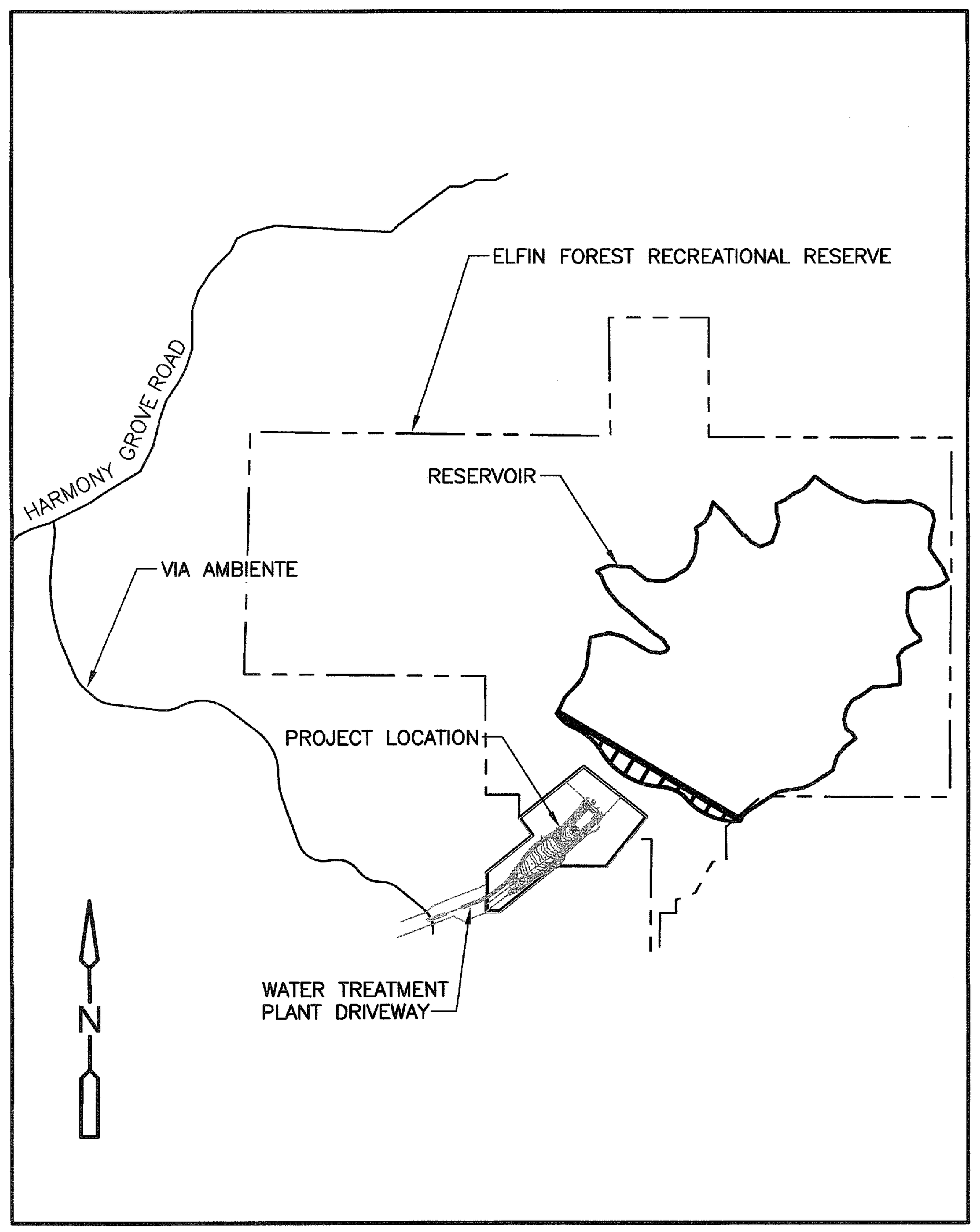
OLIVENHAIN

Municipal Water District

**RESIDUALS HANDLING BUILDING AS-BUILTS**
Supplement to the DCMWTP Condition Assessment & Improvement Recommendations RFP August 2022

# DAVID C. McCOLLOM WATER TREATMENT PLANT LT2 IMPROVEMENTS




**LOCATION MAP**

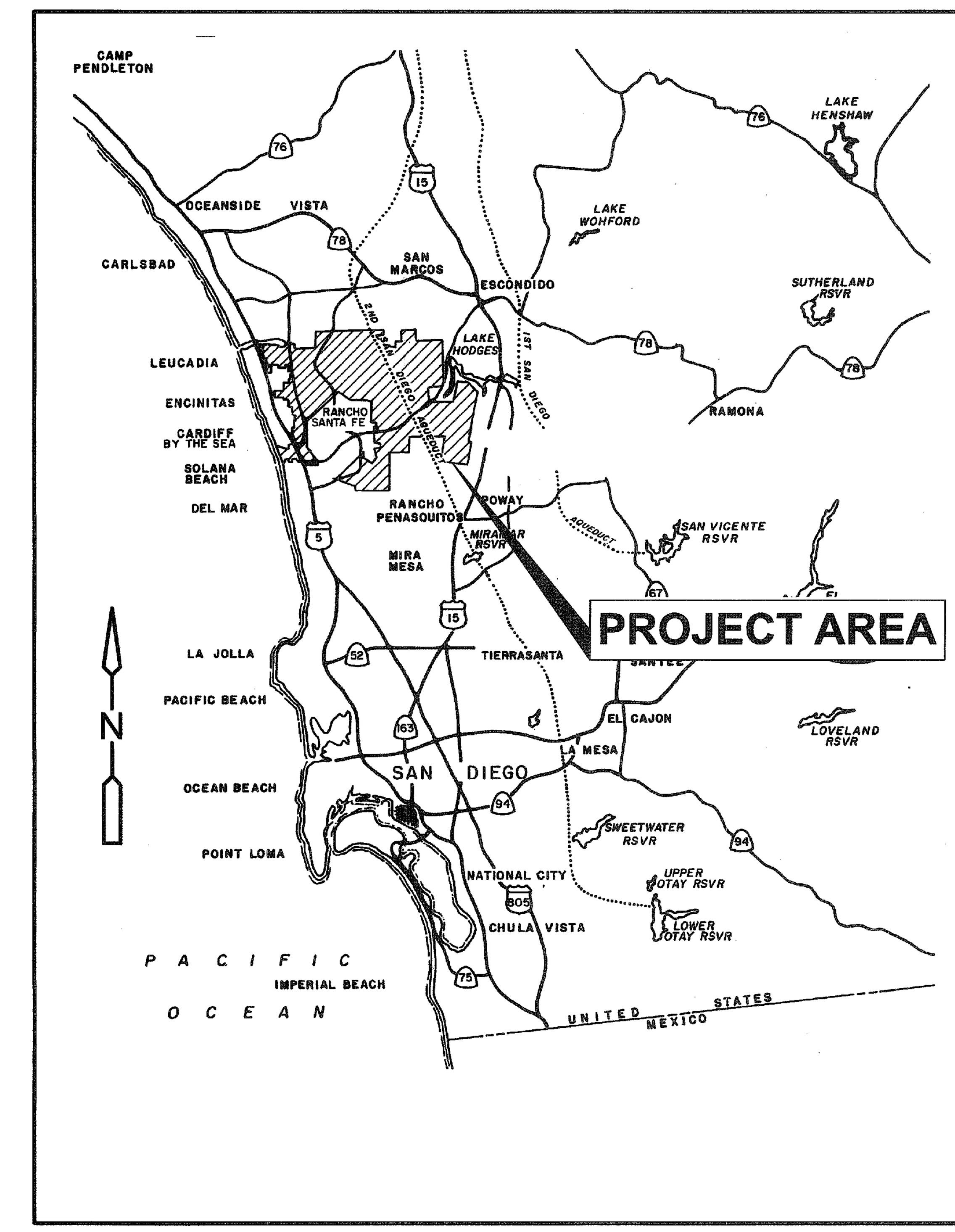
NO SCALE

## FINAL DESIGN SUBMITTAL
## DECEMBER 2010


**Olivenhain Municipal Water District**
**1966 Olivenhain Road**
**Encinitas, CA 92024**
**(760) 753-6466**


## BOARD OF DIRECTORS






**VICINITY MAP**

NO SCALE

*Prepared by:*

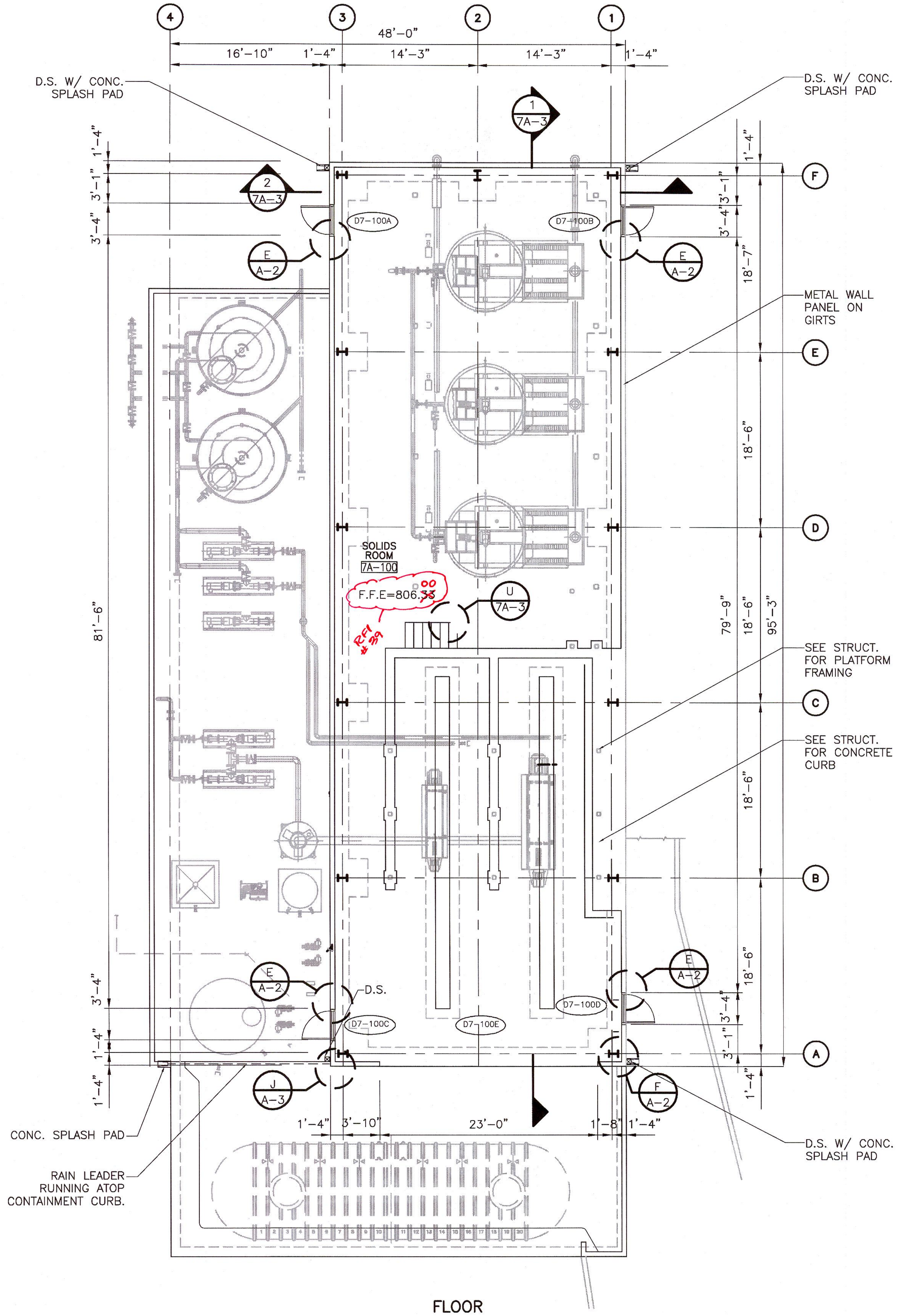
CDM Camp Dresser & McKee Inc.

*consulting*
*engineering*
*construction*
*operations*

GEORGE R. BRIEST, P.E. R.C.E. C048853 DATE

| SHEET 1 OF 218 SHEETS | G-1 |
|---|---|
| WO 179950 | |

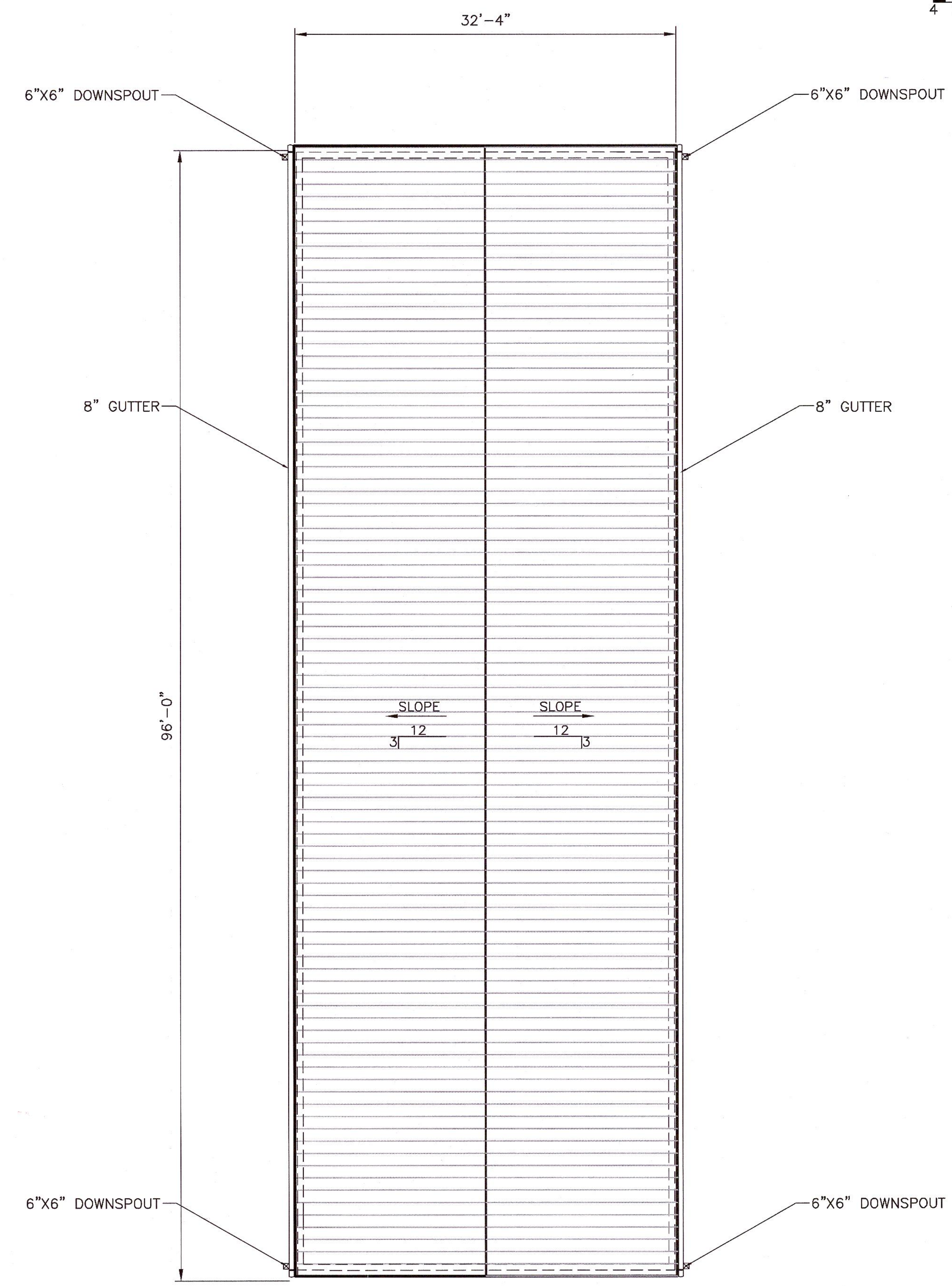
ORIGINAL SCALE IN INCHES 0 1 2 3 4




FLOOR

**PLAN**

1/8" = 1'-0"




ROOF

**PLAN**

1/8" = 1'-0"

1/8" = 1'-0"

N

BID SCHEDULE B

ORIGINAL SCALE IN INCHES

| MARK | DATE | BY | REVISIONS |
| --- | --- | --- | --- |

DESIGN JIT
DRAWN JIT
CHECK LCA

CDM

CONFORMED

OLIVENHAIN
Municipal Water District
1966 Olivenhain Road
Encinitas, CA 92024 (760)753-6466

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

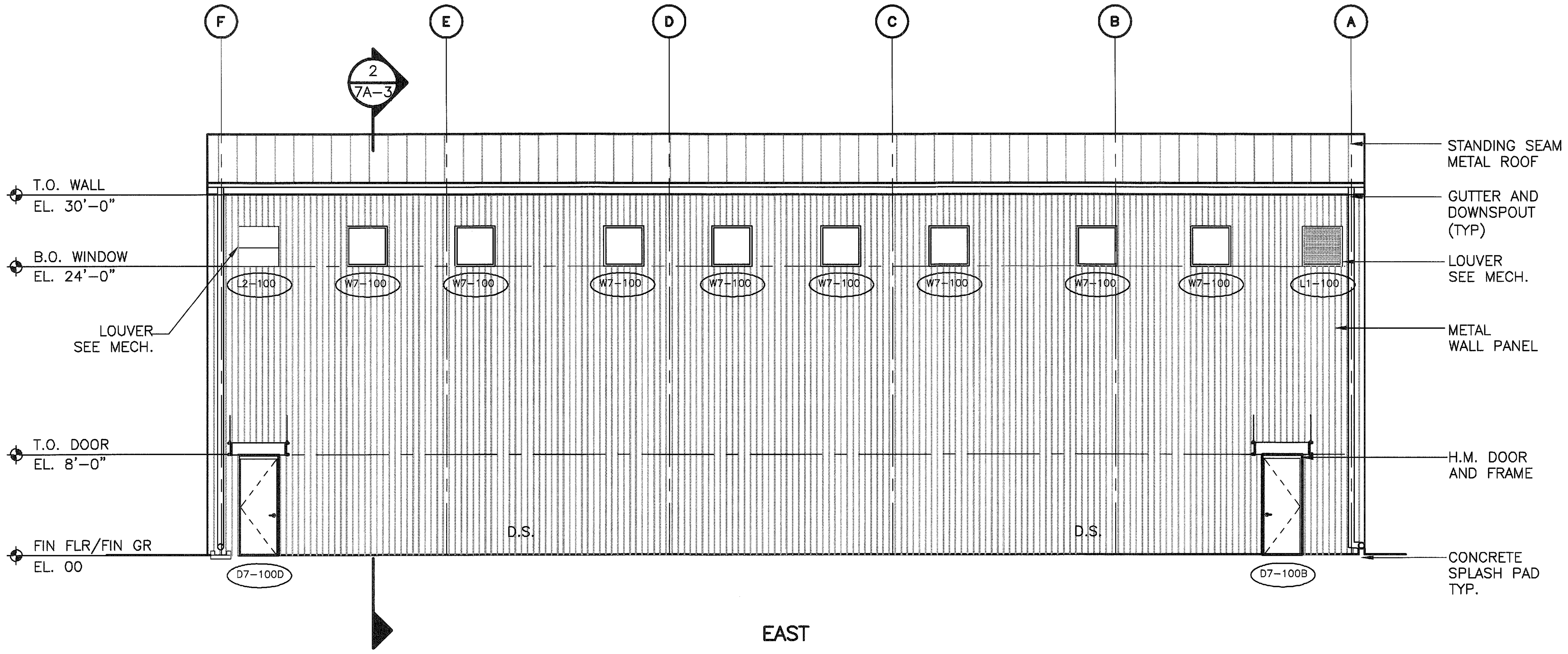
RESIDUALS HANDLING BUILDING
FLOOR PLAN/ROOF PLAN

SHEET 54/218 OF SHEETS

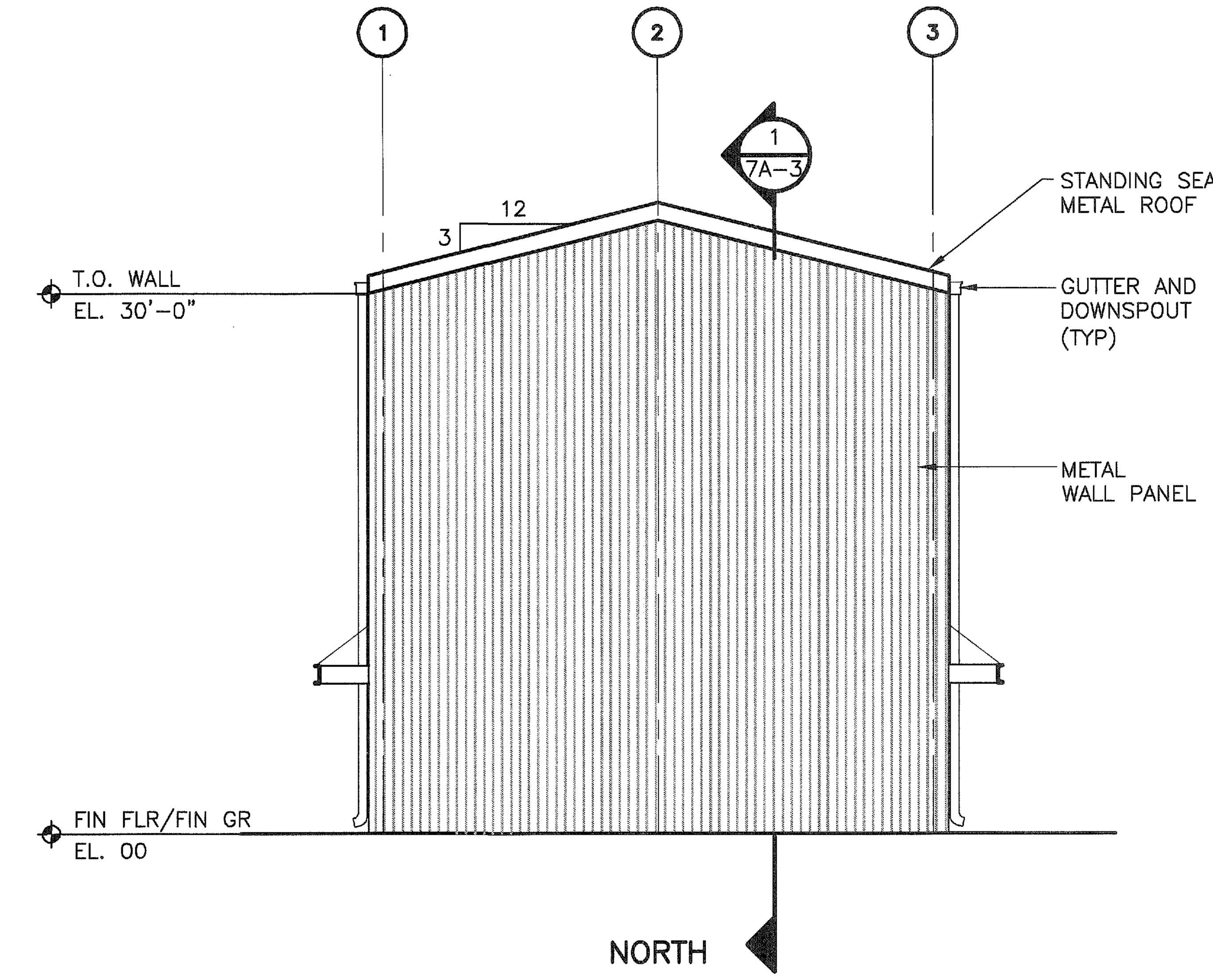
7A-1

WO 179950

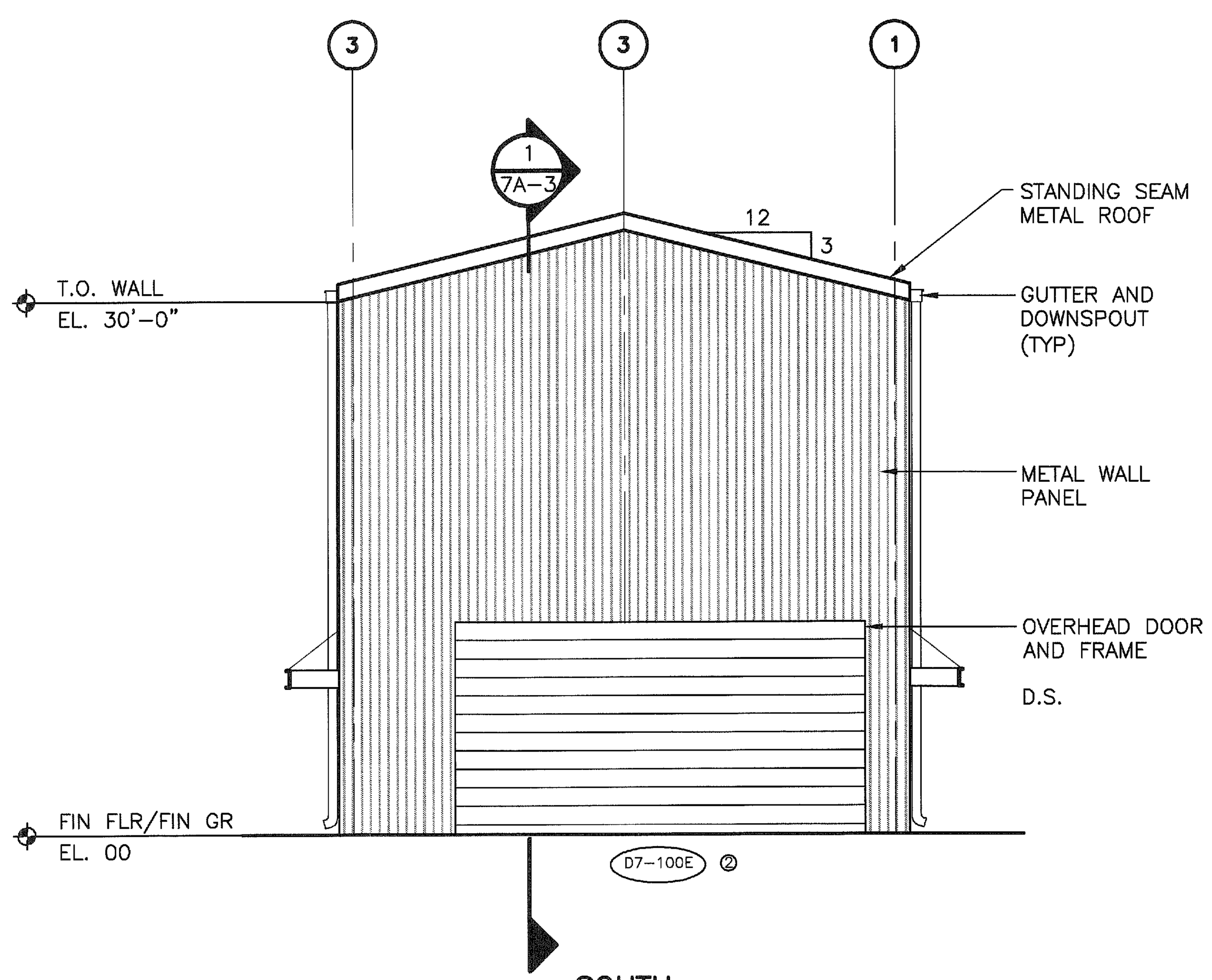
1/8" = 1'-0"



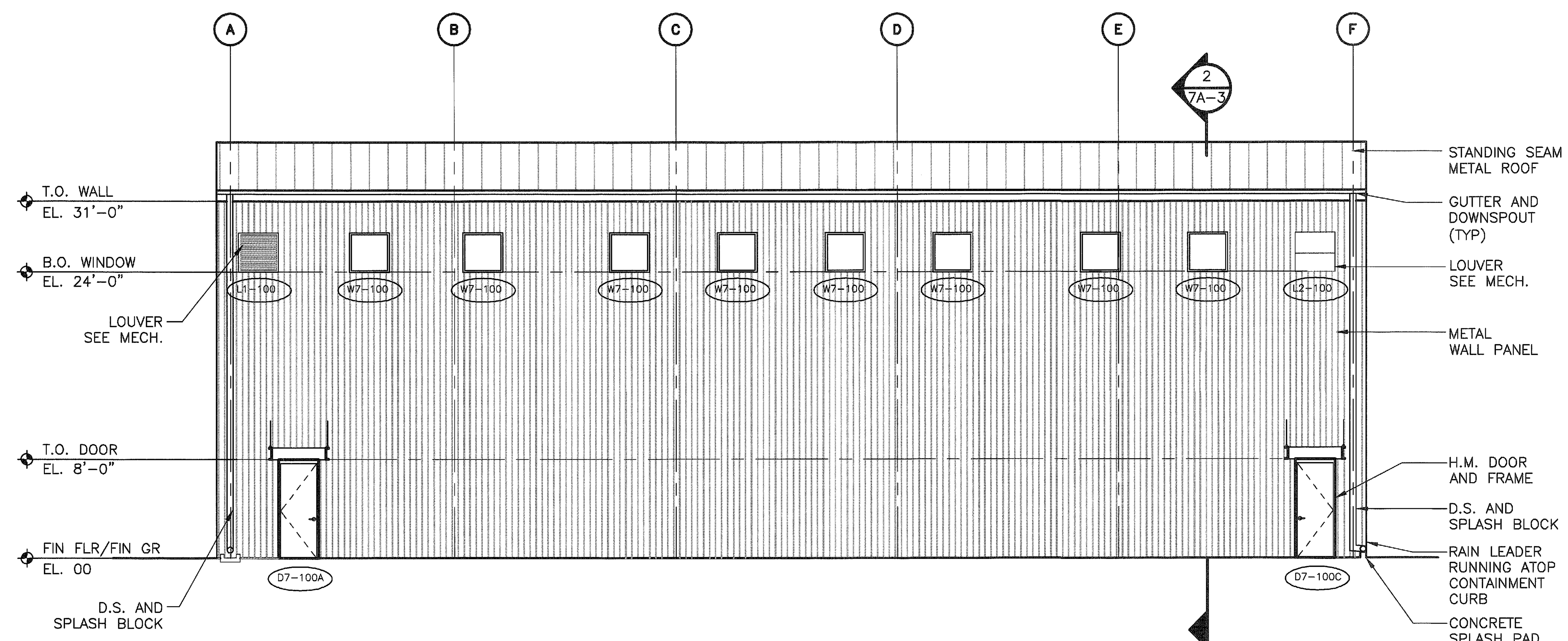

EAST
ELEVATION
1/8" = 1'-0"




NORTH
ELEVATION
1/8" = 1'-0"




SOUTH
ELEVATION
1/8" = 1'-0"




WEST
ELEVATION
1/8" = 1'-0"

BID SCHEDULE B

ORIGINAL SCALE IN INCHES

| REVISIONS | BY | DATE | MARK |
|---|---|---|---|

DESIGN JJT | DRAWN JJT | CHECK LCA

CDM
Camp Dresser & McKee
1925 Palomar Oaks Way, Suite 300
Carlsbad, CA 92008
Tel: (760) 438-7755
consulting • engineering • construction • operations

CONFORMED

OLIVENHAIN
Municipal Water District
1966 Olivenhain Road
Encinitas, CA 92024 (760)753-6466

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

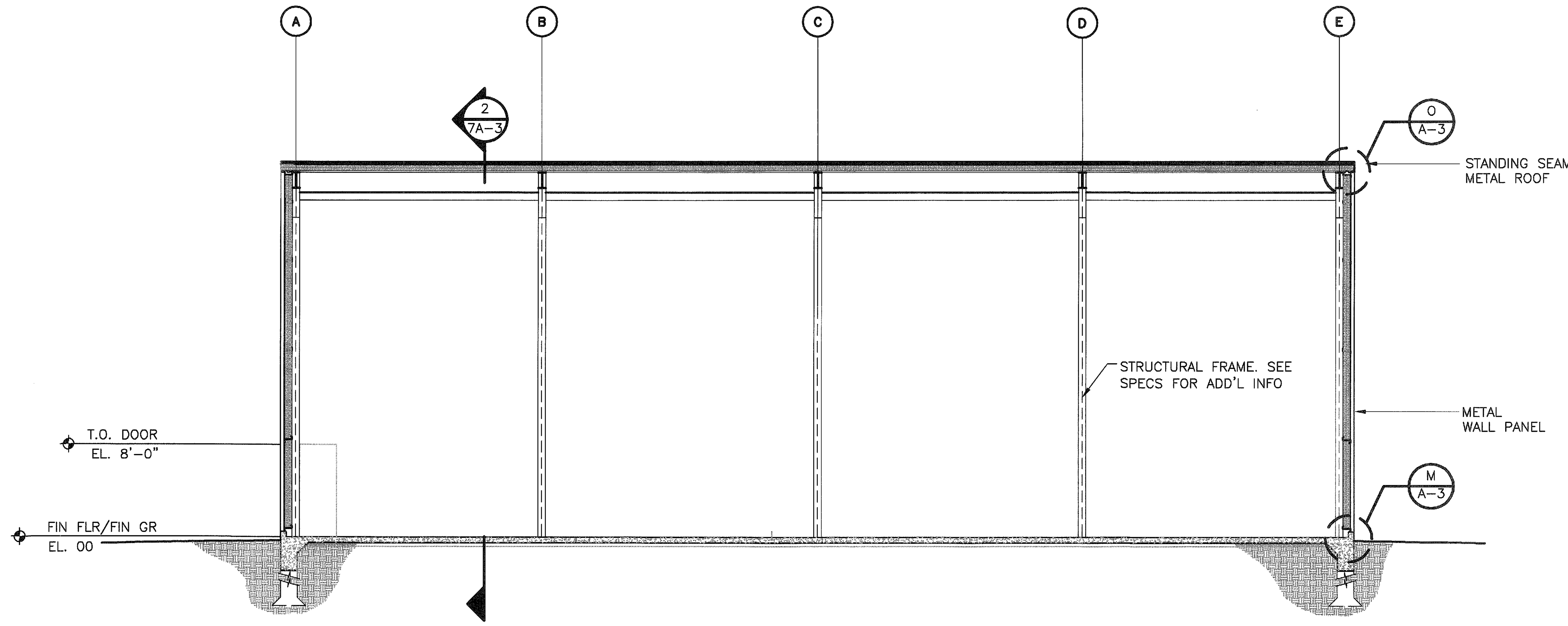
RESIDUALS HANDLING BUILDING
ELEVATIONS

SHEET 55/218 OF SHEETS

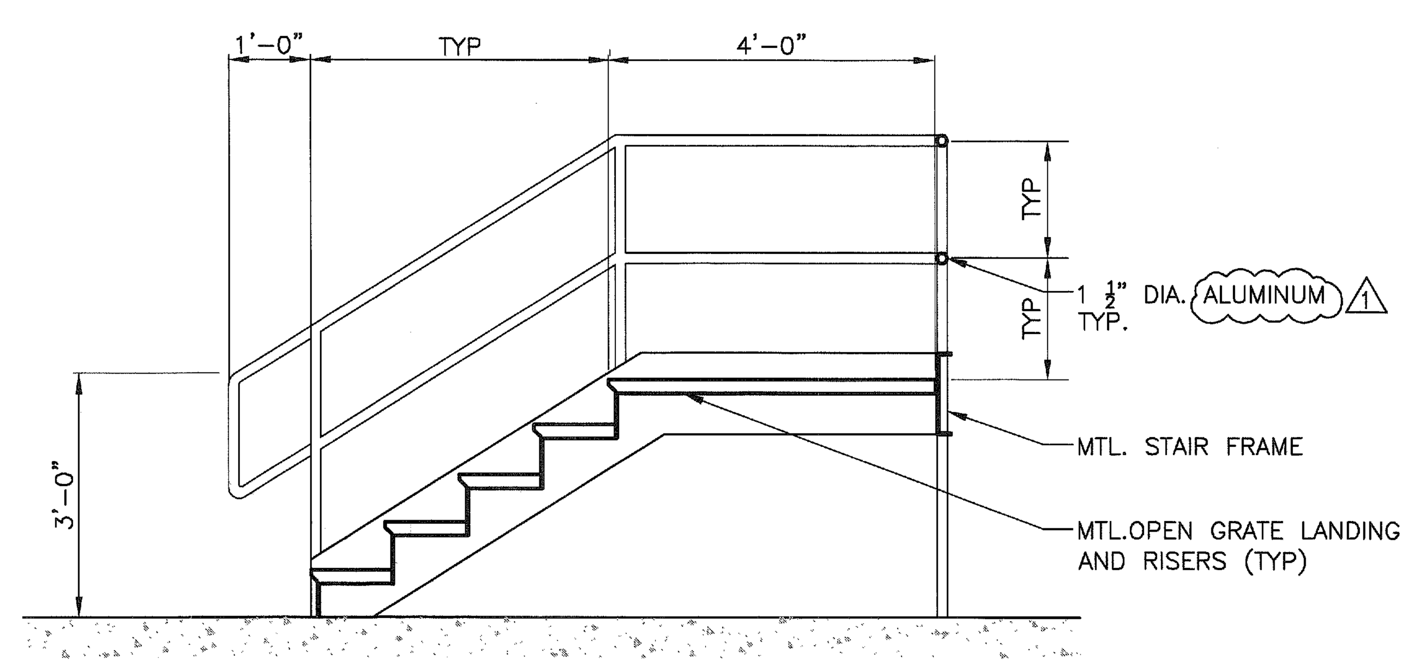
7A-2

WO 179950

1/4" = 1'- 0"
2 1 0 2 4

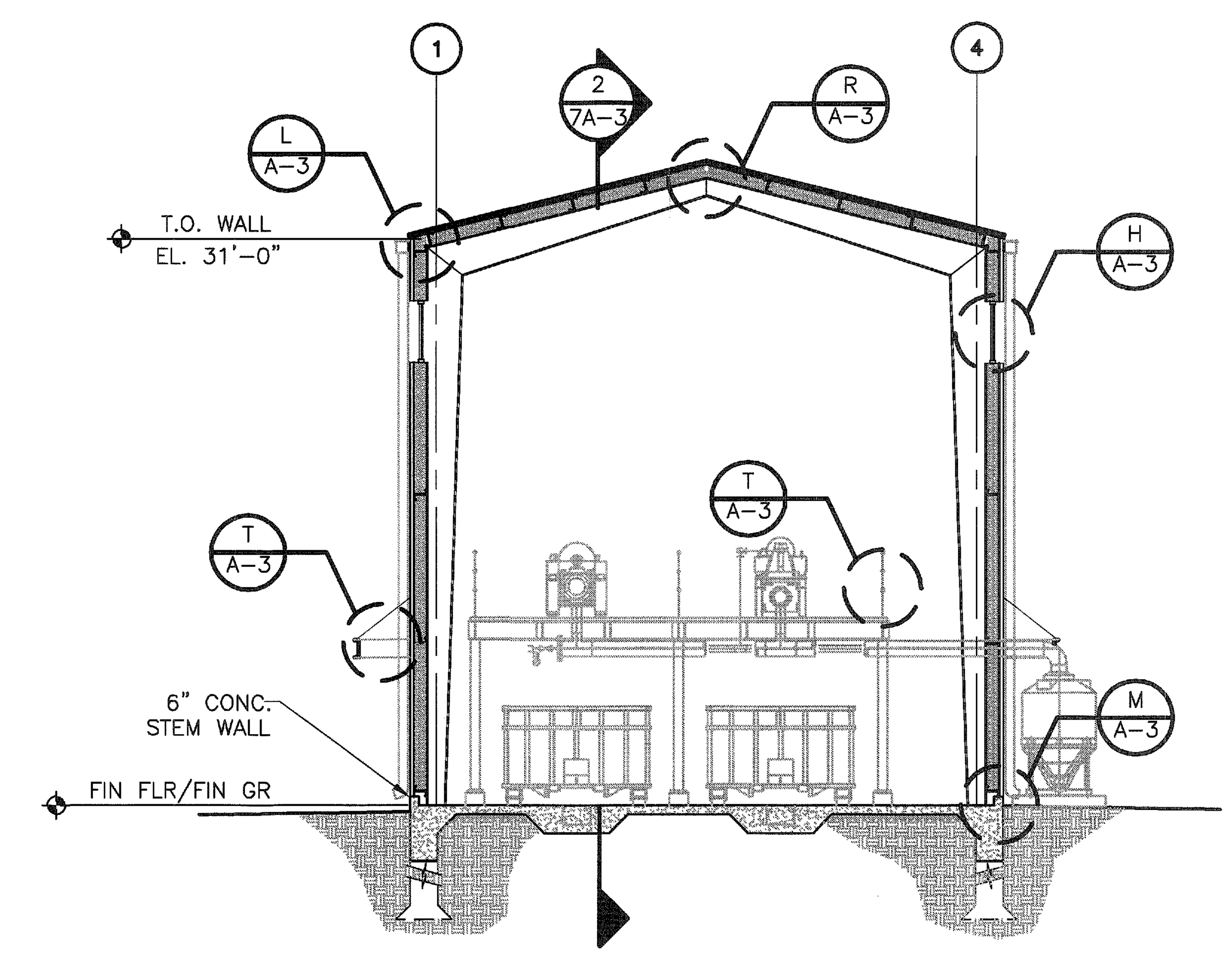



**SECTION** 1
1/8" = 1'-0"




METAL STAIR AND RAIL

**DETAIL** U
1/2" = 1'-0" 7A-3




**SECTION** 2
1/8" = 1'-0"

BID SCHEDULE B

ORIGINAL SCALE IN INCHES

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|
| 3 | 6/11 | IEC | ADDENDUM 3 |

DESIGN JJT
DRAWN JJT
CHECK LCA

CDM
consulting • engineering • construction • operations

**CONFORMED**

OLIVENHAIN Municipal Water District
1966 Olivenhain Road
Encinitas, CA 92024 (760)753-6466

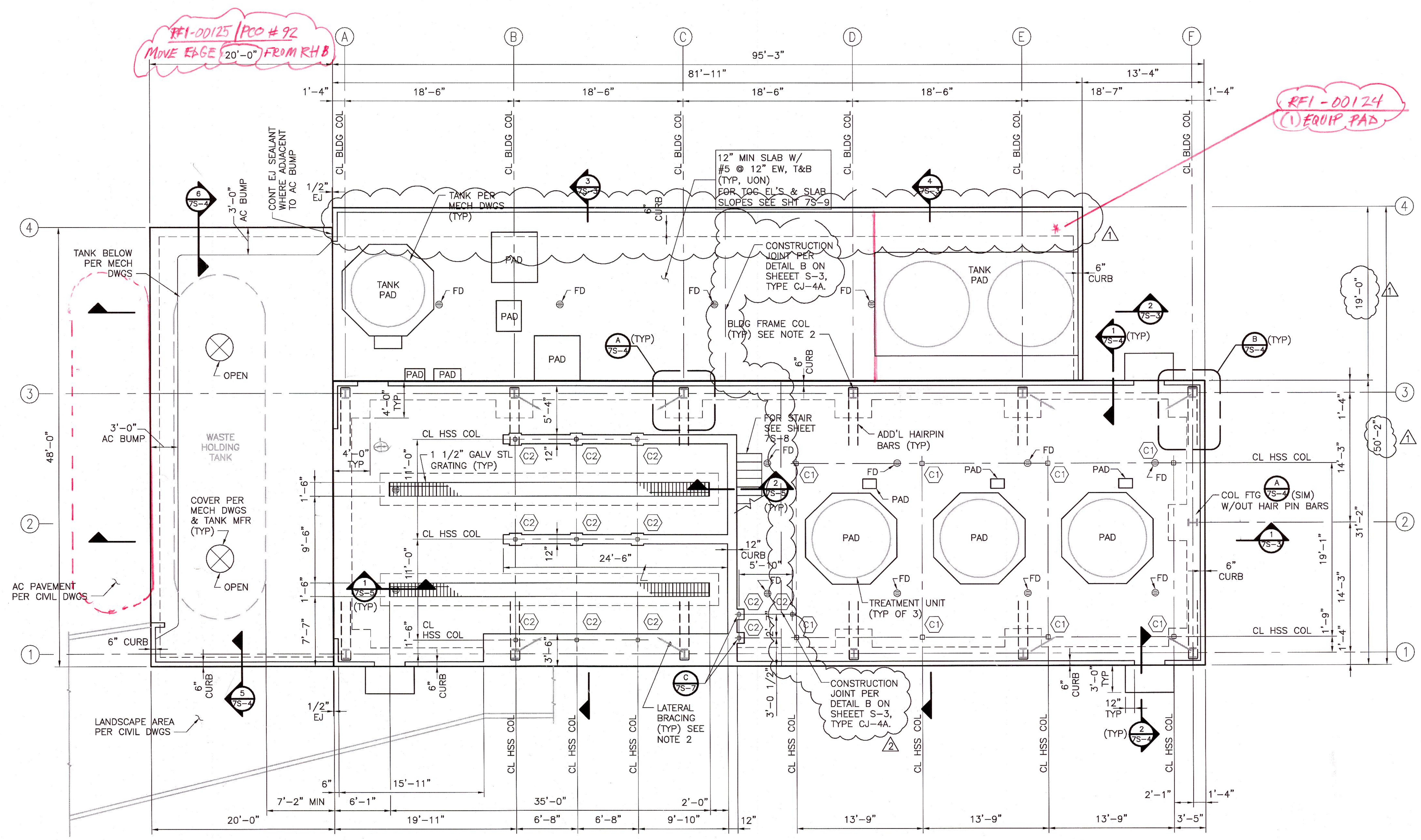
DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

RESIDUALS HANDLING BUILDING SECTIONS

SHEET 56 / 218 OF SHEETS

7A-3

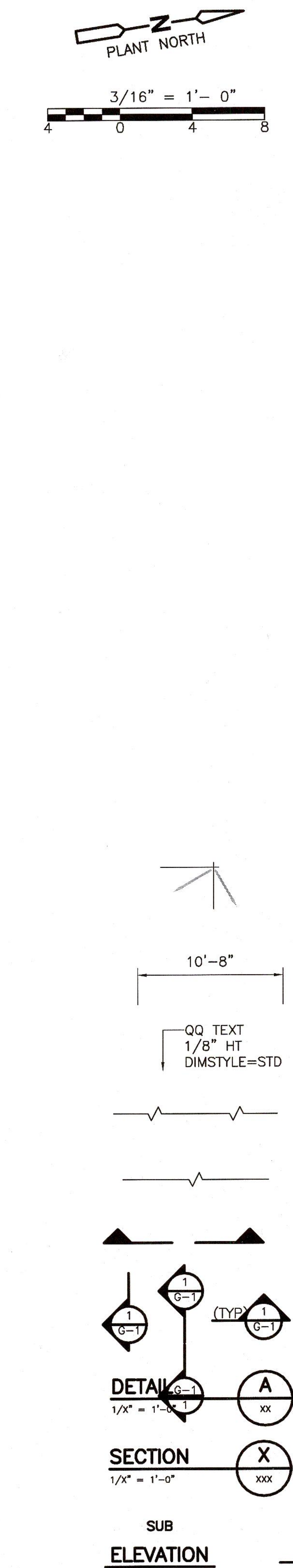
WO 179950




FOUNDATION

**PLAN**

3/16" = 1'-0"




NOTES:

1. FOR GENERAL STRUCTURAL NOTES AND TYPICAL STRUCTURAL DETAILS SEE SHEETS S-1 THROUGH S-7.

2. SIZING AND DESIGN OF THE BUILDING FRAME COLUMNS AND THE STRUCTURAL SUPPORT SYSTEM, LATERAL BRACING, BASE PLATES AND CAST-IN-PLACE ANCHOR BOLTS SHALL BE AS SPECIFIED BY PRE-ENGINEERED BUILDING SUPPLIER PER SPECIFICATION SECTION 13125.

3. DESIGN ROOF DEAD LOAD: 30 PSF
DESIGN ROOF LIVE LOAD: 20 PSF

4. DESIGN FLOOR LIVE LOAD: 300 PSF

5. (C1) INDICATES HSS 6x6x1/2 COLUMNS AT PLATFORM. SEE FRAMING PLAN ON 7S-2.

6. (C2) INDICATES HSS 5x5x5/16 COLUMNS AT PLATFORM. SEE FRAMING PLAN ON 7S-2.

**BID SCHEDULE B**

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 6/11 | IEC | ADDENDUM 2 |
| 2 | 6/11 | IEC | ADDENDUM 6 |

DESIGN CT | DRAWN JN | CHECK GH/YP

Beyaz & Patel, Inc. Consulting Engineers, San Diego, California

CDM

**CONFORMED**

OLIVENHAIN Municipal Water District, 1966 Olivenhain Road, Encinitas, CA 92024 (760)753-6466

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

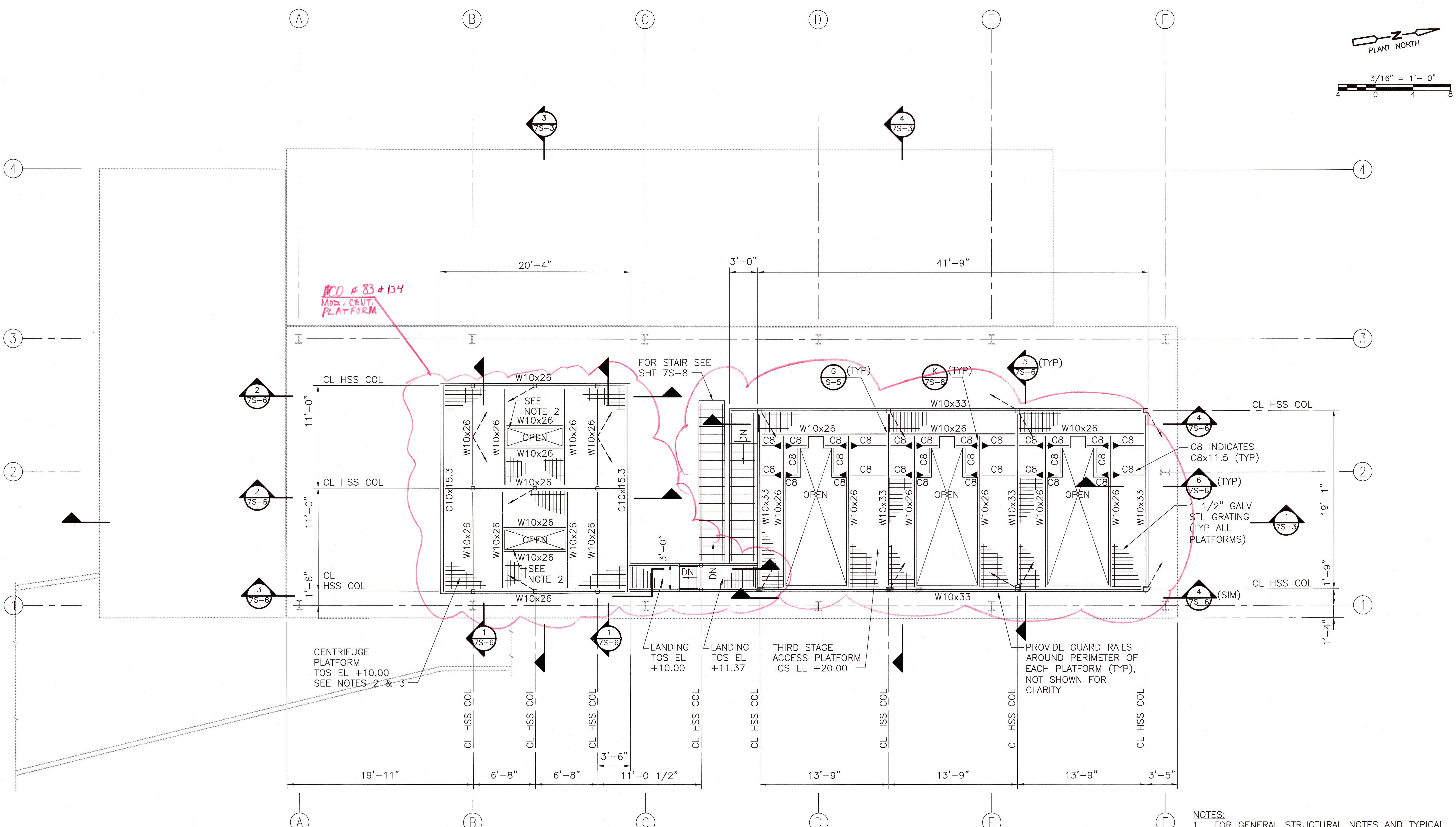
RESIDUALS HANDLING BUILDING
FOUNDATION PLAN

SHEET 79 OF 218 SHEETS — 7S-1

WO 179950

ORIGINAL SCALE IN INCHES

DWG: P:\Projects\OMWD (0002)\00xx LT2 Conformed Set\CADD\04 Design Services NM_Bid\04 Structural\10 CADD\73656-DCMWTP_LT2-7S-01.dwg USER: jnordquist
DATE: Jun 15, 2011 2:17pm XREFS: 73656-DCMWTP_LT2-G-BS 73656-DCMWTP_LT2-S-NP-RHB02




PLATFORM FRAMING

**PLAN**

3/16" = 1'–0"

NOTES:

1. FOR GENERAL STRUCTURAL NOTES AND TYPICAL STRUCTURAL DETAILS SEE SHEETS S–1 THROUGH S–7.
2. BEAM LOCATIONS SHALL MATCH WITH CENTRIFUGE SUPPORTS. COORDINATE WITH CENTRIFUGE SUPPLIER. PROVIDE ADDITIONAL STRUCTURAL FRAMING/SUPPORTS PER SUPPLIER'S REQUIREMENTS TO SUPPORT CENTRIFUGE.
3. AT THE CENTRIFUGE PLATFORM: EXCITING FREQUENCY AFTER VIBRATION ISOLATORS FROM EQUIPMENT TRANFERRED TO PLATFORM SHALL NOT EXCEED 3HZ.
4. ▶— INDICATES MOMENT CONNECTION

BID SCHEDULE B

ORIGINAL SCALE IN INCHES

DWG: P:\Projects\OMWD (0002)\00xx LT2 Conformed Set\CAD\04 Design Services NM_Bid\04 Structural\10 CADD\73656-DCMWTP_LT2-7S-02.dwg
DATE: Jun 15, 2011 2:17pm XREFS: 73656-DCMWTP_LT2-G-BS 73656-DCMWTP_LT2-S-NP-RHB02 73656-DCMWTP_LT2-S-FP-RHB02 USER: jnordquist

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|

DESIGN CT | DRAWN JN | CHECK GH/YP

Beyaz & Patel, Inc. Consulting Engineers San Diego, California

CDM Camp Dresser & McKee Carlsbad, CA consulting • engineering • construction • operations

CONFORMED

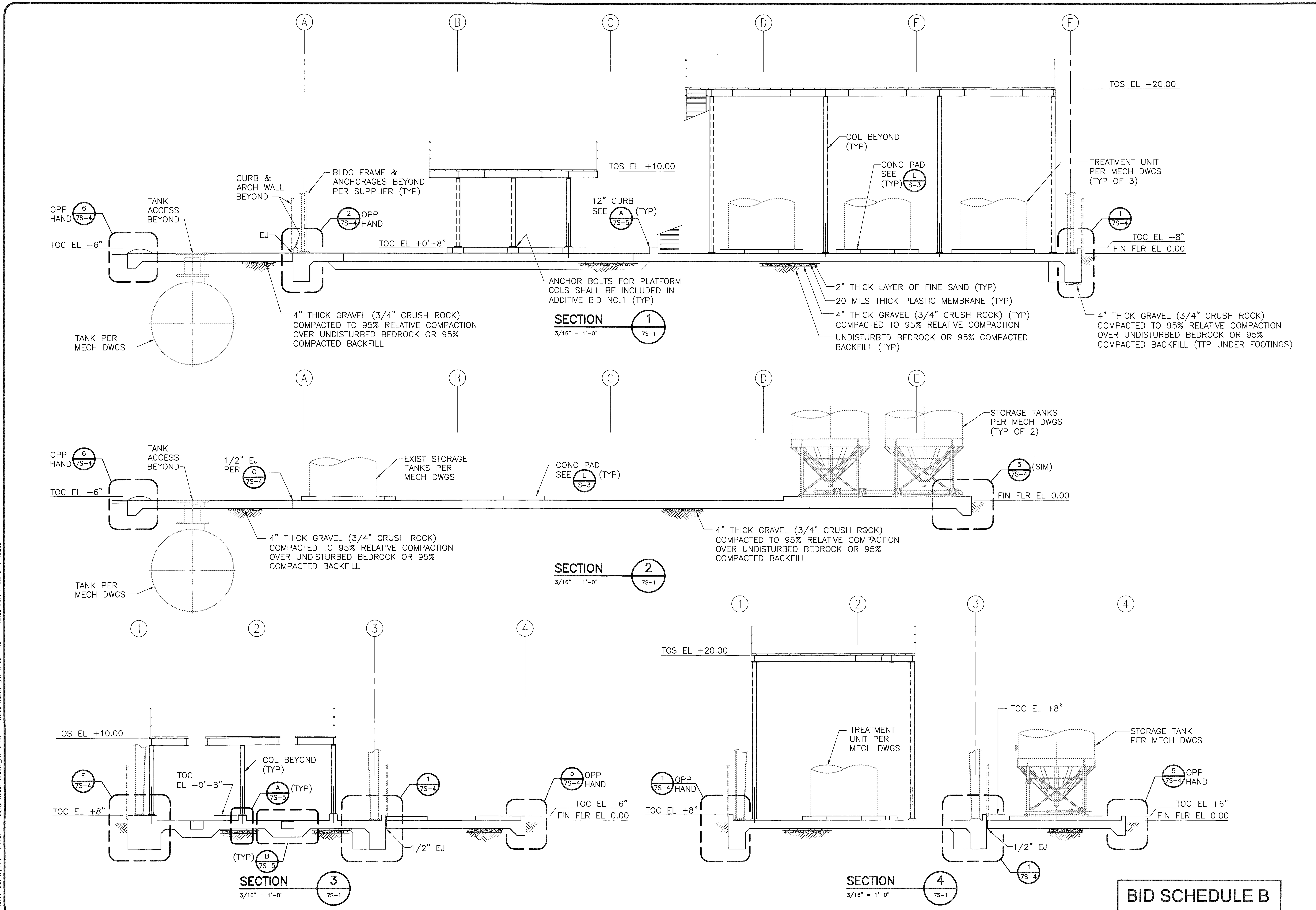
OLIVENHAIN Municipal Water District 1966 Olivenhain Road Encinitas, CA 92024 (760)753-6466

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

RESIDUALS HANDLING BUILDING
PLATFORM FRAMING PLAN

SHEET 80 OF 218 SHEETS | 7S–2

WO 179950




BID SCHEDULE B

ORIGINAL SCALE IN INCHES

CDM

Beyaz & Patel, Inc.

CONFORMED

OLIVENHAIN Municipal Water District

DAVID C. McCOLLOM WTP LT2 IMPROVEMENTS

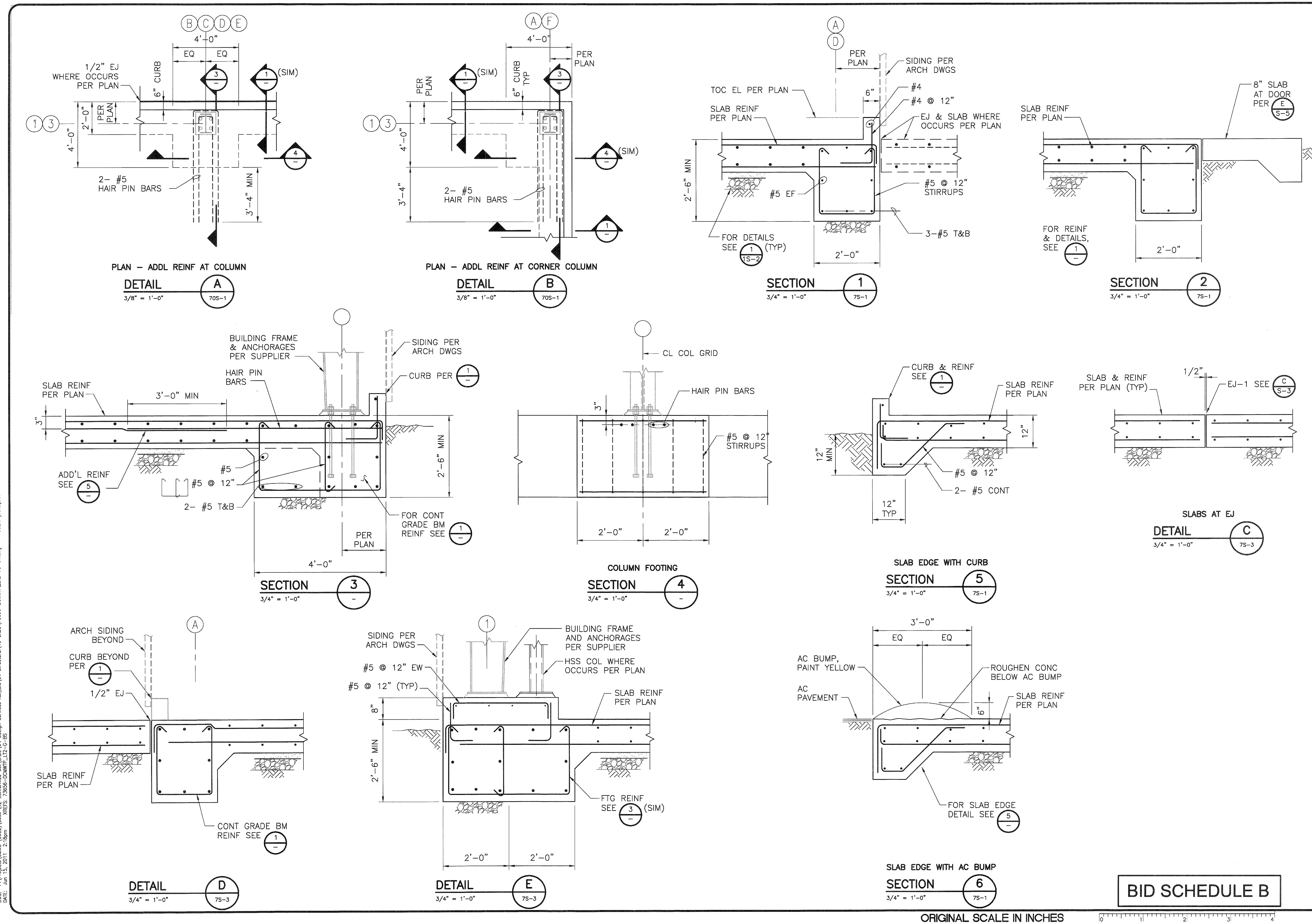
RESIDUALS HANDLING BUILDING SECTIONS

DESIGN CT | DRAWN JN | CHECK GH/YP

SHEET 81/218 OF SHEETS

7S-3

WO 179950




MARK | DATE | BY | REVISIONS

DESIGN CT | DRAWN JN | CHECK GH/YP

CDM Camp Dresser & McKee

Beyaz & Patel, Inc. Consulting Engineers San Diego, California

OLIVENHAIN Municipal Water District 1966 Olivenhain Road Encinitas, CA 92024

CONFORMED

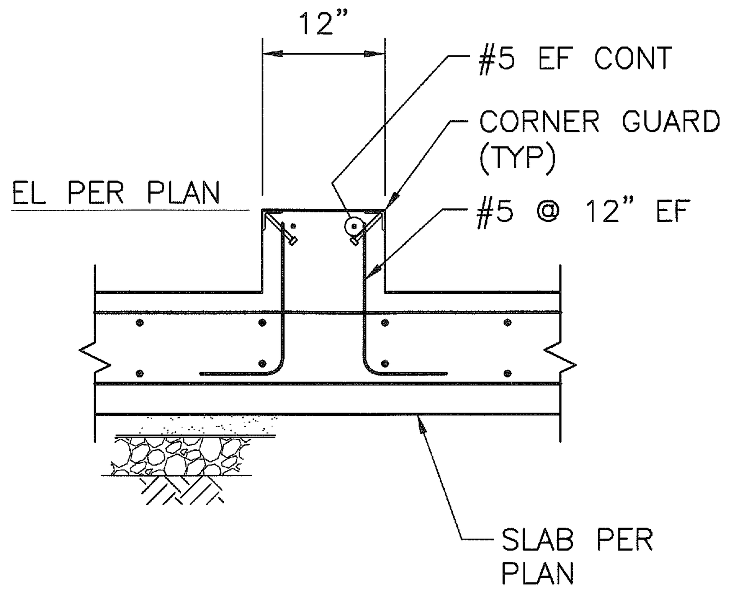
DAVID C. McCOLLOM WTP LT2 IMPROVEMENTS

RESIDUALS HANDLING BUILDING SECTIONS AND DETAILS

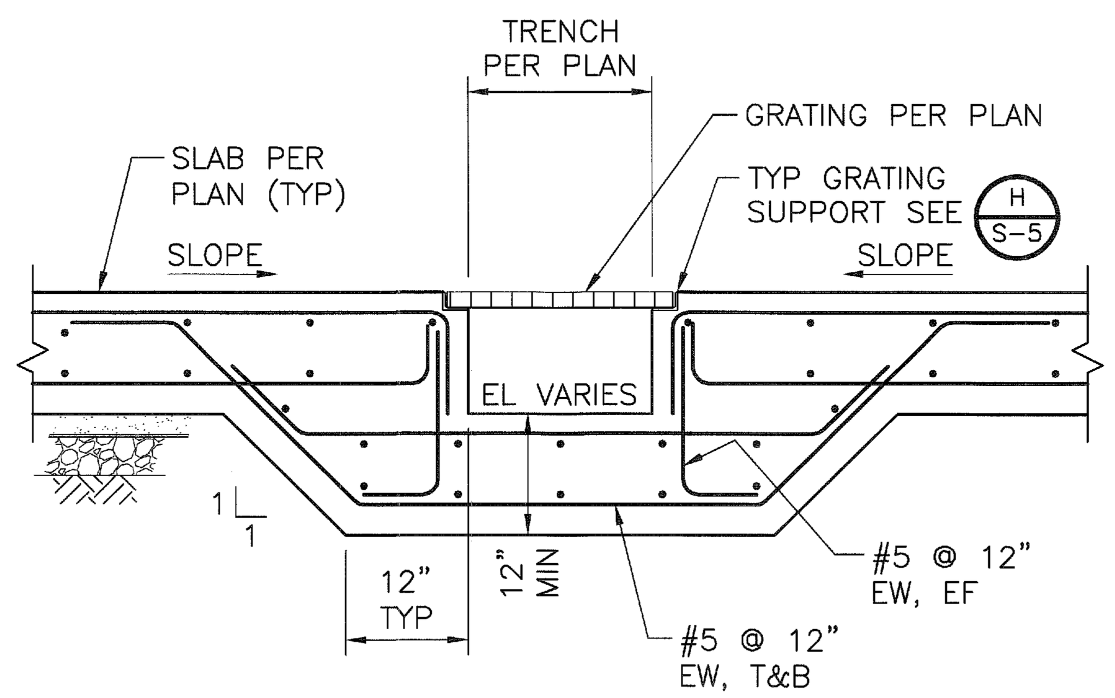
SHEET 82/218 OF SHEETS

7S-4

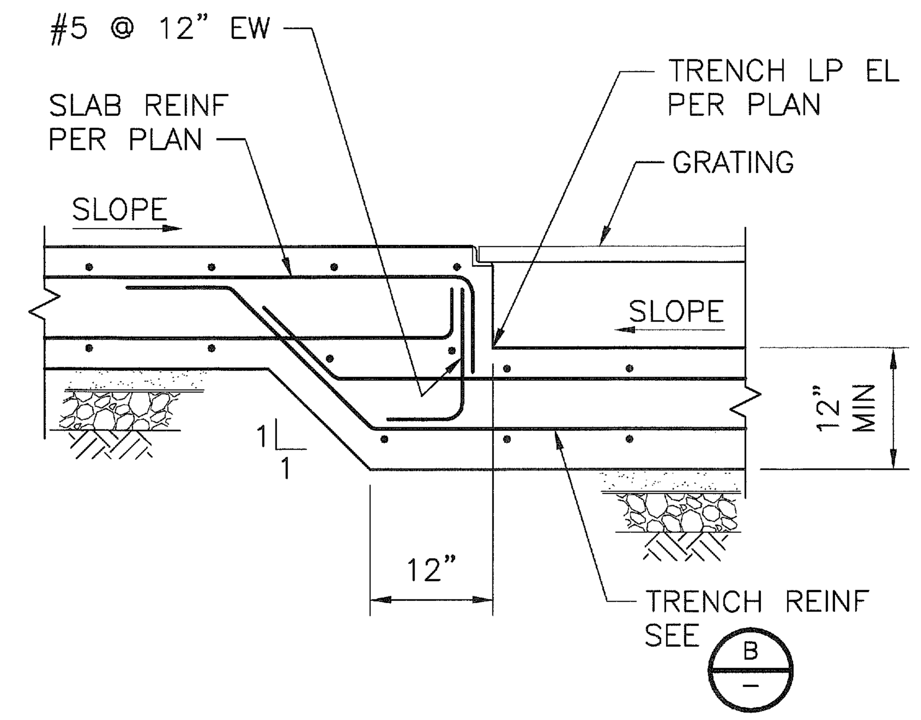
WO 179950



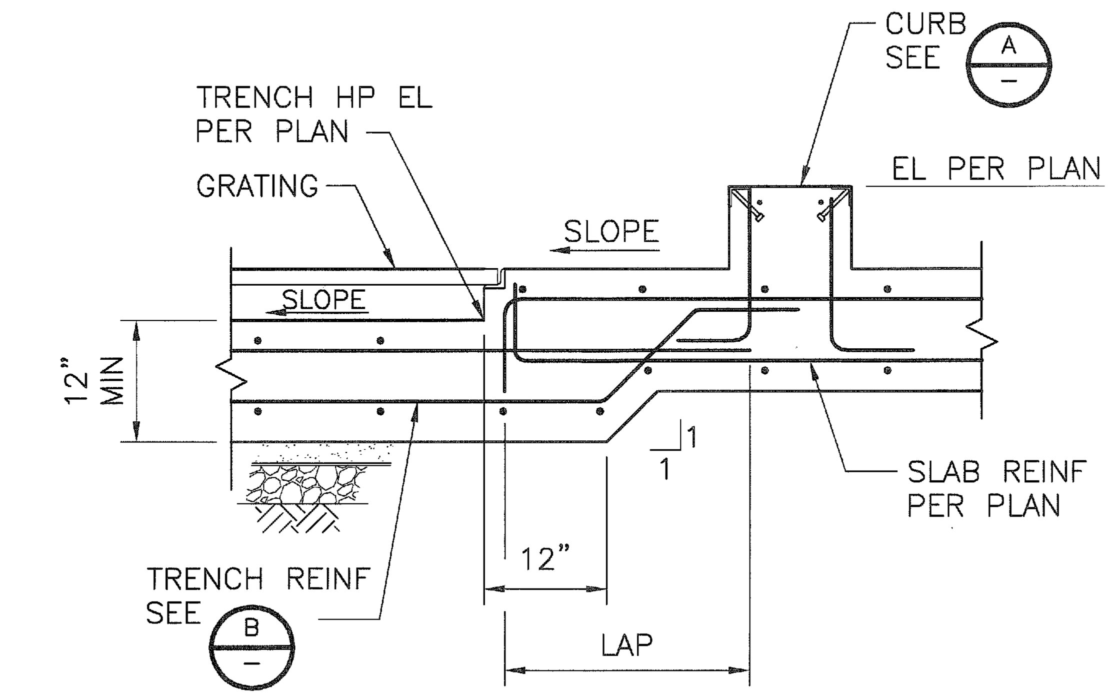

12" CONCRETE CURB
DETAIL A
3/4" = 1'-0" 7S-3




TRENCH
DETAIL B
3/4" = 1'-0" 7S-3




SECTION 1
3/4" = 1'-0" 7S-1




SECTION 2
3/4" = 1'-0" 7S-1

BID SCHEDULE B

ORIGINAL SCALE IN INCHES

DWG: P:\Projects\OMWD (0002)\00xx LT2 Conformed Set\CADD\04 Design Services NM_Bid\04 Structural\10 CADD\73656-DCMWTP_LT2-7S-05.dwg USER: jnordquist
DATE: Jun 15, 2011 2:18pm XREFS: 73656-DCMWTP_LT2-G-BS

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|

DESIGN CT | DRAWN JN | CHECK GH/YP

CDM Camp Dresser & McKee — Beyaz & Patel, Inc. Consulting Engineers San Diego, California

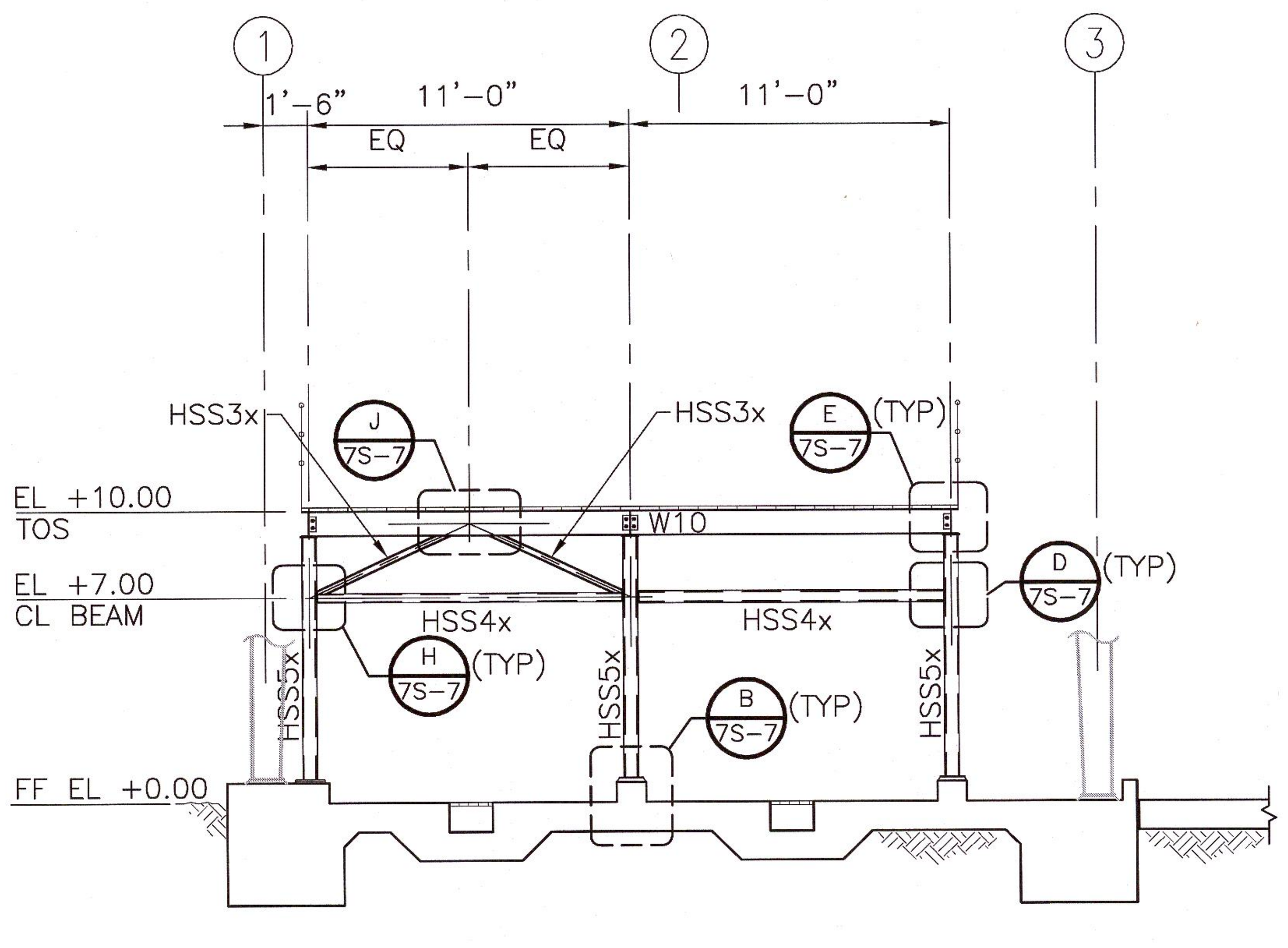
OLIVENHAIN Municipal Water District 1966 Olivenhain Road Encinitas, CA 92024

CONFORMED

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

RESIDUALS HANDLING BUILDING
SECTIONS AND DETAILS

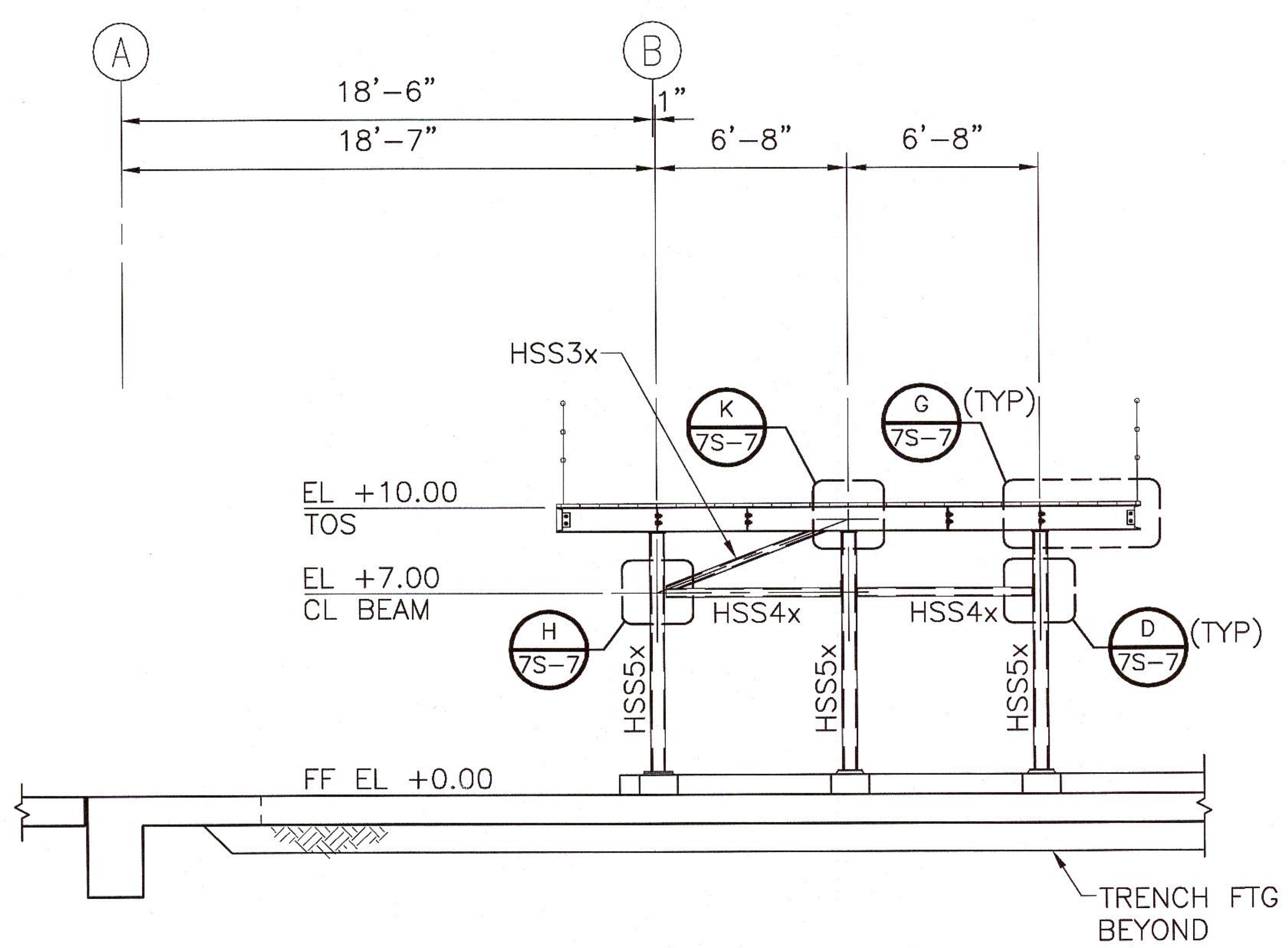
SHEET 83 / 218 OF SHEETS
7S-5
WO 179950




CENTRIFUGE PLATFORM FRAMING

SECTION 1 / 7S-2
3/16" = 1'-0"

