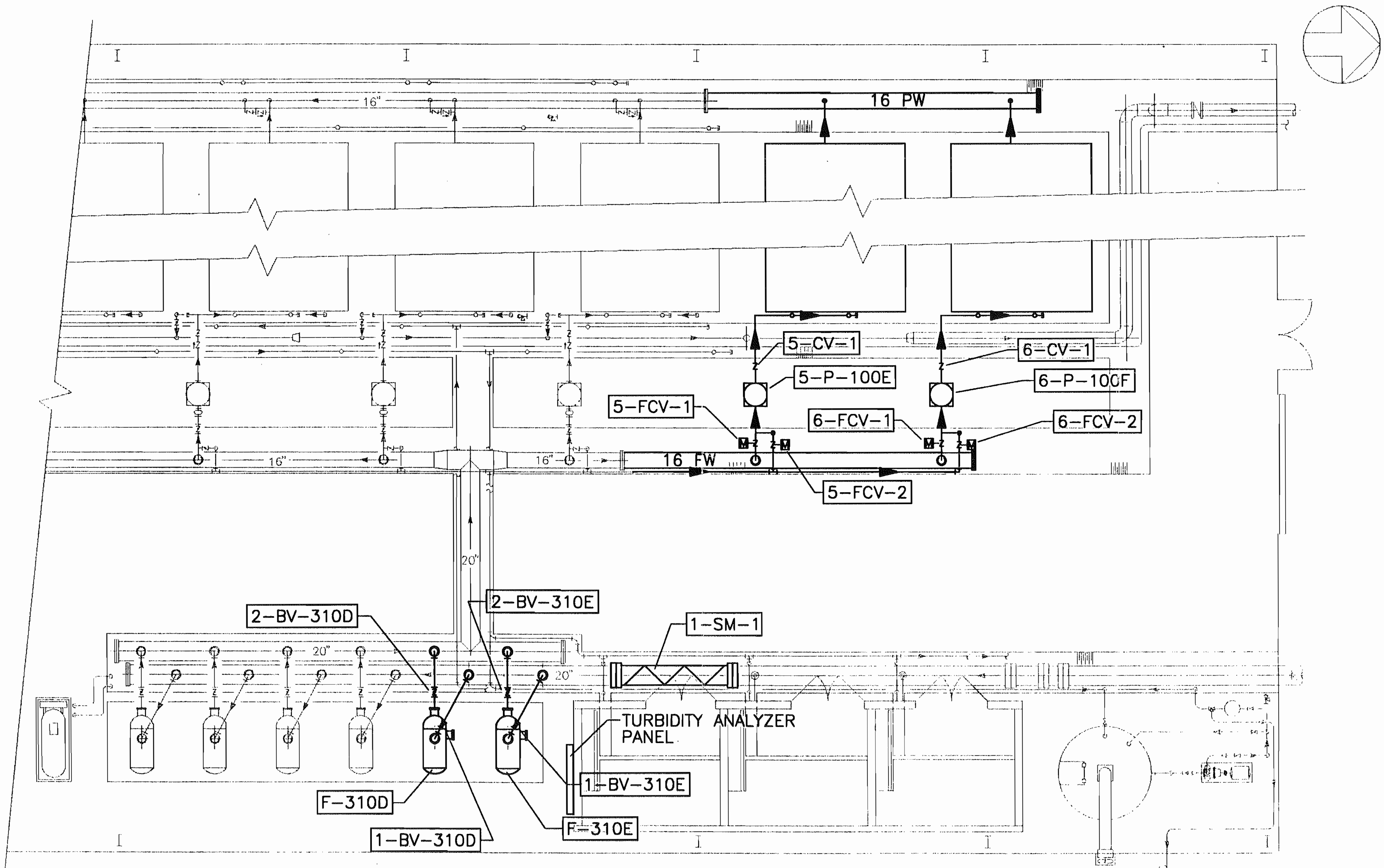
BOYLE ENGINEERING CORPORATION

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

SITE PLAN

BEC PROJECT NO. OR-S25-103-00

DRAWING P-1



PARTIAL PLAN
SCALE: 1/8"=1'-0"

BOYLE ENGINEERING CORPORATION

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

BEC PROJECT NO. OR-S25-103-00

R.O. PROCESS PLANT

DRAWING P-2

- Minimum residual pressure from the well pumps at the feed pump inlet will range between 20 to 40 psi.
- Provide head to force water through the membrane and sufficient pressure to convey the concentrate to the injection well.
- Downstream of the R.O. units, the product water will be introduced into the top of the existing product degasifiers. The existing degasifiers are approximately 17 feet high. In addition, friction loss due to piping and fittings is assumed to be 15 feet. The feed pumps will be sized so the feed pump selection will be sized to accommodate the permeate backpressure.
- An energy recovery system (ERS) may be used in the concentrate stream. If the ERS is implemented, it would take residual energy from the concentrate line and apply the energy to the feed line, either prior to the first stage or between the first and second stages. With this pressure boost, the feed pump will be able to operate at a lower total dynamic head (TDH). However, the feed pump will be sized to operate without ERS so that the plant is not dependent on the ERS. When the ERS is in operation, the variable speed feed pump will be able to reduce speed to lower pressure and reduce energy usage.

Based upon the raw water quality presented in TM P-1 and projected membrane selection in this TM, each feed pump will have the following characteristics:

Design Flow Rate:	1,068 gpm
Required Head without ERS:	422.5 psi
Horsepower	350 hp
Pump Type:	Multi-stage, vertical turbine
Materials of Construction:	316 SST
Suggested Manufacturer:	Afton, Johnston & Peerless

Membrane Units

The two membrane skids will provide a permeate production capacity of 1 mgd each and a combined additional capacity of 2 mgd for the facility. The raw water quality presented in TM No. P-1 was used as input data into three different computer programs for evaluating the membrane element selection and pressure vessel array. The objective of using the computer based analysis is to match the configuration of the existing four skids. The existing four skids are configured with 24 pressure vessels in the first stage and 12 pressure vessels in the second stage. Presently, the first stage pressure vessels are loaded with a combination of FilmTec seawater and brackish water membrane elements. The second stage has all brackish water membrane elements. Each pressure vessel is equipped with 6 membrane elements that are 40- inches long. However, if the water quality presented in TM No. P-1 deteriorates, the configuration of the skids would have to change to accommodate the change in water quality. Using the criteria stated above, three different membrane element manufacturers were evaluated. They included the following: FilmTec, Fluid Systems and Hydranautics. The basis of design for the selection of the membrane elements were as follows:

Membrane Selection Criteria:

Feedwater temperature:	25° C
Raw Water pH:	7.47
Acidified Feed Water pH:	5.95

Design Recovery:	65 %
Number of Stages:	2
Number of First-Stage Vessels:	24
Number of Second-Stage Vessels:	12
Diameter of Membrane Elements:	8 inches

The software program that was used to evaluate the FilmTec membrane element was the ROSA program. The FilmTec membrane element that was evaluated for this feedwater was a brackish water element with high salt rejection. The feedwater pressure of 344.9 psi was applied to the first-stage membranes, which resulted in a concentrate discharge pressure of 305.3 psi. Drawing P-3 presents a process schematic that includes a flow and mass balance across the plant.

The software program that was used to evaluate the fluid-system membrane elements was the ROPRO program. The fluid-system element that was evaluated for this feedwater was a brackish water element with high salt rejection and surface area. The feedwater pressure of 342.0 psi was applied to the first-stage membranes, which resulted in a concentrate discharge pressure of 305.3 psi. Drawing P-4 presents a process schematic that includes a flow and mass balance across the plant.

The software program that was used to evaluate the Hydranautics membrane elements was the RODES program. The Hydranautics membrane element that was evaluated for this feedwater was a brackish water element with high salt rejection and surface area. The feedwater pressure of 367.3 psi was applied to the first-stage membranes. An interstage pressure booster was used on this application and resulted in a concentrate discharge pressure of 472.2 psi. Drawing P-5 presents a process schematic that includes a flow and mass balance across the plant. The interstage pressure booster was evaluated only for the Hydranautics application to determine if the energy recovery system provides a cost savings to the overall operation of the plant.

Energy Recovery System

The R.O. process, by its nature, has a concentrate stream that is under a relatively high pressure. The recoverable energy is proportional to the concentrate flow rate (Qc), the pressure of the concentrate stream (Pc), and the efficiency of the energy recovery device (% eff.). This energy is normally recovered in the form of a turbine attached to either a booster pump in the membrane feed line or the concentrate pressure from first-stage feed. The energy recovered is used to boost the pressure in the feed water to the second-stage membranes. For this application, only the interstage pressure booster (between the first and second stage of each RO unit) will be evaluated. Because of this means of recovery, the recoverable energy is also proportional to the flow ratio (Qr) of the concentrate flow rate (Qc) and the feed flow rate (Qf). In the case of the proposed expansion, the flow ratio is 512.5 gpm/1068 gpm or 0.48. This ratio would be for each R.O. unit in service.

The pressure of the concentrate stream available for energy recovery will depend on the downstream conditions of the concentrate line. Only the potentially unused pressure is available for energy recovery. In the case of the existing disposal concentrate stream, the maximum discharge pressure allowed to be discharged into the injection well is 127 psi. The anticipated pressure of the concentrate stream with an ERS is 349.6 psig. The pressure available (Pa) for the energy recovery device is approximately 140.1 psig.

The amount of recoverable energy is equivalent to the resulting pressure boost to the feed stream (Pf). This is determined by the following:

Pf = (Pa) x (Qr) x (% eff.)

The application of the interstage pressure boost in the proposed R.O. plant would yield a pressure boost to the feed stream of:

Pf = (140.1 psig) x (0.48) x (% eff.) = 67 psig at 100% efficiency

Of the energy recovery devices evaluated, the highest efficiency was 78 percent for this operating point. This would then have a net feed line pressure boost of approximately 42 psig. The assumed pressure boost required from the feed pump, without an energy recovery device is approximately 410 psig. The pressure with an energy recovery device would be about 367 psig, or a reduction of 10 percent. The cost savings are directly proportional to the horsepower (HP) reduction of the feed pump motor. The horsepower required without energy recovery and with an assumed pump efficiency of 81 percent is approximately 325 HP. The horsepower required with energy recovery would be approximately 282, a reduction of 43 HP. Drawing P-6 shows the configuration of the interstage ERS. The data provided in Drawing P-6, which is presented for informational purposes only, was provided by Hydranautics (San Diego, CA) and Pump Engineering, Inc. (Monroe, MI). The electrical energy reduction would then be proportional to the HP-hours used:

kW-h = (1.341) x (HP-h) = 58 kW-h

Each of the energy recovery devices has a budgetary price estimate of $35,000. With an assumed kW-h value of $0.053 (ref. 1992 PSC Rate Case), the time to recover the cost based on 100% use of the equipment would be:

time = $35,000 / (58 kW-h) x (0.053 $/kW) = 11,386 hours or 1.3 years.

With an assumed kW-h value of ~~$6.05~~ 0.0605 SJD (ref. SSU Marco Island 1994 average Florida Power rate), the time to recover the cost based on 100% use of the equipment would be:

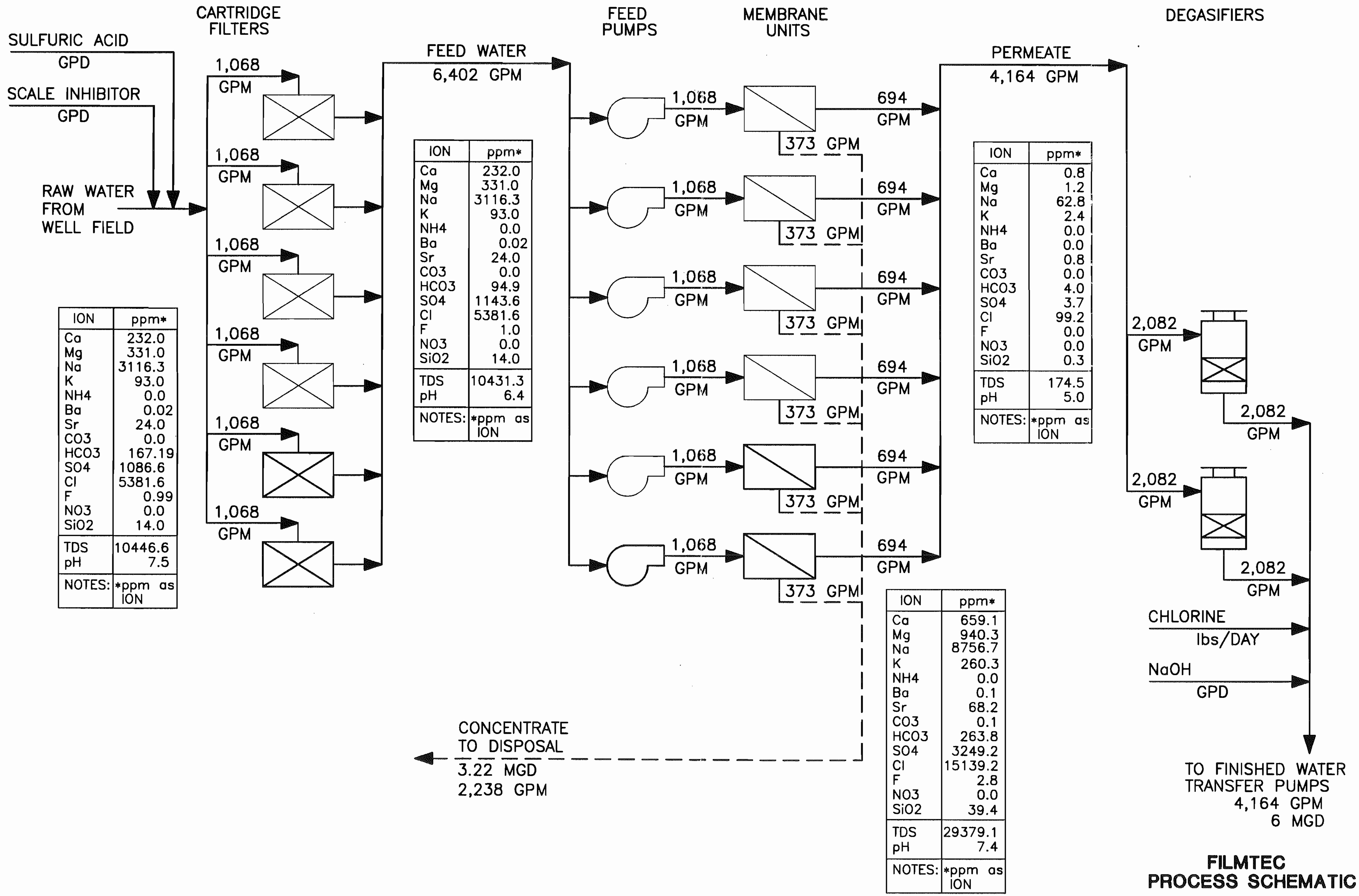
time = $35,000 / (58 kW-h) x (0.0605 $/kW) = 9,974 hours or 1.1 years.

