Design & Construction of Camanche Water Transmission Pipeline by Float-and-Sink Method

PIPELINE USER GROUP

JUNE 13, 2017
I. INTRODUCTION
II. DESIGN
III. PERMITS
IV. CONSTRUCTION
V. CONSTRUCTION CHALLENGES
VI. LESSONS LEARNED
INTRODUCTION

BACKGROUND

• An element of the WTP Replacement Project.
• Carry raw water from Mokelumne Aqueducts to the new WTP
• Allow new WTP supply water to the NS Recreation Area
• Limited rainfall in 2014 and several years of drought, reservoir at its lowest water level in 30 years
• Better pipeline construction
Camanche Water Transmission Pipeline

INTRODUCTION

Project Site Map

- San Joaquin County
- To Sacramento
- Lake Lodi
- Stockton
- To Oakland
- Camanche Lake
- Liberty Road
- Valley Springs
- Amador County
- Calaveras County
Camanche Water Transmission Pipeline

INTRODUCTION

Camanche North Shore
- 7,200 ft of 10" HDPE by Direct Bury

Camanche Reservoir
- 1,200 ft of 10" HDPE by Float & Sink, 120 Concrete Ballasts
- 90 SY of Cable Concrete Mats @ Water/Land Transition

New Camanche Water Treatment Plant (WTP)

Camanche South Shore
- ~5,800 ft of 12" HDPE by Direct Bury

Mokelumne Aqueducts
I. INTRODUCTION

II. DESIGN

III. PERMITS

IV. CONSTRUCTION

V. CONSTRUCTION CHALLENGES

VI. LESSONS LEARNED
References:

Handbook of Polyethylene Pipe
(The Plastic Pipe Institute)

M55, PE Pipe – Design and Installation
(American Water Works Association)
Float-and-Sink Basic Design Steps:

1. Selection of diameter, SDR
2. Concrete Ballast Design:
   1. Weight
   2. Geometry (1 piece, 2 pieces, dimensions, etc)
   3. Spacing
   4. Hardware (straps, bolts, etc)
3. Land/water transition
Pipelines:

- HDPE DR11 (PE4710)

CHARACTERISTICS

- Lightweight, floats in water
- Flexible, can adapt to lake bottom;
- Fusible, can be joined together by fusion in long segments;
- Non-corrosive.
Concrete Ballasts

• Design weight of concrete to achieve neutral buoyancy when floating the pipe
• Single-piece, bottom weighted to prevent rolling during floating
• 4,000 psi concrete reinforced with rebars
• 316 S.S. straps, bolts, nuts and washers
• ¼” neoprene pad
• 14”x24”x11” (H), 300 pounds
• Spaced 10 feet O.C.
# Concrete Ballasts

**Marine Installations**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_o$</td>
<td>10.750</td>
<td>in</td>
<td>Pipe Outside Diameter</td>
</tr>
<tr>
<td>$D_R$</td>
<td>11.0</td>
<td></td>
<td>Dimension Ratio</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_p$</td>
<td>0.957</td>
<td></td>
<td>Specific Gravity of Pipe</td>
</tr>
<tr>
<td>$\rho_c$</td>
<td>1.000</td>
<td></td>
<td>Specific Gravity of Pipe Contents</td>
</tr>
<tr>
<td>$\rho_w$</td>
<td>1.000</td>
<td></td>
<td>Specific Gravity of Water Outside the Pipe</td>
</tr>
<tr>
<td>$\rho_b$</td>
<td>2.400</td>
<td></td>
<td>Specific Gravity of Ballast Material</td>
</tr>
<tr>
<td>$R_w$</td>
<td>45</td>
<td>%</td>
<td>Recommended Weighting expressed as % of displaced water weight</td>
</tr>
<tr>
<td>$L$</td>
<td>10</td>
<td>ft</td>
<td>Ballast Center-to-Center Spacing</td>
</tr>
</tbody>
</table>

**Determine Required Minimum Ballast Weight (Ch. 10, Step 3c)**

- $W_{DW}$ | 39.3 | b/ft | Weight of volume of water displaced by pipe |
- $B_{w \ min}$ | 176.85 | | Minimum Submerged Ballast Weight to Anchor Pipe |
- $B_{a \ min}$ | 303.18 | | Weight of the Ballast in air |

