JORDAN VALLEY WATER CONSERVANCY DISTRICT

JORDAN VALLEY WATER TREATMENT PLANT CAPACITY AND SITE OPTIMIZATION STUDY

FINAL
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Jordan Valley Water Conservancy District

Jordan Valley Water Treatment Plant Capacity and Site Optimization Study

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1.0 EXECUTIVE SUMMARY

Carollo Engineers, Inc. (Carollo) and Jordan Valley Water Conservancy District (JVWCD) staff held workshops, discussed plant performance, reviewed record drawings, and conducted an inventory of plant facilities and operations. This report contains hydraulic, chemical storage, and process evaluations, and four process improvement alternatives to expand the existing Jordan Valley Water Treatment Plant (JVWTP) by 75 million gallons per day (mgd) to 255 mgd. Efforts as part of this study also identified projects that benefit the plant at the current capacity of 180 mgd. Cost estimates for each of the four expansion alternatives are also included.

Improvements to the following systems will benefit plant operations at 180 mgd:

- Solids dewatering.
- PAC storage.
- PEC storage.
- Sedimentation basin surface loading rates.

The hydraulic model developed for this study showed two locations in the existing plant that need to be modified for the recommended alternatives to accommodate 75 mgd of additional capacity for a total plant flow of 255 mgd:

- Finished water piping.
- Raw water piping through the Raw Water Meter Vault.

Four expansion alternatives were considered for this study:

1. Modify the existing rectangular 1985 basins with plate settlers.
2. Construct new conventional flocculation/sedimentation (floc/sed) basins parallel to the 1985 basins.
3. Construct new high rate (shorter) basins with plates parallel to the 1985 basins.
4. Construct a new plant on west side of 3200 West.

Two alternatives are recommended for JVWCD's consideration:

Alternative 2: Construct new uncovered basins parallel to the existing 1985 basins, mirroring existing processes and maintaining current design criteria. This alternative also includes the following:

- New filter building with six new filters, including additional backwash facilities.

- Solids handling improvements, including additional sludge drying beds.
- New chlorine building for additional chlorine storage and feed, new PAC facilities, and additional PEC storage.

Alternative 4: Construct new facilities west of the existing plant. This alternative also includes the following shared facilities with the existing JVWTP:

- Solids handling improvements, including additional sludge drying beds.
- Finished water reservoir storage.

Capital cost for Alternative 2 is estimated at $213 million, and Alternative 4 is estimated at $250 million, in 2015 dollars. Estimates include 30-percent contingency, 2.5-percent escalation to midpoint of construction, and 20-percent project administration costs.

Alternative 2 is the least cost alternative and maintains the existing plant style, layout, and design criteria by adding new basins next to the old basins, while Alternative 4 provides a new plant with a new lifespan that is independent of the existing plant, and would provide redundancy in an emergency.

2.0 INTRODUCTION

2.1 Purpose

The purpose of this study is to evaluate alternatives for plant expansion from 180 mgd to 255 mgd while optimizing the plant site and adjacent land owned by JVWCD. As part of this study, Carollo reviewed existing plant hydraulics, current plant process performance, and existing plant facilities, and pursued three expansion options:

- Latent plant capacity (processes with potential to perform beyond the ‘nameplate’ rated capacity).
- Expansion of existing plant facilities.
- Expansion via new, parallel facility on JVWCD-owned land west of the existing plant.

Costs for each expansion alternative are included in this report.

2.2 Background

The JVWTP is jointly owned by JVWCD and the Metropolitan Water District of Salt Lake and Sandy (MWDSLS), and is operated by JVWCD. The plant, located in Herriman, Salt Lake County, Utah, was designed in 1971 (constructed in 1972) as a 42 mgd plant and was originally used seasonally as a peaking plant to meet high summer demands.

JVWTP was expanded to 60 mgd in 1979, and to 138 mgd (180 mgd hydraulic capacity) in 1985. Plant capacity was expanded to 180 mgd by pushing the treatment process flows beyond their original design criteria while still meeting water quality objectives and with improvements to the flash mix in 2002. The plant currently operates year round and frequently operates at or near its 180 mgd capacity during summer months to meet peak day demands.

JVWCD has had long-standing plans to expand the JVWTP to 255 mgd. The need for this expansion has been delayed by new water supplies from the Southwest Groundwater Treatment Plant (RO facility) and the Central Water Project (Geneva Well Field). JVWCD currently projects the plant expansion to be between 2021 and 2025, and will likely coincide with the last block of ULS water developed by Central Utah Water Conservancy District. The additional source will be Strawberry Reservoir, conveyed through the Provo River Aqueduct, formerly the Provo Reservoir Canal or Murdock Canal, which is now enclosed.

This study focused on the area inside the plant boundaries, and did not evaluate raw water or finished water transmission capacity. Staff did indicate that additional transmission facilities will be required to deliver the additional water to the JVWTP, although there is an existing raw water pipeline from the Jordan Narrows pump station to the JVWTP from previous plans to treat water from the Jordan River.

JVWCD staff anticipates that the expansion will be paid for by JVWCD with no involvement from MWDSLS.

3.0 EXISTING PLANT CONDITIONS

3.1 Hydraulics

Carollo analyzed the existing JVWTP hydraulics using our *Hydraulix*® program, and compared it to the 1985 expansion project's hydraulic profile at 180 mgd. The 1985 hydraulic profile is consistent with the model's results, and the model was run at 255 mgd to identify hydraulic bottlenecks and evaluate the ability of the existing plant to accommodate the higher flows. Results of that analysis are presented in Section 4: Expand the Existing Plant.

The 1985 expansion project installed a new Finished Water Overflow Box (FWOB, or OFS) on the existing 90-inch finished water line upstream of the Inlet, Overflow, and Bypass structure (IOB); the plant overflow line in the IOB was abandoned, and a new 90-inch PO line was run from the FWOB to the new overflow detention basin. The overflow weir in the FWOB was set at elevation 4720.35, more than 1.5 feet below the original overflow weir elevation of 4722.08 in the IOB. (All elevations are per record drawings and have not been adjusted to the corrected datum.)

This was done to protect the filter gallery floor from becoming pressurized during a plant overflow at 180 mgd, but it also lowered the maximum operating water surface elevation (WSE) in the 8 million gallon (MG) Finished Water Reservoir (FWR) at 180 mgd by four feet, from elevation 4722.0 to elevation 4718.0. This reduces operational storage volume in the 8 MG FWR to approximately 6.4 MG when operating the JVWTP at 180 mgd. This is an operational volume reduction of 20 percent. (See 1985 drawings G-5, S-17, and 2S-9).

The new FWR project is an opportunity to identify and reduce some headloss associated with the finished water piping and regain some of this lost capacity.

3.2 Finished Water Storage and Disinfection Requirements

The existing single 8 MG FWR at the JVWTP is undersized for plant operational storage and disinfection at 180 mgd. Plant staff currently feed a very high chlorine dose to achieve required disinfection credit. With only one cell, there is no redundancy for plant operations or routine maintenance and inspections. The New FWR Pre-Design Report (Carollo, March 2014) recommends a minimum FWR storage volume of 25 MG with a baffling factor of at least 0.5 to provide adequate disinfection and operational storage volume. At the time of this report, JVWCD is proceeding with a project to add a new highly baffled 12.5 MG FWR, with plans to replace the existing 8 MG FWR with a 12.5 MG cell in the future.

These projects will resolve disinfection and operational storage volume deficiencies at the JVWTP for the current 180 mgd capacity, which will allow plant staff to reduce the chlorine dose and resume optimizing dose for disinfection byproduct control. 15 MG of additional storage, for chlorine contact time and operational storage, is recommended when the JVWTP is expanded to 255 mgd, for a total on site storage volume of 40 MG.

3.3 Raw Water Reservoir

The existing 180 MG Raw Water Reservoir (RWR) provides one day's storage at peak plant flow. JVWTP staff appreciates the flexibility this provides during maintenance of the aqueduct or emergencies when raw water delivery is interrupted.

Staff preference is to match total storage of the RWR to the overall plant capacity, which would mean an additional 75 MG of raw water storage for the 75 mgd plant expansion. It may be possible to expand the existing RWR to increase its capacity, but it is unlikely that it can be expanded to achieve the entire 75 MG increase. For planning purposes, this study assumes the construction of a new 75 MG RWR.

3.4 Current Process Performance

As mentioned previously in this report, the 1985 project expanded plant processes to 132 mgd matching existing design criteria (detention time, surface loading rates, etc.) and included modifications for a hydraulic expansion to 180 mgd. The current plant successfully operates at 180 mgd by operating beyond the originally established design criteria.

The Clarification and Washwater Report, Process Enhancements Study (Carollo, July 2005), outlined two areas of concern for operating at 180 mgd:

- The need to improve settled water turbidity.
- Resolve FWW solids dewatering problems.

Existing process performance at 180 mgd for each facility is presented below.

3.4.1 <u>Floc/Sed Basins</u>

The 2005 Report identified the need for improved sedimentation based on staff-reported problems with producing acceptable settled water turbidities at 180 mgd. Higher settled water turbidity at 180 mgd is the result of operating beyond the original design criteria. At 138 mgd (rated capacity following the 1985 expansion), there is a flocculation time of 42 minutes and the sedimentation basins operate at a surface hydraulic loading rate of 0.7 gallons per minute per square foot (gpm/sf), typical design criteria for Utah with its cold water. At 180 mgd, flocculation time is reduced to 30 minutes and the sedimentation basins operate at 0.95 gpm/sf, design criteria more conducive to the warmer water experienced during summer months.

During the first workshop for this study, JVWTP staff commented that at flows approaching 180 mgd, settled water turbidity is higher than that of peer treatment plants – approximately 2 NTU instead of less than 1 NTU, a goal set by the Partnership for Safe Water. Achieving acceptable settled water turbidity has been more of a challenge in recent years with changing water quality and the need to feed more powdered activated carbon (PAC), and feeding PAC later into the summer when high flows – and higher loading rates – make removing the extra solids more difficult. However, JVWTP staff have operated the plant successfully for several years at peak flows of 180 mgd during the warmer summer months and consider the plant processes capable of meeting finished water quality goals at 180 mgd without additional plant improvements.

3.4.2 Filters

JVWTP has 16 filters; six were constructed in 1971 and ten were constructed in 1985. The filters have a surface area of 1,408 square feet and consist of a nozzle underdrain system with twenty inches of 1.0 mm anthracite over ten inches of 0.5 mm sand. This provides an L/d ratio (depth of media divided by size of media) of 1016, which is acceptable.

With fifteen filters in operation and one offline for backwash, plant flow of 180 mgd results in a filtration rate of 5.9 gpm/sf, which is within the State of Utah's maximum filtration rate of 6.0 gpm/sf without additional pilot testing and special approval.

JVWTP staff indicate that they are able to successfully meet their Partnership for Safe Water finished water goal of 0.1 NTU on a regular basis at plant flows up to 180 mgd.

3.4.3 Solids Handling

The 2005 Report indicated that JVWTP has experienced problems with its Filter Waste Washwater (FWW) lagoons and that the washwater solids do not dewater fast enough to keep up with the FWW solids production. The 2005 Report identified several alternatives for improving the system. During workshops for this current study, JVWTP staff indicated that the problems persist and current solids dewatering facilities are undersized for operations at 180 mgd. JVWCD plans to implement one of the 2005 report alternatives following completion of the current FWR project. An additional alternative that improves current FWW handling operations and is modular to accommodate expansion to 255 mgd is presented in Section 4 of this report.

3.4.4 Chemical Storage/Feed

Carollo and JVWTP staff conducted an inventory of chemical storage and chemical feed and found most systems to be adequate both for 180 mgd and for an expanded 255 mgd capacity. Two of the chemical systems, powdered activated carbon (PAC) and cationic polymer (PEC), are undersized for current plant needs at 180 mgd.