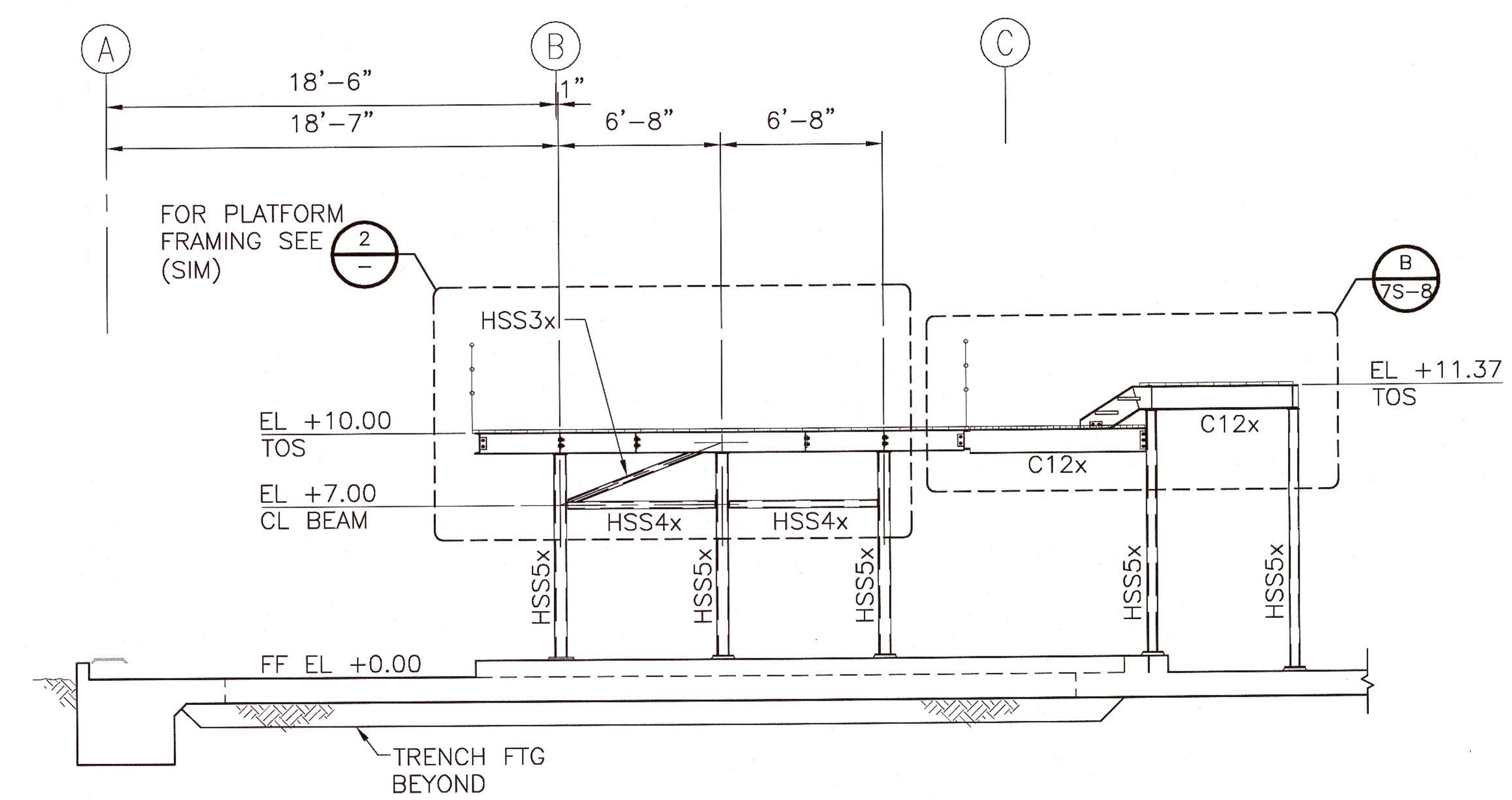
**BID SCHEDULE "C"**




CENTRIFUGE PLATFORM FRAMING

SECTION 2 / 7S-2
3/16" = 1'-0"

**BID SCHEDULE "C"**

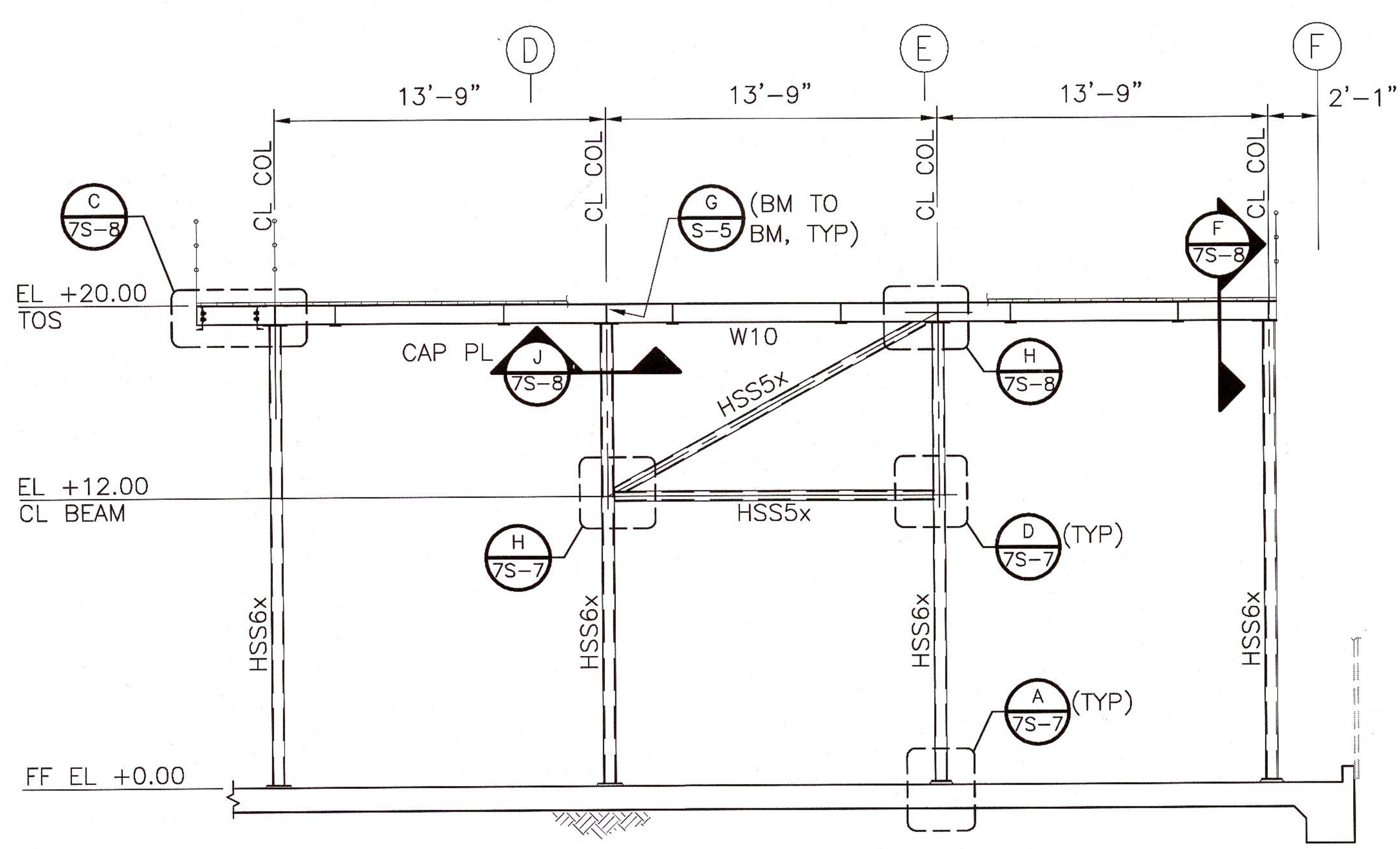



CENTRIFUGE PLATFORM FRAMING & STAIR LANDING

SECTION 3 / 7S-2
3/16" = 1'-0"

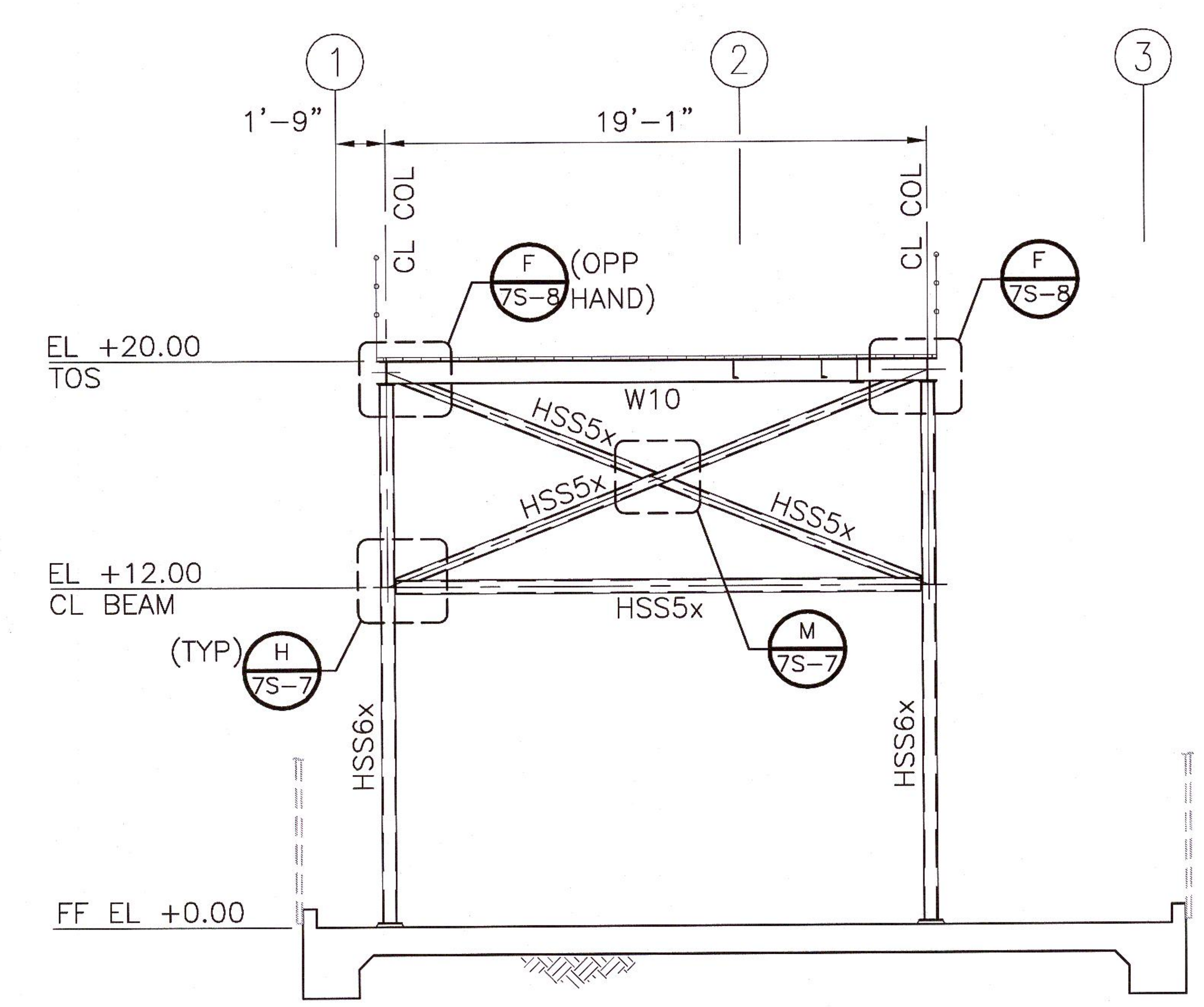
**BID SCHEDULE "C"**

SEE PCO #83




THIRD STAGE ACCESS PLATFORM FRAMING

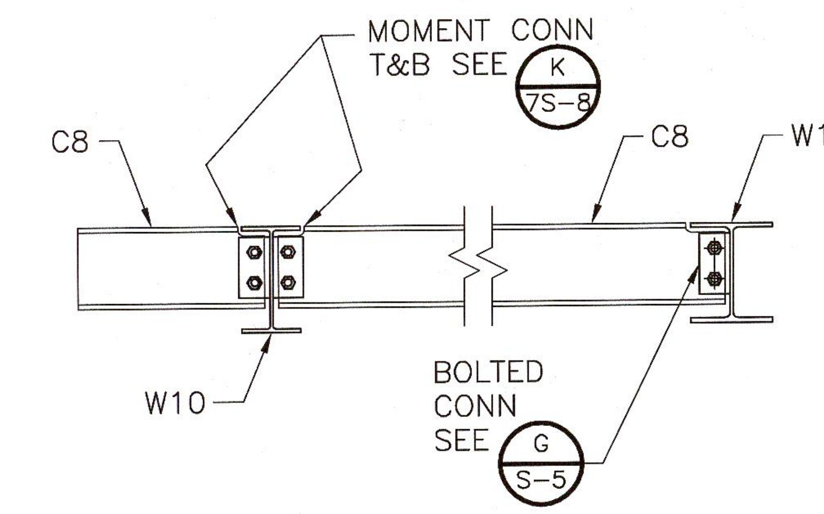
SECTION 4 / 7S-2
3/16" = 1'-0"




THIRD STAGE ACCESS PLATFORM FRAMING

SECTION 5 / 7S-2
3/16" = 1'-0"

NOTE:
1. THIS FRAME OCCURS AT EACH SET OF COLUMNS IN THE NORTH/SOUTH DIRECTION (4 PLACES) ON THE THIRD STAGE ACCESS PLATFORM.




SECTION 6 / 7S-2
3/4" = 1'-0"

FRAMING ELEVATION NOTES:

1. HSS 3x INDICATES HSS 3x3x5/16
2. HSS4x INDICATES HSS 4x4x5/16
3. HSS5x INDICATES HSS 5x5x5/16
3. HSS6x INDICATES HSS 6x6x1/2
4. W10 INDICATES W10 PER PLAN

3/16" = 1'- 0"
4 0 4 8

3/4" = 1'- 0"
1 0 1 2

**BID SCHEDULE B**

ORIGINAL SCALE IN INCHES

MARK | DATE | BY | REVISIONS

DESIGN CT
DRAWN JN
CHECK GH/YP

CDM
Beyaz & Patel, Inc.

OLIVENHAIN
Municipal Water District
1966 Olivenhain Road
Encinitas, CA 92024 (760)753-6466

CONFORMED

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

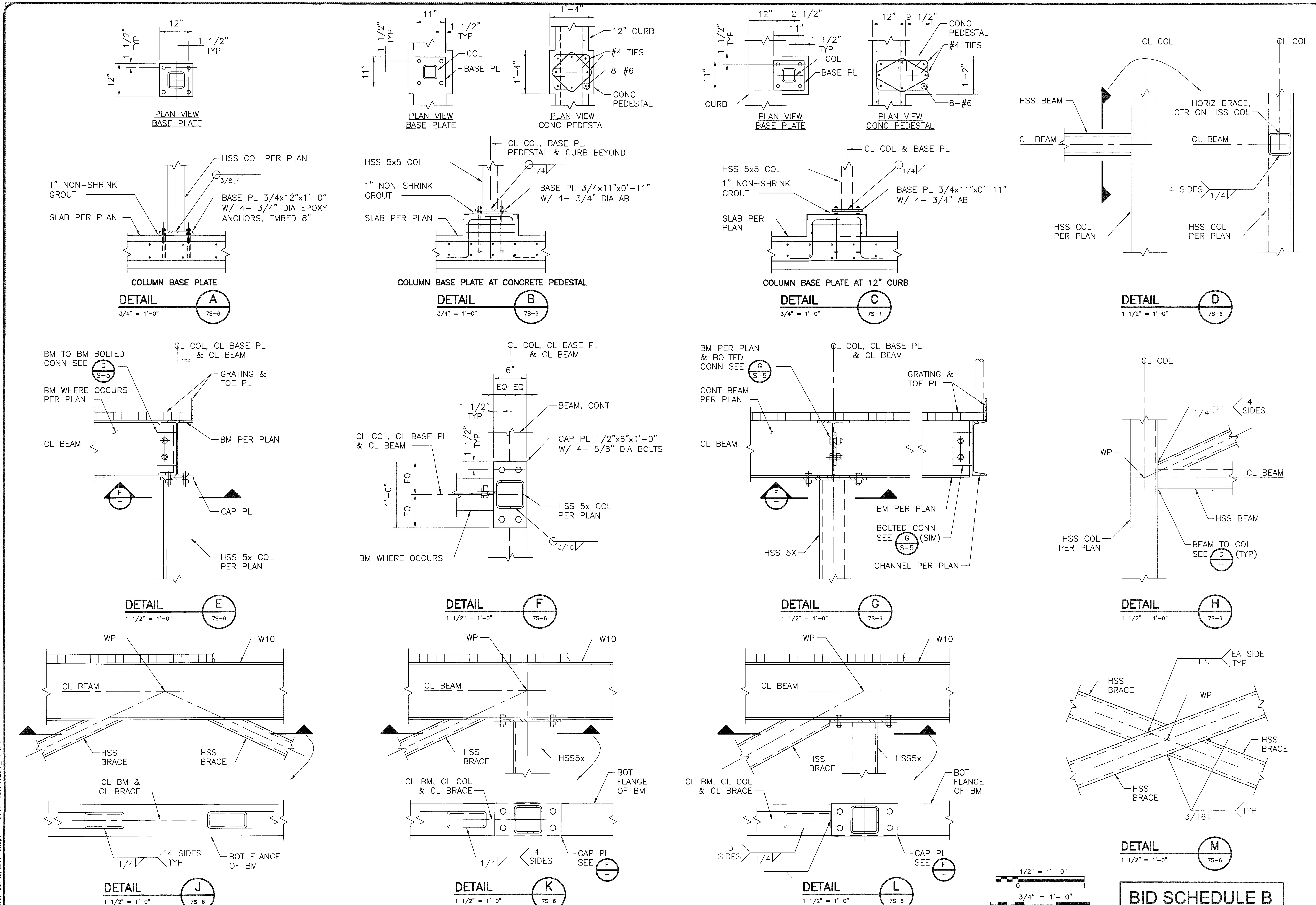
RESIDUALS HANDLING BUILDING
PLATFORM FRAMING ELEVATIONS

SHEET 84 OF 218 SHEETS

7S-6

WO 179950

DWG: P:\Projects\OMWD ... 73656-DCMWTP_LT2-7S-06.dwg
DATE: Jun 15, 2011 2:19pm
USER: jnordquist




BID SCHEDULE B

ORIGINAL SCALE IN INCHES

CONFORMED

REVISIONS | MARK | DATE | BY

DESIGN CT | DRAWN JN | CHECK GH/YP

CDM Camp Dresser & McKee

Beyaz & Patel, Inc. Consulting Engineers San Diego, California

OLIVENHAIN Municipal Water District 1966 Olivenhain Road Encinitas, CA 92024

DAVID C. McCOLLOM WTP LT2 IMPROVEMENTS

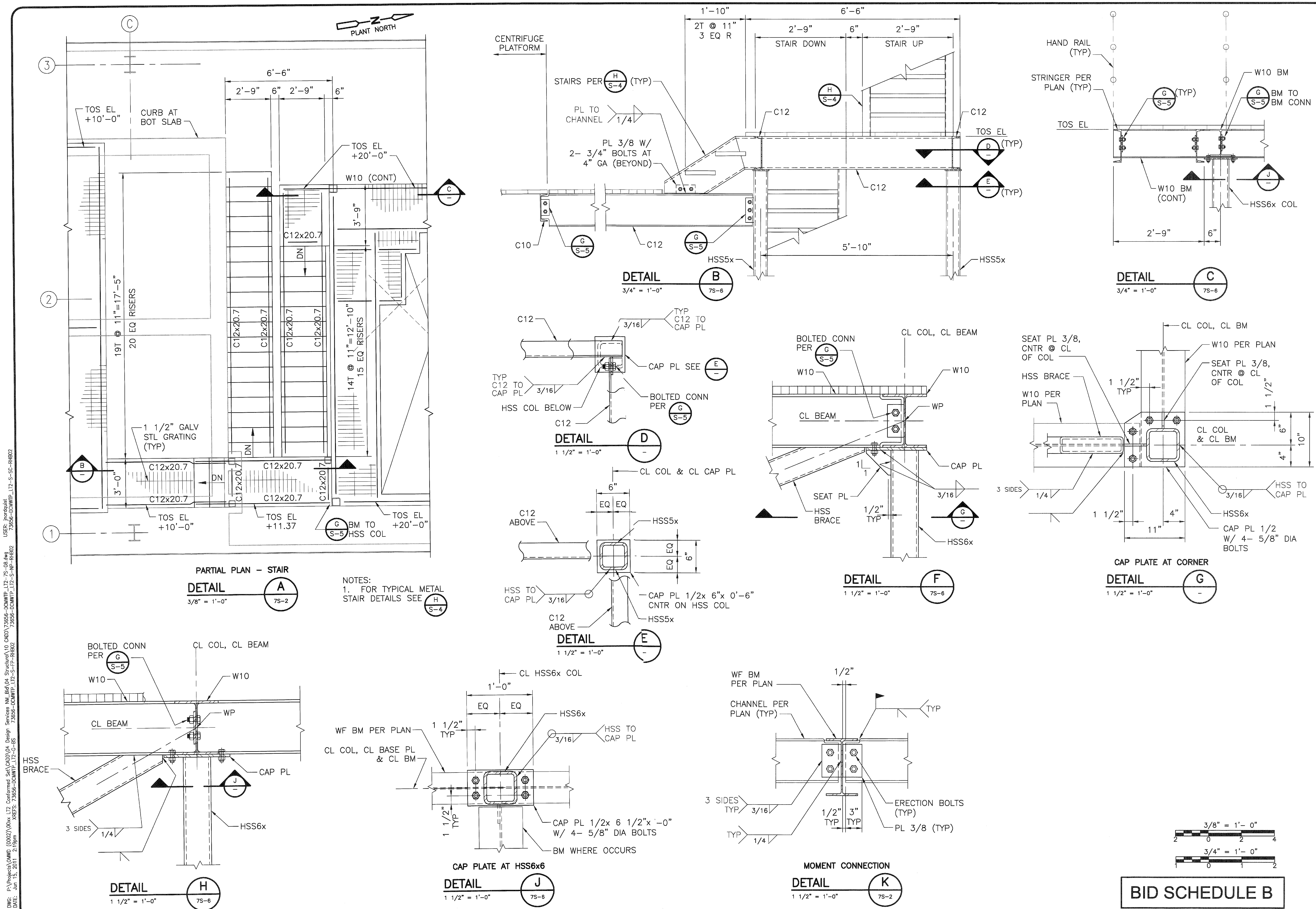
RESIDUALS HANDLING BUILDING SECTIONS AND DETAILS

SHEET 85/218 OF SHEETS

7S-7

WO 179950

DWG: P:\Projects\OMWD (0002)\90xx_LT2 Conformed Set\CAD\04 Design Services NM_Bid\04 Structural\10 CAD\73656-OCMWTP_LT2-7S-07.dwg USER: jnordquist
DATE: Jun 15, 2011 2:19pm XREFS: 73656-OCMWTP_LT2-G-BS




BID SCHEDULE B

ORIGINAL SCALE IN INCHES

DESIGN CT | DRAWN JN | CHECK GH/YP

CDM

Boyaz & Patel, Inc.

CONFORMED

OLIVENHAIN Municipal Water District

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

RESIDUALS HANDLING BUILDING
STAIR PLAN & SECTIONS

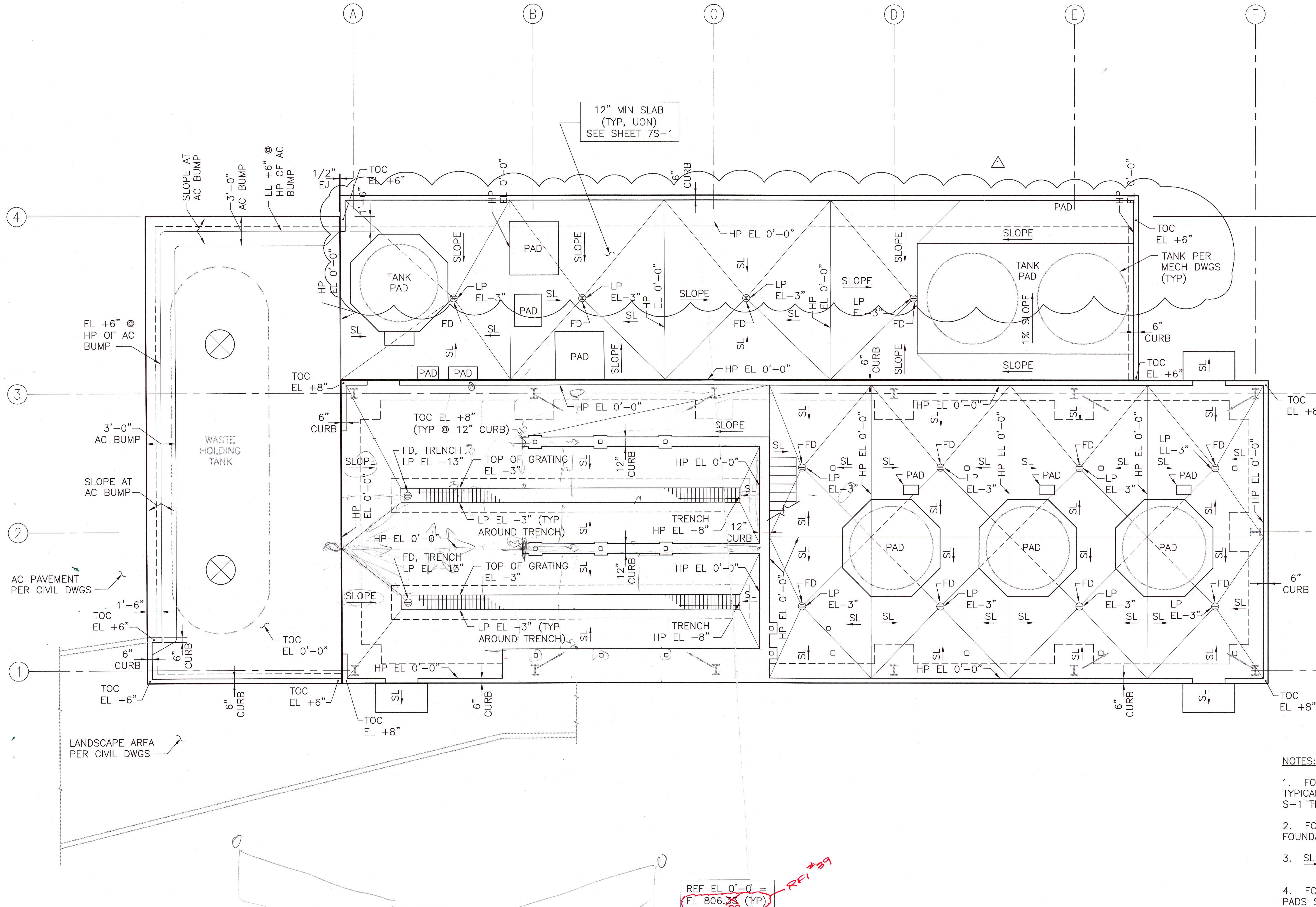
SHEET 86/218 OF SHEETS

7S-8

WO 179950

PLANT NORTH

3/16" = 1'- 0"




FLOOR SLOPES

**PLAN**

3/16" = 1'-0

NOTES:

1. FOR GENERAL STRUCTURAL NOTES AND TYPICAL STRUCTURAL DETAILS SEE SHEETS S-1 THROUGH S-7.

2. FOR ADDITIONAL INFORMATION ON THE FOUNDATION PLAN SEE SHEET 7S-1.

3. SL INDICATES DIRECTION OF SLOPED CONCRETE.

4. FOR TOP OF CONCRETE ELEVATIONS AT PADS SEE MECHANICAL DRAWINGS.

5. PROVIDE NON-SHRINK GROUT CRICKET AROUND CONCRETE PADS AS NEEDED FOR WATER TO FLOW AWAY FROM THE PAD.

BID SCHEDULE B

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|
| 2 | 6/13 | IEC | ADDENDUM 2 |

DESIGN CT | DRAWN JN | CHECK GH/YP

Beyaz & Patel, Inc. Consulting Engineers

CDM

OLIVENHAIN Municipal Water District 1966 Olivenhain Road Encinitas, CA 92024

**CONFORMED**

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

RESIDUALS HANDLING BUILDING
FLOOR SLOPE PLAN

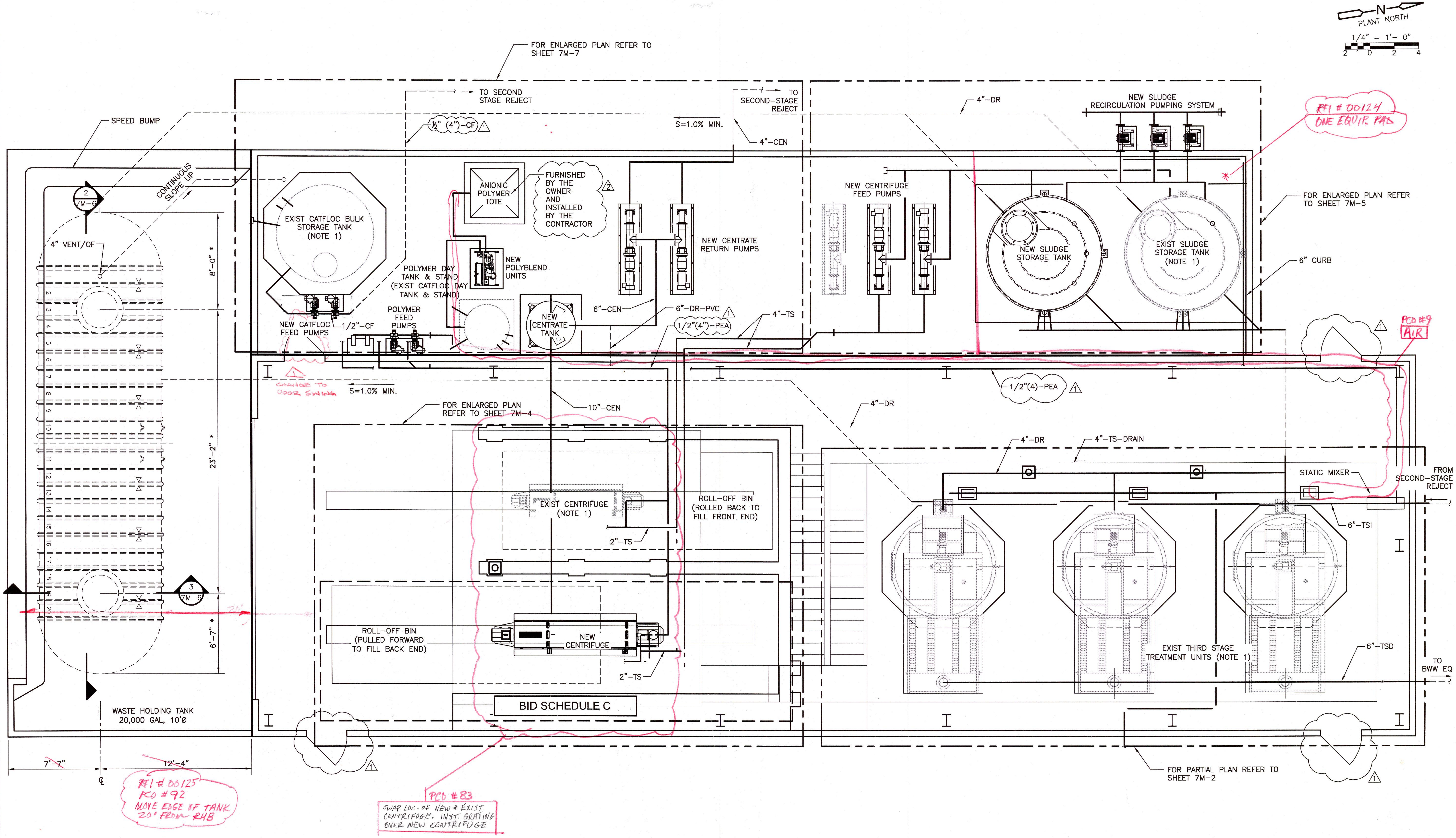
SHEET 87 / 218 OF SHEETS

7S-9

WO 179950

ORIGINAL SCALE IN INCHES

DWG: P:\Projects\OMWD (0002)\00xx LT2 Conformed Set\CADD\04 Design Services NM_Ex\04 Structural\10 CADD\73656-DCMWTP_LT2-7S-09.dwg USER: jnordquist
DATE: Jun 15, 2011 2:20pm XREFS: 73656-DCMWTP_LT2-G-BS 73656-DCMWTP_LT2-S-NP-RHB02




## PLAN
1/4" = 1'-0"

NOTES:

1. RELOCATED FROM EXISTING TREATMENT BUILDING.
2. ALL NEW CONSTRUCTION AND EQUIPMENT RELOCATION, EXCEPT FOR THE NEW CENTRIFUGE, IS PART OF BID SCHEDULE B.
3. NEW CENTRIFUGE AND APPURTENANCES ARE PART OF BID SCHEDULE C.
4. VALVES AND APPURTENANCES NOT SHOWN ON THIS SHEET, REFER TO PARTIAL AND ENLARGED PLANS.

BID SCHEDULE B

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 6/11 | IEC | ADDENDUM 2 |
| 2 | 6/11 | IEC | ADDENDUM 6 |

DESIGN JTY | DRAWN JSD | CHECK WKO

CONFORMED

CDM

OLIVENHAIN Municipal Water District

DAVID C. McCOLLOM WTP LT2 IMPROVEMENTS

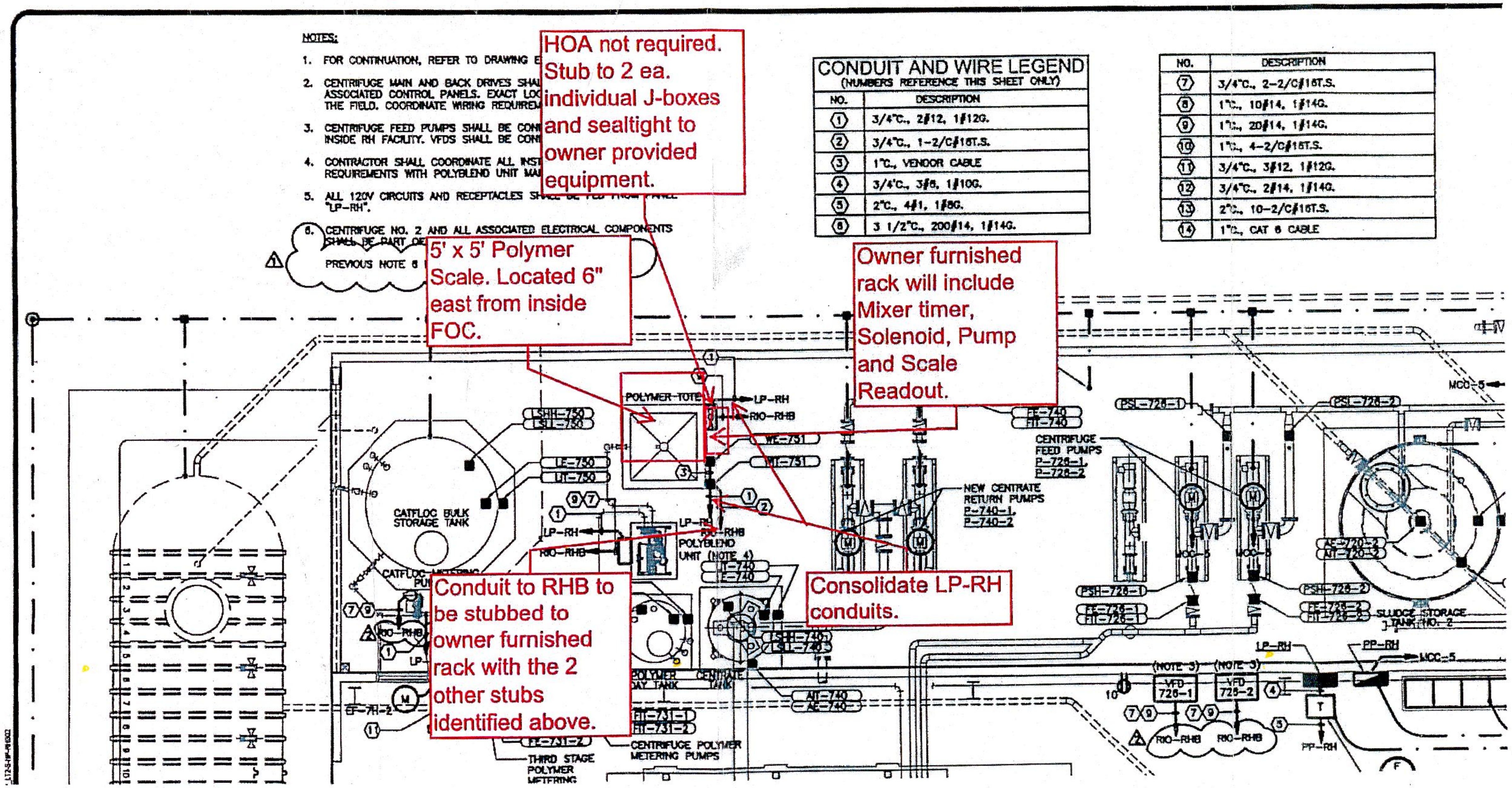
RESIDUAL HANDLING BUILDING PLAN

SHEET 117/218 OF SHEETS 7M-1

WO 179950

ORIGINAL SCALE IN INCHES

RFI - 00105




| CONDUIT AND WIRE LEGEND (NUMBERS REFERENCE THIS SHEET ONLY) | |
|---|---|
| NO. | DESCRIPTION |
| 1 | 3/4"C., 2#12, 1#12G. |
| 2 | 3/4"C., 1-2/C#16T.S. |
| 3 | 1"C., VENDOR CABLE |
| 4 | 3/4"C., 3#8, 1#10G. |
| 5 | 2"C., 4#1, 1#8G. |
| 6 | 3 1/2"C., 200#14, 1#14G. |

| NO. | DESCRIPTION |
|---|---|
| 7 | 3/4"C., 2-2/C#16T.S. |
| 8 | 1"C., 10#14, 1#14G. |
| 9 | 1"C., 20#14, 1#14G. |
| 10 | 1"C., 4-2/C#16T.S. |
| 11 | 3/4"C., 3#12, 1#12G. |
| 12 | 3/4"C., 2#14, 1#14G. |
| 13 | 2"C., 10-2/C#16T.S. |
| 14 | 1"C., CAT 6 CABLE |

NOTES:

1. FOR CONTINUATION, REFER TO DRAWING E-2.
2. CENTRIFUGE MAIN AND BACK DRIVES SHALL BE CONNECTED TO ASSOCIATED CONTROL PANELS. EXACT LOCATION TO BE DETERMINED IN THE FIELD. COORDINATE WIRING REQUIREMENTS WITH MANUFACTURER.
3. CENTRIFUGE FEED PUMPS SHALL BE CONNECTED TO VFDS LOCATED INSIDE RH FACILITY. VFDS SHALL BE CONNECTED TO MCC-5.
4. CONTRACTOR SHALL COORDINATE ALL INSTRUMENT FIELD WIRING REQUIREMENTS WITH POLYBLEND UNIT MANUFACTURER.
5. ALL 120V CIRCUITS AND RECEPTACLES SHALL BE FED FROM PANEL "LP-RH".
6. ~~CENTRIFUGE NO. 2 AND ALL ASSOCIATED ELECTRICAL COMPONENTS SHALL BE PART OF BID SCHEDULE C.~~

PREVIOUS NOTE 6 DELETED.

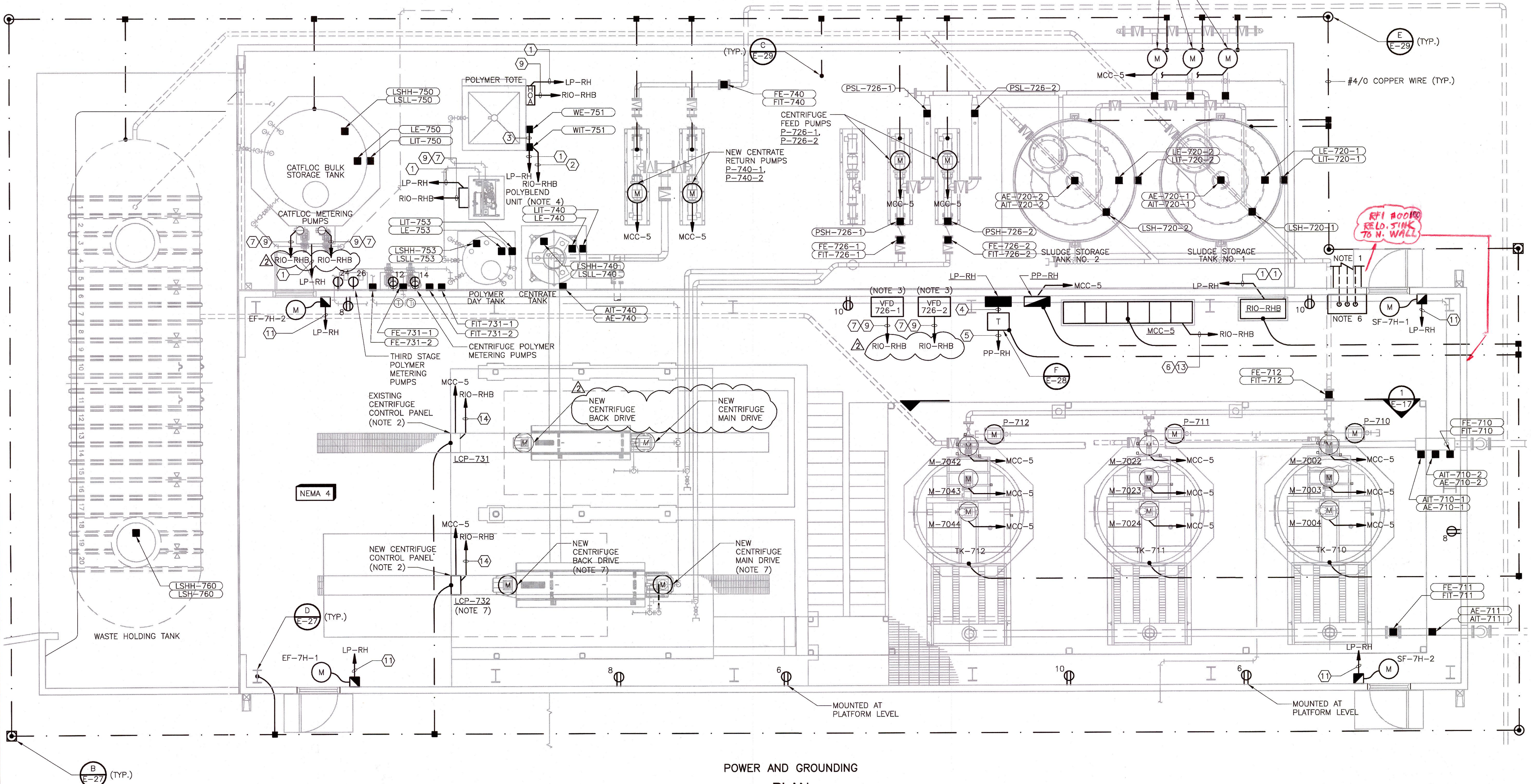
## CONDUIT AND WIRE LEGEND

(NUMBERS REFERENCE THIS SHEET ONLY)

| NO. | DESCRIPTION |
|---|---|
| 1 | 3/4"C., 2#12, 1#12G. |
| 2 | 3/4"C., 1-2/C#16T.S. |
| 3 | 1"C., VENDOR CABLE |
| 4 | 3/4'C., 3#6, 1#10G. |
| 5 | 2"C., 4#1, 1#8G. |
| 6 | 3 1/2"C., 200#14, 1#14G. |
| 7 | 3/4"C., 2-2/C#16T.S. |
| 8 | 1"C., 10#14, 1#14G. |
| 9 | 1"C., 20#14, 1#14G. |
| 10 | 1"C., 4-2/C#16T.S. |
| 11 | 3/4"C., 3#12, 1#12G. |
| 12 | 3/4"C., 2#14, 1#14G. |
| 13 | 2"C., 10-2/C#16T.S. |
| 14 | 1"C., CAT 6 CABLE |

PLANT NORTH

1/4" = 1'- 0"




POWER AND GROUNDING

PLAN

1/4" = 1'-0"

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|
| 6 | 6/11 | IEC | ADDENDUM 6 |
| 7 | 6/11 | IEC | ADDENDUM 7 |

DESIGN MF
DRAWN MF
CHECK MM

CONFORMED


CDM
Camp Dresser & McKee
1925 Palomar Oaks Way, Suite 300
Carlsbad, CA 92008
Tel: (760) 438-7755
consulting · engineering · construction · operations

OLIVENHAIN Municipal Water District
1966 Olivenhain Road
Encinitas, CA 92024 (760)753-6466


DAVID C. McCOLLOM WTP LT2 IMPROVEMENTS

ELECTRICAL R.H. BUILDING POWER AND GROUNDING PLAN

SHEET 179/218 OF SHEETS

7E-1

WO 179950

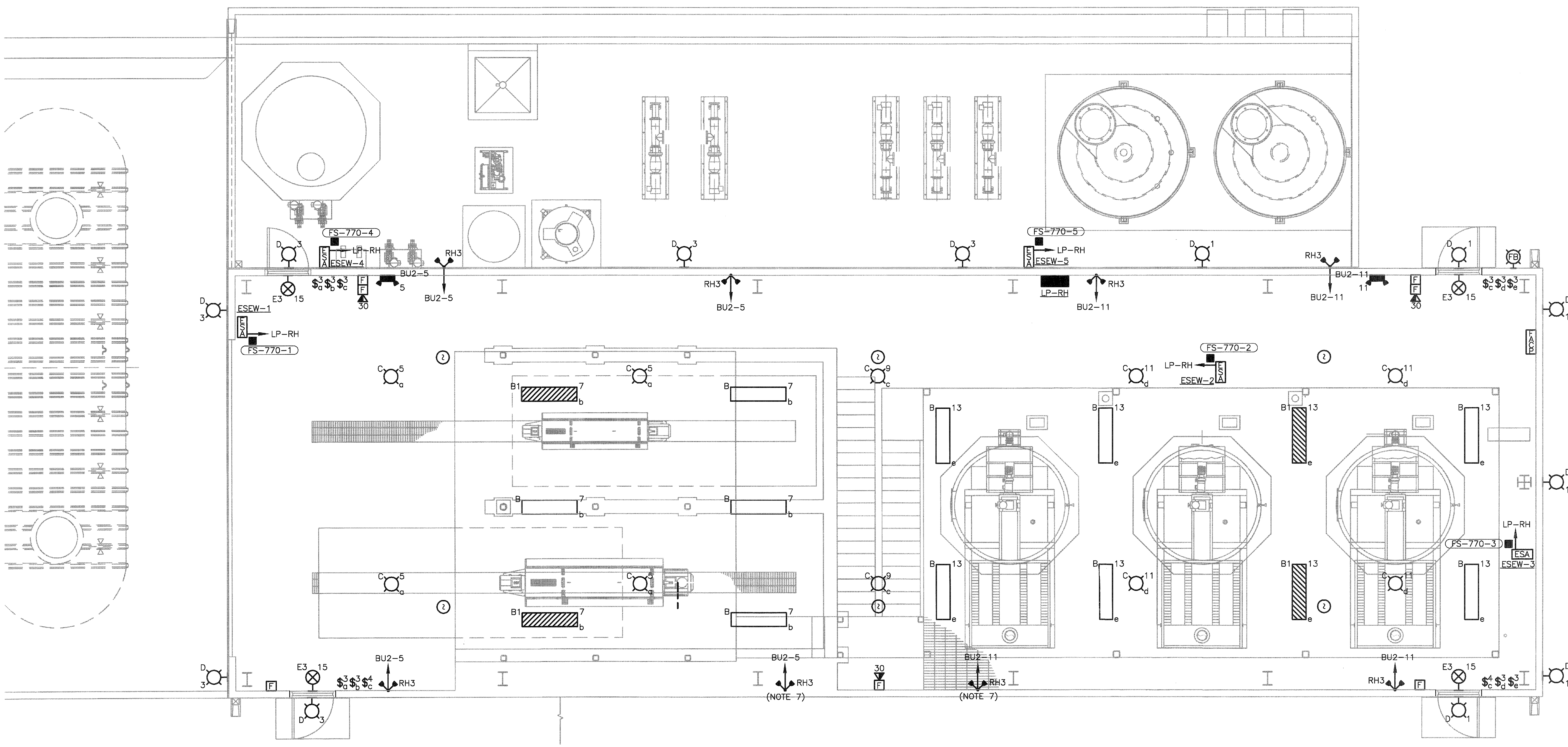
BID SCHEDULE B

ORIGINAL SCALE IN INCHES


DWG: P:\Projects\OMWD (0002)\00cc LT2 Conformed Set\CADD\04 Design Services NM_Bid\09 Electrical\10 CADD\73656-DCMWTP_LT2-7E-1.dwg USER: jnorquist
DATE: Jun 15, 2011 3:22pm XREFS: 73656-DCMWTP_LT2-G-BS 73656-DCMWTP_LT2-M-SP-RES_BLDG01 73656-DCMWTP_LT2-E-PP-RES 73656-DCMWTP_LT2-A-FL-SOLIDS 73656-DCMWTP_LT2-S-NP-RHB02

PLANT NORTH

1/4" = 1'- 0"




LIGHTING
## PLAN
1/4" = 1'-0"

NOTES:

1. WALL MOUNT OUTDOOR LUMINAIRES 8'-0" AFF.
2. MOUNT BATTERY UNITS AND REMOTE HEADS 8'-0" AFF.
3. PENDANT MOUNT ALL TYPE "B" AND TYPE "B1" FIXTURES BENEATH PLATFORMS, 10'-0" AFF.
4. PENDENT MOUNT ALL TYPE "C" FIXTURES 28'-0" AFF.
5. MOUNT EXIT SIGNS ABOVE THE DOORS.
6. CONNECT ALL LUMINAIRES TO LIGHTING PANEL LP-RH.
7. MOUNT REMOTE HEADS 8'-0" ABOVE PLATFORM.

BID SCHEDULE B

ORIGINAL SCALE IN INCHES

| MARK | DATE | BY | REVISIONS |
|---|---|---|---|

DESIGN MF | DRAWN MF | CHECK MM

CDM — Camp Dresser & McKee — consulting • engineering • construction • operations

CONFORMED

OLIVENHAIN Municipal Water District, 1966 Olivenhain Road, Encinitas, CA 92024

DAVID C. McCOLLOM WTP
LT2 IMPROVEMENTS

ELECTRICAL R.H. BUILDING
LIGHTING AND SYSTEMS PLAN

SHEET 180 OF 218 SHEETS

7E-2

WO 179950

| Asset | Description | Class | Commission Date |
|---|---|---|---|
| ACCT - 20097175000-1 | RPP WTR TREATMENT PLANT #1 | BACKFLOW | 1/15/2009 |
| ACCT - 20097175000-2 | RPP WTR TREATMENT PLANT #1 | BACKFLOW | 1/15/2009 |
| ACCT - 20097180000-1 | RPP WTR TREATMENT PLANT #2 | BACKFLOW | 1/15/2009 |
| ACCT - 20097180000-3 | RPP WTR TREATMENT PLANT #2 | BACKFLOW | 1/15/2009 |
| ACCT - 20097180000-4 | RPP WTR TREATMENT PLANT #2 | BACKFLOW | 8/12/2010 |
| ACCT - 20097180000-5 | RPP WTR TREATMENT PLANT #2 | BACKFLOW | 8/12/2010 |
| AFIF SITE | Ammonia Feed Injection Facility Site | SITE | 1/28/2010 |
| AFIF.AC.AC-1 | AFIF Air Conditioning Unit AC-1 | HVAC | 11/1/2006 |
| AFIF.BPV-6200 | BPV-6200 Back Pressure Valve | VALVE | 1/1/2016 |
| AFIF.CHEM.NH3.CP-FP1 | Ammonia Feed Pump P-6143 Control Panel | CONTROL | 10/22/2015 |
| AFIF.CHEM.NH3.CP-FP2 | Control Panel Ammonia Feed Pump 2 | OIT | 1/1/2016 |
| AFIF.CHEM.NH3.P-6143 | P-6143 Ammonia Feed Pump 1 | PUMP | 3/2/2016 |
| AFIF.CHEM.NH3.P-6143.PIPING | P-6143 Ammonia Feed Pump 1 Piping | PIPING | 1/1/2016 |
| AFIF.CHEM.NH3.P-6144 | P-6144 Ammonia Feed Pump 2 | PUMP | 1/1/2016 |
| AFIF.CHEM.NH3.P-6144.PIPING | P-6144 Ammonia Feed Pump 2 Piping | PIPING | 1/1/2016 |
| AFIF.CHEM.NH3.PIPING | PIPING Ammonia Storage Tank Piping | PIPING | 1/1/2016 |
| AFIF.CHEM.NH3.TK-6260 | TK-6260 Ammonia Bulk Storage Tank | TANK | 1/1/2016 |
| AFIF.CHEM.NH3.TK-6280 | TK-6280 Ammonia Scrubber Tank | TANK | 1/1/2016 |
| AFIF.INJ.VAULT | Ammonia Feed Injection Facility Vault | VAULT | 3/25/2016 |
| AFIF.INJ.VAULT.HATCH | Ammonia Feed Injection Vault Hatch | HATCH | 1/1/2016 |
| AFIF.INJ.VAULT.MIXINGPADDLE | Ammonia Feed Injection Vault Mixing Paddle | MIXER | 1/1/2016 |
| AFIF.INJ.VAULT.PIPING | Ammonia Feed Injection Vault Piping | PIPING | 1/1/2016 |
| AFIF.INJ.VAULT.QUILL | Ammonia Feed Injection Vault Quill | QUILL | 1/1/2016 |
| AFIF.INST.FLUOR.AIT-6255.PIPIN | AIT-6255 Fluoride residual analyzer Piping | PIPING | 1/1/2016 |
| AFIF.INST.FREECL2.AIT-6251.PIP | AIT-6251 Free Cl2 residual analyzer Piping | PIPING | 1/1/2016 |
| AFIF.INST.PIPING | Analyzer Sample Return Piping | PIPING | 2/2/2007 |
| AFIF.INST.POST.AIT-6253.PIPING | AIT-6253 APA-6000 Monochloramine analyzer Piping | PIPING | 1/1/2016 |
| AFIF.INST.TOTALCL2.AIT-6254.PI | AIT-6254 Total Cl2 residual analyzer Piping | PIPING | 1/1/2016 |
| AFIF.OIT | AFIF Operator Interface Terminal | OIT | 5/14/2015 |
| AFIF.PRV-6200 | PRV-6200 Pressure Relief Valve | VALVE | 1/1/2016 |
| AFIF.TK-6250 | TK-6250 Ammonia Facility Holding Tank | TANK | 1/1/2016 |
| EYEWASH STATION  AT FLOC BULK | EYEWASH AT FLOC BULK TANK AREA | | 1/30/2009 |
| PIPING RAW WATER HYPO | WTP.CHEM.RW.HYPO.PIPING | PIPING | 2/1/2002 |
| VA57-VIBRATION | WTP Vibration Analysis | * | 1/14/2010 |
| WAAFIF1001 | AFIF GENERATOR BATTERY CHARGER | ELEC | 3/18/2009 |
| WAAFIF1031 | AFIF AUTOMATIC GATE SYSTEM | SECURITY | 3/18/2009 |
| WAAFIF1033 | AFIF AMMONIA SOLUTION DAY TANK | TANK | 3/18/2009 |
| WAAFIF1036 | AFIF GENERATOR TRANSFER SWITCH MAIN BREAKER | ELEC | 3/18/2009 |
| WAAFIF1037 | AFIF DIAPHRAGM METERING PUMP #1 P-6261 | PUMP | 3/18/2009 |
| WAAFIF1038 | AFIF DIAPHRAGM METERING PUMP #2 P-6262 | PUMP | 3/18/2009 |
| WAAFIF1039 | AFIF AMMONIA SOLUTION TRANSFER PUMP #1 P-6230 | PUMP | 3/18/2009 |
| WAAFIF1040 | AFIF AMMONIA SOLUTION TRANSFER PUMP #2 P-6240 | PUMP | 3/18/2009 |
| WAAFIF1041 | AFIF SAMPLE RETURN PUMP | PUMP | 3/18/2009 |
| WAAFIF1044 | AFIF SAMPLE RETURN TANK | TANK | 3/18/2009 |
| WAAFIF1055 | AFIF AMMONIUM SULFATE FEEDER 6210 AIR COMPRESSOR | COMPRESS | 3/18/2009 |
| WAAFIF1056 | AFIF AMMONIUM SULFATE FEEDER 6220 AIR COMPRESSOR | COMPRESS | 3/18/2009 |
| WAAFIF1063 | AFIF AMMONIA INJECTION DIFFUSER #1 Northside | DIFFUSER | 3/18/2009 |
| WAAFIF1064 | AFIF AMMONIA INJECTION DIFFUSER #2 Southside | DIFFUSER | 3/18/2009 |
| WAAFIF1065 | AFIF Building | FACILITY | 3/23/2009 |

| | | | |
|---|---|---|---|
| WAAFIF1074 | AFIF 480/3 GENERATOR MOUNTED MAIN BREAKER 100 AMP | ELEC | 3/25/2009 |
| WAAFIF1075 | AFIF BACKUP GENERATOR | GENERATE | 3/25/2009 |
| WAAFIF6144 | AFIF AMMONIA SOLUTION PUMP P-6144 | PUMP | 5/15/2013 |
| WAAFIFGATECAM | AFIF Gate Camera | SECURITY | 6/17/2009 |
| WAWTPGATECAM | WTP Horsewall Gate Camera | SECURITY | 6/17/2009 |
| WAWTPGATECAM2 | WTP green slide gate camera | SECURITY | 2/4/2021 |
| WAWTPGATECOMM | WTP Horsewall Gate PBX Communications Interface | SECURITY | 6/17/2009 |
| WAWTPGATEDSX | WTP Horsewall Gate DSX System | SECURITY | 6/17/2009 |
| WAWTPGATEOPIN | WTP Horsewall Gate Operator - Enter | SECURITY | 6/17/2009 |
| WAWTPGATEOPOUT | WTP Horsewall Gate Operator - Exit | SECURITY | 6/17/2009 |
| WAWTPGATERDIN | WTP Horsewall Gate Reader - Enter | SECURITY | 6/17/2009 |
| WAWTPGATERDOUT | WTP Horsewall Gate Reader - Exit | SECURITY | 6/17/2009 |
| WTP 2ND STG REJECT TSS | 2ND STAGE REJECT TSS METER | XDUCER | 1/25/2010 |
| WTP 3RD STG EFFLUENT TSS | 3RD STAGE EFFLUENT TSS METER | XDUCER | 7/1/2010 |
| WTP 4TH STG EFFLUENT TSS | 4TH STAGE EFFLUENT TSS METER | XDUCER | 7/1/2010 |
| WTP FCV-8860-A | Backpulse Tank Feed FCV 8860-A | VALVE | 12/22/2010 |
| WTP FCV-8860-B | Backpulse Tank Feed FCV 8860-B | VALVE | 12/22/2010 |
| WTP FEED PRIMING VACUUM PIPING | ZW1 & ZW2 VACUUM PIPING (FEED & MIT PRIMING) | PIPING | 12/1/2010 |
| WTP GENERATOR | GENERATOR, WTP | GENERATE | 11/17/2009 |
| WTP GENERATOR-1 | GENERATOR FUEL TANK, WTP | TANK | 6/9/2016 |
| WTP HIGH BAY LITE (42) | WTP High Bay Lights (42) high press. sodium 400 watt 277V | FACILITY | 7/13/2010 |
| WTP LIT-7226 | LIT-7226 1st stage reject channel level transmitter | XDUCER | 11/22/2011 |
| WTP LIT-7226S | LIT-7226 1st stage reject channel level transmitter spare | XDUCER | 11/22/2011 |
| WTP M-2010 MIXER | M-2010 CIP SYSTEM STATIC MIXER | MIXER | 1/12/2010 |
| WTP MAIN ELEC ROOM | WTP Main Electric Room | FACILITY | 10/21/2008 |
| WTP PERMEATE PUMP VFDS | WTP Permeate Pump VFD's 1-8 | VFD | 4/30/2009 |
| WTP PIT- 9220A VAC SYS | PIT-9220A VACUUM SYS-PRIMING (ASV) | PIPING | 12/1/2010 |
| WTP PIT- 9220B VAC SYS | PIT-9220B VACUUM SYS-PRIMING (ZW1-1) | PIPING | 12/1/2010 |
| WTP PIT- 9221 VAC SYS | PIT-9221 VACUUM SYS-SIPHON (ASV) | PIPING | 12/1/2010 |
| WTP PRV NO.1 DCW | WTP PRV NO.1 DCW 1.25" Lowflow | VALVE | 6/1/2002 |
| WTP PRV NO.2 DCW | WTP PRV NO.2 DCW 2.5" Highflow | VALVE | 6/1/2002 |
| WTP SIPHON VACUUM PIPING | ZW1 & ZW2 VACUUM PIPING (FEED SIPHON) | PIPING | 12/1/2010 |
| WTP SM-35 STATIC MIXER | SM-35 STATIC MIXER - CFE (HYPO) | MIXER | 1/12/2010 |
| WTP SM-36 STATIC MIXER | SM-36 STATIC MIXER - CFE (AMMONIA) | MIXER | 1/12/2010 |
| WTP SM-85-A STATIC MIXER | SM-85-A STATIC MIXER - RAW (HYPO & ACH) | MIXER | 1/12/2010 |
| WTP SM-85-B STATIC MIXER | SM-85-B STATIC MIXER - RAW (NOT USED) | MIXER | 1/12/2010 |
| WTP-230004-CV | 1st Stage P-35-2 Check Valve | VALVE | 8/17/2010 |
| WTP-GEN-POWER-MONITOR | WTP Generator Emergency Power Monitor | CONTROL | 6/22/2012 |
| WTP-PUMP MOTORS | WTP Pump Motor Parent Asset (ALL) | MOTOR | 12/4/2008 |
| WTP-SAFETY-1 | BODY HARNESS, LARGE | SAFETY | 12/1/2018 |
| WTP-SAFETY-10 | FALL ARREST/RETRIEVAL SYSTEM | SAFETY | 8/26/2019 |
| WTP-SAFETY-11 | CONFINED SPACE BLOWER/FAN | SAFETY | 6/1/2019 |
| WTP-SAFETY-12 | CONFINED SPACE BLOWER/FAN | SAFETY | 6/1/2019 |
| WTP-SAFETY-13 | CONFINED SPACE BLOWER/FAN | SAFETY | 7/1/2010 |
| WTP-SAFETY-14 | Fall Arrest System | SAFETY | 7/30/2013 |
| WTP-SAFETY-15 | Fall Arrest System | SAFETY | 7/30/2013 |
| WTP-SAFETY-16 | Fall Arrest System | SAFETY | 7/30/2013 |
| WTP-SAFETY-17 | Fall Arrest System | SAFETY | 7/30/2013 |
| WTP-SAFETY-18 | Fall Arrest System | SAFETY | 7/30/2013 |
| WTP-SAFETY-2 | BODY HARNESS, LARGE | SAFETY | 11/1/2018 |
| WTP-SAFETY-3 | BODY HARNESS, MEDIUM | SAFETY | 6/7/2019 |
| WTP-SAFETY-4 | BODY HARNESS, MEDIUM | SAFETY | 8/1/2012 |
| WTP-SAFETY-5 | BODY HARNESS, MEDIUM | SAFETY | 8/1/2012 |