**Determine Practical Maximum Ballast Weight (Ch. 10, Step 3b). (Typically, 85% of Weight at Neutral Buoyancy)**

- $F_B$ | 26.19 | b/ft | Buoyant Force for 100% Air Filled Pipe |
- $B_{w \ max}$ | 222.62 | | 85% of the Submerged Ballast Weight to Achieve Neutral Buoyancy |
- $B_{a \ max}$ | 381.63 | | Weight of the Ballast in air |

$\left(\frac{B_{a \ min}}{B_{a \ max}}\right) = 0.79$

If $< 1$, Ballast Weight is within the Practical Maximum Weighting Limit or if $> 1$, Consider Supplemental Buoyancy during Pipe Installation (See Ch.10 Step 3b).
Concrete Ballasts
Cable Concrete Mats:
- Land/water transition
- Made up of individual concrete blocks held together by polyester cables, which are poured within the block.
- Open cell, allows vegetation growth.
Camanche Water Transmission Pipeline

DESIGN

Cable Concrete Mats
<table>
<thead>
<tr>
<th>Permit</th>
<th>Agency</th>
<th>Lead-Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Alteration Agreement</td>
<td>California Department of Fish &amp; Wildlife</td>
<td>5 months</td>
</tr>
<tr>
<td>Section 404 Permit</td>
<td>US Army Corps of Engineers</td>
<td>8 months</td>
</tr>
<tr>
<td>Concurrence Letter</td>
<td>U.S. Fish and Wildlife Service</td>
<td>Came as a result of the Army Corps permit application</td>
</tr>
<tr>
<td>Section 401 Water Quality Certification</td>
<td>Central Valley Regional Water Quality Control Board</td>
<td>11 months</td>
</tr>
</tbody>
</table>
Float-and-Sink Basic Construction Steps:

1. Site selection (staging, joining, assembling & launching)
2. Join individual pipes into continuous length
3. Mount concrete ballasts
4. Launch the portion with concrete ballasts into the water
5. Sinking
   a. Fill the pipe with water in a controlled rate
   b. Underwater inspection
6. Land/Water Transition
Pre-Construction:

- HDPE Training
  - Use of data logger & interpret data
  - Fusion procedures and joint testing

- Underwater Survey
  - Lake bottom condition
Camanche Water Transmission Pipeline
CONSTRUCTION

Trenching for Direct Bury
Camanche Water Transmission Pipeline
CONSTRUCTION

Direct Bury
Camanche Water Transmission Pipeline
CONSTRUCTION
Camanche Water Transmission Pipeline
CONSTRUCTION

WHAT IS THIS?

I DON’T EVEN...
Escape Ramp for small mammals, invertebrate and reptiles
Pipe Assembly: Submerged
Camanche Water Transmission Pipeline
CONSTRUCTION

Concrete Ballasts Production
Camanche Water Transmission Pipeline
CONSTRUCTION

Mounting / Launching Area
Camanche Water Transmission Pipeline
CONSTRUCTION

Mounting
Concrete
Ballasts
Camanche Water Transmission Pipeline
CONSTRUCTION

Launching the Assembled Pipe
Videos
LAUNCHING THE PIPELINE
Pipe Assembly:

- Direct Bury
Pipe Assembly:

• Direct Bury
Camanche Water Transmission Pipeline
CONSTRUCTION

SINKING THE PIPE

Horse Island
Sunken pipe
Remaining floated pipe
South Shore
Camanche Water Transmission Pipeline
CONSTRUCTION

Pipe Assembly:
- Direct Bury
Videos

Underwater Survey / Inspection
Camanche Water Transmission Pipeline
CONSTRUCTION

Problem: Several spans suspended in Various Locations

Possible Causes:
- Submerged too fast
- Failed to vent the air
Remedial Actions:

- 6” diesel pump, 1,600 gpm
- Setup allowed pumped-water to return to the lake
- Pumped for an hour
- Performed a second underwater survey
- Adjusted ballasts when needed
- Entire length lowered and rested at bottom except at the vertical drop
1. Permit Restrictions