Existing PAC feed is limited to approximately 8 mg/L dose at 180 mgd. Taste and odor events that require PAC have increased in frequency and magnitude in recent years, putting a strain on the PAC feed system, storage system (at max dose and max plant flow, carbon deliveries are required every few days), and on the sed basins to remove the extra solids.

The existing PEC storage system is undersized for plant flows of 180 mgd, requiring frequent small PEC deliveries when operating the plant at max dose and max plant flow. This creates logistical problems at times when suppliers cannot quickly respond to chemical orders.

Based on this evaluation, alternatives to expand the plant beyond 180 mgd will need to address these chemical storage and feed systems.

JVWTP has increased chlorine dose setpoints after the New FWR Pre-Design Report (Carollo, March 2014) identified that the 8 MG FWR does not provide enough disinfection volume to meet CT requirements at the previous low dose setpoints optimized for DBP formation control. The existing chlorine feed system is adequate to feed the necessary higher dose at 180 mgd, but the higher dose may have an adverse impact on DBP formation, and may not be a sustainable solution. This has not been addressed further in this report because design for a new FWR is underway. Expansion to 255 mgd will require additional baffled FWR storage to provide adequate disinfection volume to meet CT requirements using JVWCD's chlorine dosing strategy optimized for DBP control.

3.5 Conclusions

JVWCD had already tapped the latent plant capacity in 2002 when it began operating the floc/sed basins and filters at higher loading rates. At 180 mgd, there is no latent capacity to take advantage of to provide additional plant capacity, and additional facilities are required.

Completion of the new FWRs (new FWR project and future replacement of the existing 8 MG FWR with a larger FWR) will resolve disinfection and operational storage constraints for the current plant capacity of 180 mgd. However, improvements to the following systems would improve current plant operations until such time that the plant is expanded:

- Solids dewatering.
- PAC storage.
- PEC storage.

The JVWTP could also benefit from a reduction in surface loading rates for the sedimentation basins, although plant staff indicated current process performance is adequate.

4.0 EXPAND THE EXISTING PLANT

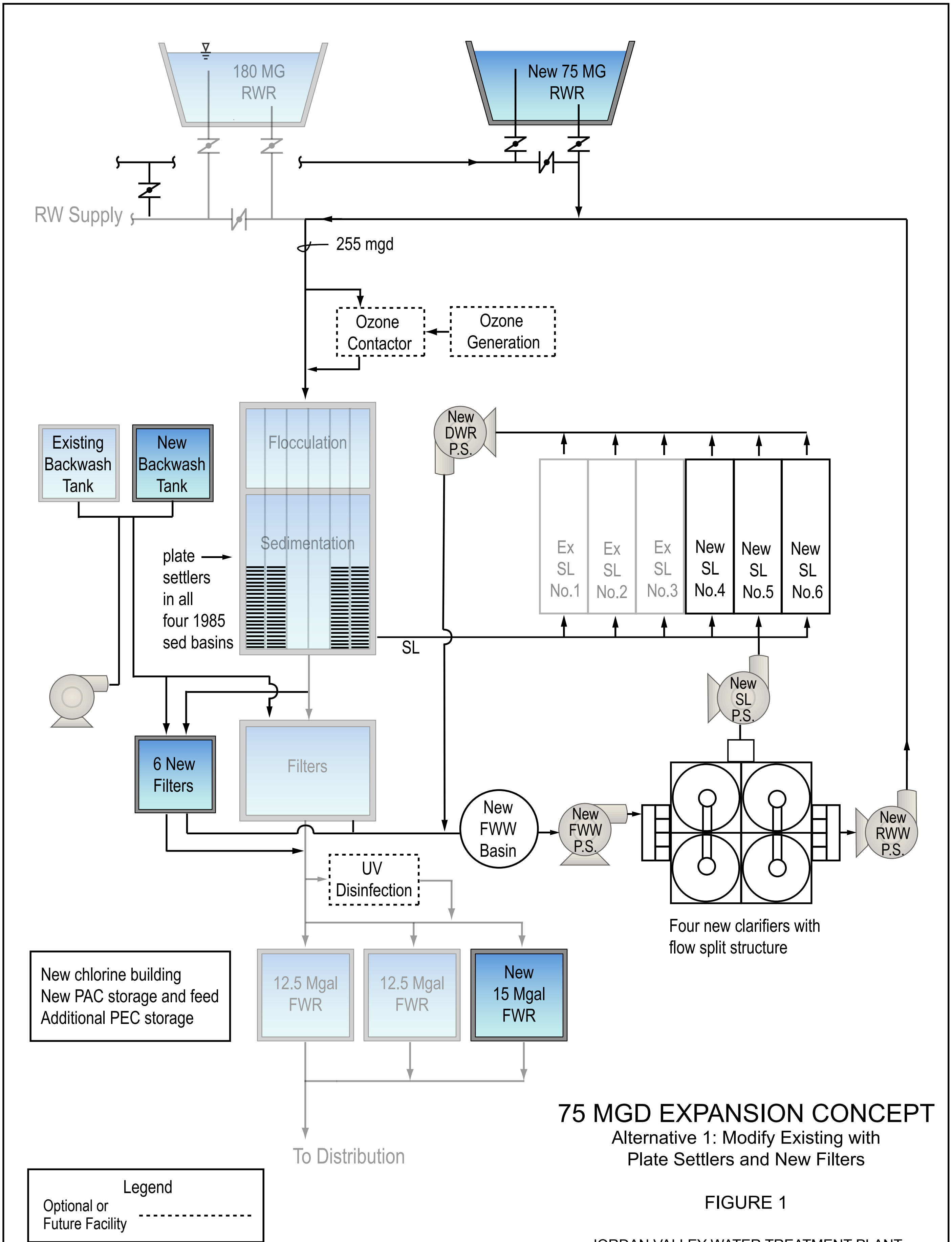
Carollo explored three alternatives to expand JVWTP by 75 mgd within the existing plant site; a fourth alternative to construct a new parallel plant is discussed in its own section. The three alternatives within the existing plant have similar features and differ only in how floc/sed is expanded:

- Alternative 1: Add two stages of flocculation and install plate settlers in the four existing 1985 floc/sed basins, and cover the sedimentation portion of those basins (Figure 1).
- Alternative 2: Construct two new uncovered floc/sed basins, one on the south side and one on the north side of the existing basins (Figure 2).
- Alternative 3: Construct two new shorter, covered floc/sed basins with plate settlers, one on the south side and one on the north side of the existing basins (Figure 3).

Each of these alternatives includes the following basic improvements:

- New filter building with six new filters, including additional backwash facilities.
- Solids handling improvements, including additional sludge drying beds.
- New chlorine building for additional chlorine storage and feed, new PAC facilities, and additional PEC storage.

This section presents a discussion on the common improvements and unique floc/sed improvements for each of the three alternatives within the existing plant footprint.