| | | | |
|---|---|---|---|
| WTP-SAFETY-6 | BODY HARNESS, MEDIUM | SAFETY | 5/1/2017 |
| WTP-SAFETY-7 | BODY HARNESS, M/L | SAFETY | 11/1/2011 |
| WTP-SAFETY-8 | BODY HARNESS, M/L | SAFETY | 8/1/2010 |
| WTP-SAFETY-9 | FALL ARREST/RETRIEVAL SYSTEM | SAFETY | 6/1/2019 |
| WTP. DAVIT CRANE.DC-1 | DAVIT CRANE.DC-1 (WTP) 1/2-TON | CRANE | 1/1/2016 |
| WTP. DAVIT CRANE.DC-2 | DAVIT CRANE.DC-2 (RHB) 1/2-TON | CRANE | 1/1/2016 |
| WTP.AC-AC-MIT96B-AIRDRY | WTP.AC-MIT96B AirDryer | * | 1/1/2013 |
| WTP.AC.3H1 | AC-3H1 INDOOR EVAP | EVAP | 1/1/2016 |
| WTP.AC.3H2 | AC-3H2 INDOOR EVAP | EVAP | 1/1/2016 |
| WTP.AC.AC.1 | AC.AC-1 AIR CONDITIONING UNIT | HVAC | 1/1/2016 |
| WTP.AC.AC.2 | AC.AC-2 AIR CONDITIONING UNIT | HVAC | 1/1/2016 |
| WTP.AC.AC.MIT96A | WTP.AC.AC.MIT96A Air Compressor Oil Free | COMPRESS | 1/1/2012 |
| WTP.AC.AC.MIT96A-AIRDRY | WTP.AC.AC.MIT96A AIR DRYER | DRYER | 1/1/2016 |
| WTP.AC.AC.MIT96A-MTR | WTP.AC.AC.MIT96A MOTOR | MOTOR | 1/1/2016 |
| WTP.AC.AC.MIT96B-MTR | WTP.AC.AC.MIT96B MOTOR | MOTOR | 1/1/2016 |
| WTP.AC.AC9675A-COMP-1 | PLANT AIR COMPRESSOR AC9675-A | COMPRESS | 6/3/2019 |
| WTP.AC.AC9675A-COMP-2 | PLANT AIR DRYER AC9675-A | DRYER | 6/3/2019 |
| WTP.AC.AC9675B-COMP-1 | PLANT AIR COMPRESSOR AC9675-B | COMPRESS | 6/3/2019 |
| WTP.AC.AC9675B-COMP-2 | PLANT AIR DRYER AC9675-B | DRYER | 6/3/2019 |
| WTP.AC/CU.3H1 | AC-3H-01 HEAT PUMP EVAPORATOR Elec. Rm. 2 | HVAC | 12/3/2012 |
| WTP.AC/CU.3H2 | AC-3H-02 HEAT PUMP EVAPORATOR Elec. Rm. 2 | HVAC | 8/21/2015 |
| WTP.AHU.AHU.1A | AIR HANDLER AHU-1A (ERT ROOM) | AIRHNDLR | 1/1/2016 |
| WTP.AHU.AHU.2A | AIR HANDLER AHU-2A (BLOWER ROOM) | AIRHNDLR | 1/1/2016 |
| WTP.AHU.AHU.2B | AIR HANDLER AHU-2B (BLOWER ROOM) | AIRHNDLR | 1/1/2016 |
| WTP.AHU.MTR-AHU.1A | AHU-1A MOTOR | MOTOR | 1/1/2016 |
| WTP.AHU.MTR-AHU.2A | AHU-2A MOTOR | MOTOR | 1/1/2016 |
| WTP.AHU.MTR-AHU.2B | AHU-2B MOTOR | MOTOR | 1/1/2016 |
| WTP.AIR.AC-3 | AC-3 Auxillary Compressor | COMPRESS | 1/1/2016 |
| WTP.AIR.SV-9671 | SV-9671 Auxillary Air Solenoid valve from surge tank | VALVE | 1/1/2016 |
| WTP.AIR.SV-9672 | SV-9672 Auxillary Air Solenoid valve to surge tank | VALVE | 1/1/2016 |
| WTP.BLWR B-85-2A | WTP.BLOWER B-85-2b A/C repair | BLOWER | 10/5/2017 |
| WTP.BLWR.85-2A | WTP 2ND STAGE BLOWER B-85-2A | BLOWER | 12/20/2013 |
| WTP.BLWR.ACU-1A | B-85-1A.ACU Air Conditioning Unit | HVAC | 1/1/2016 |
| WTP.BLWR.ACU-1B | B-85-1B.ACU Air Conditioning Unit | HVAC | 1/1/2016 |
| WTP.BLWR.ACU-2A | B-85-2A.ACU Air Conditioning Unit | HVAC | 1/1/2016 |
| WTP.BLWR.ACU-2B | B-85-2B.ACU Air Conditioning Unit | HVAC | 1/1/2016 |
| WTP.BLWR.B-85-1A | WTP 1ST STAGE BLOWER B-85-1A | BLOWER | 2/18/2015 |
| WTP.BLWR.B-85-1B | WTP 1ST STAGE BLOWER B-85-1B | BLOWER | 2/18/2015 |
| WTP.BLWR.B-85-2A | B-85-2A 2nd Stage BLOWER Package | BLOWER | 1/1/2016 |
| WTP.BLWR.B-85-2B | WTP 2ND STAGE BLOWER B-85-2B | BLOWER | 12/20/2013 |
| WTP.BLWR.BFV-8566 | BFV-8566 2nd Stage BLOWER Downstream Valve | VALVE | 1/1/2016 |
| WTP.BLWR.BFV-8568 | BFV-8568 1st Stage BLOWER Downstream Valve | VALVE | 1/1/2016 |
| WTP.BLWR.BFV-8580-1A | BFV-8580-1A Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BLWR.BFV-8580-1B | BFV-8580-1B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BLWR.BFV-8580-2A | BFV-8580-2A Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BLWR.BFV-8580-2B | BFV-8580-2B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BLWR.COMP-85-1A | B-85-1A 1st Stage BLOWER Compressor | COMPRESS | 1/1/2016 |
| WTP.BLWR.COMP-85-1B | B-85-1B 1st Stage BLOWER Compressor | COMPRESS | 1/1/2016 |
| WTP.BLWR.CV-8585-1A | CV-8585-1A Swing Check Valve | VALVE | 1/1/2016 |
| WTP.BLWR.CV-8585-1B | CV-8585-1B Swing Check Valve | VALVE | 1/1/2016 |
| WTP.BLWR.CV-8585-2A | CV-8585-2A Swing Check Valve | VALVE | 1/1/2016 |
| WTP.BLWR.CV-8585-2B | CV-8585-2B Swing Check Valve | VALVE | 1/1/2016 |
| WTP.BLWR.DPI-D-8540-1A | DPI-8540-1A-Discharge Differential Pressure Gauge | PIT | 1/1/2016 |
| WTP.BLWR.DPI-I-8540-1A | DPI-8540-1A-Inlet Filter Differential Pressure Gauge | PIT | 1/1/2016 |
| WTP.BLWR.F-8504-2A | F-8504-2A Discharge Silencer | FILTER | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.BLWR.F-D-8504-1A | F-8504-1A-Discharge Silencer | FILTER | 1/1/2016 |
| WTP.BLWR.F-D-8504-1B | F-8504-1B Discharge Silencer | FILTER | 1/1/2016 |
| WTP.BLWR.F-D-8504-2B | F-8504-2B Discharge Silencer | FILTER | 1/1/2016 |
| WTP.BLWR.F-D-8540-1B | DPI-8540-1B-Discharge Differential Pressure Gauge | PIT | 1/1/2016 |
| WTP.BLWR.F-I-8504-1A | F-8504-1A-Inlet Silencer w/ Filter | FILTER | 1/1/2016 |
| WTP.BLWR.F-I-8504-2B | F-8504-2B Inlet Silencer W/ Filter | FILTER | 1/1/2016 |
| WTP.BLWR.F-I-8540-1B | F-8540-1B-Inlet Silencer W/ Filter | PIT | 1/1/2016 |
| WTP.BLWR.MTR-85-1A | MTR-85-1A BLOWER Motor | MOTOR | 1/1/2016 |
| WTP.BLWR.MTR-85-1B | MTR-85-1B BLOWER Motor | MOTOR | 1/1/2016 |
| WTP.BLWR.MTR-85-2A | MTR-85-2A BLOWER Motor | MOTOR | 1/1/2016 |
| WTP.BLWR.MTR-85-2B | MTR-85-2B BLOWER Motor | MOTOR | 1/1/2016 |
| WTP.BLWR.PIPE | BLOWER Piping | PIPING | 1/1/2016 |
| WTP.BLWR.PRV-1-8590-1A | PRV-1-8590-1A Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-1-8590-1B | PRV-1-8590-1B Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-1-8590-2A | PRV-1-8590-2A Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-1-8590-2B | PRV-1-8590-2B Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-2-8590-1A | PRV-2-8590-1A Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-2-8590-1B | PRV-2-8590-1B Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-2-8590-2A | PRV-2-8590-2A Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-2-8590-2B | PRV-2-8590-2B Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-3-8590-1A | PRV-3-8590-1A Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-3-8590-1B | PRV-3-8590-1B Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-3-8590-2A | PRV-3-8590-2A Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.PRV-3-8590-2B | PRV-3-8590-2B Pressure Relief Valve | VALVE | 1/1/2016 |
| WTP.BLWR.VFD-85-1A | B-85-1A VFD | VFD | 1/1/2016 |
| WTP.BLWR.VFD-85-1B | B-85-1B VFD | VFD | 1/1/2016 |
| WTP.BLWR.VFD-85-2A | B-85-2A VFD | VFD | 1/1/2016 |
| WTP.BLWR.VFD-85-2B | B-85-2B VFD | VFD | 1/1/2016 |
| WTP.BP.BFV-380-1A | BFV-380-1A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-380-1B | BFV-380-1B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-380-2A | BFV-380-2A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-380-2B | BFV-380-2B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8888-A | BFV-8888-A Tank A Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8888-B | BFV-8888-B Tank B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8889-A | BFV-8889-A Tank A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8889-B | BFV-8889-B Tank B Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8898-A | BFV-8898-A FCV A Upstream isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8898-B | BFV-8898-B FCV B Upstream isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8899-A | BFV-8899-A FCV A Downstream isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.BFV-8899-B | BFV-8899-B FCV B Downstream isolation Valve | VALVE | 1/1/2016 |
| WTP.BP.CV-380-1 | CV-380-1 Check Valve | VALVE | 1/1/2016 |
| WTP.BP.CV-380-2 | CV-380-2 Check Valve | VALVE | 1/1/2016 |
| WTP.BP.FCV-8860-A | FCV-8860-A FCV A | VALVE | 1/1/2016 |
| WTP.BP.FCV-8860-B | FCV-8860-B FCV B | VALVE | 1/1/2016 |
| WTP.BP.FCV-8974 | FCV-8974 2nd Stage Backpulse FCV | VALVE | 1/1/2016 |
| WTP.BP.P-380-1 | P-380-1 First Stage Backpulse Pump | PUMP | 1/1/2016 |
| WTP.BP.P-380-1 MOTOR | P-380-1 First Stage Backpulse Pump Motor | MOTOR | 1/1/2016 |
| WTP.BP.P-380-2 | P-380-2 First Stage Backpulse Pump | PUMP | 1/1/2016 |
| WTP.BP.P-380-2 MOTOR | P-380-2 First Stage Backpulse Pump Motor | MOTOR | 1/1/2016 |
| WTP.BP.PIPING | Backpulse Piping | PIPING | 1/1/2016 |
| WTP.BP.PRV-380 | PRV-380 1st Stage Backpulse PRV | VALVE | 1/1/2016 |
| WTP.BP.TK-88-A | TK-88-A Backpulse Tank A | TANK | 1/1/2016 |
| WTP.BP.TK-88-B | TK-88-B Backpulse Tank B | TANK | 1/1/2016 |
| WTP.BRIDGE CRANE.BC-1 | BRIDGE CRANE.BC-1. 3- TON | CRANE | 1/1/2016 |
| WTP.BWEQ-P-410-2 | Second Stage return pump P-410-2 | PUMP | 1/1/2013 |
| WTP.BWEQ-P-410-3 | Second Stage return pump 410-3 | | 1/1/2013 |
| WTP.BWEQ.BFV-410-1 | BFV-410-1 Flow to Second Stage Membranes | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-410-1A | BFV-410-1A upstream P-410-1 | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.BWEQ.BFV-410-1B | BFV-410-1B downstream P-410-1 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-410-2 | BFV-410-2 Flow to Second Stage Membranes | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-410-2A | BFV-410-2A upstream P-410-2 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-410-2B | BFV-410-2B downstream P-410-2 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-410-3A | BFV-410-3A upstream P-410-3 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-410-3B | BFV-410-3B downstream P-410-3 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-415-1A | BFV-415-1B downstream P-415-1 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-415-2A | BFV-415-2A upstream P-415-2 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-415-2B | BFV-415-2B downstream P-415-2 | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-8401-1 | BFV-8401-1 Flow from Third Stage Decant | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-8401-2 | BFV-8401-2 Flow from First Stage Reject | VALVE | 1/1/2016 |
| WTP.BWEQ.BFV-8401-3 | BFV-8401-3 Tank Drain Valve | VALVE | 1/1/2016 |
| WTP.BWEQ.CV-410-1 | CV-410-1 Check Valve downstream P-410-1 | VALVE | 1/1/2016 |
| WTP.BWEQ.CV-410-2 | CV-410-2 Check Valve downstream P-410-2 | VALVE | 1/1/2016 |
| WTP.BWEQ.CV-410-3 | CV-410-3 Check valve downstream P-410-3 | VALVE | 1/1/2016 |
| WTP.BWEQ.CV-415-1 | CV-415-1 Check Valve downstream P-415-1 | VALVE | 1/1/2016 |
| WTP.BWEQ.CV-415-2 | CV-415-2 Check Valve downstream P-415-2 | VALVE | 1/1/2016 |
| WTP.BWEQ.MTR-410-1 | MTR-410-1 Second Stage Return Motor | MOTOR | 1/1/2016 |
| WTP.BWEQ.MTR-410-2 | MTR-410-2 Second Stage Return Motor | MOTOR | 1/1/2013 |
| WTP.BWEQ.MTR-410-3 | MTR-410-3 Second Stage Return Motor | MOTOR | 1/1/2016 |
| WTP.BWEQ.MTR-415-1 | MTR-415-1 Recirculation Mixing Motor | MOTOR | 1/1/2016 |
| WTP.BWEQ.MTR-415-2 | MTR-415-2 Recirculation Mixing Motor | MOTOR | 1/1/2016 |
| WTP.BWEQ.P-410-1 | P-410-1 Second Stage Return Pump #1 | PUMP | 1/1/2016 |
| WTP.BWEQ.P-410-1/2 | P-410-1 Second Stage Return Pump Motor #1 | MOTOR | 6/26/2019 |
| WTP.BWEQ.P-410-2 | P-410-2 Second Stage Return Pump #2 | PUMP | 1/1/2016 |
| WTP.BWEQ.P-410-2/3 | P-410-2 Second Stage Return Pump Motor #2 | MOTOR | 4/2/2019 |
| WTP.BWEQ.P-410-3 | P-410-3 Second Stage Return Pump #3 | PUMP | 1/1/2016 |
| WTP.BWEQ.P-410-3/4 | P-410-3 Second Stage Return Pump Motor #3 | MOTOR | 4/28/2020 |
| WTP.BWEQ.P-415-1 | P-415-1 Recirculation Mixing Pump | PUMP | 1/1/2016 |
| WTP.BWEQ.P-415-1/1 | P-415-1 Recirculation Mixing Pump Motor | MOTOR | 9/20/2018 |
| WTP.BWEQ.P-415-2 | P-415-2 Recirculation Mixing Pump | PUMP | 1/1/2016 |
| WTP.BWEQ.P-415-2/2 | P-415-2 Recirculation Mixing Pump Motor | MOTOR | 9/20/2018 |
| WTP.BWEQ.TNK-8401 | TNK-8401-Backwash Equalization Tank | TANK | 1/1/2016 |
| WTP.CHEM.ACH.CP-FP-1 | Control Panel ACH Feed Pump 1 | CONTROL | 1/1/2016 |
| WTP.CHEM.ACH.CP-FP-2 | Control Panel ACH Feed Pump 2 | CONTROL | 1/1/2016 |
| WTP.CHEM.ACH.P-815-1 | ACH Chemical pump P-815-1 | PUMP | 1/1/2013 |
| WTP.CHEM.ACH.P-815-2 | ACH Chemical Pump P-815-2 | PUMP | 1/1/2013 |
| WTP.CHEM.ACH.PIPING | PIPING ACH | PIPING | 1/1/2016 |
| WTP.CHEM.ACH.TKS | TKS ACH Storage Tank | TANK | 1/1/2016 |
| WTP.CHEM.CEB.CP.LCP-310-1 | CP CEB Feed Pump Control Panel 310-1 | CONTROL | 1/1/2016 |
| WTP.CHEM.CEB.CP.LCP-310-2 | CP CEB Feed Pump Control Panel 310-2 | CONTROL | 1/1/2016 |
| WTP.CHEM.CEB.P-310-1 | P-310-1 CEB Hypo Pump 1 | PUMP | 1/1/2016 |
| WTP.CHEM.CEB.P-310-2 | P-310-2 CEB Hypo Pump 2 | PUMP | 1/1/2016 |
| WTP.CHEM.CEB.PIPING | PIPING CEB Hypo | PIPING | 1/1/2016 |
| WTP.CHEM.CIP.BISF.CP | CP Bisulfite CIP Feed Pump Control Panel | CONTROL | 1/1/2016 |
| WTP.CHEM.CIP.BISF.CP-FP | Control Panel CIP Bisulfite Feed Pumps | CONTROL | 1/1/2016 |
| WTP.CHEM.CIP.BISF.P-5341 | P-5341 CIP Bisulfite Feed Pump 1 | PUMP | 1/1/2016 |
| WTP.CHEM.CIP.BISF.P-5342 | P-5342 CIP Bisulfite Feed Pump 2 | PUMP | 1/1/2016 |
| WTP.CHEM.CIP.BISF.PIPING | PIPING CIP Bisulfite | PIPING | 1/1/2016 |
| WTP.CHEM.CIP.BISF.TK-5301 | TK-5301 CIP Bisulfite Day Tank | TANK | 1/1/2016 |
| WTP.CHEM.CIP.CAUSTIC.CP-FP1 | Control Panel CIP Caustic Feed Pumps | CONTROL | 1/1/2016 |
| WTP.CHEM.CIP.CAUSTIC.P-5541 | P-5541 CIP Caustic Feed Pump 1 | PUMP | 1/1/2016 |
| WTP.CHEM.CIP.CAUSTIC.P-5542 | P-5542 CIP Caustic Feed Pump 2 | PUMP | 1/1/2016 |
| WTP.CHEM.CIP.CAUSTIC.PIPING | PIPING CIP Caustic | PIPING | 1/1/2016 |
| WTP.CHEM.CIP.CAUSTIC.TK-5501 | TK-5501 CIP Caustic Day Tank | TANK | 1/1/2016 |
| WTP.CHEM.CIP.CITRIC.P-6021 | CIP Citric Acid Feed Pump P-6021 | PUMP | 10/23/2015 |
| WTP.CHEM.CIP.CITRIC.PIPING | PIPING CIP Citric | PIPING | 1/1/2016 |
| WTP.CHEM.CIP.FCV-315-1 | FCV-315-1 CIP Fill Valve | VALVE | 3/3/2016 |
| WTP.CHEM.CIP.HYPO.P-5424 | P-5424 CIP Hypo Feed Pump | PUMP | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.CHEM.CIP.HYPO.PIPING | PIPING CIP Hypo | PIPING | 1/1/2016 |
| WTP.CHEM.FLUOR.CP-FP1 | Control Panel Sodium Fluoride Feed Pump 1 | CONTROL | 1/1/2016 |
| WTP.CHEM.FLUOR.CP-FP2 | Control Panel Sodium Fluoride Feed Pump 2 | CONTROL | 1/1/2016 |
| WTP.CHEM.FLUOR.CP-TP1 | Control Panel Sodium Fluoride Transfer Pump 1 | CONTROL | 1/1/2016 |
| WTP.CHEM.FLUOR.CRANE | Fluoride Loading Platform Hoist/Crane | CRANE | 1/1/2012 |
| WTP.CHEM.FLUOR.FFS-TKD-1 | FFS-TKD-1 Sodium Fluoride Day Tank | TANK | 1/1/2016 |
| WTP.CHEM.FLUOR.FFS-TKS-1 | FFS-TKS-1 Sodium Fluoride Feed Saturation Tanks | TANK | 1/1/2013 |
| WTP.CHEM.FLUOR.P-110 | P-110 Sodium Fluoride Transfer Pump 1 | PUMP | 1/1/2016 |
| WTP.CHEM.FLUOR.P-210 | P-210 Sodium Fluoride Feed Pump 1 | PUMP | 6/7/2016 |
| WTP.CHEM.FLUOR.P-220 | P-220 Sodium Fluoride Feed Pump 2 | PUMP | 6/7/2016 |
| WTP.CHEM.FLUOR.PIPING | PIPING Sodium Fluoride | PIPING | 1/1/2016 |
| WTP.CHEM.FLUOR.STORAGE | Sodium Fluoride Storage | CHEM | 7/1/2013 |
| WTP.CHEM.FLUOR.SV-055 | SV-055 SF Saturation Tank Soft Water Supply Solenoid Valve | VALVE | 1/1/2016 |
| WTP.CHEM.FW.HYPO.CP-FP-1 | Control Panel Finished Water Hypo Feed Pump 1 | CONTROL | 1/1/2016 |
| WTP.CHEM.FW.HYPO.P-5445 | P-5445 Finished Water Hypo Feed Pump 1 | PUMP | 1/1/2016 |
| WTP.CHEM.FW.HYPO.P-5445-MTR1 | P-5445 Finished Water Hypo Feed Motor 1 | MOTOR | 1/1/2016 |
| WTP.CHEM.FW.HYPO.P-5446 | P-5446 Finished Water Hypo Feed Pump 2 | PUMP | 1/1/2016 |
| WTP.CHEM.FW.HYPO.P-5446-MTR1 | P-5446 Finished Water Hypo Feed Pump Motor 2 | MOTOR | 1/1/2016 |
| WTP.CHEM.FW.HYPO.PIPING | Piping Finished Water Hypo | PIPING | 4/14/2015 |
| WTP.CHEM.FW.WTP.CHEM.FW.CAUSTI | WTP Finished Water Caustic Feed System | CHEM | 10/17/2019 |
| WTP.CHEM.RW.HYPO.CP-FP1 | Control Panel Raw Water Hypo Feed | CONTROL | 1/1/2016 |
| WTP.CHEM.RW.HYPO.P-5441 | P-5441 Raw water hypo feed pump 1 | PUMP | 1/1/2013 |
| WTP.CHEM.RW.HYPO.P-5441-MTR1 | P-5441 Raw Water Hypo Feed Motor 1 | MOTOR | 1/1/2016 |
| WTP.CHEM.RW.HYPO.P-5442 | P-5442 Raw Water Hypo feed pump2 | PUMP | 9/8/2015 |
| WTP.CHEM.RW.HYPO.P-5442-MTR2 | P-5442 Raw Water Hypo Feed Motor 2 | MOTOR | 1/1/2016 |
| WTP.CHEM.RW.HYPO.PIPING | PIPING Raw Water Hypo | PIPING | 2/2/2016 |
| WTP.CIP.BFV-315C | BFV-315 Butterfly valve CIP tanks transfer | VALVE | 1/1/2016 |
| WTP.CIP.E-315 | E-315 CIP Eductor | EDUCTOR | 6/9/2018 |
| WTP.CIP.FV-315-1A | FV-315-1A Potable Water Flow valve CIP Inlet | VALVE | 1/1/2016 |
| WTP.CIP.FV-315-1B | FV-315-1B CIP Return Flow valve Inlet | VALVE | 1/1/2016 |
| WTP.CIP.FV-315-1C | FV-315-1C Flow valve CIP Outlet | VALVE | 1/1/2016 |
| WTP.CIP.FV-315-2A | FV-315-2A Potable Water Flow valve CIP Inlet | VALVE | 1/1/2016 |
| WTP.CIP.FV-315-2B | FV-315-2B CIP Return Flow valve Inlet | VALVE | 1/1/2016 |
| WTP.CIP.FV-315-2C | FV-315-2C Flow valve CIP Outlet | VALVE | 1/1/2016 |
| WTP.CIP.P-315-1 | CIP.P-315-1 CIP Pump #1 | PUMP | 1/1/2012 |
| WTP.CIP.P-315-2 | WTP.CIP.P-315-2 CIP Pump #2 | PUMP | 1/1/2016 |
| WTP.CIP.PIPE | CIP Piping | PIPING | 12/1/2012 |
| WTP.CIP.TNK-315-1 | CIP.TANK-315-1 CIP Tank #1 | TANK | 1/1/2016 |
| WTP.CIP.TNK-315-2 | CIP.TANK-315-2 CIP Tank #2 | TANK | 1/1/2016 |
| WTP.CIP.TNK.FCV-315-1 | FCV-315-1 Flow Control Valve | VALVE | 3/3/2016 |
| WTP.COMP.OILSEP | WTP.PLANT AIR OIL/WATER SEPARATOR | DRYER | 3/14/2018 |
| WTP.COMP.OILSEP-1 | WTP.PLANT AIR OIL/WATER SEPARATOR-1 | DRYER | 3/15/2018 |
| WTP.CU.3H1 | AC-3H-01 HEAT PUMP CONDENSOR Elec. Rm. 2 | HVAC | 8/21/2015 |
| WTP.CU.3H2 | AC-3H-02 HEAT PUMP CONDENSOR Elec. Rm. 2 | HVAC | 8/21/2015 |
| WTP.EF.EF.1 | EXHAUST FAN EF-1A (RAW WATER HYPO ROOM) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.11 | WTP.EF.EF.11 EXHAUST FAN | * | 12/2/2013 |
| WTP.EF.EF.2 | WTP.EF.EF-2 EXHAUST FAN | * | 12/20/2012 |
| WTP.EF.EF.3 | EXHAUST FAN EF-3 (FINISHED WATER HYPO ROOM) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.1 | EXHAUST FAN EF-316.1 (TRAIN 1) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.10 | EXHAUST FAN EF-316.10 (TRAIN 10) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.11 | EXHAUST FAN EF-316.11 (SECOND STAGE TRAINS) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.2 | EXHAUST FAN EF-316.2 (TRAIN 2) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.3 | EXHAUST FAN EF-316.3 (TRAIN 3) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.4 | EXHAUST FAN EF-316.4 (TRAIN 4) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.5 | EXHAUST FAN EF-316.5 (TRAIN 5) | EXHSTFN | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.EF.EF.316.6 | EXHAUST FAN EF-316.6 (TRAIN 6) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.7 | EXHAUST FAN EF-316.7 (TRAIN 7) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.8 | EXHAUST FAN EF-316.8 (TRAIN 8) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.316.9 | EXHAUST FAN EF-316.9 (TRAIN 9) | EXHSTFN | 1/1/2016 |
| WTP.EF.EF.4 | EXHAUST FAN EF-4 (BATHROOMS) | EXHSTFN | 1/1/2016 |
| WTP.ELECT.MSB2.DECK | Deck Monitoring | ELEC | 9/7/2017 |
| WTP.ELECT.ROOM | WTP Electrical Room | ELEC | 1/1/2012 |
| WTP.ELECT.SDCWA.TRANSFORMER | SDCWA Emergency Generator Transformer | ELEC | 1/1/2002 |
| WTP.ERF.BFV-120A | BFV-120A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-121 | BFV-122 Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-123A | BFV-123A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-123B | BFV-123B Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-123C | BFV-123C Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-124A | BFV-124A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-124B | BFV-124B Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.BFV-124C | BFV-124C Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.ERF.ERT-123 | ERT-123 | TURBINE | 1/1/2016 |
| WTP.ERF.ERT-124 | ERT-124 | TURBINE | 1/1/2016 |
| WTP.ERF.ERT-124. | Energy Recovery Turbine 124 | TURBINE | 12/6/2013 |
| WTP.ERF.GEN-123 | GEN-123 Induction Generator | MOTOR | 1/1/2016 |
| WTP.ERF.GEN-124 | GEN-124 Induction Generator | MOTOR | 1/1/2016 |
| WTP.ERF.HPU-123 | WTP.ERF.HPU-123 | PUMP | 6/30/2015 |
| WTP.ERF.HPU-124 | HPU-124 | PUMP | 12/28/2011 |
| WTP.ERF.OWS-2 | WTP.ERF.OIL WATER SEPARATOR-2 | TANK | 1/1/2016 |
| WTP.ERF.PIPE | ERF Piping | PIPING | 1/1/2016 |
| WTP.ERF.PLG-120 | PLG-120 ERF Plunger Valve | VALVE | 1/1/2016 |
| WTP.ERT.HPU-123 | WTP.ERT.HPU-123 | PUMP | 12/2/2013 |
| WTP.HOLDING.TANK | WTP.HOLDING.TANK (THE PIT) | TANK | 1/1/2016 |
| WTP.HP.HP.1 | HP.HP-1 HEAT PUMP UNIT | HEATPUMP | 1/1/2016 |
| WTP.HP.HP.2 | HP.HP-2 HEAT PUMP UNIT | HEATPUMP | 1/1/2016 |
| WTP.HP.HP.3 | HP.HP-3 HEAT PUMP UNIT | HEATPUMP | 1/1/2016 |
| WTP.INST.ERT.AIT-PIPING | AIT-PIPING ERT Effluent Analyzer | PIPING | 1/1/2016 |
| WTP.INST.FW.IAP.PIPING | PIPING Finished Water Analyzer | PIPING | 1/1/2016 |
| WTP.INST.FW.ICP-3 | ICP-3 PLC | PLCPANEL | 10/5/2021 |
| WTP.INST.RW.TNK.AIT-PIPING | AIT PIPING Raw Water Tank Analyzer | PIPING | 1/1/2016 |
| WTP.MCC7 | WTP MCC 7 | PS | 3/30/2017 |
| WTP.MIT.PIPE | MIT Air Piping System | PIPING | 6/3/2015 |
| WTP.OSG.BLOWER1 | BLOWER 1 TK-5400 SHC Storage | BLOWER | 1/1/2016 |
| WTP.OSG.BLOWER1-MTR | BLOWER 1 Motor TK-5400 SHC Storage | MOTOR | 1/1/2016 |
| WTP.OSG.BLOWER1-PIPING | BLOWER 1 PIPING TK-5400 SHC Storage | PIPING | 1/1/2016 |
| WTP.OSG.BLOWER2 | BLOWER 2 TK-5401 SHC Storage | BLOWER | 1/1/2016 |
| WTP.OSG.BLOWER2-MTR | BLOWER 2 Motor TK-5401 SHC Storage | MOTOR | 1/1/2016 |
| WTP.OSG.BLOWER2-PIPING | BLOWER 2 PIPING TK-5400 SHC Storage | PIPING | 1/1/2016 |
| WTP.OSG.BLOWER3 | BLOWER 3 TK-5500 SHC Storage | BLOWER | 1/1/2016 |
| WTP.OSG.BLOWER3-MTR | BLOWER 3 Motor TK-5500 SHC Storage | MOTOR | 1/1/2016 |
| WTP.OSG.BLOWER3-PIPING | BLOWER 3 PIPING TK-5400 SHC Storage | PIPING | 1/1/2016 |
| WTP.OSG.BLOWER4 | BLOWER 4 OSG System Stack | BLOWER | 11/7/2019 |
| WTP.OSG.BLOWER4-MTR | BLOWER 4 Motor Stack | MOTOR | 1/1/2016 |
| WTP.OSG.BLOWER4-PIPING | BLOWER 4 PIPING Stack | PIPING | 1/1/2016 |
| WTP.OSG.BLOWERCP | BLOWER Control Panel SHC Storage | CONTROL | 1/1/2016 |
| WTP.OSG.HYDROGENBLOWER | Hydrogen Dilution BLOWER | BLOWER | 1/1/2016 |
| WTP.OSG.MICROCLOR.BRINEPUMP1 | BRINE TRANSFER PUMP 1 | PUMP | 1/1/2012 |
| WTP.OSG.MICROCLOR.BRINETNK | BRINETNK Brine tank | TANK | 1/1/2016 |
| WTP.OSG.MICROCLOR.BRINPMP-MTR1 | Brine Pump Motor | MOTOR | 1/1/2016 |
| WTP.OSG.MICROCLOR.BRINPUMP-VFD | Brine Pump VFD | VFD | 1/1/2016 |
| WTP.OSG.MICROCLOR.CELL1 | Cell 1 MICROCLOR | GEN CELL | 1/1/2016 |
| WTP.OSG.MICROCLOR.CELL10 | Cell 10 MICROCLOR | GEN CELL | 4/8/2012 |

| | | | |
|---|---|---|---|
| WTP.OSG.MICROCLOR.CELL2 | Cell 2 MICROCLOR | GEN CELL | 1/1/2016 |
| WTP.OSG.MICROCLOR.CELL3 | Cell 3 MICROCLOR | GEN CELL | 1/1/2016 |
| WTP.OSG.MICROCLOR.CELL4 | Cell 4 MICROCLOR | GEN CELL | 1/1/2016 |
| WTP.OSG.MICROCLOR.CELL5 | Cell 5 MICROCLOR | GEN CELL | 1/1/2016 |
| WTP.OSG.MICROCLOR.CELL6 | Cell 6 MICROCLOR | GEN CELL | 9/15/2013 |
| WTP.OSG.MICROCLOR.CELL7 | Cell 7 MICROCLOR | GEN CELL | 9/15/2013 |
| WTP.OSG.MICROCLOR.CELL8 | Cell 8 MICROCLOR | GEN CELL | 9/15/2013 |
| WTP.OSG.MICROCLOR.CELL9 | Cell 9 MICROCLOR | GEN CELL | 9/15/2013 |
| WTP.OSG.MICROCLOR.EXHSTFAN | EXHAUST FAN EF-2B (HYPO GENERATOR ROOM) | EXHSTFN | 1/1/2016 |
| WTP.OSG.MICROCLOR.FLOWCELL | Flow Meter Cell | METER | 1/1/2016 |
| WTP.OSG.MICROCLOR.OIT | MICROCLOR OIT | OIT | 1/1/2016 |
| WTP.OSG.MICROCLOR.PIPING | MicrOclor OSG System Piping | PIPING | 5/15/2015 |
| WTP.OSG.MICROCLOR.PLC | MicrOclor PLC | PLCPANEL | 5/6/2015 |
| WTP.OSG.MICROCLOR.RECTIFIER | Rectifier MICROCLOR | RECTFR | 1/1/2016 |
| WTP.OSG.MICROCLOR.ROTOMETER | Rotometer Brine | METER | 1/1/2016 |
| WTP.OSG.MICROCLOR.SOLENOIDVALV | Solenoid Valve | VALVE | 1/1/2016 |
| WTP.OSG.MICROCLOR.SYSTEM | MicrOclor System | OSGCELL | 1/1/2013 |
| WTP.OSG.TK-5400 | TK-5400 Onsite generation SHC Storage Tank 1 | TANK | 1/1/2013 |
| WTP.OSG.TK-5400.PIPING | TK-5400 Onsite Generation SHC Storage Tank 1 PIPING | PIPING | 1/1/2016 |
| WTP.OSG.TK-5401 | TK-5401 Onsite Generation SHC Storage Tank 2 | TANK | 1/1/2016 |
| WTP.OSG.TK-5401.PIPING | TK-5401 Onsite Generation SHC Storage Tank 1 PIPING | PIPING | 1/1/2016 |
| WTP.OSG.TK-5500 | TK-5500 Onsite Generation SHC Storage Tank 3 | TANK | 1/1/2016 |
| WTP.OSG.TK-5500.PIPING | TK-5500 Onsite Generation SHC Storage Tank 3 PIPING | PIPING | 1/1/2016 |
| WTP.PERMEATE.PIPE | Plant CFE Permeate Piping | PIPING | 1/1/2002 |
| WTP.PLANT.AIR.PIPE | Plant Air Piping System | PIPING | 1/14/2016 |
| WTP.PROCESS.BLDG. | PROCESS BUILDING | BUILDING | 1/1/2016 |
| WTP.RHB.3RD-STG-M-7024 | M-7024 3rd Stage Sludge Thickener Rake | RAKE | 1/1/2014 |
| WTP.RHB.3RD-STG.GRDRV-7002 | GRDRV-7002 3rd Stage Rapid Mixer Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7003 | GRDRV-7003 3rd Stage Flocculator Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7004 | GRDRV-7004 3rd Stage Sludge Rake Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7022 | GRDRV-7022 3rd Stage Rapid Mixer Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7023 | GRDRV-7023 3rd Stage Flocculator Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7024 | GRDRV-7024 3rd Stage Flocculator Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7042 | GRDRV-7042 3rd Stage Rapid Mixer Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7043 | GRDRV-7043 3rd Stage Flocculator Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.GRDRV-7044 | GRDRV-7044 3rd Stage Flocculator Gear Drive | GEARDRVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-710-A | HV-710-A Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-710-B | HV-710-B Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-710-C | HV-710-C Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-710-D | HV-710-D Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-710-E | HV-710-E Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-711-A | HV-711-A Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-711-B | HV-711-B Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-711-C | HV-711-C Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-711-D | HV-711-D Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-711-E | HV-711-E Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-712-A | HV-712-A Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-712-B | HV-712-B Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-712-C | HV-712-C Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-712-D | HV-712-D Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.HV-712-E | HV-712-E Sand Piper Sludge Pump Hand Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7002 | M-7002 3rd Stage Rapid Mixer | MIXER | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7003 | M-7003 3rd Stage Flocculator | FLOCLATR | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7004 | M-7004 3rd Stage Sludge Rake | RAKE | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7022 | M-7022 Rapid Mixer | MIXER | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.RHB.3RD-STG.M-7023 | M-7023 3rd Stage Flocculator | FLOCLATR | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7024 | M-7024 3rd Stage Sludge Rake, Settler #2 | PUMP | 1/1/2013 |
| WTP.RHB.3RD-STG.M-7042 | M-7042 3rd Stage Rapid Mixer | MIXER | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7043 | M-7043 3rd Stage Flocculator | FLOCLATR | 1/1/2016 |
| WTP.RHB.3RD-STG.M-7044 | M-7044 3rd Stage Sludge Rake | RAKE | 1/1/2016 |
| WTP.RHB.3RD-STG.MOV-710-1 | MOV-710-1 3rd Stage Inlet Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.MOV-710-2 | MOV-710-2 3rd Stage Outlet Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.MOV-711-1 | MOV-711-1 3rd Stage Inlet Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.MOV-711-2 | MOV-711-2 3rd Stage Outlet Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.MOV-712-1 | MOV-712-1 3rd Stage Inlet Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.MOV-712-2 | MOV-712-2 3rd Stage Outlet Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7002 | MTR-7002 3rd Stage Rapid Mixer Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7003 | MTR-7003 3rd Stage Flocculator Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7004 | MTR-7004 3rd Stage Sludge Rake Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7022 | MTR-7022 3rd Stage Rapid Mixer Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7023 | MTR-7023 3rd Stage Flocculator Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7024 | MTR-7024 3rd Stage Flocculator Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7042 | MTR-7042 3rd Stage Rapid Mixer Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7043 | MTR-7043 3rd Stage Flocculator Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.MTR-7044 | MTR-7044 3rd Stage Flocculator Motor | MOTOR | 1/1/2016 |
| WTP.RHB.3RD-STG.PIPING | 3RD-STG.PIPING-PVC | PIPING | 1/1/2016 |
| WTP.RHB.3RD-STG.PV-710 | PV-710 3rd Stage Settler 1 Outlet Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.PV-711 | PV-711 3rd Stage Settler 2 Outlet Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.PV-712 | PV-712 3rd Stage Settler 3 Outlet Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.SV-710 | SV-710 3rd Stage Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.SV-711 | SV-711 3rd Stage Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.3RD-STG.SV-712 | SV-712 3rd Stage Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.BLDG. | RESIDUAL HANDLING BUILDING | BUILDING | 1/1/2016 |
| WTP.RHB.CENTRFGE.MFCV1.CIP.FLU | MFCV1.CIP.Flush Manual control valve 1 CIP Flush | VALVE | 1/1/2013 |
| WTP.RHB.CENTRFGE.MFCV1.FLUSH | MFCV1.FLUSH Manual control valve 1 FLUSH | VALVE | 1/1/2013 |
| WTP.RHB.CENTRT.BCV-740-1 | BCV-740-1 Centrate Ball Check Valve Pump 1 | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.BCV-740-2 | BCV-740-2 Centrate Ball Check Valve Pump 2 | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.BV-740-1A | BV-740-1A Centrate Ball Valve Inlet Pump 1 | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.BV-740-1B | BV-740-1B Centrate Ball Valve Outlet Pump 1 | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.BV-740-2A | BV-740-2A Centrate Ball Valve Inlet Pump 2 | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.BV-740-2B | BV-740-2B Centrate Ball Valve Outlet Pump 2 | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.MTR-740-1 | MTR-740-1 Centrate Pump 1 | MOTOR | 1/1/2016 |
| WTP.RHB.CENTRT.MTR-740-2 | MTR-740-2 Centrate Pump 2 | MOTOR | 1/1/2016 |
| WTP.RHB.CENTRT.P-740-1 | P-740-1 Centrate Pump | PUMP | 1/1/2016 |
| WTP.RHB.CENTRT.P-740-1/1 | P-740-1 Centrate Pump Motor | MOTOR | 10/18/2018 |
| WTP.RHB.CENTRT.P-740-2 | P-740-2 Centrate Pump | PUMP | 1/1/2016 |
| WTP.RHB.CENTRT.P-740-2/2 | P-740-2 Centrate Pump Motor | MOTOR | 10/18/2018 |
| WTP.RHB.CENTRT.PIPING | CENTRT.PIPING | PIPING | 1/1/2016 |
| WTP.RHB.CENTRT.PV-740 | PV-740 Centrate Plug Valve Drain | VALVE | 1/1/2016 |
| WTP.RHB.CENTRT.TNK-740 | TNK-740 Centrate Storage Tank | TANK | 1/1/2016 |
| WTP.RHB.CENTRT.TNK-STND-740 | TNK-STND-740 Centrate Storage Tank Stand | STAND | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.BCKDRV-731-1 | CNTRFG-FD.BCKDRV-731-1 Centrifuge 1 Back drive Motor | MOTOR | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.BCV-726-1B | BCV-726-1B Centrifuge Feed Ball Check Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.BCV-726-2B | BCV-726-2B Centrifuge Feed Ball Check Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.C-731-A | C-731-A Fresh Water Solenoid Coil | COIL | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.C-731-B | C-731-B Fresh Water Solenoid Coil | COIL | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.CEN-731 | CEN-731 Centrifuge System 1 | CNTIFUGE | 1/1/2013 |
| WTP.RHB.CNTRFG-FD.MFCV1.CIP.F | MFCV1.CIP.FLUSH Manual Flow Control Valve 1 CIP Flush | ROTOMTR | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.MFCV1.FLUSH | MFCV1.FLUSH Manual Flow Control Valve 1 Flush | ROTOMTR | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.MNDRV-731-2 | CNTRFG-FD.MAINDRV-731-2 Centrifuge 1 Main drive Motor | MOTOR | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.RHB.CNTRFG-FD.MTR-726-1 | MTR-726-1 Centrifuge Feed Pump 1 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.MTR-726-2 | MTR-726-2 Centrifuge Feed Pump 2 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.P-726-1 | P-726-1 Centrifuge Feed Pump | PUMP | 1/1/2012 |
| WTP.RHB.CNTRFG-FD.P-726-1/1 | P-726-1 Centrifuge Feed Pump Motor | MOTOR | 10/18/2018 |
| WTP.RHB.CNTRFG-FD.P-726-2 | P-726-2 Centrifuge Feed Pump | PUMP | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.P-726-2/2 | P-726-2 Centrifuge Feed Pump Motor | MOTOR | 10/18/2018 |
| WTP.RHB.CNTRFG-FD.PIPING | CNTRFG-FD.PIPING | PIPING | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.PV-726-1A | PV-726-1A Centrifuge Feed Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.PV-726-1C | PV-726-1C Centrifuge Feed Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.PV-726-2A | PV-726-2A Centrifuge Feed Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.PV-726-2C | PV-726-2C Centrifuge Feed Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.PV-726-4 | PV-726-4 Centrifuge Feed Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.PV-726-5 | PV-726-5 Centrifuge Feed Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.SV-731-A | SV-731-A Fresh Water Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.CNTRFG-FD.SV-731-B | SV-731-B Fresh Water Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-750A | BV-750 Coagulant Tank Drain Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-750B | BV-750 Coagulant Tank Outlet Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-1A | BV-754-1A Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-1B | BV-754-1B Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-1C | BV-754-1C Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-2A | BV-754-2A Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-2B | BV-754-2B Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-2C | BV-754-2C Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.BV-754-C | BV-754-C Coagulant Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.CV-750 | CV-750 Coagulant Tank Inlet Fill Check Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.GV-750 | GV-750 Coagulant Tank Inlet Fill Gate Valve | VALVE | 1/1/2016 |
| WTP.RHB.COAG.MTR-754-1 | MTR-754-1 Coagulant Metering Pump 1 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.COAG.MTR-754-2 | MTR-754-2 Coagulant Metering Pump 2 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.COAG.P-754-1 | P-754-1 Coagulant metering pump 1 | PUMP | 1/1/2013 |
| WTP.RHB.COAG.P-754-2 | P-754-2 Coagulant Metering Pump 2 | PUMP | 1/1/2016 |
| WTP.RHB.COAG.PD-754-1 | PD-754-1 Coagulant Pulsation Dampner | DAMPNER | 1/1/2016 |
| WTP.RHB.COAG.PD-754-2 | PD-754-2 Coagulant Pulsation Dampner | DAMPNER | 1/1/2016 |
| WTP.RHB.COAG.PIPING | COAG.PIPING | PIPING | 1/1/2016 |
| WTP.RHB.COAG.RM-754-1 | RM-754-1 Coagulant Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.COAG.RM-754-2 | RM-754-2 Coagulant Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.COAG.STC.MXR | Coagulant 6" Static Mixer | MIXER | 1/1/2016 |
| WTP.RHB.COAG.TNK-750 | TNK-750 Coagulant Tank | TANK | 1/1/2016 |
| WTP.RHB.EXHST-FAN-EF-7H-01-FAN | EF-7H-01-FAN Exhaust Fan Assembly South End of RHB | EXHSTFN | 1/1/2016 |
| WTP.RHB.EXHST-FAN-EF-7H-01-MTR | EF-7H-01-MTR Exhaust Motor Assembly South End of RHB | MOTOR | 1/1/2016 |
| WTP.RHB.EXHST-FAN-EF-7H-02-FAN | EF-7H-02-FAN Exhaust Fan Assembly South End of RHB | EXHSTFN | 1/1/2016 |
| WTP.RHB.EXHST-FAN-EF-7H-02-MTR | EF-7H-02-MTR Exhaust Motor Assembly South End of RHB | MOTOR | 1/1/2016 |
| WTP.RHB.INST.3RD-STG.AIT-710-1 | AIT-710-1 3RD Stage Turbidity Meter | METER | 1/1/2016 |
| WTP.RHB.INST.3RD-STG.AIT-710-2 | AIT-710-2 3RD Stage Streaming Current Monitor | MONITOR | 1/1/2016 |
| WTP.RHB.INST.3RD-STG.AIT-710-3 | AIT-710-3 3RD Stage Streaming Current Monitor | MONITOR | 4/30/2019 |
| WTP.RHB.INST.3RD-STG.AIT-711 | AIT-711 Third Stage Treatment Units Decant TSS Meter | METER | 1/1/2016 |
| WTP.RHB.INST.3RD-STG.FIT-711 | FIT-711 Third Stage Decant Flow Totalizer | METER | 1/1/2016 |
| WTP.RHB.INST.3RD-STG.FIT-712 | FIT-712 Third Stage Flow to Sludge Storage Totalizer | METER | 1/1/2016 |
| WTP.RHB.INST.CENTRT.AIT-740 | AIT-740 Centrate Storage Tank Turbidity Meter | METER | 1/1/2016 |
| WTP.RHB.INST.CNTRFG.FIT-726-1 | FIT-726-1 Centrifuge Feed Pump 1 Discharge Flow Totalizer | METER | 1/1/2016 |
| WTP.RHB.INST.CNTRFG.FIT-726-2 | FIT-726-2 Centrifuge Feed Pump 2 Discharge Flow Totalizer | METER | 1/1/2016 |
| WTP.RHB.INST.SLDG-TK.AIT-720-1 | AIT-720-1 Sludge Storage Tank 1 TSS Meter | METER | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.RHB.INST.SLDG-TK.AIT-720-2 | AIT-720-2 Sludge Storage Tank 2 TSS Meter | METER | 1/1/2016 |
| WTP.RHB.OWS-3 | WTP.RHB.OIL WATER SEPARATOR-3 | TANK | 1/1/2016 |
| WTP.RHB.POLY.BV-751 | BV-751 Polymer Tank Outlet Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-752 | BV-752 Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-1A | BV-755-1A Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-1B | BV-755-1B Polymer Metering Pump 1Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-1C | BV-755-1C Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-1D | BV-755-1D Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-2A | BV-755-1A Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-2B | BV-755-2B Polymer Metering Pump 2 Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-755-2D | BV-755-1D Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-1A | BV-756-1A Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-1B | BV-756-1B Polymer Metering Pump 1 Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-1C | BV-756-1C Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-1D | BV-756-1D Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-2A | BV-756-2A Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-2B | BV-756-2B Polymer Metering Pump 2 Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-2C | BV-756-2C Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.BV-756-2D | BV-756-2D Polymer Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.CM-752-2 | CM-752-2 Polymer Control Mixing System | POLYPW | 1/1/2013 |
| WTP.RHB.POLY.CNTRL-PNL-751 | Cntrl-Pnl-751 Poly Control Panel | CONTROL | 1/1/2016 |
| WTP.RHB.POLY.MTR-755-1 | MTR-755-1 Polymer Metering Pump 1 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.POLY.MTR-755-2 | MTR-755-2 Polymer Metering Pump 2 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.POLY.MTR-756-1 | MTR-756-1 Polymer Metering Pump 1 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.POLY.MTR-756-2 | MTR-756-2 Polymer Metering Pump 2 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.POLY.P-752-1 | P-752-1 Polymer Blend System Pump | PUMP | 1/1/2016 |
| WTP.RHB.POLY.P-755-1 | P-755-1 Polymer Metering Pump 1 | PUMP | 1/1/2013 |
| WTP.RHB.POLY.P-755-2 | P-755-2 Polymer metering pump 2 | PUMP | 1/1/2013 |
| WTP.RHB.POLY.P-756-1 | P-756-1 Polymer Metering Pump 1 | PUMP | 9/16/2015 |
| WTP.RHB.POLY.P-756-2 | P-756-2 Polymer Metering Pump | PUMP | 9/16/2015 |
| WTP.RHB.POLY.PD-755-1 | PD-755-1 Polymer Pulsation Dampner Pump 1 | DAMPNER | 1/1/2016 |
| WTP.RHB.POLY.PD-755-2 | PD-755-2 Polymer Pulsation Dampner Pump 2 | DAMPNER | 1/1/2016 |
| WTP.RHB.POLY.PD-756-1 | PD-756-1 Polymer Pulsation Dampner Pump 1 | DAMPNER | 1/1/2016 |
| WTP.RHB.POLY.PD-756-2 | PD-756-2 Polymer Pulsation Dampner Pump 2 | DAMPNER | 1/1/2016 |
| WTP.RHB.POLY.PIPING | Polymer Feed System Piping | PIPING | 4/15/2016 |
| WTP.RHB.POLY.RECIRC-P-751 | Recirc-P-751 Poly Recirc Pump 1 | PUMP | 1/1/2016 |
| WTP.RHB.POLY.RM-755-1 | RM-755-1 Polymer Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.POLY.RM-755-2 | RM-755-2 Polymer Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.POLY.RM-756-1 | RM-756-1 Polymer Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.POLY.RM-756-2 | RM-756-2 Polymer Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.POLY.RTMTR-751 | RM-751 Poly Rotometer | ROTOMTR | 1/1/2016 |
| WTP.RHB.POLY.STC.MXR | Polymer 6" Static Mixer | MIXER | 1/1/2016 |
| WTP.RHB.POLY.SV-752 | SV-752 Polymer Blend Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.SV-753 | SV-753 Polymer Blend Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.POLY.TNK-751 | TNK-751 Polymer Tank | TANK | 1/1/2016 |
| WTP.RHB.POLY.TNK-753 | TNK-753 Polymer Day Tank | TANK | 1/1/2016 |
| WTP.RHB.POLY.WIT-751 | WIT-751 Polymer Tote Weight Scale | SCALE | 1/1/2016 |
| WTP.RHB.ROLL-UP-DOOR | RHB Roll up door | ROLLUP | 1/1/2016 |
| WTP.RHB.SLDG-REC.BV-725-1E | BV-725-1E Potable Water Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.BV-725-2E | BV-725-2E Potable Water Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.BV-725-3E | BV-725-3E Potable Water Ball Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.MTR-725-1 | MTR-725-1 Sludge Recirc Pump 1 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.SLDG-REC.MTR-725-2 | MTR-725-2 Sludge Recirc Pump 2 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.SLDG-REC.MTR-725-3 | MTR-725-3 Sludge Recirc Pump 3 Motor | MOTOR | 1/1/2016 |
| WTP.RHB.SLDG-REC.P-725-1 | P-725-1 Solids Mixing Pump | PUMP | 1/1/2016 |
| WTP.RHB.SLDG-REC.P-725-1/1 | P-725-1 Solids Mixing Pump Motor | MOTOR | 10/9/2018 |
| WTP.RHB.SLDG-REC.P-725-2 | P-725-2 Solids Mixing Pump | PUMP | 1/1/2016 |
| WTP.RHB.SLDG-REC.P-725-2/2 | P-725-2 Solids Mixing Pump Motor | MOTOR | 10/9/2018 |
| WTP.RHB.SLDG-REC.P-725-3 | P-725-3 Solids Mixing Pump | PUMP | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.RHB.SLDG-REC.P-725-3/3 | P-725-3 Solids Mixing Pump Motor | MOTOR | 10/9/2018 |
| WTP.RHB.SLDG-REC.PV-725-1A | PV-725-1A Sludge Recirc Pump 1 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-1B | PV-725-1B Sludge Recirc Pump 1 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-1C | PV-725-1C Sludge Recirc Pump 1 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-1D | PV-725-1D Sludge Recirc Pump 1 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-2A | PV-725-2A Sludge Recirc Pump 2 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-2B | PV-725-2B Sludge Recirc Pump 2 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-2C | PV-725-2C Sludge Recirc Pump 2 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-2D | PV-725-2D Sludge Recirc Pump 2 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-3A | PV-725-3A Sludge Recirc Pump 3 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.PV-725-3B | PV-725-3B Sludge Recirc Pump 3 Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.SV-725-1 | SV-725-1 Sludge Recirc Pump 1 PW Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.SV-725-2 | SV-725-2 Sludge Recirc Pump 2 PW Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-REC.SV-725-3 | SV-725-3 Sludge Recirc Pump 3 PW Solenoid Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-RECIRC.PIPING | SLDG-RECIRC.PIPING | PIPING | 1/1/2016 |
| WTP.RHB.SLDG-TNK-720-1 | TNK-720-1 Sludge Storage Tank 1 | TANK | 1/1/2016 |
| WTP.RHB.SLDG-TNK-720-2 | TNK-720-2 Sludge Storage Tank 2 | TANK | 1/1/2016 |
| WTP.RHB.SLDG-TNK-STND-720-1 | TNK-STND-720 Tank Stand | STAND | 1/1/2016 |
| WTP.RHB.SLDG-TNK-STND-720-2 | TNK-STND-720-2 Tank Stand | STAND | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-1A | PV-720-1A Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-1B | PV-720-1B Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-1C | PV-720-1C Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-1D | PV-720-1D Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-1E | PV-720-1E Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-2A | PV-720-2A Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-2B | PV-720-2B Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-2C | PV-720-2C Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-2D | PV-720-2D Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SLDG-TNK.PV-720-2E | PV-720-2E Sludge Tank Plug Valve | VALVE | 1/1/2016 |
| WTP.RHB.SNDPPR.P-710 | P-710 Sand Piper Sludge Pump | PUMP | 1/1/2016 |
| WTP.RHB.SNDPPR.P-711 | P-711 Sand Piper Sludge pump | PUMP | 1/1/2016 |
| WTP.RHB.SNDPPR.P-712 | P-712 Sand Piper Sludge pump | PUMP | 1/1/2016 |
| WTP.RHB.STTLR.PSU-7000 | PSU-7000 Plate Settler #1 | SETTLER | 1/1/2016 |
| WTP.RHB.STTLR.PSU-7020 | PSU-7040 Plate Settler #2 | SETTLER | 6/7/2018 |
| WTP.RHB.STTLR.PSU-7040 | PSU-7040 Plate Settler #3 | SETTLER | 1/1/2016 |
| WTP.RHB.SUPP-FAN-SF-7H-01 | SF-7H-01-FAN SUPPLY FAN ASSEMBLY NORTH END OF RHB | HVAC | 12/2/2013 |
| WTP.RHB.SUPP-FAN-SF-7H-01-FAN | SF-7H-01-FAN Supply Fan Assembly North End of RHB | EXHSTFN | 1/1/2016 |
| WTP.RHB.SUPP-FAN-SF-7H-01-MTR | SF-7H-01-MTR Supply Motor Assembly North End of RHB | MOTOR | 1/1/2016 |
| WTP.RHB.SUPP-FAN-SF-7H-02 | SF-7H-02-FAN SUPPLY FAN ASSEMBLY NORTH END OF RHB | HVAC | 5/11/2016 |
| WTP.RHB.SUPP-FAN-SF-7H-02-FAN | SF-7H-02-FAN Supply Fan Assembly North End of RHB | EXHSTFN | 1/1/2016 |
| WTP.RHB.SUPP-FAN-SF-7H-02-MTR | SF-7H-02-MTR Supply Motor Assembly North End of RHB | MOTOR | 1/1/2016 |
| WTP.RHB.WSTE-SLDG.TNK-760 | TNK-760 Waste Sludge Holding Tank | TANK | 1/1/2016 |
| WTP.RHBINST3RD-STG.FIT-710 | FIT-710 3RD Stage Inlet Flow Meter | METER | 1/1/2016 |
| WTP.RWEQ.BFV-210 | BFV-210 Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.BFV-211 | BFV-211 Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.BFV-212 | BFV-212 Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.BFV-213 | BFV-213 RWEQ Series Isolation Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.BFV-214 | BFV-214 Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.BFV-215 | BFV-215 RWEQ 1st Stage Isolation Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.GV-211 | GV-211 Drain Valve | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.RWEQ.GV-212 | GV-212 Drain Valve | VALVE | 1/1/2016 |
| WTP.RWEQ.PIPE | RWEQ Piping | PIPING | 1/1/2016 |
| WTP.RWEQ.TNK-211 | TNK-211 West RWEQ Tank | TANK | 1/1/2016 |
| WTP.RWEQ.TNK-212 | TNK-212 East RWEQ Tank | TANK | 1/1/2016 |
| WTP.SEWER.PIPING | WTP Sewer System Piping | PIPING | 1/1/2001 |
| WTP.STORAGE.BLDG. | STORAGE BUILDING | BUILDING | 1/1/2016 |
| WTP.STR.BFV-111A | BFV-111A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-111B | BFV-111 Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-111C | FV-111 Backwash Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-112A | BFV-112A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-112B | BFV-112 Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-112C | FV-112 Backwash Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-113A | BFV-113A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-113B | BFV-113 Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.STR.BFV-113C | FV-113 Backwash Valve | VALVE | 1/1/2016 |
| WTP.STR.FLT-111 | FLT-111 Strainer Filter Elements | STRAINER | 3/31/2016 |
| WTP.STR.FLT-112 | FLT-112 Strainer Filter Elements | STRAINER | 3/31/2016 |
| WTP.STR.FLT-113 | FLT-113 Strainer Filter Elements | STRAINER | 3/31/2016 |
| WTP.STR.GV-110 | GV-110 Strainer Backwash Gate Valve | VALVE | 1/1/2016 |
| WTP.STR.MTR-111 | MTR-111 Backwash Motor | MOTOR | 1/1/2016 |
| WTP.STR.MTR-112 | MTR-112 Backwash Motor | MOTOR | 1/1/2016 |
| WTP.STR.MTR-113 | MTR-113 Backwash Motor | MOTOR | 1/1/2016 |
| WTP.STR.PIPE | Strainer Piping | PIPING | 1/1/2016 |
| WTP.STR.STR-111 | STR-111 Strainer Housing | STRAINER | 1/1/2016 |
| WTP.STR.STR-112 | STR-112 Strainer Housing | STRAINER | 3/31/2016 |
| WTP.STR.STR-113 | STR-113 Strainer Housing | STRAINER | 3/31/2016 |
| WTP.SUREG.TNK.BFV-9670-2 | BFV-9670-2 24" BFV Inlet Valve to Surge Tank | VALVE | 1/1/2016 |
| WTP.SURGE.PNL | Surge Control Panel | CONTROL | 1/1/2016 |
| WTP.SURGE.TNK-9670 | TNK-9670 Surge Tank | TANK | 1/1/2016 |
| WTP.SURGE.TNK.BFV-9670-1 | BFV-9670-1 4" BFV Surge Tank Drain Valve | VALVE | 1/1/2016 |
| WTP.SURGE.TNK.CP | Surge Tank Control Panel | CONTROL | 6/2/2015 |
| WTP.TK-96-A | TK-96-A MIT TANK RECEIVER | TANK | 1/1/2016 |
| WTP.TK-96-B | TK-96-B MIT TANK RECEIVER | TANK | 1/1/2016 |
| WTP.TK9675.AR-DRY | TK 9675.AR DRY TANK RECEIVER | TANK | 1/1/2016 |
| WTP.TK9675.AR-WET | TK 9675.AR WET TANK RECEIVER | TANK | 1/1/2016 |
| WTP.TKDR.BFV-314-1A | BFV-314-1A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.TKDR.BFV-314-1B | BFV-314-1B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.TKDR.BFV-314-2A | BFV-314-2A Upstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.TKDR.BFV-314-2B | BFV-314-2B Downstream Isolation Valve | VALVE | 1/1/2016 |
| WTP.TKDR.BFV-8401-2 | BFV-8401-2 BWEQ Isolation Valve | VALVE | 1/1/2016 |
| WTP.TKDR.CV-314-1 | CV-314-1 Check Valve | VALVE | 1/1/2016 |
| WTP.TKDR.CV-314-2 | CV-314-2 Check Valve | VALVE | 1/1/2016 |
| WTP.TKDR.E-314 | E-314 Tank Drain Eductor | EDUCTOR | 1/1/2016 |
| WTP.TKDR.EDUC-314 | SV-314 Tank Drain Eductor | VALVE | 1/1/2016 |
| WTP.TKDR.M-314-1 | P-314-1 Tank Drain Pump Motor | MOTOR | 1/1/2016 |
| WTP.TKDR.M-314-2 | P-314-2 Tank Drain Pump Motor | MOTOR | 1/1/2016 |
| WTP.TKDR.P-314-1 | P-314-1 Tank Drain Pump | PUMP | 1/1/2016 |
| WTP.TKDR.P-314-2 | P-314-2 Tank Drain Pump | PUMP | 1/1/2016 |
| WTP.TKDR.PIPE | Tank Drain Piping | PIPING | 1/1/2016 |
| WTP.TKDR.PIPING | Tank Drain Piping | PIPING | 1/1/2016 |
| WTP.TKDR.STR-314 | STR-314 Tank Drain Strainer | STRAINER | 1/1/2016 |
| WTP.WTP.OWS-1 | WTP.WTP.OIL WATER SEPARATOR-1 | TANK | 1/1/2016 |
| WTP.ZW1-9.CASSETTE.A | ZW1-9 Cassette A 64M Frame | CASSETTE | 8/3/2016 |
| WTP.ZW1-9.CASSETTE.B | ZW1-9 Cassette B 64M Frame | CASSETTE | 8/3/2016 |
| WTP.ZW1-9.CASSETTE.C | ZW1-9 Cassette C 64M Frame | CASSETTE | 8/3/2016 |
| WTP.ZW1-9.CASSETTE.D | ZW1-9 Cassette D 64M Frame | CASSETTE | 7/1/2016 |
| WTP.ZW1-9.CASSETTE.E | ZW1-9 Cassette E 64M Frame | CASSETTE | 7/13/2016 |
| WTP.ZW1-9.CASSETTE.F | ZW1-9 Cassette F 64M Frame | CASSETTE | 8/3/2016 |
| WTP.ZW1-9.CASSETTE.G | ZW1-9 Cassette G 64M Frame | CASSETTE | 7/19/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1-P35-5.VFD | WTP.ZW1-P35-5.VFD | VFD | 1/1/2016 |
| WTP.ZW1.AIT-3537-1 | AIT-3537-1 Turbidimeter | METER | 8/25/2020 |
| WTP.ZW1.AIT-3537-10C | AIT-3537-10 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-1C | AIT-3537-1 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-2 | AIT-3537-2 Turbidimeter | METER | 9/13/2020 |
| WTP.ZW1.AIT-3537-2C | AIT-3537-2 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-3 | AIT-3537-3 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW1.AIT-3537-3C | AIT-3537-3 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-4 | AIT-3537-4 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW1.AIT-3537-4C | AIT-3537-4 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-5 | AIT-3537-5 Turbidimeter | METER | 8/24/2020 |
| WTP.ZW1.AIT-3537-5C | AIT-3537-5 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-6 | AIT-3537-6 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW1.AIT-3537-6C | AIT-3537-6 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-7 | AIT-3537-7 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW1.AIT-3537-7C | AIT-3537-7 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-8 | AIT-3537-8 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW1.AIT-3537-8C | AIT-3537-8 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.AIT-3537-9 | AIT-3537-9 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW1.AIT-3537-9C | AIT-3537-9 Turbidimeter Controller | CONTRLLR | 1/1/2016 |
| WTP.ZW1.CV-1 | ZW1-1 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-10 | ZW1-10 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-2 | ZW1-2 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3 | ZW1-3 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-320-B10 | ZW1-10 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-320-B9 | ZW1-9 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-1 | ZW1-1 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-2 | ZW1-2 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-3 | ZW1-3 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-4 | CV-3470-4 Train 4 Backpulse Checkvalve | VALVE | 8/4/2015 |
| WTP.ZW1.CV-3470-5 | ZW1-5 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-6 | ZW1-6 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-7 | ZW1-7 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-3470-8 | ZW1-8 Back Pulse Check valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-4 | ZW1-4 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-5 | ZW1-5 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-6 | ZW1-6 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-7 | ZW1-7 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-8 | ZW1-8 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.CV-9 | ZW1-9 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW1.E-325-1 | E-325-1 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-10 | E-325-10 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-2 | E-325-2 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-3 | E-325-3 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-4 | E-325-4 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-5 | E-325-5 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-6 | E-325-6 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-7 | E-325-7 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-8 | E-325-8 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-325-9 | E-325-9 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-1 | E-326-1 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-10 | E-326-10 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-2 | E-326-2 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-3 | E-326-3 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-4 | E-326-4 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-5 | E-326-5 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-6 | E-326-6 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-7 | E-326-7 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E-326-8 | E-326-8 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.E-326-9 | E-326-9 Post MIT Priming Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-1 | E-350-1 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-10 | E-350-10 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-2 | E-350-2 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-3 | E-350-3 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-4 | E-350-4 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-5 | E-350-5 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-6 | E-350-6 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-7 | E-350-7 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-8 | E-350-8 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.E350-9 | E-350-9 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW1.FCV-320-1 | FCV-320-1 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-10 | FCV-320-10 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-2 | FCV-320-2 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-3 | FCV-320-3 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-4 | FCV-320-4 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-5 | FCV-320-5 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-6 | FCV-320-6 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-7 | FCV-320-7 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-8 | FCV-320-8 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FCV-320-9 | FCV-320-9 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FIT-3520-1 | FIT-3520-1 Permeate Flow Meter ZW1-1 | METERPW | 3/25/2016 |
| WTP.ZW1.FIT-3520-10 | FIT-3520-10 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FIT-3520-2 | FIT-3520-2 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FIT-3520-3 | FIT-3520-3 Permeate Flow Meter ZW1-3 | METERPW | 3/25/2016 |
| WTP.ZW1.FIT-3520-4 | FIT-3520-4 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FIT-3520-5 | FIT-3520-5 Permeate flow Meter | VALVE | 1/1/2016 |
| WTP.ZW1.FIT-3520-6 | FIT-3520-6 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FIT-3520-7 | FIT-3520-7 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FIT-3520-8 | FIT-3520-8 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FIT-3520-9 | FIT-3520-9 Permeate flow Meter | METER | 1/1/2016 |
| WTP.ZW1.FV-320-A1 | FV-320-A1 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A10 | FV-320-A10 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A2 | FV-320-A2 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A3 | FV-320-A3 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A4 | FV-320-A4 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A5 | FV-320-A5 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A6 | FV-320-A6 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A7 | FV-320-A7 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A8 | FV-320-A8 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-A9 | FV-320-A9 CEB Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-B10 | FV-320-B10 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-B9 | FV-320-B9 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-C10 | FV-320-C10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-320-C9 | FV-320-C9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A1 | FV-321-A1 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A10 | FV-321-A10 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A2 | FV-321-A2 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A3 | FV-321-A3 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A4 | FV-321-A4 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A5 | FV-321-A5 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A6 | FV-321-A6 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A7 | FV-321-A7 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A8 | FV-321-A8 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-A9 | FV-321-A9 Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B1 | FV-321-B1 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B10 | FV-321-B10 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B2 | FV-321-B2 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B3 | FV-321-B3 Basin Drain Valve | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.FV-321-B4 | FV-321-B4 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B5 | FV-321-B5 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B6 | FV-321-B6 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B7 | FV-321-B7 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B8 | FV-321-B8 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-B9 | FV-321-B9 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C1 | FV-321-C1 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C10 | FV-321-C10 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C2 | FV-321-C2 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C3 | FV-321-C3 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C4 | FV-321-C4 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C5 | FV-321-C5 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C6 | FV-321-C6 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C7 | FV-321-C7 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C8 | FV-321-C8 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-321-C9 | FV-321-C9 Basin Fill Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A1 | FV-322-A1 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A10 | FV-322-A10 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A2 | FV-322-A2 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A3 | FV-322-A3 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A4 | FV-322-A4 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A5 | FV-322-A5 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A6 | FV-322-A6 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A7 | FV-322-A7 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A8 | FV-322-A8 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-A9 | FV-322-A9 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B1 | FV-322-B1 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B10 | FV-322-B10 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B2 | FV-322-B2 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B3 | FV-322-B3 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B4 | FV-322-B4 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B5 | FV-322-B5 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B6 | FV-322-B6 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B7 | FV-322-B7 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B8 | FV-322-B8 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-B9 | FV-322-B9 Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C1 | FV-322-C1 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C10 | FV-322-C10 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C2 | FV-322-C2 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C3 | FV-322-C3 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C4 | FV-322-C4 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C5 | FV-322-C5 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C6 | FV-322-C6 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C7 | FV-322-C7 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C8 | FV-322-C8 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-322-C9 | FV-322-C9 Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A1 | FV-323-A1 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A10 | FV-323-A10 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A2 | FV-323-A2 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A3 | FV-323-A3 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A4 | FV-323-A4 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A5 | FV-323-A5 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A6 | FV-323-A6 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A7 | FV-323-A7 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A8 | FV-323-A8 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-A9 | FV-323-A9 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B1 | FV-323-B1 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B10 | FV-323-B10 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B2 | FV-323-B2 CIP Basin Drain Valve | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.FV-323-B3 | FV-323-B3 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B4 | FV-323-B4 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B5 | FV-323-B5 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B6 | FV-323-B6 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B7 | FV-323-B7 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B8 | FV-323-B8 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-B9 | FV-323-B9 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C1 | FV-323-C1 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C10 | FV-323-C10 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C2 | FV-323-C2 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C3 | FV-323-C3 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C4 | FV-323-C4 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C5 | FV-323-C5 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C6 | FV-323-C6 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C7 | FV-323-C7 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C8 | FV-323-C8 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-323-C9 | FV-323-C9 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A1 | FV-324-A1 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A10 | FV-324-A10 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A2 | FV-324-A2 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A3 | FV-324-A3 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A4 | FV-324-A4 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A5 | FV-324-A5 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A6 | FV-324-A6 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A7 | FV-324-A7 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A8 | FV-324-A8 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-A9 | FV-324-A9 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B1 | FV-324-B1 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B10 | FV-324-B10 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B2 | FV-324-B2 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B3 | FV-324-B3 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B4 | FV-324-B4 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B5 | FV-324-B5 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B6 | FV-324-B6 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B7 | FV-324-B7 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B8 | FV-324-B8 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-B9 | FV-324-B9 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C1 | FV-324-C1 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C10 | FV-324-C10 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C2 | FV-324-C2 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C3 | FV-324-C3 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C4 | FV-324-C4 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C5 | FV-324-C5 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C6 | FV-324-C6 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C7 | FV-324-C7 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C8 | FV-324-C8 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-324-C9 | FV-324-C9 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-1 | FV-325-1 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-10 | FV-325-10 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-2 | FV-325-2 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-3 | FV-325-3 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-4 | FV-325-4 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-5 | FV-325-5 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-6 | FV-325-6 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-7 | FV-325-7 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-8 | FV-325-8 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-325-9 | FV-325-9 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-1 | FV-326-1 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-10 | FV-326-10 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.FV-326-2 | FV-326-2 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-3 | FV-326-3 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-4 | FV-326-4 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-5 | FV-326-5 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-6 | FV-326-6 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-7 | FV-326-7 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-8 | FV-326-8 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-326-9 | FV-326-9 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-A10 | FV-327-A10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-A9 | FV-327-A9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-B10 | FV-327-B10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-B9 | FV-327-B9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-C10 | FV-327-C10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-C9 | FV-327-C9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-D10 | FV-327-D10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-D9 | FV-327-D9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-E10 | FV-327-E10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-E9 | FV-327-E9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-F10 | FV-327-F10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-F9 | FV-327-F9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-G10 | FV-327-G10 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-327-G9 | FV-327-G9 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-1 | FV-329-1 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-10 | FV-329-10 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-2 | FV-329-2 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-3 | FV-329-3 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-4 | FV-329-4 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-5 | FV-329-5 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-6 | FV-329-6 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-7 | FV-329-7 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-8 | FV-329-8 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-329-9 | FV-329-9 Post MIT Priming Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A1 | FV-3466-A1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A2 | FV-3466-A2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A3 | FV-3466-A3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A4 | FV-3466-A4 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A5 | FV-3466-A5 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A6 | FV-3466-A6 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A7 | FV-3466-A7 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-A8 | FV-3466-A8 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B1 | FV-3466-B1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B2 | FV-3466-B2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B3 | FV-3466-B3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B4 | FV-3466-B4 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B5 | FV-3466-B5 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B6 | FV-3466-B6 Permeate Valve ZW1-6 | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-B7 | FV-3466-B7 Permeate Valve | VALVE | 1/1/2008 |
| WTP.ZW1.FV-3466-B8 | FV-3466-B8 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C1 | FV-3466-C1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C2 | FV-3466-C2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C3 | FV-3466-C3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C4 | FV-3466-C4 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C5 | FV-3466-C5 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C6 | FV-3466-C6 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C7 | FV-3466-C7 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-C8 | FV-3466-C8 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D1 | FV-3466-D1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D2 | FV-3466-D2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D3 | FV-3466-D3 Permeate Valve | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.FV-3466-D4 | FV-3466-D4 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D5 | FV-3466-D5 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D6 | FV-3466-D6 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D7 | FV-3466-D7 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3466-D8 | FV-3466-D8 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-A10 | FV-FV-3467-A10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-A9 | FV-FV-3467-A9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-B10 | FV-FV-3467-B10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-B9 | FV-FV-3467-B9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-C10 | FV-FV-3467-C10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-C9 | FV-FV-3467-C9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-D10 | FV-FV-3467-D10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-D9 | FV-FV-3467-D9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-E10 | FV-FV-3467-E10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-E9 | FV-FV-3467-E9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-F10 | FV-FV-3467-F10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-F9 | FV-FV-3467-F9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-G10 | FV-FV-3467-G10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3467-G9 | FV-FV-3467-G9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A1 | FV-3468-A1 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A2 | FV-3468-A2 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A3 | FV-3468-A3 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A4 | FV-3468-A4 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A5 | FV-3468-A5 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A6 | FV-3468-A6 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A7 | FV-3468-A7 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-A8 | FV-3468-A8 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B1 | FV-3468-B1 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B2 | FV-3468-B2 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B3 | FV-3468-B3 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B4 | FV-3468-B4 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B5 | FV-3468-B5 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B6 | FV-3468-B6 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B7 | FV-3468-B7 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-B8 | FV-3468-B8 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C1 | FV-3468-C1 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C2 | FV-3468-C2 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C3 | FV-3468-C3 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C4 | FV-3468-C4 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C5 | FV-3468-C5 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C6 | FV-3468-C6 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C7 | FV-3468-C7 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-C8 | FV-3468-C8 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D1 | FV-3468-D1 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D2 | FV-3468-D2 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D3 | FV-3468-D3 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D4 | FV-3468-D4 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D5 | FV-3468-D5 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D6 | FV-3468-D6 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D7 | FV-3468-D7 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3468-D8 | FV-3468-D8 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-1 | FV-3470-1 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-2 | FV-3470-2 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-3 | FV-3470-3 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-4 | FV-3470-4 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-5 | FV-3470-5 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-6 | FV-3470-6 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-7 | FV-3470-7 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3470-8 | FV-3470-8 Back Pulse Valve | VALVE | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.FV-3475-1 | FV-3475-1 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-10 | FV-3475-10 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-2 | FV-3475-2 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-3 | FV-3475-3 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-4 | FV-3475-4 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-5 | FV-3475-5 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-6 | FV-3475-6 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-7 | FV-3475-7 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3475-8 | FV-3475-8 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-1 | FV-3496-1 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-2 | FV-3496-2 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-3 | FV-3496-3 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-4 | FV-3496-4 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-5 | FV-3496-5 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-6 | FV-3496-6 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-7 | FV-3496-7 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3496-8 | FV-3496-8 MIT Feed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A1 | FV-3560-A1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A10 | FV-3560-A10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A2 | FV-3560-A2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A3 | FV-3560-A3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A4 | FV-3560-A4 Permeate Valve | VALVE | 3/4/2015 |
| WTP.ZW1.FV-3560-A5 | FV-3560-A5 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A6 | FV-3560-A6 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A7 | FV-3560-A7 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A8 | FV-3560-A8 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-A9 | FV-3560-A9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B1 | FV-3560-B1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B10 | FV-3560-B10 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B2 | FV-3560-B2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B3 | FV-3560-B3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B4 | FV-3560-B4 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B5 | FV-3560-B5 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B6 | FV-3560-B6 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B7 | FV-3560-B7 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B8 | FV-3560-B8 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-B9 | FV-3560-B9 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C1 | FV-3560-C1 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C10 | FV-3560-C10 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C2 | FV-3560-C2 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C3 | FV-3560-C3 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C4 | FV-3560-C4 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C5 | FV-3560-C5 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C6 | FV-3560-C6 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C7 | FV-3560-C7 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C8 | FV-3560-C8 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.FV-3560-C9 | FV-3560-C9 Permeate Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW1.M35-1 | ZW1-1 Permeate Motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-10 | ZW1-10 Permeate motor | MOTOR | 1/1/2004 |
| WTP.ZW1.M35-2 | ZW1-2 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-3 | ZW1-3 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-4 | ZW1-4 Permeate motor | MOTOR | 1/1/2001 |
| WTP.ZW1.M35-5 | ZW1-5 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-6 | ZW1-6 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-7 | ZW1-7 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-8 | ZW1-8 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.M35-9 | ZW1-9 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW1.P-35-1.VFD | WTP.ZW1.P35-1.VFD | VFD | 1/1/2016 |
| WTP.ZW1.P35-10 | P-35-10 ZW1-10 Permeate Pump | PUMP | 1/1/2016 |

| | | | |
|---|---|---|---|
| WTP.ZW1.P35-2 | P-35-2 ZW1-2 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.P35-2/1 | P-35-2 ZW1-2 Permeate Pump Motor | MOTOR | 1/1/2016 |
| WTP.ZW1.P35-3 | P-35-3 ZW1-3 Permeate Pump | PUMP | 1/1/2002 |
| WTP.ZW1.P35-4 | P-35-4 ZW1-4 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.P35-5 | P-35-5 ZW1-5 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.P35-6 | P-35-6 ZW1-6 Permeate pump | PUMP | 3/9/2016 |
| WTP.ZW1.P35-7 | P-35-7 ZW1-7 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.P35-8 | P-35-8 ZW1-8 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.P35-9 | P-35-9 ZW1-9 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.P35.1 | P-35-1 ZW1-1 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW1.SV-313-A1 | SV-313-1 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A10 | SV-313-10 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A2 | SV-313-2 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A3 | SV-313-3 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A4 | SV-313-4 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A5 | SV-313-5 Turbidimeter flow solenoid valve | METER | 1/1/2016 |
| WTP.ZW1.SV-313-A6 | SV-313-6 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A7 | SV-313-7 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A8 | SV-313-8 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-313-A9 | SV-313-9 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-1 | SV-325-1 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-10 | SV-325-10 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-2 | SV-325-2 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-3 | SV-325-3 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-4 | SV-325-4 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-5 | SV-325-5 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-6 | SV-325-6 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-7 | SV-325-7 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-8 | SV-325-8 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-325-9 | SV-325-9 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-1 | SV-326-1 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-10 | SV-326-10 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-2 | SV-326-2 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-3 | SV-326-3 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-4 | SV-326-4 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-5 | SV-326-5 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-6 | SV-326-6 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-7 | SV-326-7 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-8 | SV-326-8 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-326-9 | SV-326-9 Post MIT Priming Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-1 | SV-350-1 eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-10 | SV-350-10 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-2 | SV-350-2 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-3 | SV-350-3 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-4 | SV-350-4 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-5 | SV-350-5 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-6 | SV-350-6 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-7 | SV-350-7 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-8 | SV-350-8 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW1.SV-350-9 | SV-350-9 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW2.2ND-STG.PIPING | Second Stage Piping | PIPING | 1/26/2022 |
| WTP.ZW2.ACT-340-A3 | ACT-340-A3 CIP Basin Fill Valve Actuator | * | 12/1/2012 |
| WTP.ZW2.AIT-210 | AIT-210 Turbidimeter | METER | 1/29/2019 |
| WTP.ZW2.AIT-3737-1 | AIT-3737-1 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW2.AIT-3737-1C | AIT-3737-1 Turbidimeter Controller | CONTRLLR | 1/1/2012 |
| WTP.ZW2.AIT-3737-2 | AIT-3737-2 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW2.AIT-3737-2C | AIT-3737-2 Turbidimeter Controller | CONTRLLR | 1/1/2012 |
| WTP.ZW2.AIT-3737-3 | AIT-3737-3 Turbidimeter | METER | 1/1/2016 |
| WTP.ZW2.AIT-3737-3C | AIT-3737-3 Turbidimeter Controller | CONTRLLR | 1/1/2012 |

| | | | |
|---|---|---|---|
| WTP.ZW2.CV-1 | ZW2-1 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW2.CV-2 | ZW2-2 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW2.CV-3 | ZW2-3 Permeate Check Valve | VALVE | 1/1/2016 |
| WTP.ZW2.E-370-1 | E-370-1 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW2.E-370-2 | E-370-2 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW2.E-370-3 | E-370-3 Eductor | EDUCTOR | 1/1/2016 |
| WTP.ZW2.FCV-340-1 | FCV-340-1 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FCV-340-2 | FCV-340-2 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FCV-340-3 | FCV-340-3 Basin Fill Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FIT-3720-1 | FIT-3720-1 Permeate Flow Meter | METER | 1/1/2016 |
| WTP.ZW2.FIT-3720-2 | FIT-3720-2 Permeate Flow Meter | METER | 1/1/2016 |
| WTP.ZW2.FIT-3720-3 | FIT-3720-3 Permeate Flow Meter | METER | 1/1/2016 |
| WTP.ZW2.FIT3620-1 | FIT-3620-1 Reject Flow Meter | METER | 1/1/2016 |
| WTP.ZW2.FIT3620-2 | FIT-3620-2 Reject Flow Meter | METER | 1/1/2016 |
| WTP.ZW2.FIT3620-3 | FIT-3620-3 Reject Flow Meter | METER | 1/1/2016 |
| WTP.ZW2.FV-340-A1 | FV-340-A1 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-A2 | FV-340-A2 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-A3 | FV-340-A3 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-B1 | FV-340-B1 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-B2 | FV-340-B2 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-B3 | FV-340-B3 CIP Basin Fill Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-C1 | FV-340-C1 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-C2 | FV-340-C2 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-340-C3 | FV-340-C3 CIP Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-A1 | FV-341-A1 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-A2 | FV-341-A2 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-A3 | FV-341-A3 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-B1 | FV-341-B1 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-B2 | FV-341-B2 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-B3 | FV-341-B3 CIP Basin Drain Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-C1 | FV-341-C1 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-C2 | FV-341-C2 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-341-C3 | FV-341-C3 CIP Basin Drain Bleed Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3661-1 | FV-3661-1 Reject Flow Valve | VALVE | 12/1/2012 |
| WTP.ZW2.FV-3661-2 | FV-3661-2 Reject Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3661-3 | FV-3661-3 Reject Flow Valve | * | 12/1/2012 |
| WTP.ZW2.FV-3670-1 | FV-3670-1 Back Pulse Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3670-2 | FV-3670-2 Back Pusle Valve | VALVE | 1/1/2008 |
| WTP.ZW2.FV-3670-3 | FV-3670-3 Back Pusle Valve | VALVE | 2/11/2015 |
| WTP.ZW2.FV-3675-A1 | FV-3675-A1 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3675-A2 | FV-3675-A2 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3675-A3 | FV-3675-A3 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3675-B1 | FV-3675-B1 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3675-B2 | FV-3675-B2 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3675-B3 | FV-3675-B3 Aeration Flow Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3760-1 | FV-3760-1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3760-2 | FV-3760-2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.FV-3760-3 | FV-3760-3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-A1 | HV-3466-A1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-A2 | HV-3466-A2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-A3 | HV-3466-A3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-B1 | HV-3466-B1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-B2 | HV-3466-B2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-B3 | HV-3466-B3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-C1 | HV-3466-C1 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-C2 | HV-3466-C2 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.HV-3466-C3 | HV-3466-C3 Permeate Valve | VALVE | 1/1/2016 |
| WTP.ZW2.M36-1 | M36-1 Reject Pump Motor | MOTOR | 1/1/2016 |
| WTP.ZW2.M36-2 | M36-2 Reject Pump Motor | MOTOR | 1/1/2001 |

| | | | |
|---|---|---|---|
| WTP.ZW2.M36-3 | M36-3 Reject Pump Motor | MOTOR | 1/1/2013 |
| WTP.ZW2.M370-1 | ZW2-1 Permeate Motor | MOTOR | 1/1/2013 |
| WTP.ZW2.M370-2 | ZW2-2 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW2.M370-3 | ZW2-3 Permeate motor | MOTOR | 1/1/2016 |
| WTP.ZW2.P35-2VFD | WTP.ZW2.P35-2.VFD | VFD | 1/1/2002 |
| WTP.ZW2.P36-1 | ZW2 -P36-1 REJECT PUMP | PUMP | 12/1/2013 |
| WTP.ZW2.P36-2 | ZW2 -P36-2 REJECT PUMP | PUMP | 2/6/2015 |
| WTP.ZW2.P36-3 | ZW2 -P36-3 REJECT PUMP | PUMP | 2/6/2015 |
| WTP.ZW2.P370-1 | P-370-1 ZW2-1 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW2.P370-1.VFD | WTP.ZW2.P370-1.VFD | VFD | 1/1/2016 |
| WTP.ZW2.P370-2 | P-370-2 ZW2-2 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW2.P370-2.VFD | WTP.ZW2.P370-2.VFD | VFD | 1/1/2016 |
| WTP.ZW2.P370-3 | P-370-3 ZW2-3 Permeate Pump | PUMP | 1/1/2016 |
| WTP.ZW2.P370-3.VFD | WTP.ZW2.P370-3.VFD | VFD | 1/1/2016 |
| WTP.ZW2.SV-313-A1 | SV-313-A1 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW2.SV-313-A2 | SV-313-A2 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW2.SV-313-A3 | SV-313-A3 Turbidimeter flow solenoid valve | VALVE | 1/1/2016 |
| WTP.ZW2.SV-370-1 | SV-370-1 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW2.SV-370-2 | SV-370-2 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW2.SV-370-3 | SV-370-3 Eductor Solenoid Valve | VALVE | 1/1/2016 |
| WTP.ZW2.ZW2-1 | Membrane Train ZW2-1 | FILTER | 10/20/2001 |
| WTP.ZW2.ZW2-2 | Membrane Train ZW2-2 | FILTER | 8/14/2002 |
| WTP.ZW2.ZW2-3 | Membrane Train ZW2-3 | FILTER | 10/20/2001 |
| WTP.ZW3.P35-3.VFD | WTP.ZW3.P35-3.VFD | VFD | 1/1/2016 |
| WTP.ZW4.P35-4VFD | WTP.ZW4.P35-4.VFD | VFD | 1/1/2002 |
| WTP.ZW8.P35-8VFD | WTP.ZW8.P35-8.VFD | VFD | 1/1/2002 |
| WTP10001 | 1ST STAGE PERMEATE PUMP 1 VFD P-35-1 | VFD | 7/21/2008 |
| WTP10001-1 | 1st STAGE PERMEATE PUMP 1 VFD P-35-1 | VFD | 5/4/2015 |
| WTP10002 | 1ST STAGE PERMEATE PUMP 2 VFD P-35-2 | VFD | 7/21/2008 |
| WTP10002-1 | 1ST STAGE PERMEATE PUMP 2 VFD P-35-2 | VFD | 3/24/2009 |
| WTP10003 | 1ST STAGE PERMEATE PUMP 3 VFD P-35-3 | VFD | 7/21/2008 |
| WTP10003-1 | 1ST STAGE PERMEATE PUMP 3 VFD P-35-3 | VFD | 9/9/2011 |
| WTP10004 | 1ST STAGE PERMEATE PUMP 4 VFD P-35-4 | VFD | 7/21/2008 |
| WTP10004-1 | 1st STAGE PERMEATE PUMP 4 VFD P-35-4 | VFD | 8/3/2015 |
| WTP10005-1 | 1ST STAGE PERMEATE PUMP 5 VFD P-35-5 | VFD | 3/24/2009 |
| WTP10006 | 1ST STAGE PERMEATE PUMP 6 VFD P-35-6 | VFD | 7/21/2008 |
| WTP10007 | 1ST STAGE PERMEATE PUMP 7 VFD P-35-7 | VFD | 7/21/2008 |
| WTP10008 | 1ST STAGE PERMEATE PUMP 8 VFD P-35-8 | VFD | 7/21/2008 |
| WTP10009 | 2ND STAGE PERMEATE PUMP 1 VFD P-37-1 | VFD | 7/21/2008 |
| WTP10012 | 1ST STAGE PERMEATE PUMP 9 VFD P-35-9 | VFD | 7/21/2008 |
| WTP10013 | 1ST STAGE PERMEATE PUMP 10 VFD P-35-10 | VFD | 7/21/2008 |
| WTP10020 | 2ND STAGE REJECT PUMP 2 VFD P-36-2 | VFD | 12/7/2009 |
| WTP10021 | 2ND STAGE REJECT PUMP 3 VFD P-36-3 | VFD | 12/7/2009 |
| WTP11101 | MOV PANEL M1 | CONTROL | 7/21/2008 |
| WTP11102 | MOV PANEL M2 | CONTROL | 7/21/2008 |
| WTP11103 | MOV PANEL M3 | CONTROL | 7/21/2008 |
| WTP11104 | MOV PANEL M4 | CONTROL | 7/21/2008 |
| WTP11105 | MOV PANEL M5 | CONTROL | 7/21/2008 |
| WTP11106 | MOV PANEL M6 | CONTROL | 7/21/2008 |
| WTP11107 | MOV PANEL M7 | CONTROL | 7/21/2008 |
| WTP11108 | MOV PANEL M8 | CONTROL | 7/21/2008 |
| WTP11109 | MOV PANEL M21 | CONTROL | 7/21/2008 |
| WTP11110 | MOV PANEL M22 | CONTROL | 7/21/2008 |
| WTP11111 | MOV PANEL M23 | CONTROL | 7/21/2008 |
| WTP11121 | CONTROL CABINET ICP-1 | CONTROL | 7/21/2008 |
| WTP11122 | CONTROL CABINET ICP-2 | CONTROL | 7/21/2008 |
| WTP11123 | CONTROL CABINET ICP-3 | CONTROL | 7/21/2008 |
| WTP16001 | WTP MCC | PS | 7/21/2008 |
| WTP17001 | MSB 1 | ELEC | 7/21/2008 |