Based on the cost of the energy recovery equipment and the calculated recovery time, it appears appropriate to include an ERS in the final design. Unfortunately, this type of system is relatively new and there are only a few in operation in Florida. A final recommendation will be made during final design after further development and discussions with existing ERS facilities and Southern States Utilities' staff.

Recommendations

The following are a list of recommendations as a result of this technical memorandum:

- Install two vertical turbine feed pumps with variable frequency drives.
- Revise membrane system projections when new wells are developed.
- Evaluate all final membrane projections using an energy recovery system.
- Provide two skids with a two-stage array of 24:12.



Raw water:

ION	ppm*
Ca	232.0
Mg	331.0
Na	3116.3
K	93.0
NH4	0.0
Ba	0.02
Sr	24.0
CO3	0.0
HCO3	167.19
SO4	1086.6
Cl	5381.6
F	0.99
NO3	0.0
SiO2	14.0
TDS	10446.6
pH	7.5
NOTES:	*ppm as ION

Feed water:

ION	ppm*
Ca	232.0
Mg	331.0
Na	3116.3
K	93.0
NH4	0.0
Ba	0.02
Sr	24.0
CO3	0.0
HCO3	94.9
SO4	1143.6
Cl	5381.6
F	1.0
NO3	0.0
SiO2	14.0
TDS	10431.3
pH	6.4
NOTES:	*ppm as ION

Permeate:

ION	ppm*
Ca	0.8
Mg	1.2
Na	62.8
K	2.4
NH4	0.0
Ba	0.0
Sr	0.8
CO3	0.0
HCO3	4.0
SO4	3.7
Cl	99.2
F	0.0
NO3	0.0
SiO2	0.3
TDS	174.5
pH	5.0
NOTES:	*ppm as ION

Concentrate:

ION	ppm*
Ca	659.1
Mg	940.3
Na	8756.7
K	260.3
NH4	0.0
Ba	0.1
Sr	68.2
CO3	0.1
HCO3	263.8
SO4	3249.2
Cl	15139.2
F	2.8
NO3	0.0
SiO2	39.4
TDS	29379.1
pH	7.4
NOTES:	*ppm as ION

FILMTEC PROCESS SCHEMATIC

BOYLE

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

BEC PROJECT NO. OR-S25-103-00

DRAWING P-3

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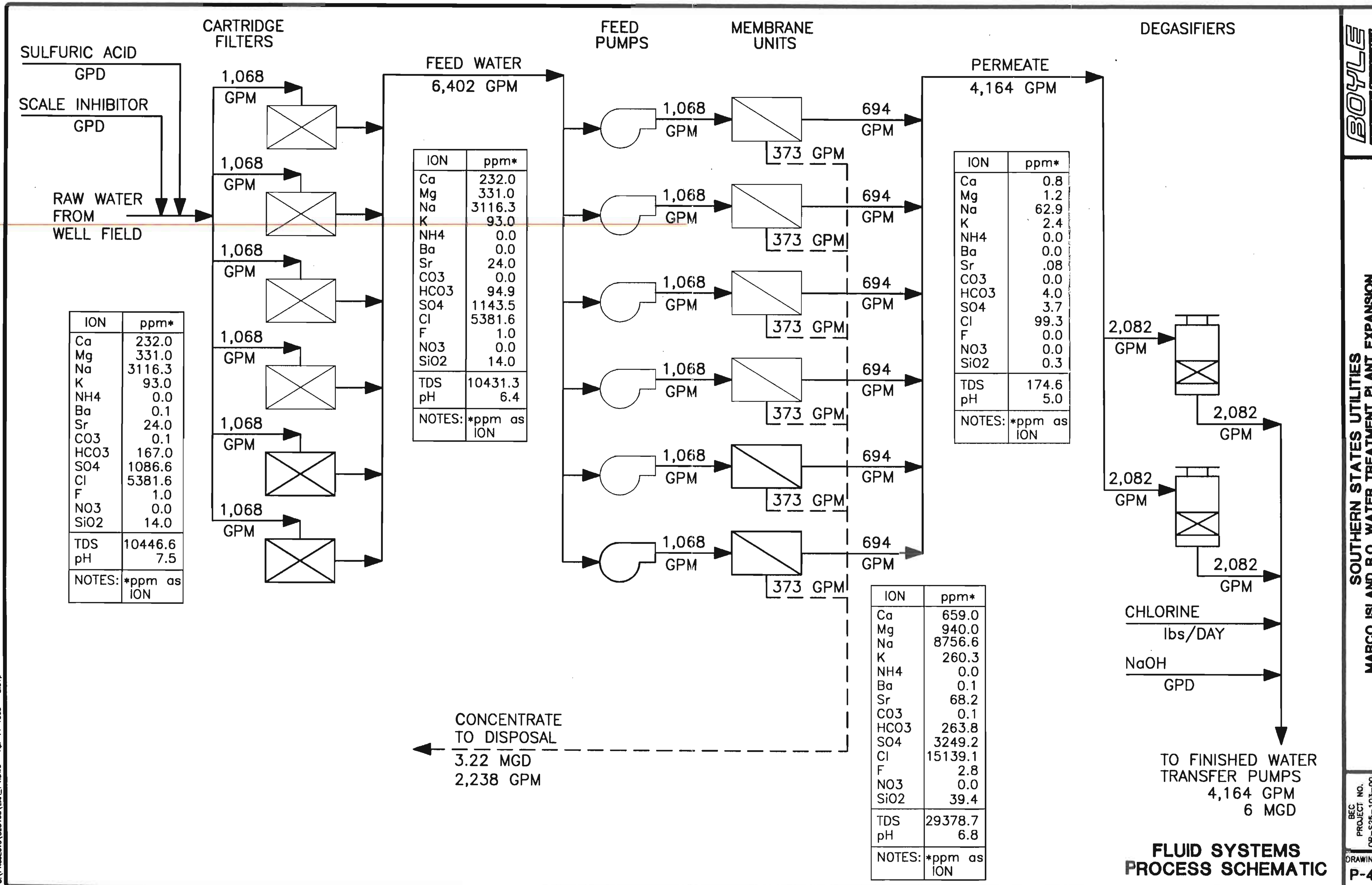


Raw water from well field:

ION	ppm*
Ca	232.0
Mg	331.0
Na	3116.3
K	93.0
NH4	0.0
Ba	0.1
Sr	24.0
CO3	0.1
HCO3	167.0
SO4	1086.6
Cl	5381.6
F	1.0
NO3	0.0
SiO2	14.0
TDS	10446.6
pH	7.5
NOTES:	*ppm as ION

Feed water:

ION	ppm*
Ca	232.0
Mg	331.0
Na	3116.3
K	93.0
NH4	0.0
Ba	0.0
Sr	24.0
CO3	0.0
HCO3	94.9
SO4	1143.5
Cl	5381.6
F	1.0
NO3	0.0
SiO2	14.0
TDS	10431.3
pH	6.4
NOTES:	*ppm as ION

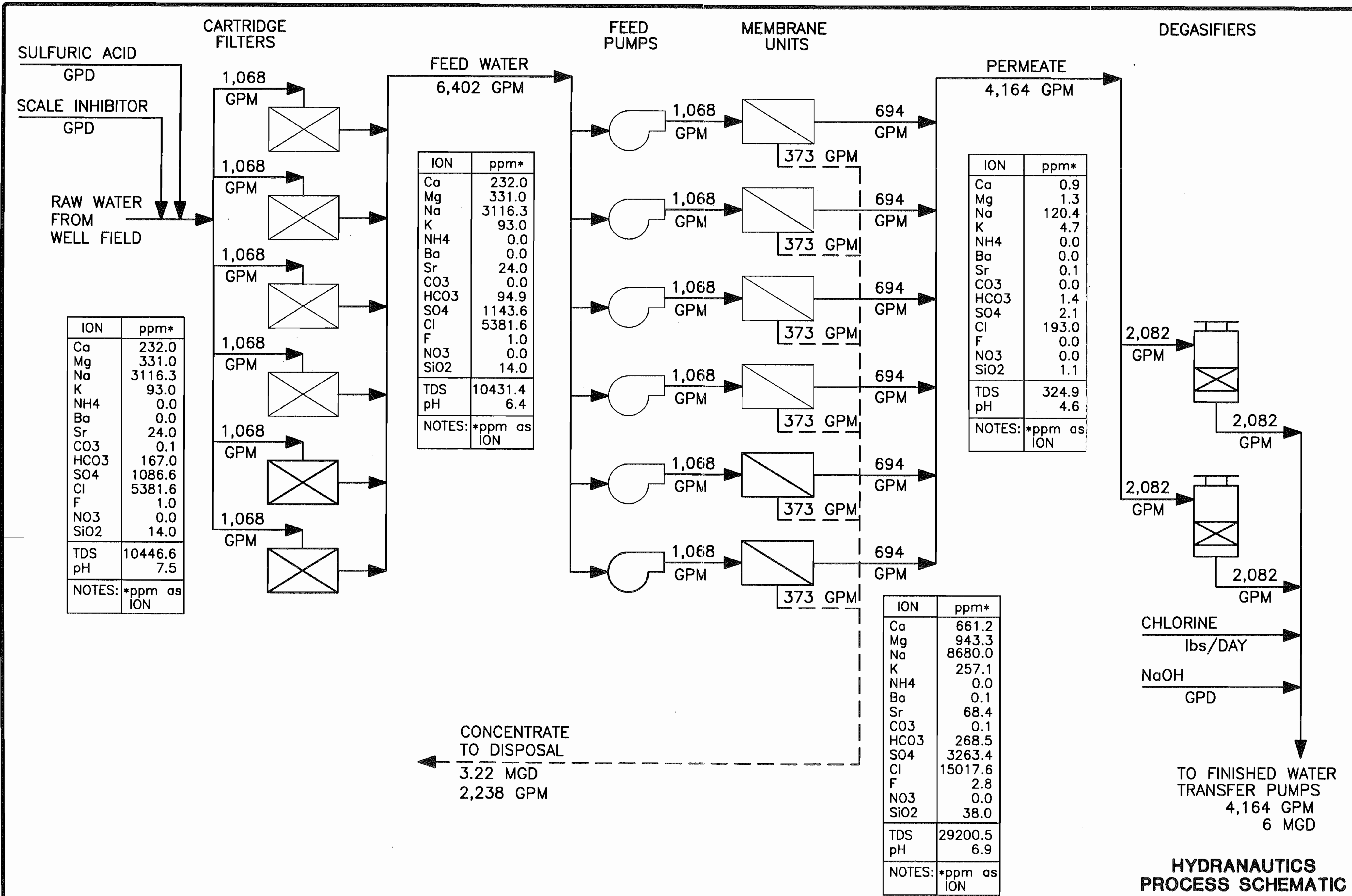
Permeate:

ION	ppm*
Ca	0.8
Mg	1.2
Na	62.9
K	2.4
NH4	0.0
Ba	0.0
Sr	.08
CO3	0.0
HCO3	4.0
SO4	3.7
Cl	99.3
F	0.0
NO3	0.0
SiO2	0.3
TDS	174.6
pH	5.0
NOTES:	*ppm as ION

Concentrate:

ION	ppm*
Ca	659.0
Mg	940.0
Na	8756.6
K	260.3
NH4	0.0
Ba	0.1
Sr	68.2
CO3	0.1
HCO3	263.8
SO4	3249.2
Cl	15139.1
F	2.8
NO3	0.0
SiO2	39.4
TDS	29378.7
pH	6.8
NOTES:	*ppm as ION

FLUID SYSTEMS PROCESS SCHEMATIC



Raw water:

ION	ppm*
Ca	232.0
Mg	331.0
Na	3116.3
K	93.0
NH4	0.0
Ba	0.0
Sr	24.0
CO3	0.1
HCO3	167.0
SO4	1086.6
Cl	5381.6
F	1.0
NO3	0.0
SiO2	14.0
TDS	10446.6
pH	7.5
NOTES:	*ppm as ION