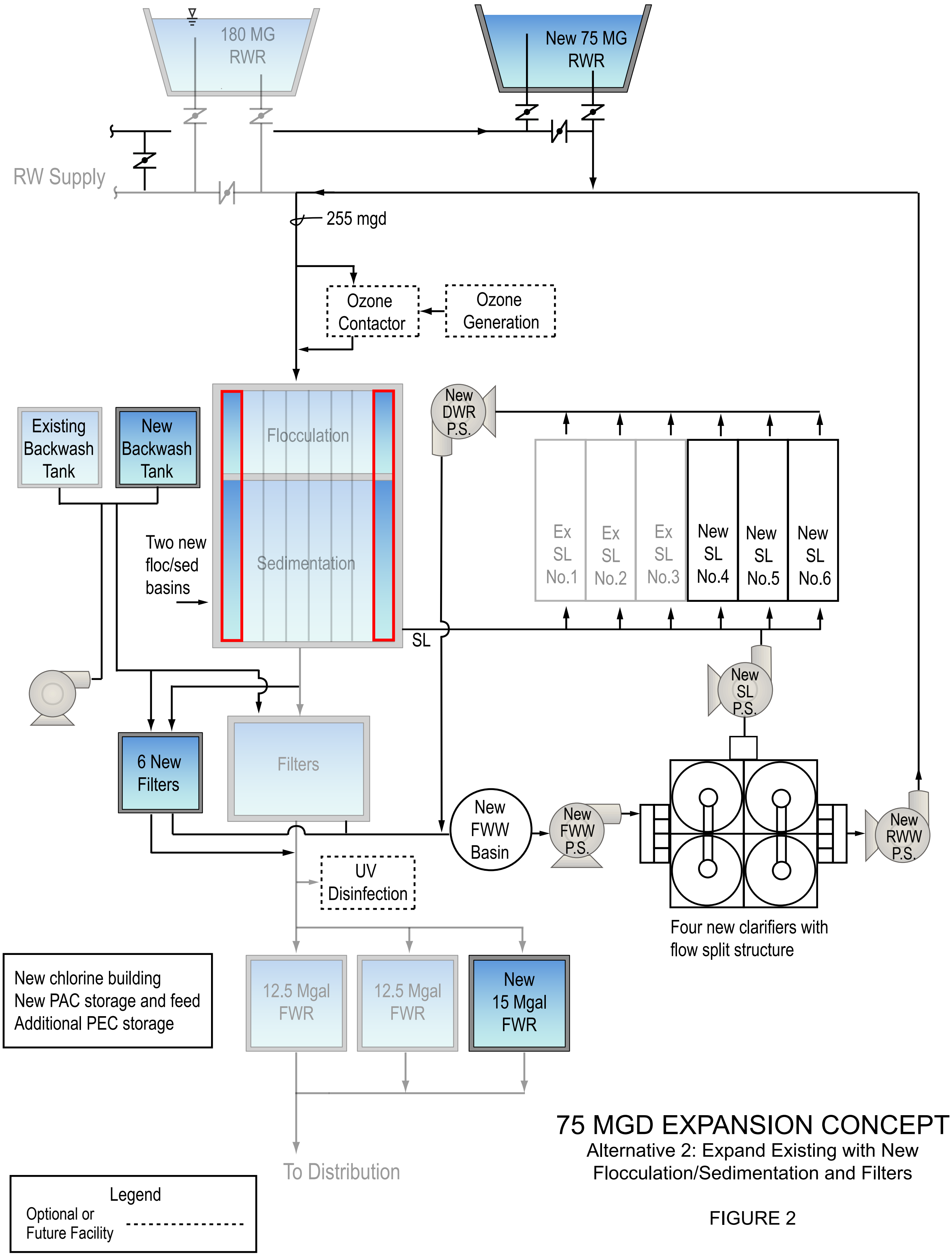


75 MGD EXPANSION CONCEPT

Alternative 1: Modify Existing with
Plate Settlers and New Filters

FIGURE 1

JORDAN VALLEY WATER TREATMENT PLANT
JORDAN VALLEY WATER CONSERVANCY DISTRICT

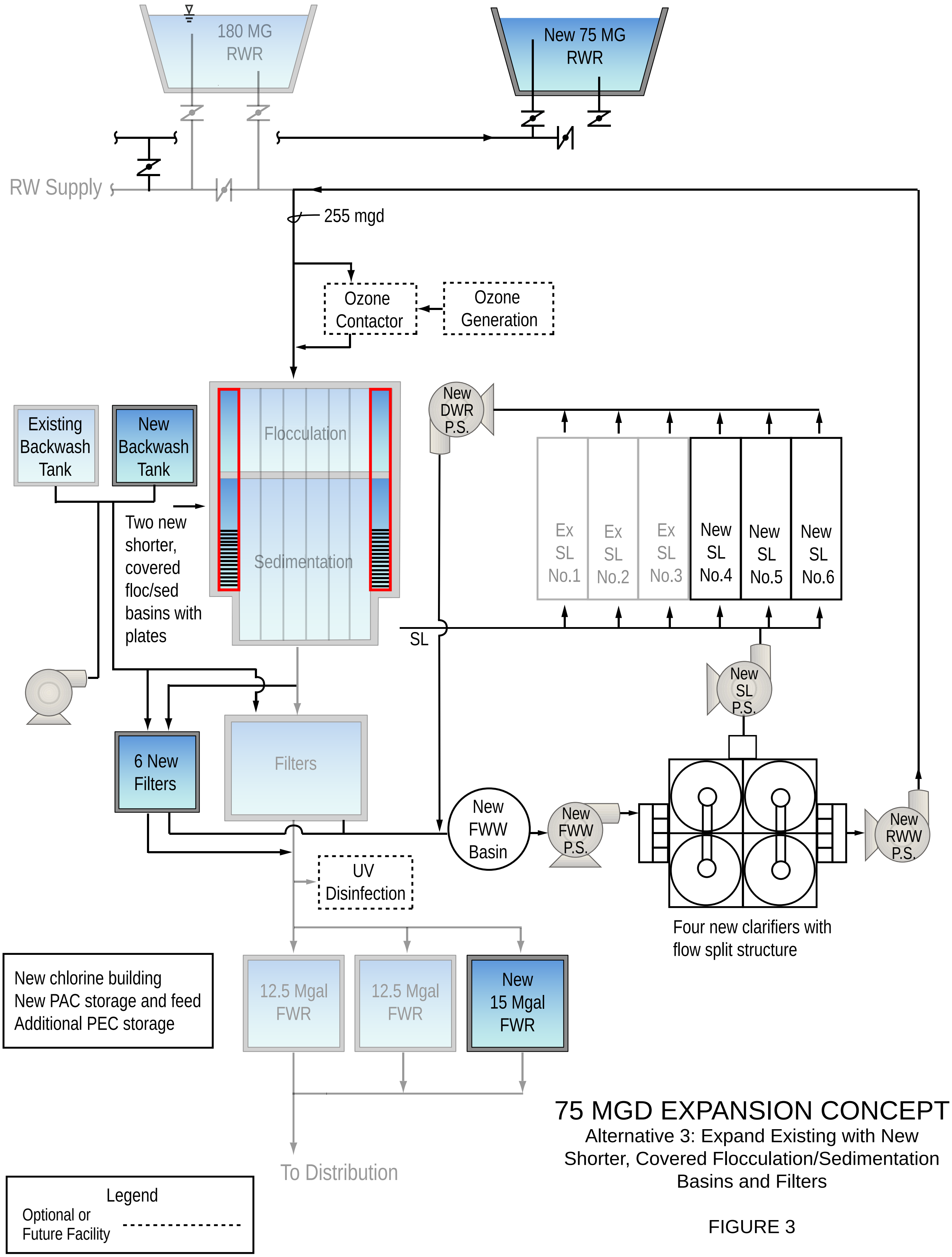


75 MGD EXPANSION CONCEPT

Alternative 2: Expand Existing with New
Flocculation/Sedimentation and Filters

FIGURE 2

JORDAN VALLEY WATER TREATMENT PLANT
JORDAN VALLEY WATER CONSERVANCY DISTRICT



75 MGD EXPANSION CONCEPT

Alternative 3: Expand Existing with New Shorter, Covered Flocculation/Sedimentation Basins and Filters

FIGURE 3

JORDAN VALLEY WATER TREATMENT PLANT

JORDAN VALLEY WATER CONSERVANCY DISTRICT

4.1 Hydraulics – common to all alternatives

The hydraulic model developed for this study showed three locations in the existing plant need to be modified to accommodate 75 mgd of additional capacity for a total plant flow of 255 mgd: finished water piping, floc/sed basin influent weir, and raw water piping.

4.1.1 Finished Water Piping

The 90-inch Finished Water pipeline leaves the west end of the existing Filter Building, turns north and runs through the FWOB, then into the IOB. A 72-inch line leaves the IOB to the east then turns north into the 8 MG FWR; this is the main inlet into the 8 MG FWR and has an energy dissipation structure inside the reservoir, presumably to reduce velocity entering the reservoir. There is second connection from the IOB to the FWR for flows up to 180 mgd – a 60-inch pipe that runs north and then tees to the east into the 8 MG FWR. There is significant headloss in these two connections to the 8 MG FWR that provide too much restriction at 255 mgd. Some of this piping will change with JVWCD's upcoming new FWR project, and additional hydraulic modeling will be required to configure the piping to accommodate 255 mgd without pressurizing the filter effluent channel or further reducing the maximum operating level in the FWR.

4.1.2 Floc/Sed Basin Influent Weir

The alternative to install plate settlers in the existing 1985 basins increases flow through those existing basins to the point that additional headloss through the existing flocculation baffle walls will submerge the influent flow-split weirs and compromise the flow split between basins. Consequently, the ports in the existing redwood baffle walls will need to be enlarged to reduce this headloss at peak flows to avoid submerging the weirs.

4.1.3 Raw Water Piping

The Raw Water Meter Vault has a long section of 60-inch pipe that produces substantial headloss at 255 mgd. This vault and associated pipe will need to be reconstructed to reduce headloss to stay within the current maximum available hydraulic gradeline.

4.2 Floc/Sed Alternatives

4.2.1 Alternative 1: Install Plate Settlers in Existing 1985 Floc/Sed Basins

This alternative increases the capacity of the existing 1985 floc/sed basins by increasing their nominal surface loading rates by adding plate settlers. The configuration of the 1985 basins is more amenable to retrofit than the original floc/sed basins because they are long and rectangular with chain and flight sludge collectors. The 1971 basins have circular clarifier mechanisms for sludge removal and are less likely to accommodate structural modifications necessary for plate settler installation. The plates are constructed of stainless steel and sit within a stainless steel frame to create a plate pack or cartridge. Plates provide additional surface area for settling and are installed at a 55-degree angle so that sludge that settles onto the plate will slide down off the plate for collection below. The plate packs (cartridges) are arranged in rows across the width of the basin with collection troughs between the rows. Each row can have multiple plate packs.

The existing 1985 floc/sed basins were constructed with blockouts in the intrabasin walls that were intended to accommodate future construction of columns for tube settlers (refer to Figure 4) and could be modified to help support plate packs. Figure 5 provides a concept for a conceptual layout from one plate settler supplier that utilizes sixty-four cartridges arranged in eight rows with eight cartridges per row and ninety-five plates per cartridge to increase the basin capacity from 30 mgd to 49 mgd.

Installing plates only in the 1985 basins requires a proportional rather than equal flow split between the basins so that flow rates for the original floc/sed basins do not increase. The existing flow split weirs are easily modified to accommodate this proportional flow split. Flocculation volume is increased to maintain flocculation time at 30 minutes at higher basins flows by re-purposing the front portion of the existing sedimentation basins for two additional flocculation stages.

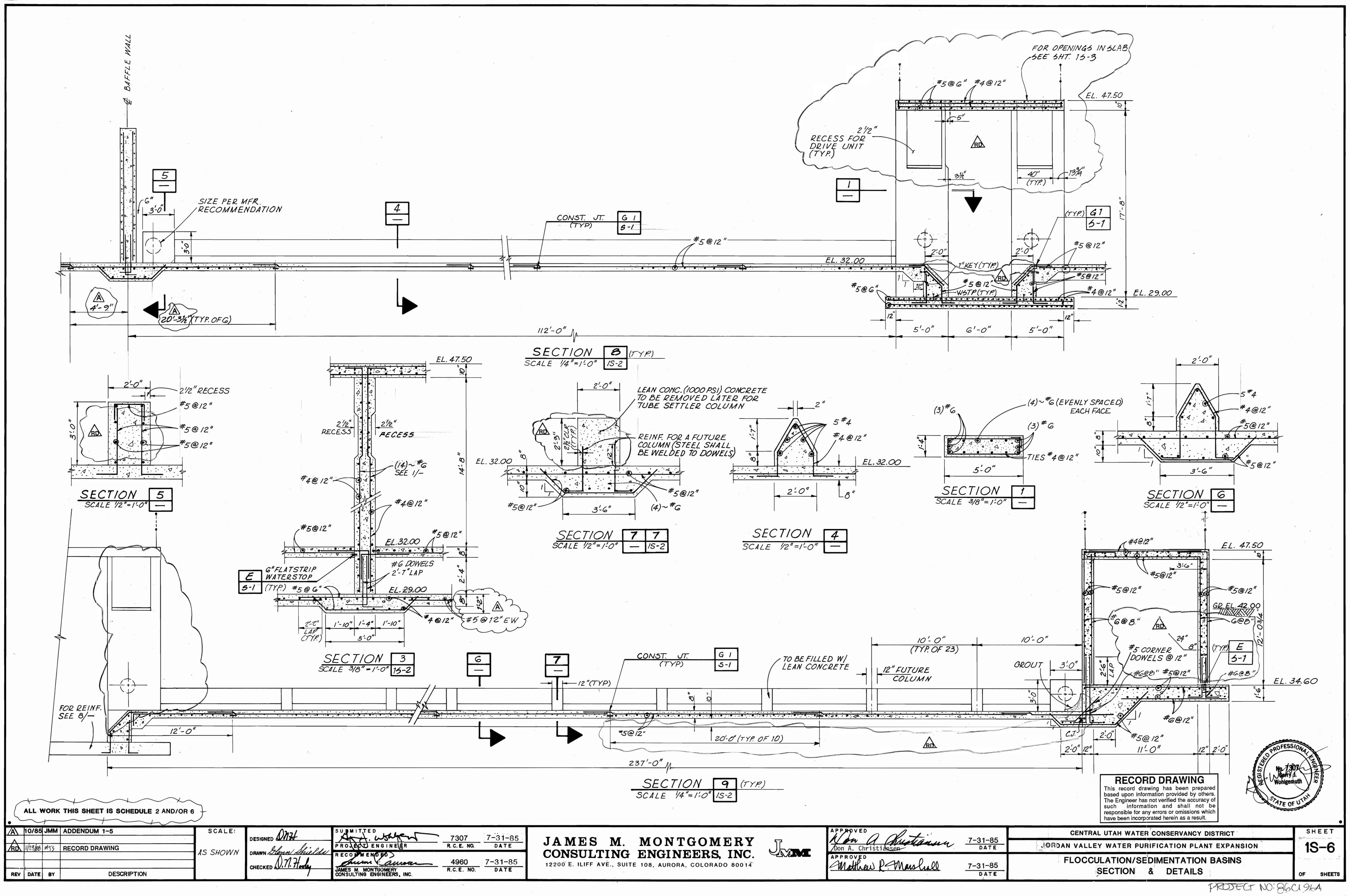
Adding plate settlers to the existing floc/sed basins creates challenges. Plates are susceptible to freezing during winter months and require more attention that traditional open basins. Plate settler installations in winter climates are typically covered with a building or other type of enclosure. This study did not perform a structural evaluation of the 1985 floc/sed basins to determine the basins' capacity to support a super-structure, but planning level costs presented in the Cost Estimate section of this report include allowances to cover the costs of a building, assuming short masonry walls and membrane roof. Actual type of enclosure and its feasibility will need to be evaluated in the pre-design effort if this alternative is selected.

Adding plate settlers to the existing floc/sed basins adds an indirect benefit by reducing net surface loading rates in the 1985 basins, which will improve overall plant performance by making the existing process more robust.

Table 1 provides design criteria for current and expanded facilities under Alternative 1.