| | | | |
|---|---|---|---|
| WTP17002 | DSB 1 | ELEC | 7/21/2008 |
| WTP17003 | DSB 2 | ELEC | 7/21/2008 |
| WTP17004 | MCC 1 | ELEC | 7/21/2008 |
| WTP17005 | MCC 2 | ELEC | 7/21/2008 |
| WTP17007 | MAIN BREAKER | ELEC | 7/21/2008 |
| WTP17008 | PANEL LA | ELEC | 7/21/2008 |
| WTP17009 | PANEL LC | ELEC | 7/21/2008 |
| WTP17010 | PANEL EB | ELEC | 7/21/2008 |
| WTP17011 | PANEL LEB | ELEC | 7/21/2008 |
| WTP17012 | PANEL EA | ELEC | 7/21/2008 |
| WTP17013 | PANEL LEA | ELEC | 7/21/2008 |
| WTP17014 | PANEL LD | ELEC | 7/21/2008 |
| WTP17015 | TUSS PUMP BREAKER PANEL | ELEC | 7/21/2008 |
| WTP17016 | PANEL LCP-5501 - Caustic Pumps | ELEC | 10/5/2009 |
| WTP17027 | LIGHTING PANEL FOR POLE AND WALL LIGHTS | ELEC | 7/21/2008 |
| WTP18101 | T 1 TRANFORMER | ELEC | 7/21/2008 |
| WTP1STSTAGEAIRVALVE | WTP 1st Stage Airation Valve FCV-8566 | CTLVALPW | 12/22/2009 |
| WTP20000 | 2ND STAGE PERMEATE PUMP 3 P-37-3 | PUMP | 7/21/2008 |
| WTP20000-1 | 2ND STAGE PERMEATE PUMP MOTOR P-37-3 | MOTOR | 5/17/2018 |
| WTP20001 | 2ND STAGE PERMEATE PUMP P-37-1 | PUMP | 7/21/2008 |
| WTP20001-1 | 2ND STAGE PERMEATE PUMP MOTOR P-37-1 | MOTOR | 5/17/2018 |
| WTP20002 | 2ND STAGE PERMEATE PUMP 2 P-37-2 | PUMP | 7/21/2008 |
| WTP20002-1 | 2ND STAGE PERMEATE PUMP MOTOR P-37-2 | MOTOR | 5/17/2018 |
| WTP20003 | 1ST STAGE PERMEATE PUMP 1 P-35-1 | PUMP | 7/21/2008 |
| WTP20004 | 1ST STAGE PERMEATE PUMP 2 P-35-2 | PUMP | 7/21/2008 |
| WTP20005 | 1ST STAGE PERMEATE PUMP 3 P-35-3 | PUMP | 7/21/2008 |
| WTP20006 | 1ST STAGE PERMEATE PUMP 4 P-35-4 | PUMP | 7/21/2008 |
| WTP20007 | 1ST STAGE PERMEATE PUMP 5 P-35-5 | PUMP | 7/21/2008 |
| WTP20008 | 1ST STAGE PERMEATE PUMP 6 P-35-6 | PUMP | 7/21/2008 |
| WTP20009 | 1ST STAGE PERMEATE PUMP 7 P-35-7 | PUMP | 7/21/2008 |
| WTP20010 | 1ST STAGE PERMEATE PUMP 8 P-35-8 | PUMP | 7/21/2008 |
| WTP20011 | FYBROC, BASIN DRAIN PUMP 2010 | PUMP | 7/21/2008 |
| WTP20012 | 1ST STAGE PERMEATE PUMP 9 P-35-9 | PUMP | 7/21/2008 |
| WTP20013 | 1ST STAGE PERMEATE PUMP 10 P-35-10 | PUMP | 7/21/2008 |
| WTP20015 | BRINE TRANSFER PUMP | PUMP | 7/21/2008 |
| WTP20016 | FYBROC, CITRIC ACID PUMP P-6021 | PUMP | 7/21/2008 |
| WTP21101 | 2ND STAGE REJECT PUMP P-36-1 | PUMP | 7/21/2008 |
| WTP21101-1 | 2ND STAGE REJECT PUMP MOTOR P-36-1 | MOTOR | 5/17/2018 |
| WTP21102 | 2ND STAGE REJECT PUMP P-36-2 | PUMP | 7/21/2008 |
| WTP21102-1 | 2ND STAGE REJECT PUMP MOTOR P-36-2 | MOTOR | 5/17/2018 |
| WTP21103 | 2ND STAGE REJECT PUMP P-36-3 | PUMP | 7/21/2008 |
| WTP21103-1 | 2ND STAGE REJECT PUMP MOTOR P-36-3 | MOTOR | 5/17/2018 |
| WTP21104 | CHEMICAL UNLOAD PUMP 1 | PUMP | 7/21/2008 |
| WTP21105 | CHEMICAL UNLOAD PUMP 2 | PUMP | 7/21/2008 |
| WTP23101 | RAW WATER SAMPLE PUMP | PUMP | 7/21/2008 |
| WTP23102 | HYPO TRANSFER PUMP 5421 | PUMP | 7/21/2008 |
| WTP23103 | FYBROC, HYPO CIP PUMP P-5424 | PUMP | 7/21/2008 |
| WTP23104 | CAUSTIC TRANSFER PUMP 5521 | PUMP | 7/21/2008 |
| WTP23106 | AMMONIA FINISH TRANSFER PUMP 6122 | PUMP | 7/21/2008 |
| WTP23107 | AMMONIA RAW TRANSFER PUMP 6121 | PUMP | 7/21/2008 |
| WTP23110-FIN | FINISHED ANALYZER PANEL RECYCLE PUMP | PUMP | 12/8/2009 |
| WTP23110-RAW | RAW ANALYZER PANEL RECYCLE PUMP | PUMP | 12/8/2009 |
| WTP23110-ZW2 | 2ND STAGE ANALYZER PANEL RECYCLE PUMP | PUMP | 12/8/2009 |
| WTP27001 | MIT AIR COMPRESSORS 1 (A) | COMPRESS | 7/21/2008 |
| WTP27002-2 | MIT AIR COMPRESSORS 2 (B) | COMPRESS | 4/3/2012 |
| WTP27005 | SURGE TANK COMPRESSOR | COMPRESS | 7/21/2008 |
| WTP28001 | HYPO BLOWER 1 | BLOWER | 7/21/2008 |
| WTP28002 | HYPO BLOWER 2 | BLOWER | 7/21/2008 |
| WTP28003 | BULK SALT STORAGE TANK BLOWER | BLOWER | 7/21/2008 |

| | | | |
|---|---|---|---|
| WTP28105 | TURBINE E | TURBINE | 7/21/2008 |
| WTP29001 | PAC METERING PUMP 7141 | PUMP | 7/21/2008 |
| WTP29002 | PAC METERING PUMP 7142 | PUMP | 7/21/2008 |
| WTP29003 | LAMELLA SETTLER POLYMER SYSTEM 7241 | PUMP | 7/21/2008 |
| WTP29004 | CENTRIFUGE POLYMER SYSTEM 7242 | PUMP | 7/21/2008 |
| WTP29005 | BISULFITE METERING PUMP 5341 | PUMP | 7/21/2008 |
| WTP29006 | BISULFITE METERING PUMP 5342 | PUMP | 7/21/2008 |
| WTP29007 | HYPO FINISHED METERING PUMP 5445 | PUMP | 7/21/2008 |
| WTP29008 | HYPO FINISHED METERING PUMP 5446 | PUMP | 7/21/2008 |
| WTP29009 | CAUSTIC METER PUMP 5541 | PUMP | 7/21/2008 |
| WTP29010 | CAUSTIC METER PUMP 5542 | PUMP | 7/21/2008 |
| WTP29011 | AMMONIA FINISH METERING PUMP 6143 | PUMP | 7/21/2008 |
| WTP29012 | AMMONIA FINISH METERING PUMP 6144 | PUMP | 7/21/2008 |
| WTP29013 | HYPO METERING PUMP 5447 | PUMP | 7/21/2008 |
| WTP29014 | HYPO METERING PUMP 5448 | PUMP | 7/21/2008 |
| WTP29015 | HYPO RAW METERING PUMP 5441 | PUMP | 7/21/2008 |
| WTP29016 | HYPO RAW METERING PUMP 5442 | PUMP | 7/21/2008 |
| WTP29017 | HYPO BACK PULSE METERING PUMP 5443 | PUMP | 7/21/2008 |
| WTP29018 | HYPO BACK PULSE METERING PUMP 5444 | PUMP | 7/21/2008 |
| WTP29019 | AMMONIA RAW METERING PUMP 6141 | PUMP | 7/21/2008 |
| WTP29020 | AMMONIA RAW METERING PUMP 6142 | PUMP | 7/21/2008 |
| WTP29021 | HYDRACELL CHEM. METERING PUMP SER. 241792 | PUMP | 8/24/2011 |
| WTP29022 | HYDRACELL CHEM. METERING PUMP SER. 242118 | PUMP | 8/24/2011 |
| WTP2NDSTAGEAIRVALVE | WTP 2nd Stage Airation Valve FCV-8568 | CTLVALPW | 12/22/2009 |
| WTP3100 | Lab 2100N turbidimeter | XDUCER | 7/21/2008 |
| WTP31005 | 2ND STAGE PERMEATE PUMP 1 MOTOR P-37-1 | MOTOR | 7/21/2008 |
| WTP31006 | 2ND STAGE PERMEATE PUMP 2 MOTOR P-37-2 | MOTOR | 7/21/2008 |
| WTP31007 | 2ND STAGE PERMEATE PUMP 3 MOTOR P-37-3 | MOTOR | 7/21/2008 |
| WTP31008 | BASIN DRAIN PUMP MOTOR P-2010 | MOTOR | 7/21/2008 |
| WTP31009 | 1ST STAGE PERMEATE PUMP 1 MOTOR P-35-1 | MOTOR | 7/21/2008 |
| WTP31010 | 1ST STAGE PERMEATE PUMP 2 MOTOR P-35-2 | MOTOR | 7/21/2008 |
| WTP31011 | 1ST STAGE PERMEATE PUMP 3 MOTOR P-35-3 | MOTOR | 7/21/2008 |
| WTP31012 | 1ST STAGE PERMEATE PUMP 4 MOTOR P-35-4 | MOTOR | 7/21/2008 |
| WTP31013 | 1ST STAGE PERMEATE PUMP 5 MOTOR P-35-5 | MOTOR | 7/21/2008 |
| WTP31014 | 1ST STAGE PERMEATE PUMP 6 MOTOR P-35-6 | MOTOR | 7/21/2008 |
| WTP31015 | 1ST STAGE PERMEATE PUMP 7 MOTOR P-35-7 | MOTOR | 7/21/2008 |
| WTP31016 | 1ST STAGE PERMEATE PUMP 8 MOTOR P-35-8 | MOTOR | 7/21/2008 |
| WTP31017 | VACUUM PUMP A MOTOR M-92-A | MOTOR | 7/21/2008 |
| WTP31018 | VACUUM PUMP B MOTOR M-92-B | MOTOR | 7/21/2008 |
| WTP31019 | VACUUM PUMP C MOTOR M-92-C | MOTOR | 7/21/2008 |
| WTP31020 | 1ST STAGE PERMEATE PUMP 9 MOTOR P-35-9 | MOTOR | 7/21/2008 |
| WTP31021 | 1ST STAGE PERMEATE PUMP 10 MOTOR P-35-10 | MOTOR | 7/21/2008 |
| WTP3469-10-ASV | ZW1_10 FV-3469-10 Angle Seat Valve | VALVE | 9/30/2010 |
| WTP3469-10-EDUC | ZW1_10 FV-3469-10 EDUCTOR | VALVE | 9/30/2010 |
| WTP3469-9-ASV | ZW1_9 FV-3469-9 Angle Seat Valve | VALVE | 9/30/2010 |
| WTP3469-9-EDUC | ZW1_9 FV-3469-9 EDUCTOR | VALVE | 9/30/2010 |
| WTP45101 | ALUM FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45102 | POLYMER FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45103 | BISULFITE FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45104 | HYPO STORAGE SYSTEM | CHEM | 7/21/2008 |
| WTP45105 | CITRIC ACID FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45107 | ION EXCHANGE SYSTEM | CHEM | 7/21/2008 |
| WTP45108 | RECTIFIER / CLORTEC GENERATION UNIT | CHEM | 7/21/2008 |
| WTP45109 | CLORTEC SODIUM HYPOCHLORITE GENERATION SYSTEM | CHEM | 7/21/2008 |
| WTP45110 | HYPO FINISHED WATER FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45111 | CAUSTIC FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45112 | AMMONIA FINISH FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45113 | HYPO REMOTE FEED SYSTEM | CHEM | 7/21/2008 |

| | | | |
|---|---|---|---|
| WTP45114 | HYPO RAW WATER FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45115 | HYPO BACK PULSE WATER FEED SYSTEM | CHEM | 7/21/2008 |
| WTP45116 | AMMONIA RAW FEED SYSTEM | CHEM | 7/21/2008 |
| WTP52001 | 3RD STAGE FLOCCULATOR  M-7003 | MIXER | 7/21/2008 |
| WTP52002 | 3RD STAGE FLOCCULATOR M-7023 | MIXER | 7/21/2008 |
| WTP52003 | 3RD STAGE FLOCCULATOR M-7043 | MIXER | 7/21/2008 |
| WTP52301 | 3RD STAGE FLASH MIXER M-7002 | MIXER | 7/21/2008 |
| WTP52302 | 3RD STAGE FLASH MIXER M-7022 | MIXER | 7/21/2008 |
| WTP52303 | 3RD STAGE FLASH MIXER M-7042 | MIXER | 7/21/2008 |
| WTP52801 | FILTRATE STATIC MIXER | MIXER | 7/21/2008 |
| WTP65501 | CENTRIFUGE | CNTIFUGE | 7/21/2008 |
| WTP65601 | CENTRATE PUMP P-7302 | PUMP | 1/14/2009 |
| WTP70201 | STRAINER 1 7611 | STRAINER | 7/21/2008 |
| WTP70202 | STRAINER 2 7621 | STRAINER | 7/21/2008 |
| WTP70203 | STRAINER 1 7611 - Motor | MOTOR | 6/24/2009 |
| WTP70204 | STRAINER 2 7621 - Motor | MOTOR | 6/24/2009 |
| WTP7021-BFV | SETTLER 7020 INLET VALVE FV-7021 | VALVE | 8/31/2010 |
| WTP70303 | STRAINER 3 7631 | STRAINER | 7/21/2008 |
| WTP70304 | STRAINER 3 7631 - Motor | MOTOR | 6/24/2009 |
| WTP70901 | OIL SEPARATOR | FACILITY | 7/21/2008 |
| WTP71001 | 1ST STAGE FEED CHANNEL | FACILITY | 7/21/2008 |
| WTP71002 | 1ST STAGE MEMBRANE BASIN TRAIN 1 | FACILITY | 7/21/2008 |
| WTP71003 | 1ST STAGE MEMBRANE BASIN TRAIN 2 | FACILITY | 7/21/2008 |
| WTP71004 | 1ST STAGE MEMBRANE BASIN TRAIN 3 | FACILITY | 7/21/2008 |
| WTP71005 | 1ST STAGE MEMBRANE BASIN TRAIN 4 | FACILITY | 7/21/2008 |
| WTP71006 | 1ST STAGE MEMBRANE BASIN TRAIN 5 | FACILITY | 7/21/2008 |
| WTP71007 | 1ST STAGE MEMBRANE BASIN TRAIN 6 | FACILITY | 7/21/2008 |
| WTP71008 | 1ST STAGE MEMBRANE BASIN TRAIN 7 | FACILITY | 7/21/2008 |
| WTP71009 | 1ST STAGE MEMBRANE BASIN TRAIN 8 | FACILITY | 7/21/2008 |
| WTP71010 | 1ST STAGE REJECT CHANNEL | FACILITY | 7/21/2008 |
| WTP71011 | 1ST STAGE MEMBRANE BASIN TRAIN 9 | FACILITY | 9/2/2009 |
| WTP71012 | 1ST STAGE MEMBRANE BASIN TRAIN 10 | FACILITY | 9/2/2009 |
| WTP71013 | 2ND STAGE MEMBRANE BASIN TRAIN 1 | FACILITY | 9/2/2009 |
| WTP71014 | 2ND STAGE MEMBRANE BASIN TRAIN 2 | FACILITY | 9/2/2009 |
| WTP71015 | 2ND STAGE MEMBRANE BASIN TRAIN 3 | FACILITY | 9/2/2009 |
| WTP71800 | 3RD STAGE COAGULANT STORAGE | TANK | 7/21/2008 |
| WTP71801 | BISULFITE DAY TANK | TANK | 7/21/2008 |
| WTP71802 | HYPO STORAGE TANK 1 | TANK | 7/21/2008 |
| WTP71803 | HYPO STORAGE TANK 2 | TANK | 7/21/2008 |
| WTP71804 | CAUSTIC TANK | TANK | 7/21/2008 |
| WTP71805 | CITRIC ACID TANK | TANK | 7/21/2008 |
| WTP71808 | BULK SALT STORAGE TANK | TANK | 7/21/2008 |
| WTP71809 | BRINE DAY TANK | TANK | 7/21/2008 |
| WTP71810 | HYPO DAY TANK FILTER WATER | TANK | 7/21/2008 |
| WTP71811 | CAUSTIC DAY TANK | TANK | 7/21/2008 |
| WTP71813 | HYPO DAY TANK REMOTE FEED | TANK | 7/21/2008 |
| WTP71814 | HYPO DAY TANK RAW WATER | TANK | 7/21/2008 |
| WTP71816-1 | SLUDGE TANK-1 | TANK | 8/23/2010 |
| WTP71816-1-FSL | SLUDGE TANK-1 Low-Flow Switch | ELEC | 8/23/2010 |
| WTP73001 | 3RD STAGE SETTLER SYSTEM #1 M-7000 | SETTLER | 7/1/2002 |
| WTP73002 | 3RD STAGE SETTLER SYSTEM #2 M-7020 | SETTLER | 7/1/2002 |
| WTP73003 | 3RD STAGE SETTLER SYSTEM #3 M-7040 | SETTLER | 1/2/2004 |
| WTP73101 | 3RD STAGE THICKENER RAKE M-7004 (#1) | THICKNER | 7/21/2008 |
| WTP73102 | 3RD STAGE THICKENER RAKE M-7024 (#2) | THICKNER | 7/1/2002 |
| WTP73103 | 3RD STAGE THICKENER RAKE M-7044 (#3) | THICKNER | 7/21/2008 |
| WTP73301 | 3RD STAGE SETTLING PLATES  7000 | SETTLER | 7/21/2008 |
| WTP73302 | 3RD STAGE SETTLING PLATES  7020 | SETTLER | 7/21/2008 |
| WTP73303 | 3RD STAGE SETTLING PLATES 7040 | SETTLER | 1/11/2010 |
| WTP77701 | WATER TREATMENT BUILDING | FACILITY | 7/21/2008 |

| | | | |
|---|---|---|---|
| WTP79101 | 2ND STAGE TRAIN 1 REJECT CONTROL VALVE | VALVE | 7/21/2008 |
| WTP79102 | 2ND STAGE TRAIN 2 REJECT CONTROL VALVE | VALVE | 7/21/2008 |
| WTP79201 | 2ND STAGE TRAIN 3 REJECT CONTROL VALVE | VALVE | 7/21/2008 |
| WTP79202 | 1ST STAGE TRAIN 1 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79203 | 1ST STAGE TRAIN 2 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79204 | 1ST STAGE TRAIN 3 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79205 | 1ST STAGE TRAIN 4 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79206 | 1ST STAGE TRAIN 5 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79207 | 1ST STAGE TRAIN 6 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79208 | 1ST STAGE TRAIN 7 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79209 | 1ST STAGE TRAIN 8 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79210 | 1ST STAGE TRAIN 1 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79211 | 1ST STAGE TRAIN 2 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79212 | 1ST STAGE TRAIN 3 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79213 | 1ST STAGE TRAIN 4 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79214 | 1ST STAGE TRAIN 5 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79215 | 1ST STAGE TRAIN 6 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79216 | 1ST STAGE TRAIN 7 MIT AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79217 | 1ST STAGE TRAIN 8 MITAIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79218 | 2ND STAGE TRAIN 1 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79219 | 2ND STAGE TRAIN 2 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79220 | 2ND STAGE TRAIN 3 AIR VALVE SYSTEM | VALVE | 7/21/2008 |
| WTP79221 | 1ST STAGE TRAIN 9 AIR VALVE SYSTEM | VALVE | 6/16/2009 |
| WTP79222 | 1ST STAGE TRAIN 10 AIR VALVE SYSTEM | VALVE | 6/16/2009 |
| WTP79301 | BACKPULSE TANK A INF ISOLATION VALVE | VALVE | 7/21/2008 |
| WTP79302 | BACKPULSE TANK B INF ISOLATION VALVE | VALVE | 7/21/2008 |
| WTP79303 | BACKPULSE TANK A EFF ISOLATION VALVE | VALVE | 7/21/2008 |
| WTP79303-1 | 1st Stage BackPulse BFV-8874 | VALVE | 9/16/2009 |
| WTP79304 | BACKPULSE TANK B EFF ISOLATION VALVE | VALVE | 7/21/2008 |
| WTP79304-1 | 2nd Stage BackPulse BFV-8974 | VALVE | 9/16/2009 |
| WTP79313 | TURBINE E CONTROL VALVE | VALVE | 1/15/2009 |
| WTP81001 | BACKPULSE TANK A | TANK | 7/21/2008 |
| WTP81002 | BACKPULSE TANK B | TANK | 7/21/2008 |
| WTP81003 | BACKPULSE TANK SYSTEM PIPING | PIPING | 9/30/2009 |
| WTP86201 | AIR SEPARATOR VESSEL | TANK | 7/21/2008 |
| WTP86202 | AIR VACUUM SEPARATOR | TANK | 7/21/2008 |
| WTP91101 | UNIT HEATER 1A | HVAC | 7/21/2008 |
| WTP91102 | UNIT HEATER 1B | HVAC | 7/21/2008 |
| WTP91103 | UNIT HEATER 1C | HVAC | 7/21/2008 |
| WTP91104 | UNIT HEATER 1D | HVAC | 7/21/2008 |
| WTP91301 | AIR HANDLING UNIT 1A | HVAC | 7/21/2008 |
| WTP91302 | AIR HANDLING UNIT 1B | HVAC | 7/21/2008 |
| WTP91303 | AIR HANDLING UNIT 2A | HVAC | 7/21/2008 |
| WTP91304 | AIR HANDLING UNIT 2B | HVAC | 7/21/2008 |
| WTP91305 | AIR FILTER UNIT A | HVAC | 7/21/2008 |
| WTP91307 | EXHAUST FAN 1B | HVAC | 7/21/2008 |
| WTP91312 | EXHAUST FAN EF-8B (FLOURIDE TANK AREA) | HVAC | 7/21/2008 |
| WTP91313 | EXHAUST FAN EF-7 (HYPO TANK AREA) | HVAC | 7/21/2008 |
| WTP91314 | EXHAUST FAN EF-8A (FLUORIDE PUMP ROOM) | HVAC | 7/21/2008 |
| WTP91315 | EXHAUST FAN EF-9 (ALUMINUM CHLOROHYDRATE TANK AREA)) | HVAC | 7/21/2008 |
| WTP91316 | POWERED EXHAUST AC 1 | HVAC | 7/21/2008 |
| WTP91317 | POWERED EXHAUST AC 2 | HVAC | 7/21/2008 |
| WTP91318 | POWERED EXHAUST HP 1 | HVAC | 7/21/2008 |
| WTP91319 | POWERED EXHAUST HP 2 | HVAC | 7/21/2008 |
| WTP91320 | POWERED EXHAUST HP 3 | HVAC | 7/21/2008 |
| WTP91321 | CL2 GEN VENTILATION | HVAC | 7/21/2008 |
| WTP91501 | AIR CONDITIONER 1 MCC Room adjust econmiser | HVAC | 7/21/2008 |
| WTP91502 | AIR CONDITIONER 2 | HVAC | 7/21/2008 |

| | | | |
|---|---|---|---|
| WTP91503 | AIR CONDITIONER 3 | HVAC | 7/21/2008 |
| WTP91601 | HEAT PUMP 1 | HVAC | 7/21/2008 |
| WTP91602 | HEAT PUMP 2 | HVAC | 7/21/2008 |
| WTP91603 | HEAT PUMP 3 | HVAC | 7/21/2008 |
| WTP95101 | FIRE EXSTINGUISHERS PLANT WIDE | SAFETY | 7/21/2008 |
| WTP95301 | EYE WASH SHOWER HYPO BULK STORAGE #5 | SAFETY | 7/21/2008 |
| WTP95302 | EYE WASH SHOWER CITRIC BULK STORAGE | SAFETY | 7/21/2008 |
| WTP95303 | EYE WASH SHOWER AMMONIA BULK STORAGE | SAFETY | 7/21/2008 |
| WTP95304 | EYE WASH SHOWER CHEM DELIVERY AREA | SAFETY | 7/21/2008 |
| WTP95305 | EYE WASH SHOWER SOUTH WALL TRAIN 1 | SAFETY | 7/21/2008 |
| WTP95306 | EYE WASH SHOWER SOUTH WALL TRAIN 6 | SAFETY | 7/21/2008 |
| WTP95307 | EYE WASH SHOWER SOUTH WALL TRAIN10 | SAFETY | 7/21/2008 |
| WTP95308 | EYE WASH SHOWER ERT ROOM | SAFETY | 7/21/2008 |
| WTP95309 | Eyewash Shower Ammonia Delivery Area | SAFETY | 12/3/2008 |
| WTP96002 | FINISH WATER PANEL PH METER | XDUCER | 7/21/2008 |
| WTP96003 | RAW WATER PANEL PH METER | XDUCER | 7/21/2008 |
| WTP96101 | ORP ANAYLZER CIP | XDUCER | 7/21/2008 |
| WTP96102 | 2100N lab turbidimeter | XDUCER | 7/21/2008 |
| WTP96301 | 1ST STAGE TRAIN 1 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96302 | 1ST STAGE TRAIN 2 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96303 | 1ST STAGE TRAIN 3 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96304 | 1ST STAGE TRAIN 4 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96305 | 1ST STAGE TRAIN 5 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96306 | 1ST STAGE TRAIN 6 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96307 | 1ST STAGE TRAIN 7 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96308 | 1ST STAGE TRAIN 8 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96309 | 2ND STAGE TRAIN 1 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96310 | 2ND STAGE TRAIN 2 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96311 | 2ND STAGE TRAIN 3 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96312 | FINISH WATER PANEL TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96313 | RAW WATER PANEL TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96314 | 1ST STAGE TRAIN 9 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96315 | 1ST STAGE TRAIN 10 TURBIDITY METER | XDUCER | 7/21/2008 |
| WTP96401 | 1ST STAGE TRAIN 1 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96402 | 1ST STAGE TRAIN 2 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96403 | 1ST STAGE TRAIN 3 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96404 | 1ST STAGE TRAIN 4 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96405 | 1ST STAGE TRAIN 5 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96406 | 1ST STAGE TRAIN 6 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96407 | 1ST STAGE TRAIN 7 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96408 | 1ST STAGE TRAIN 8 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96409 | 1ST STAGE TRAIN 9 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96410 | 1ST STAGE TRAIN 10 PARTICLE COUNTER | XDUCER | 7/21/2008 |
| WTP96501 | 1ST STAGE TRAIN 1 FLOW METER | XDUCER | 7/21/2008 |
| WTP96502 | 1ST STAGE TRAIN 2 FLOW METER | XDUCER | 7/21/2008 |
| WTP96503 | 1ST STAGE TRAIN 3 FLOW METER | XDUCER | 7/21/2008 |
| WTP96504 | 1ST STAGE TRAIN 4 FLOW METER | XDUCER | 7/21/2008 |
| WTP96505 | 1ST STAGE TRAIN 5 FLOW METER | XDUCER | 7/21/2008 |
| WTP96506 | 1ST STAGE TRAIN 6 FLOW METER | XDUCER | 7/21/2008 |
| WTP96507 | 1ST STAGE TRAIN 7 FLOW METER | XDUCER | 7/21/2008 |
| WTP96508 | 1ST STAGE TRAIN 8 FLOW METER | XDUCER | 7/21/2008 |
| WTP96509 | 2ND STAGE TRAIN 1 FLOW METER | XDUCER | 7/21/2008 |
| WTP96510 | 2ND STAGE TRAIN 2 FLOW METER | XDUCER | 7/21/2008 |
| WTP96511 | 2ND STAGE TRAIN 3 FLOW METER | XDUCER | 7/21/2008 |
| WTP96512 | FLOW METER INFLUENT | XDUCER | 7/21/2008 |
| WTP96513 | 1ST STAGE BACK PULSE FLOW METER | XDUCER | 7/21/2008 |
| WTP96514 | 2ND STAGE BACK PULSE FLOW METER | XDUCER | 7/21/2008 |
| WTP98001 | PLC 1 | OIT | 7/21/2008 |
| WTP98002 | OIT 2 | OIT | 7/21/2008 |

| | | | |
|---|---|---|---|
| WTP98003 | PLC 2 | OIT | 7/21/2008 |
| WTP98004 | PLC 3 | OIT | 7/21/2008 |
| WTP98005 | OIT 1 | OIT | 7/21/2008 |
| WTP98301 | Crispin Air relief Valve | VALVE | 7/21/2008 |
| WTP98302 | FV-9284 BRAY BFV priming vacuum isolation | VALVE | 7/21/2008 |
| WTP98303 | FV-9286 BRAY BFV feed siphon vacuum isolation | VALVE | 7/21/2008 |
| WTP98304 | MIT VALVE | VALVE | 7/21/2008 |
| WTP98305 | 1ST STAGE TRAIN 3 - MIT SOLENOID | SOLVALVE | 7/21/2008 |
| WTP98306 | ZW2 2 BLOWER VALVE | VALVE | 7/21/2008 |
| WTP98307 | BACKPULSE VALVE ZW2 2 | VALVE | 7/21/2008 |
| WTP98308-1 | SETTLER 7000 DUMP VALVE FV-7005 | VALVE | 1/11/2010 |
| WTP98312 | FV-9284 air sep vessel priming vacuum isolation valve | VALVE | 7/21/2008 |
| WTP98312B | FV-9286 air sep vessel feed siphon vacuum isolation valve | VALVE | 12/8/2011 |
| WTP98434 | NaOCl Storage Tank MOV FV-5464 | | 8/28/2009 |
| WTP98510 | ZW1_1 FV-3470-1 BFV | VALVE | 7/28/2009 |
| WTP98520 | ZW1_2 FV-3470-2 BFV | VALVE | 7/28/2009 |
| WTP98530 | ZW1_3 FV-3470-3 BFV | VALVE | 7/28/2009 |
| WTP98540 | ZW1_4 FV-3470-4 BFV | VALVE | 7/28/2009 |
| WTP98550 | ZW1_5 FV-3470-5 BFV | VALVE | 7/28/2009 |
| WTP98560 | ZW1_6 FV-3470-6 BFV | VALVE | 7/28/2009 |
| WTP98570 | ZW1_7 FV-3470-7 BFV | VALVE | 7/28/2009 |
| WTP98580 | ZW1_8 FV-3470-8 BFV | VALVE | 7/28/2009 |
| WTP98600 | ZW1_9 FV-3466-A-9 BFV | VALVE | 7/28/2009 |
| WTP98601 | ZW1_9 FV-3466-B-9 BFV | VALVE | 7/28/2009 |
| WTP98602 | ZW1_9 FV-3466-C-9 BFV | VALVE | 7/28/2009 |
| WTP98603 | ZW1_9 FV-3466-D-9 BFV | VALVE | 7/28/2009 |
| WTP98604 | ZW1_9 FV-3466-E-9 BFV | VALVE | 7/28/2009 |
| WTP98605 | ZW1_9 FV-3466-F-9 BFV | VALVE | 7/28/2009 |
| WTP98606 | ZW1_9 FV-3466-G-9 BFV | VALVE | 7/28/2009 |
| WTP98607 | ZW1_9 FV-3467-A-9 BFV | VALVE | 7/28/2009 |
| WTP98608 | ZW1_9 FV-3467-B-9 BFV | VALVE | 7/28/2009 |
| WTP98609 | ZW1_9 FV-3467-C-9 BFV | VALVE | 7/28/2009 |
| WTP98610 | ZW1_9 FV-3467-D-9 BFV | VALVE | 7/28/2009 |
| WTP98611 | ZW1_9 FV-3467-E-9 BFV | VALVE | 7/28/2009 |
| WTP98612 | ZW1_9 FV-3467-F-9 BFV | VALVE | 7/28/2009 |
| WTP98613 | ZW1_9 FV-3467-G-9 BFV | VALVE | 7/28/2009 |
| WTP98614 | ZW1_10 FV-3466-A-10 BFV | VALVE | 7/28/2009 |
| WTP98615 | ZW1_10 FV-3466-B-10 BFV | VALVE | 7/28/2009 |
| WTP98616 | ZW1_10 FV-3466-C-10 BFV | VALVE | 7/28/2009 |
| WTP98617 | ZW1_10 FV-3466-D-10 BFV | VALVE | 7/28/2009 |
| WTP98618 | ZW1_10 FV-3466-E-10 BFV | VALVE | 7/28/2009 |
| WTP98619 | ZW1_10 FV-3466-F-10 BFV | VALVE | 7/28/2009 |
| WTP98620 | ZW1_10 FV-3466-G-10 BFV | VALVE | 7/28/2009 |
| WTP98621 | ZW1_10 FV-3467-A-10 BFV | VALVE | 7/28/2009 |
| WTP98622 | ZW1_10 FV-3467-B-10 BFV | VALVE | 7/28/2009 |
| WTP98623 | ZW1_10 FV-3467-C-10 BFV | VALVE | 7/28/2009 |
| WTP98624 | ZW1_10 FV-3467-D-10 BFV | VALVE | 7/28/2009 |
| WTP98625 | ZW1_10 FV-3467-E-10 BFV | VALVE | 7/28/2009 |
| WTP98626 | ZW1_10 FV-3467-F-10 BFV | VALVE | 7/28/2009 |
| WTP98627 | ZW1_10 FV-3467-G-10 BFV | VALVE | 7/28/2009 |
| WTP98628 | ZW_1 FV-3475-10 | SOLVALVE | 7/14/2011 |
| WTP98630 | ZW2_1 FV-3670-1 BFV | VALVE | 7/28/2009 |
| WTP98631 | ZW2_2 FV-3670-2 BFV | VALVE | 7/28/2009 |
| WTP98632 | ZW2_3 FV-3670-3 BFV | VALVE | 7/28/2009 |
| WTP98640 | ZW2_1 FV-3760-1 BFV | VALVE | 9/10/2009 |
| WTP98641 | ZW2_2 FV-3760-2 BFV | VALVE | 9/10/2009 |
| WTP98642 | ZW2_3 FV-3760-3 BFV | VALVE | 9/10/2009 |

| | | | |
|---|---|---|---|
| WTP99301 | ROLL UP DOOR 1 | FACILITY | 7/21/2008 |
| WTP99302 | ROLL UP DOOR 2 | FACILITY | 7/21/2008 |
| WTP99303 | First Stage Train 1 Float Switches | DI | 4/19/2002 |
| WTP99304 | First Stage Train 2 Float Switches | DI | 4/19/2002 |
| WTP99305 | First Stage Train 3 Float Switches | DI | 4/19/2002 |
| WTP99306 | First Stage Train 4 Float Switches | DI | 4/19/2002 |
| WTP99307 | First Stage Train 5 Float Switches | DI | 4/19/2002 |
| WTP99308 | First Stage Train 6 Float Switches | DI | 4/19/2002 |
| WTP99309 | First Stage Train 7 Float Switches | DI | 4/19/2002 |
| WTP99310 | First Stage Train 8 Float Switches | DI | 4/19/2002 |
| WTP99311 | First Stage Train 9 Float Switches | DI | 4/19/2002 |
| WTP99312 | First Stage Train 10 Float Switches | DI | 4/19/2002 |
| WTP99313 | Second Stage Train 1 Float Switches | DI | 4/19/2002 |
| WTP99314 | Second Stage Train 2 Float Switches | DI | 4/19/2002 |
| WTP99315 | Second Stage Train 3 Float Switches | DI | 4/19/2002 |
| WTP99316 | VACUUM PUMP D MOTOR M-92-D | MOTOR | 12/5/2008 |
| WTP99317 | Centrate Tank Level Floats | DI | 1/12/2009 |
| WTPBUILDING/GROUNDS | WATER TREATMENT PLANT BUILDING/GROUNDS | | 12/5/2008 |
| WTPGATE1 | WTP Horse Wall Automated Gate | SECURITY | 8/5/2008 |
| WTPGREENGATE | WTP Green Gate PBX Communications Interface | SECURITY | 8/27/2020 |
| WTPHEATER-1 | WTP CIP HEATER A | ELEC | 10/1/2008 |
| WTPHEATER-2 | WTP CIP HEATER B | ELEC | 10/1/2008 |
| WTPHEATER-CONTROL | WTP CIP HEATER CONTROL PANEL | CONTROL | 10/1/2008 |
| WTPHEATER-SYSTEM | WTP CIP HEATER SYSTEM | ELEC | 10/1/2008 |
| WTPLAN126 | WTP 126 SWITCH | NETWORK | 8/2/2008 |
| WTPNET26 | WTP 26 SWITCH | NETWORK | 8/2/2008 |
| WTPROUTER | WTP ROUTER | NETWORK | 12/12/2011 |
| WTPTELEMROUTER | WTP Cisco ASA5515 ROUTER | NETWORK | 12/20/2017 |
| WTPTELESWITCH | WTP Cisco 3650 Layer 3 switch | NETWORK | 2/14/2019 |
| WTPVIDEO | WTP Conference RM Video System | INFOTECH | 4/17/2014 |
| WTPWASTEHOLDINGPIT | WTP WASTE HOLDING PIT | WETWELL | 6/3/2002 |

**Exhibit B**

Hazen and Sawyer
11260 El Camino Real, Suite 102
San Diego, CA 92130
858.764.5520

# David C. McCollom Water Treatment Plant Capacity Reliability Study

Final Report – Revision 1
January 24, 2018

Hazen

## Table of Contents


Table of Contents ..... i

Executive Summary ..... 1

1. Recovery of Strainers Backwash Water ..... 10

1.1 Background ..... 10

1.2 Proposed Improvements ..... 11

1.3 Solids Removal ..... 12

1.4 Strainer Backwash Recovery Equalization ..... 15

1.5 Proposed Location ..... 16

1.6 Electrical Considerations ..... 16

1.7 Impacts to the Existing Backwash Waste Storage Tank and Existing Stage 2 Ultrafiltration ..... 17

1.8 Existing Backwash Waste Equalization Tank ..... 18

1.9 Estimation of Probable Cost ..... 20

2. Stage 2 UF Membranes Expansion ..... 21

2.1 Proposed Expansion ..... 21

2.2 Impacts to Existing Piping and other Stages ..... 28

2.3 Blowers ..... 29

2.4 Traveling Bridge Crane ..... 30

2.5 Electrical Improvements ..... 30

2.6 Maintenance of Plant Operations ..... 31

2.7 Recommendations ..... 31

2.8 Estimation of Probable Cost ..... 32

3. DAF Addition to Stage 3 ..... 33

3.1 Background ..... 33

3.2 Stage 2 Reject Solids Characterization ..... 34

3.3 Strainer Backwash Solids Projection ..... 35

3.4 Proposed DAF System ..... 37

3.5 Summary of Major Equipment ..... 38

3.6 Coagulant Feed System and Storage ..... 40

3.7 DAF Solids (Float) Management ..... 40

3.8 Accommodations for Water Treatment Residuals System Expansion ..... 41

3.9 Electrical and Instrumentation requirements ..... 41

3.10 Hydraulic Requirements ........ 41
3.11 Operational Considerations ........ 41
3.12 Recommendations ........ 42
3.13 Estimation of Probable Cost ........ 43
4. Stage 4 Centrifuge Addition ........ 45
4.1 Background ........ 45
4.2 Water Quality Characteristics and Solids Generation Estimates ........ 46
4.3 Existing Water Treatment Residuals System ........ 48
4.4 Accommodations for Water Treatment Residuals System Expansion ........ 49
4.5 Proposed Conceptual Water Treatment Residuals System Improvements ........ 50
4.6 Electrical Considerations ........ 52
4.7 Operational Considerations ........ 52
4.8 Recommendations ........ 53
4.9 Estimation of Probable Cost ........ 54
Table 4-5 – Estimation of Probable Cost for Centrifuge Addition ........ 54
5. Potential Alternatives for DBPs Reduction ........ 55
5.1 Background ........ 55
5.2 Water Quality and Disinfection Byproduct Characteristics ........ 56
5.3 Existing Disinfection Practices at the WTP ........ 66
5.4 Options for DBP Reduction ........ 66
5.5 Screening-Level Evaluation ........ 70
5.6 Potential Alternatives for DCMWTP ........ 74
5.7 Recommendations ........ 80
Appendix A – Vendor Submittals ........ 82

Hazen

## List of Tables

Table ES - 1. Solids Removal Equipment Ranking........ 2
Table ES - 2. Summary of Proposed Modifications to Stage 2 ........ 3
Table ES - 3. Summary of the Proposed DAF System to Stage 3 ........ 5
Table ES - 4. Summary of Proposed Modifications to Stage 4 ........ 6
Table ES - 5. Prioritized Alternatives for DBPs Reduction........ 7
Table ES - 6. Summary of the Estimated Costs for Each Proposed Improvements........ 8
Table ES - 7. Project Prioritization for Different Phases of Improvements........ 9

Table 1-1. Design Conditions – Normal Mode ........ 12
Table 1-2. Design Conditions – Impaired Mode ........ 13
Table 1-3. Solids Removal Equipment Summary ........ 14
Table 1-4. Solids Removal Equipment Ranking ........ 15
Table 1-5. Strainer Backwash Recovery System Equipment Summary*........ 15
Table 1-6. Stage 1 Ultrafiltration Operating Parameters........ 17
Table 1-7. Stage 2 Ultrafiltration System Operating Parameters........ 18
Table 1-8. Scenario 1: Normal Strainer BW Mode, Three Stage 2 UF Trains, Plate Settlers. 19
Table 1-9. Scenario 2: Normal Strainer BW Mode, Three Stage 2 UF Trains, Plate Settlers & DAF ........ 19
Table 1-10. Scenario 3, Impaired Strainer BW Mode, Three Stage 2 UF Trains, Plate Settlers & DAF ........ 19
Table 1-11. Scenario 4, Impaired Strainer BW Mode, Four Stage 2 UF Trains, Plate Settlers & DAF ........ 19
Table 1-12. Estimate of Probable Cost for Strainers Backwash Water Recovery........ 20
Table 2-1. Summary of Design and Operating Parameters for Stage 2 UF System ........ 21
Table 2-2. Zenon UF Scope of Supply ........ 22
Table 2-3. Stage 2 Header Conditions with Three Trains Operating........ 29
Table 2-4. Stage 2 Header Conditions with Four Trains Operating ........ 29
Table 2-5. Velocity in Upsized Feed and Permeate Headers........ 29
Table 2-6. Stage Scour Air System Operating Summary ........ 30
Table 2-7. Summary of Proposed Modifications........ 31
Table 2-8. Estimation of Probable Cost for UF Train Addition........ 32
Table 3-1. Design Conditions – DAF System........ 38
Table 3-2. Major Mechanical Equipment........ 38
Table 3-3 – Summary of Proposed Modifications ........ 42
Table 3-4 Estimation of Probable Cost for DAF Addition........ 43
Table 4-1. Estimated raw water solids generation, MWD Lake Skinner (CDM, 20102). ........ 46
Table 4-2. Centrifuge influent estimates for the DCMWTP from a "Solid-Liquid Mass Balance" model (CDM, 2010) ........ 48
Table 4-3. Simple comparison of single to dual centrifuge operation at the DCMWTP assuming 73.5 hours equipment operation time required per week. ........ 52

Table 4-4 – Summary of Proposed Modifications ... 53
Table 4-5 – Estimation of Probable Cost for Centrifuge Addition ... 54
Table 5-1. DBP Reduction Alternatives ... 67
Table 5-2. Options for DBP Reduction at the DCMWTP ... 68
Table 5-3. Criterion Weighting ... 71
Table 5-4. Screening Level Decision Matrix ... 72
Table 5-5. Decision Matrix Results ... 74
Table 5-6. Level Two Evaluation of Potential Options ... 75
Table 5-7. Prioritized Alternatives ... 80

## List of Figures

Figure ES - 1. Strainer Backwash Recovery System Schematic ... 2

Figure 1-1. Bollfilter type 6.18/500 DN 500 Automatic Backwash Strainer ... 10
Figure 1-2. Strainer Backwash Recovery System Schematic ... 12
Figure 1-3. Hydro International, Grit King ... 13
Figure 1-4. Smith-Loveless, PISTA V10 ... 14
Figure 1-5. Ovivo, Jeta ... 14
Figure 1-6. Proposed Strainer Backwash Recovery System Location ... 16
Figure 2-1. Existing Stage 2 Trains, Upper Plan View ... 24
Figure 2-2. Existing Stage 2 Trains, Upper Plan View ... 25
Figure 2-3. Proposed Stage 2 Expansion (Fourth Train), Lower Plan View ... 26
Figure 2-4. Proposed Stage 2 Expansion (Fourth Train), Upper Plan View ... 27
Figure 2-5. Proposed Stage 2 Expansion (Fourth Train), Section View ... 28
Figure 2-6. Traveling Bridge Crane ... 30
Figure 3-1. Turbidity Data from Stage 2 Reject ... 35
Figure 3-2. Stage 3 Process Flow Diagram with Proposed Modifications ... 37
Figure 3-3. Component layout of proposed DAF System ... 39
Figure 3-4 – Proposed Strainer Backwash Recovery System Location ... 43
Figure 4-1. Process Flow Diagram with proposed modifications ... 46
Figure 4-2. Layout of the new centrifuge and centrifuge feed pump ... 50
Figure 4-3. Existing and new centrifuge feed pumps ... 51
Figure 4-4. Picture and general dimensions for Alfa Laval ALDEC 45 ... 51
Figure 5-1. TOC Concentrations in Raw and Finished Water at the DCMWTP ... 59
Figure 5-2. TTHM Concentrations at Sampling Sites in the Distribution System ... 60
Figure 5-3. TTHM LRAA Trends in the Distribution System ... 61
Figure 5-4. TTHM OEL Trends in the Distribution System ... 62
Figure 5-5. HAA5 Concentrations at Sampling Sites in the Distribution System ... 63
Figure 5-6. TOC vs. TTHM Concentrations in Finished Water ... 64
Figure 5-7. Lack of Simple Correlation between FW TOC and FW TTHM ... 65
Figure 5-8. Option for GAC Siting ... 77
Figure 5-9. Alternative for GAC Siting ... 78
Figure 5-10. Option for UV Siting ... 79

## Executive Summary

The David C. McCollom Water Treatment Plant (DCMWTP), owned and operated by the Olivenhain Municipal Water District (OMWD), is a 34 MGD ultrafiltration membrane treatment plant utilizing surface water from either the Colorado River or the State Water Project via the Metropolitan Water District of Southern California (MWD) and the San Diego County Water Authority (SDCWA). Hazen and Sawyer (Hazen) is assisting OMWD with the evaluation of potential improvements to various processes at the DCMWTP as part of a Capacity Reliability Study. A series of Technical Memoranda (TM) were prepared as part of this study, and each TM addressed a different process improvement being considered as part of this study. Sections 2 through 5 of this report correspond to TM 1 through 5, respectively. The processes evaluated included:

- Recovery of the Backwash Waste Water from the Strainers (TM 1)
- Addition of One UF Membrane Treatment Train to Stage 2 (TM 2)
- Addition of a Dissolved Air Flotation (DAF) System to Stage 3 (TM 3)
- Addition of a Centrifuge to Stage 4 (TM 4)
- Evaluation of Disinfection Alternatives and DBPs Control (TM 5)

**Strainers Backwash Waste Water Recovery**

The investigation of the proposed strainer backwash recovery (SBWR) system led to evaluation of two modes of operation: normal mode and impaired mode. The normal mode of operation would be carried out for approximately ten (10) months of the year, when the raw water quality is relativity good and the strainers backwash according to the scheduled timer. When the raw water quality is diminished, the elevated suspended solids concentration and presence of filamentous algae will cause the SBWR system to operate in impaired mode. The impaired raw water will require a greater degree of solids and algae removal.

The SBWR system will include solids removal, flow equalization, and a pump station to send the flow either to the existing BWWEQ tank (normal mode) or to the new DAF (impaired mode). This is shown in the schematic presented in **Figure ES - 1**. This system can be further optimized in the preliminary design to potentially eliminate the need for the transfer pumps from the Recovery EQ tank to the BWWEQ and the DAF system in Stage 3.

Three types of equipment that remove solids were investigated and ranked (**Table ES - 1**) based on cost, power consumption, and footprint. The systems from Hydro International and from Smith &Loveless Inc. were ranked similarly. However, for conservative reasons, Smith & Loveless was considered in the cost estimate for this study (the higher cost of the two).

The solids removal equipment is proposed to be located in the same building with the new DAF system for Stage 3, which is west of the existing Stage 3 building. Alternatively, the system can be placed outside under a canopy. The cost estimate considered the solids removal system in a building.

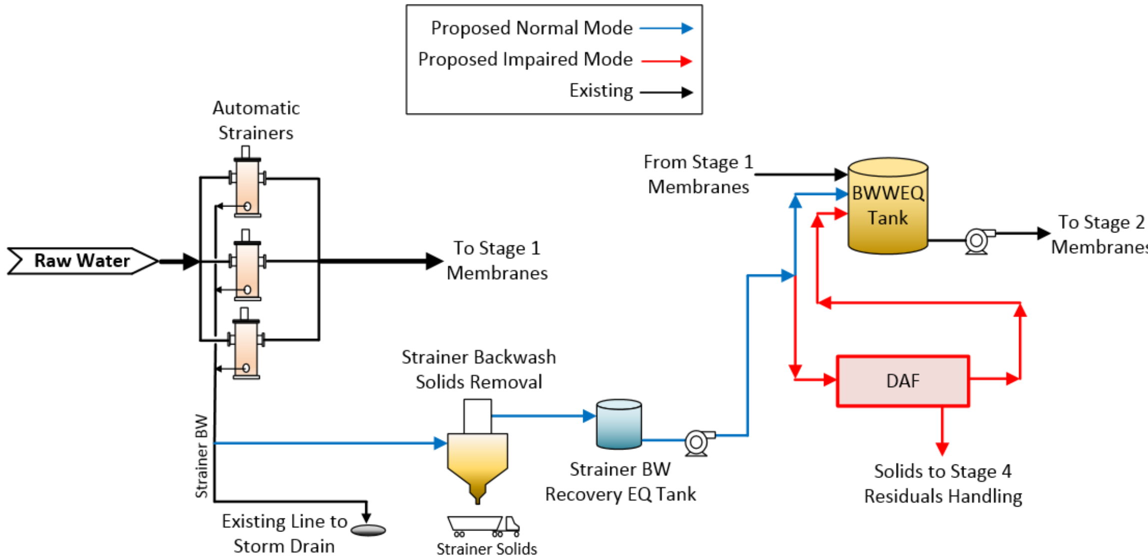



**Figure ES - 1. Strainer Backwash Recovery System Schematic**

**Table ES - 1. Solids Removal Equipment Ranking**

| Manufacturer | Model | Cost | Power Consumption | Footprint | Overall Rank |
|---|---|---|---|---|---|
| Hydro International | Grit King | 3 | 3 | 3 | 9 |
| Smith & Loveless Inc. | PISTA V10 | 2 | 2 | 3 | 7 |
| Ovivo | Jeta | 1 | 1 | 1 | 3 |

The recovered water will impact other stages of the treatment, including Stages 2 and 3. Stage 2 feeds from the existing backwash waste EQ tank (BWWEQ), which has sufficient buffer capacity to hold the strainers backwash water in the normal operating mode. When the strainers would operate in impaired mode, which generates significantly more waste water volume, the BWWEQ tank will likely overflow. The overflow condition can be addressed by operating with all four UF trains in Stage 2, or by increasing the current capacity of Stage 2 from 850 gpm/train to 1,000 gpm/train (design capacity). Another option for preventing BWWEQ tank overflow is sending some of the strainers backwash waste water to the storm drain.

**UF Train Addition to Stage 2**

The DCMWTP utilizes two separate UF systems referred to as Stage 1and Stage 2. The Stage 1 UF system is the primary water treatment for the plant. Stage 2 treats Stage 1 reject as well as supernatant from Stage 3 plate settlers that recover backwash from Stage 2. With the current configuration, the Stage 2 UF system is a choke point in the overall plant production. Stage 2 is comprised of three UF trains. When one train is taken offline for cleaning or service, the overall plant capacity is reduced by approximately 33%. This study evaluated the feasibility of expanding the Stage 2 UF system by 33% with the addition of one more train.

The proposed location for the new UF train is directly adjacent to the existing train, where the CIP pumps are currently located, at the western end of the membrane trains. The addition of a new train next to train 13 will require relocation of the CIP pumps, CIP piping, chemical feed piping, and the elevated walkway. The compressed air equipment, currently located in the area north of the Stage 2 membrane trains, would require relocation outside the membrane building (north side). The CIP pumps would be relocated to the area previously occupied by the compressed air system.

The addition of the forth train will require saw-cutting, demolition, forming a new foundation, doweling into the existing floor slab, and providing watertight joints all around. Based on review of the record drawings and photos of the interior of the water treatment building, it appears feasible to add a new fourth basin of similar dimensions adjacent to the existing Stage 2 basins without compromising the building foundation or outer metal building structure.

The elevated walkway that currently surrounds train 13 will need to be reconfigured. If the existing walkway structure is reused, the spacing between the support columns and the basin wall will likely encroach on much of the available space that traverses between the north and south roll-up doors. If a new walkway is installed, it can be designed such that the support columns and the stairs are positioned to maximize the clearance to move equipment through this area. The cost estimate presented in this document considers that a new walkway would be required.

The chemical feed lines that are routed from the chemical rooms along the south wall and underneath the elevated walkway will need to be moved underneath the relocated elevated walkway, similar to the existing chemical piping arrangement. Final location of the stairs will be determined during preliminary design. **Table ES - 2** summarizes the proposed modifications.

**Table ES - 2. Summary of Proposed Modifications to Stage 2**

| Item | Comment |
|---|---|
| Add Concrete Basin | Will require significant modifications to the existing plant infrastructure, including concrete work inside the membrane building. |
| Add Membrane System | Will require SCADA integration, additional piping, valves, and associated hardware. |
| Modify and Relocate the Walkway | Will encroach into the remaining space between Stage 2 and the west masonry wall. |
| CIP System Relocation | Potential challenges locating the pumps and associated piping in the area north of the Stage 2 membranes. |
| Air System Relocation | Relocate the existing equipment outside to the north side of the membrane treatment building, or to another location to be more optimal. |
| CIP Drain | Relocate the drain north of Stage 2, closer to the relocated CIP pumps. |
| Electrical and I/O Upgrades | Upgrade the feeder circuit and the upstream breaker for MCC-2. Evaluate Panel CC-3 for capacity to handle additional I/O. |
| Relocated Elevated Walkway | Reuse the existing structure or redesign with new material. |

**Dissolved Air Flotation (DAF) Addition to Stage 3**

The plant currently utilizes three (3) lamella plate settlers for solids removal and thickening of water treatment residuals. During peak flows, all three lamella plate settlers are required to operate in duty mode to meet the treatment capacity, with no redundancy. Additionally, the DCMWTP must reduce treatment capacity by 33% when any one settler unit is taken down for maintenance. A DAF system is proposed to provide enhanced capacity and redundancy for the existing plate settlers. The DAF system is proposed to also treat strainer backwash water during periods when raw water quality diminishes due to the presence of filamentous algae.

Based on the 600 gpm (0.86 mgd) flowrate of strainer backwash water to the DAF system, it is anticipated that a packaged DAF system would be a more cost-effective option than a component engineered system. A packaged DAF system would also allow for a faster design and construction schedule compared to a traditional DAF design for this size.

The strainer backwash water solids characteristics are not known at this time; it is recommended that bench-scale and/or pilot testing be performed to determine the required dose for treating strainer backwash water. The anticipated coagulant to be used for the DAF system would be Nalco 4954, which was tested during DAF pilot testing and is currently utilized for the Stage 3 plate settlers. For a dedicated coagulant system, a bulk storage tank, day tank, transfer pumps, and metering pumps would be provided. For preliminary sizing purposes, it was assumed that the DAF coagulant dose would be similar to the doses tested during pilot testing (60 mg/L). At this dose, a 3,000-gal bulk storage tank would be provided for 30 days of storage.

The possibility of pumping the DAF float directly to the exiting sludge tanks should be explored in the preliminary design phase, after an analysis of the characterization of suspended solid in the strainer backwash water and hydraulic analysis have been completed. For the purposes of this preliminary sizing, it was assumed that the float will be collected in a holding tank, and two solids transfer pumps (one duty, one standby) will convey solids to the Stage 4 solids holding tanks, prior to being dewatered using the centrifuge(s). For preliminary sizing purposes, it was assumed that the solids content would be similar to Stage 2 reject (76 NTU avg.) and the DAF coagulant dose would be similar to the doses tested during pilot testing (60 mg/L). Based on these assumptions, a floated solids holding tank was sized to be 10,000 gal to provide between 1-2 days of storage.

It may be possible for the DAF clarified water to flow by gravity to the BWWEQ tank; however, this must be confirmed during preliminary design. For the purposes of this planning level study, it is conservatively assumed that the DAF clarifiers water will require pumping. A hydraulic analysis is recommended during preliminary design to adequately size these pumps. For preliminary sizing purposes, it is assumed that two (1 duty, 1 standby) 600 gpm pumps will be provided; however, a larger number of smaller pumps may be preferable for operational flexibility.

The DAF system is proposed to be located west of the residuals treatment building. The new building will be sized to also allow placement of the grit removal from the strainer backwash water. For preliminary sizing purposes, it is assumed that a 155 ft x 55 ft building will be provided for the DAF system and SBWR system.

**Table ES - 3. Summary of the Proposed DAF System to Stage 3**

| Item | Comment |
|---|---|
| New DAF Building | Building to include new DAF system and the grit removal for the strainer backwash recovery system. |
| Packaged DAF System (600 gpm) | New DAF system to be provided with recycle pumps, air compressors, saturators, etc. Ladders, stairs and platforms not included in DAF package and provided separately. |
| Floated Solids Holding Tank and Pumps | Tank sizes to be confirmed during preliminary design based on verified solids loading. Pumps to be sized appropriately to pump back to existing solids holding tanks. |
| Clarified Water pumps | Pumps to be sized based on system hydraulic analysis to pump to the backwash water equalization tank. |
| Coagulant System | Tank and pump sizes to be confirmed during preliminary design based on verified coagulant doses. |
| Piping | Modifications to allow Stage 2 reject and/or centrate to be directed to the DAF system. New piping to allow recovered strainer backwash water to be directed to the DAF system. |
| Electrical | The DAF system can be supplied from MCC-5. The existing circuits, main circuit breaker, and upstream breaker supplying MCC-5 would have to be upgraded to 600A to support the new load. |

**Centrifuge Addition to Stage 4**

The reject from Stage 2 is currently treated by the three Stage 3 lamella plate settlers, which serve as thickeners upstream of the Stage 4 dewatering centrifuge. While the existing centrifuge can adequately handle the range of water treatment residuals historically generated at the DCMWTP, a second unit is proposed to enhance reliability and redundancy of Stage 4.

The existing centrifuge (Centrifuge 1) was upgraded by the manufacturer in 2010. While the model of Centrifuge 1 (Aldec 406) is no longer manufactured, Alfa Laval currently manufactures a version (Aldec 45) with many of the same features and would provide the same capacity as the existing unit. The variable frequency drives that were provided in the 2010 upgrade are no longer available from Alfa Laval, but similar drives can be used that essentially provide the same or greater functionality. The controls systems for the new centrifuge can be integrated into the existing control panel.

The new centrifuge is proposed to be located in the area on the elevated platform as planned in the LT2 Improvements project. The new Centrifuge Feed Pump 3 and Centrifuge Feed Line 2 are recommended to match the existing assets. A new electrical circuit breaker and variable frequency drive will be necessary for the proposed new progressive cavity pump. The proposed pump has an updated design which allows for fully servicing the pump in-place. The proposed piping configuration will allow any of the three pumps to convey flow to either centrifuge if only one centrifuge is in operation. This configuration will also allow flow to be conveyed to both centrifuges simultaneously with Centrifuge Feed Pump 2 serving as a swing spare.

It may also be necessary to install a dedicated polymer feed pump for Centrifuge 2. While polymer could be fed to Centrifuge 2 through the same system that feeds Centrifuge 1, a second pump would provide redundancy, simplify the operation of the centrifuge polymer feed system, and would allow simultaneous operation of both centrifuges. Adding a second polymer feed pump and new lines is recommended.

Depending on the operation, the DAF unit considered to be added to Stage 3 could be expected to routinely produce a higher concentration of solids in the thickened sludge when compared to the lamella plate settlers. However, since the thickened sludge from both types of thickening processes will be collected and stored in the thickened sludge storage tanks, the thickened sludge will be blended and equalized, and a relatively uniform stream can be expected to be conveyed to the centrifuges. In discussing the potential for variability in thickened sludge characteristics, Alfa Laval indicated little concern for the operation of the centrifuges, except a potential reduction in hydraulic capacity due to a slight reduction in the efficiency of the centrifuge due to the thicker solids concentration.

An additional improvement to be considered is related to the capture of the strainer backwash waste stream. One component of the solids in this stream is likely grit, including Asiatic clam shells. This material can be expected to have a detrimental impact on the lifetime of certain wear items in the centrifuges. The service or replacement of some of these wear items can be significant as it involves servicing the centrifuge at the manufacturer's facilities. Alfa Laval indicated that it is possible to provide a tungsten-carbide material upgrade for the feed zone of the centrifuge that would mitigate some of the wear caused by abrasive solids. However, it is recommended to capture the abrasive solids ahead of the treatment system to avoid introduction to the centrifuges.

**Table ES - 4. Summary of Proposed Modifications to Stage 4**

| Item | Comment |
|---|---|
| Centrifuge 2 | Proposed model will operate similarly to the existing centrifuge, and can be fully integrated with the existing control system. |
| Centrifuge Feed Pump 3 | Addition of the third centrifuge feed pump, with associated mechanical and piping improvements, will accommodate simultaneous operation of both centrifuges with redundancy. |
| Dewatering Polymer Feed Pump 2 | The second polymer feed pump, feed line and associated mechanical improvements will be dedicated to Centrifuge 2. |

**Evaluation of Disinfection Alternatives and DBPs control**

The water quality of the two water sources (Colorado River and State Water Project) feeding DCMWTP can differ considerably. The State Water Project (SWP) water typically contains more DBPs precursors relative to the Colorado River water (CRW). As such, when MWD increases the ratio of SWP water in the blend, OMWD experiences higher formation of DBPs at the treatment plant and in the distribution system. OMWD has little control over the blend ratios and must be prepared to treat a source water with higher percentages of SWP water while maintaining plant capacity and regulatory compliance.

Utilizing a stepwise process, a total of 24 alternatives for DBPs reduction were screened. The top alternatives were prioritized based on a cost-benefit analysis in terms of expected DBP reduction and estimated capital costs. The recommended alternatives and are presented in **Table ES - 5**.

**Table ES - 5. Prioritized Alternatives for DBPs Reduction**

| Alternative | Overall Expected Impact on DBP Reduction | Taste &Odor Reduction | Planning-level Capital Cost Estimates |
|---|---|---|---|
| Install UV Disinfection for Giardia Credit | High | No | $2M-$3M |
| Install UV Disinfection for Giardia and Virus Credit | High | No | $5M-$7M (est.) |
| Install GAC Contactors | High | Yes | $13M-$15M |
| Install GAC Contactors and Pre-Ozone | High | Yes | $22M-$25M (est.) |
| Add Aeration/Mixing to One or More Storage Reservoirs in Distribution System | Medium | No | $400k-$700k per Reservoir (Assume 7 Reservoirs, or Approx. $5M) |
| Add/change Pre-oxidant to Ozone or Chlorine Dioxide | Low | Yes | $8M-10M |

Most of these DBP reduction processes require some form of bench or pilot scale testing to confirm expected reduction in the DBP formation potential and the capital and operating costs. GAC should be piloted to determine overall effectiveness, which can be measured by break-through curves generated for TOC and pre-formed DBPs. The breakthrough curves help establish design conditions (e.g., required empty bed contact time) and operating costs (i.e., GAC replacement frequency). Pilot testing can also evaluate different types of carbon to identify the most cost-effective option. The cost of piloting is a function of the number of carbons tested and the length of the tests. Previous pilots tests have been completed in the $50,000 - $100,000 range per season of testing. The blend of source water would need to be determined.

Ozone as a pre-oxidant to GAC can also be tested as part of the pilot experiments. Ozone fed water prior to GAC frequently changes the process into a biologically-active carbon (BAC). As this testing involves the development of a biomass within the column, it often requires a longer trial period, which will increase the piloting costs. Ozone alone (i.e., without GAC) can be evaluated on the bench-scale with jar testing. The costs are a function of the ozone doses and source water quality changes to be tested. Often these jar tests can be performed in as little time as one week and cost approximately $20k-$40k per season.

Aeration effectiveness on TTHM stripping can be modeled and/or tested. The vendors have desktop models that are used to predict TTHM removal. UV systems do not typically need piloting if designed for disinfection only. However, UV transmittance (UVT) measurements will be needed to establish design and operating doses. In addition, water quality characteristics need to be examined to determine the potential for fouling of the quartz sleeves. Fouling potential can be experimentally tested if water quality review identifies potentially problematic characteristics.

There are several general good practices that OMWD should continue that help with DBP reduction. With the free chlorine CT currently being achieved in the finished water piping, the downstream injection of ammonia should be evaluated for mixing and its effectiveness in maintaining a 5:1 chlorine to ammonia ratio. In addition, hydraulic modeling of the distribution system should be conducted and/or the SCADA-data reviewed to determine optimum operations to minimize water age in the system.

In summary, it is recommended that OMWD:

1. Begin collecting UV transmittance data (at 254 nm) of the source water, post Stage 1, and finished water. The data should be collected at various times for a period of at least six months.
2. Plan and budget for a UV disinfection basis of design report.
3. Plan and budget for pilot testing of GAC with or without ozone.
4. Collect data specific to each of the storage reservoirs within the distribution system and submit to aeration/mixer vendors to better refine costs and performance of TTHM reduction systems.

**Estimate of Probable Cost**

**Table ES - 6** presents a summary of the engineer's estimate of the probable construction costs for each proposed implementation. With the exception of the DBPs alternative, the costs represent the total cost of the project, including engineering, contractor overhead and profit, contingency etc. Details of each assumptions are presented in the individual sections of this report. It should be noted that the contingency assumed is dependent on project definition at this level of the study. For example, a 25% contingency was assumed for the strainers backwash water recovery and DAF addition, whereas a 20% contingency was assumed for the UF train addition to Stage 2 and the centrifuge addition to Stage 4.

The cost estimate presented for the DBP's alternatives does not represent the total cost of the project. It reflects the range of costs for the installed equipment for an array of six options, and should be used for ranking the alternatives, as presented in Section 5.

**Table ES - 6. Summary of the Estimated Costs for Each Proposed Improvements**

| Stage Number | Description | Estimated Cost |
|---|---|---|
| - | Strainers Backwash Waste Recovery | $1,370,000 |
| 2 | UF Train Addition | $4,403,000 |
| 3 | DAF Addition | $5,005,000 |
| 4 | Centrifuge Addition | $844,000 |
| - | DBPs Alternatives | $2,000,000-$25,000,000[1)] |

[1)] This represents an estimation of the installed equipment and shall be used only for alternatives ranking. It does not reflect the overall cost of implementing DBPs treatment.

**Recommendations for Project Phasing**

OMWD may decide not to install all the proposed improvements at once, but rather phase the improvements over a number of years. A summary of the recommended priorities for the improvements is presented in **Table ES-7** and discussed below.

- The recovery of the backwash water from the strainers would result in more water processed by the UF trains in Stage 2. This can lead to occasional overflow of the BWWEQ tank. The overflow can be prevented by either operating the existing UF closer to the design flow (1,000 gpm permeate) or directing some of the backwash waste water to the storm drain, per current operation. There are some concerns with the filamentous algae resulting in the BWWEQ tanks and from there, into the Stage 2 UF membrane feed water, which will be detrimental to the membrane operation. The proposed DAF system in Stage 3 will remove most of the floating solids from the strainers BWW water. The removed solids from the DAF system will require processing by the centrifuge, and as such, it is recommended that this phase is implemented after the DAF is added to Stage 3 and a second centrifuge is added to Stage 4.

- The addition of a fourth train to Stage 2 is an important element of the reliability improvements, as the plant production capacity is reduced by 33% when one train is in CIP or down for maintenance. This phase should be prioritized and implemented early.
- The DAF system will provide redundancy to Stage 3. Similar to Stage 2, Stage 3 capacity is reduced by 33% when one of the plate settlers is down for maintenance. The addition of the DAF system is recommended to follow the addition of the fourth UF train to Stage 2.
- The centrifuge in Stage 4 has no redundancy. The addition of the second centrifuge will provide 100% redundancy and will allow for both the DAF system and plate settlers to operate at the same time. Based on the criticality of this stage, this phase of the project is recommended to be implemented after or simultaneous to the DAF addition.
- DBPs treatment should be considered high priority. The variability in the source water quality poses a risk to exceed the DBPs MCL. The capability to reduce or to prevent formation of the DBPs at the treatment plant or in the distribution system will result in flexibility in operation while maintaining the plant capacity and meeting all drinking water quality standards.

**Table ES - 7. Project Prioritization for Different Phases of Improvements**

| Proposed Improvement Phase | Recommended Priority | Recommended Order of Implementation |
|---|---|---|
| Strainers BWW Recovery | Low | 5 |
| UF 4th train to Stage 2 | High | 2 |
| DAF System to Stage 3 | Average | 3 |
| Centrifuge to Stage 4 | Average | 4 |
| DBPs Reduction/Treatment | High | 1 |

# 1. Recovery of Strainers Backwash Water

## 1.1 Background

The David C. McCollum Water Treatment Plant (DCMWTP) is a direct filtration facility that utilizes three 500-micron Bollfilter Type 6.18/500 DN 24" automatic backwashing strainers (**Figure 1-1)** to pretreat the flow into the facility and reduce the solids loading onto the Stage 1 membranes. A blend of Colorado River Water (CRW) and State Project Water (SPW) enters the DCMWTP via the San Diego County Water Authority (SDCWA) pipeline. Under normal operating conditions, each strainer backwashes primarily on a timer set point (every 3 hours, but can vary based on operator input) and secondarily on a differential pressure (4 psi). Regardless of the trigger, the strainers backwash sequentially, with only one strainer backwashing at a time. The backwash duration is 1 to 2 minutes per strainer, at an average flow rate of 600 gpm. This results in approximately 14,400 to 28,800 gallons per day (5 to 10 million gallons per year) of backwash water that is currently directed to the storm drain.

Historically, during April and July, the raw water quality diminishes significantly, most notably due to the presence of filamentous algae. Filamentous algae is also associated with the transition between the San Diego canal and Lake Skinner sources. The algae have an adverse impact on the strainers, forcing the strainers to operate in a constant backwashing mode until the strainers are cleared of debris, or they are taken out of service and cleaned manually. During this period of diminished raw water quality, backwash waste water generated per day increases significantly. The following evaluation analyzes the feasibility of recovering the strainer backwash waste water.

**Figure 1-1. Bollfilter type 6.18/500 DN 500 Automatic Backwash Strainer**

## 1.2 Proposed Improvements

The preliminary investigation of the proposed strainer backwash recovery (SBWR) system led to evaluation of two modes of operation: normal mode and impaired mode. The normal mode of operation would be carried out for approximately ten (10) months of the year, when the raw water quality is relativity good and the strainers backwash according to the scheduled timer. When the raw water quality is diminished, the suspended solids concentration is elevated and filamentous algae will cause the SBWR system to operate in impaired mode. The impaired raw water will require a greater degree of solids removal, including algae removal.

Mechanical separators typically used for grit and suspended solids removal are not very effective for removing algae. If algae are not removed before entering the backwash waste equalization (BWWEQ) tank, they will be sent to the Stage 2 membranes. Algae are a concern with respect to hollow fiber membrane systems and should be prevented from entering the Stage 2 membrane basins. Experience has shown that fibrous material such as algae can be difficult to backwash off membranes. Polysaccharides from the algae can coat the membrane surface with a hard thin film restricting flow across the membrane surface. Once this occurs, the removal of the film is difficult. For this reason, it is proposed that when operating in impaired mode, the strainer backwash waste water would be sent to the new DAF system that will be added to Stage 3. A DAF system can remove algae and also the carried-over solids that are not removed by the proposed grit removal system. When operating in impaired mode, the SBWR flow will utilize 100% of the DAF treatment capacity. It is assumed that in the impaired mode, the existing Stage 3 clarifiers will treat Stages 2 and 4 as they currently do through the existing plate settlers. Once the analysis of the solids constituents is performed for the BW waste water, an investigation should be carried out whether the BWW can be sent to the existing plate settlers. It is possible that the broken shells and snails, as well as other abrasive solids could impact negatively the performance of the settlers, as well as potentially damage the equipment.

The SBWR system will include solids removal, flow equalization, and a pump station to send the flow either to the existing BWWEQ tank (normal mode) or to the new DAF (impaired mode). This is shown in the flow schematic presented in **Figure 1-2.**

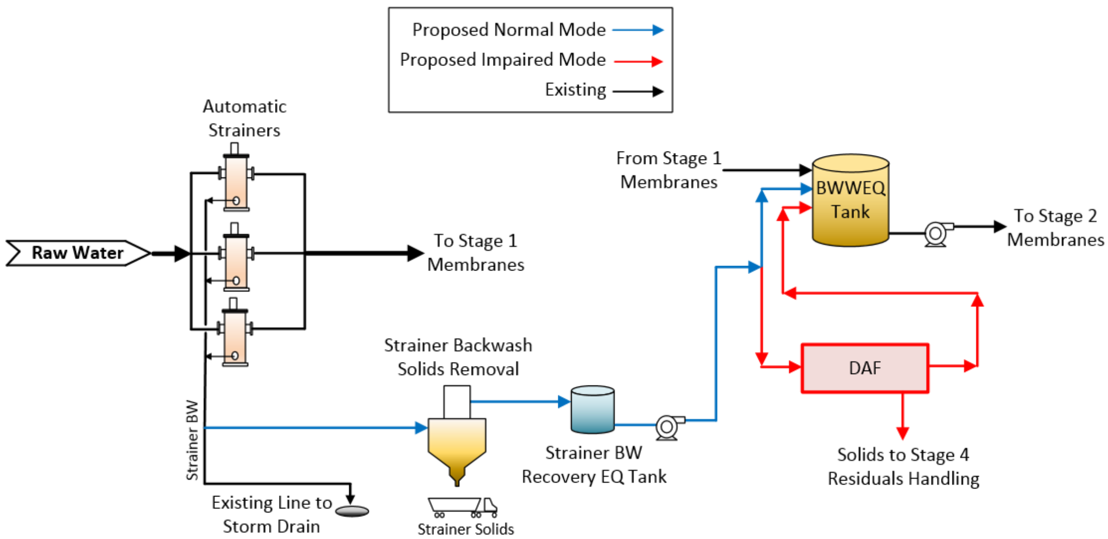



**Figure 1-2.** Strainer Backwash Recovery System Schematic

## 1.3 Solids Removal

Regardless of the mode of operation, the solids will need to be removed before the strainer backwash water can be recovered. Several technologies were evaluated for this study. The proposed equipment will require that the dewatered solids are trucked to a landfill. Because the strainers backwash periodically, the solids removal equipment will be required to treat intermittent flow. The normal mode operating conditions are presented in **Table 1-1** and the impaired mode operating conditions are presented in **Table 2**. The strainer backwash water solid concentrations and particle distribution are unknown. However, the equipment vendors indicated that the capacity for solids removal is independent of the amount of solids and it is controlled by the flow rate to the unit. Nevertheless, it is recommended that a full characterization of the backwash water quality be performed during preliminary design, in order to refine the solids load rates.

**Table 1-1.** Design Conditions – Normal Mode

| Parameter | Unit | Value |
|---|---|---|
| Strainer Backwash Flow | gpm | 600 |
| Strainer Backwash Frequency | hour | 3 |
| Strainer Backwash Duration / Strainer | min | 2 |
| Solids Makeup | - | Sand, Grit, Asiatic Clam & Snail Remnants (Larger than 500 µm) Filamentous Algae |

The impaired mode design conditions are presented in **Table 1-2** below.

**Table 1-2.** Design Conditions – Impaired Mode

| Parameter | Unit | Value |
|---|---|---|
| Strainer Backwash Flow | gpm | 600 |
| Strainer Backwash Frequency | - | Continuous |
| Strainer Backwash Duration | min | Continuous |
| Solids Makeup | - | Sand, Grit, Asiatic Clam & Snail Remnants, (Larger than 500 µm) Filamentous Algae |

Solids removal equipment from three vendors was investigated: Grit King by Hydro International, PISTA V10 by Smith-Loveless, and Jeta by Ovivo (**Figure 1-3, Figure 1-4, and Figure 1-5**). Industry experience has shown these to be proven technologies for solids and grit removal.

**Figure 1-3. Hydro International, Grit King**

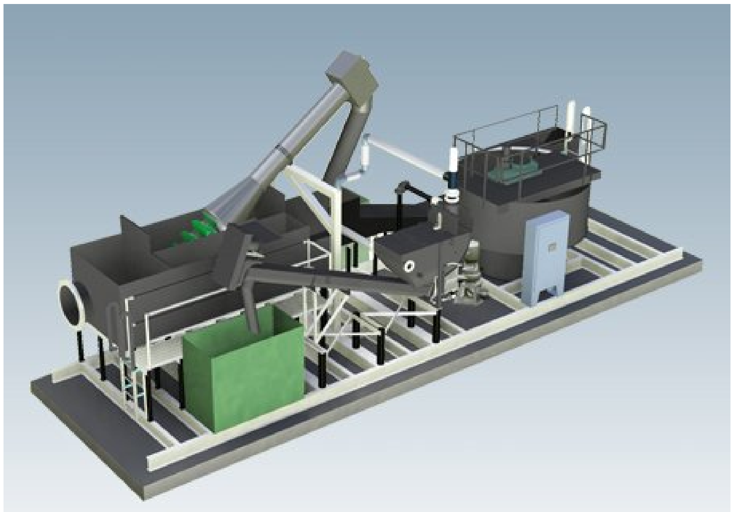


Figure 1-4. Smith-Loveless, PISTA V10

Figure 1-5. Ovivo, Jeta

The solids removal equipment is summarized in **Table 1-3** below.

**Table 1-3. Solids Removal Equipment Summary**

| Manufacturer | Model | Flow Capacity (gpm) | Power Consumption (HP) | Footprint (ft x ft) | Equipment Cost |
|---|---|---|---|---|---|
| Hydro International | Grit King | 650 | 2 | 20 x 9 | $153,000 |
| Smith & Loveless Inc. | PISTA V10 | 650 | 6 | 22 x 8 | $246,905 |
| Ovivo | Jeta | 694 | 18 | 30 x 30 | $325,210 |

The solids removal equipment systems are ranked in **Table 1-4** based on cost, power consumption, and footprint. For each criterion, the systems are ranked from one to three, with three being the most advantageous and one being least advantageous. The overall ranking is the sum of the ranking for each criterion. The systems from Hydro International and from Smith &Loveless Inc. are ranked similarly, however, Smith & Loveless was considered in the cost estimate for this study (the higher cost of the two).

**Table 1-4.** Solids Removal Equipment Ranking

| Manufacturer | Model | Cost | Power Consumption | Size | Overall Rank |
|---|---|---|---|---|---|
| Hydro International | Grit King | 3 | 3 | 3 | 9 |
| Smith & Loveless Inc. | PISTA V10 | 2 | 2 | 3 | 7 |
| Ovivo | Jeta | 1 | 1 | 1 | 3 |

## 1.4 Strainer Backwash Recovery Equalization

An equalization (EQ) tank and a pump station will be required downstream of the solids removal system since it operates at atmospheric pressure. The SBWR EQ tank will serve two purposes. When operating in normal mode, the periodic flow from the strainers can be equalized prior to discharge into the existing BWWEQ tank which helps maintain a constant flow to the Stage 2 membranes. When operating in impaired mode, the strainer backwash flow can be equalized prior to entering the stage 3 DAF.

Preliminary tank sizing is constrained by the two operating modes. When operating in normal mode, the periodic backwash volumes will be between 2,000 to 4,000 gallons delivered at about 600 gpm over approximately 6 minutes, every 3 to 4 hours. When operating in impaired mode, the assumption is a continuous 600 gpm flow through the solids removal equipment into the EQ tank.

Based on the anticipated flows for both modes of operation, the upper volumetric boundary is 4,000 gallons. Therefore, allowing for 2 complete strainer backwash cycles, the proposed conceptual equalization volume is 10,000 gallons. The proposed transfer pump station will consist of two 600 gpm, 10 HP pumps, 1 duty and 1 standby.

**Strainer Backwash Recovery System Equipment Summary**

**Table 1-5** below summarizes the major equipment required for the proposed strainer backwash recovery system.

**Table 1-5.** Strainer Backwash Recovery System Equipment Summary*

| Description | Quantity | Size |
|---|---|---|
| Solids Removal System | 1 | 650 gpm |
| SBWR EQ Tank | 1 | 10,000 gal |
| SBWR Transfer Pumps | 2 (1 duty, 1 standby) | 650 gpm, 10HP |

* plus the necessary piping, appurtenances, instrumentation, etc.

## 1.5 Proposed Location

The proposed location for the strainer backwash recovery system is inside the new DAF building. The new building is proposed to be located on the western part of the site, between the existing Backwash Waste EQ tank and the existing residuals handling building (**Figure 1-6**). If desired, the SBWR system could be located outside to the west of the proposed DAF building, underneath a canopy structure. The cost estimate for this system assumes that the SWRS system is located inside the DAF building.