Feed water:

ION	ppm*
Ca	232.0
Mg	331.0
Na	3116.3
K	93.0
NH4	0.0
Ba	0.0
Sr	24.0
CO3	0.0
HCO3	94.9
SO4	1143.6
Cl	5381.6
F	1.0
NO3	0.0
SiO2	14.0
TDS	10431.4
pH	6.4
NOTES:	*ppm as ION

Permeate:

ION	ppm*
Ca	0.9
Mg	1.3
Na	120.4
K	4.7
NH4	0.0
Ba	0.0
Sr	0.1
CO3	0.0
HCO3	1.4
SO4	2.1
Cl	193.0
F	0.0
NO3	0.0
SiO2	1.1
TDS	324.9
pH	4.6
NOTES:	*ppm as ION

Concentrate:

ION	ppm*
Ca	661.2
Mg	943.3
Na	8680.0
K	257.1
NH4	0.0
Ba	0.1
Sr	68.4
CO3	0.1
HCO3	268.5
SO4	3263.4
Cl	15017.6
F	2.8
NO3	0.0
SiO2	38.0
TDS	29200.5
pH	6.9
NOTES:	*ppm as ION

HYDRANAUTICS PROCESS SCHEMATIC

BOYLE ENGINEERING CORPORATION

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

BEC PROJECT NO. OR-S25-103-00

DRAWING P-5

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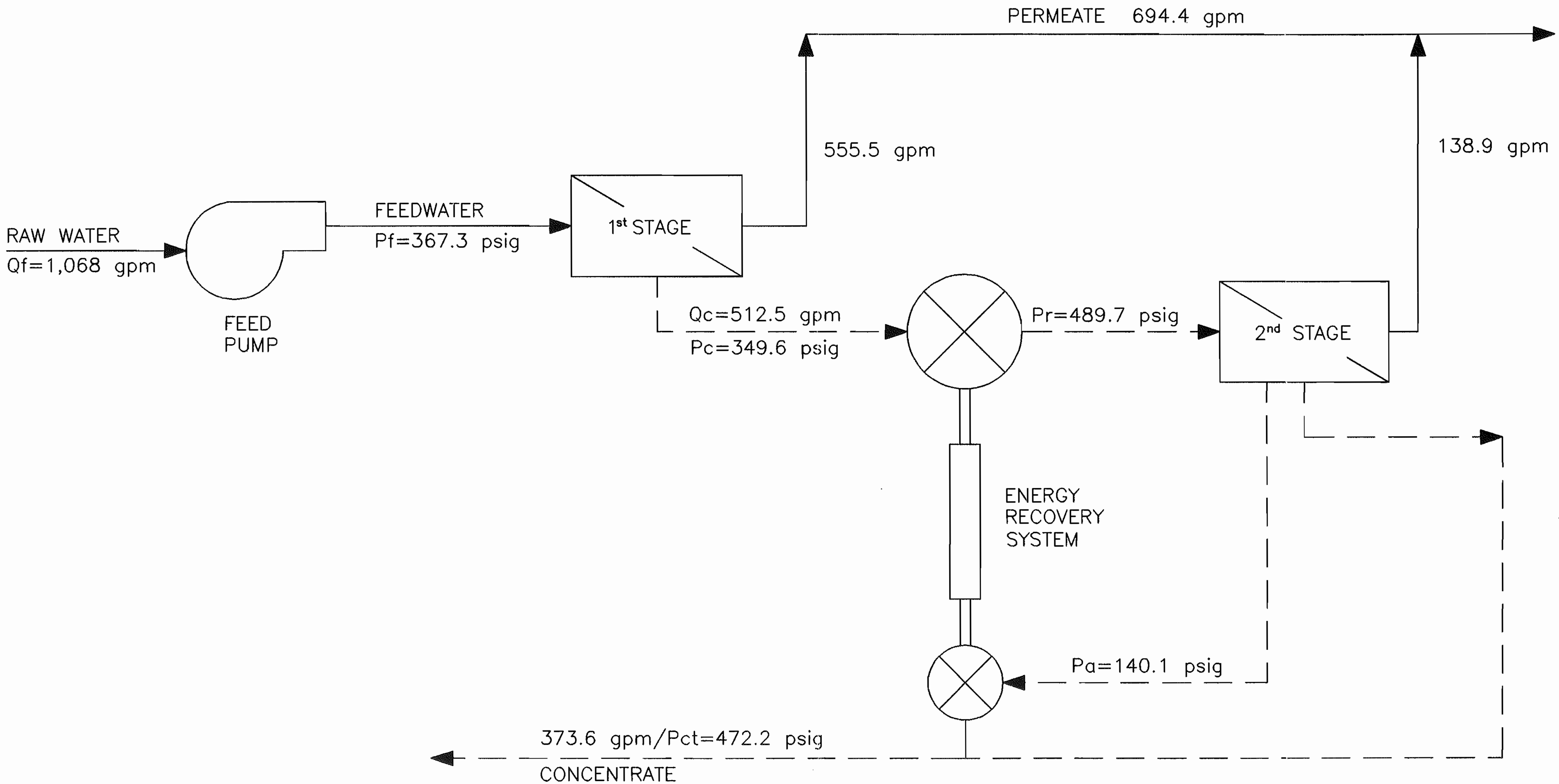

INTERSTAGE ENERGY RECOVERY SYSTEM

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

BOYLE ENGINEERING CORPORATION

BEC PROJECT NO. OR-S25-103-00

DRAWING P-6

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TECHNICAL MEMORANDUM No. P-4

Subject: Post Treatment

Purpose and Scope

Technical Memorandum (TM) No. P-4 has been prepared to evaluate the existing degasifier systems for removing hydrogen sulfide and carbon dioxide from the permeate at the expansion capacity of 6.0 mgd.

Presently, the existing four R.O. skids are producing a permeate water with a pH of 5.9. The projected pH of the permeate water produced by the two new skids will range between 5.0 and 5.5. The blended permeate stream from the existing and new skids will have a pH range of 5.6 to 5.8. This is considered to be an acceptable pH before the degasification process. It is estimated that approximately 99 percent of the total sulfides in the permeate will be removed as hydrogen sulfide gas during degassing at a feed pH of 5.8.

Design Criteria

Degasifier

The existing degasifiers are located on top of the clearwell at the transfer pump station. The permeate enters the top of the degasifiers and flows down by gravity through approximately 12 feet of randomly packed media. The existing centrifugal blowers are used to blow air up through the degasifiers, countercurrent to the flow of permeate.

The following design parameters are for the existing degasifiers in service:

Expanded Design Flow:	**6 mgd**
Number of Existing Degasifiers:	2
Air Flow per Degasifier:	3,500 cfm
Depth of Packed Media:	12 feet
Diameter of Degasifier:	12 feet
Loading Rate:	18.4 gpm/sf
Air to Water Ratio:	12.4

Recommendation/Conclusion

The following list of recommendations are from this technical memorandum.

- The hydraulic loading of the degasifier at the expanded 6 mgd is within design limits for randomly packed media.

- Increase the air to water ratio of the system by increasing the size of the centrifugal blower motor or change the sheave setting on the blower drive.
- Monitor differential pressure across the packed media for fouling.
- Monitor the hydrogen sulfide emitted from the degasifier towers.

TECHNICAL MEMORANDUM No. P-5

Subject: Odor Control System

Purpose and Scope

Technical Memorandum (TM) No. P-5 has been prepared to evaluate the existing odor control system capacity for removing the hydrogen sulfide (H_2S) and carbon dioxide (CO_2) from the degasifier air stream. Presently, H_2S and CO_2 gases are controlled by a chemical absorption process using solutions of sodium hydroxide (NaOH). The system is also equipped for feeding chlorine solution for further reduction of the H_2S gas, however, the chlorine system is not in operation.

Presently, the existing R.O. skids are producing a permeate water with a pH range of 5.6 to 5.9. The projected pH of the permeate water produced by the two new skids will range between 5.0 to 5.5. The blended permeate stream of the existing and new R.O. skids will range between 5.6 to 5.8.

Design Criteria

The existing odor control system was designed based on handling the gaseous odor created by producing 6 mgd of permeate water as the maximum plant capacity. The hydrogen sulfide concentration, reported in the manuals prepared by Elkins Construction for the feedwater from existing wells, is 3 mg/l, while the acidified feed carbon dioxide concentration has been reported at 61 mg/l.

The existing system uses a one-stage process. The offgas from the degasifiers is forced upward through the scrubbing tower. The hydrogen sulfide laden offgas travels upward through the tower, while a solution of sodium hydroxide is sprayed from the top of the tower. The counter-current liquid scrubbing transfers the hydrogen sulfide from the air to a waste solution. The large dosage of sodium hydroxide increases the pH of the scrubbing solution above 10.6 which promotes the disassociation of H_2S to HS^- and $S^=$. A portion of the recycled scrubbing solution is continually wasted or removed to prevent excessive sulfide build up. As a result, makeup streams of sodium hydroxide must be continually delivered to the packed-tower system.

The service conditions of the existing Odor-Control System are as follows:

Ambient Air Temperature:	30-100° F
Relative Humidity:	up to 100%
Number of Towers:	1
Unit Degasifier Flow Rate, mgd:	3
Flow Rate to Tower, mgd	6
Design Water H_2S Concentration (as sulfide ion) to degasifier:	68.8 ppmv

Air Flow Rate:	14,000
Maximum H_2S Outlet Concentration:	1.43 ppmv
Purge Rate (gpm)	11

Recommendations/Conclusions

The odor-control system presently in operation has been sized to remove hydrogen sulfide and carbon dioxide from the permeate stream at the 6 mgd expansion capacity.

The following list of recommendations are a result of this technical memorandum:

- Monitor the H_2S emissions from the odor control.
- Evaluate the need of adding chlorine solution to the recirculation line to obtain additional oxidation of the H_2S prior to emission to the atmosphere.

TECHNICAL MEMORANDUM No. P-6

Subject: Transfer Pump (Post-Treatment)

Purpose and Scope

Technical Memorandum (TM) No. P-6 addresses changing the existing constant speed pumps to operate as a variable frequency drive (VFD) system. The existing transfer pumps lift the permeate water from the clearwell sump to the three ground storage tanks located on the site. The vertical turbine pumps are supported from the slab that covers the clearwell sump. The pumps are manually operated from the control console located in the operation building. In addition to the manual control by the operator, the pumping capacity is automatically regulated by a modulating valve downstream of the pumps prior to the ground storage tank. The modulating valve is actuated by the rising and falling level inside the clearwell sump. The purpose of adding the VFD is to maintain the modulating valve in the open position to reduce head loss and power cost. The transfer pumps also are equipped with an independent level switch to automatically shut down the pumps when the water level reaches the low level set point in the clearwell sump.

Design Criteria

The three constant-speed transfer pumps will be converted to VFD units. The conversion to a variable frequency drive unit on one of the pumps will allow the modulating valve to remain in the 100 % open position under normal operating conditions. The rule of thumb for variable-speed pumping is that the variable-speed pumping capacity be a minimum of 1.5 times the constant-speed capacity. This would require a minimum of two pumps being converted to variable speed. If only two pumps are converted, then the constant-speed pump would be used only as a standby pump. The standby pump would have to be manually exercised and would not see much service. It is recommended that all three pumps be converted to variable speed allowing the pumps to be alternated into the pumping cycle. The control of the transfer pump station will be further investigated in TM No. I-1.

The existing design parameters for the transfer pumps are as follows:

Pump Numbers:	P-323A, P-323B, P-323C
Type:	Vertical Turbine
Materials of Construction	316 SST
Design Flow Per Pump:	2,291 gpm
Design Head:	46.2 ft.
Motor horsepower:	40

Recommendations

The following list of recommendations are a result of this technical memorandum.

- Install three variable-frequency drives (VFD) per TM No. E-1.
- Install controls to operate the transfer pump station with variable speed pumps per TM No. I-1

TECHNICAL MEMORANDUM No. P-7

Subject: Concentrate Pumping Station

Purpose and Scope

Technical Memorandum (TM) No. P-7 has been prepared to evaluate the existing concentrate pumping station. In addition, it addresses the requirements of adding a third concentrate pump with a variable frequency drive. The concentrate pumps are used to transfer odor control, scubber blowdown and water from the cleaning and flushing system to the concentrate injection well. The existing concentrate wet well contains two constant speed, vertical turbine pumps.

Design Criteria

At the current plant capacity of 4.0 mgd, the odor control blowdown is approximately 11 gpm. Increasing the plant capacity to 6 mgd and maintaining a recovery of 65 percent would increase the odor control blowdown waste flow to 16.5 gpm. At that flow rate, the wet well would fill up to the working level in approximately 4.5 hours. However, this wet well is also used for membrane flushing and cleaning pumps, which could pump approximately 280 to 780 gpm to the wet well. At that rate, the wet well would fill up in approximately 6 minutes, when the wet well started at its lowest operating level. The addition of a variable frequency drive unit on a concentrate wet well pump will allow the wet well to operate at essentially a constant liquid level. Drawing P-7 presents an overall layout of the concentrate pumping station with the addition of the third concentrate pump.

The rule of thumb for variable-speed pumping is that the variable-speed pumping capacity be a minimum of 1.5 times the constant-speed capacity. This would require a minimum of two pumps being converted to variable speed. If only two pumps are converted, then the constant-speed pump would be used only as a standby pump. The standby pump would have to be manually exercised and would not see much service. It is recommended that all three pumps be converted to variable speed allowing the pumps to be alternated into the pumping cycle.