Table 1 Design Criteria for Current and Expanded Facilities
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District

Description	Units	Current	Add 2 stages of flocculation and plate settlers	Comments
Flocculation				
Type: Vertical shaft, parallel flow				
Old Basins	No.	2	2	
Flow Rate, each	mgd	30.0	30.0	
Number of Stages	No.	4	4	4x2, 42.5' x 26'
Water Depth	ft	10.0	10.0	
Volume, Total	gal	1,323,000	1,323,000	
Flocculation Time	min	32	32	
1985 Basins	No.	4	4	
Flow Rate, each	mgd	30.0	48.8	
Number of Stages	No.	4	6	60'x30' each stage
Water Depth	ft	12	12	
Volume, Total	gal	2,586,000	3,879,000	
Flocculation Time	min	31	29	
Sedimentation				
Type: Rectangular, chain & flight				
Old Basins	No.	2	2	
Water Depth	ft	10	10	
Basin Dimensions	ft x ft	85 x 257	85 x 257	
Volume, each	gal	1,635,000	1,635,000	
Sed Basin Contact Time	min	78	78	
Surface Area, each	ft2	21,845	21,845	
Nominal Surface Loading Rate	gpm/ft2	0.95	0.95	
1985 Basins	No.	4	4	
Water Depth	ft	12	12	
Basin Dimensions	ft x ft	60 x 360	60 x 360	
Volume, each	gal	1,940,000	1,940,000	
Sed Basin Contact Time	min	93	57	
Nominal Plate Surface Area, each	ft2		10,200	60 x 170 plate coverage
Nominal Surface Loading Rate	gpm/ft2	0.97	3.32	

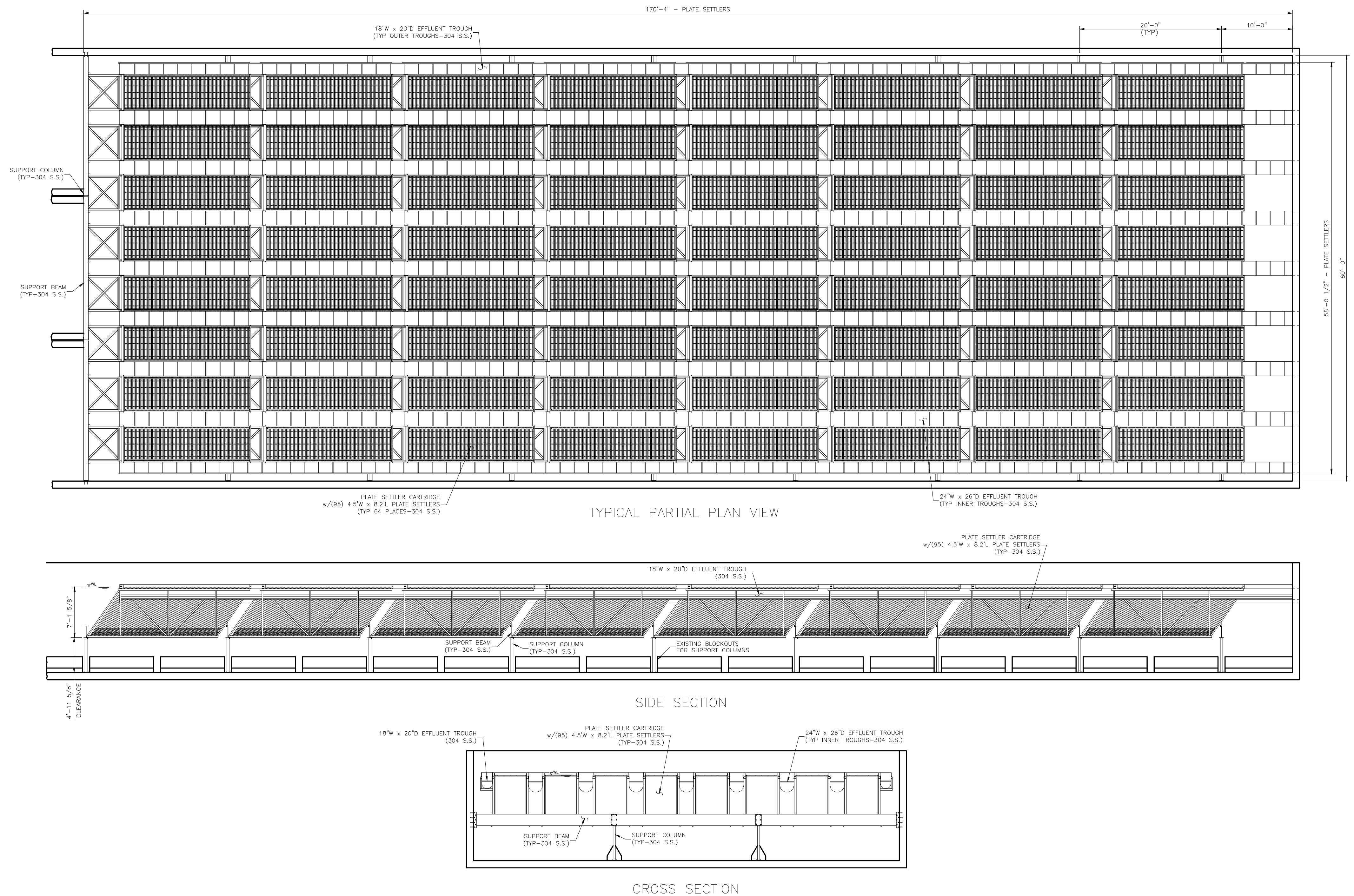


Drawing 1S-6 from 1985 Expansion Project

FIGURE 4

JORDAN VALLEY WATER TREATMENT PLANT

JORDAN VALLEY WATER CONSERVANCY DISTRICT



MEURER RESEARCH, INC. 6270 Joyce Dr., Golden, CO 80403	PROJECT NAME: JORDAN VALLEY WPP PROJECT LOCATION: UT	DRAWN BY: CDH DATE: 8-13-14	TYPICAL BASIN VIEWS - 50 MGD SYSTEM CONCEALED BEAM PLATE SETTLER SYSTEM	This drawing and the contents thereof are the property of Meurer research Inc. and may not be copied without the consent of Meurer Research, Inc.. This drawing may not be used in any way that would be detrimental to the aforementioned.	DRAWING NUMBER D01

Plate Settler Conceptual Layout from MRI

FIGURE 5

JORDAN VALLEY WATER TREATMENT PLANT
JORDAN VALLEY WATER CONSERVANCY DISTRICT

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4.2.2 Alternative 2: Construct Two Additional Floc/Sed Basins

JVWTP staff is able to operate the existing floc/sed basins to produce acceptable settled water quality at 180 mgd; based on regarding current plant performance, Alternative 2 increases floc/sed capacity by installing two new identical floc/sed basins using the same hydraulic loading rates and configuration as the existing 1985 basins. The new basins would be constructed parallel to the existing 1985 basins.

Table 2 provides design criteria for current and expanded facilities under Alternative 2.

**Table 2 Add Two New Floc/Sed Basins Parallel to Existing 1985 Basins
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District**

Description	Units	Current	Add 2 New Floc/Sed Basins Parallel to 1985 Basins	Comments
Flocculation				
Type: Vertical shaft, parallel flow				
Old Basins	No.	2	2	
Flow Rate, each	mgd	30.0	31.9	
Number of Stages	No.	4	4	4x2, 42.5' x 26'
Water Depth	ft	10.0	10.0	
Volume, Total	gal	1,323,000	1,323,000	
Flocculation Time	min	32	30	
1985 Basins	No.	4	4	
Flow Rate, each	mgd	30.0	31.9	
Number of Stages	No.	4	4	60'x30' each stage
Water Depth	ft	12	12	
Volume, Total	gal	2,586,000	2,586,000	
Flocculation Time	min	31	29	
New Expansion Basins	No.		2	
Flow Rate, each	mgd		31.9	
Number of Stages	No.		4	
Water Depth	ft		12	
Volume, Total	gal		1,293,000	75 x 25 per stage
Flocculation Time	min		29	
Sedimentation				
Type: Rectangular, chain & flight				
Old Basins	No.	2	2	
Water Depth	ft	10	10	
Basin Dimensions	ft x ft	85 x 257	85 x 257	85 x 257
Volume, each	gal	1,635,000	1,635,000	

Table 2 Add Two New Floc/Sed Basins Parallel to Existing 1985 Basins Jordan Valley WTP Capacity and Site Optimization Study Jordan Valley Water Conservancy District				
Description	**Units**	**Current**	**Add 2 New Floc/Sed Basins Parallel to 1985 Basins**	**Comments**
Sed Basin Contact Time	min	78	74	
Surface Area, each	ft2	21,845	21,845	
Nominal Surface Loading Rate	gpm/ft2	0.95	1.01	
1985 Basins	No.	4	4	
Water Depth	ft	12	12	
Basin Dimensions	ft x ft	60 x 360	60 x 360	
Volume, each	gal	1,940,000	1,940,000	
Sed Basin Contact Time	min	93	88	
Nominal Plate Surface Area, each	ft2	21,600	NA	
Nominal Surface Loading Rate	gpm/ft2	0.97	1.03	
New Expansion Basins	No.		2	
Water Depth	ft		12	
Basin Dimensions	ft x ft		60 x 360	
Volume, each	gal		1,940,000	
Sed Basin Contact Time	min		88	
Nominal Surface Loading Rate	gpm/ft2		1.03	

4.2.3 Alternative 3: Construct Two Additional Floc/Sed Basins with Plates

This alternative is similar to the previous alternative, except that the new basins are equipped with plate settlers and are consequently substantially shorter. Covering the new, shorter basins is much easier than covering the large existing basins because the existing basin walls were not originally designed for a superstructure. Smaller basins with plates leave additional space available for other facilities and these new basins could be designed for even higher flow rates to reduce surface loading on the existing basins and improve JVWTP's overall settled water quality.

Table 3 provides design criteria for current and expanded facilities under Alternative 3.

Table 3	Add Two New Shorter, Covered Floc/Sed Basins with Plates Jordan Valley WTP Capacity and Site Optimization Study Jordan Valley Water Conservancy District			
Description	**Units**	**Current**	**Add 2 New Shorter, Covered Floc/Sed Basins with Plates Parallel to 1985 Basins**	**Comments**
Flocculation				
Type: Vertical shaft, parallel flow				
Old Basins	No.	2	2	
Flow Rate, each	mgd	30.0	31.9	
Number of Stages	No.	4	4	4x2, 42.5' x 26'
Water Depth	ft	10.0	10.0	
Volume, Total	gal	1,323,000	1,323,000	
Flocculation Time	min	32	30	
1985 Basins	No.	4	4	
Flow Rate, each	mgd	30.0	31.9	
Number of Stages	No.	4	4	60'x30' each stage
Water Depth	ft	12	12	
Volume, Total	gal	2,586,000	2,586,000	
Flocculation Time	min	31	29	
New Expansion Basins	No.		2	
Flow Rate, each	mgd		31.9	
Number of Stages	No.		4	
Water Depth	ft		12	
Volume, Total	gal		1,293,000	60 x 30 per stage
Flocculation Time	min		29	
Sedimentation				
Type: Rectangular, chain & flight				
Old Basins	No.	2	2	
Water Depth	ft	10	10	
Basin Dimensions	ft x ft	85 x 257	85 x 257	
Volume, each	gal	1,635,000	1,635,000	
Sed Basin Contact Time	min	78	74	
Surface Area, each	ft2	21,845	21,845	
Nominal Surface Loading Rate	gpm/ft2	0.95	1.01	

Table 3 Add Two New Shorter, Covered Floc/Sed Basins with Plates Jordan Valley WTP Capacity and Site Optimization Study Jordan Valley Water Conservancy District				
Description	**Units**	**Current**	**Add 2 New Shorter, Covered Floc/Sed Basins with Plates Parallel to 1985 Basins**	**Comments**
1985 Basins	No.	4	4	
Water Depth	ft	12	12	
Basin Dimensions	ft x ft	60 x 360	60 x 360	
Volume, each	gal	1,940,000	1,940,000	
Sed Basin Contact Time	min	93	88	
Nominal Surface Loading Rate	gpm/ft2	0.97	1.03	
New Expansion Basins	No.		2	
Water Depth	ft		12	
Basin Dimensions	ft x ft		60 x 360	
Volume, each	gal		1,940,000	
Sed Basin Contact Time	min		88	
Nominal Plate Surface Area, each	ft2		7,800	60 x 130 plate coverage
Nominal Surface Loading Rate	gpm/ft2		1.03	

4.3 Filters – common to all alternatives

The existing 16 filters already operate near the Utah DDW maximum default filtration rate of 6.0 gpm/sf when the plant is running at 180 mgd. Based on the available headloss for solids accumulation, filter box design, media configuration, and ability to accommodate additional media, these filters are strong candidates for operation at higher filtration rates up to 8.0 gpm/sf. JVWCD should consider a future project to pilot test and rerate the filters with Utah DDW to operate at higher rates. This effort was beyond the scope of this project, and expansion alternatives are based on maintaining the existing filtration rate.