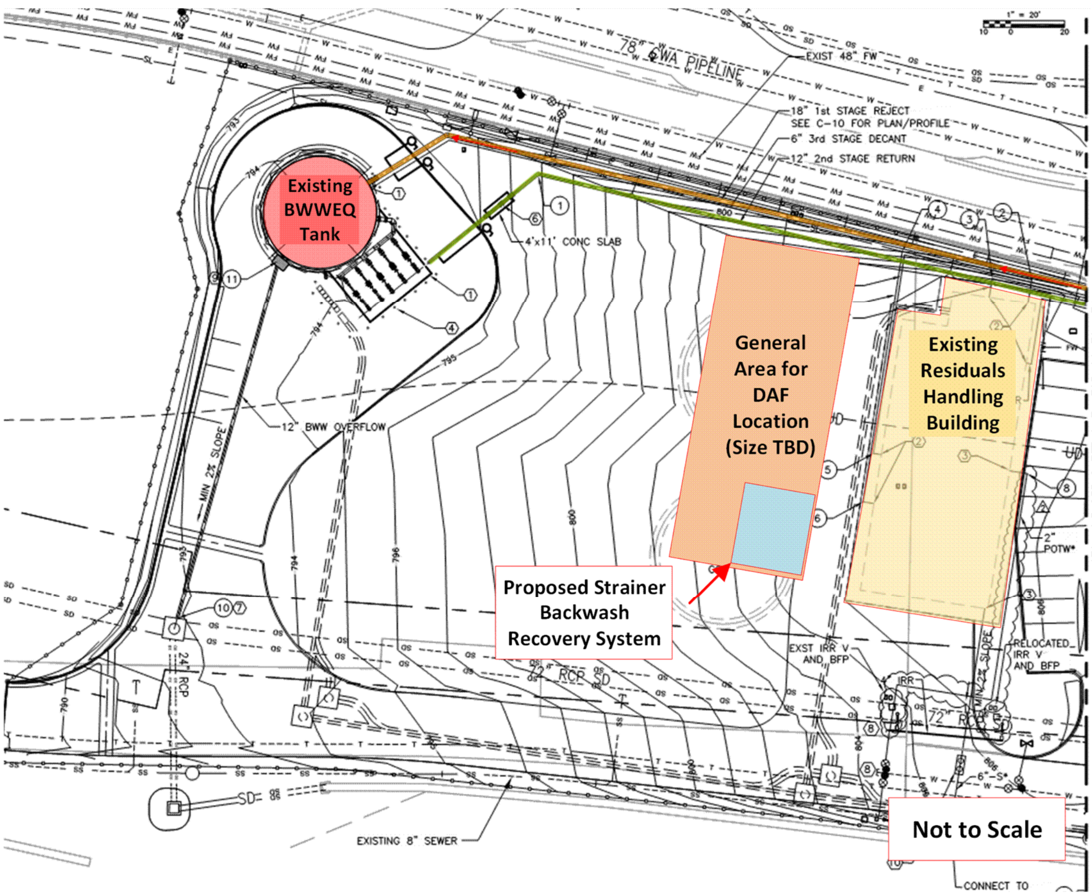



**Figure 1-6. Proposed Strainer Backwash Recovery System Location**

## 1.6 Electrical Considerations

The SBWR system can be connected to the MCC-5, along with the DAF system (Section 3) and the centrifuge (Section 4). MCC-5 was one of three MCCs included in the LT2 Improvements project conducted in 2011. This motor control center currently has a connected load of approximately 180 A. The three new systems (SBWR, DAF, and centrifuge) proposed to be connected to this MCC will have a new load of 194 A, bringing the total connected load to 374 A on a bus rated for 600A. The existing circuits, main circuit breaker, and upstream breaker supplying MCC-5 would have to be upgraded to 600A to support the new load. The cost estimate associated with the upgrades to MCC-5 is included in the DAF system presented in Section 3.

## 1.7 Impacts to the Existing Backwash Waste Storage Tank and Existing Stage 2 Ultrafiltration

The proposed SBWR system will need to be integrated into the existing Stage 2 ultrafiltration system through the existing 260,000-gallon BWWEQ tank. The following summarizes the evaluation of impacts of the proposed changes.

Currently, Stage 2 is supplied from the Stage 1 backwash and the recovered Stage 3 water. Flow through the plant can vary based on factors such as demand, time of year, and equipment / resource availability. This evaluation is a high-level analysis that assumes the plant is operating near full capacity and simplifies operations into basic conditions to establish the average flows.  It should be noted the intent of this analysis is to examine the feasibility of integrating the proposed SBWR system into the existing facility and identify any major flaws. The DCMWTP is a very complex facility and a more extensive analysis would be required in the detail design.

Factors examined for this analysis were the maximum daily Stage 1 backwash volume, the maximum Stage 3 return flow, the maximum Stage 2 capacity, and the expected strainer backwash flows.

*Stage 1 Backwash*

Stage 1 is comprised of 10 Zenon UF trains; however, not all of the trains are outfitted the same, and consequently do not operate under the same parameters. Trains 1 through 8 have the same membrane surface area, while Trains 9 and 10 are configured differently and include a larger membrane surface area. Trains 1-8 and Trains 9-10 backwash at different time intervals and discharge different volumes.  The differences are summarized in **Table 1-6** and are based on plant operating data from August 2017 when the plant operated at about 95% capacity. For this analysis, a conservative assumption was used and only the standard backwash waste was considered. Periodic maintenance cleans are also discharged into the BWWEQ tank, however they do not occur every day and result in an overall reduced volume. Therefore, the total Stage 1 UF daily standard backwash volume from all trains is approximately 2,220,036 gallons per day (2.22 MGD). This volume is sent to the Stage 2 membrane system.

**Table 1-6. Stage 1 Ultrafiltration Operating Parameters**

| Parameter | Unit | Trains 1 -8 | Trains 9 & 10 |
|---|---|---|---|
| Backwash Volume / Train | gal | 30,135 | 29,582 |
| Number of Trains Operating | - | 7 (N-1) | 2 |
| Backwash / Train / Day | - | 8 | 9 |
| Backwash Volume | Gal/day | 1,687,560 | 532,476 |

*Stage 3 Clarified Water*

In addition to the Stage 1 UF backwash, the Stage 3 clarified water is also sent to the Stage 2 membrane system via the BWWEQ tank. This flow ranges from 350 to 520 gpm (0.65 – 0.75 MGD). A conservative estimate of 0.75 MGD was assumed. Combined with the Stage 1 backwash, the assumed existing maximum flow to the Stage 2 membrane system is 3.21 MGD.

*Stage 2 Ultrafiltration System*

The existing Stage 2 system consists of 3 trains, each configured identically with 7 cassettes housing 20 membrane modules and 1 cassette containing 64 membrane modules. The Stage 2 UF system operates in a "Feed and Bleed" arrangement at 85% recovery. The maximum net permeate flow is 1000 gpm and the system is offline 6.25% of the time for periodic backwashes. This translates to a 93.75% online time, or 1,350 minutes per day. Under these conditions, Stage 2 is assumed to have a maximum production capacity of 4.32 MGD. At 85% recovery, this equates to 5.08 MGD feed flow. The Stage 2 operating parameters are summarized in **Table 1-7.**

**Table 1-7.** Stage 2 Ultrafiltration System Operating Parameters

| Parameter | Unit | Value |
|---|---|---|
| Number of Stage 2 UF Trains | # | 3 |
| Stage 2 UF Max Net Permeate/Train | gpm (MGD) | 1000*(1.44) |
| Stage 2 Recovery | % | 85 |
| Online Time | min/day | 1350 |
| Max Stage 2 Permeate Capacity | MGD | 4.32 |
| Max Stage 2 Feed | MGD | 5.08 |

*Current Stage 2 production is limited to a max instantaneous flow of 850 gpm due to limitations of the Stage 2 reject pumps.

Based on the operating assumptions stated for Stages 1, 2, and 3, Stage 2 has an approximate maximum of 2.11 MGD (1,470 gpm) extra capacity to treat the proposed SBWR flow.

When the SBWR system is operating in normal mode, the Stage 2 UF system should have extra capacity to process the additional flow. However, when the SBWR system is operating in impaired mode, the Stage 2 UF system will likely be at or near its theoretical capacity. This evaluation has assumed that during the SBWR system impaired mode of operation, the strainers will be in continuous or near continuous backwash. This is a very conservative assumption and it is likely that the strainers will not be backwashed continuously. If the strainers backwash continually, the existing BWWEQ and Stage 2 UF systems could be overwhelmed. It is recommended that the existing strainer backwash connection to the storm drain is kept in place as a contingency should the strainer backwash begins to outpace Stage 2.

## 1.8 Existing Backwash Waste Equalization Tank

The usable capacity for the BWWEQ tank is 140,400 gallons. Evaluation of the impacts of the proposed SBWR system on the existing BWWEQ tank will be difficult as there are many dynamic factors that affect the BWWEQ tank such as the Stage 2 UF membrane condition. Most flow feeding the BWWEQ tank is from the Stage 1 backwash waste water. Based on the operating conditions stated above, the maximum hourly volume into the tank from Stage 1 is 92,500 gallons. Four operating scenarios are presented in **Table 1-8** through **Table 1-11**. Each scenario assumes a maximum hourly flow into the BWWEQ tank from the Strainers, Stage 1, and Stage 3. Each scenario also assumes two cases for Stage 2: the maximum design flow and the current maximum operating flow. A positive flow balance represents extra capacity in the BWWEQ tank while a negative balance represents a tank overflow condition.

As presented in **Tables 9** and **10**, when the DAF system would operate in parallel with the plate settlers, the buffer capacity in the BWWEQ tank becomes very limited during normal operation mode (5,450 gal excess capacity) or is exceed in the impaired operation mode (27,550 overflow). Increasing the current operating feed water flow to the Stage 2 to the design flow would result in increased capacity in the tank and would avoid water overflow. Alternatively, the BWWEQ tanks overflow can be prevented by running the Stage 2 with all four trains at the same time (**Table 11**).

The flow assumptions made for normal mode operation coincide with approximately 80% of operating data from 2016 and 2017 showing normal months. To verify this conclusion, a detailed flow analysis is recommended as part of design.

**Table 1-8. Scenario 1: Normal Strainer BW Mode, Three Stage 2 UF Trains, Plate Settlers**

| Source | Flow IN (gal/h) | Total Flow IN (gal/h) | Total Flow OUT (gal/h) | | Flow Balance (gal/h) |
|---|---|---|---|---|---|
| From Strainers | 3,600 | 127,300 | Max Design | 211,765 | 84,465 |
| From Stage 1 | 92,500 | | | | |
| From Stage 3 | 31,200 | | **Max Current** | **168,750** | 41,450 |

**Table 1-9. Scenario 2: Normal Strainer BW Mode, Three Stage 2 UF Trains, Plate Settlers & DAF**

| Source | Flow IN (gal/h) | Total Flow IN (gal/h) | Total Flow OUT (gal/h) | | Flow Balance (gal/h) |
|---|---|---|---|---|---|
| From Strainers | 3,600 | 163,300 | Max Design | 211,765 | 48,465 |
| From Stage 1 | 92,500 | | | | |
| From Stage 3 | 67,200 | | **Max Current** | **168,750** | 5,450 |

**Table 1-10. Scenario 3, Impaired Strainer BW Mode, Three Stage 2 UF Trains, Plate Settlers & DAF**

| Source | Flow IN (gal/h) | Total Flow IN (gal/h) | Total Flow OUT (gal/h) | | Flow Balance (gal/h) |
|---|---|---|---|---|---|
| From Strainers | 36,600 | 196,300 | Max Design | 211,765 | 15,465 |
| From Stage 1 | 92,500 | | | | |
| From Stage 3 | 67,200 | | **Max Current** | **168,750** | (-27,550) |

**Table 1-11. Scenario 4, Impaired Strainer BW Mode, Four Stage 2 UF Trains, Plate Settlers & DAF**

| Source | Flow IN (gal/h) | Total Flow IN (gal/h) | Total Flow OUT (gal/h) | | Flow Balance (gal/h) |
|---|---|---|---|---|---|
| From Strainers | 36,600 | 196,300 | Max Design | 211,765 | 86,050 |
| From Stage 1 | 92,500 | | | | |
| From Stage 3 | 67,200 | | **Max Current** | **225,000** | 28,700 |

## 1.9 Estimation of Probable Cost

**Table 1-12. Estimate of Probable Cost for Strainers Backwash Water Recovery**

| Item Description | Total Costs |
|---|---|
| Sitework | $96,000 |
| Concrete | $19,700 |
| Equipment | $344,200 |
| Mechanical | $23,100 |
| Electrical | $72,500 |
| Instrumentation and Control | $38,900 |
| **Total Installed Equipment** | $594,400 |

| Item | Description | | Total Cost |
|---|---|---|---|
| 1 | Total Installed Equipment | | $594,400 |
| 2 | General Conditions (allowed factor at this time) | 10.0% | $59,440 |
| | | **Subtotal:** | **$ 653,840** |
| 3 | Contractor Overhead | 10.0% | $65,384 |
| | | **Subtotal:** | **$719,224** |
| 4 | Contractor Profit | 10.0% | $71,922 |
| | | **Subtotal:** | **$791,146** |
| 5 | Sales Tax (on materials only) | 8.5% | $31,165 |
| | | **Subtotal:** | **$822,311** |
| 6 | Escalation at 3% annually* | 6.9% | $56,549 |
| | | **Subtotal:** | **$878,860** |
| 7 | Bond and Insurance | 3.0% | $26,366 |
| | | **Subtotal:** | **$905,226** |
| 8 | Contingency | 25.0% | $226,307 |
| | **Probable Bid Cost** | | **$1,132,000** |
| 9 | Engineering | 8.0% | $90,560 |
| 10 | CM | 10.0% | $113,200 |
| 11 | Legal/Admin/Permitting | 3.0% | $33,960 |
| | **Probable Project Cost** | | **$1,369,720** |
| 12 | Additional Cost for Canopy | | $223,669 |
| | **Probable Project Cost (with Canopy)** | | **$1,593,000** |

*Assumes construction starts in January 2020.

# 2. Stage 2 UF Membranes Expansion

The David C. McCollum Water Treatment Plant (DCMWTP) utilizes two separate Ultrafiltration (UF) systems referred to as Stage 1and Stage 2. The Stage 1 UF system is the primary water treatment for the plant. Stage 2 treats Stage 1 reject as well as supernatant from the third stage (Stage 3) (plate settlers) that recover backwash from Stage 2. With the current configuration, the Stage 2 UF system is a choke point in the overall plant production. Stage 2 is comprised of three UF trains. When one train is taken offline for cleaning or service, the overall plant capacity is reduced by approximately 33%. This technical memorandum evaluates the feasibility of expanding the Stage 2 UF system by 33% with the addition of one more train. The expansion will increase capacity reliability by providing operational redundancy, allowing Stage 2 to operate in an N+1 configuration and the plant production to not be affected by one offline train.

## 2.1 Proposed Expansion

Stage 2 currently consists of three trains outfitted with Zenon ZeeWeed 500D UF cassettes and modules. Each basin is configured identically, with 7 cassettes housing 20 membrane modules and 1 cassette containing 64 membrane modules. Each UF train is housed in an open concrete basin. The Stage 2 UF system operates in “Feed and Bleed” mode at 85% recovery. The Stage 2 UF system has a net design permeate flow of 1000 gpm. However due to hydraulic limitations with the Stage 2 reject pumps, Stage 2 currently has a maximum net production of 850 gpm. Adjusting for production time lost to periodic backwashing this equates to 4.32 MGD, assuming all three trains are operating at maximum flow. The Stage 2 UF configuration is summarized in **Table 2-1**.

**Table 2-1. Summary of Design and Operating Parameters for Stage 2 UF System**

| Parameter | Unit | Value |
|---|---|---|
| Number of Stage 2 UF Trains | # | 3 |
| Membrane Make and Model | - | Zenon ZeeWeed 500D |
| 20 Module Cassettes | # | 7 |
| 64 Module Cassettes | # | 1 |
| Total modules per Train | # | 204 |
| Online Factor | min/day | 1,350 (93.8%) |
| Net Permeate Flow /Train (Design) | gpm | 1000* |
| Design Capacity (all trains) | MGD | 4.32 |
| Stage 2 Recovery | % | 85 |

*Current Stage 2 production is limited to a max instantaneous flow of 850 gpm due to limitations of the Stage 2 reject pumps.

The proposed expansion will add 33% to the existing Stage 2 capacity by adding one UF train identical to the existing trains. The additional Stage 2 capacity provided by a new train will provide sufficient redundancy to allow for one Stage 2 train to be offline for cleaning or service without the need to reduce Stage 1 production capacity.

The proposed location for the new UF train is directly adjacent to the existing train 13 (or adjacent to train 3 of the Stage 2) where the CIP pumps are currently located, at the western end of the membrane trains. A careful review of the as-built drawings in conjunction with the field investigation concluded this will be the ideal location for a new train with respect to constructability and integration into the existing facility.

**Table 2-2** summarizes the equipment to be supplied by Zenon for the proposed new Stage 2 train. **Figure 2-1** and **Figure 2-2** show the existing conditions in and around the proposed area and Figure 2-3, **Figure 2-4**, and **Figure 2-5** show the proposed changes.

**Table 2-2. Zenon UF Scope of Supply**

| Item | Quantity | Description |
|---|---|---|
| Membrane Modules | 204 | ZeeWeed 500D, 340 $ft^2$ |
| 20 Module Membrane Cassettes | 7 | ZW500D 20M |
| 64 Module Membrane Cassettes | 1 | ZW500D 64M |
| Permeate Pump | 1 | To match existing |
| Reject Pump | 1 | To match existing |
| Permeate & Reject Flow Meters | 1 (each) | To match existing |
| Permeate & Reject Inlet and Discharge Valves | 4 | To match existing |
| In Basin Piping | - | 1 x 10” Permeate<br>1 x 10” Basin Fill<br>1X 4” Aeration Header<br>Permeate Spool Connection<br>Air Spool Connection<br>Cyclic Aeration Valves |
| Cassette Support System | - | Beams<br>Brackets<br>Hanger Arms<br>Leveling Pins |
| Remote I/O Panel * | 1 | To match existing |
| Instruments (Turbidity Meter & Particle Counter) | 1 (each) | To match existing |

*Verification of spare capacity in CC-3 for new I/O to occur during preliminary design.

The existing Stage 2 reject pumps currently are not meeting their design flow requirements. Operations have reported occurrences when the reject pumps are called to produce 175 gpm at 100% speed with the actual flow being about 165 gpm. Other times the reject demand is only 100 gpm and the pumps cannot meet this flow consistently. Operating data from March and August 2017 indicates Stage 2 operates at an average 81% recovery. During preliminary design, an evaluation of the existing pumps along with detailed hydraulic analysis of the reject pipe network is recommended to identify the cause of the UF reject flow restrictions.

The addition of a new train next to train 13 will require relocation of the CIP pumps, CIP piping, chemical feed piping, and the elevated walkway. The compressed air equipment is currently located in the area north of the Stage 2 membrane trains. The proposed expansion would require the compressed air equipment be relocated outside the membrane building on the north side. The final location to be determined during preliminary design. The CIP pumps would be relocated to the area previously occupied by the compressed air system. This will require careful planning during design of the rerouted CIP piping to ensure adequate accesses to the existing Stage 2 reject pumps, piping, and instruments as well as the CIP pumps. This will likely require some of the CIP pipe run overhead. The existing CIP pumps are assumed to be reused, however modification of the CIP piping could have an adverse impact to the new pump hydraulics, i.e. insufficient NPSPA or increase discharge head resulting in a flow reduction. The operating point of the relocated pumps and revised piping will be required during the detailed design.

The CIP system drains into a buried pipe located just south of the current CIP pump location. This is highlighted in blue in **Figure 2-1**. This drain pipe will need to be relocated because the proposed new train will be situated directly over this location (**Figure 2-3**).

**Figure 2-3** shows a proposal for relocation of the drain. The new buried drain pipe can be aligned on the west side of Stage 2 and the drain be located north of Stage 2, near the CIP pumps. Reuse of all existing equipment, instruments, and valves is assumed. All relocated CIP pipes are assumed new.

The 2010 LT2 plant upgrades changed the Stage 1 mode of operation from feed and bleed to deposition. Because of this change, flow from Stage 1 to Stage 2 is no longer by gravity. As part of a detailed design, the plant hydraulics could be analyzed to evaluate the feasibility of constructing the new basin at the existing floor elevation. This will require detailed analysis of the basin fill hydraulics, the basin fill controls, as well as an evaluation of the relationship between the new Stage 2 train and the existing Stage 2 trains. This study assumes that the basin for the forth train will be identical to the existing three trains.

The concrete basins for the existing trains are recessed down below the building floor slab. The addition of the forth train will require saw-cutting, demolition, forming a new foundation, doweling into the existing floor slab, and providing watertight joints all around. Based on review of the record drawings and photos of the interior of the water treatment building, it appears feasible to add a new fourth basin of similar dimensions adjacent to the existing Stage 2 basins without compromising the building foundation or outer metal building structure.

The elevated walkway that currently surrounds train 13 will need to be reconfigured. **Figure 2-2** shows the existing walkway and **Figure 2-4** shows a possible reconfigured walkway. It is believed that much of the existing structure could be reused. Once the new basin is in place, there should be approximately 14 ft between the west wall of train 14 and the existing masonry wall. If the existing walkway structure is reused, the spacing between the support columns and the basin wall will likely encroach on much of the available space that traverses between the north and south roll-up doors. If a new walkway is installed, it can be designed such that the support columns and the stairs are positioned to maximize the clearance to move equipment through this area (**Figure 2-6)**. The cost estimate presented in this document considers that a new walkway would be required.

The chemical feed lines that are routed from the chemical rooms along the south wall and underneath the elevated walkway (highlighted purple in **Figure 2-1** through **Figure 2-4)** will need to be moved underneath the relocated elevated walkway, similar to the existing chemical piping arrangement. Final location of the stairs to be determined during preliminary design. New piping is assumed for the relocated chemical piping.

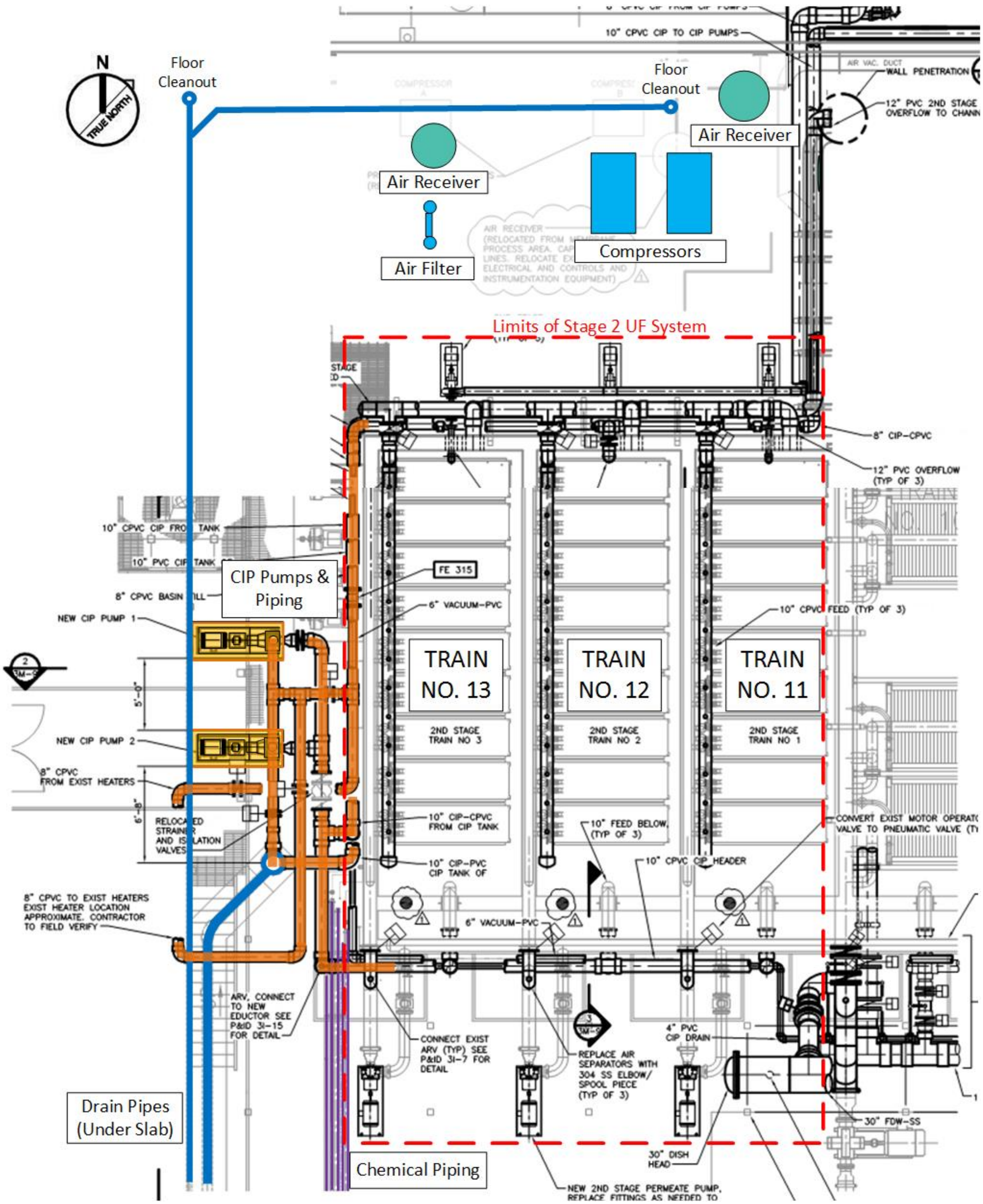



**Figure 2-1. Existing Stage 2 Trains, Upper Plan View**

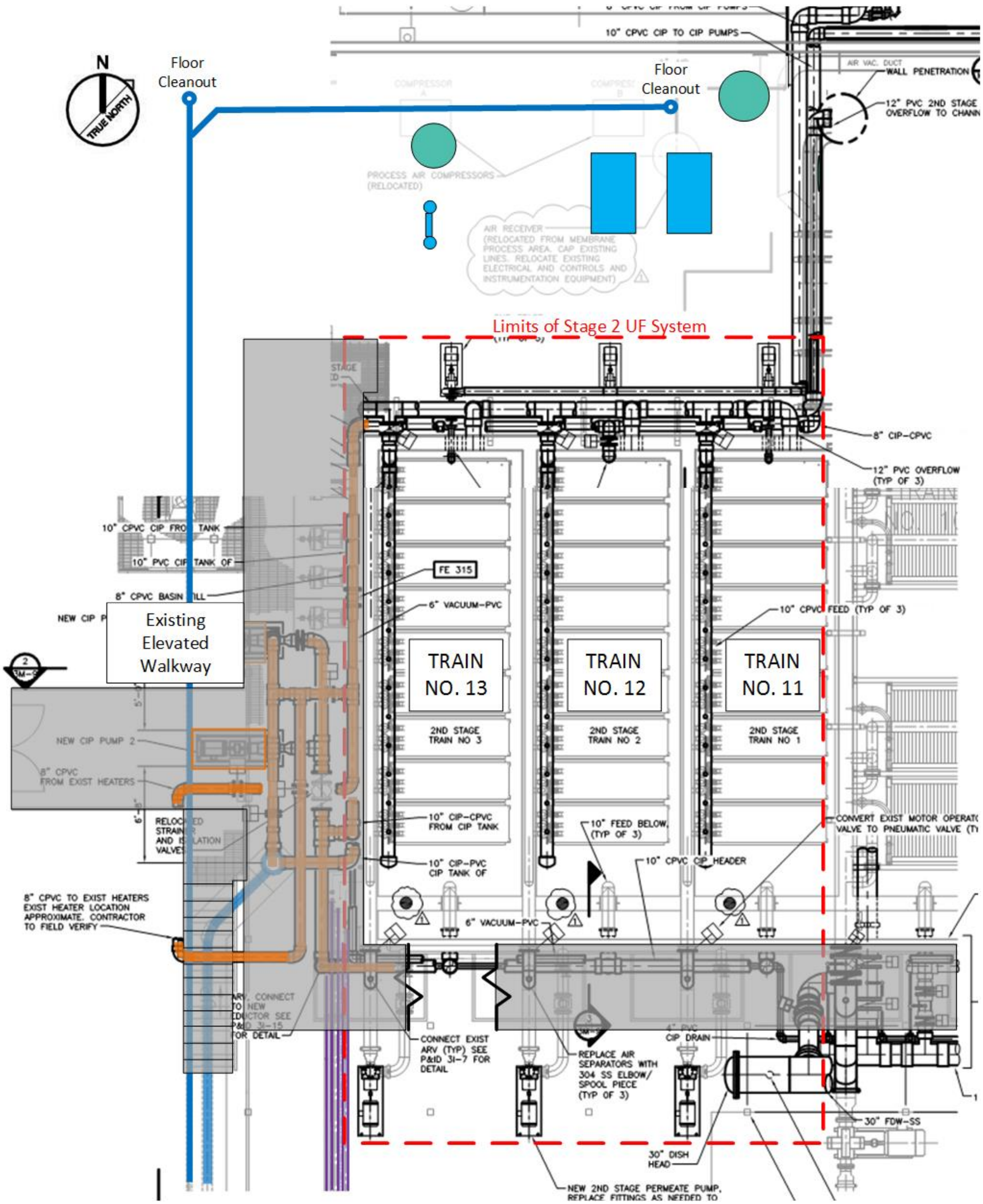



**Figure 2-2. Existing Stage 2 Trains, Upper Plan View**

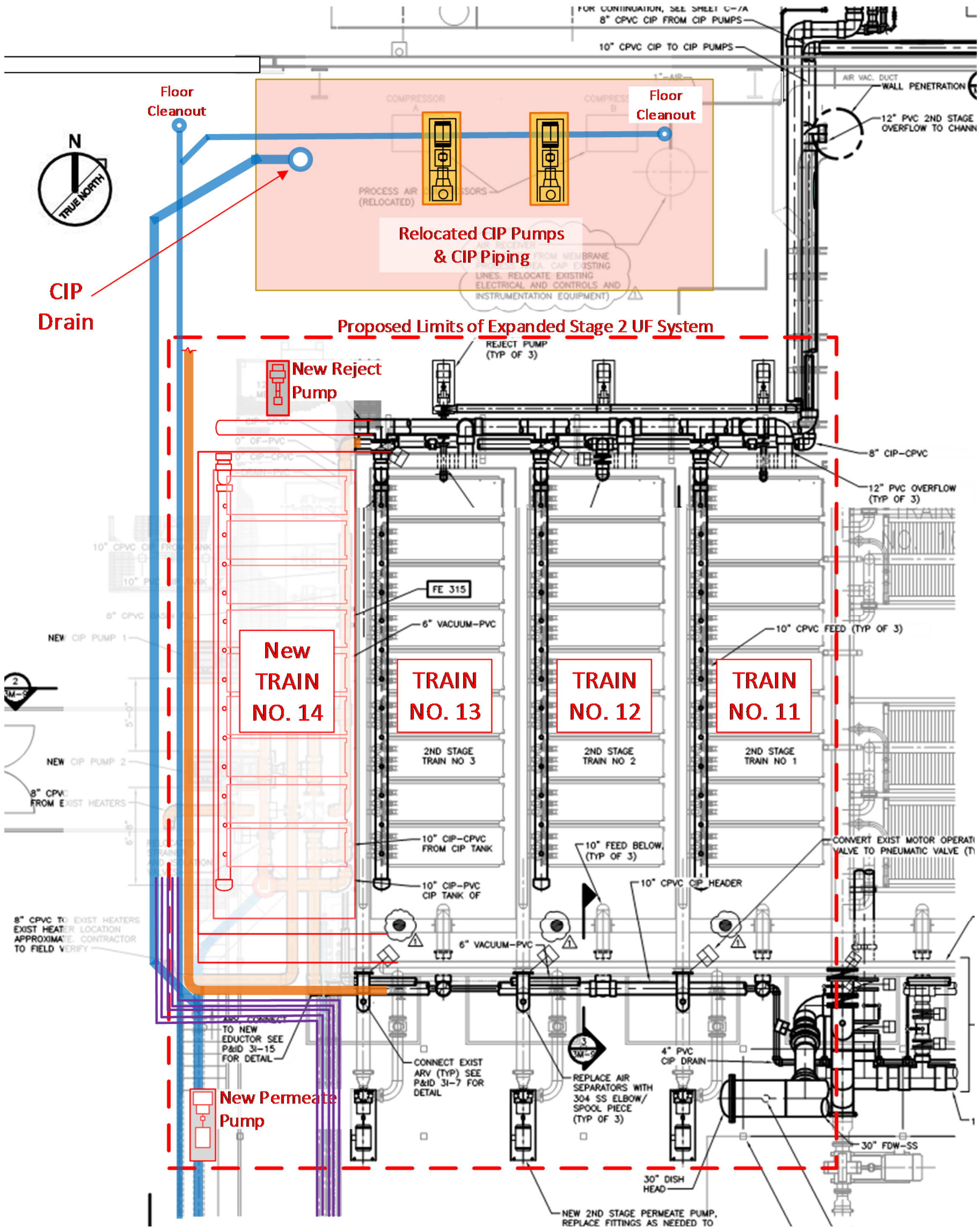



Figure 2-3. Proposed Stage 2 Expansion (Fourth Train), Lower Plan View

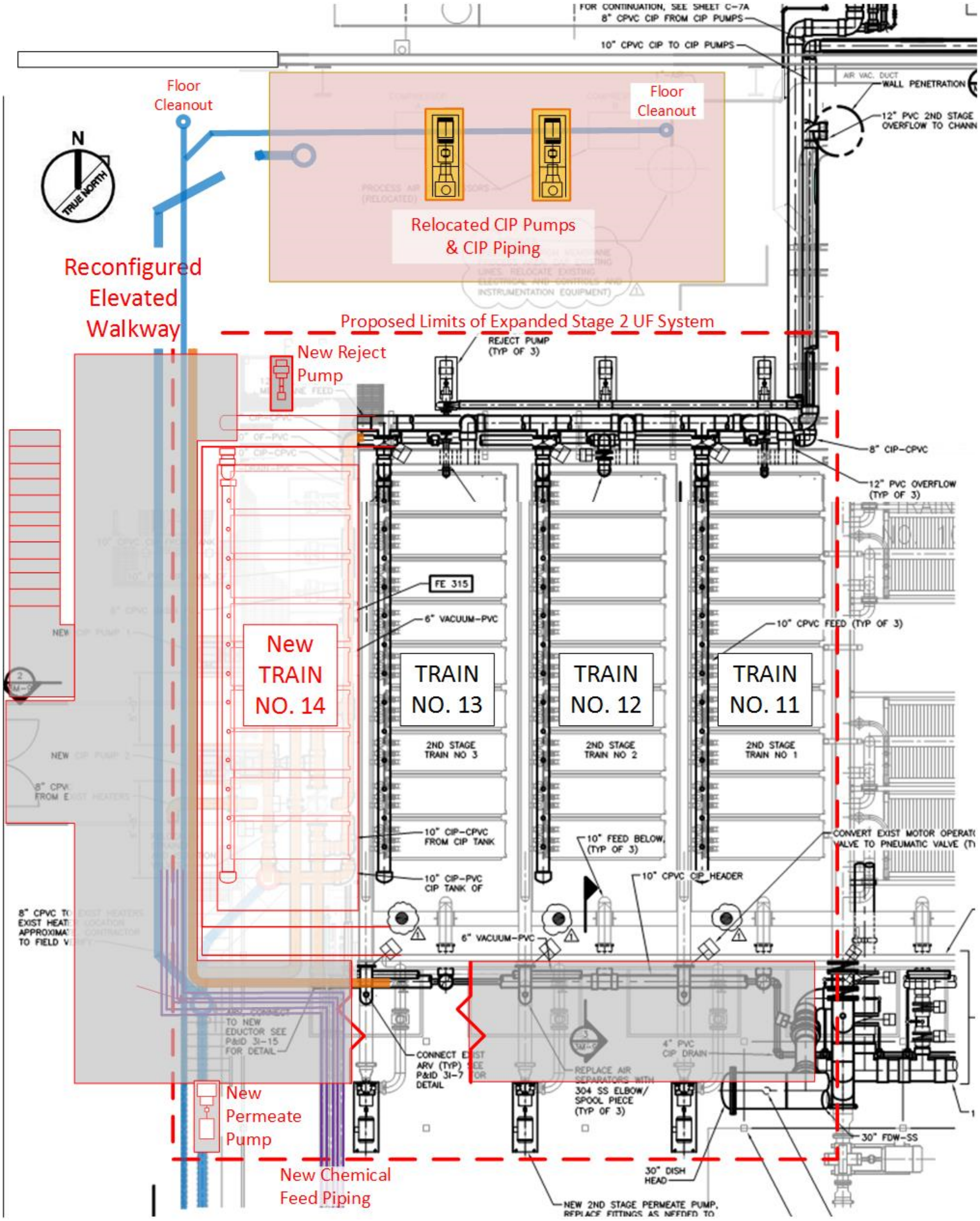



**Figure 2-4. Proposed Stage 2 Expansion (Fourth Train), Upper Plan View**

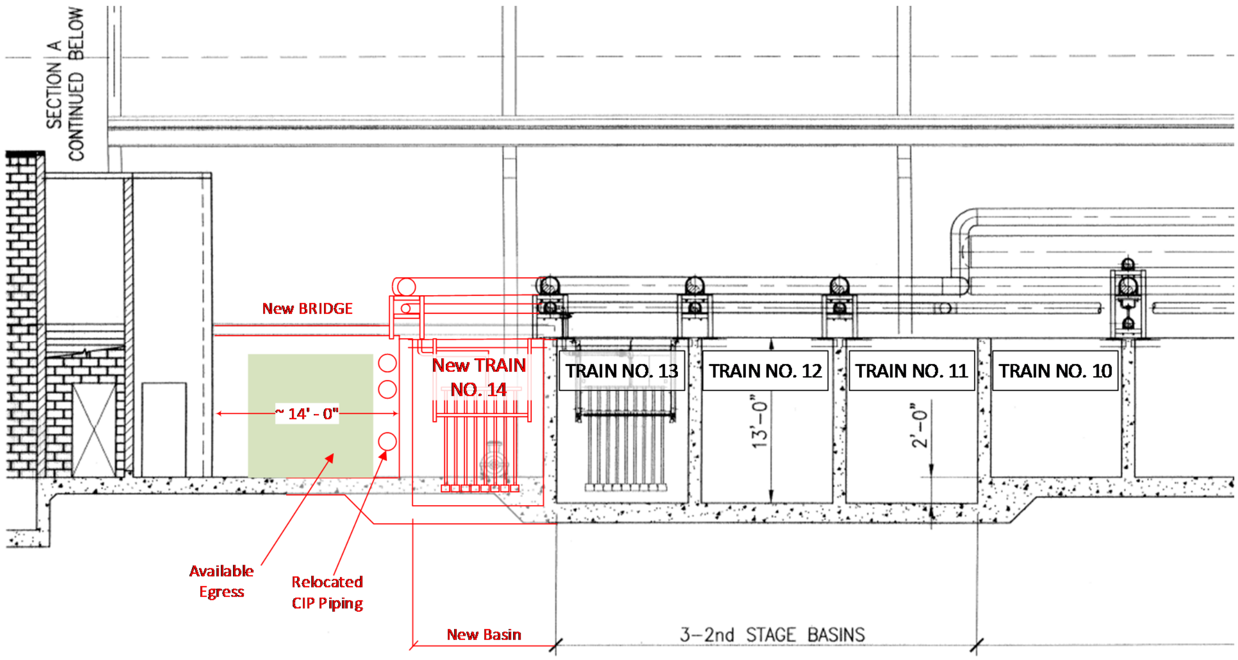



**Figure 2-5. Proposed Stage 2 Expansion (Fourth Train), Section View**

## 2.2 Impacts to Existing Piping and other Stages

Operating with all four trains in the Stage 2 would impact the water recovered and fed to Stage 1. California Department of Drinking Water (DDW) limits the total amount of backwash recovered water to equal or less than 10% of the total plant influent flow. At the maximum total influent flow of 34 MGD, the maximum flow from the Stage 2 allowed for recovery would be 3.4 MGD. This is approximately 99% of the maximum flow that all four trains would produce in Stage 2.

Operating with all four Stage 2 trains would also produce 33% more reject, which will be sent to Stage 3. The impacts to Stage 4 of running with 4 trains in Stage 2 is incorporated into the discussion of DAF addition in Section 3.

The proposed Stage 2 UF expansion assumes the new UF train will be a redundant unit and Stage 2 will operate in an N+1 configuration, with one train in standby. **Table 2-3** presents a summary of the pipe velocities of the feed, permeate, and reject pipes with three Stage 2 UF trains operating at 1000 gpm. Hypothetically all four trains could be operated during times when lowering the flux is beneficial, i.e. when the Stage 2 membrane performance has degraded, or when the BWWEQ tank is critically high. **Table 2-4** present a summary of the hydraulic conditions assuming four train are operating at 1000 gpm. The pipe velocities of the feed and permeate headers are high for both cases, well above the industry standard of 7.0 ft/s. The velocity in the reject header with three or four trains operating is 5.5 ft/s and 7.4 ft/s, which are deemed acceptable. If the option to operate all for trains simultaneously is desired, it is recommended that the feed and permeate headers be replaced with 16” and 14” piping, respectively

(**Table 2-5**). Such replacement will require approximately 300 ft of new buried pipeline for the feed header, from the backwash waste EQ pump station to the Stage 2 membrane system. Two valves and a flowmeter on the feed header will also require replacement. The permeate header is approximately 200 ft long. The decision of upgrading the headers would need to consider the capital costs versus the benefit of operating with all four trains in Stage 2, which will only be on temporary basis, when the raw water quality is impaired or Stage 1 UF membranes require extensive backwash.

**Table 2-3. Stage 2 Header Conditions with Three Trains Operating**

| Service | Size (in) | Material | Flow (GPM) | Pipe Velocity (ft/sec) |
|---|---|---|---|---|
| Feed Header | 12 | CPVC | 3,530 | 11.30 |
| Permeate Header | 10 | SS | 3,000 | 11.29 |
| Reject Header | 6 | PVC | 450 | 5.64 |

**Table 2-4. Stage 2 Header Conditions with Four Trains Operating**

| Service | Size (in) | Material | Flow (GPM) | Pipe Velocity (ft/sec) |
|---|---|---|---|---|
| Feed Header | 12 | CPVC | 3,530 | 11.30 |
| Permeate Header | 10 | SS | 4,000 | 15.05 |
| Reject Header | 6 | PVC | 5,10 | 7.52 |

**Table 2-5. Velocity in Upsized Feed and Permeate Headers**

| Service | Proposed Size (in) | Flow (GPM) | | Pipe Velocity (ft/sec) | |
|---|---|---|---|---|---|
| | | Three Trains | Four Trains | Three Trains | Four Trains |
| Feed Header (CPVC) | 16 | 3530 | 4,700 | 7.14 | 9.52 |
| Permeate Header (SS) | 14 | 3,000 | 4,000 | 6.60 | 8.80 |

## 2.3 Blowers

Low pressure scour air is currently supplied to the stage 2 UF system by 2 blowers that operate in in a duty standby configuration. The Zenon UF system operates in one of two aeration modes, *cyclic* or *constant* aeration control. When operating in cyclic control, air is supplied to half of the cassettes in a basin for a period of time, i.e. 30 seconds, then the flow is cycled to the other half of the basin. In constant control scour, air is supplies to the entire basin. The current volumetric air flow set point is 675 SCFM. Therefore, when operating in cyclic mode, 675 SCFM is directed to half of the train's cassettes at any given time, hence the total flow rate is 675 SCFM. When operating in constant mode, 675 SCFM is directed to all the cassettes in the train, hence the flow total rate is 1,350 SCFM. This is summarized in **Table 2-6**. Currently, when opening all 3 Stage 2 UF trains in cyclic mode the existing blowers can maintain the air requirements. When operating all three trains in constant mode the blowers operate near the limits of its capacity. If four Stage 2 UF are to be operated at the same time, with the low pressure air system operating in constant mode, the existing blowers will likely need to be upgraded.

**Table 2-6. Stage Scour Air System Operating Summary**

| Train | Aeration Control Mode | Volumetric Air Flow |
|---|---|---|
| ZW2-1 | Cyclic | 675 (SCFM) |
| ZW2-2 | Cyclic | 675 (SCFM |
| ZW2-3 | Constant | 1,350 (SCFM) |

## 2.4 Traveling Bridge Crane

The limits of the traveling bridge crane were evaluated with respect to the location of the new proposed Stage 2 UF train to verify the new proposed location will be accessible by the crane. **Figure 6** is section AS-3 from volume 2 of the Boyle Engineering March, 2000 structural drawing set with the new train super imposed and indicates the new prosed equipment will assessable with the crane.

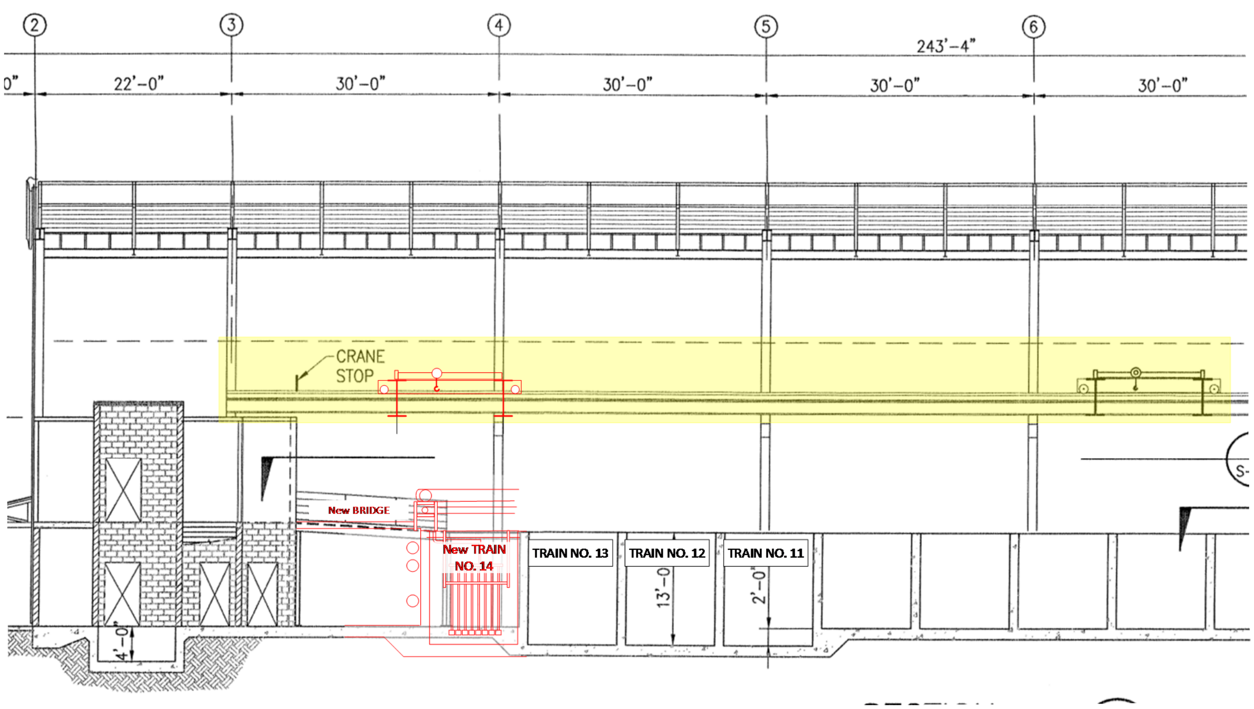



**Figure 2-6. Traveling Bridge Crane**

## 2.5 Electrical Improvements

The new UF train would likely be fed by MCC-2, which has a calculated load of 397Amps (A) based on the provided single line diagrams. The proposed new load (excluding improvements or additions to the existing air blowers) would be 40A. MCC-2 has a bus rating of 600A and thus has enough capacity to accommodate the new train. However, the feeder circuit as well as the upstream breaker to this MCC would have to be upgraded to 600A.

The existing air blowers are fed from MCC-4, which has a total connected load of 692A on a bus rated for 800A. Upgrading the blowers from 100 HP to 150 HP will bring the total connected load to 804A. Further understanding of plant operations may be required to draw a conclusion on the operating load on this MCC and its capacity to feed the proposed blower improvements. The cost estimate for this study did not considered upgrades to MCC-4.

## 2.6 Maintenance of Plant Operations

The addition of a new Stage 2 UF membrane train will require significant construction which will require interruption to the overall facility. During the detailed design a Maintenance of Plant Operation (MOPO) plan will need to be developed to outline and minimize plant shutdowns.

## 2.7 Recommendations

The new proposed Stage 2 UF train is recommended to be located adjacent to the existing Stage 2 train 13. This will require relocation of the existing CIP system to the area north of the existing Stage 2 UF trains, which will in turn require the relocation of the compressed air system currently located in the area prosed for the CIP system. The fabricated elevated walkway that surround the upper level of the UF basins will also need to be reconfigured to accommodate the new UF basin. **Table 2-7** summarizes the discussion above with regards to proposed modifications to accommodate the addition of the fourth train in Stage 2.

**Table 2-7. Summary of Proposed Modifications**

| Item | Comment |
|---|---|
| Add Concrete Basin | Will require significant modifications to the existing plant infrastructure, including concrete work inside the membrane building. |
| Add Membrane System | Will require SCADA integration, additional piping, valves, and associated hardware. |
| Modify and Relocate the Walkway | Will encroach into the remaining space between Stage 2 and the west masonry wall. |
| CIP System Relocation | Potential challenges locating the pumps and associated piping in the area north of the Stage 2 membranes. |
| Air System Relocation | Relocate the existing equipment outside to the north side of the membrane treatment building, or to another location to be more optimal. |
| CIP Drain | Relocate the drain north of Stage 2, closer to the relocated CIP pumps. |
| Electrical and I/O Upgrades | Upgrade the feeder circuit and the upstream breaker for MCC-2. Evaluate Panel CC-3 for capacity to handle additional I/O. |
| Relocated Elevated Walkway | Reuse the existing structure or redesign with new material. |

## 2.8 Estimation of Probable Cost

**Table 2-8. Estimation of Probable Cost for UF Train Addition**

| Item Description | Total Costs |
|---|---|
| Sitework | $164,200 |
| Concrete | $55,100 |
| Miscellaneous Metals | $123,200 |
| Equipment | $1,149,600 |
| Mechanical | $75,800 |
| Electrical | $187,000 |
| Instrumentation and Control | $35,700 |
| **Total Installed Equipment** | $1,790,600 |

| Item | Description | | Total Cost |
|---|---|---|---|
| 1 | Total Installed Equipment | | $1,790,600 |
| 2 | General Conditions (allowed factor at this time) | 10.0% | $179,060 |
| | | **Subtotal:** | **$1,969,660** |
| | | | |
| 3 | Contractor Overhead | 10.0% | $196,966 |
| | | **Subtotal:** | **$2,166,626** |
| 4 | Contractor Profit | 10.0% | $216,663 |
| | | **Subtotal:** | **$2,383,289** |
| 5 | Sales Tax (on materials only) | 8.5% | $98,195 |
| | | **Subtotal:** | **$2,481,484** |
| 6 | Escalation at 3% annually* | 4.8% | $118,898 |
| | | **Subtotal:** | **$2,600,382** |
| 7 | Bond and Insurance | 3.0% | $78,011 |
| | | **Subtotal:** | **$2,678,393** |
| 8 | Contingency | 20.0% | $535,679 |
| | | **Probable Bid Cost** | **$3,214,000** |
| 9 | Engineering | 8.0% | $257,120 |
| 10 | CM | 10.0% | $321,400 |
| 11 | Legal/Admin/Permitting | 3.0% | $96,420 |
| | | **Probable Project Cost** | **$3,888,940** |
| 12 | Additional Cost for Stage 2 Feeder and Permeate Header | | $514,406 |
| | | **Probable Project Cost (with Stage 2 Feeder and Permeate Header)** | **$4,403,000** |

*Assumes construction starts January 2019.

## 3. DAF Addition to Stage 3

This section presents the conceptual design of a dissolved air flotation (DAF) system addition to Stage 3 at the DCMWTP. The plant currently utilizes three (3) lamella plate settlers for solids removal and thickening of water treatment residuals. Each of the existing plate settler systems was designed for 150 gpm capacity. During peak flows, all three lamella plate settlers are required in duty mode to meet the treatment capacity (lack of N+1 redundancy). In addition, the DCMWTP must reduce treatment capacity by 33% when any one settler unit is taken down for maintenance. DCMWTP staff are interested in adding a DAF system to provide enhanced capacity and redundancy for the existing plate settlers. In addition, the DAF system is proposed to treat strainer backwash water during periods when raw water quality diminishes due to the presence of filamentous algae.

The objectives of the sections are:

- Characterize the conditions related to current solids removal and thickening operations at the DCMWTP based on information provided by OMWD;
- Provide a conceptual design of a DAF system and other associated improvements, including location of major components;
- Present considerations related to the operation of Stage 3 along with other improvements in consideration at the DCMWTP; and
- Present the opinion of probable cost for the conceptual improvements.

### 3.1 Background

Raw water treated at the DCMWTP is obtained from relatively high-quality surface sources; however, water quality (turbidity and algae) can change depending on source water blending. A new DAF system is being considered for solids thickening in addition to the plate settlers. The DAF system will serve as a full redundant unit to the plate settlers and will augment the treatment of the strainers backwash waste during periods of declined water quality. Currently, Stage 2 UF reject and centrate from the Stage 4 centrifuge dewatering process are sent to the Stage 3 plate settlers for clarification and thickening. A project is planned to replace the internal components of the plate settlers due to ageing and corrosion. The updated components have potential to increase capacity; however, performance will need to be verified upon completion of the project.

Additionally, the flow of strainer backwash water is also being considered for treatment by the proposed DAF process during challenging water quality periods when strainer backwash can be nearly continuous for periods of time. Section 1 describes the proposed strainer backwash treatment. Under current operations that flow is discharged to on-site storm water drainage. The new DAF system can provide flexibility to treat and recover a large portion of the strainer backwash flow.

The purpose of the DAF process is to separate most of the solids present in Stage 2 reject, centrate or strainer backwash water by floating them to the tank surface for removal. Flotation is achieved by injecting a pressurized air-saturated recycle stream into the process flow. After flocculation, the water is exposed to micro-bubbles that are created by saturating 8 to 20 percent of the filtered water stream (DAF recycle) with air in a packed tower pressure vessel (saturator) at 65 to 95 psig. The DAF recycle is added in the DAF contact zone and the pressure is suddenly reduced to atmospheric levels by the use of specially designed nozzles. As a result of the drop in pressure, air is released in the form of micro-bubbles that attach to the flocculated particles and float the particles to the surface of the tank. This process forms a dense foam (float) at the water surface. Periodically, the float is removed by a mechanical skimmer. The DAF float is then collected in a DAF holding tank and pumped to the centrifuges (Stage 4) for mechanical dewatering.

## 3.2 Stage 2 Reject Solids Characterization

The solids entering the Stage 3 process includes solids from Stage 2 and centrate from Stage 4 (centrifuge). The turbidity of the Stage 2 reject is monitored by an online turbidimeter (AIT-710-1). The daily averages of the collected turbidity data from January 2016 to December 2017 are provided in **Figure 3-1**. The turbidity data shows that the Stage 2 reject is highly variable depending on solids in the source water and the amount of treatment chemicals used at the DCMWTP. The turbidity during challenging source water conditions regularly peaks above 100 NTU, but on average is approximately 76 NTU. These turbidity levels are toward the high-end of solids treated by DAF systems; however, a pilot study was performed to confirm DAF performance capabilities at the DCMWTP (discussed below).

### DAF Pilot Testing

In September 2010, a five-week pilot study was performed by Leopold (now Xylem) to evaluate DAF to treat solids entering Stage 3 of the DCMWTP. The pilot study tested various DAF operating strategies and several coagulants. The water quality (turbidity) during this time was consistent with the data presented in **Figure 3-1,** as turbidity in the water feeding Stage 3 was ranging between 60 and 80 NTU. The study evaluated loading rates between 4 to 8 gpm/ft$^2$ and DAF recycle rates between 7.3 to 19%. While there was some variability in the DAF pilot performance, mostly due to DAF pilot operational challenges, the DAF system did perform successfully to remove solids (as indicated by reducing turbidity). According to the study, the most effective operating strategy was a loading rate of 4 gpm/ft$^2$, with a recycle rate of 10%, and a flocculation time of 13 minutes. This operating strategy produced an average turbidity of 0.3 NTU. The most successful coagulant tested during the study was Nalco 4954, which is the current coagulant used in Stage 3 treatment.

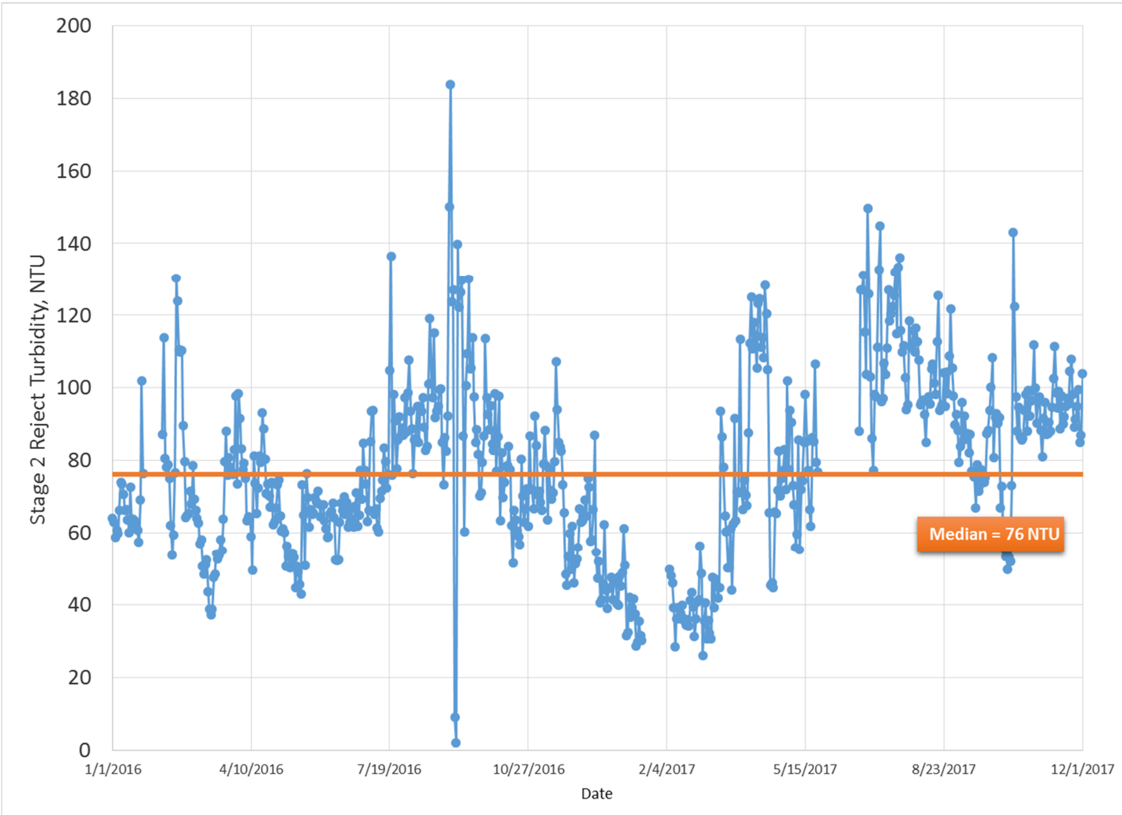



**Figure 3-1. Turbidity Data from Stage 2 Reject**

## 3.3 Strainer Backwash Solids Projection

The strainer backwash water solids concentrations and particle distribution are currently unknown as they have been discharged to storm water drainage without monitoring. The characterization of suspended solids in the strainer backwash water will directly correlate to the floated solids removed in the DAF system; therefore, the characterization of suspended solids is important to properly sizing the equipment. It is recommended that a full characterization of the backwash water quality (after straining) be performed during preliminary design to refine the solids loading rates and appropriately size the DAF system and floated solids holding tank.

The pilot plant testing described above was performed on Stage 2 reject water only; therefore, the DAF system performance may differ significantly when treating strainer backwash water. At this time, the successful parameters from DAF testing (flocculation time, loading rate, and recycle rate) are assumed to be sufficient for treating strainer backwash water. It is recommended that bench-scale and/or pilot testing be performed on the strainer backwash water to confirm that the proposed DAF design parameters are adequate for treatment.

**Projected Future Operations**

Under normal operations, the Stage 2 reject and Stage 4 centrate is conveyed to the Stage 3 plate settlers. The Stage 4 centrate is collected in a tank and intermittently recycled/blended with Stage 2 reject water prior to Stage 3. Depending on the optimization of centrifuge operation, some residual polymer may recycle and affect the performance of the plate settlers. Additionally, centrate must be pumped back to the main treatment building to be blended with the Stage 2 reject. As an option, the DAF system can operate in parallel with the plate settlers, and the centrate can be directed to the new DAF system (shorter pipe run) during normal operations.

As described in Section 1 - Strainer Backwash Water Recovery (SBWR) system, two operating scenarios are anticipated: normal mode and impaired mode. The normal mode of operation would be carried out for approximately ten (10) months of the year, when the raw water quality is relativity good and the strainers intermittently backwash based on time (about once every 3 hours), or when differential pressure on the strainers exceeds 4 psi. When the raw water quality is diminished, the strainer backwash quality may require an alternate treatment to adequately assure solids and algae removal. It is anticipated that treating the strainer backwash water with the DAF system would be more advantageous than the lamella plate settlers as there may be elevated levels of algae that are typically more likely to float than settle. The DAF system configuration will allow for parallel operation with the plate settlers during periods of increased flows and/or solids loading.

Below are the projected Stage 3 solids clarification and thickening future operations during normal and impaired mode. The proposed DAF operations at the DCMWTP are presented schematically in **Figure 3-2**.

***Normal Mode***

- Plate settlers provide routine solids removal and thickening operations of Stage 2 reject and Stage 4 centrate
- DAF system provides redundancy to plate settlers (and vice versa)
- DAF system treats centrate flow (optional)

***Impaired Mode***

- Plate settlers provide routine solids removal and thickening operations of Stage 2 reject and Stage 4 centrate
- DAF system treats higher flows from strainer backwash
- DAF system treats centrate flow (optional)

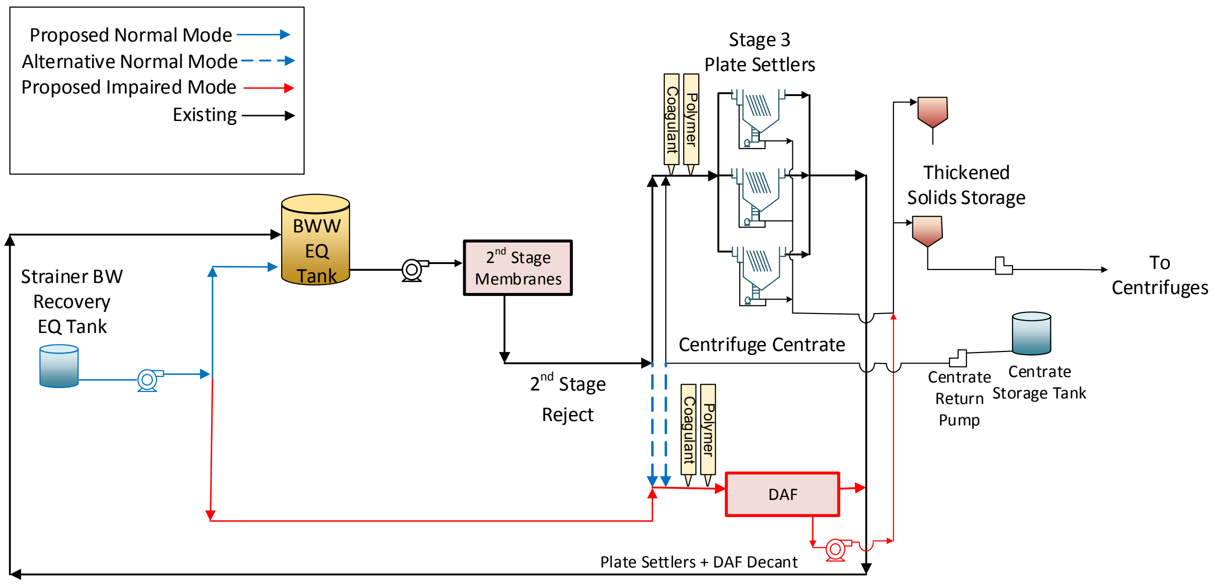



**Figure 3-2. Stage 3 Process Flow Diagram with Proposed Modifications**

## 3.4 Proposed DAF System

Based on the 600 gpm (0.86 mgd) flowrate of strainer backwash water to the DAF system, it is anticipated that a packaged DAF system would be a more cost-effective option than a component engineered system. A packaged DAF system may also allow for a faster design and construction schedule compared to a traditional DAF design for this size. Several vendors provide packaged DAF systems for drinking water treatment including Xylem (formally Leopold), Suez (formally IDI), and Roberts. Other manufacturers produce DAF systems for industrial or wastewater purposes; however, because they do not have confirmed NSF 61 materials they were not considered. The Suez system is a high rate DAF system that operates between 10-20 gpm/ft$^2$. Although the footprint would be reduced at the higher loading rates, performance of this system could not be confirmed; therefore, a system with a conventional loading rate was considered.

For the purpose of this preliminary conceptual layout, Xylem systems are used because the system utilizes a conventional loading rate system that has proven results for the DCMWTP. The proposed design utilizes one DAF train sized to treat 600 gpm; however, if desired, two (2) 300gpm trains may be installed as an alternative. Two (2) smaller trains would allow for operation at lower flows and provide more flexibility, but it anticipated that the design would be approximately 40-50% more expensive based on discussions with Xylem representatives. The design parameters and major equipment anticipated for the DAF system are provided in **Table 3-1** and **Table 3-2** respectively.

**Table 3-1. Design Conditions – DAF System**

| Parameter | Unit | Value |
|---|---|---|
| Maximum Flow | gpm | 600 |
| Number of Trains | - | 1 |
| Number of Basins per Train | - | 1 |
| Number of Flocculation Stages per Basin | - | 2 |
| Flocculation Time at Design Flow | min | 12 |
| Basin Loading Rate at Design Flow | $gpm/ft^2$ | 4 |
| Recycle Percentage | % | 8-20, 10% average |
| Recycle Flow Per Train | gpm | 70 gpm |

**Table 3-2. Major Mechanical Equipment**

| Parameter | Qty | Sizing |
|---|---|---|
| Static Mixers | 1 | - |
| Flocculation Mixers | 2 | 1 HP ea. (2 HP total) |
| Air compressors | 2 | 1.4 scfm , 5 HP ea. |
| Mechanical Skimmer | 1 | 1 HP |
| Saturators | 1 | - |
| Recycle Pumps | 2 | 70 gpm, 210 ft, 10 HP ea (1 duty, 1 standby) |
| Clarified Water Transfer Pumps | 2 | 600 gpm, 10 HP ea. (1 duty, 1 standby) |
| Number of Solids Pumps | 2 | 20 gpm, 5 HP ea. (1 duty, 1 standby) |
| Coagulant System | 2 | 10 gpm, 1 HP ea. (1 duty, 1 standby) |

The DAF system will require platforms, ladders, railings, and walkways for operator access to the top of the DAF unit. Conceptual layout of the equipment is provided in **Figure 3-3**. The approximate planning level cost for the DAF equipment shown in **Figure 3-3** is $670,000.

### 3.5 Summary of Major Equipment

Mixing and Flocculator Equipment:

- Static Mixer - An in-line static mixer shall be provided on the influent line
- Flocculators - Each of the two flocculation stages will have an axial impeller type vertical mixer.

Recycle System Equipment:

- Recycle Pumps - Two (2) recycle pumps, (1) duty and (1) standby under normal conditions shall be provided. Both pumps may be required for higher recycle flows when solids loading from Stage 2 warrants a higher bubble concentration. The pumps shall be vertical multi-stage type each shall be controlled by a variable frequency drive to allow the recycle flow to be adjusted to provide the desired performance

Hazen

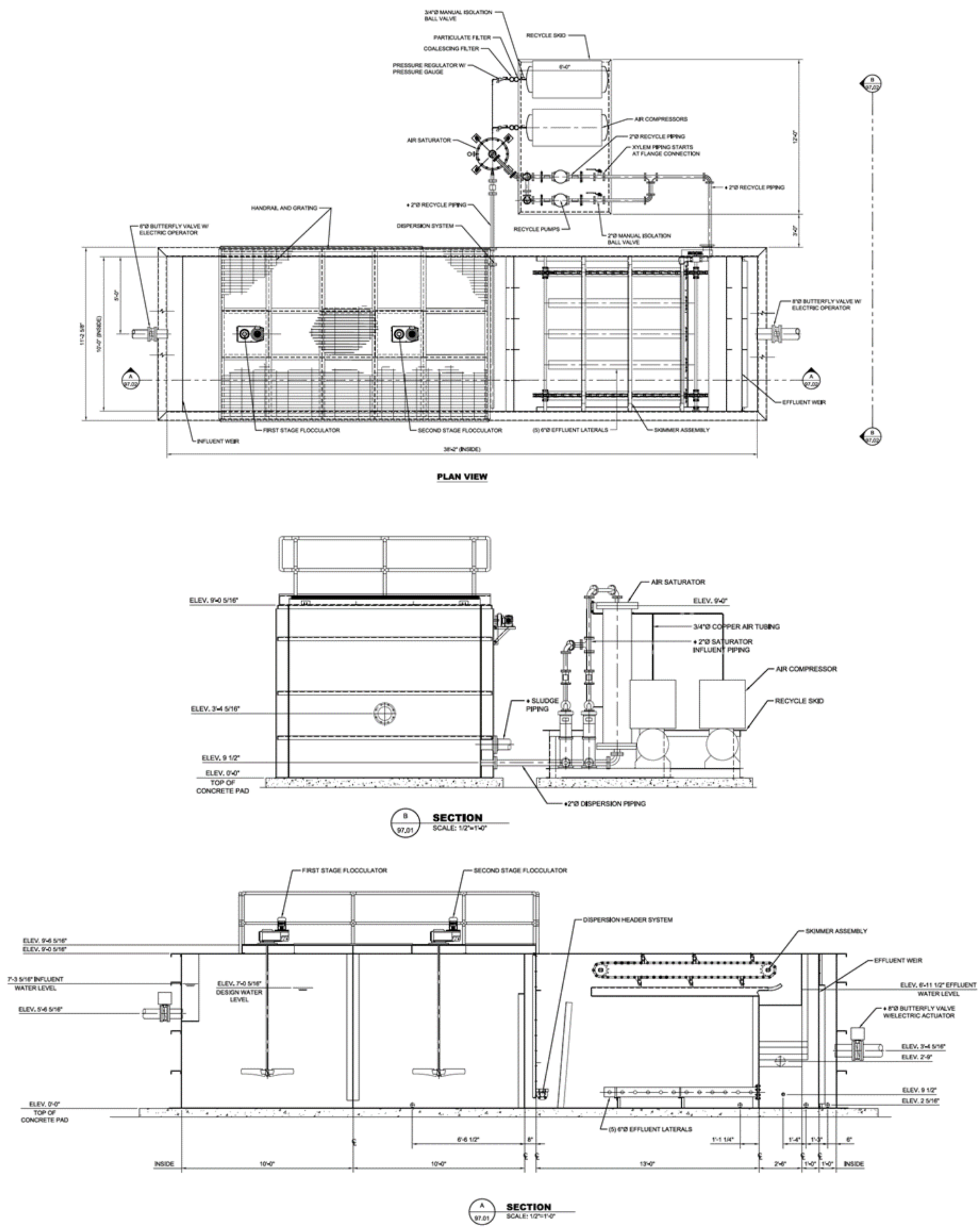



**Figure 3-3. Component layout of proposed DAF System**

- Air Compressors – Two (2) air-cooled, oil-less rotary scroll air compressor package shall be provided to saturate air. Each package shall be mounted on an air receiver tank. The compressor package shall come complete with compressor, receiver, interconnecting piping, all accessories and appurtenances specified or otherwise required for proper operation.
- Saturation Tank - A packed tower air saturation tank with polypropylene packing shall be provided for saturating water. An injector style air saturator is not recommended.
- Dispersion Manifolds - Dissolved air dispersion manifolds shall be in the contact zone at the entrance to the DAF tank. Each manifold will be supplied with fixed orifice dispersion nozzles to uniformly disperse the saturated water. Two or three manifolds will be provided to help assure the appropriate bubble concentration over the anticipated range of recycle flows.

DAF System Tank Accessories:

- Process Tank - The dissolved air flotation process tank shall be constructed of painted carbon steel plates, suitable for potable water treatment. Tanks shall be supplied with FRP flow control weir plate, including two stage flocculation area, one flotation area, one solids area and one effluent area. The process tank will be provided with an appropriate coating for corrosion resistance of the water to be treated.
- Mechanical Skimmers – A chain and flight mechanical skimmer system with a non-metallic chain shall be provided. The motor shall be provided with a VFD motor and controller to allow the skimming rate to be adjusted as needed to remove float at the desired rate and frequency.
- Launder pipes – The clarified water shall be collected through perforated launder pipes fixed to the bottom of the process tank. The pipes shall be constructed of Schedule 80 PVC.

### 3.6 Coagulant Feed System and Storage

The strainer backwash water solids characteristics are not known at this time; therefore, the required coagulant dose and storage requirements cannot be estimated. It is recommended that bench-scale and/or pilot testing be performed to determine the required dose for treating strainer backwash water. The anticipated coagulant to be used for the DAF system would be Nalco 4954, which was tested during DAF pilot testing and is currently utilized for the Stage 3 plate settlers. Additional metering pumps could be added to the existing coagulant system in the solids treatment building and pumped into the process piping prior to the DAF system; however, it is likely that a dedicated coagulant system for the DAF system may be more desirable based on the relative distances of the various treatment processes. For a dedicated coagulant system, a bulk storage tank, day tank, transfer pumps, and metering pumps would be provided. For preliminary sizing purposes, it was assumed that the DAF coagulant dose would be similar to the doses tested during pilot testing (60 mg/L). At this dose, a 3,000-gal bulk storage tank would be provided for 30 days of storage.

### 3.7 DAF Solids (Float) Management

The possibility of pumping the DAF float directly to the exiting sludge tanks should be explored in the preliminary design phase, after an analysis of the characterization of suspended solid in the strainer backwash water and hydraulic analysis have been completed. For the purposes of this preliminary sizing, it was assumed that the (float will be collected in a holding tank, and two solids transfer pumps (one duty, one standby) will convey solids to the Stage 4 solids holding tanks, prior to being dewatered using the centrifuge(s). The actual solids concentration of the strainer backwash water is unknown at this time. The solid transfer pumps will be piped and valved to provide dual purpose by permitting recirculation of solids in the float holding tank to help dissipate residual air and help normalize the concentration of solids delivered to the Stage 4 solids holding tanks. Currently it is assumed that float solids will be dewatered in Stage 4 using the same anionic polymer at a similar dose. For preliminary sizing purposes, it was assumed that the solids content would be similar to Stage 2 reject (76 NTU avg) and the DAF coagulant dose would be similar to the doses tested during pilot testing (60 mg/L). Based on these assumptions, a floated solids holding tank was sized to be 10,000 gal to provide between 1-2 days of storage.

### 3.8 Accommodations for Water Treatment Residuals System Expansion

The new DAF system will be provided to augment rather than replace the existing Stage 3 plate settlers; therefore, existing space within the residuals treatment building is not available. The DAF system is proposed to be located west of the residuals treatment building as show in Figure 3-4. The new building will be sized to also allow placement of the grit removal from the strainer water. The proposed layout is preliminary, as the sizing conditions for several pieces of equipment (coagulant storage and floated solids holding tank) are currently unknown. For preliminary sizing purposes, it is assumed that a 155 ft x 55 ft building will be provided for the DAF system and SBWR system.

### 3.9 Electrical and Instrumentation requirements

The DAF system will require 460 volts, 3 phase, 60 hertz service for the equipment. The system is proposed to be connected to MCC-5, as discussed in Section 1. It is recommended that the findings are confirmed during preliminary design to determine what electrical improvements are required to support the new DAF system. The DAF system will be provided with a Main Control Panel complete with a PLC and a visual HMI display. The PLC will be tied into the overall plant SCADA system. A turbidity meter would be required to analyze the clarified water from the DAF system and help monitor the performance.

### 3.10 Hydraulic Requirements

It may be possible for the DAF clarified water to flow by gravity to the backwash water equalization storage tank; however, this must be confirmed during preliminary design. For the purposes of this planning level study, it is conservatively assumed that the DAF clarifies water will require pumping to the existing backwash water equalization storage tank prior to the Stage 2 Membrane process. A hydraulic analysis is recommended during preliminary design to adequately size these pumps. For preliminary sizing purposes, it is assumed that two (1 duty, 1 standby) 600 gpm pumps will be provided; however, a larger number of smaller pumps may be desired for operational flexibility.

### 3.11 Operational Considerations

The strainer backwash water will contribute more solids to Stage 3, and could potentially increase the load to the centrifuge(s). Section 4 further details the addition of a second centrifuge, and it is anticipated that this will be sufficient to treat the additional thickened solids. The DAF unit is expected to routinely produce a higher concentration of solids when compared to the lamella plate settlers. Since the thickened solids from both processes will be collected and stored in the thickened solids storage tanks, blended and equalized, a relatively uniform solids concentration will be conveyed to the centrifuge(s).

The performance of the thickening process may be impacted by optimization of coagulant dose. The streaming current monitor (SCM) is used to control coagulant for Stage 2 effluent. It is possible that the length of the sample line from the point of withdrawal to the instrument is excessive, and creates longer than desired detention times to appropriately control ACH coagulant dose. Solids can settle in the sample line, which further impact the representativeness of the sample and impact the desired ACH coagulant dose control. Further, the current location of SCM sample withdrawal should be evaluated with respect to the point of ACH coagulant and polymer dose locations to assure that chemical reactions are complete and all chemicals have been completely dispersed, without excessive time delays. Correlating the turbidity data to optimize coagulant dose is also recommended to aid in thickening operations. Because the solids content of the strainer backwash water has not been characterized, it is recommended that an additional turbidity analyzer be placed on the strainer backwash water line to assist operations in optimizing treatment of that future flow to the DAF system.