The wet well characteristics are as follows:

Length, ft.	20
Width, ft.	12
Depth, ft.	9
HWL, ft. (measured from floor)	3
LWL, ft. (measured from floor)	0.5
Working Volume, gal	4,488

The pump characteristics are as follows:

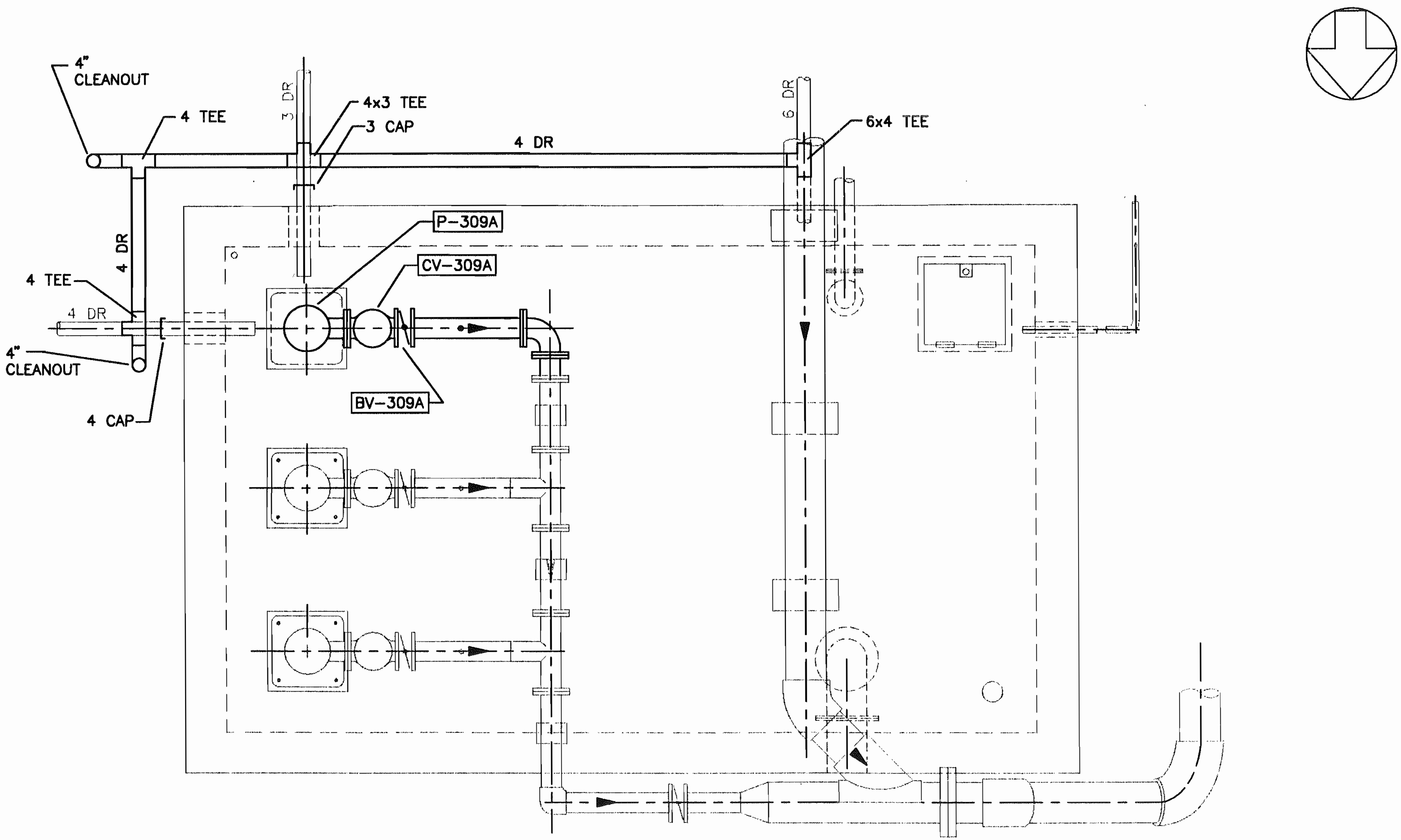
Pump Numbers:	P-309B, P-309C
Manufacturer/Model:	Afton Pumps, Inc. GSV 4X10PXC
Type:	Vertical Centrifugal
Construction Materials:	316 SS
Design Flow per Pump:	240 gpm
Design Head:	280 ft.
Motor Horsepower:	30
Motor Speed:	1800 rpm

There are two drain lines that enter the wetwell at a location near the new pump. One is a 3-inch drain from the acid neutralization tank and the other is a 4-inch drain from the workshop. There is a possibility that water falling from these pipes could entrain air that would enter the pump and affect its operation. In order to prevent this possibility, the pipes will be intercepted by a 4-inch PVC pipe outside the wetwell and be rerouted to connect to the 6-inch trench drain line. The pipe to the wetwell that remains will be capped. Intercepting the flow outside the well prevents the need of anyone having to enter the wetwell to reroute the piping, allowing the pump station to stay on line.

Recommendations

The following list of recommendations are a result of this technical memorandum.

- Install one vertical turbine wet well pump with a variable frequency drive (VFD) per TM No. E-1.
- Install controls to operate the concentrate wet well pumping station with variable-frequency speed pumps per TM No. I-1.
- Reroute the 3-inch and 4-inch drain lines away from the pump.



PLAN
SCALE: 3/8" = 1'-0"

BOYLE ENGINEERING CORPORATION

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

CONCENTRATE WET WELL

BEC PROJECT NO. OR-S25-103-00

DRAWING P-7

TECHNICAL MEMORANDUM No. P-8

Subject: Process Chemical Systems

Purpose and Scope

Technical Memorandum (TM) No. P-8 has been prepared to evaluate the existing chemical feed systems throughout the R.O. treatment process. The purpose of each chemical will be presented herein. The chemicals that are presently used throughout the plant processes are shown in the following table.

Process	Chemical
Pretreatment	Sulfuric Acid, Anti-Scalant
Post Treatment	Sodium Hydroxide
Odor Control	Sodium Hydroxide

Design Criteria

The addition of an in-line static mixer downstream of the sulfuric acid and anti-scalant injection point will provide a more uniform mixing and dispersion of the chemicals in the feedwater to the membrane skids. All buried sulfuric, anti-scalant and sodium hydroxide chemical piping is regulated under FDEP Section 62-761.630, *Release Detection Standards for Integral Piping.*

Pretreatment

Sulfuric Acid

The sulfuric acid (66° Baume' 93 percent) is presently used for pH adjustment to condition the feed-water in order to reduce the potential for calcium carbonate ($CaCO_3$) scaling of the membranes. The acid is added upstream of the cartridge filters.

A. Storage

The existing lined steel horizontal tank is provided to store bulk quantities of sulfuric acid at 93 percent concentration. The storage tank is sized to provide approximately 15 days storage at the expanded capacity of 6 mgd. The tank is equipped with a desiccator on the vent to reduce the amount of moisture entering the tank during emptying.

The concentrated acid is transferred from the bulk storage tank to the day tank by gravity flow.

The low density, polyethylene vertical day tank is sized to provide approximately one day's storage at the expanded capacity of 6 mgd.

B. Feed System

The existing metering pumps for pH adjustment have variable speed and stroke capabilities. The body is constructed of cast iron, with Teflon diaphragms. There is one chemical metering pump which feeds chemical to the six R.O. units and the output is adjustable for the number of units operating. There is one additional pump that serves as a backup for the system.

Scale Inhibitor

The scale inhibitor is injected into the raw water prior to the cartridge filters and this provides mixing before the feed water contacts the R.O. elements. The addition of a scale inhibitor is to protect the membranes by interfacing with the precipitation process of the sulfates of calcium, barium, and strontium.

A. Storage

The existing storage facilities consist of 55 gallon drums stored in the process room.

The scale inhibitor is pumped from the drums to the day tank using a drum pump.

The existing vertical day tank is constructed of low-density polyethylene. The day tank is sized to provide approximately 12 days storage at the expanded capacity of 6 mgd.

B. Feed System

The metering pumps for injection of scale inhibitor have variable stroke capabilities. The body is constructed of cast iron, with a Teflon diaphragm. There is one chemical metering pump to cover the range of flows required by up to six operating R.O. units, each producing 1 mgd of permeate. There is one additional pump that serves as a backup for the system.

pH Control

Sodium Hydroxide

A. Storage

The existing horizontal tank is stores bulk quantities of sodium hydroxide at a 50 percent concentration. The storage tank is sized to provide approximately 29 days storage for both the pH adjustment and odor control system at the expanded capacity of 6 mgd.

The concentrated caustic is transferred from the bulk storage tank to the day tank by gravity flow.

The caustic is diluted to a 25 percent concentration in the day tanks using potable water and mixing devices to create a consistent solution. The vertical day tanks are constructed of low-density polyethylene. The tanks are sized to provide approximately 3.4 days of storage for both the pH adjustment and odor control system at the expanded capacity of 6 mgd.

B. Feeding System

The existing metering pumps for the injection sodium hydroxide have variable speed and stroke capabilities. The one chemical metering pump to cover the range of flows required by up to six operating R.O. units, each producing 1 mgd of permeate. There is one additional pump that serves as a back-up for the systems.

Odor Control System

Sodium Hydroxide

Sodium hydroxide is injected into the scrubber vessel to maintain a constant chemical solution pH of 11.5. By maintaining this pH, the system removes approximately 85 percent of the hydrogen sulfide (H_2S) from the influent air stream.

The following tables present the existing equipment and tank size for the four chemical feed systems (Sulfuric Acid, Scale Inhibitor and Sodium Hydroxide - pH adjustment, Odor Control).

Pretreatment - Raw Water

A. Sulfuric Acid

Dosage Rate (December 1994):	103.5 mg/l
Existing Equipment	
Number of Metering Pumps:	1 + 1
Flow range per pump	0 - 25.05 gph
Bulk Storage Capacity	10,000 gallons
Day Storage Capacity	552 gallons
Projected Chemical Requirements for Expansion to 6.0 mgd	
Dosage rate per metering pump:	21.75 gph
Number of days storage in bulk tank:	15 days
Number of hours storage in day tank:	63 hours

B. Scale Inhibitor

Dosage Rate (December 1994):	4.07 mg/l
Existing Equipment	
Number of Metering Pumps:	1 + 1
Flow range per pump	0 - 2.23 gph
Day Storage Capacity	350 gallons
Projected Chemical Requirements for Expansion to 6.0 mgd	
Dosage rate per metering pump:	1.21 gph
Number of days storage in day tank:	12.0 days

pH Adjustment

C. Sodium Hydroxide

Dosage Rate (December 1994):	11.42 mg/l
Existing Equipment	
Number of Metering Pumps:	2
Flow range per pump	0 - 19.18 gph
Projected Chemical Requirements for Expansion to 6.0 mgd	
Dosage rate per metering pump:	2.23 gph

Odor Control

A. Sodium Hydroxide

Dosage Rate (December 1994):	21.02 mg/l
Existing Equipment	
Number of Metering Pumps:	4
Flow range per pump	0 - 19.18 gph
Bulk Storage Capacity	5,000 gallons
Day Storage Capacity	700 gallons
Chemical Requirements of Expansion at 6.0 MGD	
Dosage rate per metering pump:	6.3 gph
Number of days storage in bulk tank:	25
Number of days storage in day tank:	3.4
Number of days storage in bulk tank: (1)	39 days
Number of days storage in day tank: (1)	3.4 days

Note: (1) The sodium hydroxide day and bulk storage tanks are used to supply both the sodium hydroxide for pH adjustment and Odor Control System.

Recommendations

The following list of recommendations are a result of the this technical memorandum.

- Install an in-line static mixer upstream of the cartridge filters.
- Provide split dual containment piping for all buried chemical feed pipelines.
- When the new wells' water quality is analyzed, review capacity of the sulfuric acid and scale inhibitor systems.

TECHNICAL MEMORANDUM No. P-9

Subject: Chlorine System

Purpose and Scope

Technical Memorandum (TM) No. P-9 has been prepared to evaluate the existing chlorination system for disinfection of the R.O. permeate and oxidation of the hydrogen sulfide in the odor control system.

Design Criteria

A. Feed System

Presently, the system has two chlorinators , a 200 and a 2,000 ppd unit, feeding chlorine gas to the system. The gas is injected into a potable water stream, making the chlorine solution. The solution is injected into the permeate between the clearwell and ground storage tank and prior to being pumped to distribution. In addition, the chlorine solution feed was intended to be used for the Odor Control System, however, the system has not required the use of chlorine to further reduce the hydrogen sulfide concentration emitted to the atmosphere.

The chlorine solution is split by four 50 ppd rotameters for feeding the solution at two disinfection locations; prior to the GST and prior to the distribution system.

The system has sufficient chlorination capacity for disinfection at 2,200 ppd feeding capabilities, however, at the expansion capacity of 6 mgd, the disinfection of the permeate would require approximately 252 ppd for disinfection. At that dosage rate, the demand ppd would exceed the 200 ppd feed capacity of one chlorinator and would be at the low range of the 2,000 ppd unit. Both of these scenarios would cause difficulties in controlling and maintaining a constant chlorine dosage rate.