2. Late Contract Award

3. Construction Sequence Changed

4. Contractor’s “Office” Performance

5. Relationship between Contractor and Subcontractor
1. Permit Restrictions

A. **USF&W**: Trenching in Wetlands only allowed in September, October, and November

B. **USF&W**: Trenching in Upland Areas only allowed from May Through October

C. **CDF&W**: No Construction in Lake Bed After January 15.

D. **CDF&W**: All work ceases if 0.2” of rain forecast within 24 hours. A dry out period of 24 hours is required after the rain event.

E. **RWQCB**: 6 standard conditions and 28 technical conditions.
### Camanche Water Transmission Pipeline

**CONSTRUCTION CHALLENGES**

<table>
<thead>
<tr>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
</tr>
</thead>
</table>

**PERMIT WORK RESTRICTIONS**

- **Work Allowed in Upland Areas (>252’)**
  - (U.S. Fish & Wildlife)
  - *NTCFW*

- **Work Allowed in Welands**
  - (U.S. Fish & Wildlife)

- **Work Allowed in Areas Below Upland Areas (< 252’)**
  - (CA Department of Fish & Wildlife)

- **Ready for Service**
- **Contract Accepted**
2. Late Contract Award

A. Contract Milestones

1. Award – July 28, 2015
2. NTP – September 23, 2015
3. NTCFW - October 13, 2015
4. Required RFS (Ready for Services)
   1. Phase 1: Oct 31, 2015 (6,000 LF water pipe in upland area)
   2. Phase 1: Jan 8, 2015 (5,400 LF treated water pipe)
   3. Phase 2: July 15, 2016 (5,800 LF raw water pipe)
5. Project Completion August 5, 2016
### PERMIT WORK RESTRICTIONS

<table>
<thead>
<tr>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
</tr>
</thead>
</table>

- **Work Allowed in Upland Areas (>252’)**
  - (U.S. Fish & Wildlife)

- **Work Allowed in Wetlands**
  - (U.S. Fish & Wildlife)

- **Work Allowed in Areas Below Upland Areas (< 252’)**
  - (CA Department of Fish & Wildlife)

- **NTCFW**
  -  

- **Ready for Service**
  -  

- **Contract Accepted**
  -  

---

*EBMUD*
PHASE I
Profile 10” Treated Water Pipeline
Phase II
Profile 10” and 12” Raw Water Pipeline

STA 0+90, BEGIN
12” RWP

12” HDPE RAW WATER PIPELINE

EL 252

EXISTING GROUND

STA 58+54
END 12” RWP

Camanche South Shore WTP

UPLAND

UPLAND

58+54
3. Construction Sequence Changed

i. Phase I - 8,270 feet of 10-inch HDPE pipeline (purchased by the District)

ii. Phase II - 5,800 feet of 12-inch HDPE pipeline

iii. After award, required to complete Phase 2 first due to water quality issues at the reservoir. Pre-purchased pipe was 10”, for Phase 1 pipeline, not 12” required for Phase 2.
4. Contractor’s Office Performance

A. No NTCF unless all required submittals are complete

B. Difficulties in Meeting District’s Submittal Requirements

C. Scheduling Of Work And Fabrication

D. Payment Schedule & Progress Payments
5. Contractor’s Relationships With Subcontractors

- Hired by the General Contractor
- Assist in Float-and-Sink
- Not working well
- Stop communicating
High Water Table
Camanche Water Transmission Pipeline

OTHER CONSTRUCTION CHALLENGES
Camanche Water Transmission Pipeline

OTHER CONSTRUCTION CHALLENGES
Hazards are known but often not visible.
LESSONS LEARNED

1. Allow enough time to acquire permits and completion of project

2. Do not allow the contract to proceed until all paperwork has been received

3. Meet more often with the contractor to obtain necessary submittals and keep on track.

4. Fill rate is important during sinking of the pipe.
VIDEOS
Aerial View of the Project
Camanche Water Transmission Pipeline

Thank You
Questions??