## 3.12 Recommendations

**Table 3-3** summarizes our findings and proposed improvements for the addition of a new DAF System.

**Table 3-3 – Summary of Proposed Modifications**

| Item | Comment |
|---|---|
| New DAF Building | Building to include new DAF system and the grit removal for the strainer backwash recovery system. |
| Packaged DAF System (600 gpm) | New DAF system to be provided with recycle pumps, air compressors, saturators, etc. Ladders, stairs and platforms not included in DAF package and provided separately. |
| Floated Solids Holding Tank and Pumps | Tank to be sizes to be confirmed during preliminary design based on verified solids loading. Pumps to be sized appropriately to pump back to existing solids holding tanks. |
| Clarified Water pumps | Pumps to be sized appropriates based on system hydraulic analysis to pump to the backwash water equalization tank. |
| Coagulant System | Tank and pump sizes to be confirmed during preliminary design based on verified coagulant doses. |
| Piping | Modifications to allow Stage 2 reject and/or centrate to be directed to the DAF system. New piping to allow recovered strainer backwash water to be directed to the DAF system. |
| Electrical | Can be supplied from MCC-5. The existing circuits, main circuit breaker, and upstream breaker supplying MCC-5 would have to be upgraded to 600A to support the new load. |

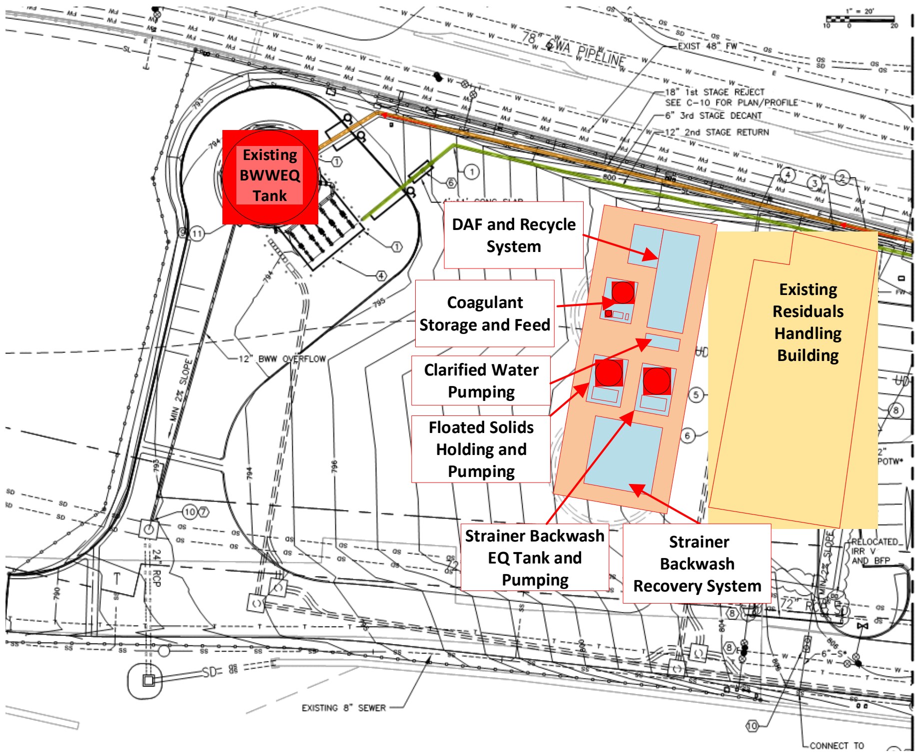



**Figure 3-4 – Proposed Strainer Backwash Recovery System Location**

## 3.13 Estimation of Probable Cost

**Table 3-4 Estimation of Probable Cost for DAF Addition**

| Item Description | Total Costs |
|---|---|
| Sitework | $68,500 |
| Concrete | $178,600 |
| Miscellaneous Metals | $492,900 |
| Equipment | $974,300 |
| Mechanical | $73,400 |
| Electrical | $289,500 |
| Instrumentation and Control | $103,900 |
| **Total Installed Equipment** | $2,182,000 |

| Item | Description | | Total Cost |
|---|---|---|---|
| 1 | Total Installed Equipment | | $2,182,000 |
| 2 | General Conditions (allowed factor at this time) | 10.0% | $218,200 |
| | | **Subtotal:** | **$2,400,200** |
| 3 | Contractor Overhead | 10.0% | *$240,020* |
| | | **Subtotal:** | **$2,640,220** |
| 4 | Contractor Profit | 10.0% | *$264,022* |
| | | **Subtotal:** | **$2,904,242** |
| 5 | Sales Tax (on materials only) | 8.5% | *$123,780* |
| | | **Subtotal:** | **$3,028,022** |
| 6 | Escalation at 3% annually* | 6.1% | *$184,407* |
| | | **Subtotal:** | **$3,212,429** |
| 7 | Bond and Insurance | 3.0% | *$96,373* |
| | | **Subtotal:** | **$3,212,429** |
| 8 | Contingency | 25.0% | *$827,200* |
| | | **Probable Bid Cost** | **$4,136,000** |
| 9 | Engineering | 8.0% | *$330,880* |
| 10 | CM | 10.0% | *$413,600* |
| 11 | Legal/Admin/Permitting | 3.0% | *$124,080* |
| | | **Probable Project Cost** | **$5,004,560** |

*Assumes construction starts July 2019

# 4. Stage 4 Centrifuge Addition

This section presents the findings from the evaluation of the addition of a centrifuge in Stage 4 at the DCMWTP. The plant currently utilizes one centrifuge for the dewatering of water treatment residuals. While the existing centrifuge can adequately handle the range of water treatment residuals historically generated at the DCMWTP, OMWD is interested in adding a second unit to enhance reliability and redundancy. The objectives of this section are:

- Characterize the conditions related to dewatering operations at the DCMWTP based on information provided by OMWD;
- Provide a conceptual layout of the proposed centrifuge and other associated improvements;
- Present considerations related to the operation of the proposed improved Stage 4 water treatment residuals dewatering system in light of other improvements in consideration at the DCMWTP; and
- Present the opinion of cost for the conceptual improvements.

## 4.1 Background

The DCMWTP utilizes a series of treatment processes in the production of high quality potable water. Figure 4-1Figure 3-2 schematically represents these processes. Mechanical screening of raw water is followed by two stages of membrane filtration (Stages 1 and 2). Both stages provide ultrafiltration membrane treatment. The reject from the Stage 1 is filtered by the Stage 2 membranes, and the filtrate from Stage 2 is blended with raw water upstream of the Stage 1 membranes.

Stage 2 reject is directed to a series of residuals handling processes to maximize water recovery and minimize the disposal of residuals off-site. The reject from Stage 2 is currently treated by the three Stage 3 lamella plate settlers, which serve as thickeners upstream of the Stage 4 dewatering centrifuge. Sludge thickened in Stage 3 is stored in the two thickened sludge storage tanks before it is pumped to the centrifuge. The overflow from the plate settlers is recycled and blended with the Stage 2 influent, while the Stage 4 centrate flow is blended with the Stage 3 influent. Other than backwash flow from the raw water mechanical strainers, the plant currently has no liquid discharges. Dewatered residuals are collected in roll-off containers and trucked off-site.

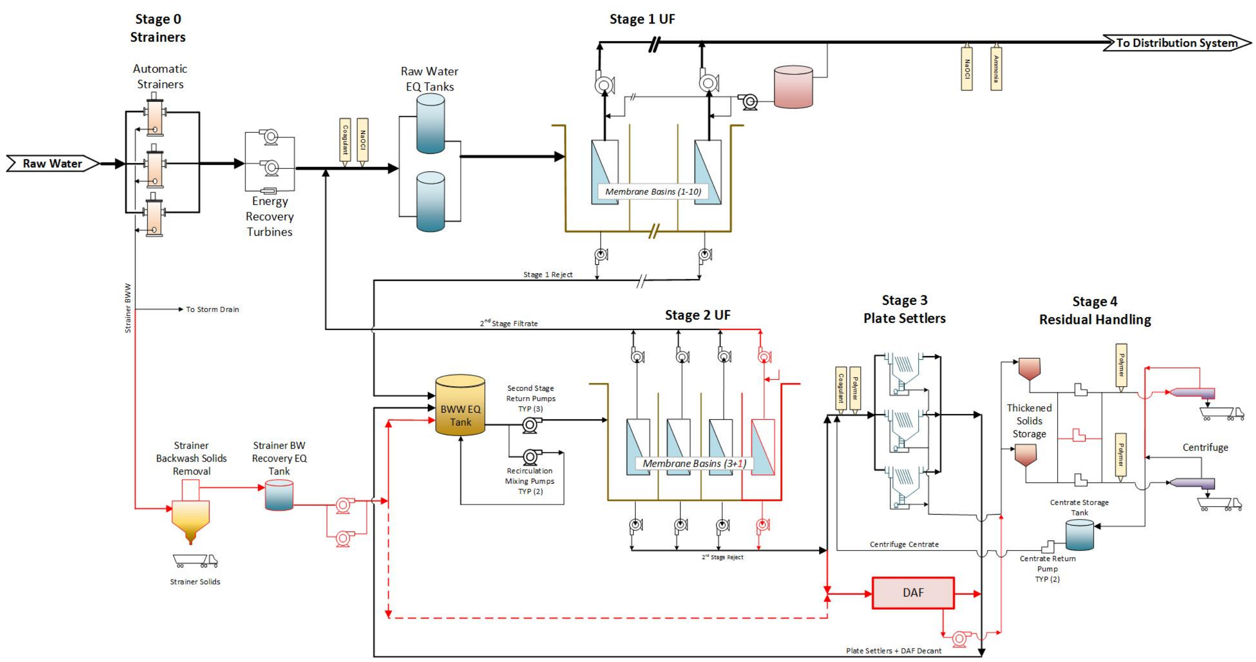



**Figure 4-1. Process Flow Diagram with proposed modifications**

## 4.2 Water Quality Characteristics and Solids Generation Estimates

Raw water treated at the DCMWTP is obtained from relatively high quality surface sources. Characterization of solids generated at the DCMWTP was estimated by others based on raw water quality as sampled and is summarized in **Table 4-1**. These estimated values were developed from 95$^{th}$ percentile raw water quality data collected at the MWD Lake Skinner outlet (between 8/22/02 and 8/19/08), industry references[1], stoichiometric calculations and certain assumptions for projecting the generation of solids based on water quality factors[2].

**Table 4-1. Estimated raw water solids generation, MWD Lake Skinner (CDM, 2010[2]).**

| Solids Constituent | Estimated Solids Generation (dry lb/MG treated water) |
|---|---|
| **Turbidity** | 17.35 |
| **Color** | 11.68 |
| **Total Organic Carbon** | 25.35 |
| **Iron** | 0.64 |
| **Manganese** | 0.12 |
| **Total Estimated Raw Water Solids** | 55.14 |

Since these values are representative of the 95$^{th}$ percentile of raw water quality parameters, solids quantities under more typical conditions can be expected to be significantly less. For instance, the 95$^{th}$ percentile value for turbidity was 1.6 ntu, but plant staff have reported a recent average raw water

[1] *Integrated Design and Operation of Water Treatment Facilities* (Kawamura, 2000).

[2] *Supplemental Preliminary Design Report, David C. McCollom Water Treatment Plant LT2 Improvements Project* (CDM, February 2010).

turbidity of 1.2 ntu from 2015 through November 2017. The difference between the 95th percentile and the recent average turbidity level corresponds to 11.9 dry lb/MG of treated water, a 25% reduction for turbidity and a 7.9% reduction overall. Additional average or typical data was not available for detailed analysis, however the estimates in Table 1 are useful in understanding the higher-end of the range of solids generated at the plant based on raw water quality.

In addition to raw water quality, the various chemicals added for the treatment of process streams at the DCMWTP also contribute to solids generation. The chemicals and their application points are as follows:

- aluminum chlorohydrate (ACH)
    - coagulant (Stage 1)
- sodium hypochlorite
    - pre-oxidant and disinfectant (Stage 1 and finished water)
- Catfloc 4954
    - coagulant (Stage 3)
- polymer
    - thickening aid (Stage 4)

Among these chemicals, the only non-trivial impact on the generation of solids is due to the addition of ACH upstream of the Stage 1 filters, and Catfloc 4954 upstream of the Stage 3 lamella plate settlers. In order to estimate the impact, the LT2 PDR assumed the amount of solids generated by the addition of ACH ($Al_2Cl(OH)_5$) would be equivalent to the addition of aluminum sulfate ($Al_2(SO_4)_3 \cdot 18H_2O$) which, at a dose of 3 mg/L, should correspond to 6.7 pounds of dry solids for every MG of water treated at the plant (per LT2 PDR). Since the ratios of aluminum to the molecular weights of ACH (30.9%) and aluminum sulfate (8.1%) are very different, this assumption may not be appropriate.

The exact chemical composition of Catfloc 4954 is proprietary, but it is also composed of aluminum compounds. The estimated solids generated from the use of Catfloc 4954 (as extrapolated from the LT2 PDR) was apparently approximately 0.78 times the mass of the assumed 90 mg/L dose to the influent of the Stage 3 thickening units, ranging between approximately 7.3 to 7.8 pounds of dry solids for every MG of water treated at the plant (under the three flow conditions modeled). The basis for this estimate is not clear based on the LT2 PDR.

Additional information related to the ACH and Catfloc 4954 solutions used at the DCMWTP is necessary in order to further evaluate the validity of the assumptions in the model. Hazen also recommends that the chemical characteristics of water treatment residuals be analyzed by a qualified laboratory as a means of confirming the aluminum solids component of the water treatment residuals. Understanding the total mass of aluminum in a sludge sample, relative to the total mass of the sample and the mass of the other constituents in the sample, could provide evidence related to the effect of ACH and Catfloc 4954 doses on the generation of water treatment residuals at the DCMWTP.

A "Solid-Liquid Mass Balance" model was developed by CDM to estimate the conveyance of the water treatment residuals between processes at the DCMWTP. This model utilized the solids generation estimates as described above and assumed certain performance criteria for the different processes in order to estimate the flow rates and solids concentrations in different process and waste streams. **Table 4-2** presents the model estimates for the daily centrifuge influent flow rates and solids load at both average plant production and the design capacity of the plant. These values are useful for the selection of centrifuges and in predicting operating requirements—particularly the time necessary to dewater the water treatment residuals generated by the plant. These values suggest a thickened sludge concentration of approximately 1% at both average and design plant production, which is relatively consistent with the range of thickened sludge concentrations reported by the plant staff (1 – 1.5%), and is consistent with what is typically seen with lamella plate settler units operated at loading rates in accordance with manufacturer recommendations.

**Table 4-2. Centrifuge influent estimates for the DCMWTP from a "Solid-Liquid Mass Balance" model (CDM, 2010)**

| | Centrifuge Influent | |
|---|---|---|
| | **Flow (MGD)** | **Solids Loading (ppd)** |
| **Average Plant Production (20 MGD)** | 0.025 | 2,128 |
| **Design Capacity (34 MGD)** | 0.03 | 2,518 |

The approximate rate of water treatment residuals generation at the DCMWTP is discussed in the following section, and is useful in the consideration of the accuracy of this model.

## 4.3 Existing Water Treatment Residuals System

Water treatment residuals are currently collected and thickened in the Stage 3 lamella plate settler units (TK-710, TK-711 and TK-712). The thickened sludge from these units is collected and stored in two sludge storage tanks. Sludge from these tanks is conveyed by one of two progressive cavity centrifuge feed pumps (P-726-1 and P-726-2, both powered by variable frequency drives) to Centrifuge 1 (CEN-731) for dewatering. Centrifuge 1 is located in the Residuals Handling Building on an elevated platform. The dewatered residuals are discharged via a chute into a roll off container. This container is moved by operations staff using a forklift in the interest of evenly filling it with water treatment residuals, which are ultimately disposed of off-site. Centrate from the centrifuge is collected in a centrate tank and is recycled to the Stage 3 influent by two centrate return pumps (P-740-1 and P-740-2).

Centrifuge 1 (Model Aldec 406) was manufactured in 2002 by Alfa Laval. The centrifuge was manufactured based on the following design criteria.[3]

- Sludge flowrate: 42 gpm
- Feed solids: 2%
- Cake solids: 23%
- Polymer dose: 16 lb/dry ton
- Recovery: 95%

The centrifuge was upgraded by the manufacturer in 2010 and was relocated to its current location in the Residuals Handling Building. The following is a list of the upgrades to the centrifuge and associated controls:

[3] Personal communication with Alfa Laval representative (e-mail message from Alfredo Fernandez, 11/22/17).

- 7.5 HP AC VFD Baldor Premium Efficiency Back Drive Motor
- Prefabricated Frame Modification Assembly to accommodate new Back Drive Motor
- NEMA 4X Centrifuge Operator Panel
- NEMA 12 Centrifuge Starter Panel
- ABB PLC
- ABB Model 800 HMI (PP845)
- ABB Variable Frequency Drives
- Power Loss Ride through Protection Feature

The Alfa Laval criteria listed above corresponds to an approximate hydraulic capacity of 60,000 gpd and a solids capacity of 10,000 ppd. These values are consistent with the typical operation of the centrifuge as reported by the DCMWTP operations staff (10.5 hrs/day, 7 days/wk) generating approximately 32 cubic yards (CY) of wet solids each week. One cubic yard of dewatered sludge from water treatment residuals generally weighs approximately 1 ton or 2,000 lb. If the dewatered sludge is 26% dry solids, approximately 16,600 lb of dry solids is generated at the DCMWTP in a typical week (or 2,400 ppd). This general approximation is slightly greater (13%) than the values estimated by the model under average plant production conditions. The hydraulic loading rates to the centrifuge was calculated based on this approximation, assuming a 1.2% thickened sludge concentration and 73.5 equipment operating hours in a week. The hydraulic loading rate is approximately 38 gpm and is within the manufacturer's design capacity of 42 gpm.

The model uses turbidity values that are slightly higher than typical conditions, but the values predicted in the model are slightly lower than what appears to be normally generated. The difference could be explained by a possible underestimation in the model of solids generated from the use of ACH and Catfloc 4954. However, the possibility of a discrepancy with the "Solids-Liquid Mass Balance" model does not have a practical impact on the operation of the DCMWTP centrifuge. It is worth considering, however, due to the possibility that the amount of solids generated at the plant may be more significantly related to aluminum-based precipitates from ACH and possibly from Catfloc 4954. The reliable production of safe drinking water is the primary goal of the DCMWTP and a change to the doses of the ACH or Catfloc 4945 solutions should never be considered if it could have a detrimental impact to meeting that goal. However, it may be worth considering reducing these chemical doses if it could reduce the quantities of water treatment residuals generated at the plant without detrimentally affecting the treatment performance of the plant.

## 4.4 Accommodations for Water Treatment Residuals System Expansion

Recent improvements at the DCMWTP provided a footprint and support systems for both Centrifuge 1 and an anticipated second centrifuge. Specifically, space for the second centrifuge was provided on the same elevated platform as the existing centrifuge. Space and piping accommodations were also provided for a third centrifuge feed pump.

Accommodations related to electrical supply and controls for the second centrifuge were also provided. Feeder breaker LCP-732 in Motor Control Center 5 was designated for the second centrifuge. The feeder breakers for both the existing centrifuge and the second centrifuge are sized to accommodate 30-hp main drives and 7.5-hp back drives. A centrifuge control panel was also installed on the same elevated platform near Centrifuge 1. Accommodations were made with the control panel to support the second centrifuge including, but not limited to, providing a second PLC for the future centrifuge and include the representation of the second centrifuge graphically on the visual HMI displays.  Some efforts to fully integrate the second unit will almost certainly be necessary when it is installed in the future, but this effort will have been greatly simplified by these accommodations.

## 4.5 Proposed Conceptual Water Treatment Residuals System Improvements

OMWD is considering adding a second centrifuge at the DCMWTP to enhance reliability and redundancy for the dewatering of water treatment residuals generated at the plant.  The proposed centrifuge will have the same operating capacity as the existing centrifuge.  A third centrifuge feed pump is also proposed along with a second centrifuge feed line dedicated to the second centrifuge. **Figure 4-2** presents the proposed layout for the new centrifuge 2 (CEN-732), new centrifuge feed pump 3 (P-726-3) and new feed line.  These new features are also shown schematically in **Figure 4-3**.

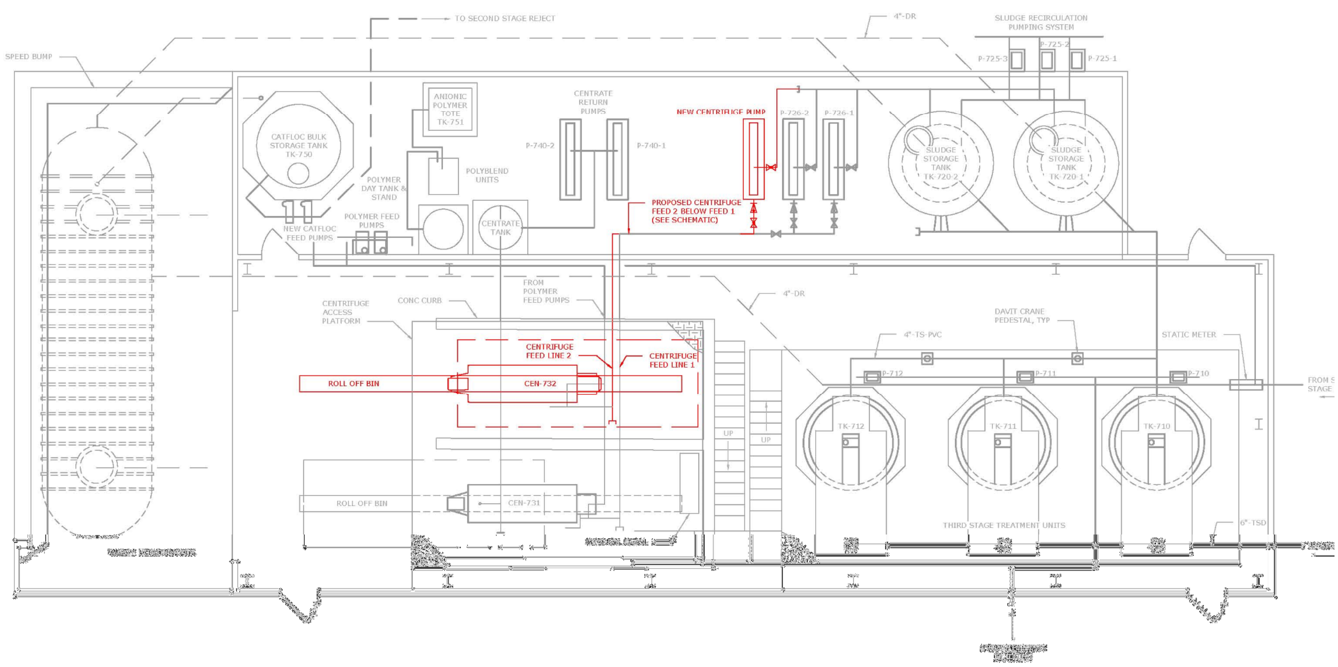



**Figure 4-2. Layout of the new centrifuge and centrifuge feed pump**

While the model of Centrifuge 1 (Aldec 406) is no longer manufactured, Alfa Laval currently manufactures a similar version (Aldec 45, **Figure 4-4**) that would provide at least the same capacity as the existing unit.  Alfa Laval provided a data sheet for this unit (attached), and indicated it is designed for sludge with a 2% solids concentration at a flow rate of 70 gpm.  The budgetary cost of this unit is $250,000 including controls, delivery and start-up support, but excluding installation costs and the costs associated with constructing associated support systems.

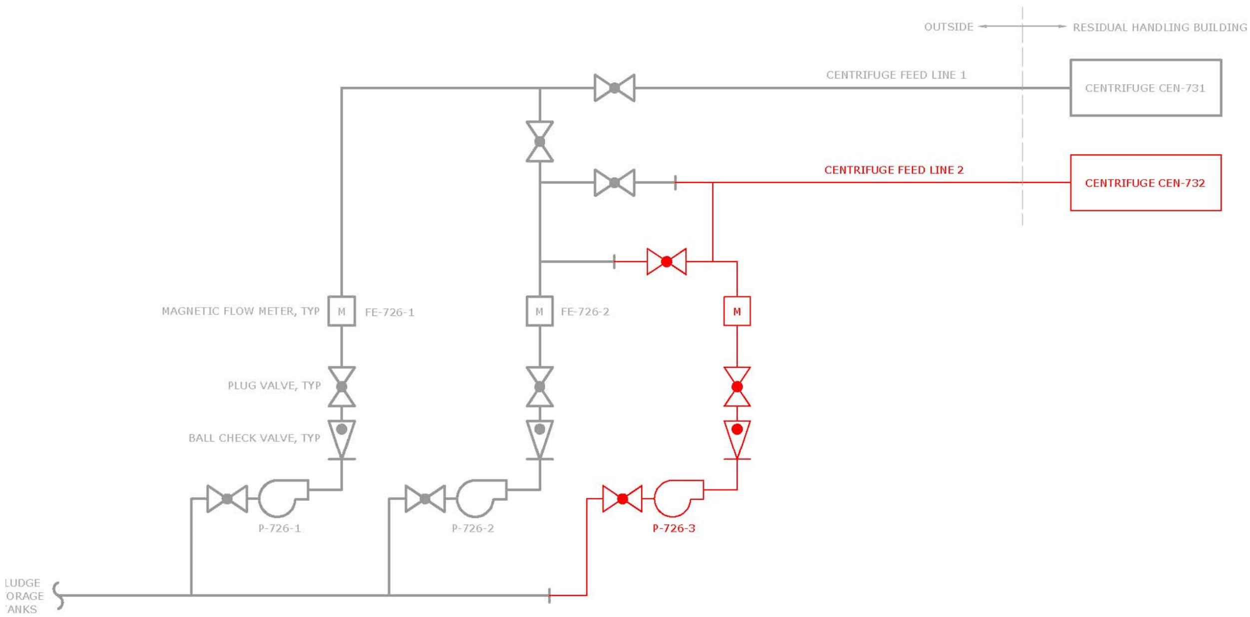



**Figure 4-3. Existing and new centrifuge feed pumps.**

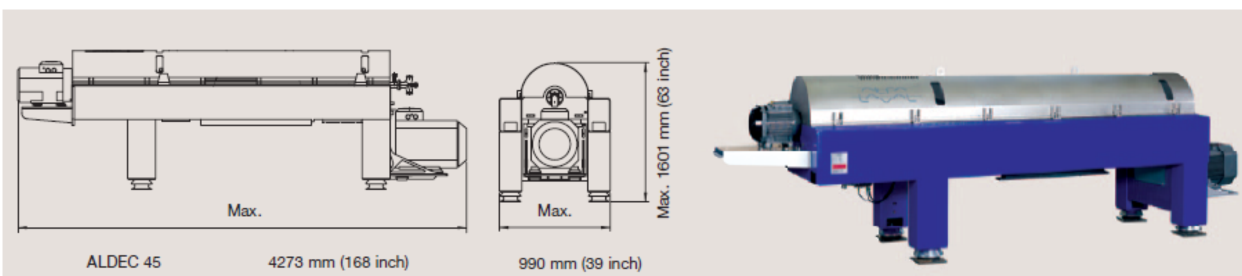



**Figure 4-4. Picture and general dimensions for Alfa Laval ALDEC 45**

Alfa Laval indicated that it will be possible to match many of the same features of the proposed centrifuge to the upgraded Centrifuge 1. The variable frequency drives that were provided in the 2010 upgrade are no longer available from Alfa Laval, but similar drives can be used providing essentially the same or greater functionality. The controls systems for the new centrifuge can be integrated with the existing control panel.

The new Centrifuge 2 is proposed to be located in the area on the elevated platform as planned in the LT2 Improvements project. The platform for the centrifuges appears to be structural adequate from a high level review Considering vibration loading based on the proposed new improvements of having two centrifuges in operation, the natural frequency of the platform would need to be compared with the operating frequency of the equipment to verify that the platform frequency is outside the design ratio for the equipment, otherwise there can be an issue with resonance. If necessary, additional stiffening of the platform can be proposed. Also, in order to get the natural frequency of the platform is would have to be modeled with structural software. Such determination should occur in design. The adequacy of the other systems in place, including the electrical feed for the new centrifuge, should also be verified as part of the preliminary design.

The new Centrifuge Feed Pump 3 (Netzsch NEMO Progressive Cavity Pump model NM053BY01L07K.2) and Centrifuge Feed Line 2 are recommended to match the existing assets. The A new electrical circuit breaker and variable frequency drive will be necessary for the proposed new progressive cavity pump, which has a 5-hp motor. The proposed pump has an updated design with allows for fully servicing the pump in-place. A technical data sheet for the pump is attached. Isolation valves, check valves and other mechanical appurtenances for the new pump are recommended to match the existing pumps.

The new feed line, as indicated in Figure 3, will provide additional redundancy to the existing system. This configuration would allow for any of the three pumps to convey flow to either centrifuge if only one centrifuge is in operation. The configuration would also allow for conveying flow to both centrifuges simultaneously with Centrifuge Feed Pump 2 serving as a swing spare.

It may also be necessary or advisable to install a dedicated polymer feed pump for Centrifuge 2. While polymer could be fed to Centrifuge 2 through the same system that feeds Centrifuge 1, a second pump would provide redundancy, would simplify the operation of the centrifuge polymer feed system, and would allow for the simultaneous operation of both centrifuges. Adding a second polymer feed pump and new lines is therefore recommended.

## 4.6 Electrical Considerations

The electrical considerations for the centrifuge system were discussed in Section 1.

## 4.7 Operational Considerations

The existing water treatment residuals system is typically operated for 10.5 hours each day, seven days each week. The installation of the second centrifuge will provide OWMD with additional operational flexibility. Assuming the new centrifuge is operated at the same loading rate as the existing unit, the simultaneous operation of the two centrifuges could reduce the operating time each day by 50%, or it could reduce the required number of days of centrifuge operation as long as adequate thickened sludge storage is available. **Table 4-3** presents a simple comparison of operational approaches assuming a total of 73.5 hours of equipment time is required each week for the dewatering of water treatment residuals at the DCMWTP. The dual centrifuge operation could reduce the operating time to well within one 8-hour shift over both a 5-day or 7-day operating week.

**Table 4-3. Simple comparison of single to dual centrifuge operation at the DCMWTP assuming 73.5 hours equipment operation time required per week.**

| Mode of Operation | Daily Hours of Operation | |
|---|---|---|
| | 7-Days | 5-Days |
| Single centrifuge operation | 10.5 | 14.7 |
| Dual centrifuge operation | 5.25 | 7.4 |

Other improvements being considered as part of this study include the addition of a dissolved air flotation (DAF) process in parallel with the existing lamella plate settlers in Stage 3 for the thickening of water treatment residuals. Depending on the operation, the DAF unit could be expected to routinely produce a higher concentration of solids in the thickened sludge when compared to the lamella plate settlers. However, since the thickened sludge from both types of thickening processes will be collected and stored in the thickened sludge storage tanks, the thickened sludge will be blended and equalized, and a relatively uniform stream can be expected to be conveyed to the centrifuges.

In discussing the potential for variability in thickened sludge characteristics, Alfa Laval indicated little concern for the operation of the centrifuges, except a potential reduction in hydraulic capacity due to a slight reduction in the efficiency of the centrifuge due to the thicker solids concentration. For instance, an increase of thickened sludge concentration to 4% would reduce the hydraulic capacity of the new unit to approximately 35 gpm, while the solids capacity would remain constant. However, OMWD currently has the capability of reducing the solids concentration in the existing sludge storage tanks by adding water and mixing the sludge in the tanks with sludge recirculation pumps. This capability will be useful for controlling the concentration of solids in the thickened sludge in order to optimize the performance of the centrifuges.

Another improvement under consideration is related to the capture of the raw water strainer backwash stream. One component of the solids in this waste stream is likely grit, including Asiatic clam shells. This material can be expected to have a detrimental impact on the lifetime of certain wear items in the centrifuges. The service or replacement of some of these wear items can be significant as it involves servicing of the centrifuge at the manufacturer's facilities. Alfa Laval indicated that it is possible to provide a tungsten-carbide material upgrade for the feed zone of the centrifuge that would mitigate some of the wear caused by abrasive solids. However, it is recommended to capture the abrasive solids ahead of the treatment system and avoid introduction to the centrifuges. This proposed improvement is addressed in greater detail in Section 1.

## 4.8 Recommendations

**Table 4-4** summarizes our findings and proposed improvements for improvements to the DCMWTP Stage 4 water treatment residuals system.

**Table 4-4 – Summary of Proposed Modifications**

| | Item | Comment |
|---|---|---|
| 1 | Centrifuge 2 | Proposed model will operate similarly to existing centrifuge, and can be fully integrated with the existing control system. |
| 2 | Centrifuge Feed Pump 3 | Addition of the third centrifuge feed pump, with associated mechanical and piping improvements, will accommodate simultaneous operation of both centrifuges with redundancy. |
| 3 | Dewatering Polymer Feed Pump 2 | The second polymer feed pump, feed line and associated mechanical improvements will be dedicated to Centrifuge 2. |

## 4.9 Estimation of Probable Cost

### Table 4-5 – Estimation of Probable Cost for Centrifuge Addition

| Item Description | Total Costs |
|---|---|
| Equipment | $307,200 |
| Mechanical | $13,600 |
| Electrical | $32,100 |
| Instrumentation and Control | $28,900 |
| **Total Installed Equipment** | $381,700 |

| Item | Description | | Total Cost |
|---|---|---|---|
| 1 | Total Installed Equipment | | $381,700 |
| 2 | General Conditions (allowed factor at this time) | 10.0% | $38,170 |
| | | **Subtotal:** | **$419,870** |
| 3 | Contractor Overhead | 10.0% | $41,987 |
| | | **Subtotal:** | **$461,857** |
| 4 | Contractor Profit | 10.0% | $46,186 |
| | | **Subtotal:** | **$508,043** |
| 5 | Sales Tax (on materials only) | 8.5% | $23,931 |
| | | **Subtotal:** | **$531,974** |
| 6 | Escalation at 3% annually* | 6.9% | $36,583 |
| | | **Subtotal:** | **$568,557** |
| 7 | Bond and Insurance | 3.0% | $17,057 |
| | | **Subtotal:** | **$585,613** |
| 8 | Contingency | 20.0% | $117,123 |
| | | **Probable Bid Cost** | **$703,000** |
| 9 | Engineering | 8.0% | $56,240 |
| 10 | CM | 10.0% | $70,300 |
| 11 | Legal/Admin/Permitting | 2.0% | $14,060 |
| | | **Probable Project Cost** | **$843,600** |

*Assumes construction starts January 2020

# 5. Potential Alternatives for DBPs Reduction

This section presents the findings from the evaluation of potential alternatives that could reduce disinfection byproducts (DBPs) at the DCMWTP and in the distribution system. Over the past year, OMWD has been impacted by a change in imported raw water blending ratio, which has led to variable source water quality, increased organics loading, and rising THM concentrations. The THM issue has been exacerbated at times by the presence of pre-formed THMs in the source water due to chlorination of the raw water by MWD. The primary objective of this study is to evaluate options to achieve the required disinfection credit under all source water conditions while maintaining DBP levels within regulatory compliance, meeting OMWD goals, and achieving optimized pathogen protection.

## 5.1 Background

**Raw Water Sources for the DCMWTP**

The source water for the DCMWTP originates from the Colorado River Water (CRW) and/or the State Water Project (SWP) via MWD. MWD controls the blend ratio between these two sources; that is, the source water at the DCMWTP consists of some percentage of CRW, with the remaining fraction from SWP. However, the water quality of these two sources can differ considerably, with the SWP typically containing more DBP precursors relative to the CRW. As such, when MWD increases the ratio of SWP water, OMWD experiences higher formation of DBPs at the DCMWTP and in the distribution system. Since OMWD has no control over the blend ratios, it must be prepared to treat a source water with higher fractions of SWP while maintaining the plant capacity and regulatory compliance.

**Regulated Disinfection Byproducts**

Regulatory compliance associated with disinfection byproducts requires a balance among several simultaneous objectives that include the acute risk of pathogens exposure, the long-term risk of suspected carcinogenic DBPs, and the acute and long-term impacts of exposure to lead and copper in the distribution system. These objectives are regulated among Safe Drinking Water Act requirements associated with the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), Stage 2 Disinfectants and Disinfection Byproducts Rule (S2D/DBPR), and the Lead and Copper Rule (LCR), respectively. While OMWD has historically been in compliance with the L2ESWTR, S2D/DBPR, and the LCR, it is important to understand the regulations, so that the process/system changes that may be implemented to help reduce DBPs will not adversely impact compliance with these rules.

Compliance with the maximum contaminant limits (MCLs) for TTHM (80 µg/L) and $HAA_5$ (60 µg/L) is determined through the use of a Locational Running Annual Average (LRAA) at critical monitoring sites identified during the Initial Distribution System Evaluation (IDSE). The LRAA approach uses the annual average at each sampling location to determine compliance, addressing concerns of spatial variation in DBP exposure throughout the distribution system. The number of system monitoring locations again depends on the size of the population served by the given water system. The IDSE and LRAAs calculation will lead to lower DBP concentration requirements overall. However, this approach may still allow individual DBP samples above the MCL even when the system is in compliance. The rule requires systems that exceed operational evaluation levels (OELs) to evaluate system operational practices and identify opportunities to reduce DBP concentrations in the distribution system.

DBPs are formed by a chemical disinfectant (e.g., free chlorine) reacting with natural organic matter (NOM). Formation begins as soon as chlorine is added to the water at the DCMWTP and may continue as long as free chlorine and NOM are available. While a significant percentage of DBP formation may occur during primary disinfection, MCL violations typically occur in the distribution system as a result of continued exposure to free chlorine and extended contact time.

Parameters affecting DBP formation include detention time, chlorine residual, NOM concentration, pH and temperature. TTHM formation increases with an increase in each of these factors. The same is generally true for $HAA_5$ formation, with two notable exceptions: $HAA_5$ formation is favored as pH decreases, and, at very long detention times and low disinfectant residuals, biological degradation of $HAA_5$ can occur, causing a decrease in $HAA_5$ concentration. Among these factors, chlorine residual, pH, and NOM concentration are typically controlled at the water treatment plant (WTP), while temperature is not cost-effective to control, leaving detention time (water age) as the primary parameter that may be influenced by distribution system design and operation. Reducing water age by modifying distribution system design and operation is therefore one important aspect of DBP control, although reducing water age alone may not be sufficient to attain S2/DBPR compliance.

Many utilities establish internal objectives or goals for DBP concentrations to ensure compliance and/or establish a "buffer" to the MCL. Potential DBP compliance goals are outlined as follows:

- No LRAA exceeding the MCL
- No LRAA exceeding 80% (or other percentage) of the MCL
- No OEL exceeding the MCL
- No Quarterly value exceeding the MCL

OMWD would like to target LRAA values for TTHM and $HAA_5$ equal to or below 60% of the MCL, which is approximately the averages that historically have been achieved prior to the recent source water blends with a significantly higher ratio of SWP. These historical trends are shown in later sections of this memorandum.

**Unregulated Disinfection Byproducts**

Many DBPs have been identified that are not included within the current regulations for THMs and $HAA_5$. Several of these emerging DBPs may be more prevalent in finished waters and/or harmful to public health than those currently regulated. As such, researchers continue to investigate the occurrence and toxicity of the numerous potential byproducts formed as a part of disinfection. These studies, along with the Environmental Protection Agency's (EPA's) focus during the Contaminant Candidate List (CCL) and Unregulated Contaminant Monitoring Rule (UCMR) processes, may ultimately lead to expansion of the regulated DBPs. Thus, any treatment changes considered by OMWD should be flexible and/or rigorous enough to handle these potential short- and long-term regulations.

## 5.2 Water Quality and Disinfection Byproduct Characteristics

Water quality evaluation for this memorandum focused on historical TOC and DBP concentrations. Between 2013 and early 2017, the TOC and DBP levels were relatively consistent, with infrequent peaks occurring throughout this period. The DCMWTP does not regularly measure dissolved organic carbon (DOC) in the source water or finished water, but did perform a study to correlate DOC to TOC. The study indicated that the DOC fraction in the TOC is approximately 0.96 (96%). During the first quarter of 2017, MWD changed the source water blend to a higher fraction of SPW, which is clearly noticeable in water quality recorded at the plant. The following figures summarize the trends associated with TOC and DBPs.

- **Figure 5-1** – Source water TOC, finished water TOC, and the corresponding percent removal are shown in this chart. The significant shift in source water TOC is shown by the high peak in March-April 2017. Based on this data, the DCMWTP achieves approximately 15% TOC removal within the plant. Note that the percent removal of TOC required by EPA's Stage 1 D/DBP Rule is 15% when alkalinity is greater than 120 mg/L as $CaCO_3$ and source water TOC is between 2 and 4 mg/L and is 23% when alkalinity is between 60 and 120 mg/L as CaCO3 and source water TOC is between 2 and 4 mg/L. The percentages rise to 25% (ALK>120) and 35% (60<ALK<120) when source water TOC increases above 4 mg/L.

- **Figure 5-2** – As shown in this chart, the TTHM concentrations in the finished water and at the monitoring points in the distribution system were historically at or below 60% of the MCL of 80 µg/L. When the source water changed during the first quarter of 2017, the TTHM concentrations increased significantly. During this time, the chart also indicates that significant formation continued after the finished water monitoring point.

- **Figure 5-3** – Compliance with the S2D/DBPR is based on long-term running annual averages at each monitoring location in the distribution system. The LRAA is based on current and the previous three quarterly results. As shown in the chart, the peak in early 2017 did not result in non-compliance as the historical levels have been low. However, the upward trend is noted and could lead to a violation if the source water quality was not improved.

- **Figure 5-4.** TTHM OEL Trends – DBP regulations also include early indicators of non-compliance by establishing operational levels that lead to system evaluation and changes if exceeded. Since the OEL calculation emphasizes current quarter results, the OEL for TTHM in early 2017 spiked above 80% of MCL. OEL triggers would be exceeded if source water quality remained poor.

- **Figure 5-5.** HAA5 – Although the primary focus of this study is TTHM, this figure indicates that the spike in early 2017 resulted in high levels of $HAA_5$, which approached 80% of the MCL in at least one of the sampling locations.

- **Figure 5-6.** TOC vs. TTHM – DBP formation potential is a function of multiple parameters. However, one of the key water quality characteristics is organic carbon, and a spike in source water TOC in early 2017 was reflected in a DBP spike. In this chart, the finished water TOC is plotted along with finished water TTHM and TTHM readings at one of the sampling locations within the distribution system. As it can be seen in this chart, the general patterns of TOC change in the finished water are reflected in the resulting DBP production (with a few exceptions), indicating that TOC plays an important role in DBPs formation potential.

- **Figure 5-7.** Lack of Simple Correlation between FW TOC and FW TTHM – Concentrations of finished water TTHMs was plotted against the finished water TOC. As seen in this chart, there is no simple correlation among the data, which emphasizes that variation in DBP production is also a result of other water quality characteristics (e.g., pH and water temperature), specific component groups within the TOC measurement (e.g., humic and fulvic acids), and distribution system dynamics (e.g., water age).

In terms of the other important water quality characteristics in DBP formation, the plant staff at the DCMWTP did notice a shift in pH when the source water fraction of SPW increased. Specifically, the pH decreased from the typical pH value in low-8 range to values closer to the mid-7 range. At this time, MWD was supplying a blend that consisted of approximately 60% SPW and 40% CRW. In order to increase the pH during this time, the plant fed sodium hydroxide to increase the pH of the finished water back into the low-8 range. This finished water pH is targeted to minimize distribution system corrosion (i.e., increase LSI).

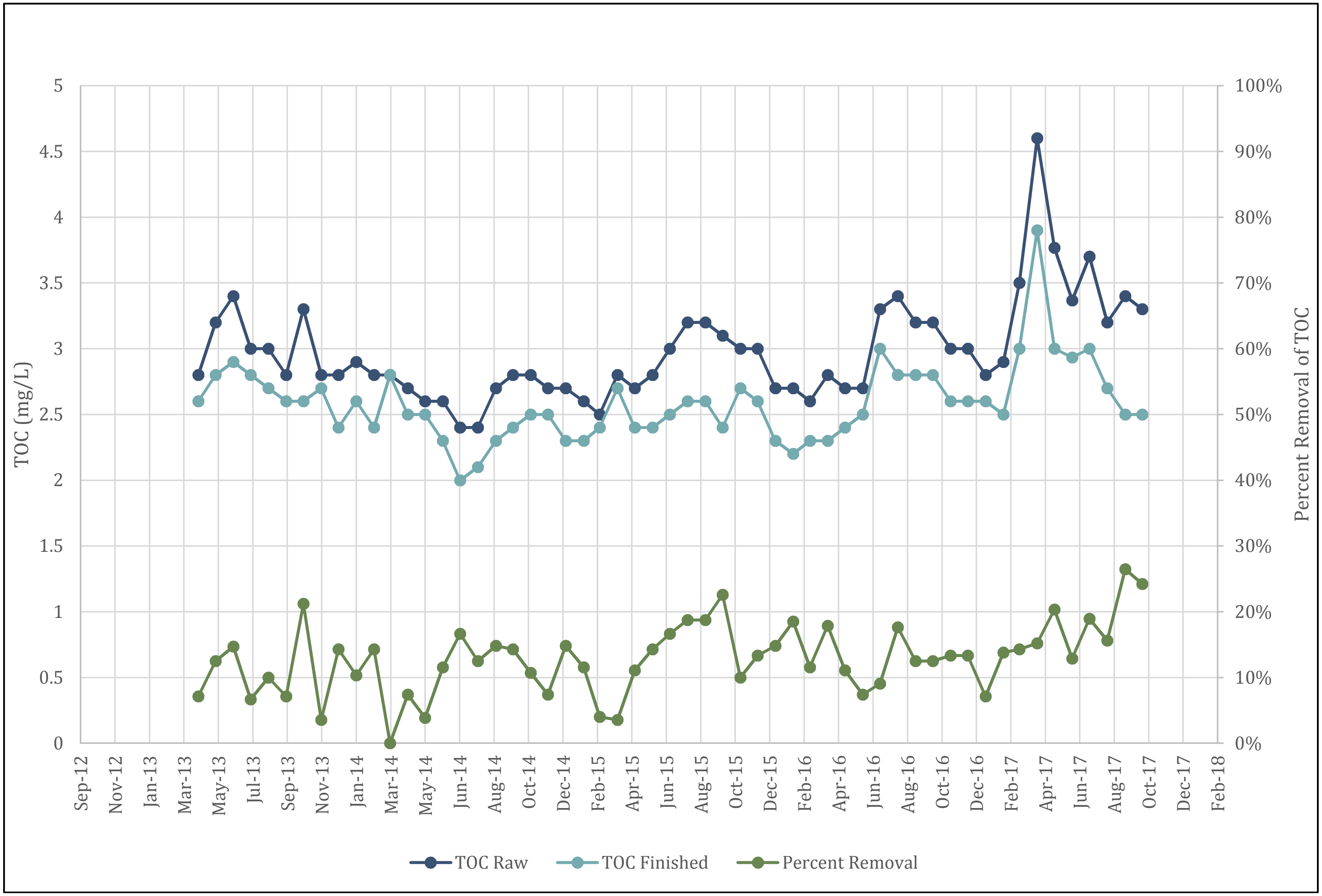



**Figure 5-1. TOC Concentrations in Raw and Finished Water at the DCMWTP**

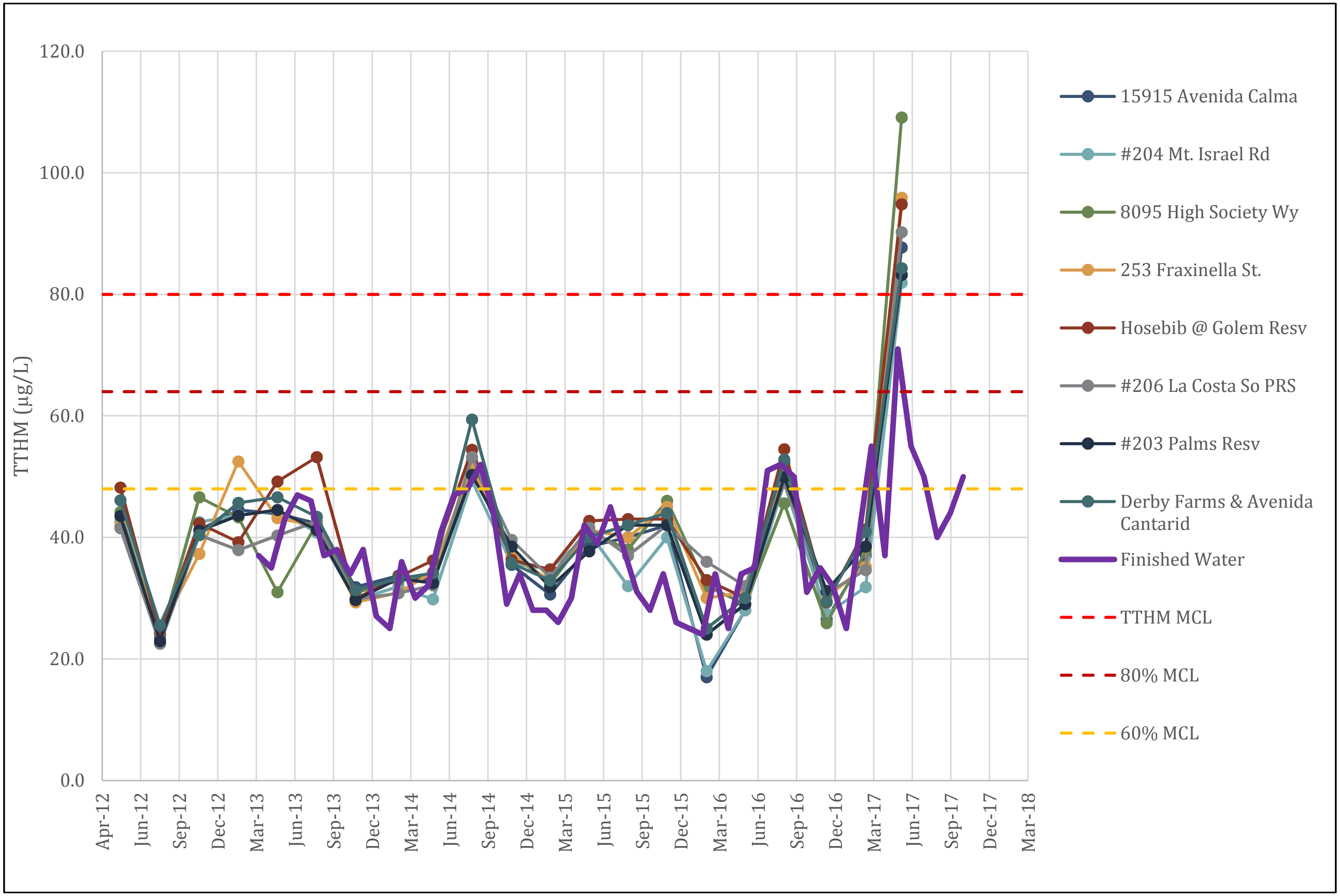



**Figure 5-2. TTHM Concentrations at Sampling Sites in the Distribution System**

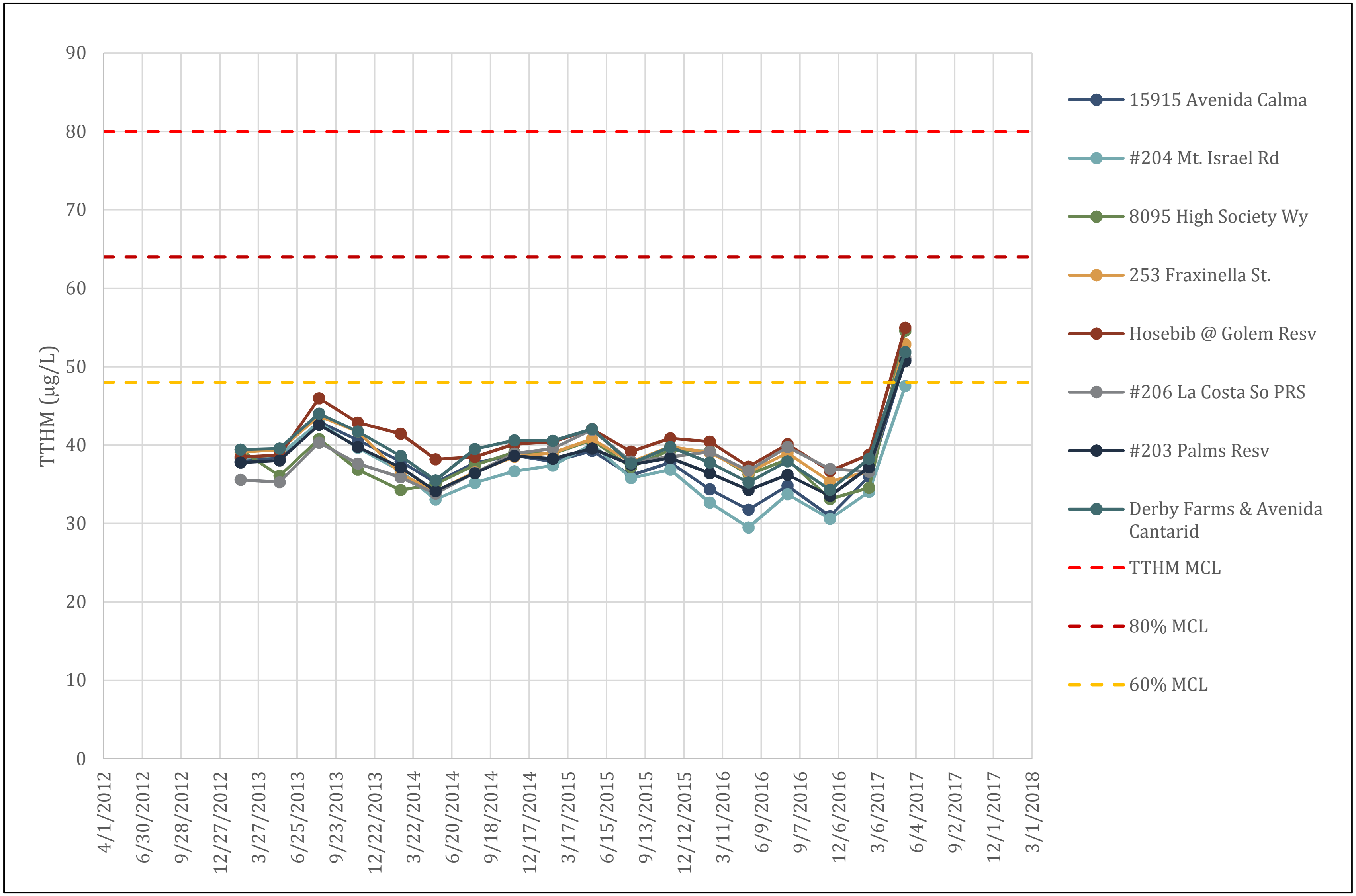



**Figure 5-3. TTHM LRAA Trends in the Distribution System**

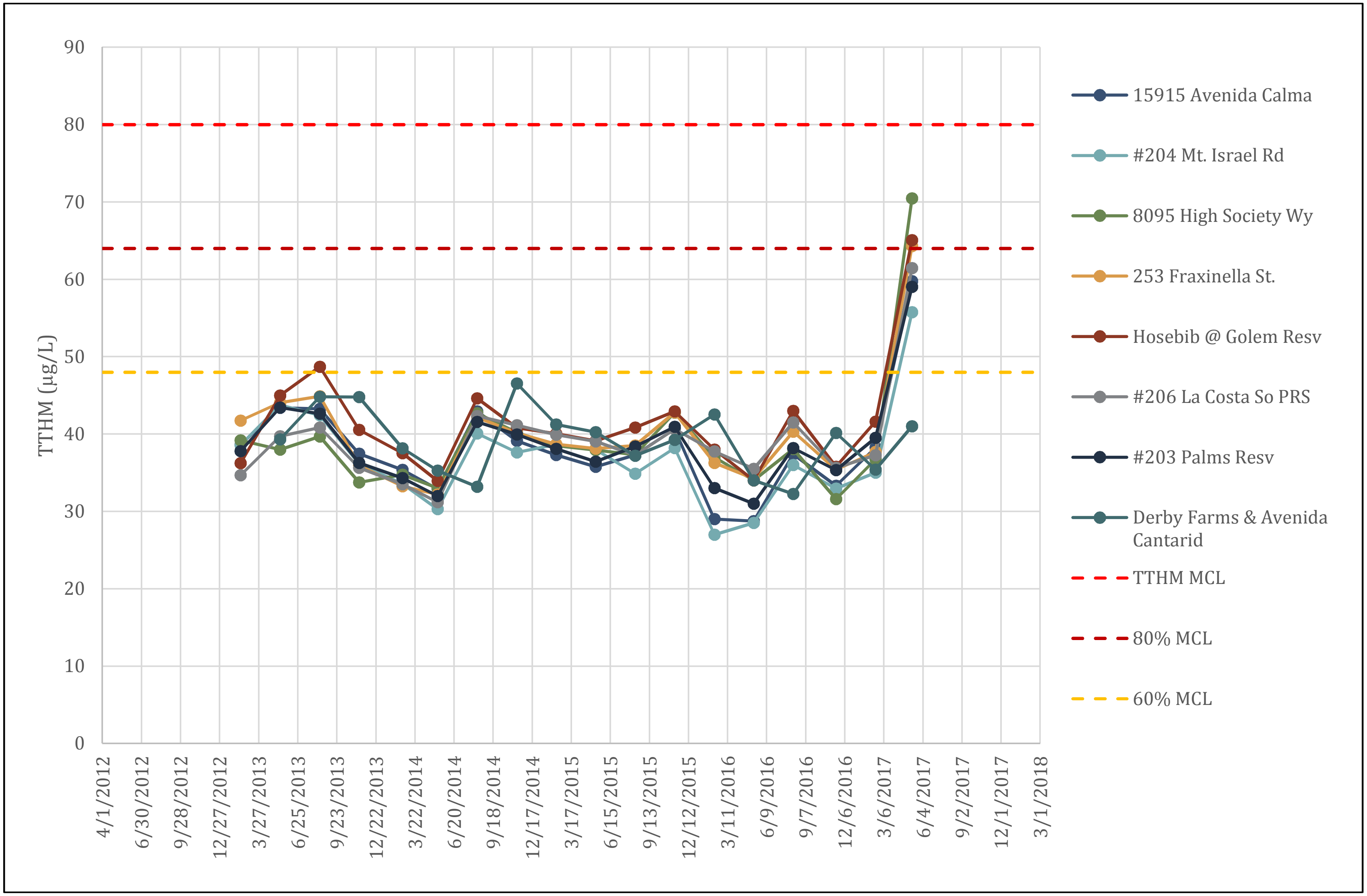



**Figure 5-4. TTHM OEL Trends in the Distribution System**

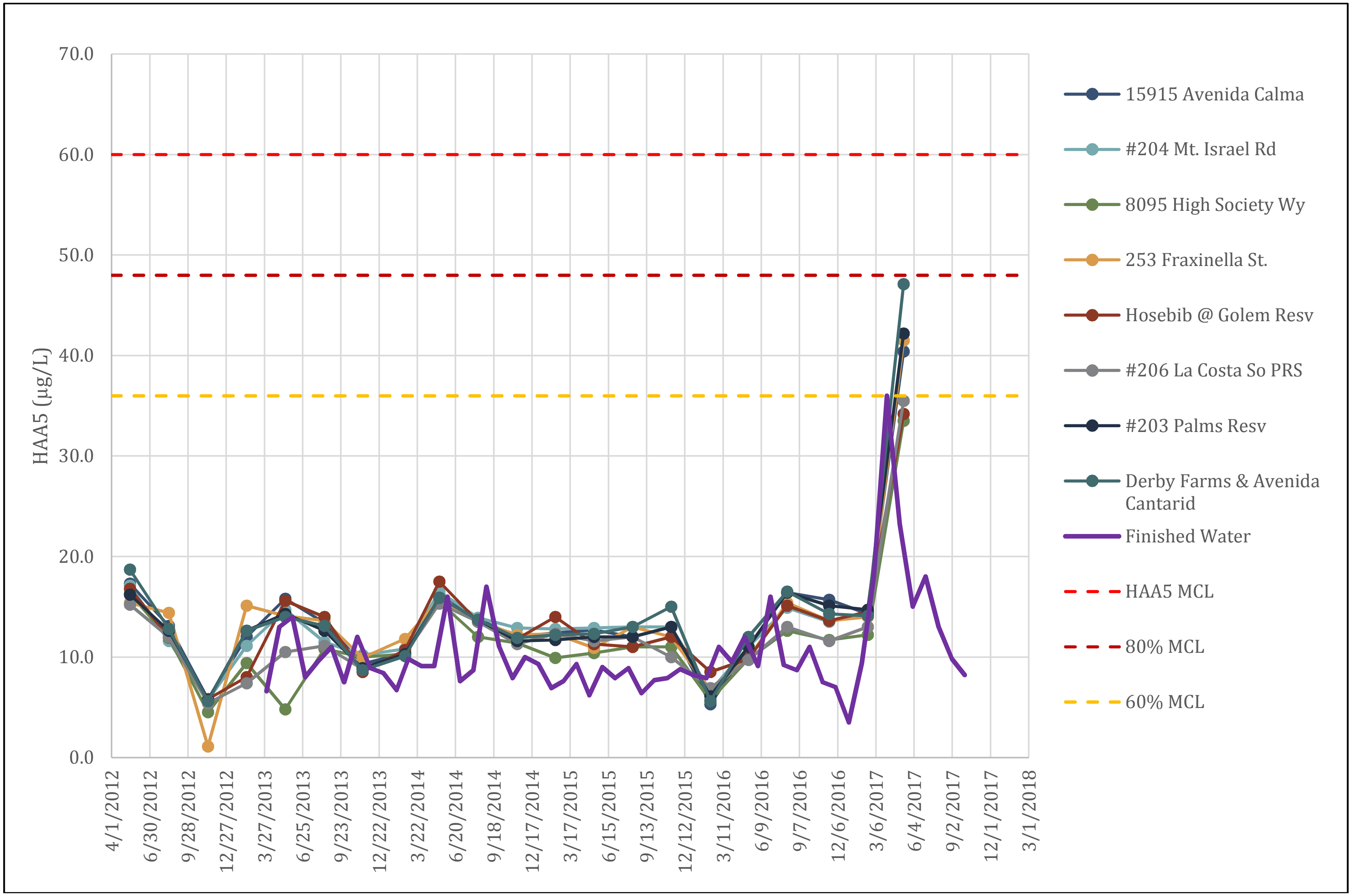



**Figure 5-5. HAA5 Concentrations at Sampling Sites in the Distribution System**

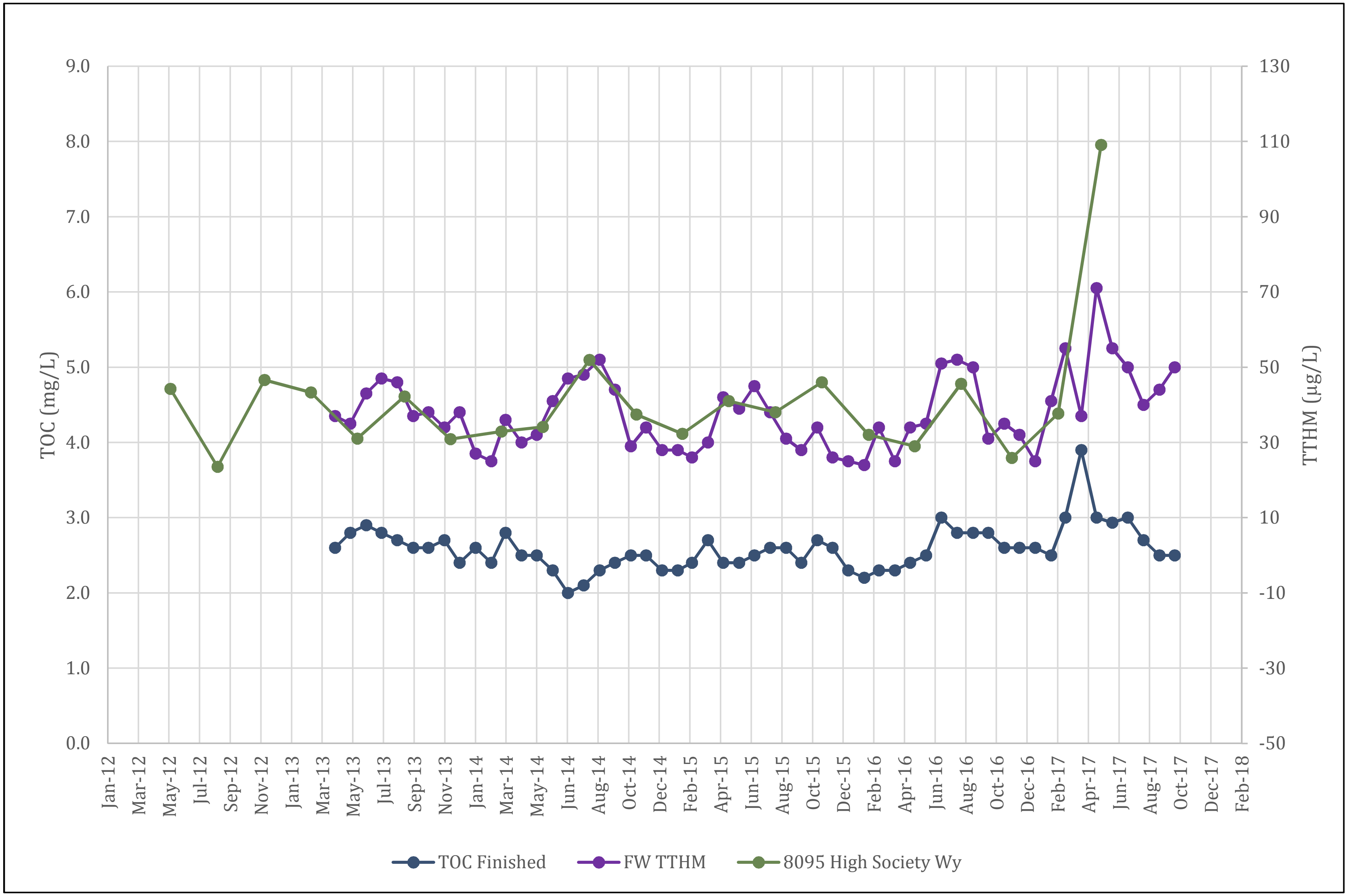



**Figure 5-6. TOC vs. TTHM Concentrations in Finished Water**

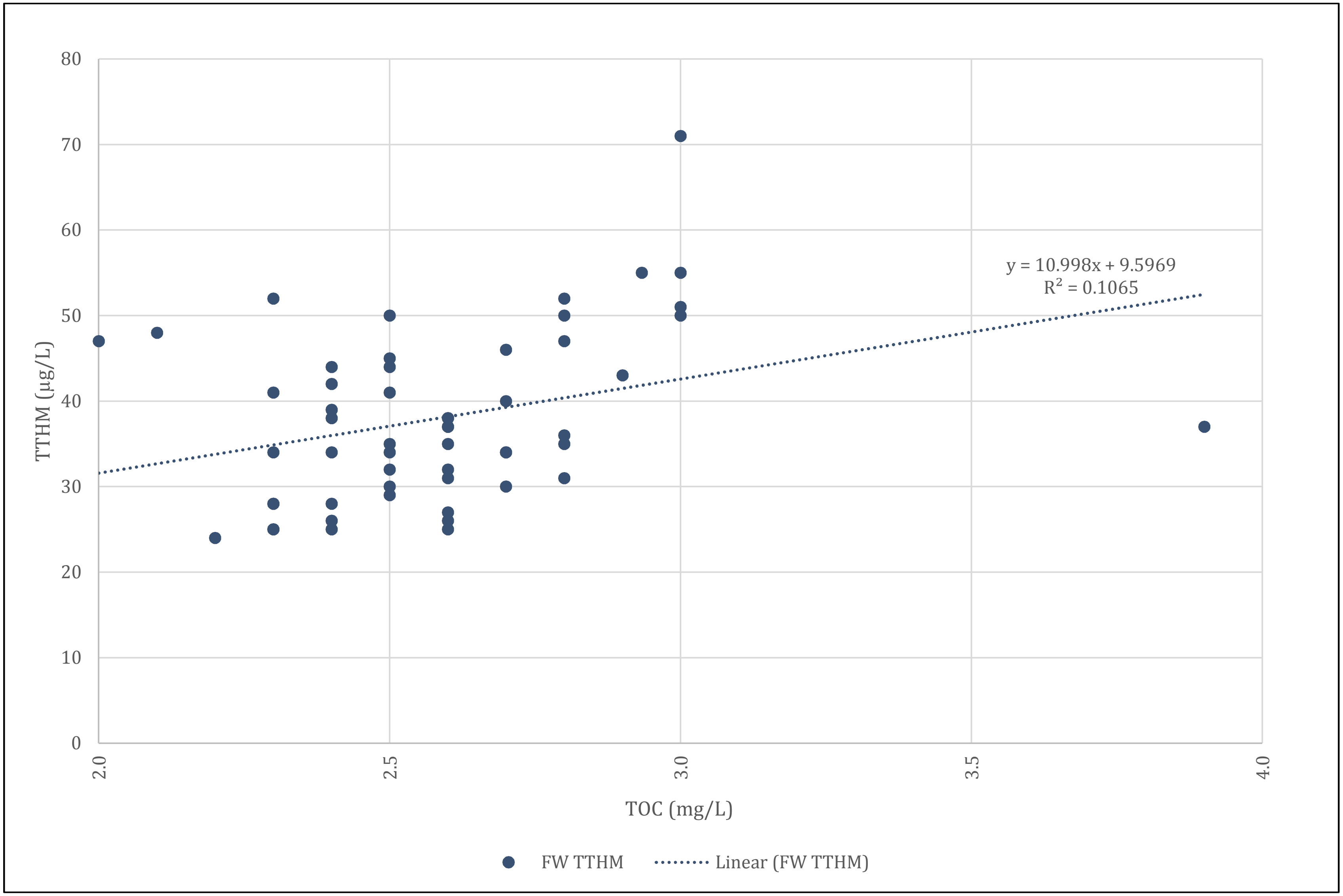



**Figure 5-7. Lack of Simple Correlation between FW TOC and FW TTHM**

## 5.3 Existing Disinfection Practices at the WTP

Primary disinfection is achieved at the DCMWTP through a combination of removal credits for the UF membrane system and inactivation credits from free chlorine. The free chlorine must achieve 0.50-log *Giardia* inactivation and 3-log virus inactivation. The DCMWTP does not have a chlorine contact tank or clearwell onsite and, thus, must use approximately 4,925 linear feet of finished water piping (360 LF 42"-dia; 4,565 LF 48"-dia) for free chlorine contact time. Secondary disinfection (distribution system residual) is achieved with chloramines. The ammonia is injected approximately 1-mile downstream of the plant discharge in the distribution system, but before any storage reservoirs. OMWD staff currently report that there are no problems with nitrification or residual management within the distribution system.

The DCMWTP currently has three available chlorine feed points within the plant, including the following:

- Upstream of Strainers – This feed point is not currently in use, but the capability is maintained to help control biological activity/mussels in the strainers.
- Upstream of the Raw Water Equalization (RWEQ) Tanks – A low dose of free chlorine is currently fed at this location for control of biological activity/mussels in the Stage 1 Membranes. The sodium hypochlorite is dosed upstream of the RWEQ Tanks and the residual is measured downstream of the RWEQ tanks. The raw water target residual at this location had been approximately 1.0 mg/L; however, when the SPW ratio increased and the TTHM concentrations began to rise in early 2017, the raw water chlorine residual was lowered to 0.8 mg/L or less to help minimize DBP formation.
- Downstream of Stage 1 Membranes – This location is the DCMWTP's primary chlorine feed location for disinfection. The current dose target is set to achieve a residual of 2.9 mg/L.

## 5.4 Options for DBP Reduction

As DBPs present significant regulatory compliance concerns for OMWD, readily-implementable, proven, and feasible alternatives are needed. Common strategies for reducing DBP formation are listed below:

- Source water management and/or change.
- Treatment processes/improvements, implemented at the DCMWTP, to reduce DBPs precursors and/or minimize formation of DBPs.
- Strategies involving the distribution system to remove DBPs and/or reduce water age.

Evaluation of these strategies involves a stepwise assessment of operational and treatment improvements, with the goal of determining the most cost-effective method for ensuring regulatory compliance within a margin of safety. A list of alternatives and actions which may be used to address DBP compliance is shown in **Table 5-1**. **Table 5-2** describes the relevance to, and technical feasibility at the DCMWTP for each of these potential DBP reduction alternatives.

**Table 5-1. DBP Reduction Alternatives**

| Potential Alternative or Action |
|---|
| Source Water Management |
| Develop TOC/UV254 correlation to manage source water episodes |
| Optimize Current Plant Operations |
| Disinfection |
| Alternate Coagulants |
| Powdered Activated Carbon |
| Implement Large Scale Treatment Modifications |
| Primary Disinfection |
| Alternate Pre-oxidants |
| Ion Exchange Resins [e.g., Magnetic Ion Exchange (MIEX®)] |
| Filter GAC Cap |
| Biological Filtration |
| Post-Filter Granular Activated Carbon |
| Membranes |
| Add/Improve Clearwell(s) |
| Implement Distribution System Operation Strategies for Reducing Water Age |
| Flushing |
| Examine Disconnected Loops / Dead Ends |
| Take Tanks Offline |
| Optimize Tank Operation |
| Implement Distribution System Treatment |
| Tank Aeration |
| Biologically Active Carbon |

**Table 5-2. Options for DBP Reduction at the DCMWTP**

| Item | Group | Potential Alternative or Action | Relevance to DCMWTP | Consider in Screening Evaluation |
|---|---|---|---|---|
| 1 | **Source Water Management** | Develop raw water TOC/UV254 to TTHM and HAA5 correlation curves to manage source water episodes. Develop triggers for plant adjustments. | It would be beneficial for the District to continue to characterize the daily source water quality (e.g., TOC/DOC, Cl residual from MWD, etc.) including using online instrumentation. Bench-scale testing should also be considered to check formation potential at various raw water quality levels. This data may be available through MWD and SDCWA but would need to be correlated to the DCMWTP. These improvements will help identify changes in source water quality but are only useful as an indicator of potential for elevated DBPs. Downstream adjustments will still need to be made. | **Yes (as a general recommendation)** |
| 2 | | Change blending ratio of source waters | The District does not have control of blend ratio. | No |
| 3 | | Switch raw water sources | District may not have this flexibility. Reservoir water could be used but may not decrease the formation potential. | No |
| 4 | **Optimize Current Plant Operations** | Optimize existing disinfection process | Because plant does not have a contact basin and is disinfectant contact time is limited to the volume of the existing finished water piping, flexibility for improvements to current disinfection process is limited. This option would include optimization of chlorine dosing and better control of chloramination process (chlorine to ammonia ratio, improve mixing, feedback). [Note that this should be a goal no matter the other options selected]. Also, the plant could consider addition of a dedicated contact tank to have better control over chloramination process - this option is included below. | **Yes** |
| 5 | | Optimize existing coagulation process (e.g., pH control, alternative ACH brand) | Coagulants typically can be optimized for DBP precursor removal by increasing dose and/or decreasing pH. However, the dose at the DCMWTP is limited so as to not negatively impact the operations of the Stage 1 UF membranes. The plant increased the dose from 2.5 mg/L to near 5 mg/L, which did not significantly improve TOC removal but did begin to negatively affect the membrane flux. Thus, it is unlikely that the current coagulant could be optimized for enhanced coagulation at doses low enough to not hinder membranes without a settling step. Jar testing would be needed to determine TOC removal as a function of pH and dose. | **Yes** |
| 6 | | Switch to alternative coagulants | Iron coagulants are typically more amenable to lower pH and, thus, higher precursor removal. However, as referenced above, it is unlikely that a high enough dose could be added for enhanced coagulation without negatively impacting the Stage 1 membranes. Conventional pre-treatment facilities for coagulation/flocculation/sedimentation would eliminate this limitation and is considered in alternatives below. Bench-scale jar testing would be needed to estimate DBP reduction as a function of coagulant dose and pH. The potential for increased solids production and the necessary solids handling capacity would need to be considered. Without a settling step, it is unlikely that a change in coagulants would have any impact at doses low enough to not hinder the membranes operation. | **Yes** |
| 7 | | Add powdered activated carbon (PAC) to raw water | The existing Stage 1 membranes can handle PAC; however, the type and dose would need to be in compliance with Zenon's recommendations in order to avoid nullifying the existing and new warranties on the membranes. The dose would be limited because of this concern and, thus, precursor removal (and preformed DBP removal) is likely to be small. Jar testing would need to be performed to determine the optimum PAC type and dose for DBP reduction. | **Yes** |
| 8 | **Implement Large Scale Treatment Modifications** | Change primary disinfection process - UV disinfection | A UV disinfection system can be installed to deliver the necessary 0.5-log *Giardia* inactivation credit to replace the need for extended free chlorine contact time. The system can also be upsized to deliver 3-log virus credit to completely eliminate the need for free chlorine contact time. This system would then allow the plant to immediately inject ammonia downstream of the post-membrane chlorine site to minimize the formation of disinfection byproducts. The system could also be designed to support a potential future upgrade to an Advanced Oxidation Process (AOP) (e.g., UV/$H_2O_2$) system for destruction of taste and odor (T&O) compounds and/or emerging contaminants. | **Yes** |
| 9 | | Change primary disinfection process - ozone | District has a 60% design for ozone/BAC. Ozone could be used for primary disinfection, precursor destruction, and/or pretreatment for biologically active carbon contactors. In order to accomplish multiple objectives, may need new contact basins in addition to footprint for the ozone generators. Brominated DBPs were noted in historical water quality data; source water bromide and ozone would result in bromate formation. Potential for AOP options for future contaminants. | **Yes** |
| 10 | | Change primary disinfection process - chlorine dioxide | $ClO_2$ can be used for primary disinfection but may require an onsite contact tank to control CT and residual. Dose would be limited by MCL for chlorite formation. $ClO_2$ would also provide some precursor destruction. | **Yes** |
| 11 | | Switch to alternative pre-oxidants - chlorine dioxide | The plant does not currently use a preoxidant; however, there is chlorine residual in the source water and the plant does add a small dose of chlorine prior to the RWEQ tanks for biological control in the Stage 1 membrane process. This chlorine could be replaced by chlorine dioxide if a residual could be carried into the membranes. Dose may not be high enough to significantly degrade precursors. Chlorite formation would need to be considered. Bench-scale testing could be performed to determine impact of replacement of pre-chlorine with chlorine dioxide. | **Yes** |

| Item | Group | Potential Alternative or Action | Relevance to DCMWTP | Consider in Screening Evaluation |
|---|---|---|---|---|
| 12 | Implement Large Scale Treatment Modifications | Switch to alternative pre-oxidants - ozone | Ozone can be used as a pre-oxidant; however, because of the expense required to implement ozone, it should be considered for multiple objectives, e.g., primary disinfection. See item above. | No |
| 13 | | Incorporate proprietary TOC reduction resins (e.g., MIEX) | Several vendors offer proprietary ion exchange resins targeting TOC removal (e.g., MIEX, Tonka). Implementation would require construction of contact/settling tanks. Additional solids handling and disposal would need to be considered. In addition, regeneration waste water (brine) would need to be disposed/recycled. Limited site space for contactors upstream of Phase 1 membranes. | **Yes** |
| 14 | | Add a GAC cap to filters | DCMWTP does not have conventional media filters. | No |
| 15 | | Convert to biological filtration | DCMWTP does not have conventional media filters. | No |
| 16 | | Add post-filter GAC | Post-filter GAC could accomplish multiple objectives, including TOC/precursor removal to minimize DBP formation downstream and removal of pre-formed DBPs from the source water. GAC can also help mitigate T&O issues as well as emerging contaminants. Pilot-testing would be required to determine best media and the time to break-through, which impacts operational costs. Many pressure contactors needed for 100% flow treatment; may only need a 50% flow treatment blend to shave peak TOC issues. Site space, capital costs, and GAC replacement costs must be considered. Backwash water handling may require additional BWEQ tank. Note that GAC located upstream of the Stage 1 membranes could be explored to serve as pretreatment to the membranes in addition to removal of DBP precursors and pre-formed DBPs. In this raw water location, the GAC filters would also serve as a particle removal process, which could impact operations in terms of backwash frequency. | **Yes** |
| 17 | | Add high-pressure membranes | High-pressure membranes (nanofiltration, RO) can remove high molecular weight DBPs (and precursors such as TOC). However, these membranes are energy-intensive and generate considerable volumes of reject water that would need to be disposed of. Capital and operational costs would be high. These membranes would also be removing more characteristics than needed and could increase aggressiveness of water. | **Yes** |
| 18 | | Add clearwell/contact basin to optimize existing disinfection process. | As noted in the OMWD's LT2 study, the addition of a contact tank/clearwell could help the plant optimize the disinfection and chloramination process. Hydraulics would need to be considered as re-pumping might be necessary. Size of tank would be a function of CT and needed operational storage, as well as site space limitations. Since the plant has resolved previous issues related to flow/pressure variability, improvement would be minimal. | **Yes** |
| 19 | | Install finished water aeration within treatment plant - In a new contact basin. | THMs, especially chloroform, are volatile and can be stripped using an aeration process. A new contact tank could be installed to facilitate aeration as well as optimize the disinfection process. Hydraulics would need to be considered as re-pumping might be necessary downstream of the tank. Note that HAAs are not removed by aeration. | **Yes** |
| 20 | | Install aeration within treatment plant - In existing RWEQ tanks. | Although THMs are volatile, the stripping process does require minimum air:water ratios and contact time. The RWEQ tank volumes are relatively small and result in minimal contact time (minutes). Information on the tank dimensions and flows was provided to aeration system manufacturers, and they indicated that detention time was too short to effectively strip THMs. Thus, this option would not be effective. | No |
| 21 | | Implement full conventional pretreatment (coagulation/flocculation/sedimentation) prior to membranes | Installing conventional coagulation, flocculation, and sedimentation upstream of the Stage 1 membranes would offer the flexibility to increase/optimize coagulant selection and dose to perform enhanced coagulation for TOC/precursor removal. Site space and solids production would be a concern. Hydraulics could also be an issue if trying to install such system between the energy-recovery units and the RWEQ tanks. | **Yes** |
| 22 | Implement Distribution System Optimization Strategies to Reduce Water Age | Distribution System Optimization:<br>- Implement flushing program/auto-flushers<br>- Eliminate dead-ends (impact likely small)<br>- Take unneeded distribution storage tanks offline<br>- Optimize operations to improve turn-over/reduce water age | Full-characterization of the distribution system was not a part of this project's scope. Modeling may be required to determine if/how tanks could be removed/optimized to minimize water age. Based on DBP data, there does not seem to be a single "problem" zone that could be targeted as all sample points tended to trend together. Although more would need to be known about the distribution system to quantify DBP reduction by water age reduction, it is still recommended that the District consider distribution system optimization as part of best practices/continual improvement. | No |
| 23 | Implement Distribution System Treatment | Install tank aeration in distribution system | Installation of aeration systems within distribution system storage tanks can be an effective method for stripping of THMs. The tanks within the District's system appear to be more than sufficiently sized to incorporate aeration systems. Hydraulics would need to be studied/modeled to determine how these tanks operate under high/low demand periods and which ones could have the most impact in terms of DBP reduction in any/all problematic areas. Since the DBP sample sites tend to trend together, aeration systems may need to be installed in numerous tanks to effectively reduce THM levels. Note that HAAs are not effectively removed by aeration. | **Yes** |
| 24 | | Install BAC in distribution system | Biologically-active carbon can reduce both THMs and HAAs in the distribution system in problematic areas. However, these systems can be cost-, site-, and operationally-intensive. For the District's system in which there does not seem to be one primary problematic area, multiple systems might be needed. Backwash water disposal is needed. BAC is best suited for areas of high HAAs. District's current problem is primarily THMs. | No |

## 5.5 Screening-Level Evaluation

As shown in **Table 5-2**, there are numerous potential options that could be implemented to optimize the disinfection process and/or reduce DBP formation at the DCMWTP. The first step in narrowing the list of options was to determine which options were not technically feasible for this installation, and these options are identified in the last column of **Table 5-2**. For the remaining options, a list of screening-level criteria was developed to prioritize the most effective options. For this analysis, the following criteria were selected for the initial evaluation:

- Potential to Reduce DBPs (Size of Impact)
  - Not all of the options work equally well on DBP reduction. Thus, the potential impact of the process on DBP formation was considered by this criterion.
- Operational Complexity
  - This criterion is intended to indicate how well the process change could be incorporated into existing treatment system and the ease/difficulty with which the process could be operated at the plant.
- Cost
  - A relative high-level judgement on the capital and operating costs required for implementation of the process.
- Will Easily Fit on Site
  - Site space is limited at the DCMWTP. Thus, this criterion provides a relative comparison of the size of the footprint required for the option.
- Will Easily Fit into Hydraulic Profile
  - This criterion is intended to distinguish whether the option could fit within the hydraulic grade line currently established between the source water and the distribution system.
- Will Help Reduce T&O
  - OMWD has experienced taste-and-odor events in the past, and, thus, the potential to achieve multiple objectives at the plant was considered as part of the evaluation.
- Increases Solids Production
  - As described in previous technical memoranda for this project, solids handling and treatment are critical limitations within the treatment plant. Some of the options considered for DBP reduction will produce a separate solids stream that must be considered within the evaluation.
- Will Produce Additional Liquid Waste Stream that will Need to be Recycled
  - Similar to the solids criterion, several of the DBP reduction options could produce a waste stream that must be handled within the DCMWTP. As OMWD targets zero-discharge, this liquid waste stream would need to be routed through the secondary phases and ultimately recycled.
- Potential to Negatively Impact Membrane Performance
  - The performance of the Stage 1 membranes is critical to the finished water quality and overall productivity of the DCMWTP. Thus, any process changes should not negatively impact the Stage 1 (or Stage 2) membranes.