B. Chlorine Scales/Storage

The existing chlorination storage facility has been designed for one-ton chlorine containers receiving, unloading, storing and chemical feeding. The chlorine storage area has six spaces for chlorine to be weighed on container scales. The six containers on scales provides approximately 12,000 pounds of chlorine available for service. The expansion to 6 mgd maximum capacity will require approximately 252 ppd for disinfection of the product water. At that dosage rate, that would provide approximately 47 days of storage.

Recommendations

The following recommendation is the a result of this technical memorandum.

- Replace the 200 ppd injector and throat with a 500 ppd unit to meet the additional chlorination requirements for the potable water supply.
- Evaluate the use of two 50 ppd rotameter units to handle chemical flows.

TECHNICAL MEMORANDUM No. P-10

Subject: Membrane Cleaning/Flushing System

Purpose and Scope

Technical Memorandum (TM) No. P-10 has been prepared to evaluate the existing membrane cleaning system.

Through the life of the membrane system, membrane cleaning will be required. The frequency of cleaning will be determined by the rate at which the membranes are fouled. The type of cleaning agent may be determined by the membrane manufacturer after the plant is in operation and the interaction between the membranes and feed water can be better evaluated. The cleaning agents used today range from acids for mineral scale removal to alkali detergents and biocides for removal of organic and biological fouling.

Membrane flushing of the membrane train with permeate water is the normal procedure every time a train is taken off line after service. The flushing of the first-stage elements will require approximately 5 to 10 gpm, at a pressure sufficient to deliver the flushed concentrate to the concentrate clearwell.

Design Criteria

The existing membrane cleaning system has been designed to clean either one-half of the first-stage or the entire second-stage pressure vessels at one time. The train is configured as a 24:12 array; with that array, the system is designed to clean 18 pressure vessels at one time. The minimum required cleaning flow per pressure vessel is 40 to 45 gpm, per the membrane manufacturer. The membrane cleaning pump will require approximately 810 gpm to satisfy the manufacturer's recommendations. The minimum cleaning tank size to clean 18 pressure vessels and piping would require the tank volume to be approximately 2,000 gallons. The horizontal cartridge filter is designed to filter the cleaning solutions that is pumped through the pressure vessels.

The service conditions for the existing membrane cleaning system are as follows:

Membrane Cleaning Pump

- Design Operating Flow (gpm): 780
- Design Discharge Head (ft.): 115.0

Cleaning Tank

- Design Capacity (gallons): 2,000

Cartridge Filter

- Design Operating Flow/10" Filter Element (gpm): 5.0
- Filter Particles (micron): 3

The existing membrane flushing system has been designed to flush one membrane skid. The flushing pumps are located on the slab of the degasifier clearwell. The flushing pump feeds the degasifier permeate water to each of the membrane trains through a common header pipe. The service conditions for the existing membrane flushing system are as follows:

Membrane Flushing Pumps

- Design Operating Flow (gpm): 286
- Design Discharge Head (ft.): 182

Recommendations

The following are a list of recommendations that are a result of this technical memorandum.

- Relocate pressure gauge downstream of cartridge filter.
- Equip pressure gauges with diaphragm seals for protection and accuracy of the gauge.
- Analyze the permeate water in the degasifier clearwell for bacteria and for elevated dissolved oxygen concentrations.
- Field verify the operating pressure and resulting capacity of both the membrane cleaning and flushing pumps.
- Enhancements to the cleaning piping system should be performed to facilitate the cleaning process.

TECHNICAL MEMORANDUM No. P-11

Subject: Blending Surface Water and Brackish Ground Water for RO Feed Supply

Purpose and Scope

At the request of SSU, Technical Memorandum (TM) No. P-11 addresses issues related to the blending of surface water supply source (local quarry water in proximity to the Marco Island RO plant) with brackish ground water sources for potential use as a feed water for the RO plant. This TM represents a preliminary review of general issues related to use of surface water feed for membrane processes, and has been prepared as a review exercise only. This TM has not been prepared to present any design related information and is assumed to not be a viable alternative for the design of the expansion of the RO plant. It is inherently assumed in this preliminary design procedure that the expansion of the Marco Island RO plant that groundwater sources (existing and under development) available on the island will be used for feedwater.

Because the potential use of surface water as a feed source is a viable altermative for SSU and would have an impact on future process considerations, this TM has been prepared for informational purposes only. In addition, TM No. P-11 will present those items needing further study and consideration to characterize the necessary baseline of information required for use of a fresh water and brackish water blend prior to RO treatment.

Background Topic Perspective

Reverse osmosis treatment of surface water has in the past been historically limited to conversion of open seawater to potable water in areas where freshwater was not available. In more recent times, use of microfiltration, ultrafiltration and nanofiltration membrane processes has advanced the use of surface water treatment with membrane technology. However, there are a number of technical concerns associated with the use of a surface water as RO feed supply water by itself or as a blend with brackish ground water.

A major problem would occur if there was irreversible fouling of the membrane elements. Irreversible physico-chemical and microbial fouling of the membranes elements at the RO plant would result in a reduction of the membrane efficiency. Fouling is defined as the build-up of non-cleaning or insoluble materials on the surface of the membrane which restrict and reduce flow through the membrane. Because equilibrium chemistry will differ widely from one supply source to another, the changes inherent to variability of surface supply water quality may impact the operation of the existing RO plant. In coastal areas, sodium and chloride is typically more predominant and hence would have more importance on the water chemistry than calcium and carbonate (Watson and Missimer, 1994). However the use of surface water and groundwater as sources of supply will change the equilibrium chemistry of the feedwater and impact chemical additions during process operation.

Surface Water Quality Impacts

The various natural characteristics of a surface water supply and surrounding watershed can have a significant effect on water quality. The watershed can impact the water supply physically, chemically and microbiologically. The stratification of a surface water impoundment and reservoir can also have significant impacts on water quality, particularly dissolved oxygen and temperature.

Membrane processes are sensitive to water quality changes (Duranceau, 1993). Knowledge of the long-term changes in water quality (seasonal variation) and the potential for short-term events (algae bloom) is essential for determining additional pretreatment requirements necessary to reduce fouling potential and maintain water production (permeate flux) at the RO plant should a surface water supply be available.

Additional pretreatment of the Marco surface water source would be necessary to protect the RO membrane elements if a surface source or blended surface/groundwater was used as the RO feedwater. This could potentially include the use of ultrafiltration for pretreatment.

Temperature

The influence of viscosity on flux is apparent in Poiseuille's law, where water flux increases as viscosity decreases. Viscosity decreases as temperature increases. Consequently, accurate comparisons of water flux requires that viscosity be adjusted to a common temperature (typically 77 degrees Fahrenheit), or that the tests be conducted at the same temperature. The diffusivity of water increases as temperature increases, but to a lesser degree than does viscosity. The flux can most easily be adjusted for temperature using equations that are provided by the manufacturer of the membrane.

The effect of seasonal temperature variations of the surface water with the brackish water from the groundwater sources is at present unknown. Impacts of loss of water production at the RO Plant due to decreases in temperature as a result of blended cooler surface waters with steady-state (ambient room temperature) groundwater supplies may deteriorate flux production. A flux production decline as much as *1 percent per degree Fahrenheit* is typical, and will result in either loss of production or increase in net operating pressure (Belfort, 1984). The surface water supply seasonal variations and effects on blends of the brackish water source remains unknown at the present time.

Biological Fouling

In general, microorganisms will proliferate where there is an adequate source of nutrients and favorable environmental conditions. The membrane surface will often serve as an ideal location for organism attachment growth because the attached microorganisms feed on the nutrients carried past them across the membrane surface. Once a plant is infested, mantaining water production becomes more difficult.

An example of the impact of biological fouling and the importance of salinity shock treatment to control biofouling has been realized at the City of Dunedin RO plant. The City's membrane process relies on ground water under the influence of a surface water source and has often experienced biological fouling (i.e. *psuedonomas* bacteria) since start-up in 1992. The biofouling is reduced when cleaning is performed with salt solutions and other chemicals.

The plant's feedwater has elevated dissolved oxygen levels, contains iron and manganese, and has significant heterotrophic plate count (HPC) levels in the ground water source. Operation at low pH (approximately 4.5) can prevent *psuedonomas* bacteria growth, however, yeast and mold infestation occurred when operating at the lower pH (Knippel and Bolin, 1995). Yeast and mold are partially controlled during cleaning using salt solutions.

These results would indicate that a surface water supply could be mixed with brackish water to produce a salinity which would inhibit biological growth experienced in membrane plants using aerated feedwaters (ie. fresh surface water sources of supply). The evaluation of blending brackish water and brackish groundwater supplies has not been demonstrated nor determined for the Marco Island RO plant.

Colloidal Silica

Silica may be present either as a colloid or in a soluble form. The maximum concentration of silica depends on the crystalline form of silica present. Quartz has a maximum concentration of 10 mg/L, whereas amorphous silica has a solubility of about 120 mg/L as SiO_2, and typically controls the formation of silica oxide in membrane processes. Colloidal silica can be effectively removed during pretreatment by using a coagulant such as sodium aluminate or ferric chloride (Potts et al., 1981).

Silica solubility is difficult to increase, relative to the solubility of inorganic salts, because silica is not in an ionic form and is unaffected by ionic strength and most antiscalents. The potential colloidal silica loading of the surface water supply to the RO plant is at present unknown.

Assimilable Organic Carbon

Organisms utilize carbon, nitrogen and phosphorous for the synthesis of cell material and the generation of energy for sustained growth. Easily assimilable organic carbon (AOC) is that portion of the total organic carbon (TOC) which can be readily digested by aquatic organisms and used for cellular growth. Typically, the AOC comprises just a fraction (typically less than 10 percent) of the total dissolved organic carbon (Van der Kooij, 1982). The AOC content of the existing brackish wellfield at present and potential surface supply are unknown, and hence impacts on microbial growth specific to the Marco Island RO plant cannot be predicted at the present time.

Bacteria

Growth is defined as the increase in bacterial numbers in the membrane system as a result of cell reproduction. Significant growth will occur at the expense of an organic and/or inorganic substrate. The combination of low nutrient concentration in waters with large flow rates can transport tremendous quantities of nutrients to fixed microorganisms on the membrane surface.

Since most bacteria in aquatic environments exist at solid-liquid interfaces, the membrane structure provides an excellent opportunity for continual bacterial growth. Many bacteria often produce secondary metabolites (antibiotics, bacteriocins and colcins) which can inhibit competing organisms but further foul the membrane element. The seasonal bacteriological cycle of the surface water supply is at present unknown.

Viruses

Over the years, not as much research has been conducted on virus removal by RO systems as compared to that which has been performed on bacteria removal and biological fouling of membrane systems. Stating that virus size and the membrane transport theory are evidence for rejection, many manufacturers of membranes and RO equipment claim that no viruses should be found in the permeate water. However, viruses (coliphage T2 and poliovirus) were found to penetrate commercial grade asymmetrical cellulose acetate membranes, which most likely was due to imperfections in the cross linkages of the membrane (Eisenberg and Middlebrooks, 1986). Virus release was, however, found to be minimal (<1 percent).

Reverse osmosis membranes with smaller molecular weight cutoffs have been found to be superior to ultrafiltration membranes for endotoxin rejection. RO spiral wound membranes, containing an interfacially polymerized polyamide and preceded by a polysulfone ultrafiltration membrane produced and endotoxin free solution. When compared to the ultrafiltration membranes, reverse osmosis membranes provided an endotoxin free solution (Klein et. al., 1983).

Surface Water Supply Intake Design

The design yield of the surface water supply will in part determine the type and location of an intake structure at the surface water impoundments. The intake structure may require the inclusion of additional pretreatment facilities prior to pumping, transmission and blending with brackish water at the RO plant. Conventional intakes will not provide significant filtering of the surface water supply. It may be more desirable to use an alternative design concept that would provide additional pretreatment and produce a higher quality feed water prior to brackish water blending.

Recommendations

1. If not available, the surface water supply replenishment rate and safe yield of supply for production capacity should be determined.

2. The surface water supply must be further evaluated to come to a more complete understanding of the chemical, biological and physical constraints prior to proceeding with surface water blend operations to serve as a supplemental water supply source for the RO plant. This would include an evaluation of the AOC levels in the surface water supply source and brackish wells to determine relative impact on AOC mass loading to the membrane elements.

3. A comprehensive conceptual treatment alternative evaluation and feasibility study should be performed on the surface water supply source to determine the feasibility for use as a feed water source for the Marco Island RO plant. The evaluation would include development of an experimental protocol which would include pilot and bench testing. Ultrafiltration pretreatment should be included as one of several alternative tests in the evaluation of the surface supply.

4. Several alternative types of spiral wound membrane elements currently available in the market that have different polymer material film compositions should be evaluated for use with a feed water consisting of a blended brackish ground water and surface water supply. The ideal membrane characteristics required would include that the membrane be manufactured of a material that is resistive to a number of solvents, a wide range in pH, can withstand rigorous cleanings, and uphold to elevated temperatures for short periods of time.

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TECHNICAL MEMORANDUM No. E-1

Subject: Electrical

Purpose and Scope

Technical Memorandum (TM) No. E-1 addresses the selection of systems, components and relationships of electrical equipment relative to connection and location as they are to occur for the proposed Marco Island R.O. Water Treatment Plant Electrical Distribution System expansion.

Design Criteria

The electrical distribution system design for the Marco Island R.O. Regional Water Treatment Plant will meet the following criteria:

- Incorporate electrical design provisions for expansion of the plant capacity from 4 mgd to 6 mgd.
- Be based on existing drawings, produced by Stone & Webster, Ft. Lauderdale, Fl, dated 7/31/90, which have been provided to Boyle Engineering by the Owner, and information obtained during a site visit.
- Electrical design documents will be comprised of one line diagrams, specific details, and specifications.