Six additional filters (twenty-two filters total) matching the size and configuration of the existing filters are needed to achieve 255 mgd. An additional backwash tank and a new dedicated backwash supply line is recommended to avoid the bottleneck that can result from backwashing more than twenty filters each day with a single backwash system.

The new filters could be constructed west of the existing Filter Building by extending the filter inlet channels and filter effluent line across to the new building. This also represents an opportunity to resolve headloss issues in the filter effluent line.

Table 4 provides design criteria for current and expanded filter and backwash facilities.

Table 4 Additional Filtration and Backwash Facilities
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District

Description	Units	Current	New Filter and BW Facilities	Comments
Filtration				
Type: Gravity, dual media, influent weir	No.	16	22	6 new filters
Area Each	ft2	1,408	1,408	six @ 2 (11x64)
Total Area	ft2	22,528	30,976	
Nominal Rate	gpm/ft2	5.6	5.7	
Max Rate (one in backwash)	gpm/ft2	5.9	6.0	6 gpm/ft2 max rate for dual media
Flow Rate, Each (@ max rate)	mgd	12.0	12.1	
Typical Unit Filter Run Volume	gal/ft2/run	8,500	8,500	
Filter Run Time	hrs	24	24	
Filter Plant Production Efficiency	%	96.7%	96.7%	
Estimated Daily Backwashes	No.	17	23	
Backwash Vol, per wash (incl RTW)	gal/wash	377,000	377,000	
Waste BW Vol, per wash (incl RTW)	gal/cycle	377,000	377,000	
Total Estimated Vol Backwash, Daily	gpd	6,409,000	8,671,000	
Backwash Supply				
Type: Elevated circular tank	No.	1	2	
Volume	gal	1,000,000	2,000,000	
Number Backwash Volumes	No.	2	5	
Backwash Supply Pumps	No.	4	4	
Pumping Capacity (one in stdby)	gpm	10,000	10,000	
Time to Replace BW Volume	hrs	0.6	0.6	

4.4 Solids Dewatering – common to all alternatives

Adding 75 mgd of plant capacity will increase solids and filter waste washwater (FWW) production substantially. Current solids dewatering facilities are undersized and underperforming. The alternatives outlined in the 2005 Report are appropriate alternatives for improving the solids handling system for the 180 mgd plant capacity. However, these will not be sufficient to accommodate expansion to 255 mgd due to increased number of backwashes, increased recycle water, and increased solids production. To accommodate expansion to 255 mgd, Carollo recommends replacing the existing system with a more robust strategy that will simplify operations and improve performance. The reconfigured system will also dramatically improve operations for the current 180 mgd capacity and could be implemented in a phased approach.

The reconfigured solids dewatering improvement system is described below and Table 5 provides design criteria for current and expanded facilities.

Table 5 Solids Dewatering Design Criteria
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District

Description	Units	Current	With Solids Dewatering Improvements @ 255 mgd	Comments
Existing Solids Handling Facilities				
Solids Production Estimates				
Average Annual Plant Flow Rate	mgd	81	115	
Plant Treated Water Production	Mg/yr	29,565	41,884	
Average Annual Unit Sludge Production Rate	lbs/Mgal	122	122	Max is 169 in June, drops to 109 in July with no PAC
Estimated Annual Solids Production	lbs/yr	3,606,930	5,109,818	
Solids Removed by Sed Basins (80% efficiency)	lbs/yr	2,705,198	3,832,363	
Solids Removed by Filters	lbs/yr	901,733	1,277,454	
1985 FWW Lagoons				
Type: Rectangular, trap shaped	No.	2	2	
Bottom Area, each	ft2	22,000	22,000	
Water Depth, max	ft	8	8	
Volume, each (at max depth)	gal	1,700,000	1,700,000	
Unit Sludge Loading Rate, per cycle	lbs/ft2	4	4	
Sludge Capacity, each per cycle (@USLR)	lbs/cycle	88,000	88,000	
Annual Drying Cycles, each	No./yr	2	2	
Total Annual Drying Capacity (@ lbs/ft2/yr USLR)	lbs/yr	352,000	352,000	
Annual Required USLR (based on production)	lbs/ft2/yr	20	29	
Excess Capacity beyond FWW Solids	lbs/yr	(549,733)	(925,454)	Existing FWW lagoons are deficient at current capacity of 180 mgd

Table 5	Solids Dewatering Design Criteria Jordan Valley WTP Capacity and Site Optimization Study Jordan Valley Water Conservancy District			
Description	**Units**	**Current**	**With Solids Dewatering Improvements @ 255 mgd**	**Comments**
New Solids Handling Facilities				
New FWW Equalization Basin				
Type: Circular, concrete, w/ scraper	No.		1	
Volume, each	gal		754,096	
Diameter	ft		92.5	
Height	ft		15.0	
Total Volume	gal		754,000	
Number Backwash Volumes	No.		2.0	
New FWW Transfer Pump Station				
Number of Pumps (VFD)	No.		3	
Capacity, Each	gpm		3,500	
Firm Capacity	gpm		7,000	
Time to Return One BW Vol (at firm)	hrs		0.9	
New FWW Clarifier				
Number	No.		4	
Diameter	ft2		100.0	
Area, each	ft2		7,854	
Hydraulic Loading Rate (@ firm recycle)	gpm/ft2		0.35	
New Washwater Return Pump Stations				
Large Pumps (VFD)	No.		2	
Capacity, each	gpm		6,000	
Small Pumps	No.		2	
Capacity, each	gpm		2,000	
Time to Transfer FWW Volume (1 pump)	hrs		0.6	
Sludge Lagoons				
Type: Rectangular, earthen	No.	3	6.0	
Area of Cell 1 (west)	ft2	93,000	93,000	
Area of Cell 2	ft2	93,000	93,000	
Area of Cell 3	ft2	106,000	106,000	
Area of New Cells	ft2		105,000	
Total Sludge Lagoon Area (at bottom elev)	ft2	292,000	607,000	
Sludge Drying Capacity (@ lb/sf/yr USLR)	lbs/yr	2,336,000	4,856,000	
Required Annual USLR (based upon production)	lbs/ft2/yr	9.3	6.3	
Applied Sludge to Lagoons	lbs/yr	2,705,198	3,832,363	
Excess Capacity beyond FSB Solids	lbs/yr	(369,198)	1,023,637	
Combined FWW/SL Condition: Excess Capacity	lbs/yr		98,182	

The following solids dewatering improvements for the 255 mgd capacity would also create a substantially improved system for the current 180 mgd capacity plant:

- Demo existing backwash clarifier and construct a new FWW equalization basin with pump station in its place.
- Demo existing FWW lagoons and construct four new 100-foot diameter clarifiers with pump station in their place.

The following solids dewatering improvements are only required when the plant expands to 255 mgd and can be common facilities whether the plant is expanded within the existing footprint (as described in this Section 4.0) or with new facilities on the west side of 3200 West (as described in the next Section 5.0).

- Construct three additional sludge drying beds on the east side of the plant.

4.5 Chemical Storage/Feed – common to all alternatives

The assessment of the entire chemical storage and feed system is included in the Appendix. With the exception of three systems, all existing chemical systems are satisfactory for operation at 180 mgd and easily expanded to 255 mgd with simple modifications – adding a tank where a future tank is planned, or providing larger chemical feed pumps. The three systems that require more extensive improvements are chlorine, powdered activated carbon, and cationic polymer.

4.5.1 Chlorine

The JVWTP currently uses one-ton chlorine cylinders to produce chlorine dioxide for preoxidation and disinfection and to dose chlorine post-filtration for primary disinfection and distribution system residual. The chlorine storage and feed area houses twenty-four cylinders. Twelve cylinders are online at a time and each is equipped with a 500 pound per day (ppd) vacuum regulator. There are six 2,000 ppd chlorinators, three dedicated to raw water locations, and three dedicated to finished water locations. All six are appropriately backflow protected.

Expansion to 255 mgd will require twelve more cylinders and two more chlorinators. There is no space to expand the existing chlorine room for additional chlorine storage and feed equipment. Carollo recommends relocating the existing chlorine storage and feed equipment to a new building to accommodate expansion needs, and to isolate chlorine storage from the occupied portion of the plant. The details of locating and configuring the new chlorine storage building are beyond the scope of this study and will need to be developed in future planning efforts.

4.5.2 Powdered Activated Carbon (PAC)

PAC storage and feed consists of two buried 38,500 gallon concrete tanks that are intended to store PAC slurry at a concentration of one pound per gallon. Two tube pumps rated at 30,000 milliliters per minute meter the solution to the point of application. The storage tanks provide only five to seven days of storage at an average PAC dose of 8 mg/L when the plant is operating near its 180 mgd capacity. This creates logistical problems for plant staff when ordering PAC, as there are no local producers or suppliers and timing of shipments can pose a problem if there are delays. This is exacerbated by the increased PAC demand from other water treatment plants in the area struggling with the same taste and odor challenges.

If JVWCD continues to rely on PAC for addressing taste and odor (as has been assumed in this study), Carollo recommends replacing the buried slurry tanks with aboveground silos to increase PAC storage and feed capabilities for current plant operations. Silos are modular, so an additional silo could be added when the plant is expanded to 255 mgd.

The frequency and duration of taste and odor events have substantially increased in the last three years, and this appears to be a long-term trend. The cost, complexity, and treatment impacts of feeding PAC for longer periods each year, coupled with the process benefits of ozone, make ozone an attractive long-term solution for the JVWTP that JVWCD should consider for either the existing 180 mgd plant or the expanded 255 mgd facility. It is worth noting that other large water treatment plants treating the same source as the JVWTP all have ozone facilities.

4.5.3 Cationic Polymer (PEC)

Current PEC storage at the JVWTP consists of a buried 4,000 gallon tank on the south side of the Filter Building and a 2,000 gallon tank inside the building that transfers upstairs to a day tank. The actual usable storage is less than 6,000 gallons because it is difficult to transfer this highly viscous liquid by gravity from the buried tank to the interior tank. This is inadequate storage at higher plant flows, which leads to frequent deliveries and logistical issues for plant operators. Additional PEC storage is recommended for both the current 180 mgd capacity and the 255 mgd expansion.

4.6 Finished Water Storage

Table 6 (reproduced here from New FWR Pre-Design Report [FWR PDR]) provides finished water storage comparison for several water treatment plants. Based on the criteria established for the FWR PDR, the minimum, recommended, total on-site storage volume for a 255 mgd JVWTP is 40 MG.

Operational and disinfection storage volume requirements were evaluated using the methodology established in the FWR PDR. Figure 6 presents disinfection calculations that show that a 40 MG FWR baffled to a T10 of at least 0.5 meets JVWCD goals for a disinfection safety factor of 2.0 with the reservoir less than half full. This provides sufficient operational storage to allow the plant to operate at a near constant rate throughout the year.