Not all of these criteria are equal in importance for evaluating the processes. Weighting factors from 1 to 10, where 1 is least important and 10 is most important, were applied to each of the criteria. The weighting factors selected for the screening evaluation are shown in **Table 5-3**. These factors may be modified by OMWD as necessary to reflect the importance and priorities associated with a disinfection optimization / DBP reduction project.

**Table 5-3. Criterion Weighting**

| Criterion | Weighting Factor |
|---|---|
| Potential to Reduce DBPs (Size of Impact) | 10 |
| Operational Complexity | 4 |
| Cost | 8 |
| Will Easily Fit on Site | 7 |
| Will Easily Fit into Hydraulic Profile | 6 |
| Will Help Reduce T&O | 2 |
| Increases Solids Production | 7 |
| Will Produce Additional Liquid Waste Stream that will Need to be Recycled | 8 |
| Potential to Negatively Impact Membrane Performance | 9 |

Each of the DBP reduction options was then evaluated under each criterion and a score assigned. The resulting decision matrix is shown in **Table 5-4**. The results of the decision matrix, prioritized by total weighted score, are shown in **Table 5-5**.

**Table 5-4. Screening Level Decision Matrix**

| Criterion No.: | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criterion: | Potential to Reduce DBPs | | Operational Complexity | | Cost | | Will Easily Fit on Site | | Will Easily Fit into Hydraulic Profile | | Will Help Reduce T&O | | Increases Solids Production | | Will Produce Additional Liquid Waste Stream that will Need to be Recycled | | Potential to Negatively Impact Membrane Performance | | | |
| Weight: | 10 | | 4 | | 8 | | 7 | | 6 | | 2 | | 7 | | 8 | | 9 | | | |
| Option | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Selection - Score | Weighted Score | Total Raw Score | Total Weighted Score |
| Develop TOC triggers for plant adjustments. | May have Medium-Small Impact - 2 | 20 | Low - 3 | 12 | Low - 3 | 24 | Yes - 3 | 21 | Yes - 3 | 18 | No - 1 | 2 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 24 | 169 |
| Optimize existing disinfection process | Likely to have Small or No Impact - 1 | 10 | Medium - 2 | 8 | Low - 3 | 24 | Maybe - 2 | 14 | Maybe - 2 | 12 | No - 1 | 2 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 20 | 142 |
| Optimize existing coagulation process | Likely to have Small or No Impact - 1 | 10 | Low - 3 | 12 | Low - 3 | 24 | Yes - 3 | 21 | Yes - 3 | 18 | No - 1 | 2 | Yes - 1 | 7 | No - 3 | 24 | Yes - 1 | 9 | 19 | 127 |
| Switch to alternative coagulants | Likely to have Small or No Impact - 1 | 10 | Medium - 2 | 8 | Low - 3 | 24 | Yes - 3 | 21 | Yes - 3 | 18 | No - 1 | 2 | Yes - 1 | 7 | No - 3 | 24 | Yes - 1 | 9 | 18 | 123 |
| Add powdered activated carbon (PAC) to raw water | May have Medium Impact - 3 | 30 | Medium - 2 | 8 | Low - 3 | 24 | Yes - 3 | 21 | Yes - 3 | 18 | Maybe - 2 | 4 | Yes - 1 | 7 | No - 3 | 24 | Yes - 1 | 9 | 21 | 145 |
| Change primary disinfection process - UV disinfection | Highly Likely to have Large Impact - 5 | 50 | Medium - 2 | 8 | Medium - 2 | 16 | Maybe - 2 | 14 | Maybe - 2 | 12 | No - 1 | 2 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 23 | 174 |
| Change primary disinfection process - ozone | May have Medium Impact - 3 | 30 | High - 1 | 4 | High - 1 | 8 | Maybe - 2 | 14 | Maybe - 2 | 12 | Yes - 3 | 6 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 21 | 146 |
| Change primary disinfection process - chlorine dioxide | May have Medium Impact - 3 | 30 | High - 1 | 4 | Medium - 2 | 16 | Maybe - 2 | 14 | Maybe - 2 | 12 | Maybe - 2 | 4 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 21 | 152 |
| Switch to alternative pre-oxidants - chlorine dioxide | Likely to have Small or No Impact - 1 | 10 | Low - 3 | 12 | Low - 3 | 24 | Yes - 3 | 21 | Yes - 3 | 18 | Maybe - 2 | 4 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 24 | 161 |

| Criterion No.: | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Criterion:** | **Potential to Reduce DBPs** | | **Operational Complexity** | | **Cost** | | **Will Easily Fit on Site** | | **Will Easily Fit into Hydraulic Profile** | | **Will Help Reduce T&O** | | **Increases Solids Production** | | **Will Produce Additional Liquid Waste Stream that will Need to be Recycled** | | **Potential to Negatively Impact Membrane Performance** | | | |
| **Weight:** | **10** | | **4** | | **8** | | **7** | | **6** | | **2** | | **7** | | **8** | | **9** | | | |
| **Option** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Selection - Score** | **Weighted Score** | **Total Raw Score** | **Total Weighted Score** |
| Switch to alternative pre-oxidants - ozone | May have Medium-Small Impact - 2 | 20 | Medium - 2 | 8 | Medium - 2 | 16 | Yes - 3 | 21 | Yes - 3 | 18 | Maybe - 2 | 4 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 23 | 159 |
| Incorporate proprietary TOC reduction resins (e.g., MIEX) | May have Medium Impact - 3 | 30 | Medium - 2 | 8 | Medium - 2 | 16 | Maybe - 2 | 14 | Maybe - 2 | 12 | Maybe - 2 | 4 | Yes - 1 | 7 | Yes - 1 | 8 | No - 3 | 27 | 18 | 126 |
| Add post-filter GAC | Highly Likely to have Large Impact - 5 | 50 | Medium - 2 | 8 | High - 1 | 8 | Maybe - 2 | 14 | Maybe - 2 | 12 | Yes - 3 | 6 | No - 3 | 21 | Yes - 1 | 8 | No - 3 | 27 | 22 | 154 |
| Add high-pressure membranes | Highly Likely to have Large Impact - 5 | 50 | High - 1 | 4 | High - 1 | 8 | Maybe - 2 | 14 | No - 1 | 6 | Maybe - 2 | 4 | Yes - 1 | 7 | Yes - 1 | 8 | No - 3 | 27 | 17 | 128 |
| Add clearwell/contact basin to optimize disinfection process. | May have Medium-Small Impact - 2 | 20 | Low - 3 | 12 | Medium - 2 | 16 | Maybe - 2 | 14 | Maybe - 2 | 12 | No - 1 | 2 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 21 | 148 |
| Install finished water aeration within treatment plant - In a new contact basin. | May have Medium Impact - 3 | 30 | Medium - 2 | 8 | Medium - 2 | 16 | Maybe - 2 | 14 | Maybe - 2 | 12 | No - 1 | 2 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 21 | 154 |
| Implement full conventional pretreatment (coag/floc/sed) prior to membranes | Likely to have Large-Medium Impact - 4 | 40 | High - 1 | 4 | Medium - 2 | 16 | Maybe - 2 | 14 | Maybe - 2 | 12 | No - 1 | 2 | Yes - 1 | 7 | Maybe - 2 | 16 | No - 3 | 27 | 18 | 138 |
| Install tank aeration in distribution system | May have Medium Impact - 3 | 30 | Medium - 2 | 8 | Medium - 2 | 16 | Yes - 3 | 21 | Yes - 3 | 18 | No - 1 | 2 | No - 3 | 21 | No - 3 | 24 | No - 3 | 27 | 23 | 167 |

**Table 5-5. Decision Matrix Results**

| Item | Group | Alternative | Total Weighted Score |
|---|---|---|---|
| 8 | Implement Large Scale Treatment Modifications | Change primary disinfection process - UV disinfection | 174 |
| 1 | Source Water Management | Develop raw water TOC/UV254 to TTHM and HAA5 correlation curves to manage source water episodes. Develop triggers for plant adjustments. | 169 |
| 23 | Implement Distribution System Treatment | Install tank aeration in distribution system | 167 |
| 11 | Implement Large Scale Treatment Modifications | Switch to alternative pre-oxidants - chlorine dioxide | 161 |
| 12 | Implement Large Scale Treatment Modifications | Switch to alternative pre-oxidants - ozone | 159 |
| 16 | Implement Large Scale Treatment Modifications | Add post-filter GAC | 154 |
| 19 | Implement Large Scale Treatment Modifications | Install finished water aeration within treatment plant - In a new contact basin. | 154 |
| 10 | Implement Large Scale Treatment Modifications | Change primary disinfection process - chlorine dioxide | 152 |
| 18 | Implement Large Scale Treatment Modifications | Add clearwell/contact basin to optimize existing disinfection process. | 148 |
| 9 | Implement Large Scale Treatment Modifications | Change primary disinfection process - ozone | 146 |
| 7 | Optimize Current Plant Operations | Add powdered activated carbon (PAC) to raw water | 145 |
| 4 | Optimize Current Plant Operations | Optimize existing disinfection process | 142 |
| 21 | Implement Large Scale Treatment Modifications | Implement full conventional pretreatment (coag/floc/sed) prior to membranes | 138 |
| 17 | Implement Large Scale Treatment Modifications | Add high-pressure membranes | 128 |
| 5 | Optimize Current Plant Operations | Optimize existing coagulation process (e.g., pH control, alternative ACH brand) | 127 |
| 13 | Implement Large Scale Treatment Modifications | Incorporate proprietary TOC reduction resins (e.g., MIEX) | 126 |
| 6 | Optimize Current Plant Operations | Switch to alternative coagulants | 123 |

## 5.6 Potential Alternatives for DCMWTP

The results of the screening decision matrix indicate several key potential solutions to help reduce DBP formation at the DCMWTP and in the distribution system, including:

- Changing/modifying the primary disinfection system by adding a UV disinfection system.
- Use air-stripping of TTHM to reduce levels in the distribution system.
- Consider installation of a new oxidation process (e.g., ozone).
- Utilize granular activated carbon at the treatment plant.

These options are considered in more detail in **Table 5-6**. Sample site plans for several of these options are shown in **Figure 5-8**, **Figure 5-9**, and **Figure 5-10**. All new processes would be optimized around the locations of existing yard pipes.

**Table 5-6. Level Two Evaluation of Potential Options**

| Parameter | Alternatives | | | | | |
|---|---|---|---|---|---|---|
| | **Install UV Disinfection for Giardia Credit** | **Install UV Disinfection for Giardia and Virus Credit** | **Add Aeration/Mixing to One or More Storage Reservoirs in Distribution System** | **Add/change Pre-oxidant to Ozone or Chlorine Dioxide** | **Install GAC Contactors** | **Install GAC Contactors and Pre-Ozone** |
| **Design Criteria** | 0.5-1.0 log Giardia | 3-log Virus | 30-50% TTHM Reduction | Pre-oxidant doses, assume side-stream injection of ozone | 50% Plant Flow Capacity / Blend | 50% Plant Flow Capacity / Blend |
| **DBP Reduction Mechanism** | Elimination of extended free chlorine contact time in FW pipe; determine only that necessary for virus inactivation, then inject ammonia for chloramination. | Elimination extended free chlorine contact time in FW pipe; inject ammonia for chloramination immediately after primary free chlorine feed. | Air stripping of formed TTHMs | Oxidization of DBP precursors | Removal of pre-formed DBPs; removal of DOC | Removal of pre-formed DBPs; removal of DOC; biological degradation of pre-formed HAAs |
| **Effectiveness on THMs** | High | High | High | Low | Medium | High |
| **Effectiveness on HAAs** | High | High | None | Low | Medium | High |
| **Disinfection credit - Giardia** | UV | UV | Free Cl CT | Free Cl CT (plus ozone or ClO2 if designed as such) | Free Cl CT | Free Cl CT (plus ozone if designed as such) |
| **Disinfection credit - Viruses** | Free Cl CT | UV | Free Cl CT | Free Cl CT | Free Cl CT | Free Cl CT |
| **Disinfection Multi-barrier / Crypto** | UV | UV | None | None (unless ozone designed at disinfectant doses) | None | None (unless ozone designed at disinfectant doses) |
| **T&O Reduction** | None | Low | None | Medium | High | High |
| **Location in Process Flow** | Post Stage 1 Permeate Pumps | Post Stage 1 Permeate Pumps | Distribution System | Pre RWEQ Tanks | Post Stage 1 Permeate Pumps | GAC - Post Stage 1 Permeate Pumps; Ozone – Pre- or Post- Stage 1 Membranes |
| **Location on Plant Site** | Between BWEQ and new DAF facility | Between BWEQ and new DAF facility | Distribution System | Northeast of Stage 1 Membrane Building | Between BWEQ and new DAF facility -or- Southwest of existing fence-line in open area | Between BWEQ and new DAF facility -or- Southwest of existing fence-line in open area |
| **Hydraulic Profile Impacts** | Headloss should fit within HGL between Stage 1 Permeate Pumps and Distribution System Reservoirs | Headloss should fit within HGL between Stage 1 Permeate Pumps and Distribution System Reservoirs | Minimal - To be installed inside reservoirs in distribution system | Side-stream injection could be used to avoid maintenance of diffusers. Ozone contactors would need to be installed within HGL between energy recovery and Phase 1 membranes | Location between Stage 1 Permeate Pumps and Distribution system but would need to confirm available HGL since headloss can be significant. | Location between Stage 1 Permeate Pumps and Distribution system but would need to confirm available HGL since headloss can be significant, especially under biologically-active conditions. See ozone for side-stream injection. |
| **Potential Size of Impact on DBP Reduction** | High | High | Medium | Low | High | High |
| **Planning-level Capital Costs** | $2M-$3M | $5M-$7M (est.) | $400k-$700k per Reservoir | $8M-10M | $13M-$15M | $22M-$25M (est.) |
| **O&M Cost Impacts** | Medium | Medium | Low | Low | High | High |
| **General Advantages, Disadvantages, and/or Considerations** | Fits within site space and hydraulic profile | Fits within site space and hydraulic profile | Can be installed within existing tanks and targeted at problem areas | Ozone has potential to form bromate if bromide present in source waters. | Contactors require backwashing, which creates new waste stream that would need to be recycled | Ozone has potential to form bromate if bromide present in source waters |
| | Capital and O&M costs relative to other options | No free chlorine contact needed to meet inactivation credits | Does not remove HAAs | Chlorine dioxide has potential to form chlorite | GAC replacement costs can be high | Contactors require backwashing, which creates new waste stream that would need to be recycled |
| | Does not remove pre-formed DBPs nor DBP precursors | Does not remove pre-formed DBPs nor DBP precursors | Flow must pass through tanks (i.e., not bypass during high-demand periods) | Potential to deliver biologically unstable water into distribution system (e.g., risk of nitrification) if no downstream biological filtration/contactor. | | |
| | Does not degrade many emerging contaminants unless expanded to AOP | Does not degrade many emerging contaminants unless expanded to AOP | | | | |
| **Design Options** | Expansion for AOP | Expansion for AOP | Construction of contact tank at DCMWTP for aeration | Ozone contact tanks vs. side-stream injection | Capacity of GAC (blend ratio) | Capacity of GAC (blend ratio); ozone contactors vs. side-stream injection |

| Parameter | Alternatives | | | | | |
|---|---|---|---|---|---|---|
| | **Install UV Disinfection for Giardia Credit** | **Install UV Disinfection for Giardia and Virus Credit** | **Add Aeration/Mixing to One or More Storage Reservoirs in Distribution System** | **Add/change Pre-oxidant to Ozone or Chlorine Dioxide** | **Install GAC Contactors** | **Install GAC Contactors and Pre-Ozone** |
| **Info/Action Needed to Confirm Effectiveness/ Costs** | Confirm performance curves of Permeate Pumps vs. HGL of distribution system reservoirs | Confirm performance curves of Permeate Pumps vs. HGL of distribution system reservoirs | Confirm dimensions of system reservoirs | Confirm bromide concentrations (if any) in source/finished waters | Confirm performance curves of Permeate Pumps vs. HGL of distribution system reservoirs | Confirm performance curves of Permeate Pumps vs. HGL of distribution system reservoirs |
| | Measure UVT of finished water over extended period | Measure UVT of finished water over extended period | Confirm actual detention time and flow rate in/out of reservoirs during both low- and high-demand periods | Bench-scale testing to determine impact on DBP formation potential under various doses | Pilot-scale tests to determine break-through curves for TOC, TTHM, and HAA5 for various carbon types and EBCTs. | Pilot-scale tests to determine break-through curves for TOC, TTHM, and HAA5 for various carbon types and EBCTs. |
| | Perform bench-scale tests to show change in DBP formation potential under varying contact times | | Consider desktop modeling and/or vendor-testing to determine expected reductions in THMs. | Bench-scale testing to determine residual decay and formation of byproducts (bromate, chlorite/chlorate) | Blend-ratio of GAC-treated vs. untreated finished water needed to meet DBP objectives | Blend-ratio of GAC-treated vs. untreated finished water needed to meet DBP objectives |
| | Confirm contact time needed for virus inactivation credit | | | | | |
| **Recommendations** | Yes - Proceed with BODR | Design of Giardia inactivation only since minimal CT needed for virus credit. | Distribution system modeling | Bench-scale testing | Pilot-scale testing | Pilot-scale testing |

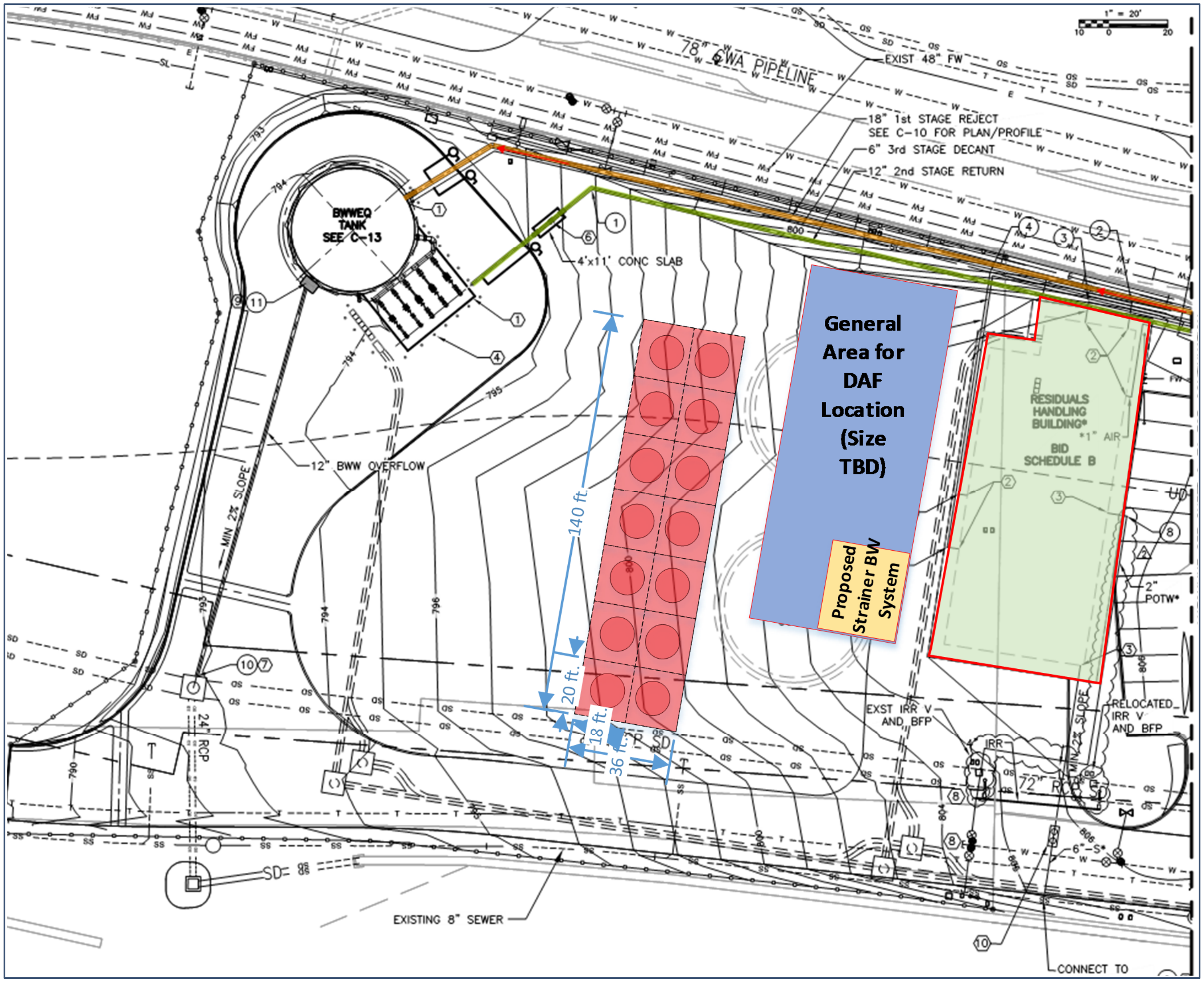



Figure 5-8. Option for GAC Siting


**Figure 5-9. Alternative for GAC Siting**

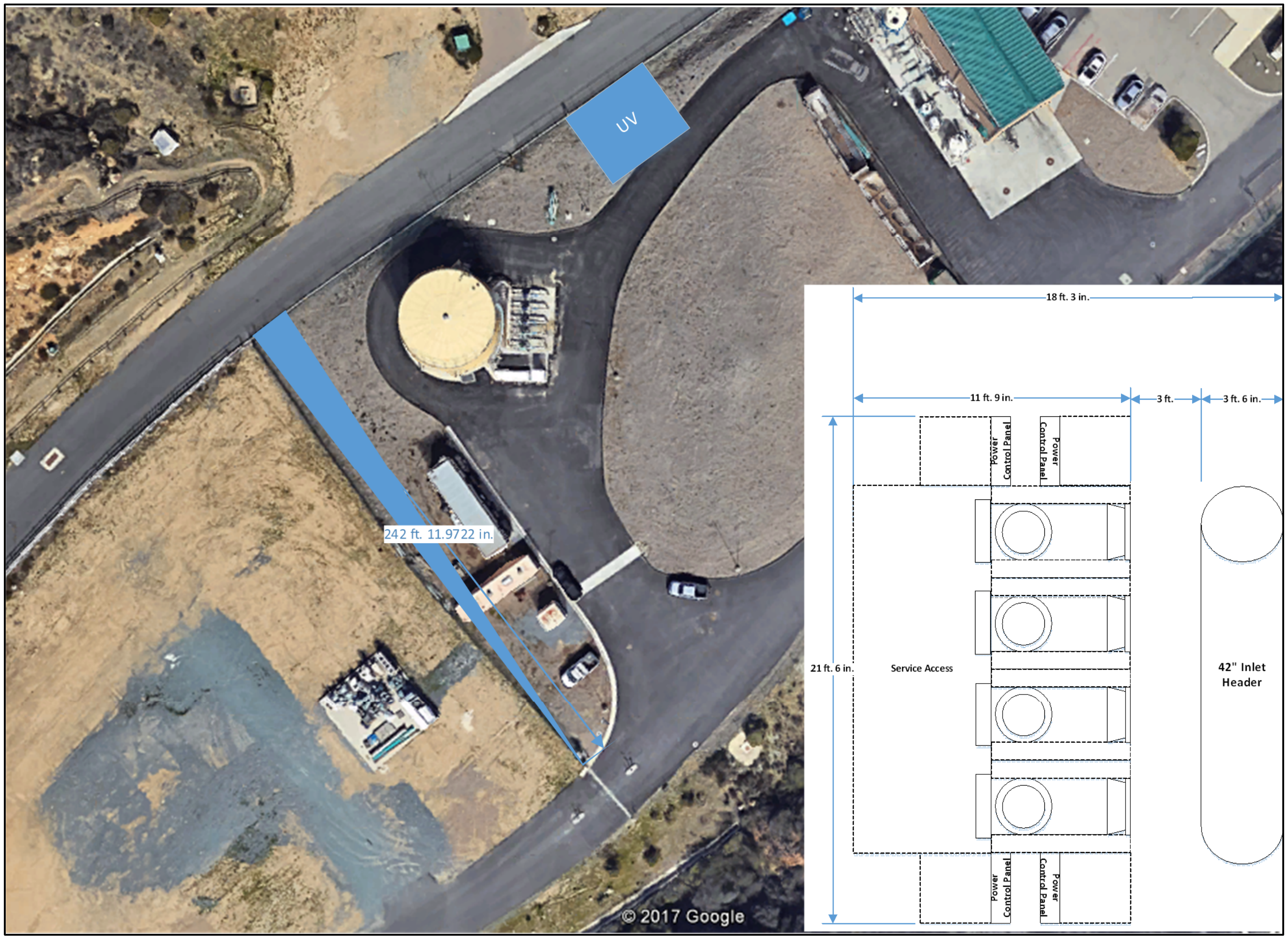



**Figure 5-10. Option for UV Siting**

## 5.7 Recommendations

**Table 5-6** presented general recommendations as part of the evaluation of each alternative. The alternatives can be prioritized based on cost-benefit in terms of expected DBP reduction and estimated capital costs. The results are shown in **Table 5-7**.

**Table 5-7. Prioritized Alternatives**

| Alternative | Overall Expected Impact on DBP Reduction | Taste &Odor Reduction | Planning-level Capital Cost Estimates |
|---|---|---|---|
| Install UV Disinfection for Giardia Credit | High | No | \$2M-\$3M |
| Install UV Disinfection for Giardia and Virus Credit | High | No | \$5M-\$7M (est.) |
| Install GAC Contactors | High | Yes | \$13M-\$15M |
| Install GAC Contactors and Pre-Ozone | High | Yes | \$22M-\$25M (est.) |
| Add Aeration/Mixing to One or More Storage Reservoirs in Distribution System | Medium | No | \$400k-\$700k per Reservoir (Assume 7 Reservoirs, or Approx. \$5M) |
| Add/change Pre-oxidant to Ozone or Chlorine Dioxide | Low | Yes | \$8M-10M |

Most of these DBP reduction processes require some form of bench- or pilot-scale testing to confirm expected reduction in formation potential and the capital and operating costs.

- UV systems do not typically need piloting if designed for disinfection only; however, UVT measurements will be needed to establish design and operating doses. In addition, water quality characteristics need to be examined to determine the potential for fouling of the quartz sleeves. Fouling potential can be experimentally-tested if water quality review identifies potentially problematic characteristics.

- GAC should be piloted to determine overall effectiveness, which can be measured by break-through curves generated for TOC and pre-formed DBPs. These break-through curves help establish design conditions (e.g., required empty-bed contact time) and operating costs (i.e., GAC replacement frequency). DBP formation potential is measured on each of the column effluent streams to determine expected reduction of both TTHM and $HAA_5$. Pilot testing also evaluates different types of carbon to determine the most cost-effective option. Carbon options can be tested on the bench-scale with Rapid Scale Small Column Tests (RSSCTs), but it is recommended that pilot-scale units be used to better predict operating conditions as well as carbon effectiveness. Depending on OMWD preferences, this testing can be done on both warmer and colder waters (i.e., two seasons). The cost of piloting is a function of the number of carbons tested and the length of the tests, but previous pilots have been completed in the \$50,000 - \$100,000 range per season of testing. The blend of source water would need to be determined.

  - Ozone as a pre-oxidant to GAC can also be tested as part of the pilot experiments. Ozone fed prior to GAC frequently changes the process into a biologically-active carbon (BAC). As this testing involves the development of a biomass within the column, it often is a longer trial period, which will increase the piloting costs.

- Aeration effectiveness on TTHM stripping can be modeled and/or tested. The vendors have desktop models that are used to predict TTHM removal. The models are based on tank volume, tank size, flow rates in and out of the tank, detention time, and water quality characteristics. Testing is more complex given the need to match air:water ratios and is often not needed if tank modeling is matched with accurate distribution system hydraulic modeling and operation.

- Ozone alone (i.e., without GAC) can be evaluated on the bench-scale with jar testing. The costs are a function of the number of ozone doses and source water quality changes to be tested. Often these jar tests can be performed in as little time as one week and cost approximately $20k-$40k per season.

There are also several general good practices that OMWD should continue to help with DBP reduction. With the free chlorine CT currently being achieved in the finished water piping, the downstream injection of ammonia should be evaluated to determine effective mixing and to evaluate chlorine-to-ammonia ratios. In addition, the distribution system should be evaluated through modeling and/or SCADA-data review to determine optimum operations to minimize water age in the system.

In summary, it is recommended that OMWD:

1. Begin collecting UV transmittance data (at 254 nm) of the source water, post Stage 1 Membranes, and finished water. The data should be collected at least once per day for a period of at least six months. On several days during the early part of this period, multiple samples should be collected throughout the day to determine if/how transmittance changes on a diurnal basis. An absorbance scan from 200 nm to 400 nm should be completed once per month. All of these activities can be completed by plant-staff.

2. Plan and budget for a UV disinfection basis-of-design report.

3. Plan and budget for pilot testing of GAC with or without ozone.

4. Collect data specific to each of the storage reservoirs within the distribution system and submit to aeration/mixer vendors to better refine costs and performance of TTHM reduction systems.

Hazen

# Appendix A – Vendor Submittals

| Treatment Technology | Quote Detail | Contact |
|---|---|---|
| Liquid Phase GAC (Calgon) | • $225K per unit vessel (Include freight and initial fill with GAC)<br>• Replacement media cost: Approx. $1.55/lb (including disposal), which at 40,000 lb/vessel equals $62,000/vessel. Currently assuming 14 vessels: 14 x $62k = $870,000. | Ben Goecke<br>bgoecke@calgoncarbon.com<br>425-286-0754<br>Email Quote on 12/4/2017 |
| LPUV (Trojan) | • $ 110K for unit LPUV (Model SwiftSC D30)<br>• $ 280 for unit each lamp (each reactor has 30 lamps, lamp changeout is every 12,000 hr) | Jordan Fournier<br>jfournier@trojanuv.com<br>519-457-3400<br>Email Quote on 12/4/2017 |
| Aeration (Solarbee) | • $ 426K per reservoir (Include 5 aerators, 1 ventilation, 5 control panels), target 35-45% THM removal<br>• Vendor does not recommend aeration of raw water equalization tank due to low retention time | Harvey Hibl<br>harvey.hibl@medoraco.com<br>303-887-5323<br>Quote on 12/1/2017 |
| Aeration (PAX) | • $ 733K per reservoir (Include 1 mixer, 2 ventilations, 9 surface aerators, 1 control panel), target 46% TTHM removal<br>• Vendor does not recommend aeration of raw water equalization tank due to low retention time | Kevin Sanner<br>ksanner@ugsicorp.com<br>310-975-9719<br>Quote on 12/4/2017 |

For additional information, reference following vendor information sheets.

Job no

PETERSON STRUCTURAL ENGINEERS

**San Diego Office**
10650 Treena Street
Suite 208
San Diego, CA 92131
858.842.1674

June 29, 2022

# DRAFT Technical Memorandum

***To:*** Geoff Fulks – Operations Manager
Lindsey Stephenson, PE – Engineering Manager
Tom Arellano – Water Treatment Facilities Supervisor
Evan DeWindt – Water Treatment Plant Lead Operator
Olivenhain Municipal Water District
19090 Via Ambiente Road, Escondido, CA 92029

***From:*** Tom Bloomer, PE
Senior Associate Engineer
Joe Wendt, PE
Senior Project Manager
Peterson Structural Engineers, Inc.

***Subject:*** David. C. McCollom Water Treatment Plant Condition Assessment

***PSE Project Number:*** 2103-0037

## Project Background/Executive Summary

Peterson Structural Engineers (PSE) has conducted a structural condition assessment at the David C. McCollom Water Treatment Plant (DCM WTP)(33.068569°, -117.140351°) at the request of owner and operator Olivenhain Municipal Water District (OMWD, District), in response to areas of deterioration and corrosion observed by District staff at the DCM WTP. Areas of concern identified and addressed in the condition assessment include the floor slab of the sodium hypochlorite room, the primary and secondary stage basins, and the stainless-steel pipes in the blower room.

Site visits to the DCM WTP were conducted by PSE employees on January 26$^{th}$, January 27$^{th}$, and March 22$^{nd}$, 2022, to observe the extent of the deterioration at the locations listed in Table 1 and investigate and opine on potential drivers for the deterioration. This technical memorandum will summarize the results of the structural condition assessment, as well as provide recommendations and engineers opinion of probable cost for repair and rehabilitation. See Figure 1 for the investigated locations in plan. Our references to locations within each structure assessed will be based on the Plant North arrow shown on the as-built drawings.

Based on the as-built drawings provided, PSE understands that the DCM WTP was constructed in 2000 and received improvements associated with the LT2 requirements in 2011.

*Table 1: Structures Evaluated*

| Structure Description | Summary of Observed Issue |
|---|---|
| Secondary Stage Basin 2 | Liner in good condition, Loss of cementitious matrix in corewall |
| Primary Stage Basin 3 | Leakage at south wall |
| Sodium Hypochlorite Room - Floor Slab | Concrete cracking, delamination of mortar overlay |
| Exterior Masonry Wall – Sodium Hypochlorite & Fluoride Rooms | Cracking, efflorescence, and deterioration of cementitious matrix |
| Blower Room – Pipe Gallery | External corrosion at welded joints |

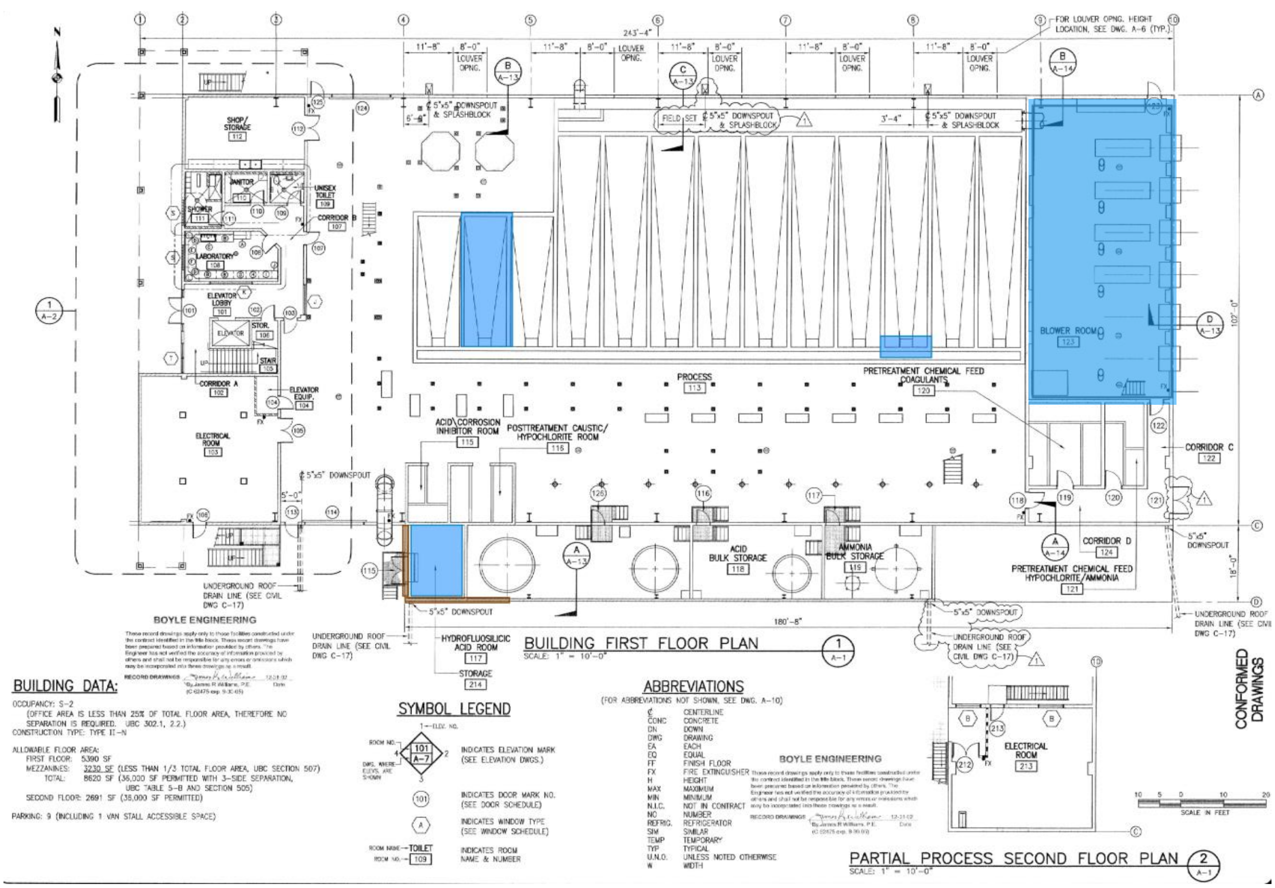



*Figure 1: Locations of Areas Evaluated at David C. McCollom Water Treatment Plant*

## Condition Assessment

### 1st and 2nd Stage Basins

Based on the as-built drawings, the primary stage consists of (10) basins 50'-0" by 10'-0" by 11'-0" deep. The secondary stage consists of (2) basins 31'-0" by 9'-11" by 13'-0" deep, and (1) basin 31'-0" by 9'-10" by 13'-0" deep. Based on correspondence with the District, we understand that in 2006 the District installed a high-density polyethylene (HDPE) sheet liner in each of the primary and secondary stage basins to protect the concrete from observed deterioration and sloughing of the concrete that was causing the membranes to foul.

In preparation for the site visit, the District cut (7) rectangular openings, measuring between 68 $in^2$ and 132 $in^2$ in area, in the liner of the secondary stage basin No. 2. (1) opening was cut around a pipe penetration on the north wall approximately 3'-4" off the ground, and (2) holes were cut in the liner of each of the remaining walls, at approximately 1 ft and 9 ft off the ground. PSE was assisted with confined space entry into secondary stage basin No. 2 by Capstone Fire and Safety Management. The concrete that was visible through the openings in the liner varied in condition from fair to poor.

On the north wall of the basin, the concrete surrounding the pipe penetration appeared to be extremely deteriorated and eroded (Photograph 1). The cement matrix was worn away, exposing pieces of aggregate up to 1 ¼" in size. The east wall appeared to have minor surface deterioration and slight aggregate exposure but was in generally good condition at both locations where the liner was cut (Photograph 2 & Photograph 3). The concrete visible behind the lower cut in the liner on the south wall was also minorly deteriorated but in overall good condition (Photograph 4). At the upper liner cuts on the south and west walls, the concrete had minimal deterioration and was in overall good condition, possibly due to the positioning of the cuts very close to or above the normal water level. The concrete behind the lower liner cut on the west wall had significant deterioration and aggregate exposure (Photograph 5).

Additionally, the floor liner was observed to have several small holes, evidenced by sediment that leaked out as the liner was stepped on (Photograph 6). Several of the structural members at the top of the basin wall that are used to support the grating over the basin were observed to be moderately corroded (Photograph 7).

On the exterior of the basins, there were approximately (3) vertical cracks along the south wall of the basins, at secondary stage basin No. 3, primary stage basin No. 7, and primary stage basin No. 3. The cracks observed at secondary stage basin No. 3 and primary stage basin No. 7 appear to have autogenously healed[1] leaving behind a white efflorescence[2] (Photograph 8). The crack at primary stage basin No. 3 was observed to be actively leaking (Photograph 9). An effort was made by DN Tanks to pressure inject an NSF 61 certified foam into the crack during the visit. Initially the injection slowed the leak. However, when we returned to the site in late March the leak had increased since January but appeared to still be less than the original flow rate.

[1] Autogenous healing is the self-healing principle of a crack that is experiencing a slow flow of water that carries elements in the concrete mixture to the surface that ultimately blocks further passage of water.
[2] Efflorescence is the white salt deposit on the surface of the wall that results after the water has evaporated from the surface.

Sodium Hypochlorite Room Floor Slab

The sodium hypochlorite room is on the second story of a reinforced concrete masonry structure. On the first floor of the building, and immediately below the sodium hypochlorite room, is the fluoride room. According to information from District staff, the sodium hypochlorite room was originally an office, and the fluoride room was originally storage space before both rooms were converted to their current purposes. PSE understands that there have been two sodium hypochlorite systems installed in the sodium hypochlorite room over the life of the plant, both of which have had issues with leaks. The original on-site sodium hypochlorite generation system was replaced in 2014 with a PSI Microclor OSHG MC 2400 unit. Prior to installation of the PSI OSHG system, carpeting in the sodium hypochlorite room was removed and the floor was coated with Tnemec Hi-Build Epoxoline II Series L69. It is hypothesized that the carpet in the room when the original system was operating may have exacerbated the deterioration of the concrete since it likely retained the moisture of the highly concentrated chlorine mixture (NaOCl) for extended periods of time. It is important to note that the American Concrete Institute (ACI) Manual of Concrete Practice Code 350 – "Code Requirements for Environmental Engineering Concrete Structures" identifies Sodium Hypochlorite (up to 15%) as a Group 3B – Corrosion of Concrete, and that concrete exposed to this Group of chemicals should be given a protective coating.

Although we understand the current system to be less prone to leaks when compared to the original system, the PSI OSHG system was observed to be actively leaking while PSE was on site on January 26$^{th}$ (Photograph 10). During our visit in March, we observed that the leaking had been controlled by directing the flows into 5-gallon buckets and there was a blower in the room to dry up the previous spills.

The top surface of the slab in the sodium hypochlorite room was observed to have severe cracking and spalling in the areas around the equipment (Photograph 11 &Photograph 12). The underside of the slab, the ceiling of the fluoride room, was observed to have cracks up to 0.1 inches wide and blistering in the white coating (Photograph 13). Figure 2 is an approximate map in plan of the cracks. The 12" thickened slab edge displayed significant cracking up to 0.06" thick, and spalling, especially on the exterior face of the edge above the doorway (Photograph 14 & Photograph 15).

When sounded with a hammer, several large hollow areas spanning the full height of the thickened slab edge were observed. Some of the cracks in the concrete edge propagated into the masonry above or below the concrete. Two cracks in the slab edge on the south wall extended through the masonry to the ground (Photograph 16). Additional cracks were present in the masonry walls of the structure, including a full-height crack in the southwest corner of the fluoride room with efflorescence around it (Photograph 17). A 51" long vertical crack was also observed on the exterior of the southwest corner (Photograph 18). PSE noted moderate corrosion on the interior of the fluoride room door, indicating that the chlorinated solution from the sodium hypochlorite room is likely leaking through the cracks and down into the door frame (Photograph 19).

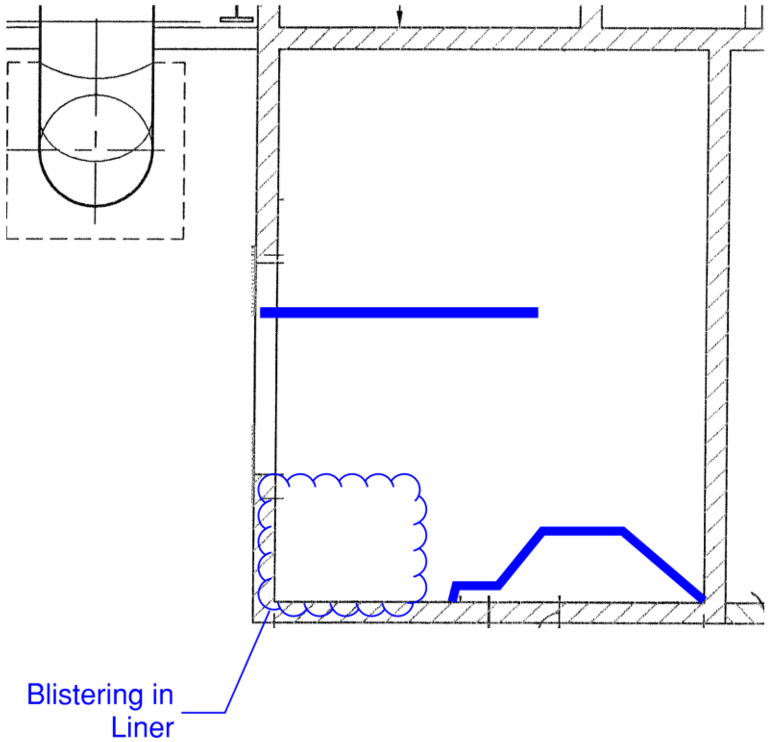



*Figure 2: Map of Cracks in Underside of Slab*

At the January 27th site visit, PSE was joined by an employee of DN Tanks, who performed investigative removal of the concrete in the top of the slab in the sodium hypochlorite room to expose the top layer of reinforcement. Figure 3 shows an approximate map of the locations where the investigations were conducted. The exposed reinforcement was observed to be moderately corroded (Photograph 20 & Photograph 21). The clear cover varied from ¾" to 3 ½" in the exposed areas. The original as-built drawings state the clear cover shall be 1 ½". DN Tanks also removed a portion of the CMU block and grout on the exterior southwest corner of the structure to expose the vertical reinforcement. The reinforcement in that location was also moderately corroded (Photograph 22).

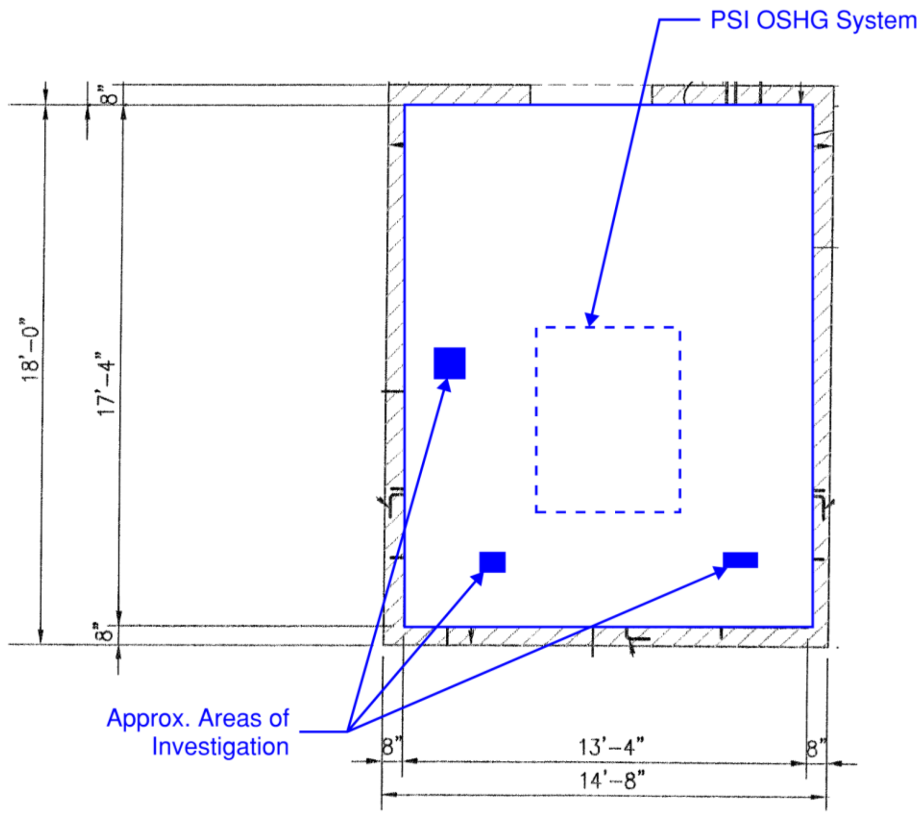



*Figure 3: Areas of Investigative Concrete Removal in Top of Slab*

Based on initial findings, PSE returned to DCM WTP with DN Tanks on March 22, 2022, to perform investigative concrete removal on the underside and edge of the slab. Concrete was removed from the underside of the slab in three areas, (2) of which corresponded to areas of cracking in the slab, the other area serving as a control area to estimate the overall condition of the reinforcement. See Figure 4 for an approximate map of the areas of investigation. In the two cracked areas, which sounded disbonded or hollow when struck with a hammer, the concrete chipped apart very easily and small voids were observed in the slab, indicating existing delamination at the underside of the slab surface. The exposed reinforcement in both directions was moderately to significantly corroded (Photograph 23 & Photograph 24). In the area where the slab was not cracked, chipping into the concrete was more difficult, indicating that the concrete in these locations was well consolidated and in apparent good condition in that location. The reinforcement exposed in this area was free from corrosion (Photograph 25). Concrete removal was performed in one location on the slab edge above the fluoride room doors. The exposed rebar in this location was observed to be severely corroded with moderate section loss (Photograph 26). This location was selected because the area was already starting to spall and break away from the slab. Concrete removal in other locations, such as the larger hollow areas to the right of the door frame, was determined to be inadvisable due to the difficulty in repairing a larger area of concrete.

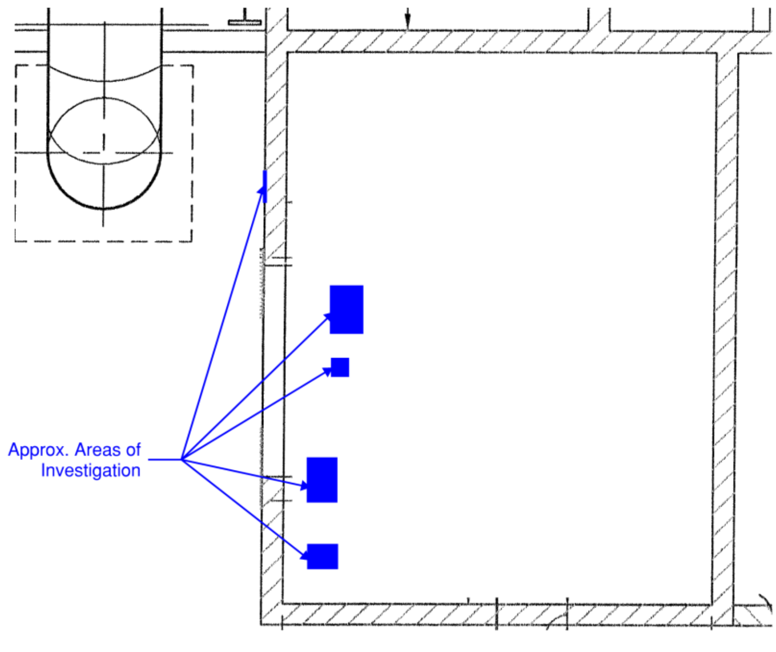



*Figure 4: Areas of Investigative Concrete Removal in Underside and Edge of Slab*

## Blower Room Pipes

The stainless-steel piping in the blower room was found to be moderately corroded along the welds (Photograph 27 & Photograph 28). No section loss was noted on the exterior of the piping. The exterior welds on the piping were observed to be in overall good condition, with minor to moderate corrosion and staining. Welded patch plates were observed on the pipes in locations that appear to have had leaks in the past. The lack of material loss on the exterior of the pipes indicates that the corrosion may be originating from the welds on the interior of the pipe. Additional information on the condition of the pipes may be found in Appendix C: Harper and Associates Report.

## Structural Analysis

The sodium hypochlorite system is assumed to weigh 2,500 lbs based on information from the manufacturer. This load is assumed to be distributed evenly across the floor slab as an area load equivalent to 12 pounds per square foot. As indicated in the original as-built drawings and as found in the investigative removal of concrete from the slab, the slab is reinforced in the north-south direction with #5 bars at 8" o.c. (Bottom), and in the east-west direction with #4 bars at 16" o.c. (Top) and 8" o.c. (Bottom). A two-way analysis of the slab was conducted in SAP2000, assuming pinned edges on the south, east, and west sides, and a fixed edge on the north side where the slab connects to the main building. The slab was analyzed for self-weight, the weight of the chlorination system, and an assumed 125 psf live load. The model indicates that the slab requires a minimum of 0.16 $in^2/ft$ of steel at the bottom face of the slab. The bottom steel provided in the slab, 0.3 sqin/ft, is significantly more than the required steel for the given loading, assuming no section loss of the existing reinforcing. The section loss in the reinforcing steel due to corrosion does not appear to reduce the reinforcing steel area to an amount lower than the minimum required. Therefore, the slab appears to be adequate for the given loading in its existing observed condition. However, action to prevent further deterioration and corrosion of the reinforcement is very strongly recommended.

## Recommendations

Note that the cost estimates provided are intended to be considered equivalent to a class 4 estimate per the Association for the Advancement of Cost Engineering (AACE) International Recommended Practice No. 18R-97 (Cost Estimate Classification System – as applied in engineering, procurement, and construction for the process industries) and were prepared to form the basis for project screening and preliminary budget approval for the work. The estimates were developed to consider the probable construction costs (material, labor, and equipment) of recommended improvement projects for the basins, sodium hypochlorite room and pipes in the blower room and do not consider soft costs (engineering, permitting, project management, etc.) that may be needed. In addition, the estimate assumes that each recommendation would be performed as a separate project. There may be cost savings if multiple projects were to be performed concurrently. Given the preliminary nature of the estimates provided, it is recommended that an additional 30% contingency be considered for planning purposes. While the objective is to provide a cost estimate that is as close to the actual costs as possible, it can vary significantly due to varying factors which include but are not limited to the contractor's experience and project understanding as well as the state of economy, and bidding climate.

### 1st and 2nd Stage Basins

It is recommended that the existing liner is removed, and a coating system is applied to the concrete surfaces in the primary and secondary stage basins. Following the removal of the liner, the concrete surface should be thoroughly inspected and areas that have significant damage should be repaired in accordance with the selected coating system. After the inspection and repairs, the surfaces receiving the coating system shall be properly prepared to meet the coating manufacturer's recommendations and ensure a competent bond to the concrete. The District may consider a polyurethane coating or a compound fiberglass mat reinforced coating system, such as Tnemec series 215ML/22. PSE understands that this coating system has recently been installed on the interior surfaces of the basins at the San Diego County Water Authority's Twin Oaks WTP. Alternatively, the HDPE liner can be replaced with a new, properly sealed HDPE liner. However, as is evident with the current HDPE liner system, it is very difficult to ensure moisture does not penetrate behind the liner, so a coating system is recommended over a new liner.

Based on information from the coating contractor completing the basin re-coating at Twin Oaks and the product manufacturer, the cost to coat all of the basins at DCM is estimated to be between $1.1 and $1.85 Million. This estimate assumes that three adjacent basins can be initially taken offline to prevent vapor transmission through the common wall during the application of the new coating. After the first basin is coated, only 2 basins will be required to go offline at a time. The estimate assumes a continuous operation to coat all the basins (primary and secondary, total of 13) and also includes mobilization, labor, materials, and demobilization/project close-out. The estimate also includes an allowance for patching large cracks and/or voids up to 15% of the total surface area being coated. The removal of the existing liner as well as the removal and storage of the membranes is excluded.

### Sodium Hypochlorite Room Floor Slab

It is recommended that any additional existing cracking and delamination in the floor slab in the sodium hypochlorite room be repaired by chipping out damaged concrete as necessary and filling in with a corrosion inhibiting bonding agent, such as Sika Armatec 110 EpoCem, and then repaired with a repair mortar such as SikaTop 122+. The repaired concrete surfaces are recommended to be coated in the sodium hypochlorite and fluoride rooms in order to prevent any further deterioration of the concrete and corrosion of the reinforcement.

Continued deterioration of the slab and reinforcement may weaken the slab and create an unsafe condition. Thus, it is recommended that repairs should take place in the next 6 months.

To ensure a more chemically resilient floor, PSE contacted Tnemec to provide input on a possible coating system. The objective of the coating system is to create a barrier to the concrete, similar to a secondary containment system. Tnemec recommends using their Ultra-Tread® S Series 242 and/or 245 depending on the depth of the material being broadcast over the floor. Ultra-Tread® is a polyurethane modified concrete that behaves like a flowable mortar floor topping. It is anticipated that the existing floor will need a self-leveling mortar as a filler in locations that exceed a depth of ½”. Following the application of Ultra-Treed® the surface will be coated with Tneme-Glaze Series 280 which is a modified polyamine epoxy. Each one of these products has chemical resistance properties including sodium hypochlorite.

Based on information from Tnemec, the cost to install the coating system described above is estimated to be between $20,000 and $30,000. This cost may be reduced if done in conjunction with the rehabilitation work on the basins. The high cost per square foot is the result of the small surface area being coated and the number of steps and professional installers required to complete the project. The estimate includes mobilization, labor, materials, and demobilization/project close-out. The estimate does not include the removal of the PSI OSHG system.

In addition to replacing the existing coating with a more resilient coating, it would be beneficial to include a drainage system that would direct any leaks outside of the room. Our site visit identified a pipe conduit through the south block wall that could be repurposed as a drain. If leaks are directed to a storage vessel that can accommodate a sump pump or flow by gravity it would be possible to direct the sodium hypochlorite solution out through this conduit. Installing a drainage system will help prolong the life of the coating system. The cost to install this system is estimated to be between $7,500 and $10,000. The District’s staff may wish to consider developing and installing this system to save money.

<u>Blower Room Pipes</u>

It is recommended that further investigation is conducted on the condition of the interior welds on the pipes to determine the state of their condition. This may be done using a scope camera. The welds may then be evaluated for any potential repairs, and, if necessary, a dye penetrant may be used on any new and existing welds to confirm that all defects have been found and repaired.

## Conclusion

PSE appreciates the opportunity to share our findings and be part of the evaluations and condition assessments at the District's DCM WTP. We share the District's concern regarding the condition of the structures included in this Technical Memorandum and recommend the repairs presented are implemented as soon as possible to prevent further deterioration and risk to on-site personnel.

PSE recommends the District continue to periodically monitor and maintain the overall condition of the structures and document any changes to the conditions presented.

## Endorsement

This report was prepared by Tom Bloomer, PE (CA License 64361), or under his direct supervision while an employee of Peterson Structural Engineers. All work is original and represents the opinions of a professional engineer registered in the State of California.

## Appendix A: Photographs

*Photograph 1: Concrete at Pipe Penetration on North Wall (01/26/2022)*

*Photograph 2: Concrete at Lower Liner Cut on East Wall (01/26/2022)*

*Photograph 3: Concrete at Upper Liner Cut on East Wall (01/26/2022)*

*Photograph 4: Concrete at Lower Liner Cut on South Wall (01/26/2022)*

*Photograph 5: Concrete at Lower Liner Cut on West Wall (01/26/2022)*

*Photograph 6: Hole in Floor Liner and Sludge (01/26/2022)*

*Photograph 7: Corrosion on Basin Steel Beams (01/26/2022)*

*Photograph 8: Crack and Efflorescence in Primary Basins*

*Photograph 9: Leaking Crack in Primary Stage Basin No. 3 (01/26/2022)*

*Photograph 10: Leaking from Chlorination System in Sodium Hypochlorite Room (01/26/2022)*

*Photograph 11: Damage to Sodium Hypochlorite Room Floor Slab (01/26/2022)*

*Photograph 12: Damage to Sodium Hypochlorite Room Floor Slab (01/26/2022)*

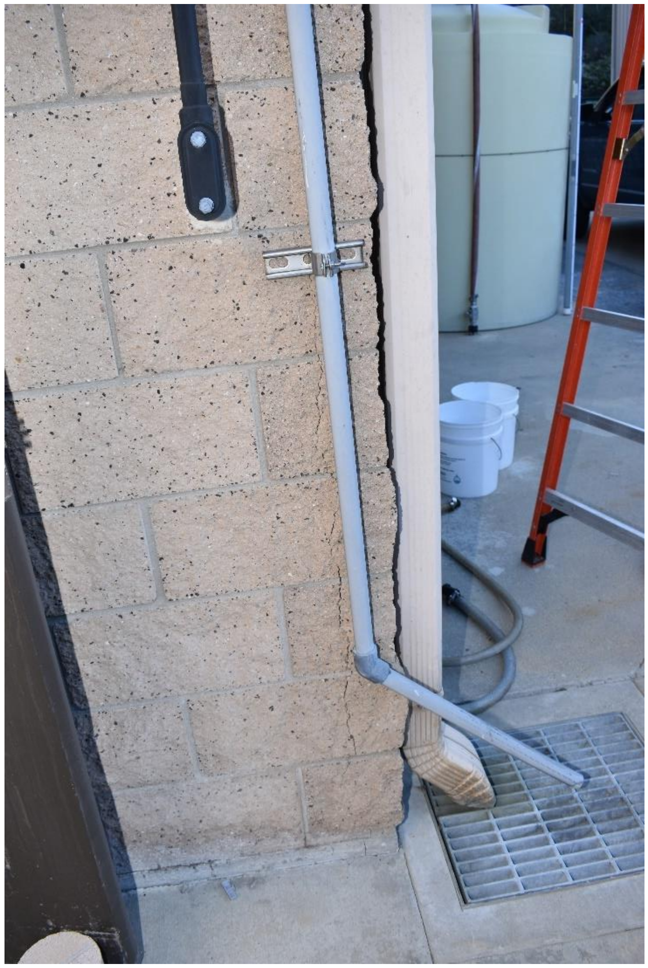
*Photograph 13: Cracking in Fluoride Room Ceiling Slab (01/27/2022)*

*Photograph 14: Cracking and Spalling in Slab Thickened Edge (01/27/2022)*

*Photograph 15: Damage to Slab Thickened Edge (01/27/2022)*

*Photograph 16: Cracking in Slab Thickened Edge and Masonry Wall (01/27/2022)*

*Photograph 17: Vertical Crack in Southwest Corner of Fluoride Room (01/27/2022)*



*Photograph 18: Exterior Vertical Crack at Southwest Corner of Fluoride Room (01/27/2022)*

*Photograph 19: Corrosion on Door of Fluoride Room (01/26/2022)*

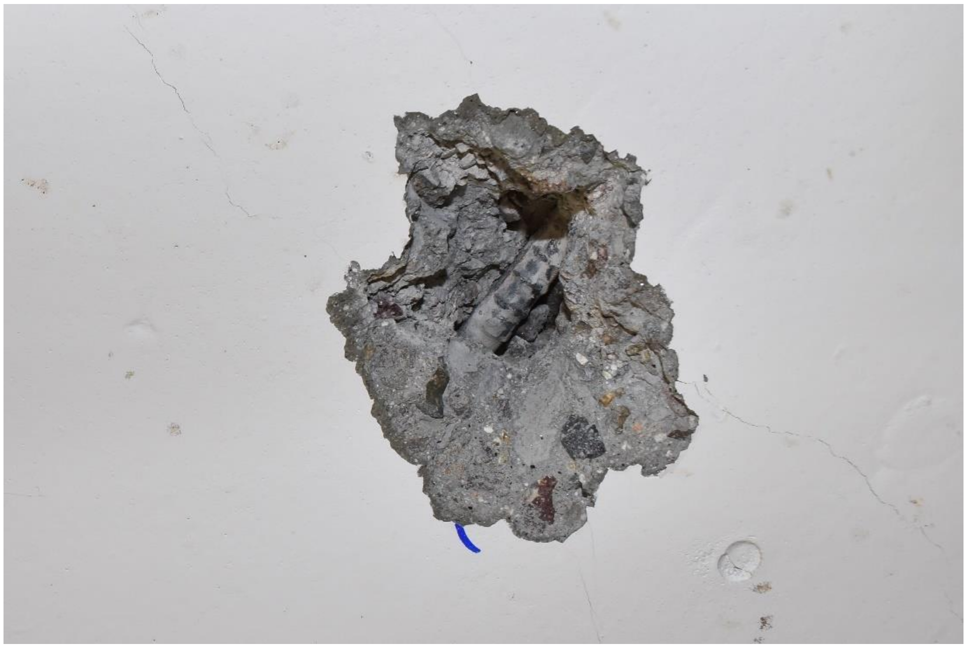

*Photograph 20: Exposed reinforcement in Sodium Hypochlorite Room Floor Slab (01/27/2022)*

*Photograph 21: Exposed reinforcement in Sodium Hypochlorite Room Floor Slab (01/27/2022)*

*Photograph 22: Exposed Reinforcement at Southwest Corner of Fluoride Room (01/27/2022)*

*Photograph 23: Exposed Reinforcement in Ceiling of Fluoride Room, at Cracking Location (03/22/2022)*

*Photograph 24: Exposed Reinforcement in Ceiling of Fluoride Room, at Cracking Location (03/22/2022)*



*Photograph 25: Exposed Reinforcement in Ceiling of Fluoride Room, in Area Without Cracks (03/22/2022)*

*Photograph 26: Exposed Reinforcement in Thickened Slab Edge (03/22/2022)*

*Photograph 27: Corrosion on Blower Room Piping (01/26/2022)*

*Photograph 28: Corrosion on Blower Room Piping (01/26/2022)*

## Appendix B: Budget Level Cost Estimates

| Dimensions Represent the Area to be Coated | | | | |
|---|---|---|---|---|
| **Description/Dimensions** | Length (ft) | Width (ft) | Height (ft) | Total Area to be Coated (SQFT) |
| Sodium Hypochlorite Room | 17.33 | 14.33 | 0.67 | 290.67 |
| First Stage Basins (10 total, price given per basin) | 50.0 | 10.0 | 11.0 | 1820.00 |
| Second Stage Basins (3 total, price given per basin) | 31.0 | 9.92 | 13.0 | 1371.25 |

******Areas for the basins are only the interior surface currently covered by the HDPE liner.***

| | **Unit costs account for the total surface area being treated** | | **Budget Level Estimates** | | | | |
|---|---|---|---|---|---|---|---|
| **Description/Estimates** | Lower Estimate (includes prep, labor and material) Per SQFT | Upper Estimate (includes prep, labor and material) Per SQFT | Contingency | Rough Order Planning Estimate - Lower Range | Rough Order Planning Estimate - Upper Range | Total Lower Range Estimate **(all Basins)** | Total Upper Range Estimate **(all Basins)** |
| Sodium Hypochlorite Room | $50.00 | $75.00 | 35% | **$19,620.00** | **$29,430.00** | | |
| First Stage Basins (10 total, price given per basin) | $35.00 | $60.00 | 35% | $85,995.00 | $147,420.00 | **$859,950.00** | **$1,474,200.00** |
| Second Stage Basins (3 total, price given per basin) | $45.00 | $70.00 | 35% | $83,303.44 | $129,583.13 | **$249,910.31** | **$388,749.38** |
| | | | | | **TOTAL** | **$1,109,860.31** | **$1,862,949.38** |

## Appendix C: Harper and Associates Report

# HARPER & ASSOCIATES ENGINEERING, INC.

CONSULTING ENGINEERS

*1240 E. Ontario Ave., Ste. 102-312, Corona, CA 92881-8671*
*Phone (951) 372-9196   Fax (951) 372-9198*
*www.harpereng.com*

## CORROSION REPORT

| | |
|---|---|
| PROJECT: | Corrosion Engineering Evaluation of Stainless-Steel Piping and Liner in Second Stage Filter Basins |
| STRUCTURES: | Membrane Building (Train No. 8)<br>Blower Room (Stainless-Steel Piping) |
| OWNER: | Olivenhain Municipal Water District |
| LOCATION: | Encinitas, California |
| INVESTIGATED BY: | Andre Harper, Project Engineer |
| DATE: | January 2022 |

## I. GENERAL INFORMATION

### A. Contract Information

Harper & Associates Engineering, Inc. was retained by PSE/Olivehain Municipal Water District to accomplish field investigation of the HDPE liner in second stage concrete filter basins and stainless-steel piping in the blower room to observe liner and pipe surfaces and conditions, with photographs taken to record conditions. Concrete surfaces, where exposed were also investigated in the filter basins. According to information provided by others the liner was installed sometime in 2012. This report has been prepared with observations, conclusions, recommendations, and cost estimates for accomplishing the work.

This Corrosion Report is prepared solely based on noted field investigation. Conclusions and recommendations are strictly those determined by Consultant to be consistent with the best and most experienced practice within the corrosion engineering profession.

### B. Site Conditions

The concrete filter basins and pipe gallery are located in at the District owned treatment plant in Encinitas. There is adequate room adjacent to the filter basin for vehicles and equipment. No difficulty is anticipated for Contractor mobilization, assuming use of normal portable air compressor and related equipment.

There are other basins, piping and processes within the building which could be adversely affected by dust and contamination associated with abrasive blast cleaning and painting operations. Accordingly, extreme caution must be exercised during all cleaning and painting operations.

C. Existing Liners and Piping

1. Based on the field investigation and records provided, the liner and piping systems are as follows:

a. Concrete Filter Basins – The concrete basins are lined with High Density Polyethylene (HDPE).

b. Blower Room Pipe Gallery – The 42” pipe is marked as Schedule 5s T-304-L. It is assumed that the other stainless-steel piping is the same.

## II. INVESTIGATION

A. Investigation was accomplished as follows:

1. Surfaces were inspected by traversing the piping gallery and entering the filter basin via a ladder.

2. Light was supplied via natural light and a strobe for the pictures.

3. Various chipping tools were employed to examine typical areas of defective liner and corrosion on the piping.

4. Photographs were taken of typical and specific areas to illustrate condition of surfaces.

## III. OBSERVATIONS

A. Based upon the above reported investigation, the following observations were noted:

1. HDPE Liner in Second Stage Filter Basins

a. The HDPE liner exhibits numerous defects, holes, and gaps along the seams. (Photos I-1 through I-25)

b. Minor to moderate corrosion is present on the beams supporting the grating. (Photos I-1 through I-6)

c. The HDPE liner is bulging out from the concrete wall in several locations. (Photos I-6, I-7, I-17, and I-18)

d. Severely exposed aggregate is present where the liner was cut around a pipe penetration. (Photo I-9)

e. Random holes were found in the liner and random pop rivets were found to be loose and/or missing. (Photos I-10 through I-13)

f. Varying degrees of exposed aggregate are present where coupons of the liner were removed for inspection. (Photos I-14 through I-19)

g. Random seams between HDPE panels were found to be loose. (Photos I-20 and I-21)

h. Moisture and sludge were found to be coming up through the liner at miscellaneous holes, seams, and patches. (Photos I-22 through I-25)

2. Blower Room Stainless-Steel Piping

a. Minor to moderate general corrosion and staining are present along the welds and random patch plates on the stainless-steel piping. (Photos I-1 through I-34)

b. Patch plates have been welded over welds that appear to have been leaking in the past. (Photos I-8 through I-12, I-14, and I-15)

c. Areas of darker corrosion and dark staining are present at random patches. (Photos I-18 through I-21)

d. Close-up photos illustrating that little to no exterior metal loss is present. (Photos I-20 through I-25)

e. Only minor stain and no patch plates are present on the smaller diameter stainless-steel piping. (Photos I-26 through I-34)

## IV. CONCLUSIONS

A. Based on the above noted observations, the following conclusions are drawn:

1. HDPE Liner in Second Stage Filter Basins

a. The HDPE liner is in generally poor condition based on the number of defects present and the amount of moisture and sludge that appears to be getting behind the liner and making contact with the concrete substrate. The concrete will continue to deteriorate over time if the sludge and water continue to get behind the liner. Based on the type of liner and installation procedures that were utilized for this particular HDPE liner, it is HAE’s opinion that the liner was not installed in a manner that would prevent water from getting behind the liner and contacting the concrete. There are other liners and/or coating systems that could be used, that would prevent the water from contacting the concrete.

b. Minor to moderate random corrosion on the beams above the basin appears to be due to defects in the galvanized beams and possibly mechanical damage that could have occurred when personnel are working around the basins.

c. The liner bulging out from the concrete walls appears to be due to a combination of the liner not being sufficiently mechanically bonded to the concrete walls and moisture and sludge getting behind the liner.

d. The severely exposed aggregate is due to the concrete being exposed to chemicals in the water that deteriorate the surface layer. Low alkalinity will also adversely affect the concrete.

e. Random holes in the liner appear to be mostly due to missing pop rivets, but some holes may be due to mechanical damage as the holes do not seem to fit the pattern the pop rivets were installed.

f. Varying degrees of exposed aggregate found where coupons were removed are due to the reasons noted in A. 1. d. The varying degrees of deterioration most likely correspond with the length of time the concrete was exposed to the moisture behind the liner.

g. HAE is not familiar with this particular liner material, and therefore does not know how the seams are connected. It could be a mechanical connection, thermal welding, glue or some other fastening method. It is also not known if the failure at the joints is widespread or if the failures are isolated.

h. Moisture and sludge behind the liner is due to the various points of deterioration and holes in the liner discussed above.

2. Stainless-Steel Piping

a. The vast majority of the exterior of the stainless-steel piping is in good condition with random spots of corrosion and staining present. The interior surfaces could not be inspected, but it is anticipated that the interior welds are severely corroded and are the primary source of the corrosion that is being found on the exterior of the piping.

b. The patch plates and random spots of corrosion are likely due to porosity of the welds on the interior of the piping.

c. Darker spots of corrosion appear to indicate the location of perforations.

## V. RECOMMENDATIONS

A. Based on the above noted observations and conclusions, the following recommendations are offered.

1. HDPE Liner Second Stage Filter Basins

a. HAE recommends installing a Hypalon or HDPE liner that is completely sealed so water cannot flow behind the liner or applying a high-build coating system to all concrete surfaces. As can be seen below, the cost for a liner verses a high-build coating system is relatively close. However, installing the liner around all the piping and appurtenances would be very difficult and it only takes one area that is not properly sealed to allow water to flow behind the entire liner in the basin. Therefore, HAE would recommend installing the high-build coating system. The coating will protect the concrete from further degradation and if random defects develop in the coating over time, it will not compromise the entire system.

b. The corrosion on the overhead beams should be monitored, and if the minor to moderate corrosion leads to metal loss the corroded beam(s) should be replaced.

c. At this time, no significant concrete damage was observed, but when the entire liner is removed there may be areas of damage. When a new liner or coating system is installed, an optional item should be included for cementitious repairs for significant concrete damage if needed.

2. Stainless-Steel Piping

a. As it appears that the exterior of the piping is in relatively good condition, it is HAE's recommendation that the interior of the piping be evaluated to determine if the interior welds are porous or isolated imperfections are present. It may be necessary to grind out and replace defective portions or entire welds on the interior of the pipe.

b. The existing and new welds should be tested with a dye penetrant to confirm that all defects are found and repaired.

## VI. COST ESTIMATES

A. Based on current and previous projects of similar scope, preliminary cost estimates for work as noted in RECOMMENDATIONS were calculated by using data from those projects. There are three (3) basins at 10'x33'x12' high and nine (9) basins at 10'x50'x12' high for a total of 21,550 sq. ft.

1. Furnish and install a HDPE or Hypalon Liner: Installation of a liner would be in the cost range of $20 to $25 per square foot for a total of 21,550 sq. ft. or $431,000 to $538,750, excluding removal of the existing liner.

a. 10'x33'x12' Basin = $20,660 to $25,825 per Basin
b. 10'x50'x12' Basin = $28,800 to $36,000 per Basin

2. Abrasive blast cleaning the concrete walls and floors and applying a polyurethane coating system would be in the cost range of $22 to 28 per square foot for a total of 21,550 sq. ft. or $474,100 to $603,400, excluding removal of the existing liner.

a. 10'x33'x12' Basin = $22,726 to $28,924 per Basin
b. 10'x50'x12' Basin = $31,680 to $40,320 per Basin

3. Repairing random corrosion on the wall, columns and floor would be in the cost range of $40 to $50 per sq. ft. The quantity of repairs cannot be determined until the liner is removed and the interior of the basins can be better evaluated.

Respectfully submitted,

HARPER & ASSOCIATES ENGINEERING, INC.