Overview

The electrical distribution system for the Marco Island R.O. Regional Water Treatment Plant was originally sized to allow for the installation of two additional R/O skids to provide for expansion from 4 mgd to 6 mgd. Existing Switchgear will be used wherever possible during the expansion process.

Technical Memorandum (TM) No. E-2 will address the Motor Controls, however, because the two components are integral, some overlap will be mentioned in this technical memorandum.

Utility Company Service

The existing Utility Company 277/480 volt, three phase, four wire electrical service will be utilized for the expansion without modifications.

It is recommended that a power quality study be done, by the local Utility or qualified third party, for the existing Utility Service. Users at the site have indicated that previous VFD equipment failures are thought to be directly caused by power quality problems from the Utility Service. The power company was requested to monitor the power, however, data was not provided to the owner to indicate the quality of the incoming Utility Service.

The Pads supporting three existing Utility Company Transformers located outside the process building are shifting at their present location. The Transformers should be inspected, by the Utility Company or qualified third party, to determine the susceptibility of existing transformer feeders and conduits to damage due to the shifting transformer pads.

Electrical Distribution System

The existing Switchboard equipment was manufactured by Park, Detroit, using Westinghouse drawout circuit breakers. It is a 277/480 volt, 3 phase, four wire, distribution system consisting of three Switchboards, (SWGR-301A, SWGR-301B, and SWGR-301C) each fed from a separate transformer, and each providing power to a separate motor control center.

The three existing Motor Control Centers (MCC-301A, MCC-301B, and MCC-301C) were manufactured by Challenger (Westinghouse).

The existing 480 VAC switchgear SWGR-301C has two spare 800 amp drawout circuit breakers in place that will be used for the two new 400 HP pump motors. These will be used to provide power to the motors via two new VFD controllers. Existing spare 4" conduit running from SWGR-301C to the future motor locations will be used to provide power.

The original Stone & Webster drawings show a total of four 120/208 three phase panelboards, but only three were installed.

A new 480 volt, three phase, four wire electrical panelboard will be installed to provide 480 VAC power for new motorized valves to be provided with the new R/O skids. Power for the panelboard will be provided from MCC-301A.

Utilization Voltages

The voltage supplied throughout the site will accommodate the standard voltages required for the R/O Plant and the following equipment utilization voltages will be used:

Motor control	120 volts, single phase
Motors, less than 1/2 hp	120 volts, single phase
Motors, 1/2 to 125 hp	480 volts, 3 phase

Generator

There are no power generation facilities on site. Addition of generator is not part of the expansion.

The Components and Connections:

VFD Motor Controllers

The four existing VFD controllers are located in the second floor VFD room on an existing raised concrete housekeeping pad that is poured in place. The pad was sized for a total of six VFD controllers and two spare conduits through the slab were provided for future expansion via an existing raceway from the first floor Switchgear to the second floor. One of the two conduits is blocked by the existing VFD controllers.

An existing Air Handler (ACC-200), is located within the second floor VFD room. It is currently located directly adjacent to the pad provided for the future VFDs and blocks access to the pad provided for the future VFDs. Neither the future VFDs or the existing A/C unit will work properly without revising their locations as provided for in the original design concept.

There are two options for expansion:

1. Provide a new housekeeping pad and new conduit for the new VFD controllers. The pad would be located within the VFD room and the floor would be core drilled for conduit down to the first floor switchgear.
2. Relocate the existing ACC-200 air handler unit and use the existing poured pad and raceway as originally intended. At least one coredrill would have to be made to provide access for conduit and wire from the first floor due to blockage of the existing conduit opening by the existing VFD equipment.

Option 1 is recommended since that would limit the number of contractors on the site during the expansion and minimize the potential damage that could occur, to the air handler, during relocation of the equipment. A new housekeeping pad will have to be provided in any case since a total of four VFD drives are to be provided under this expansion.

The VFD drives to be provided under this expansion are:

a) Two 400 HP VFD drives for the feed water booster pumps.

b) Three 50 HP VFD drives to be interposed in the power circuit for existing Product Transfer Pumps P-323A, P-323B, and P-323C.

c) One 40 HP VFD drive for a new concentrate pump (P-309C) and Two VFD drives for the existing concentrate pumps P-309A and P-309B.

A new housekeeping pad will be poured in the second floor VFD room for the new VFD drives. The floor will be core drilled for new conduits for the power feeders and control circuits.

Conductors, Wire and Cable

All wire and cable will be copper. The conductors will be copper Type XHHW or Type THWN/THHN. For single conductors No. 12 AWG will be the minimum size of conductor for power and lighting systems and No. 14 AWG will be the minimum size of conductor for control systems.

Discrete signals for instrumentation will use No. 14 AWG minimum. Analog signals for instrumentation will use No. 18 AWG minimum.

Conductors sized No. 10 AWG and smaller will be identified by solid color insulation. Conductors sized No. 8 AWG and larger will have black insulation and be identified by the application of colored plastic adhesive tape at the ends of each conductor and at each splice. All conductors of like phase will bear the same color identification tape as follows: black, red and blue for Phases A, B and C of 208 volt systems; and brown, yellow and orange for Phases A, B and C of 480 volt systems. The circuits will be tested prior to being energized.

Minimum wire size for power wiring will be No. 12 AWG. Minimum wire size for control wiring will be No. 14 AWG.

System Control

Provisions will be made in the design to allow for control and monitoring of new major components of the system including R/O feed pumps, transfer pumps, concentrate/waste pumps, chemical feed pumps, motorized valves, and heaters, and the various chemical system pumps from the control room of the Plant.

Transformers

The existing electrical service transformers will be used without modification.

Panelboards

New panelboards will be bolt-on, circuit breaker type. The panelboards will be provided with NEMA-4X enclosures with hinged front doors, access latches and door locks. Existing panelboards on site are manufactured by Westinghouse, therefore, new panelboards will be manufactured by Westinghouse and will comply with UL and NEMA standards. The buses contained in the panelboards will be copper. Each new panelboard will have a minimum of 20% spare breakers and spaces for future breakers.

Circuit Breakers

Existing circuit breakers shall be used where practical. New circuit breakers to be installed in existing equipment will match existing circuit breakers as to style and type.

All new branch circuit breakers, in new panelboards, will be of the bolt-on type and sized according to the National Electrical Code (NEC).

Marking and Labeling

Existing Switchboards and MCCs will retain their present labels. New circuit breakers in Switchboards and MCCs will have new engraved laminated nameplates provided.

Electrical equipment will have black-on-white laminated plastic nameplates identifying each item with its respective service or function. Both the name of the equipment being served and its associated component number will be shown on the nameplates.

All new disconnect switches, and major electrical devices will be identified by engraved plastic laminate nameplates.

Typed schedules will to be provided in new panelboards.

Raceways

The wiring will be installed in a raceway system. The type of raceway system to be used will depend on the application/location of the system.

Indoor raceways will be polyvinyl chloride (PVC) Schedule 40. Raceway systems serving power panels, motors and equipment will be concealed as much as possible. Spare conduits will be provided where applicable.

Outdoor underground raceways will be polyvinyl chloride (PVC) Schedule 40, except where stub-ups occur. Where stub-ups occur outdoors, PVC coated, rigid galvanized steel or schedule 80 PVC will be used at owners option.

EMT and IMC raceway will only be used, instead of PVC, on this project in applicable areas where PVC is prohibited by code, such as return air plenums above the ceiling, in the administrative area only.

Flexible conduit will be Carflex, as manufactured by Carlon, with the appropriate fittings and will be used where vibration isolation is required.

Grounding and Lightning Protection

Design of grounding for the electric distribution system and equipment will be based on the guidelines and procedures given in IEEE Standard 142 "Recommended Practice for Grounding of Industrial and Commercial Power Systems".

The conduits will contain a separate ground conductor sized based on NEC requirements. Conduit systems will be installed as a combination of steel and plastic and will not be used as the primary grounding system.

Process piping will be bonded to the ground system. Grounding resistance will be designed for a reading of 5 ohms or less.

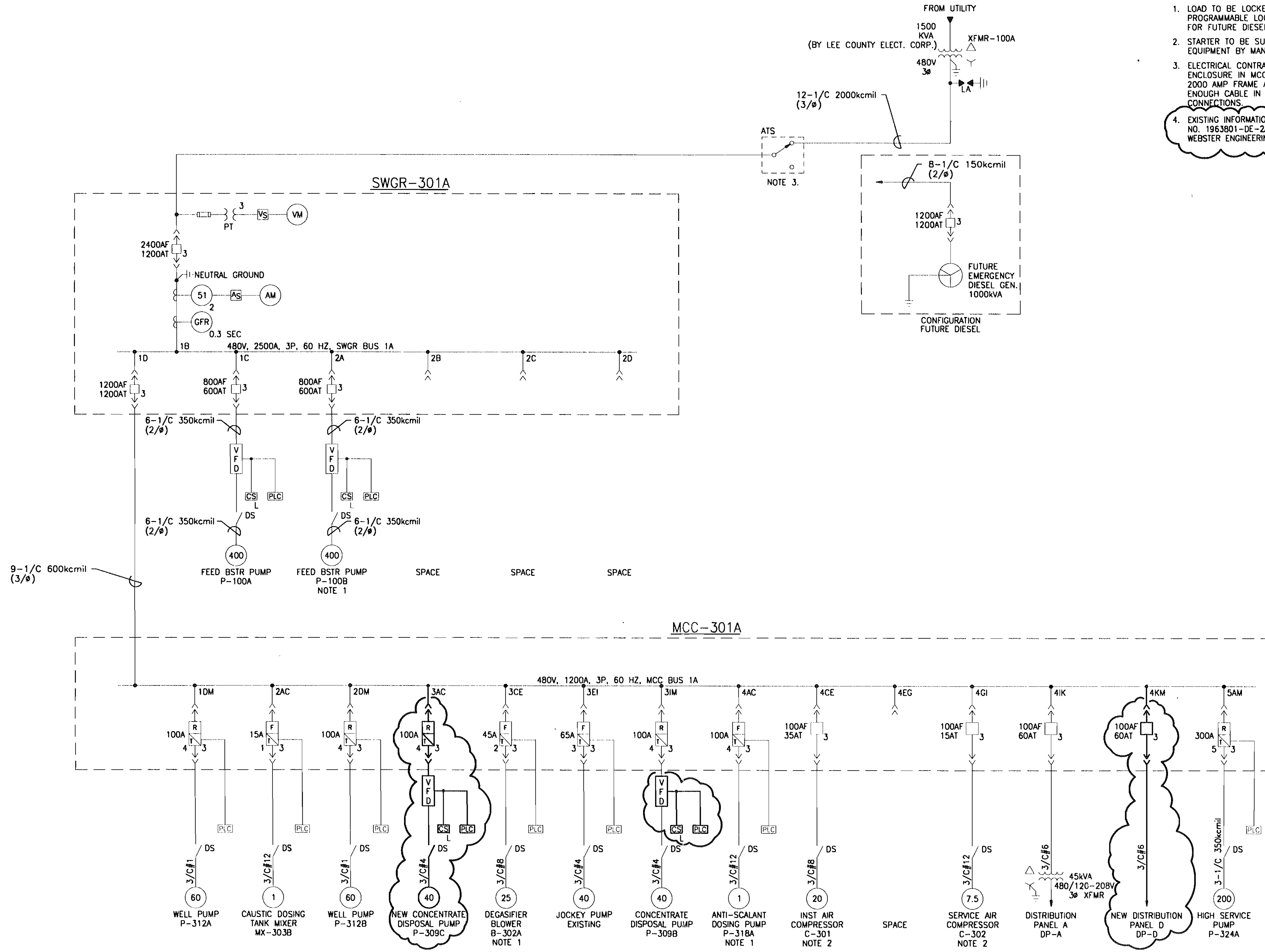
The existing Lightning Protection System will be used without Modification except for bonding new equipment as per guidelines given in NFPA 780. Metallic components will be bonded to the down conductors when located within 6 feet of the down conductor.

Surge suppressers will be installed on new data, communication, telephone and instrumentation lines entering and leaving buildings. Power input lines at new panelboards, electronic enclosures, and instrumentation lines will also be protected by surge suppressers. Suppression Devices shall be type ‘A’, ‘B’ or ‘C’ as applicable.

Recommendations

The following are a list of recommendations from this technical memorandum:

- Perform a power study analysis of the Utility Power.
- Inspect the existing transformer pads for stability.



NOTES:

1. LOAD TO BE LOCKED OUT BY PROGRAMMABLE LOGIC CONTROL FOR FUTURE DIESEL GENERATOR OPERATION
2. STARTER TO BE SUPPLIED WITH EQUIPMENT BY MANUFACTURER.
3. ELECTRICAL CONTRACTOR TO SUPPLY SUITABLE ENCLOSURE IN MCC ROOM TO HOUSE FUTURE 2000 AMP FRAME AUTO-TRANSFER SWITCH. LEAVE ENOUGH CABLE IN ENCLOSURE TO MAKE UP FUTURE CONNECTIONS.
4. EXISTING INFORMATION OBTAINED FROM AS-BUILT DWG. NO. 1963801-DE-2A-2, SHT. E-2 FROM STONE & WEBSTER ENGINEERING CORP. DATED 4-3-91

DATE | REVISIONS | NO.