Table 6

Finished Water Storage Comparison
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District

Purpose: Compare FWR capacities at various WTPs to determine a ballpark range for emergency/operational storage at JVWTP

Background/ Assumptions: Clearwell capacities are included in the table for comparison, but most are not included in storage calculations because of effluent weirs
Storage hours are calculated based on FWR volumes assuming tanks are full
*Note that Susumu design manual recommends minimum of two clearwells/reservoirs (or one reservoir with two cells) with total minimum volume of 15% of plant capacity

Table 1

Owner	Plant	Plant Capacity, MGD	Clearwell volume, MG	FWR volume, MG Tank 1	Tank 2	Tank 3	*Storage, % of plant capacity	Storage, hrs	Notes	
WBWCD	Weber South	32	1	4.3			13%	3.2	1	
	Davis North	46	1	12			26%	6.3	2	
	Davis South	16		4			25%	6.0		
SLCPU	City Creek									
	Parleys									
	Big Cttnwd									
Metro	Little Cttnwd	143		9	10		13%	3.2	8	
	PotM	70		20			29%	6.9	3	
CUWCD	Utah Valley	80	2	20	15		44%	10.5		
	Duchesne	8		2	2.8		60%	14.4		
	Ashley	15	1	10			67%	16.0		
WCWCD	Quail Creek	60	0.5	5	9.3	10	41%	9.7	4	
Out of state plants										
Arlington, TX	John Kubala	97.5		10	10		21%	4.9	5	
KCWA, Bakersfield, CA	Henry Garnett	106	4.7	3	3		10%	2.4	7	clearwell included in calcs
Sacramento	Sac River	160	5.6	9.5	5		13%	3.0	6,7	clearwell included in calcs
Sacramento	EA Fairbairn	180	3	20	4		15%	3.6		
JVWCD	**Jordan Valley**	42	**n/a**	8			**19%**	**4.6**	1971, original plant	
		60		8			13%	3.2	1979, plant expansion	
		180		**8**			**4%**	**1.1**	**1985, plant expansion**	
		180		8	12.5		11%	2.7	add 12.5 MG tank	
		180		12.5	12.5		14%	3.3	replace 8 with 12.5 MG tank	
		255		12.5	12.5	15	16%	3.8	*get to Susumu minimum	

Notes

1 The 1 MG clearwell also serves as storage for the South Ogden pump station that feeds a local pressure zone and the hospital
2 The 12 MG tank is offsite (plant has no room for on site storage), but there are very few connections between the plant and the 12 MG tank
3 20 MG tank with two 10 MG cells
4 There are two clearwells, each with 0.236 MG capacity
5 two 5 MG cells make up Tank 1 and are also used for CT; Tank 2 is multiple 2 MG tanks in the distribution system on the same pressure zone
6 A 2.8 MG clearwell and 2.8 MG CT basin.
7 We don't know much about the distribution system of these California plants, there may be additional FW storage outside the plant but still on the same pressure zone as the plant; data is included as a quick glance outside the state
8 10 MG tank is offsite a few miles away from plant, but on same HGL (overflow is at the plant); tank provides operational storage for SLC

PARALLEL CONFIGURATION W/FUTURE FWR @ 255 MGD

Month	Flow and Quality Conditions			Chlorine Dioxide Disinfection								Chlorine Disinfection -- RESERVOIRS ARE IN PARALLEL							Total	Meets Minimum Ratio?	Meets Min Safety Factor?
	WTP				90" RW Pipe		Floc Basins			SW Channels		Filters				Total FWR Storage					
																0.48 % full					
	Flow (mgd)	Temp. (Deg. C)	pH	ClO2 CTr* mg min/L	CTa mg min/L	CTa/ CTr	No. Floc Basins	CTa mg min/L	CTa/ CTr	CTa mg min/L	CTa/ CTr	No. Filters Online	CTa mg min/L	CTr** mg min/L	CTa/ CTr	CTa mg min/L	CTr** mg min/L	CTa/ CTr	CTa/CTr		2
C, mg/L					0.10			0.00		0.00			0.0			0.6					
January	57	7.1	8.0	4.2	1.3	0.3	2	0.0	0.0	0.0	0.0	6	0.0	28.1	0.0	146.3	30.0	4.9	5.2		
February	57	5.9	7.9	4.2	1.3	0.3	2	0.0	0.0	0.0	0.0	6	0.0	30.0	0.0	146.3	32.0	4.6	4.9		
March	85	6.1	8.0	4.2	0.8	0.2	2	0.0	0.0	0.0	0.0	8	0.0	30.2	0.0	97.5	32.3	3.0	3.2		
April	85	10.3	8.4	4.0	0.8	0.2	2	0.0	0.0	0.0	0.0	8	0.0	26.1	0.0	97.5	27.9	3.5	3.7		
May	128	12.7	8.3	3.7	0.6	0.2	3	0.0	0.0	0.0	0.0	12	0.0	21.7	0.0	65.0	23.2	2.8	3.0		
June	170	14.1	8.2	3.4	0.4	0.1	4	0.0	0.0	0.0	0.0	15	0.0	18.8	0.0	48.8	20.1	2.4	2.5		
July	255	16.1	8.1	3.1	0.3	0.1	6	0.0	0.0	0.0	0.0	15	0.0	15.9	0.0	32.5	17.0	1.9	2.0		
August	255	16.5	8.0	3.1	0.3	0.1	6	0.0	0.0	0.0	0.0	15	0.0	14.6	0.0	32.5	15.6	2.1	2.2		
September	170	16.0	8.1	3.1	0.4	0.1	4	0.0	0.0	0.0	0.0	15	0.0	16.0	0.0	48.8	17.1	2.9	3.0		
October	113	14.4	8.6	3.4	0.6	0.2	3	0.0	0.0	0.0	0.0	8	0.0	21.1	0.0	73.1	22.5	3.2	3.4		
November	57	10.0	8.4	4.0	1.3	0.3	2	0.0	0.0	0.0	0.0	6	0.0	27.5	0.0	146.3	29.4	5.0	5.3		
December	57	7.1	8.3	4.2	1.3	0.3	2	0.0	0.0	0.0	0.0	6	0.0	31.7	0.0	146.3	33.9	4.3	4.6		

Process Conditions

CT Contactor	Volume (gals)	T10/T
90" RW Pipe to FM	500,000	1
Floc Basin, each (New)	640,000	0.65
Settled Water Channels	478,720	0.8
Filters, each	130,000	0.9
Total FWR	40.0	0.5
Required Log Inactivation (*Giardia*) =		0.5

Notes:

* Required CT value (CTr) for chlorine dioxide disinfection per EPA Guidance Manual.

** Required free chlorine CTr calculated using Norton Equation for extrapolating EPA CT tables.

operational storage: plant production at which sleeves are constant:

MG	MGD
20.8	255

10 months of year can leave sleeves fixed

3.76 hours of storage at 255 MGD

volume required for CT

19.20 MG

volume available for operational

20.8 MG

PARALLEL CONFIGURATION W/FUTURE FWR @ 255 MGD

FIGURE 6

JORDAN VALLEY WATER TREATMENT PLANT

JORDAN VALLEY WATER CONSERVANCY DISTRICT

carollo

4.7 Conclusions

All three floc/sed expansion alternatives within the existing plant footprint require the same base option of additional filters, additional backwash facilities, expanded solids dewatering facilities, and upgrades to select chemical systems. Costs for these three alternatives are provided in Section 6.0 of this report.

The existing 180 mgd plant could benefit substantially from improvements to the following processes and/or facilities:

- Solids dewatering.
- PAC storage.
- PEC storage.
- Sedimentation basin surface loading rates.

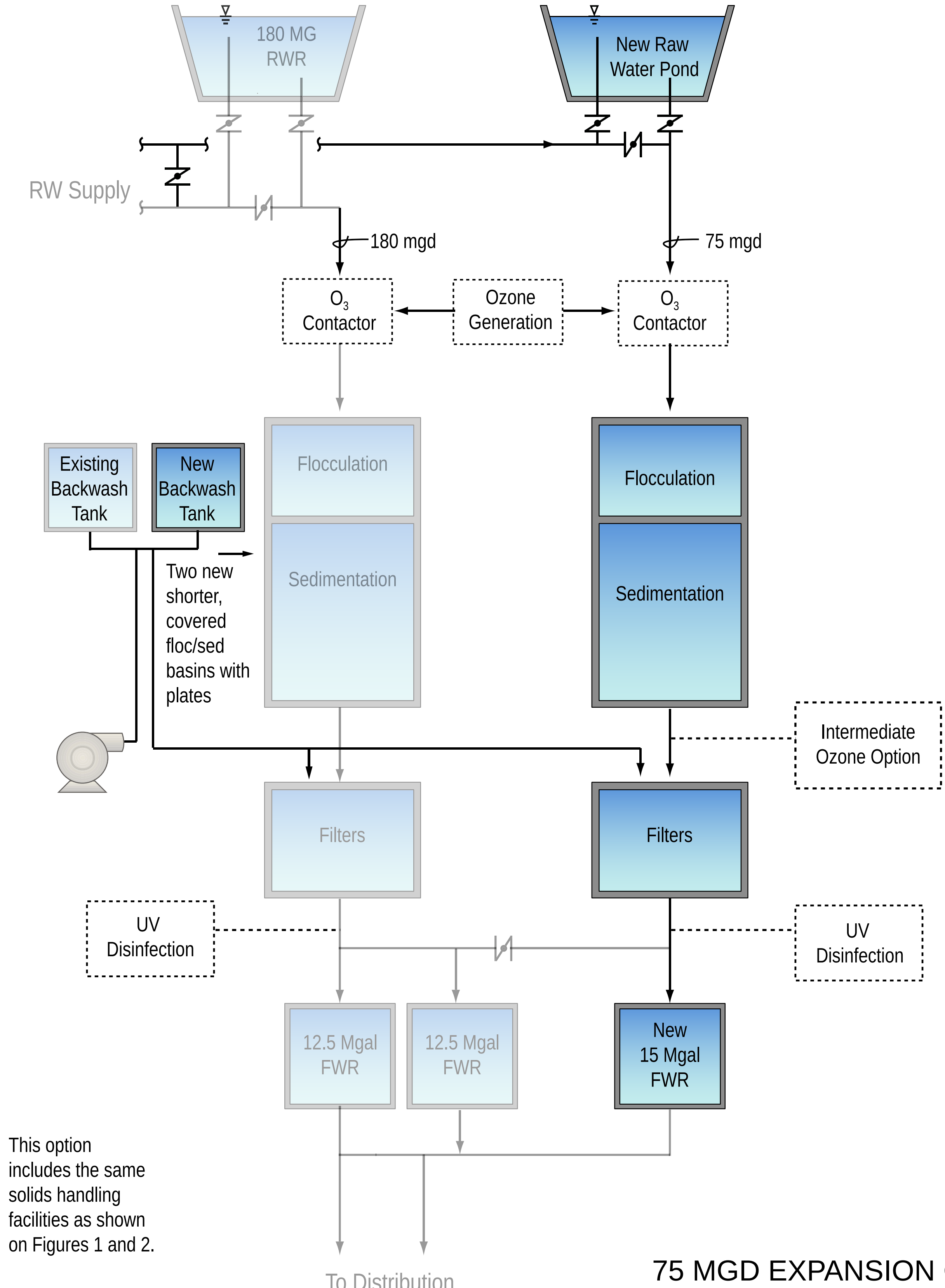
5.0 EXPAND WITH NEW PLANT

Alternative 4 expands the existing JVWTP by constructing a new 75 mgd facility on JVWCD land west of the existing plant. This new plant will include the facilities outlined below.