Andre Harper
Project Engineer

# HARPER & ASSOCIATES ENGINEERING, INC.

CONSULTING ENGINEERS

*1240 E. Ontario Ave., Ste. 102-312, Corona, CA 92881-8671*
*Phone (951) 372-9196 Fax (951) 372-9198*
*www.harpereng.com*


PHOTOGRAPHIC SURVEY

PROJECT: Corrosion Engineering Evaluation of Stainless-Steel Piping and Liner in Second Stage Filter Basins

STRUCTURE: Membrane Building (Train No. 8)
HDPE Lined Second Stage Filter Basin

OWNER: Olivenhain Municipal Water District

LOCATION: Encinitas, California

PHOTOGRAPHED BY: Andre Harper, Project Engineer

DATE: January 2022

---

I-1 View of the upper portion of a 2nd stage basin and the galvanized grating above the basin. Note minor to moderate corrosion on the beams supporting the grating.

I-2 View of the temporary ladder and HDPE liner on the walls in the background.

I-3 View of one of the support beams, illustrating minor to moderate corrosion on the beam.

I-4 View of the upper wall of the basin, illustrating generally good condition of the HDPE liner.

I-5 Same as Photo I-4, except in a different location. Note white pop rivets along the top edge of the HDPE liner and randomly on the lower surfaces.

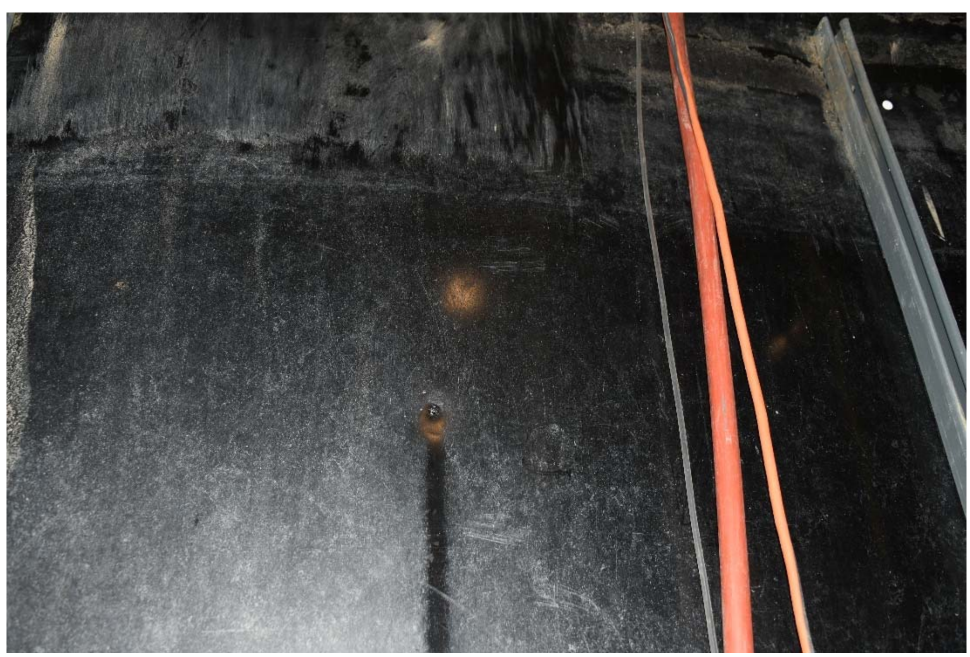
I-6 View of the upper portion of the HDPE liner, illustrating an area where the liner is bowed out from the wall.

I-7 View of the lower portion of the basin, illustrating generally good condition of the liner material.

I-8 View of a PVC pipe penetrating the concrete, illustrating the liner has been cut around the penetration and pop riveted to the concrete.

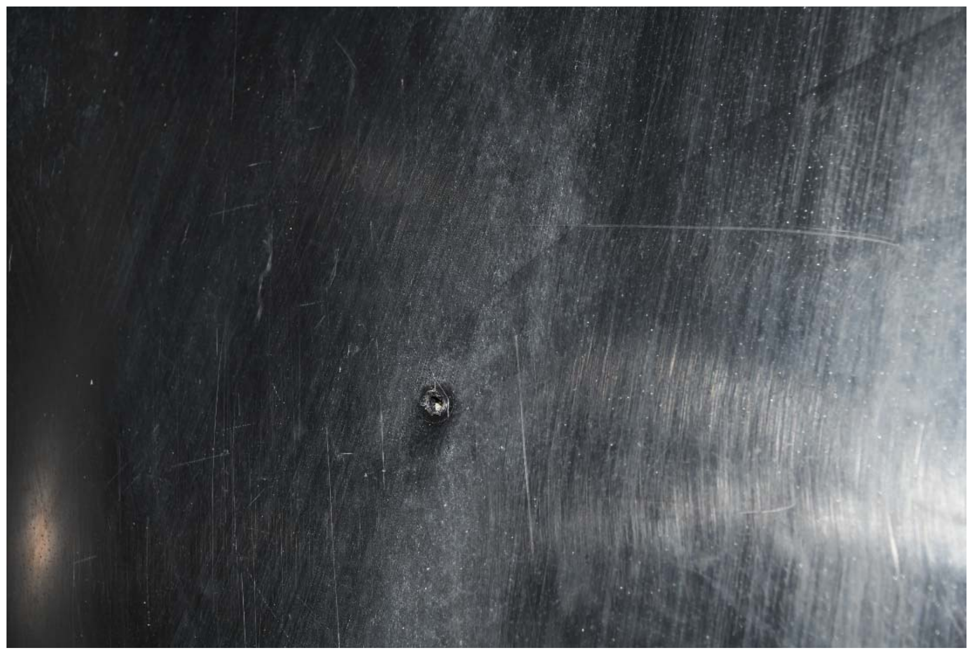
I-9 Same as Photo I-8, except a closer view of the cut out. Note aggregate is severely exposed around the pipe.

I-10 View of the liner, illustrating a hole with brown staining around the hole and moisture running down the liner below the hole.



I-11 Close-up view of the line, illustrating two holes with an unknown red material present.

I-12 Close-up view of the liner, illustrating a hole with a white spot in the middle.



I-13 View of the liner, illustrating a pop rivet that is coming loose.

I-14 View of a cut out in the liner, illustrating generally good condition of the concrete in this location.

I-15 Same as Photo I-14, except in a different location. Note lightly exposed aggregate.

I-16 Same as Photos I-14 and I-15, except in a different location. Note moderately exposed aggregate in this location.

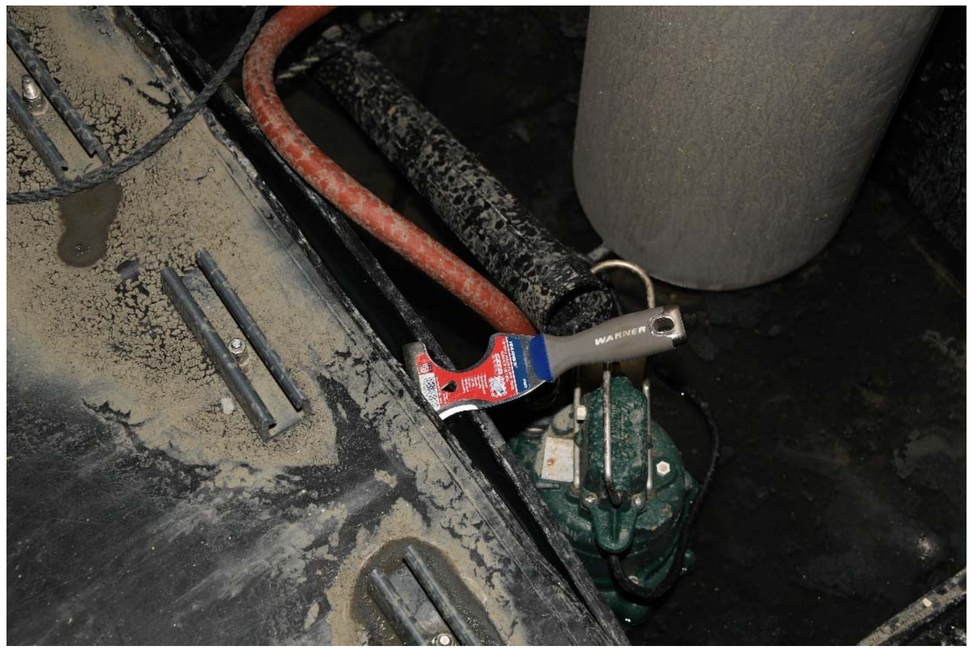
I-17 View of a cut out near the bottom of the wall, illustrating the liner is bowed away from the concrete.

I-18 Same as Photo I-17, except a scraper was utilized to illustrate the distance between the concrete and backside of the liner.

I-19 Same as Photos I-17 and I-18, except in different location.

I-20 View of a scraper inserted into a vertical lap seam, illustrating the seam is not tight in this location. Note the head of a white pop rivet above the scraper.

I-21 Same as Photo I-20, except on the floor of the basin.



I-22 View of the floor of the basin, illustrating spots of moisture coming up through the liner.

I-23 Same as Photo I-22, except at the other end of the basin.

I-24 View of a patch with 4 bolts penetrating through the liner, illustrating moisture coming through the patch and minor corrosion on the bolts.

I-25 Close-up view of the floor, illustrating holes with moisture and sludge coming up through the holes.

# HARPER & ASSOCIATES ENGINEERING, INC.

CONSULTING ENGINEERS

*1240 E. Ontario Ave., Ste. 102-312, Corona, CA 92881-8671*
*Phone (951) 372-9196   Fax (951) 372-9198*
*www.harpereng.com*

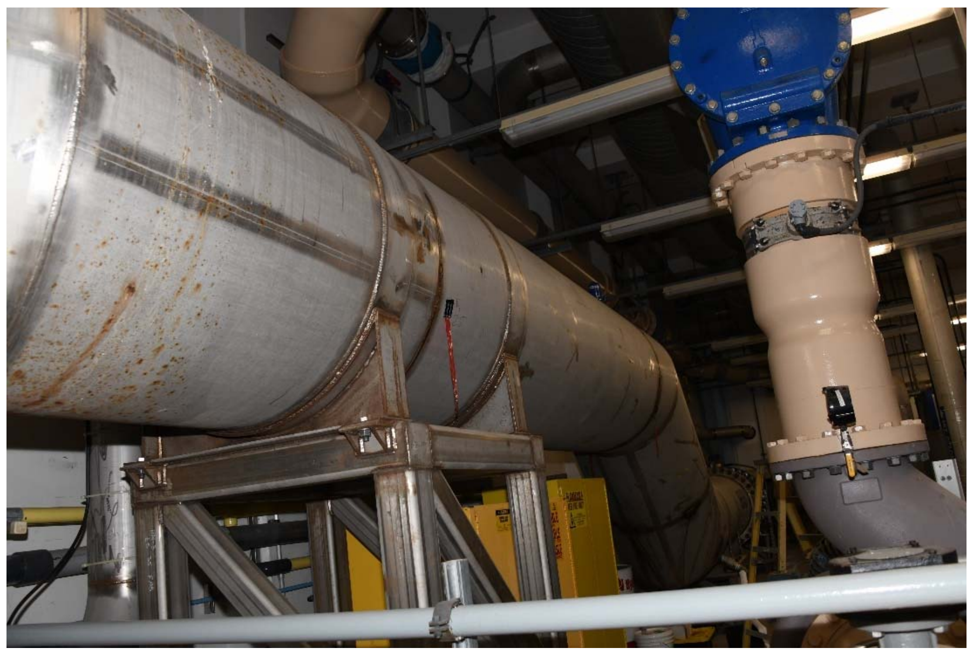

PHOTOGRAPHIC SURVEY

| | |
|---|---|
| PROJECT: | Corrosion Engineering Evaluation of Stainless-Steel Piping and Liner in Second Stage Filter Basins |
| STRUCTURE: | Blower Room Stainless-Steel Piping |
| OWNER: | Olivenhain Municipal Water District |
| LOCATION: | Encinitas, California |
| PHOTOGRAPHED BY: | Andre Harper, Project Engineer |
| DATE: | January 2022 |

I-1 View of stainless-steel piping transporting combined influent, illustrating corrosion staining at the circumferential welds.

I-2 Same as Photo I-1, except in a different location. Note welded patches on circumferential welds.

I-3 Same as Photos I-1 and I-2, except at a stainless-steel support stand. Note random spots of corrosion on the piping in this location.



I-4 Same as Photo I-3, except at the backside of the piping.

I-5 View of a butt strap and saddle, illustrating minor corrosion staining along the welds.


I-6 View of a Victaulic coupling, illustrating very little to no corrosion on the coupling or along the edges.

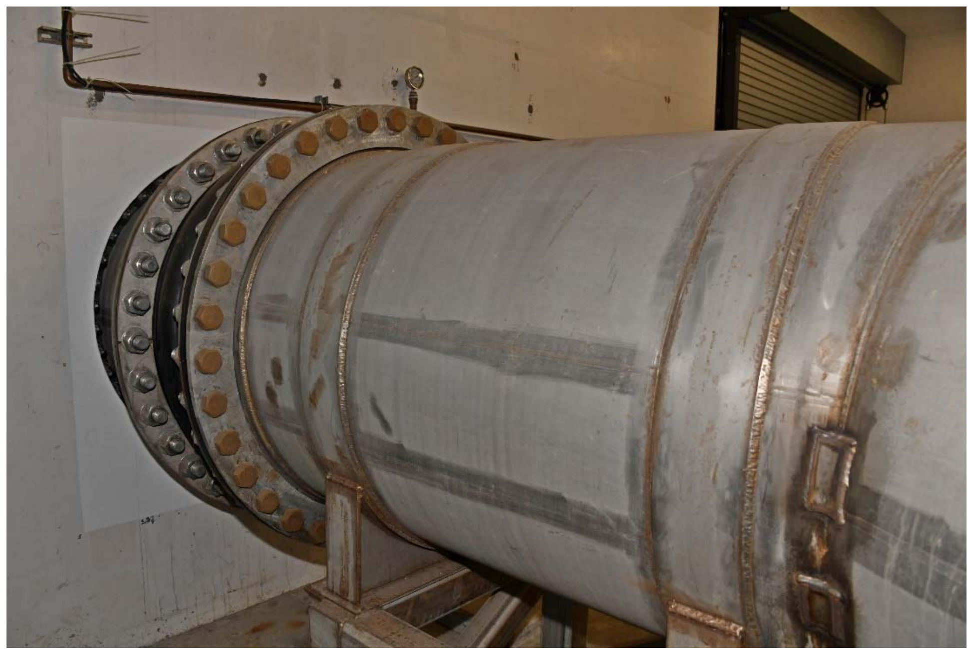
I-7 View of a circumferential weld, illustrating rust scale present where it appears the pipe has been leaking.

I-8 View of a weld that appears to have been overlayed with an additional weld. Note dark spots where it appears leaks are present.


I-9 View of a welded patch on the bottom side of the pipe, illustrating dark areas that appear to have been leaking.

I-10 Same as Photo I-9, except in a different location.

I-11 View of two weld patches on the topside of the pipe, illustrating stains running down the pipe where it appears leaking has been occurring.



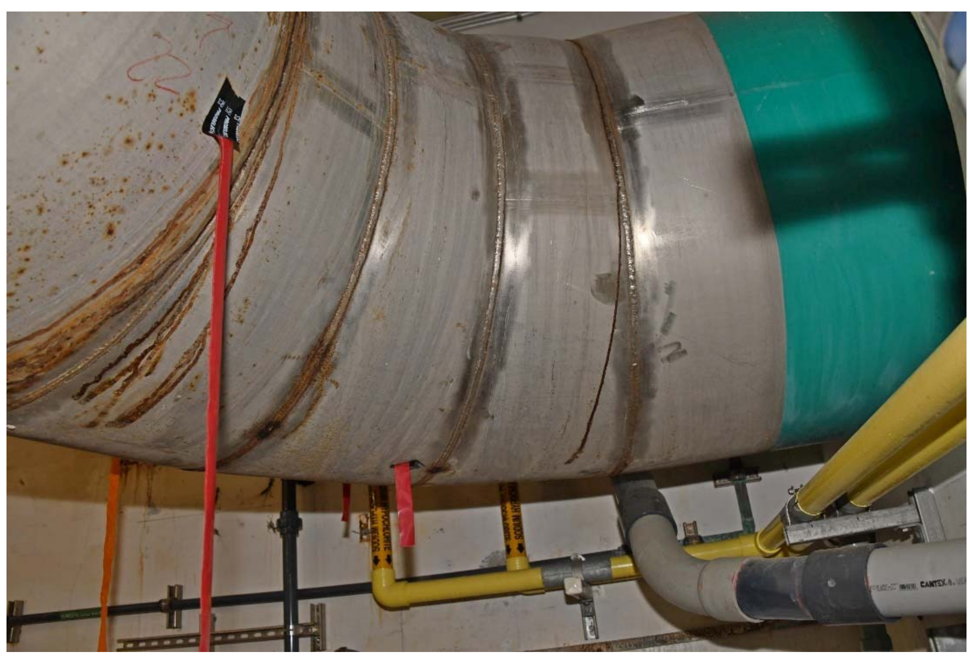
I-12 View of the pipe penetrating the north wall, illustrating minor corrosion staining on the welds and bolt heads at the flange.

I-13 View of the tanks and piping just outside of the north wall, illustrating the apparent good condition of the piping.

I-14 Same as Photo I-12, except on the other side of the piping. Note welded patches on the corner of the elbow.

I-15 Same as Photo I-14, except just past the Victaulic coupling. Note welded patches in this location also.


I-16 View of an elbow, illustrating staining where it appears leaking has been occurring.



I-17 Same as Photo I-16, except on the other side of the elbow.

I-18 View of the topside of the pipe, illustrating a welded patch that appears to have been leaking.

I-19 Same as Photo I-18, except rust scale has been scraped away to examine the substrate.

I-20 Same as Photo I-19, except a closer view of the area that was scraped. Note apparent pinhole where scraping was accomplished.

I-21 Same as Photos I-18 through I-20, except at a different patch. Note dark spot above the patch where it appears leaking has occurred.


I-22 Close-up view of the pipe, illustrating a dark wet spot at the junction of two welds where it appears leaking has occurred or is beginning to occur.

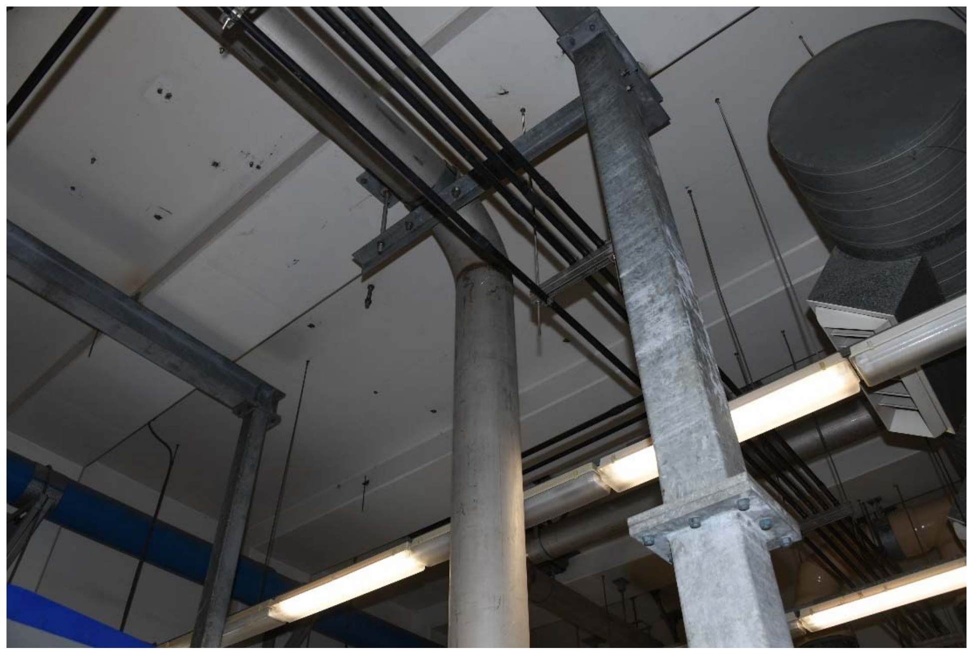
I-23 Same as Photo I-22, except after the wet spot was wiped away and corrosion scraped. No obvious pinhole was seen.

I-24 Close-up view of the pipe at a weld patch, illustrating dark corrosion along the top weld on the patch.


I-25 Same as Photo I-24, except at a different patch. Note dark area at the bottom of the weld patch.

I-26 View of 1st stage air piping, illustrating the overall good condition of the piping.


I-27 Same as Photo I-26, except in a different location.



I-28 View of 2nd stage air piping, illustrating very minor corrosion on the piping and along random welds.

I-29 Same as Photo I-28, except in a different location.


I-30 Same as Photos I-28 and I-29, except in a different location. Note good condition of the piping.


I-31 View of backpulse piping, illustrating minor corrosion and staining on the stainless-steel piping and on the white Victaulic couplings.

I-32 View of 2nd stage permeate piping, illustrating random minor corrosion on the piping.


I-33 Same as Photo I-32, except in a different location.


I-34 Same as Photos I-32 and I-33, except at the north wall.

## Appendix D: Coating Systems

# SERIES 215ML/22

## MAT-REINFORCED LINING SYSTEM FOR MEMBRANE FILTER TANKS

With the advancement of membrane filter technology, many treatment facilities are moving to ultrafiltration or microfiltration systems, whether for raw water or for wastewater in the form of an ultrafiltration membrane or membrane bioreactor (MBR). These systems provide a high quality effluent with a much smaller plant footprint. Immersion-type filters which require tanks or basins are a popular choice due to their increased efficiency and ease of maintenance. However, the processes involved with operating and maintaining the filters, whether in water or wastewater treatment, can subject concrete tank linings to a unique set of demands. Tnemec, a leader in protective coatings for water and wastewater treatment, developed the Series 215ML/22 Mat-Reinforced Lining System to protect concrete from aggressive cleaning methods, impact, and thermal shock from elevated backwash/backflush temperatures, while ensuring safe contact with drinking water.

### THE SYSTEM

Every coating in Tnemec's Series 215ML/22 Mat-Reinforced Chemical-Resistant Lining System is NSF/ANSI Standard 61-certified—from the primer, to the fiberglass-reinforced intermediate coat, to the topcoat. The lining consists of Series N140F Pota-Pox Plus, a penetrating concrete primer, Series 215 Epoxy Surfacer, a 100% solids epoxy bedding coat, with an embedded ¾ ounce fiberglass mat, and a topcoat of Series 22 Epoxoline. This high performance lining system was developed specifically to provide long-lasting performance in both membrane filtration and MBR process tanks.

### THE BENEFITS

- *Penetrating concrete primer*
- *100% solids epoxy basecoat and topcoat*
- *Fiberglass reinforcement*
- *Chemical and permeation resistant*
- *Resistant to impact and abrasion from cassette movement*
- *Resistant to thermal shock from elevated temperature backwashing or backflushing*
- *100% NSF/ANSI Standard 61 certified*

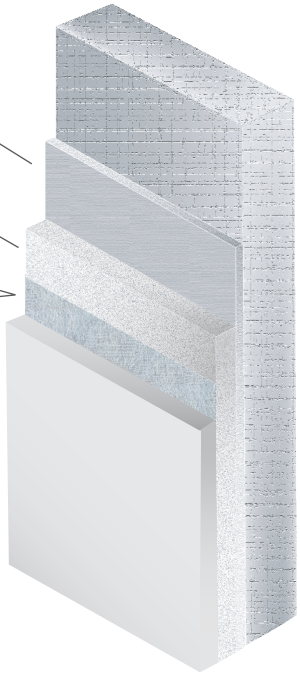
**Primer**
Series N140F Pota-Pox® Plus
*3-6 Mils DFT*

**Bedding Coat**
Series 215 Surfacing Epoxy
*60-80 Mils DFT*

**Reinforcement**
Series 211-215 Fiberglass Mat

**Saturant Coat**
Series 22 Epoxoline

**Topcoat**
Series 22 Epoxoline
*20-30 Mils DFT*



**Tnemec Company Incorporated** 6800 Corporate Drive Kansas City, Missouri 64120-1372 1-800-TNEMEC1 Fax: 816-483-3969 tnemec.com

# ULTRA-TREAD® S SERIES 245

## PRODUCT PROFILE

**GENERIC DESCRIPTION** Polyurethane Modified Concrete

**COMMON USAGE** Ultra-Tread S is a low odor, slurry applied, flowable mortar floor topping designed for monolithic applications in abusive service areas. It provides superior performance to other flooring systems such as acid brick, quarry tile and most polymer flooring systems. Designed for use in food and beverage facilities, pharmaceutical and processing areas, commercial and restaurant kitchens or anywhere a durable floor topping is required. Provides excellent chemical resistance and withstands thermal shock due to hot liquids and aggressive cleaning procedures. Areas may be quickly returned to service within hours of installation, depending on temperature and humidity. Ultra-Tread S is a self-priming base coat that can be applied to 10 day old concrete. It can withstand moisture vapor transmission up to 20 lbs (per ASTM F 1869) and relative humidity up to 99% (per ASTM F 2170).

**COLORS** Gray and Red. **Note:** Additional lead times may apply when ordering Beige, Black, Blue, Green, Off White and Yellow. Aromatic urethanes chalk and yellow with age, extended exposure to UV and artificial lighting. **Note:** Colored quartz or decorative flake may be broadcast to refusal into the system, creating a multi-colored or tweed look. A variance in color may be noticeable and require a second broadcast layer of colored quartz or decorative flake. A sample is recommended for color selection.

**FINISH** Matte

**SPECIAL QUALIFICATIONS** Formulated with antimicrobial properties. Does not support bacteria or fungal growth. Contact your Tnemec representative for specific test results.

Series 245 was tested in accordance with, and passed, the California Dept. of Public Health (CDPH) Standard Method v1.2 and meets the requirements of LEED v4.1 Low-Emitting Materials, Collaborative for High Performance Schools-Paints & Coatings, Living Building Challenge Materials Petal 10, and WELL Building Standard v2 X06 VOC Restrictions.

## COATING SYSTEM

**SURFACER/FILLER/PATCHER** Series 242 (extended with aggregate) or Series 243, 244. Patching should be allowed to cure a minimum of six hours prior to placement of the Series 245 to avoid blistering or doming of the Series 245. Series 215, or 201 or 208 mixed with fumed silica, may be used for small patches or crack repairs. Certain high-early strength, cementitious repair mortars are also acceptable. Contact Tnemec for further qualifications.

**PRIMERS** Self-priming

**INTERMEDIATE** Series 222, 233, 237, 238, 239, 252SC, 256, 257. **Note:** Series 245 must be broadcast to refusal with aggregate, colored quartz or decorative flake if topcoating. Broadcast aggregate or colored quartz at an approximate rate of 0.5 lb per sq ft or 4 to 5 sq ft per pound and decorative flake at an approximate rate of 0.25 lb per sq ft. The Series 245 base coat will account for approximately 1/8"-3/16" of the desired system thickness.

**TOPCOATS** Series 222, 233, 237, 238, 239, 246, 247, 248, 252SC, 256, 257, 280, 280FC, 281, 282, 284, 285, 286, 290, 291, 294, 295, 296, 297. **Note:** These topcoats may only be used when recommended aggregate has been broadcast to refusal into the wet Series 245 or the cured surface of the Series 245 has been cleaned and thoroughly abraded by grinding prior to topcoating. **Note:** If Series 247 (tinted), 248 (tinted), 290, 291 or 297 is selected for the finish coat over a broadcast system, a grout coat of Series 222, 233, 237 or 238 (tinted), 256 (tinted), 257 (tinted), 280, 281 or 284 is required. If Series 247 (clear), 248 (clear), 285, 294, 295 or 296 is selected for the finish coat over a broadcast system, a grout coat of 237 or 238 (clear), 256 (clear), 257 (clear) or 284 is required.

## SURFACE PREPARATION

Prepare surfaces by method suitable for exposure and service.

**CONCRETE** Allow new poured-in-place concrete to cure a minimum of 10 days at 75°F (24°C). Verify concrete dryness in accordance with ASTM F 1869 “Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride” (moisture vapor transmission should not exceed 20 pounds per 1,000 square feet in a 24 hour period), F 2170 “Standard Test Method for Determining Relative Humidity in Concrete using in situ Probes” (relative humidity should not exceed 99%), or D 4263 “Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method” (no moisture present). **Note:** The testing listed above cannot guarantee avoidance of future moisture related problems particularly with existing concrete slabs. This is especially true if the use of an under slab moisture vapor barrier cannot be confirmed or concrete contamination from oils, chemical spills, unreacted silicates, chlorides or Alkali Silica Reaction (ASR) is suspected.

Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Abrasive blast, shot-blast, water jet or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers and other contaminants and to provide a minimum ICRI-CSP 5 or greater surface profile. Large cracks, voids and other surface imperfections should be filled with a recommended filler or surfacer.

**ALL SURFACES** Must be clean, dry and free of oil, grease and other contaminants. Do not apply over existing coatings. **Note:** Substrate conditions which can adversely affect the adhesion of Series 245 Ultra-Tread S include: concrete that is structurally unsound, wet, damp, contaminated, or inadequately profiled at the time of application, absent or inadequate under slab moisture vapor barrier, hydrostatic pressure, Alkali Silica Reaction (ASR), and migration of oils, chemicals, and other contaminants.

# ULTRA-TREAD® S | SERIES 245

## TECHNICAL DATA

**VOLUME SOLIDS**
100% (mixed)

**RECOMMENDED DFT**
3/16" to 1/4" (5 mm to 6 mm). Series 245 can be applied as a stand alone mortar (neat) at 3/16"-1/4" (5 mm - 6 mm). Broadcasting with aggregate to refusal at 3/16" (5 mm) neat will yield a total thickness of 1/4" (6 mm), at 1/4" (6 mm) neat will yield a total thickness of 5/16" (8 mm). **Important:** Series 245 should not exceed 1/2" (13 mm) thickness when applied neat. Refer to coverage rates table for more information. **Note:** Exceeding the recommended coating thickness may result in blistering of the product. Avoid excessive coating thickness by thoroughly filling voids, depressions and cracks with recommended filler or surfacer prior to Series 245 application.

**CURING TIME**

| Temperature | Min. Recoat | Light Traffic | Place In Service † |
|---|---|---|---|
| 75°F (24°C) | 6 hours | 8 hours | 12 hours |

† For full resistance to chemicals and steam cleaning, 24 hour cure is needed.
Curing time varies with surface temperature, air movement, humidity and film thickness. **Note:** For faster curing and low temperature applications, add No. 44-714 Ultra-Tread Accelerator, see separate product data sheet for cure information.

**VOLATILE ORGANIC COMPOUNDS**
Parts A & B: 0.16 lbs/gallon (19 grams/litre)
Parts A, B & C: 0.07 lbs/gallon (8 grams/litre)

**THEORETICAL COVERAGE**
23 sq ft per small kit at 1/4" 31 sq ft per small kit at 3/16"

**NUMBER OF COMPONENTS**
Three—Liquids: Part A & Part B, Aggregate: Part C

**PACKAGING**

| | Part A (partially filled) | Part B | Part C (Aggregate) | Mixed Yield | Small Kit Equivalent |
|---|---|---|---|---|---|
| Extra Large Kit | 1-tote | 1-tote | 300-42.5 lb. bags | 1083.3 gallons (4100.7 L) | 300 |
| Medium Kit | 1-5 gallon pail | 1-5 gallon pail | 5-42.5 lb. bags | 17.9 gallons (67.8 L) | 5 |
| Small Kit | 1-1 gallon jug | 1-1 gallon jug | 1-42.5 lb. bag | 3.6 gallons (15.6 L) | 1 |

**Note:** Empty measuring pails are available. Reference F100-H189-UT for the 2-gallon Part A pail and F100-H190-UT for the 2-gallon Part B pail. Empty measuring pails are only needed for breaking down Series 241, 242 and 245 part A & B components when mixing Medium and X-Large Kits. The measuring pails are not needed for Small Kits as the part A & B components are already prefilled at the correct fill amounts.

**NET WEIGHT PER GALLON**
16.28 ± 0.25 lbs (7.38 ± 0.11 kg) (mixed)

**STORAGE TEMPERATURE**
Minimum 35°F (2°C) Maximum 110°F (43°C)
Material should be stored at temperatures between 70°F and 90°F (21°C and 32°C) for at least 48 hours prior to use.

**TEMPERATURE RESISTANCE**
(Dry) Continuous 235°F (112°C). At thicknesses of ¼" or greater, resistant to aggressive chemical cleaning, thermal shock from steam or hot water, and occasional high temperature liquid spills or discharge at temperatures from -40°F (-40°C) to 250°F (121°C).

**SHELF LIFE**
Part A: 12 months Part B: 12 months Part C: 12 months

**FLASH POINT - SETA**
N/A

**HEALTH & SAFETY**
This product contains chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product.
**Keep out of the reach of children.**

## APPLICATION

**COVERAGE RATES**
Before commencing, obtain and thoroughly read the *StrataShield Application Guide for Polyurethane Modified Concrete.*

| Applied Neat | Broadcast To Refusal | Small Kit Coverage |
|---|---|---|
| 3/16” (5 mm) | 1/4" (6 mm) | 31 sq ft (2.8 m²) |
| 1/4" (6 mm) | 5/16" (8 mm) | 23 sq ft (2.1 m²) |

**Important:** Series 245 should not exceed 1/2" (13 mm) thickness when applied neat. **Note:** Exceeding the recommended coating thickness may result in blistering of the product. Avoid excessive coating thickness by thoroughly filling voids, depressions and cracks with recommended filler or surfacer. Application below minimum or above maximum recommended thicknesses may adversely affect performance. Above rates are based on theoretical coverage. Actual coverage will vary based on condition of substrate.

**MIXING** When mixing Small Kits use a variable speed 850-RPM drill and four-inch (4") dispersion blade, slowly mix the entire contents of both the A and B components for a minimum of one minute. Continue agitation and slowly add the Part C aggregate and mix until material is uniform and no dry aggregate is present. The entire mixing procedure should take approximately three minutes. **Note:** Part B is moisture sensitive. Do not open until ready to mix.

When mixing Medium and Extra-Large kits, mix 0.9117 gallons of Part A component with 0.7993 gallons of Part B component. **Note:** Empty mixing pails are available for measuring these kit sizes. Reference F100-H189-UT for the 2-gallon Part A pail and F100-H190-UT for Part B pail. Slowly mix the measured amount of both the part A and B components for a minimum of one minute. Continue agitation and slowly add one Part C aggregate and mix until material is uniform and no dry aggregate is present. The entire mixing procedure should take approximately three minutes. **Note:** Part B is moisture sensitive. Do not open until ready to mix.

The Medium Kits break down to equal five (5) Small Kits or units and the Extra-Large Kits break down to equal three hundred (300) Small Kits or units. Single batch mixes equal to one (1) Small Kit or unit are frequently mixed in five-gallon pails. Multiple batch mixes are frequently mixed in larger portable, Hippo style mixers and used for larger pours.

**Accelerator:** For accelerated cure on low temperature applications add Series 44-714 Ultra-Tread Accelerator to the Series 245 Part A prior to mixing. The proper amount of Series 44-714 is based upon ambient temperature; At 70°F (21°C) with 50% relative humidity 1 oz per small kit will result in a 9 hour maximum cure time, 2 oz per small kit will result in a 7.5 hour maximum cure time, 3 oz per small kit will result in a 6.5 hour maximum cure time. **Note:** Material will set up quickly if not applied immediately after mixing.

**THINNING** **DO NOT THIN.**

**POT LIFE** Without 44-714: 15 minutes at 75°F (24°C)
Higher material temperatures will significantly reduce the pot life and working time.

With 44-714 when using maximum amount (3 oz): 15 minutes at 60°F (16°C) 10 minutes at 70°F (21°C)

**APPLICATION** This unique self-leveling mortar system is typically applied by trowel, screed rake or cam rake, backrolled with a loop roller and broadcast to refusal with 30/50 mesh aggregate, colored quartz or decorative flake. **Note:** Series 245 can be applied as a stand-alone mortar. If topcoating, the mortar, while still wet, **must** be broadcast to refusal with aggregate, color quartz or decorative flake typically completed within 10 to 15 minutes of application. Color quartz and/or decorative flake systems will require an additional broadcast layer using Series 222, 224, 237, 238, 256 or 257 clear to obtain a uniform appearance and texture before applying the desired clear finish coats. This will typically result in a total system thickness of 1/4"-5/16". **Note:** Series 245 **must** be broadcast to refusal with aggregate, colored quartz or decorative flake. Broadcast 30/50 aggregate or colored quartz at a rate of 0.5 lbs per sq ft and decorative flake at a rate of 0.25 lbs or 4-5 sq ft per lb.

**APPLICATION EQUIPMENT** **Apply:** Trowel, screed rake or cam rake.
**Finish:** Porcupine roller or loop roller.
**Note:** For detailed instructions, refer to the StrataShield Application Guide for Polyurethane Modified Concrete.

**SURFACE TEMPERATURE** Minimum of 40°F (4°C), optimum 65°F to 80°F (18°C to 27°C), maximum of 85°F (29°C). The substrate temperature should be at least 5°F (3°C) above the dew point. Coating will not cure below minimum surface temperature.

**MATERIAL TEMPERATURE** For optimum application, handling and performance, the material temperature during application should be between 60°F and 80°F (16°C and 27°C). Temperature will affect the workability. Cool temperatures increase viscosity and decrease workability. Warm temperatures will decrease viscosity and significantly shorten pot life and working time.

**AMBIENT HUMIDITY** Humidity must be below 85%.

**CLEANUP** Flush and clean all equipment immediately after use with xylene or MEK.

## RECOMMENDED USE DEFINITIONS

**IMMERSION SERVICE (Most Severe) – IS**
Suitable for continuous contact with chemical exposure up to specified temperature.

**CARGO/TEMPORARY IMMERSION – CI**
Suitable for 60 day continuous contact with chemical exposure up to specified temperature. The coating will show no effects, except slight softening or discoloration, possibly permanent, after 60 days or less continuous immersion. When used in transport or hauling conditions, the vessel must be completely drained to prevent puddling that would constitute continuous immersion.

**SECONDARY CONTAINMENT – SC**
Suitable for continuous contact up to 72 hours with chemical exposure or vapors using a mat-reinforced coating system or polymer concrete. The coating will show no effects, except slight softening or discoloration, after 72 hours exposure to chemical or vapors.

**FREQUENT CONTACT – FC**
Suitable for frequent splash or up to 72 hours exposure to concentrated vapors. The coating will show no effects, except slight softening or discoloration, possibly permanent, after eight hours continuous immersion in the liquid chemical or 72 hours exposure to the vapor.

**OCCASIONAL CONTACT (Least Severe) – OC**
Suitable for occasional splash and spillage or occasional exposure to concentrated vapors. The coating will show no effects, except slight softening or discoloration, following short exposure to splash or spillage which evaporates, is hosed off, or dried overnight, or 24 hours exposure to vapor.

**NOT EVALUATED – NE**
This chemical has not been evaluated for the listed chemical. Please contact Tnemec Technical Services for more information.

**NOT RECOMMENDED – NR**
This product is not recommended for the listed exposure.

## IMPORTANT NOTES

The term "chemicals" is used broadly in this guide and can refer to various constituents including, but not limited to, acids, fatty acids, food and beverage materials, finished and unrefined hydrocarbons, as well as individual chemicals and chemical blends. Unless otherwise referenced, the concentrations listed are aqueous solutions of the chemicals.

Temperature can have a significant effect on a coating's chemical resistance. Prior to coating selection, due care should be taken to determine the service temperature of stored chemicals, elevated temperature caused by natural environmental conditions (i.e. radiant heat from sun, weather), and temperature fluctuations during service (i.e. loading of cargo, service cycling).

Chemical mixtures and alternating chemical storage can aggressively degrade a coating or lining system. Prior to coating selection and application, the expected chemical exposures and sequence of chemical storage should be discussed with Tnemec Technical Service to ensure the proper coating is selected.

Proper surface preparation is always important to ensure optimum coating performance, but it is even more so for coatings that will undergo chemical exposure. Carefully read product data sheets along with related application guides to determine the required level of surface preparation and surface profile.

Structural designs of tanks, structures, and containment areas can greatly affect coating performance. Sharp angles, channels, edges, corners, pits, voids, defects, rough welds, and other similar conditions present areas that are either difficult to coat or achieve the required film thickness. Avoid skip welds in favor of continuous welds. A stripe coat on these areas, prior to full coating application, can help achieve needed film thickness and prevent premature coating failure. (Reference NACE SP0178-2007 for more information.)

The length of a coating system's service life depends on surface cleanliness and preparation prior to application, proper application procedures, exposure conditions, physical abuse, cleaning techniques, and frequency of inspection, maintenance, and repair. No coating system has an unlimited service life. Regular inspection of the coating system can prolong service life by identifying areas in need of repair. Additionally, regular inspections can determine when the coating system is nearing its end of service and should be completely replaced.

Chemical resistance information is provided for the purpose of establishing a general profile of the coating and was obtained through laboratory testing, field experience, and industry knowledge. Test results were produced in a controlled environment and Tnemec makes no claim that any tests, or published chemical resistance information, accurately represent all environments or correlate to actual field performance. Application, environmental and design factors, chemical temperatures, chemical mixtures, sequence of storage, conditions of service, and cleaning procedures can significantly impact coating performance, so due care must be exercised in the selection and use of the coating. Tnemec disclaims responsibility for product use outside its published information. Contact Tnemec Technical Service to review full project details before the coating or coating system is selected and applied.

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| 1, 1, 1-Trichloroethane (Trichloroethane) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Acetaldehyde | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Acetic Acid | | | | | |
| 5% | 100°F (38°C) | NR | NR | NR | NR |
| 10% | NR | NR | NR | NR | NR |
| 30% | NR | NR | NR | NR | NR |
| Acetic Acid, Glacial | NR | NR | NR | NR | NR |
| Acetic Anhydride | 100°F (38°C) | NR | NR | NR | NR |
| Acetone | NR | NR | NR | NR | NR |
| Adipic Acid | | | | | |
| 25% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Allyl Alcohol | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Aluminum Bromide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Aluminum Chloride | | | | | |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Aluminum Nitrate | | | | | |
| 50% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Aluminum Sulfate (Alum) | | | | | |
| 49% | 100°F (38°C) | NR | NR | NR | NR |
| Ammonium Chloride | | | | | |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ammonium Hydroxide (Aqua Ammonia) | | | | | |
| 30% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ammonium Nitrate | | | | | |
| 10% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 20% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| 38% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 50% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 65% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 83% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ammonium Persulfate | | | | | |
| 10% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ammonium Sulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ammonium Sulfide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Amyl Acetate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Amyl Alcohol | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Aniline Hydrochloride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Aqua Regia | 100°F (38°C) | NR | NR | NR | NR |
| Barium Sulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Barium Sulfide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Beer [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Benzaldehyde | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Benzene | 100°F (38°C) | NR | NR | NR | NR |
| Benzene Sulfonic Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Bromine Gas (Dry) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Bromine Water, Sat'd | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Butyl Acrylate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Butyric Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Cadmium Chloride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Calcium Bisulfite | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Calcium Bromide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Calcium Chloride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Calcium Nitrate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Calcium Nitrite | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| Calcium Sulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Carbon Dioxide (gas) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Carbon Tetrachloride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Castor Oil [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Chloroacetic Acid | | | | | |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Chlorobenzene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Chloroform | 100°F (38°C) | NR | NR | NR | NR |
| Chromic Acid | | | | | |
| 10% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Citric Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Corn Oil [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Cottonseed Oil [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Crude Oil (Sour) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Cyclohexane | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Cyclohexanone | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Dichloroacetic Acid | | | | | |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Diesel Fuel (Fuel Oil, Diesel Oil) | 80°F (27°C) | 80°F (27°C) | NR | NR | NR |
| Dimethyl Formamide | NR | NR | NR | NR | NR |
| Dimethylaniline | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Dinitrobenzene | 100°F (38°C) | NR | NR | NR | NR |
| Ethanol (Denatured Alcohol, Ethyl Alcohol) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ethyl Acetate | 100°F (38°C) | NR | NR | NR | NR |
| Ethyl Chloride | 100°F (38°C) | NR | NR | NR | NR |
| Ethyl Sulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ethylamine | | | | | |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ethylene Dichloride | 100°F (38°C) | NR | NR | NR | NR |
| Ethylene Glycol | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ferric Chloride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ferric Nitrate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Ferric Sulfate | | | | | |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 60% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Fluorosilicic Acid (Hydrofluorosilicic Acid) | | | | | |
| 10% | 100°F (38°C) | NR | NR | NR | NR |
| 25% | NR | NR | NR | NR | NR |
| Formaldehyde | | | | | |
| 37% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Furfuryl Alcohol | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Gasoline (Unleaded) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Glycerin | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Glycolic Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Gold Plating (Cyanide) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Gold Plating Solution | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Grape Juice [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Heptane | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Hexane | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Hydrochloric Acid | | | | | |
| 37% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Hydrofluoric Acid | | | | | |
| 10% | NR | NR | NR | NR | NR |
| 20% | NR | NR | NR | NR | NR |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| Hydrogen Peroxide | | | | | |
| 30% | 100°F (38°C) | NR | NR | NR | NR |
| Hypochlorous Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Isopropyl Alcohol (Isopropanol) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Isopropyl Ether | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Jet A Fuel | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Kerosene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Lactic Acid | | | | | |
| 85% | NR | NR | NR | NR | NR |
| Lard [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Lead Acetate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Linseed Oil [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Maleic Acid | | | | | |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Malic Acid | 100°F (38°C) | NR | NR | NR | NR |
| Methyl Acetate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Methyl Chloride | 100°F (38°C) | NR | NR | NR | NR |
| Methyl Ethyl Ketone | 100°F (38°C) | NR | NR | NR | NR |
| Methyl Isobutyl Ketone | 100°F (38°C) | NR | NR | NR | NR |
| Methylene Chloride | NR | NR | NR | NR | NR |
| Milk [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Mineral Oil | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Mineral Spirits | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Molasses [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Naphthalene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Nitric Acid | | | | | |
| 5% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.



[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| 10% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 25% | 100°F (38°C) | NR | NR | NR | NR |
| 70% | NR | NR | NR | NR | NR |
| Nitrobenzene | 100°F (38°C) | NR | NR | NR | NR |
| Perchloric Acid | | | | | |
| 30% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Perchloroethylene (Tetrachloroethylene) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Phosphoric Acid | | | | | |
| 43% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 85% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Picric Acid | | | | | |
| 10% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Bicarbonate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Bromide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Carbonate | | | | | |
| 25% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Chlorate | NR | NR | NR | NR | NR |
| Potassium Chloride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Cyanide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Fluoride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Hydroxide | | | | | |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Nitrate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Permanganate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Persulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Potassium Sulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Propionic Acid | | | | | |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Propylene Glycol | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Pyridine | | | | | |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 100% | 100°F (38°C) | NR | NR | NR | NR |
| Salicylic Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Silver Nitrate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Skydrol | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Acetate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Bicarbonate [1] (Baking Soda) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Bisulfate | | | | | |
| 30% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Bisulfite | | | | | |
| 38% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Borate (Borax) | NR | NR | NR | NR | NR |
| Sodium Chloride (sat'd) (Brine, Water (Sea), Salt Brine) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Dichromate (all) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Fluoride | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Hydroxide (Caustic Soda) | | | | | |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Oxalate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Peroxide | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Sulfide (all) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sodium Sulfite | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Stannic Chloride (all) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Stearic Acid (conc) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| Stoddard Solvent | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Styrene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sugars [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sulfur Trioxide (wet) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Sulfuric Acid (Sulphuric Acid) | | | | | |
| 30% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| 50% | 100°F (38°C) | NR | NR | NR | NR |
| 70% | NR | NR | NR | NR | NR |
| 98% | NR | NR | NR | NR | NR |
| Tartaric Acid [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Tetrachloroethane | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Toluenesulfonic Acid | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Trichloroacetic Acid | | | | | |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Trichlorobenzene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Trichloroethylene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Triethylenetetramine | 100°F (38°C) | NR | NR | NR | NR |
| Trisodium Phosphate (Sodium Phosphate (Tribasic)) | | | | | |
| 20% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Turpentine | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Urea | | | | | |
| 50% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Urea Ammonium Nitrate | | | | | |
| 32% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Vegetable Oil [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Vinegar [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Water (deionized, non-potable) [1] (Water (Demineralized, Non-potable)) | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| Chemical | Occasional Contact | Frequent Contact | Secondary Containment | Cargo Immersion | Immersion Service |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

[1] Product is NOT suitable for direct or indirect food contact. Intended Use and temperature information relates to product's performance capabilities only.

[2] Product is suitable for direct or indirect food contact. Reference the product data sheet for more information.

| | Intended Use (Maximum Temperature Listed) | | | | |
|---|---|---|---|---|---|
| **Chemical** | **Occasional Contact** | **Frequent Contact** | **Secondary Containment** | **Cargo Immersion** | **Immersion Service** |
| Water (distilled, non-potable) [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Wine (alcohol by volume) | | | | | |
| 10% [1] | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Xylene | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Zinc Chloride | | | | | |
| 40% | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |
| Zinc Sulfate | 100°F (38°C) | 100°F (38°C) | NR | NR | NR |

IMPORTANT: Definitions for the terms and acronyms used in this guide to describe the recommended exposures, along with other important information, can be found on the cover page of this guide or by contacting Tnemec Technical Service. Coatings should not be applied in a chemical exposure environment until the user has thoroughly read and understood the product information and full project details have been discussed with Tnemec Technical Service.

TNEMEC

PRODUCT DATA SHEET

# TNEME-GLAZE SERIES 280

## PRODUCT PROFILE

**GENERIC DESCRIPTION** Modified Polyamine Epoxy

**COMMON USAGE** A glaze-like corrosion resistant coating for walls, ceilings, floors and other surfaces; resistant to frequent pressurized hot water and detergent cleaning. Used as a topcoat/sealer for heavy duty wall and floor systems or in a stand-alone high-performance function. Excellent chemical, stain- and abrasion-resistance for a variety of substrates.

**COLORS** Available in the 16 standard StrataShield colors. Special colors available, please contact your Tnemec representative. **Note:** Epoxies chalk and yellow with age, extended exposure to UV and artificial lighting. Caution should be taken when selecting white and light pastel colors. Lack of ventilation, incomplete mixing, miscatalyzation or the use of heaters that emit carbon dioxide and carbon monoxide during application and initial stages of curing may cause amine blush, possibly affecting adhesion of subsequent topcoats.

**FINISH** Gloss. (Roller application provides an orange peel finish.)

**SPECIAL QUALIFICATIONS** Series 280 meets the requirements of LEED-Low-Emitting Materials, Collaborative for High Performance Schools-Paints & Coatings, WELL Building Standard-VOC Restrictions , and Living Building Challenge–Healthy Interior Performance. Contact your Tnemec representative for more information.

## COATING SYSTEM

**SURFACER/FILLER/PATCHER** Series 130, 215, 218, 1254. **Note:** A repair kit of 201, 208 or 233 mixed with fumed silica, is available for small patching/surfacing repairs. For more extensive repairs and additional information, contact your Tnemec representative or Tnemec Technical Services.

**PRIMERS** **Concrete:** Self-priming or Series 27WB, 201, 205, 208, 233, 237, 238, 241.
**CMU:** Self-priming over filled CMU
**Wall board, Wood & Drywall:** Self-priming or Series 151, 201, 233. **Note:** For taping joints on wall board or drywall in areas that will be frequently wet, subject to chemical cleaning, thermal shock, impact, and VHP (or similar) cleaning, use Sheetrock brand Durabond 90. For taping joints on wood or cement board, use Series 273 Part D fiberglass tape and Series 215 as taping compound. Reference Technical Bulletin 21-118.

**INTERMEDIATE** Series 206, 210, 233, 237, 237SC, 238, 241, 242, 245, 270, 273, 280

**TOPCOATS** Series 73, 247, 248, 280, 290, 291, 297, 1074, 1075, 1080, 1081

## SURFACE PREPARATION

Prepare surfaces by method suitable for exposure and service. Refer to the appropriate primer data sheet for specific recommendations.

**HORIZONTAL CONCRETE** Allow new poured-in-place concrete to cure a minimum of 28 days at 75°F (24°C). Verify concrete dryness in accordance with ASTM F 1869 "Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride" (moisture vapor transmission should not exceed three pounds per 1,000 square feet in a 24 hour period), F 2170 "Standard Test Method for Determining Relative Humidity in Concrete using in situ Probes" (relative humidity should not exceed 80%), or D 4263 "Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method" (no moisture present). **Note:** The testing listed above cannot guarantee avoidance of future moisture related problems particularly with existing concrete slabs. This is especially true if the use of an under slab moisture vapor barrier cannot be confirmed or concrete contamination from oils, chemical spills, unreacted silicates, chlorides or Alkali Silica Reaction (ASR) is suspected.

Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Abrasive blast, shot-blast, water jet or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers and other contaminants and to provide a minimum ICRI-CSP 3 or greater surface profile. Large cracks, voids and other surface imperfections should be filled with a recommended filler or surfacer. **Note:** For moisture content exceeding 3 lbs per 1,000 sq ft or relative humidity in excess of 80%, Series 208 or 241 may be substituted for the primer. Refer to the Series 208 or 241 product data sheet for more information.

**VERTICAL CONCRETE** When self-priming: Allow new concrete to cure 28 days. Abrasive blast or mechanically abrade concrete to remove laitance, form release agents, curing compounds, hardeners, sealers and other contaminants and to provide surface profile. (Reference SSPC-SP13)

**CMU** When self-priming: Allow new mortar to cure 28 days. Surfaces must be clean, dry, sound and free of all contaminants. Level all protrusions and mortar spatter. For pinhole free surface, use recommended surfacer/filler/patcher.

**WALL BOARD, WOOD & DRYWALL** Must be clean, dry and free of oil, grease and other contaminants. **Note:** When using moisture resistant and/or high impact wall board or cement board in wet environments, utilize Series 215 and fiberglass tape or compound suitable for wet environments.

**ALL SURFACES** Must be clean, dry and free of oil, grease and other contaminants.

## TECHNICAL DATA

**VOLUME SOLIDS** 100% (mixed) †

**RECOMMENDED DFT** **Horizontal:** 6.0 to 12.0 mils (150 to 305 microns) per coat.
**Vertical:** 4.0 to 8.0 mils (100 to 205 microns) per coat
Additional coats may be required for appearance or hiding.

**CURING TIME**

| Temperature | To Topcoat | To Place in Service |
|---|---|---|
| 75°F (24°C) | 8-24 hours | 24 hours |

**Note:** If more than 24 hours have elapsed between coats, the coated surface must be mechanically abraded before topcoating.

**VOLATILE ORGANIC COMPOUNDS** **Unthinned:** 0.19 lbs/gallon (22 grams/litre)
**Thinned 5% (No. 2 Thinner):** 0.52 lbs/gallon (63 grams/litre)
**Thinned 5% (No. 42 Thinner):** 0.50 lbs/gallon (59 grams/litre) †

# TNEME-GLAZE | SERIES 280

**THEORETICAL COVERAGE** 1,604 mil sq ft/gal (39.4 m²/L at 25 microns). See APPLICATION for coverage rates. †

**NUMBER OF COMPONENTS** Two: Part A and Part B (2 Parts A to 1 Part B by volume)

**PACKAGING**

| | PART A | PART B | When Mixed |
|---|---|---|---|
| Large Kit | 2-5 gallon pails | 1-5 gallon pail | 15 gallons (56.8 L) |
| Small Kit | 2-1 gallon cans | 1-1 gallon pail | 3 gallons (11.4 L) |

**NET WEIGHT PER GALLON** 11.85 ± 0.25 lbs (5.37 ± 0.11 kg) mixed †

**STORAGE TEMPERATURE** Minimum 40°F (4°C) Maximum 90°F (32°C)
**Note:** Material should be stored at temperatures between 70°F and 90°F (21°C and 32°C) for at least 48 hours prior to use.

**TEMPERATURE RESISTANCE** (Dry) Continuous 250°F (121°C) Intermittent 275°F (135°C)

**SHELF LIFE** 12 months at recommended storage temperature.

**FLASH POINT - SETA** N/A

**HEALTH & SAFETY** This product contains chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product.
**Keep out of the reach of children.**

## APPLICATION

**COVERAGE RATES** Before commencing, obtain and thoroughly read the StrataShield Installation and Application Guide for floors.

| | Dry Mils (Microns) | Wet Mils (Microns) | Sq Ft/Gal (m²/Gal) |
|---|---|---|---|
| Horizontal | 6.0-12.0 (150-305) | 6.0-12.0 (150-305) | 134-267 (12.4-24.8) |
| Vertical | 4.0-8.0 (100-205) | 4.0-8.0 (100-205) | 200-401 (18.6-37.3) |

Allow for overspray, surface irregularities and waste. Film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance. †

**MIXING** Use a variable speed drill with a PS Jiffy blade. Slowly mix 2 parts A component, and while under agitation add 1 part B component and mix for a minimum of two minutes. Ensure that all Part B is blended with Part A by scraping the pail walls with a flexible spatula. Apply the mixed material within pot life limits after agitation.
**Note:** A large volume of material will set up quickly if not applied or reduced in volume.
**Caution: Do not reseal mixed material. An explosion hazard may be created.**

**THINNING** Normally not required. May thin up to 5% or 6.4 ounces (190 mL) per gallon to improve application properties. Brush and roll application use No. 2 Thinner. Spray application use No. 42 Thinner.

**POT LIFE** 25 to 30 minutes at 70°F (21°C) 15 to 20 minutes at 80°F (27°C) 8 to 10 minutes at 90°F (32°C)
Increasing material temperatures will significantly reduce the pot life.

**APPLICATION EQUIPMENT** Brush, roller, squeegee and airless spray.

**Airless Spray**

| Pump | Tip Orifice | Atomizing Pressure | Mat'l Hose ID | Manifold Filter |
|---|---|---|---|---|
| Graco "King" 45:1 or 56:1 | 0.019"-0.033" (485-840 microns) | 4,000-5,000 psi (275-344 bar) | 3/8" to 1/2" (9.5 to 12.7 mm) | 60 mesh (250 microns) |

**Roller:** Use high quality 3/8" to 1/2" shed resistant, synthetic woven nap roller cover.
**Brush:** Use high quality synthetic or nylon bristle brush.
**Horizontal:** Squeegee and backroll. Brush small areas only.
**Vertical:** Roll or spray and backroll. Brush small areas only. **Spraying should only be considered as a means to transfer the material to the surface and should be followed by backrolling.**

**SURFACE TEMPERATURE** Minimum of 55°F (13°C), optimum 65°F to 80°F (18°C to 27°C), maximum of 90°F (32°C). The substrate temperature should be at least 5°F (3°C) above the dew point. To avoid outgassing, concrete temperature should be stabilized or in a descending temperature mode. Material should not be applied in direct sunlight.

**MATERIAL TEMPERATURE** For optimum application, handling and performance, the material temperature during application should be between 70°F and 90°F (21°C and 32°C). Temperature will affect the workability. Cool temperatures increase viscosity and decrease workability. Warm temperatures will decrease viscosity and shorten pot life.

**CLEANUP** Flush and clean all equipment immediately after use with xylene or MEK.

**† Values may vary with color.**

BUILDING TRUST

PRODUCT DATA SHEET

# Sika® Armatec®-110 EpoCem

BONDING PRIMER AND REINFORCEMENT CORROSION PROTECTION

## PRODUCT DESCRIPTION

Sika® Armatec®-110 EpoCem is a cementitious epoxy resin compensated 3-component, solvent-free, coating material with corrosion inhibitor, used as bonding primer and reinforcement corrosion protection.

## USES

- Suitable in concrete repair as corrosion protection for reinforcement
- Suitable as a bonding primer on mortar, steel, and on placing fresh, plastic concrete to existing hardened concrete
- Protection to reinforcing steel in areas of thin concrete cover

## CHARACTERISTICS / ADVANTAGES

- Contains EpoCem® technology - improved bonding agent
- Extended open times for repair mortars
- Excellent adhesion to concrete and steel
- Contains corrosion inhibitor
- Good resistance to water and chloride penetration
- High shear strength
- Long pot life
- Can be brushed on or applied using spray gun
- Can be used exterior on-grade
- Excellent bonding bridge for cement or epoxy based repair mortars
- High strength, unaffected by moisture when cured
- Non-flammable, solvent free

## PRODUCT INFORMATION

| | |
|---|---|
| **Chemical Base** | Portland cement, epoxy resin, selected aggregates and additives. |
| **Packaging** | |

| Unit | A | B | C | ABC |
|---|---|---|---|---|
| 3.5 gal (13.2 L) | 47.6 oz (1.4 L) | 122.1 oz (3.6 L) | 46.82 lb (21.3 kg) | A + B in carton, C in bag |
| 1.65 gal (6.2 L) | 22.7 oz (0.67 L) | 57.6 oz (1.7 L) | 5.5 lb (2.5 kg) (4 bags) | Factory-proportioned units in a pail |

**Appearance / Color**

| | |
|---|---|
| Component A | White liquid |
| Component B | Colorless liquid |
| Component C | Gray powder |

| | |
|---|---|
| **Shelf Life** | 12 months from date of production if stored properly in original, unopened and undamaged sealed packaging |
| **Storage Conditions** | Store dry at 40–95 °F (4–35 °C) |

Protect Component A and B from freezing. If frozen, discard.
Protect Component C from moisture. If damp, discard.

## TECHNICAL INFORMATION

| | | | |
|---|---|---|---|
| **Compressive Strength** | 3 days | 4,500 psi (31.0 MPa) | (ASTM C-109) 73 °F (23 °C) 50 % R.H. |
| | 7 days | 6,500 psi (44.8 MPa) | |
| | 28 days | 8,500 psi (58.6 MPa) | |
| **Flexural Strength** | 28 days | 1,250 psi (8.6 MPa) | (ASTM C-348) 73 °F (23 °C) 50 % R.H. |
| **Splitting Tensile Strength** | 28 days | 600 psi (4.1 MPa) | (ASTM C-496) 73 °F (23 °C) 50 % R.H. |
| **Tensile Adhesion Strength** | **Bond of steel reinforcement on concrete** | | |
| | Sika® Armatec® 110 EpoCem coated | 625 psi (4.3 MPa) | (ASTM C-1583) 73 °F (23 °C) 50 % R.H. |
| | Epoxy coated | 508 psi (3.5 MPa) | |
| | Plain reinforcement | 573 psi (4.0 MPa) | |
| **Slant Shear Strength** | **Bonding agent properties** (14 d. moist cure, plastic to hardened concrete) | | |
| | Wet on wet | 2,800 psi (19.3 MPa) | (ASTM C-882) 73 °F (23 °C) 50 % R.H. |
| | 24 hr. open time | 2,600 psi (17.9 MPa) | |
| **Permeability to Water Vapor** | Control | $7.32 \times 10^{-10}$ ft/sec | |
| | 145 psi (10 bar) | $8.92 \times 10^{-15}$ ft/sec | |
| **Diffusion Resistance to Water Vapor** | µ $H_2O$ ~100 | | |
| **Permeability to CO2** | µ $CO_2$ ~14,000 | | |

**Corrosion Test**

**Time-to-Corrosion Study**
- Sika® Armatec®-110 EpoCem more than tripled the time to corrosion
- Reduced corrosion rate by over 40 %

## APPLICATION INFORMATION

**Fresh Mortar Density**

A+B+C ~125 lb/ft³ (~2.0 kg/l)

**Coverage**

| | | |
|---|---|---|
| | **Bonding agent** | 80 ft²/gal (7.4 m²/l) |
| | **Corrosion Protection** | 40 ft²/gal (3.7 m²/l) |

(Coverage figures do not include allowance for surface profile and porosity or material waste)

**Layer Thickness**

| | Min. thickness of 1 coat | Coat |
|---|---|---|
| **Bonding agent** | 20 mils | 1 |
| **Corrosion Protection** | 20 mils | 2 |

| | |
|---|---|
| **Product Temperature** | 65°-75°F (18°-24°C) |
| **Ambient Air Temperature** | 40–95 °F (5–35 °C) |
| **Substrate Temperature** | 40–95 °F (5–35 °C) |
| **Pot Life** | ~ 90 minutes |
| **Waiting / Recoat Times** | Sika repair mortars and non-fast setting concrete can be applied on Sika® Armatec®-110 EpoCem within a maximum time of: |

| Temperature | Maximum Waiting Time |
|---|---|
| 80°- 95 °F (26°- 35 °C) | 6 hours |
| 65°-79 °F (18°- 26 °C) | 12 hours |
| 50°- 64° F (10°- 17° C) | 16 hours |
| 40°- 49° F (4°- 9° C) | wet-on-wet |

# APPLICATION INSTRUCTIONS

## SURFACE PREPARATION

Concrete

- Free from dust, loose material, surface contamination and materials which reduce bond or prevent suction or wetting by repair materials.
- Delaminated, weak, damaged and deteriorated concrete and where necessary sound concrete shall be removed by suitable means.
- Substrate must be Saturated Surface Dry (SSD) with no standing water.

Steel reinforcement

- Rust, scale, mortar, concrete, dust and other loose and deleterious material which reduces bond or contributes to corrosion shall be removed by blast cleaning or other means of mechanical abrasion and reinforcement.
- Should be fully exposed and have all corrosion removed.

## MIXING

- Sika® Armatec®-110 EpoCem can be mixed with a low-speed (< 250 rpm) electric drill mixer.
- Shake components A and B thoroughly before opening.
- Pour liquid components A and B into a suitable mixing vessel and mix for 30 seconds.
- While still mixing components A and B slowly add powder component C.
- Mix the three components together for a minimum 3 minutes until blend is uniform and free of lumps, minimizing addition of air.
- Mix only the quantity that you can be applied within the pot life.
- DO NOT ADD WATER.

## APPLICATION

As reinforcement corrosion protection

- Apply by stiff-bristle brush or spray at 80 $ft^2$ /gal.
- Take special care to properly coat the underside of the totally exposed steel.
- Allow coating to dry 2-3 hours at 73 °F, then apply a second coat at the same coverage.
- Allow to dry again before the repair mortar or concrete is applied.
- Pour or place repair within 7 days

As a bonding primer

- Apply using a stiff-bristle brush or broom. To achieve good bond, Sika® Armatec®-110 EpoCem must be applied well into the substrate, filling all pores and ensure complete coverage of all surface irregularities (minimum layer thickness 1/64” (0.5 mm).
- Spray apply with Goldblatt Pattern Pistol or equal equipment.
- Apply the freshly mixed patching mortar or concrete wet on wet, or up to the maximum recommended open time, onto the bonding slurry.

## CURING TREATMENT

Sika® Armatec®-110 EpoCem must be protected against contamination and rain until application of the repair mortar.

## CLEANING OF TOOLS

Clean all tools and application equipment with water immediately after use. Hardened material can only be mechanically removed.

# LIMITATIONS

- Avoid application in direct sun and/or strong wind and/or rain.
- Do not add water.
- Not a vapor barrier.
- Apply only to sound, prepared substrates.
- Not recommended for use with expansive grouts and SikaQuicks
- Use of semi-dry mortars onto Sika® Armatec®-110 EpoCem must be applied “wet on wet”
- When used in overhead applications with hand placed patching mortars, use “wet on wet” for maximum mortar built thickness.
- Substrate profile as specified by the overlay or repair material is still required.
- As with all cement based materials, avoid contact with aluminum to prevent adverse chemical reaction and possible product failure. Insulate potential areas of contact by coating aluminum bars, rails, posts etc. with an appropriate epoxy such as Sikadur® Hi-Mod 32.

## BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

## OTHER RESTRICTIONS

See Legal Disclaimer.

## ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

### DIRECTIVE 2004/42/CE - LIMITATION OF EMISSIONS OF VOC

| | |
|---|---|
| A+B+C combined | 50 g/l |

## LEGAL DISCLAIMER

- **KEEP CONTAINER TIGHTLY CLOSED**
- **KEEP OUT OF REACH OF CHILDREN**
- **NOT FOR INTERNAL CONSUMPTION**
- **FOR INDUSTRIAL USE ONLY**
- **FOR PROFESSIONAL USE ONLY**

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates (“SIKA”), the user must always read and follow the warnings and instructions on the product’s most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA’s Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within the product’s shelf life. User determines suitability of product for intended use and assumes all risks. User’s and/or buyer’s sole remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs. **NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.**

Sale of SIKA products are subject to the Terms and Conditions of Sale which are available at https://usa.sika.com/en/group/SikaCorp/termsandconditions.html or by calling 1-800-933-7452.

**Sika Corporation**
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: +1-800-933-7452
Fax: +1-201-933-6225
usa.sika.com

**Sika Mexicana S.A. de C.V.**
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537

BUILDING TRUST

# PRODUCT DATA SHEET

# SikaTop®-122 Plus

Two-component, polymer-modified, cementitious, trowel-grade mortar plus Sika FerroGard® 901 penetrating corrosion inhibitor

## PRODUCT DESCRIPTION

SikaTop®-122 Plus is a two-component, polymer-modified, portland cement based, fast-setting, trowel-grade mortar. It is a high-performance repair mortar for horizontal and vertical surfaces and offers the additional benefit of Sika FerroGard® 901, a penetrating corrosion inhibitor.

## USES

- On grade, above and below grade on concrete and mortar.
- On horizontal surfaces.
- As a structural repair material for parking structures, industrial plants, walkways, bridges, tunnels, dams, ramps, floods, etc.
- To level concrete surfaces.
- As an overlay system for topping/resurfacing concrete.

## CHARACTERISTICS / ADVANTAGES

- Extremely low shrinkage **proven by four industry standard test methods**
- High compressive and flexural strengths
- High abrasion resistance
- Increased freeze/thaw durability and resistance to deicing salts
- Compatible with coefficient of thermal expansion of concrete - Passes ASTM C-884
- Increased density - improved carbon dioxide resistance (carbonation) without adversely affecting water vapor transmission (not a vapor barrier)
- Sika FerroGard® 901, a penetrating corrosion inhibitor - reduces corrosion even in the adjacent concrete

## APPROVALS / STANDARDS

- USDA certifiable for the food industry
- ANSI/NSF Standard 61 potable water compliant
- Tested per ICRI guideline for inorganic repair material data sheet protocol guideline n°320.3R

## PRODUCT INFORMATION

| | | |
|---|---|---|
| **Packaging** | **Component A** | **Component B** |
| | 1 gal (3.78 L) jug<br>4/carton | 61.5 lb (28.9 kg) bag |
| **Appearance / Color** | Concrete gray when mixed | |
| **Shelf Life** | 12 months from date of production if stored properly in original, unopened and undamaged sealed packaging | |
| **Storage Conditions** | Store dry at 40–95 °F (4–35 °C)<br>Protect Component A from freezing. If frozen, discard. | |

| | | | |
|---|---|---|---|
| | Protect Component B from moisture. If damp, discard. | | |
| **Density** | 136 lbs/ft³ (2.18 kg/L) | | (ASTM C-138) |

## TECHNICAL INFORMATION

| | | | |
|---|---|---|---|
| **Compressive Strength** | 1 day | 2,500 psi (17.2 MPa) | (ASTM C-109) 73 °F (23 °C) 50 % R.H. |
| | 7 days | 5,300 psi (36.5 MPa) | |
| | 28 days | 7,000 psi (48.3 MPa) | |
| **Modulus of Elasticity in Compression** | 28 days | $3.0x10^6$ psi | (ASTM C-469) 73 °F (23 °C) 50 % R.H. |
| **Flexural Strength** | 28 days | 1,500 psi (10.3 MPa) | (ASTM C-293) 73 °F (23 °C) 50 % R.H. |
| **Splitting tensile strength** | 28 days | 500 psi (3.4 MPa) | (ASTM C-496) 73 °F (23 °C) 50 % R.H. |
| **Tensile Strength** | 28 days | 2,000 psi (13.8 MPa) | (ASTM C-882 modified)* |
| | * Mortar scrubbed into substrate at 73 °F (23 °C) and 50 % R.H. | | |
| **Pull-Out Resistance** | 7 days | >300 psi (2.1 MPa) | (ASTM C-1583) 73 °F (23 °C) 50 % R.H. |
| | 28 days | 400 psi (2.8 MPa) | |

| | | | | |
|---|---|---|---|---|
| **Shrinkage** | 28 days | 1''x1''x11-1/4'' specimen | < 0.05 % | (ASTM C-157 modified (mod. ICRI 320.3R)) 73 °F (23 °C) 50 % R.H. |
| | | 3''x3''x11-1/4'' specimen | < 0.021 % | |

| | | | |
|---|---|---|---|
| **Ring test** | Duration | >70 days | (ASTM C-1581) 73 °F (23 °C) 50 % R.H. |
| | Average Max Strain | -9 µstrain | |
| | Average Stress Strain | 0.49 psi/day | |
| | Potential for Cracking | Low | |
| **Baenziger block** | 90 days | No cracking | |
| **Freeze-Thaw Stability** | 300 cycles | 98 % | (ASTM C-666) |
| **Rapid Chloride Permeability** | 28 days | < 500 C | (ASTM C-1202 AASHOT T-277) |

## APPLICATION INFORMATION

| | | | |
|---|---|---|---|
| **Mixing Ratio** | Plant-proportioned kit, mix entire unit. | | |
| **Fresh mortar density** | 136 lbs/ft³ (2.18 kg/l) | | (ASTM C-138) |
| **Coverage** | Neat | 0.51 ft³ (0.02 m³) per unit | |
| | Extended with 42 lb (19 kg) of 3/8" (9.5 mm) gravel | 0.75 ft³ (0.03 m³) per unit | |
| | (Coverage figures do not include allowance for surface profile and porosity or material waste) | | |

| | | Min. | Max. in one lift |
|---|---|---|---|
| **Layer Thickness** | **Neat** | 1/8" (3.2 mm) | 1" (25 mm) |
| | **Extended** | 1" (25.4 mm) | 4" (101.6 mm) |

| | | |
|---|---|---|
| **Product Temperature** | 65–75 °F (18–24 °C) | |
| **Ambient Air Temperature** | > 45 °F (7 °C) | |
| **Substrate Temperature** | > 45 °F (7 °C) | |
| **Set Time** | 35–70 minutes | (ASTM C-266) |
| **Final set time** | > 90 minutes | (ASTM C 266)<br>73º F (23º C),<br>50% R.H. |
| **Finishing time** | 50–120 minutes<br>Note: All times start after adding Component 'B' to Component 'A' and are highly affected by temperature, relative humidity, substrate temperature, wind, sun and other job site conditions. | |

## BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

## ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

## LIMITATIONS

- Do not use solvent-based curing compound.
- Size, shape and depth of repair must be carefully considered and consistent with practices recommended by ACI or ICRI. For additional information, contact Technical Service.
- For additional information on substrate preparation, refer to ICRI Guideline No.310.2R Coatings, Polymer Overlays, and Concrete Repair.
- If aggressive means of substrate preparation is employed, substrate strength should be tested in accordance with ACI 503 Appendix A prior to the repair application.
- As with all cement based materials, avoid contact with aluminum to prevent adverse chemical reaction and possible product failure. Insulate potential areas of contact by coating aluminum bars, rails, posts etc. with an appropriate epoxy such as Sikadur 32 Hi-Mod.
- Refer to Sika® Antisol®-250 W product data sheet for use.

## APPLICATION INSTRUCTIONS

### SURFACE PREPARATION

- Concrete, mortar, and masonry products must be clean and sound.
- Remove all deteriorated concrete, dirt, oil, grease, and other bond-inhibiting materials from the area to be repaired.
- Be sure repair area is not less than 1/8" (3.2mm) in depth.
- Preparation work should be done by high pressure water blast, scabbler or other appropriate mechanical means to obtain an exposed aggregate surface profile of ±1/16"-1/8" (1.6-3.2 mm) (CSP-5-6).
- To ensure optimum repair results, the effectiveness of decontamination and preparation should be assessed by a pull-off test.
- Saw cutting of edges is preferred and a dovetail is recommended.
- Substrate should be Saturated Surface Dry (SSD) with clean water prior to application. No standing water should remain during application.

### PRIMING

- Reinforcing steel: Steel reinforcement should be thoroughly prepared by mechanical cleaning to remove all traces of rust. Where corrosion has occurred due to the presence of chlorides, the steel should be high pressure washed with clean water after mechanical cleaning. For priming of reinforcing steel use Sika® Armatec® 110 EpoCem (consult PDS).

- Concrete Substrate: Prime the prepared substrate with a brush or sprayed applied coat of Sika® Armatec® 110 EpoCem (consult PDS). Alternately, a scrub coat of SikaTop®-122 Plus can be applied prior to placement of the mortar. The repair mortar has to be applied into the wet scrub coat before it dries.

### MIXING

- Pour approximately 7/8 of Component ‘A’ into the mixing container.
- Add Component ‘B’ (powder) while mixing continuously.
- Mix mechanically with a low-speed drill (400–600 rpm) and mixing paddle or mortar mixer.
- Add remaining Component ‘A’ (liquid) to mix if a more loose consistency is desired.
- Mix to a uniform consistency, maximum 3 minutes.
- Thorough mixing and proper proportioning of the two components is necessary.
- Refer to ACI 306 Guidelines when there is a need to place this product in cold & hot temperatures. Thinner application will be more sensitive to the temperature

### EXTENSION WITH AGGREGATES

- For applications greater than 1" (25.4 mm) in depth, add 3/8" (9.5 mm) coarse aggregate.
- Pour all of Component ‘A’ into mixing container.
- Add all of Component ‘B’ while mixing, then introduce 3/8" (9.5 mm) coarse aggregate at desired quantity.
- Mix to uniform consistency, maximum 3 minutes.
- The aggregate must be non-reactive (reference ASTM C-1260, C-227 and C-289), clean, well graded, Saturated Surface Dry (SSD), have low absorption and high density, and comply with ASTM C-33 size number 8 per Table 2.
- Do not use limestone aggregate.
- Variances in the quality of the aggregate will affect the physical properties of SikaTop®-122 Plus and may result in different strengths.
- The addition rate is 42 lb (19 kg) of aggregate per bag. It is approximately 3.0-4.5 gallons (11.3-17.0 L) by loose volume of aggregate.

### APPLICATION

- SikaTop®-122 Plus must be scrubbed into the substrate, filling all pores and voids.
- Force material against edge of repair, working toward center.
- After filling repair, consolidate, then screed.
- Allow mortar or concrete to set to desired stiffness, then finish with wood or sponge float for a smooth surface, or broom or burlap-drag for a rough finish.

### CURING TREATMENT

- As per ACI recommendations for Portland cement concrete, curing is required.
- Moist cure with wet burlap and polyethylene, a fine mist of water or a water Sika® Antisol®-250 W* compatible curing compound meeting ASTM C-309.
- Curing compounds adversely affect the adhesion of following lifts of mortar, leveling mortar or protective coatings.
- Moist curing should commence immediately after finishing.
- Protect freshly applied mortar from direct sunlight, wind, rain and frost.
- To prevent from freezing, cover with insulating material.

* Pretesting of curing compound is recommended.

## OTHER RESTRICTIONS

See Legal Disclaimer.

# LEGAL DISCLAIMER

- **KEEP CONTAINER TIGHTLY CLOSED**
- **KEEP OUT OF REACH OF CHILDREN**
- **NOT FOR INTERNAL CONSUMPTION**
- **FOR INDUSTRIAL USE ONLY**
- **FOR PROFESSIONAL USE ONLY**

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates ("SIKA"), the user must always read and follow the warnings and instructions on the product's most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA's Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within the product's shelf life. User determines suitability of product for intended use and assumes all risks. User's and/or buyer's sole remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs. **NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.**

Sale of SIKA products are subject to the Terms and Conditions of Sale which are available at https://usa.sika.com/en/group/SikaCorp/termsandconditions.html or by calling 1-800-933-7452.

**Sika Corporation**
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: +1-800-933-7452
Fax: +1-201-933-6225
usa.sika.com

**Sika Mexicana S.A. de C.V.**
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537