DESIGN FA | DRAWN FA | DATE MAY 95

PROJECT MANAGER ROBERT T. MURPHY
REG. NO. 36132
ACCOUNT: 15-525-103-00

BOYLE ENGINEERING CORPORATION

480V SINGLE LINE DIAGRAM BUS 301A

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

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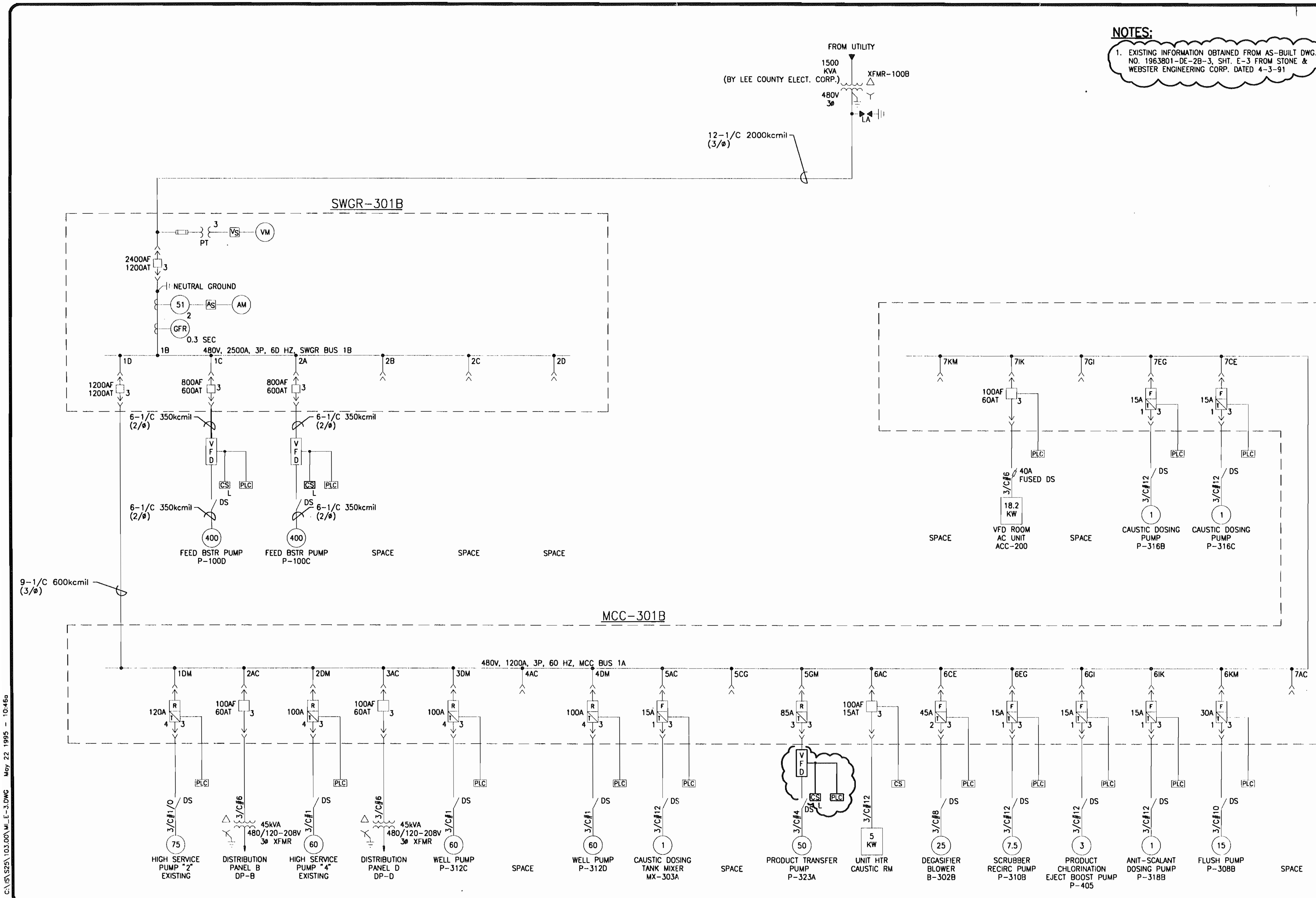

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DESIGN FA | DRAWN FA | DATE MAY 95

PROJECT MANAGER ROBERT T. MURPHY
REG. NO. 36132
ACCOUNT: 15-S25-103-00

BOYLE ENGINEERING CORPORATION

480V SINGLE LINE DIAGRAM BUS 301B

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

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TECHNICAL MEMORANDUM No. E-2

Subject: Electrical Motor Control Systems

Purpose and Scope

Technical Memorandum (TM) No. TM-E-2 addresses the type of motor control systems to be utilized for the proposed Marco Island RO Water Treatment Plant. The components to be addressed in this Technical Memorandum consist of the use and application of variable frequency drive starters, solid state soft start starters, across the line full voltage starters, the use of motor control centers, and the method of arrangement for small motor control and motor operated valves required for instrumentation.

Design Criteria

The motor control design for the Marco Island RO Regional Water Treatment Plant will meet the following criteria:

1. Provide variable frequency drive (VFD) starters for all motors that are used to drive pump and fans that require variable flow or variable speed for the water treatment process, as described in (insert tech memo numbers here).

2. Provide soft start solid state (SSSS) starters to serve as bypass contactors, for all VFDs referred to in item 1 and as starters for all motors rated above 50 hp.

3. Provide across the line starters for all 3 phase, 480 volt motors rated 40 hp or less which are not provided with VFD drive control.

4. Provide manual or automatic motor starter switches as applicable for all single phase, 120 or 208 volt motors to be installed as part of the water treatment plant expansion.

Overview

Variable frequency drive starters (VFDs) and an associated soft start solid state (SSSS) by-pass contactor will be provided for two high pressure feed pumps rated at 400 hp each.

Magnetic across the line starters will be provided for all 3-phase motors rated 40 hp and less not provided with VFD control, that will be installed during the expansion of the plant.

Each motor requiring automatic control will be provided with a magnetic motor starter for control. Each motor not requiring automatic control will be provided a manual motor starter switch.

EQUIPMENT

Variable Frequency Drive Starters

Variable frequency drive (VFD) starters will be current source inverters, of the adjustable frequency type with capacity capable of providing a quality of wave form so as to achieve full rated output of the pump motor at the required service factor of 1.15. The minimum acceptable efficiency of the starter will be 95% at 100% speed and 87% at 60% speed. The minimum power factor of the system will not be lower than 0.90 throughout the speed range. The starter input frequency range will be 57 to 63 hertz. The starter will be protected with an integral circuit breaker which will be door interlocked and have under voltage protection with automatic restart. In addition the starter will have phase sequence lockout and phase loss lockout.

The drive will be specified to include an AC input reactor to limit the effects of notching, to limit the effects of harmonic feedback to the input source, and to provide easy integration with the computer control system.

Existing Switchboard equipment will incorporate feeder breakers for VFD starters. However, the VFD starters will be stand alone units not physically incorporated into the Switchboards.

Reduced-Voltage Starters

Reduced Voltage Starters will not be used.

Across the Line Starters

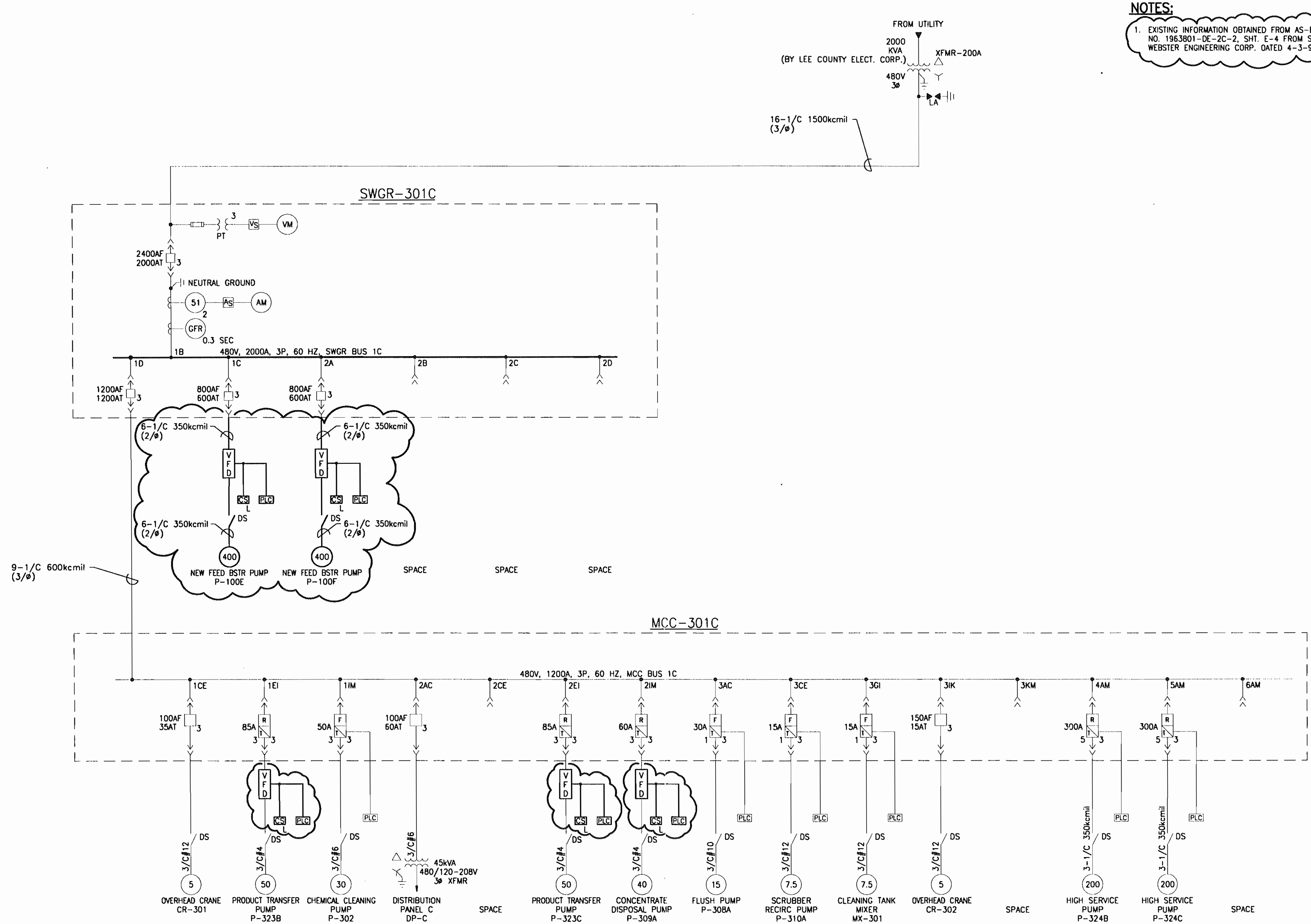
Three phase motors rated 50 hp and below will be protected and controlled by across the line magnetic motor starters having thermal element protection on each phase conductor. Starters will be of the non-reversing type, single or two speed as required by the equipment to be served. Spare parts including thermal element overloads and main line contacts will be provided for future maintenance. Each starter will be provided with a control transformer to permit low voltage control.

Manual Motor Starters

Manual motor starters will be utilized to protect fractional HP motors that are not required to start automatically. Each manual motor starter will be equipped with a thermal element sized to the motor current demand.

Motor Control Centers (with the exception of fractional 120 volt motors)

It is the intent of the design to incorporate as many motor starters into the existing motor control center structures as possible.



NOTES:

1. EXISTING INFORMATION OBTAINED FROM AS-BUILT DWG. NO. 1963801-DE-2C-2, SHT. E-4 FROM STONE & WEBSTER ENGINEERING CORP. DATED 4-3-91

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REVISIONS | NO. | DATE

DESIGN FA | DRAWN FA | DATE MAY 95

PROJECT MANAGER ROBERT T. MURPHY
REG. NO. 36132
ACCOUNT: IS-525-103-00

BOYLE ENGINEERING CORPORATION

480V SINGLE LINE DIAGRAM BUS 301C

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

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TECHNICAL MEMORANDUM No. I-1

Subject: Instrumentation

Purpose and Scope

1. Technical Memorandum (TM) No. TM I-1 addresses the Process Instrumentation and microprocessor based Supervisory Control and Data Acquisition (SCADA) system associated with the expansion of the Reverse Osmosis Water Treatment Facility at Marco Island, Florida. This is not intended to be a complete design of the proposed expanded process control system, but rather a means for the Utility to evaluate the proposed control logic, recommended changes to the existing process control system, and to serve as the basis for the final design.

2. Providing the Utility has not experienced major difficulties with the monitoring and control system associated with the operation of the existing Reverse Osmosis facility, there does not appear to be any justification for changing the proposed control system design from the DISTRIBUTED CONTROL SYSTEM ARCHITECTURE currently being used. In this system centralized Host Computers (CPUs) supervise field mounted Programmable Logic Controllers (PLCs) within the confines of the facility, and interface with a radio frequency based telemetry system to communicate with the Remote Terminal Units (RTUs) located at selected "off-site" well pumps.