- RW reservoir and raw water piping modifications: Plant staff indicated they prefer to maintain the current ratio of raw water reservoir storage to plant capacity.
- Flow control: The new facility will operate with its own flow control.
- Ozone: The schematic for the new facility includes a placeholder for pre- or intermediate-ozone to account for recent changes in raw water quality and based on the successful implementation of ozone at peer plants treating the same water.
- Pretreatment: The flash mix and flocculation/sedimentation basins include plate settlers to reduce basin size and improve plant performance.
- Solids dewatering facilities: The schematic is based on joint use of solids dewatering facilities constructed on the original plant site to take advantage of existing infrastructure.
- New filter building: Eight new filters with slightly smaller surface area than existing; eight filters are required to maintain the existing 6.0 gpm/sf filtration rate with one filter out of service.
- Backwash facilities: The schematic is based on joint use of existing backwash pumps and backwash tank, with an additional backwash tank and a dedicated backwash pipe to the new filters.
- New filter waste washwater equalization basin: This facility equalizes flow before pumping to existing solids dewatering facilities.
- Chemical storage/feed: There will be a new, standalone chemical storage and feed for the new facility.
- UV: The schematic includes provisions for future installation of ultraviolet disinfection equipment.
- Finished water storage: The schematic assumes the 8 MG FWR has been replaced with a 12.5 MG FWR and that for the expansion to 255 mgd, an additional 15 MG FWR will be constructed for a total installed volume of 40 MG.

Complete design criteria for new facilities are provided in the Appendix for comparison to current plant operations and expansion within the existing plant.

A schematic for this alternative is presented in Figure 7.



Legend

Optional or Future Facility - - - - - - - - - - -

75 MGD EXPANSION CONCEPT

Alternative 4: New 75 mgd Plant

FIGURE 7

JORDAN VALLEY WATER TREATMENT PLANT

JORDAN VALLEY WATER CONSERVANCY DISTRICT

6.0 COSTS

6.1 O&M Considerations

JVWCD employs a plant manager and five plant operators at JVWTP. One of the operators is designated as the lead operator; the other four operators are on shift work so that the plant is staffed twenty-four hours a day, seven days a week. There are two operators on site for approximately six hours, three days a week.

Operators are limited to plant operations and very light maintenance; most maintenance items are addressed by submitting a work order to separate maintenance staff.

6.1.1 Expanding the Existing Plant

Alternatives 1, 2, and 3 will add time to an operator's rounds to check additional floc/sed basins and solids handling facilities, but this is not expected to be a significant amount. These three alternatives also include a separate filter building with six new filters for a total of twenty-two filters. Summer operations may require backwashing all twenty-two filters in the same day, which may mean backwashing two filters at the same time, and will likely require additional supervision.

Alternatives 1, 2, and 3 should include considerations for one additional full time employee.

6.1.2 Expanding with a New Plant

Alternative 4 would create separate stand-alone facilities that, although close to the existing plant, will require additional supervision. Only one facility, either the existing WTP or the new WTP, is anticipated to operate year-round, with the other facility operating to meet high summer demands and shutting down from late fall to spring.

Alternative 4 should include considerations for at least two additional full time employees to operate the separate facilities during summer months, and to supplement existing staff while one facility is shut down.

6.2 Ozone Cost Considerations

Evaluating ozone as a part of the existing plant processes is beyond the scope of this study; however, given that as of May 2015 all of the large water treatment plants that treat the same source water as the JVWTP have ozone facilities, it is worthwhile to provide a placeholder cost for ozone.

There are four possible ozone configurations:

1. Single 255 mgd facility (Alternatives 1, 2, and 3).
2. Common 255 mgd facility (Alternative 4).
3. Separate 180 mgd and 75 mgd facilities (Alternative 4).
4. Single 75 mgd facility (Alternative 4).

Table 7 summarizes the costs for each ozone option. Table 8 includes a single cost for ozone to allow more equal comparison of the four alternatives. The cost listed in the table is based on a common 255 mgd facility that assumes pre-ozone contact basins constructed on the south side of the existing plant in line with the existing 90-inch RW pipe. Intermediate ozone would require additional yard piping and a pump station and would be more expensive. A specific ozone planning study would need to be performed to select among the four alternatives and between pre-ozone or intermediate ozone. Planning level ozone costs should be updated at that time.

Table 7 Ozone Planning Costs
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District

Description	**Construction Cost[1]**
Single 255 mgd facility (Alternatives 1, 2, and 3)	$37,500,000
Common 255 mgd facility (Alternative 4)	$37,500,000
Separate 180 mgd and 75 mgd facilities (Alternative 4)	$26,000,000; $15,000,000
Single 75 mgd facility (Alternative 4)	$15,000,000

Notes:
(1) Construction cost values in this table do not include contingency or other project costs.

6.3 UV Cost Considerations

Ultraviolet (UV) disinfection at JVWTP is not required based on current regulations, bin classification for cryptosporidium, and JVWCD's use of chlorine for primary disinfection. Furthermore, only one of the large water treatment plants treating the same source has implemented UV, and that facility does not rely on UV to comply with regulations. A future decision to install UV at JVWTP would likely be driven by a change in water quality or regulations (e.g. additional log removal required for cryptosporidium) or a JVWCD decision to move away from chlorine for primary disinfection. Finished water hydraulic constraints identified in section 3 create real challenges for inserting UV into the existing plant, and require special considerations to address those challenges that are beyond the scope of this project. Given the hydraulic constraints and the lack of a regulatory or water quality driver for implementation in the existing JVWTP, UV facility costs have not been included for Alternatives 1, 2, or 3.

UV would be easier to include in the new 75 mgd water treatment plant because it can be designed into the hydraulic profile. Table 8 includes a planning level cost for 75 mgd UV facilities associated with a new WTP.

Capital costs for each of the four expansion alternatives described in this report are presented in Table 8.

Table 8 JVWTP Expansion Alternatives: Capital Cost Estimates
Jordan Valley WTP Capacity and Site Optimization Study
Jordan Valley Water Conservancy District

Description	Alt. 1: Plates in '85 Basins	Alt. 2: New Basins	Alt. 3: New Short Basins	Alt. 4: New 75 mgd WTP	Comments
General Conditions	$10,600,000	$9,700,000	$10,100,000	$11,500,000	
Civil / Site work	$900,000	$1,600,000	$1,400,000	$2,900,000	
RWR, 75 MG	$2,900,000	$2,900,000	$2,900,000	$2,900,000	
Yard Piping	$4,000,000	$4,100,000	$4,100,000	$6,000,000	
Landscaping	$150,000	$200,000	$200,000	$500,000	
Plant Inlet Structure	$0	$0	$0	$250,000	
Floc/Sed Basins	$26,400,000	$15,000,000	$20,000,000	$19,200,000	
Filters	$15,600,000	$15,600,000	$15,600,000	$16,500,000	
UV Disinfection	$0	$0	$0	($7,200,000)	not included in total cost
Ozone	$37,500,000	$37,500,000	$37,500,000	$37,500,000	See Section 6.2
FWR	$14,000,000	$14,000,000	$14,000,000	$14,000,000	15 MG FWR
Chemical Feed Facilities	$5,000,000	$5,000,000	$5,000,000	$10,000,000	
Operations Building	$0	$0	$0	$3,000,000	
Backwash Supply Facilities	$3,000,000	$3,000,000	$3,000,000	$3,000,000	
FWW Basin and PS	$2,500,000	$2,500,000	$2,500,000	$3,000,000	
FWW Clarifiers, PS	$4,500,000	$4,500,000	$4,500,000	$4,500,000	
Sludge Lagoons	$3,000,000	$3,000,000	$3,000,000	$3,000,000	
Electrical	$19,600,000	$17,800,000	$18,600,000	$21,800,000	
Instrumentation	$4,000,000	$3,600,000	$3,800,000	$4,400,000	
Construction Estimate	**$153,650,000**	**$140,000,000**	**$146,200,000**	**$163,950,000**	
Contingency (30%)	$46,100,000	$42,000,000	$43,860,000	$49,190,000	
Escalation to Midpoint	$3,850,000	$3,500,000	$3,660,000	$4,100,000	
Eng, Admin, Legal (20%)	$30,730,000	$28,000,000	$29,240,000	$32,790,000	
TOTAL COST (with ozone)	**$234,400,000**	**$213,500,000**	**$223,000,000**	**$250,100,000**	
TOTAL COST (without ozone)	**$177,200,000**	**$156,400,000**	**$165,800,000**	**$203,900,000**	

7.0 CONCLUSION

Alternative 1, installing plate settlers inside the four existing 1985 basins, is the most expensive onsite alternative, due mainly to the cost of plates and covering the very large basins. However, this alternative also provides a process benefit to the existing plant by installing enough plates for the entire basin flow rate (49 mgd) rather than the incremental expansion capacity (i.e. the incremental 19 mgd for each 1985 basin), which will improve overall plant performance.

Alternative 2, constructing new uncovered basins parallel to the existing 1985 basins, is the lowest cost alternative, and mirrors the existing processes. However, this adds new construction around aging existing construction, and offers no improvements to current process performance.

Alternative 3, constructing new shorter covered basins with plates, is less expensive than Alternative 1 but more expensive than Alternative 2. It provides new technology with plate settlers that will perform better than the open basins, but also adds minor complexity to the existing plant in that it will look and operate differently than the other floc/sed basins.

Alternative 4, constructing new facilities on the west side of 3200 West, is the most expensive alternative. However, this alternative provides a new plant with a new lifespan that is independent of the existing plant, and would provide redundancy in an emergency. Expanding with a new plant will also provide flexibility to replace the existing plant when it has reached the end of its useful life.

Of these four alternatives, Alternative 2 is the least expensive and most similar to current plant processes and operations. Alternative 4, although the most expensive, but provides a new state-of-the-art facility to supplement the existing JVWTP and provides the significant benefit of process redundancy. For these reasons, Alternatives 2 and 4 are recommended for JVWCD's consideration.

APPENDIX A – DESIGN CRITERIA

Appendix
Process Capacity Summary Information
JVWTP
Jordan Valley WTP

Description	Units	Current	Expand Exist w/FSB & Filters	Modify Exist w/ Plates	New 75 mgd WTP	Comments
Plant Flow Rate	mgd	180	255	255	75	
	gpm	125,100	177,225	177,225	52,125	
Net Plant Production Rate (minus recycle)	mgd	174	247	247	73	
Flash Mixing						
Pumped Diffusion Mixer	No.	1			1	
Number Pumps	No.	2			2	
Capacity	gpm	3,500				
Mixing Gradient, G	1/sec	461	326	326		
Mixing Gradient, Gt		1,992	1,988	1,988		
Size, each pump	Hp	50				
Flocculation						
Type: Vertical shaft, parallel flow						
Old Basins	No.	2	2	2		
Flow Rate, each	mgd	30.0	31.9	30.0		
Number of Stages	No.	4	4	4		4x2, 42.5' x 26'
Water Depth	ft	10.0	10.0	10.0		
Volume, Total	gal	1,323,000	1,323,000	1,323,000		
Flocculation Time	min	32	30	32		
1985 Basins	No.	4	4	4		
Flow Rate, each	mgd	30.0	31.9	48.8		
Number of Stages	No.	4	4	6		60'x30' each stage
Water Depth	ft	12	12	12		
Volume, Total	gal	2,586,000	2,586,000	3,879,000		
Flocculation Time	min	31	29	29		
New Expansion Basins	No.		2		2	
Flow Rate, each	mgd		31.9		38	
Number of Stages	No.		4		4	
Water Depth	ft		12		18	
Volume, Total	gal		1,293,000		2,019,900	75 x 25 per stage
Flocculation Time	min		29		39	
Sedimentation						
Type: Rectangular, chain&flight						
Old Basins	No.	2	2	2		
Water Depth	ft	10	10	10		
Basin Dimensions	ft x ft	85 x 257	85 x 257	85 x 257		85 x 257
Volume, each	gal	1,635,000	1,635,000	1,635,000		
Sed Basin Contact Time	min	78	74	78		
Surface Area, each	ft2	21,845	21,845	21,845		
Nominal Surface Loading Rate	gpm/ft2	0.95	1.01	0.95		
1985 Basins	No.	4	4	4	2	
Water Depth	ft	12	12	12	18	
Basin Dimensions	ft x ft	60 x 360	60 x 360	60 x 360	75 x 120	
Volume, each	gal	1,940,000	1,940,000	1,940,000	1,212,000	
Sed Basin Contact Time	min	93	88	57	47	
Nominal Plate Surface Area, each	ft2	NA	NA	10,200	6,750	60x170 and 75 x 90 plate coverage
Nominal Surface Loading Rate	gpm/ft2	0.97	1.03	3.32	3.86	
New Expansion Basins	No.		2			
Water Depth	ft		12			
Basin Dimensions	ft x ft		60 x 360			
Volume, each	gal		1,940,000			
Sed Basin Contact Time	min		88			
Nominal Surface Loading Rate	gpm/ft2		1.03			
Filtration						
Type: Gravity, dual media, weir, elev tank bw	No.	16	22	22	8	6 new filters
Area Each	ft2	1,408	1,408	1,408	1,240	six @2(11x64) vs 8@16x80
Total Area	ft2	22,528	30,976	30,976	9,920	
Nominal Rate	gpm/ft2	5.6	5.7	5.7	5.3	
Max Rate (one in backwash)	gpm/ft2	5.9	6.0	6.0	6.0	6 gpm/ft2 max rate for dual media
Flow Rate, Each (@ max rate)	mgd	12.0	12.1	12.1	10.7	
Typical Unit Filter Run Volume	gal/ft2/run	8,500	8,500	8,500	10,000	
Filter Run Time	hrs	24	24	24	28	
Filter Plant Production Efficiency	%	96.7%	96.7%	96.7%	96.7%	
Estimated Daily Backwashes	No.	17	23	23	7	
Backwash Vol, per wash (incl RTW)	gal/wash	377,000	377,000	377,000	210,000	
Waste BW Vol, per wash (incl RTW)	gal/cycle	377,000	377,000	377,000	210,000	
Total Estimated Vol Backwash, Daily	gpd	6,409,000	8,671,000	8,671,000	1,470,000	
Backwash Supply						
Type: Elevated circular tank	No.	1	2	2	1	
Volume	gal	1,000,000	2,000,000	2,000,000	750,000	
Number Backwash Volumes	No.	2	5	5	3	
Backwash Supply Pumps	No.	4	4	4	4	
Pumping Capacity (one in stdby)	gpm	10,000	10,000	10,000	10,000	
Time to Replace BW Volume	hrs	0.6	0.6	0.6	0.4	

	FWW Handling Facilities						
	Solids Production Estimates						
0.5	Average Annual Plant Flow Rate	mgd	81	115	115	34	
	Plant Treated Water Production	Mg/yr	29,565	41,884	41,884	12,319	
	Average Annual Unit Sludge Production Rate	lbs/Mgal	122	122	122	122	
	Estimated Annual Solids Production	lbs/yr	3,606,930	5,109,818	5,109,818	1,502,888	
0.75	Solids Removed by Sed Basins	lbs/yr	2,705,198	3,832,363	3,832,363	1,127,166	
	Solids Removed by Filters	lbs/yr	901,733	1,277,454	1,277,454	375,722	
	1985 FWW Lagoons						
	Type: Rectangular, trap shaped	No.	2	2	2		
	Bottom Area, each	ft2	22,000	22,000	22,000		
	Water Depth, max	ft	8	8	8		
	Volume, each (at max depth)	gal	1,700,000	1,700,000	1,700,000		
	Unit Sludge Loading Rate, per cycle	lbs/ft2	4	4	4		
	Sludge Capacity, each per cycle (@USLR)	lbs/cycle	88,000	88,000	88,000		
	Annual Drying Cycles, each	No./yr	2	2	2		
	Total Annual Drying Capacity (@ lbs/ft2/yr USLR)	lbs/yr	352,000	352,000	352,000		
	Annual Required USLR (based on production)	lbs/ft2/yr	20	29	29		
	Excess Capacity beyond FWW Solids	lbs/yr	(549,733)	(925,454)	(925,454)		
	Old FWW Clarifier						
	Type: Circular, concrete, w/ scraper	No.	1				
	Surface Area	ft2	9,500				
	Volume	gal	1,000,000				
	Number FWW Volumes	No.	2.7				
	Sludge Pumps	No.	2				
	Capacity, each	gpm	500				
	Old Recycle Pump Station						
	Large Pumps (VFD)	No.	2				
	Capacity, each	gpm	6,000				
	Small Pumps	No.	2				
	Capacity, each	gpm	2,000				
	Time to Transfer FWW Volume (1 pump off)	hrs	0.6				
	New FWW Basin (POMWTP Style)						
	Type: Rectangular, buried concrete, POMWTP	No.		1	1	1	
	Volume, each	gal		763,960	763,960	469,059	
	Water Depth	ft		12.0	12.0	11.0	
	Length, each	ft		185.0	185.0	190.0	
	Width, each	ft		46.0	46.0	30.0	
	Total Volume	gal		763,000	763,000	469,000	
	Number Backwash Volumes	No.		2.0	2.0	2.2	
	New FWW Flow Equalization Basin (FEB) SK Style						
	Type: Circular, concrete, w/ scraper	No.		1	1		
	Volume, each	gal		754,096	761,572		
	Diameter	ft		92.5	90		
	Water Depth	ft		15.0	16.0		
	Total Volume	gal		754,000	761,000		
	Number Backwash Volumes	No.		2.0	2.0		
	New FWW Transfer Pump Station						
	Number of Pumps (VFD)	No.		3	3	3	
	Capacity, Each	gpm		3,500	3,500	2,800	
	Firm Capacity	gpm		7,000	7,000	5,600	
	Time to Return One BW Vol (at firm)	hrs		0.9	0.9	0.6	
	New FWW Clarifier						
	Number	No.		4	4	4	
	Diameter	ft2		100.0	100.0	100.0	
	Area, each	ft2		7,854	7,854	7,854	
85%	Hydralic Loading Rate (@ firm recycle rate)	gpm/ft2		0.35	0.35	0.28	
	New Washwater Return Pump Stations						Used existing?
	Large Pumps (VFD)	No.		2			
	Capacity, each	gpm		6,000			
	Small Pumps	No.		2			
	Capacity, each	gpm		2,000			
	Time to Transfer FWW Volume (1 pump out)	hrs		0.6			
	Solids Handling Facilities						
	Solids Production Estimates						
0.45	Average Annual Plant Flow Rate	mgd	81	115	115	34	
	Plant Treated Water Production	Mg/yr	29,565	41,884	41,884	12,319	
	Average Annual Unit Sludge Production Rate	lbs/Mgal	122	122	122	122	Max is 169 in June, drops to 109 in July with no PAC
	Estimated Annual Solids Production	lbs/yr	3,606,930	5,109,818	5,109,818	1,502,888	
0.75	Solids Removed by Sed Basins	lbs/yr	2,705,198	3,832,363	3,832,363	1,127,166	
	Solids Removed by Filters	lbs/yr	901,733	1,277,454	1,277,454	375,722	
	Sludge Lagoons						
	Type: Rectangular, earthen	No.	3	6.0	6.0	2.0	
	Area of Cell 1 (west)	ft2	93,000	93,000	93,000	93,000	
	Area of Cell 2	ft2	93,000	93,000	93,000	93,000	
	Area of Cell 3	ft2	106,000	106,000	106,000	106,000	
	Area of New Cells	ft2		105,000	105,000	105,000	
	Total Sludge Lagoon Area (at bottom elev)	ft2	292,000	607,000	607,000	199,000	
8	Sludge Drying Capacity (@ lbs/ft2/yr USLR)	lbs/yr	2,336,000	4,856,000	4,856,000	1,592,000	
	Required Annual USLR (based upon production)	lbs/ft2/yr	9.3	6.3	6.3	5.7	
	Applied Sludge to Lagoons	lbs/yr	2,705,198	3,832,363	3,832,363	1,127,166	
	Excess Capacity beyond FSB Solids	lbs/yr	(369,198)	1,023,637	1,023,637	464,834	
	Combined FWW/SL Condition: Excess Capacity	lbs/yr		98,182	98,182	95,637	

Chemical Feed Facilities						
Aluminum Chlorohydrate (ACH)						
						Always try to unload a full shipment into an empty tank
Storage Tanks	No	3				
Storage Capacity (each)	gal	16,000				
Storage Capacity (total)	gal	48,000				
Metering Pumps (grundfos, digital diaphram)	No	2				
Capacity (each)	mL/min	2,500				
Average dose at high flow	mg/L	6.0				
Days of storage	day	59.5				
Polymer (PE1); Cationic						
Storage Type: Bulk tank with day tanks	No	1				1 inside, on main level, fills with buried tank
						2000 gal vertical tank inside, linked fill pipe with
Storage Capacity	gal	4,000				buried tank
Metering Pumps (grundfos, digital diaphram)	No	1				2 day tanks on scales
						(steve says this is tightest chemical, need more
Capacity (each)	mL/min	2,500				storage at high flows)
						2 polyblends, don't use them anymore for
Average dose at high flow	mg/L	1.2				polydadmac (mixing doesn't make a difference)
						dilutes cationic in the winter to help pumps on low
Days of storage	day	28.8				end
Polymer (PE2); Nonionic polyelectrolyte						
Storage Type: pallets of 55 lb bags	No	40				Clarifloc N3300P
Storage Capacity (each)	gal	300				filter aid
Storage Capacity (total)	gal	600				.01 - 0.6 lbs per gallon
Metering Pumps (grundfos, digital diaphram)	No	2				polyblend
Capacity (each)	mL/min	2,500				
Average dose at high flow	mg/L	0.02				
Days of storage	day					
Powder Activated Carbon (PAC)						
Storage Type: Silo	No	2				
Storage Capacity	lbs, ea	38,500				1 lb/gal PAC
	lbs, total	77,000				
Metering Type (Watson Marlow tube pumps)	No	2				concern about tube pump crushing PAC
Feeder Capacity	mL/min	30,000				not enough storage
Average dose at high flow	mg/L	8				shipments every 7-10 days
Days of storage	day	6.4				
Chlorine (CLG) (Gas)						
Storage Tanks (1-ton cylinders)	No	24				
Storage Capacity (each)	lbs	2,000				
Storage Capacity (total)	lbs	48,000				500 ppd vaccuum regulator on each container
Chlorinators	No	6				3 are backflow protected for RW, 3 for post
Capacity (each)	lb/day	2,000				pre and post
Average dose at high flow	mg/L	2-3.5				change out sometimes 2 or 3 per day
Days of storage	day	10.7				no auto-switchover valve, have 12 online at a time
Fluoride (FL)						
Storage Tanks	No	3				
Storage Capacity (each)	gal	5,900				day tank on a scale w/ultrasonic
						flooded suction transfer pump to day tank
Storage Capacity (total)	gal	17,700				(operator initiated)
Metering Pumps (peristaltic)	No	2				
Capacity (each)	mL/min	700, 2250				same pump, different tube sizes
Average dose at high flow	mg/L	0.5				
Days of storage	day	62.8				
Chlorine Dioxide (CLD)						
Storage Tanks	No	1	Same	Same		
Storage Capacity (each)	gal	2,500	Same	Same		
Storage Capacity (total)	gal	2,500	Same	Same		
On-site Generators	No	2	Same	Same		
Capacity (each)	ppd	2,500	Same	Same		
Average dose at high flow	mg/L	0.6	Same	Same		
Chlorine gas useage	ppd	750.0	1,060	1,060		
Sodium Hypochlorite Storage Tanks	No	2	3	3		
Storage Capacity (each)	gal	6,000	6,000	6,000		
Storage Capacity (total)	gal	12,000	18,000	18,000		
Storage Capacity (25% solution)	Days	25	26	26		