3. For the proposed expansion, a new local PLC access station will be provided for, and dedicated to the monitoring and control requirements of each of the new reverse osmosis trains. The new PLCs will interface with a new 586 CPU via a fiber-optic data highway. The benefits to be derived from this design include, but are not limited to the following:

   a) The two new R.O. trains and the anticipated five new "off-site" wells could be operated independently of the existing system. This reduces the possibility of the entire facility being dropped "off-line" by a computer crash or a communication link failure.

   b) Current computer technological advancements will provide the advantages of both the increased speed of response and expanded memory capacity.

   c) The new Host CPU could be programmed as a back-up for the existing system.

Design Criteria

The Marco Island R.O. Facility has been subdivided into four process areas for preliminary design purposes. The four areas are identified as follows:

1. Well field and Pre-treatment Process Area.

2. Membrane System Process Area.

3. Post-Treatment, Ground Storage and Distribution System Process Area.
4. Chemical Storage, Handling and Feed System Process Area.

SCADA Design Recommendations By Process Area

Well field and Pre-treatment Process Area.

1. The new well pumps, associated monitoring and control instrumentation, and the revisions to the existing telemetry system required to transmit the monitoring and control functions between each well pump and the R.O. Plant SCADA System Central Process Unit, will be furnished and installed under a separate contract, and shall include the following monitoring and control functions for each well pump installation:

    a) Well Drawdown Level
    b) Pump Discharge Flow
    c) Pump Discharge Pressure
    d) Utility Power and Phase Monitoring
    e) Control Power
    f) Hand/Off/Auto (H.O.A.) Switch Position
    g) Flow via Burmad Valve
    h) Pump Run
    i) Pump Failure
    j) Communication Link Failure

    All of the above will be displayed on the Operator's terminal located in the plant control room. Each well pump can be started and stopped at the pump using the "Hand" and "Off" modes of the H.O.A. switch. In the "Auto" mode the pumps will be started and stopped from the R.O. Plant via the telemetry system.

2. With the addition of the proposed new well pumps, the raw water flow rate to the facility will be increased. This will require that the existing raw water flow meter (FT-301) be recalibrated to accommodate the increased flow rate.

3. It is recommended that the raw water turbidity monitoring system using the Hach 1700 series low-range turbidimeter (AT-204) be replaced by a turbidity system with a sealed flow-through unit. The HF Scientific Micro 200 is a recommended replacement.

Membrane System Process Area

1. It is anticipated that the general arrangement of the proposed new R.O. trains will be essentially the same arrangement as the existing R.O. trains with the possible exception of process piping sections containing flow metering devices. If the decision is made to use insert Venturi meters, the piping configuration will be modified to provide the required straight run of pipe before and after the meters. If the decision is made to use the more expensive magnetic flow meters where metering runs are not required, the piping changes for flow measurement purposes will be minimal.

2. The annubar type flow measurement devices, currently installed on the existing trains, do not develop sufficient differential pressure form the operating process flow rates to provide accurate monitoring and control functions and should eventually be replaced.

3. The other proposed change will be that the automatic process control valves will be furnished with electric motor actuators with local manual Open/Close hand switches and over-ride hand wheels. The motor actuators will include valve position transmitters which will permit the valve position to be displayed on the operator's terminal in the control room.

Post-Treatment, Ground Storage and Distribution System Process Area

1. The proposed Facility expansion includes the addition of variable-speed drives to the existing transfer pumps at the Transfer Pump Station. A pump control matrix in the new software package will provide the means for the pump alternation. The matrix will be developed to that in the "manual" mode the operator can manually start and stop any or all of the transfer pumps any time. With the matrix in the "Automatic" mode, the Transfer Pumps are stated On and Off in response to changes in the liquid level in the Degasifier Clearwell. The operator will determine the pump assignment to the stages of the matrix. The existing clearwell level transmitter (LT-512) and the software level controller (LIC-512) may be utilized to generate the level control signal to the new pump variable frequency drives. Interlocks will be provided to stop the transfer pumps should a high-liquid level condition develop in the Ground Storage Tank(s). The existing level controlled pneumatic actuated valve located in the discharge piping from the Transfer Pumps should be removed from service.

2. The proposed Facility expansion also includes the addition of a variable-speed drive to the existing pumps at the existing Concentrate Sump. The two existing concentrate pumps are currently controlled by liquid level switches actuated by level changes in the concentrate sump. The addition of the variable-speed drives will require a continuous level signal for the pump speed control, thus the existing level switches will be replaced by an ultrasonic level sensing system. The pumps will be controlled by a pump control matrix, as described above for the Transfer Pumps.

Chemical Storage, Handling and Feed System Process Area

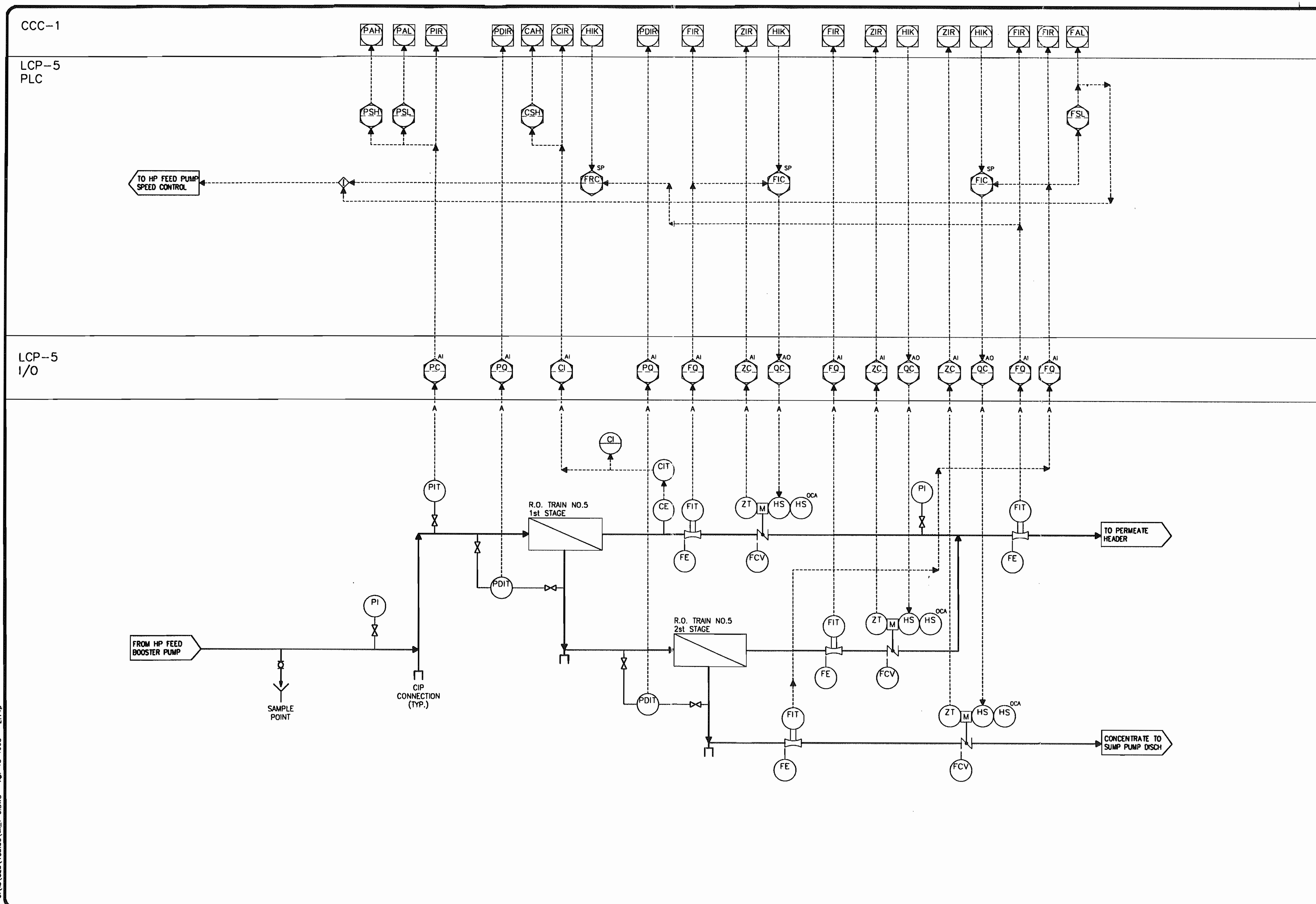
The necessary changes to the Chemical Storage, Handling and Feed System will be limited to the interfacing of the new software to the existing system. No physical equipment changes will be required.

Summary

the proposed expansion of the existing facility provides an opportunity to enhance the operation of the existing facility while providing monitoring and control equipment required for the new R.O. trains. The following recommendations are submitted for consideration:

1. Provide a new 586 industrialized computer as the CPU for the expanded SCADA system.
2. Utilize electric motor actuated control valves on the new R.O. trains.
3. Utilize magnetic flow meters to measure process flows on the new R.O. trains.

4. Utilize inset type Venturi flow meters to measure flows on the new R.O. trains, (should magnetic flow meters be considered too expensive).
5. Replace the existing Hach 1700 Series Turbidimeter with a HF Scientific Micro 200 model.
6. Provide a software Pump-Control Matrix for the Transfer Pumps with variable-speed drives.
7. Investigate the need to continue using the Level Control Valve located on the discharge piping from the Transfer Pumps.
8. Provide a software Pump-Control Matrix for the Concentrate Pumps with variable-speed drives.
9. Provide a continuous level monitoring and control system for the Concentrate Sump.



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PROJECT MANAGER
HENN REBANE, P.E.
REG. NO. 8928
ACCOUNT: IS-525-103-00

BOYLE ENGINEERING CORPORATION

P & 1 DIAGRAM TWO STAGE R.O. PROCESS SYSTEM

SOUTHERN STATES UTILITIES
MARCO ISLAND R.O. WATER TREATMENT PLANT EXPANSION

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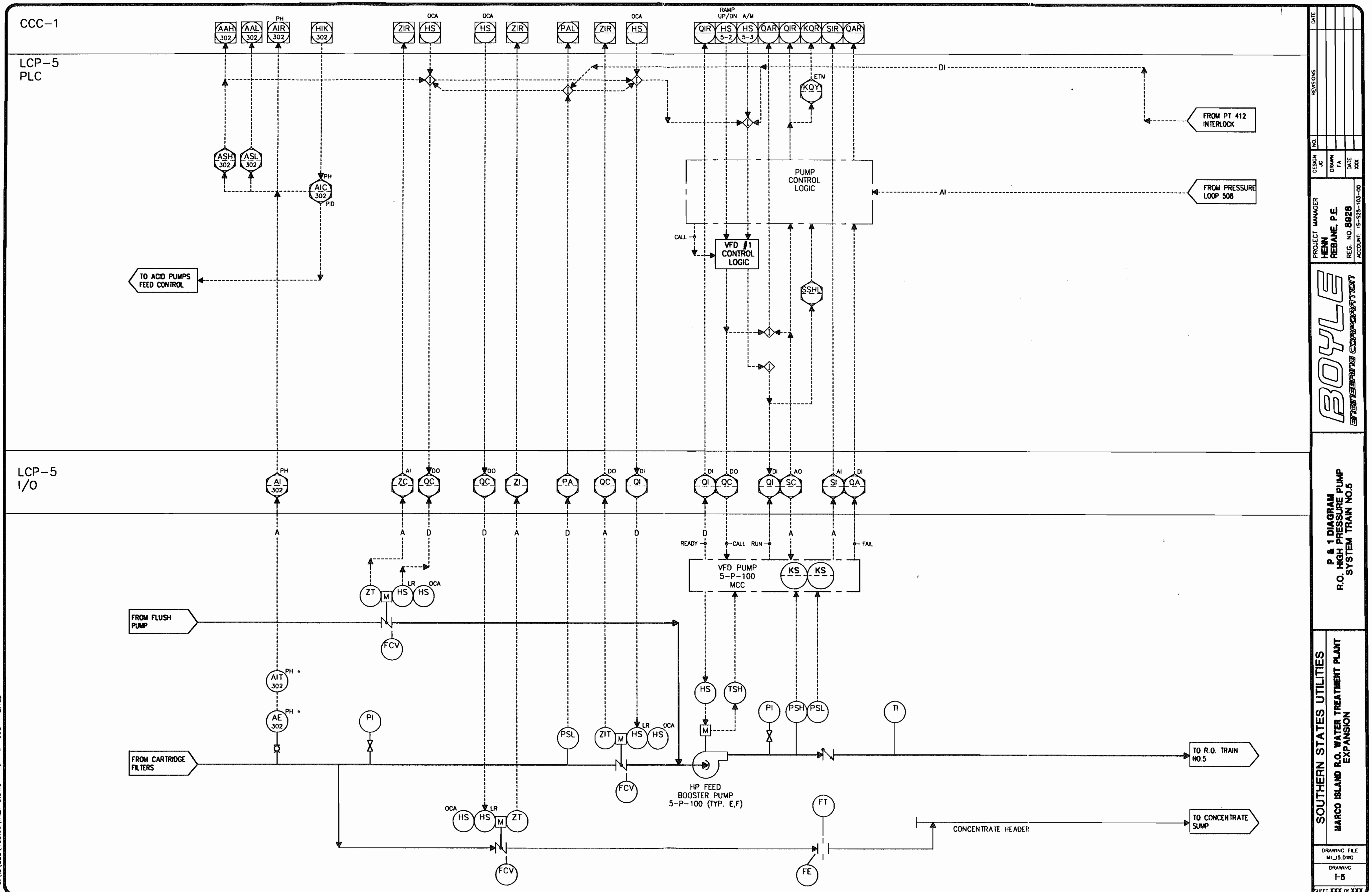

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