Water Resources Department
725 Summer St NE, Suite A
Salem, OR 97301-1271

2013 Oregon Dam Safety Conference

Holiday Inn
Wilsonville Conference Center
25425 Southwest 95th Avenue
Wilsonville, OR 97070

February 26, 2013

8:00 a.m. - 5:00 p.m.

PRESENTATION TOPIC:

Replacing/Repairing Conduits by Slip Lining, Case Histories

LINER PLACEMENT OBSTACLES:

Can you identify three major obstacles encountered when Replacing/Repairing Conduits thru Dams using Slip Lining?

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EDUCATION: University of Washington; Seattle, Washington
Master of Science in Hydraulic Engineering, 1968

REGISTRATION: Professional Civil Engineer in the States of Washington and Oregon
Professional Hydraulic Engineer in the State of Washington

AFFILIATIONS: American Society of Civil Engineers
American Public Works Association, Washington Chapter
Water Environmental Federation, WEF

PRACTICE: Martig Engineering (Consulting Engineer)
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EXPERIENCE:

Mr. Martig has been in private practice as a Consulting Engineer for over 40 years.

His clients include State Agencies, Counties, Cities, Indian Tribes, Industries, Commercial Developers, and private property Owners.

Completed projects include a wide variety of Civil, Hydraulic/Hydrology, and Environmental Engineering projects involving: water supply; water treatment; sanitary sewerage; wastewater treatment; storm drainage; groundwater sources; geomorphology; stream flow; stream rehabilitation; landslides; salmon hatcheries; dams; hydroelectric; landfills; gravel mining; noise; controls & instrumentation; land development; streets & roads; and a host of environmental issues.

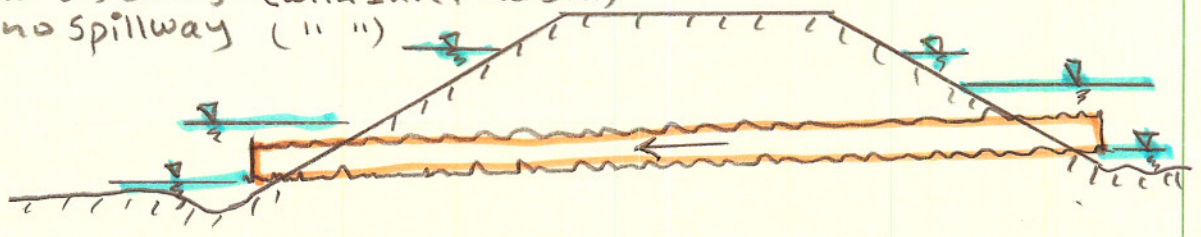
He also has developed patents for unique Open-Channel Flow Monitoring Equipment.

Dam Configurations

(Typically Encountered)

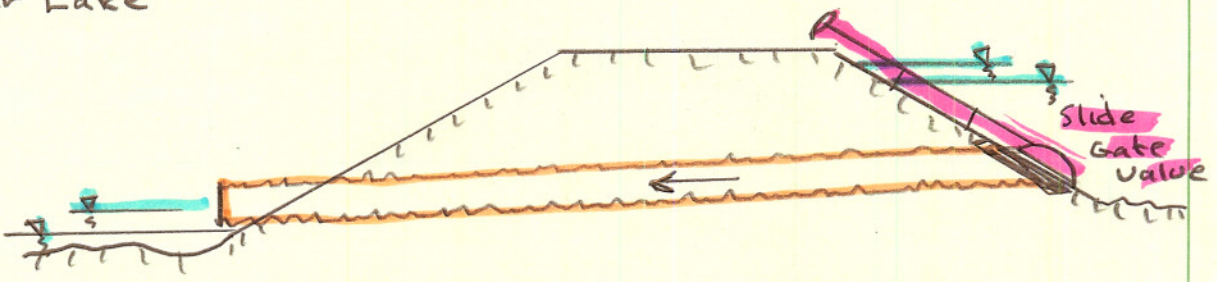
Configuration (i):

a) Elk Creek (with D.S. Flap Gate)
b) Swano Discharge (with Inlet Wier Box)
c) Swano Spillway (" ")



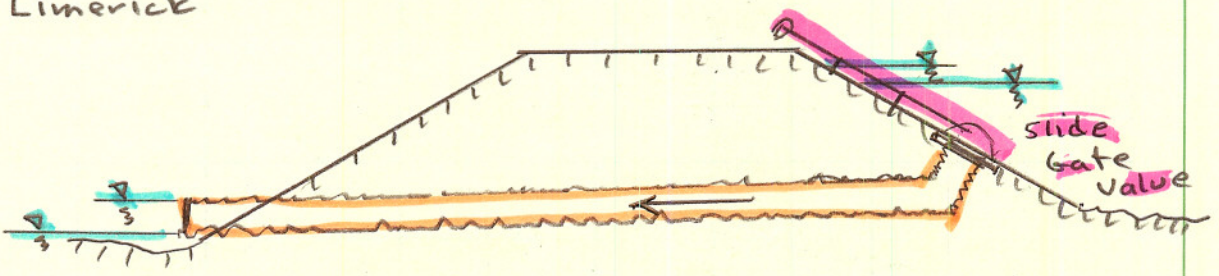
Configuration (ii):

Timber Lake



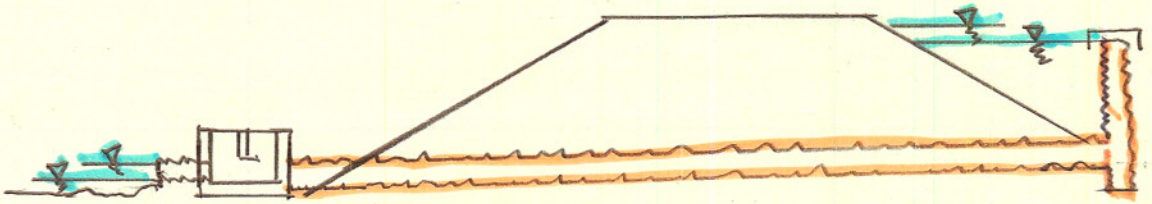
Configuration (iii):

Lake Limerick



Configuration (iv)

Tuck Lake



ELK RIVER TIDE GATE REPAIR
EMERGENCY REPAIRS
TO EXISTING FLOOD CONTROL STRUCTURE

(4-Pages of Illustration)

Dam Purpose: To prevent Salt Water Tidal Back-Flooding of Elk Creek's Lowland Watershed.

Problem: Extreme Corrosion of the three 48" CMP Pipes, at the downstream end, and total destruction of the flood control Flap-Gate Valves.

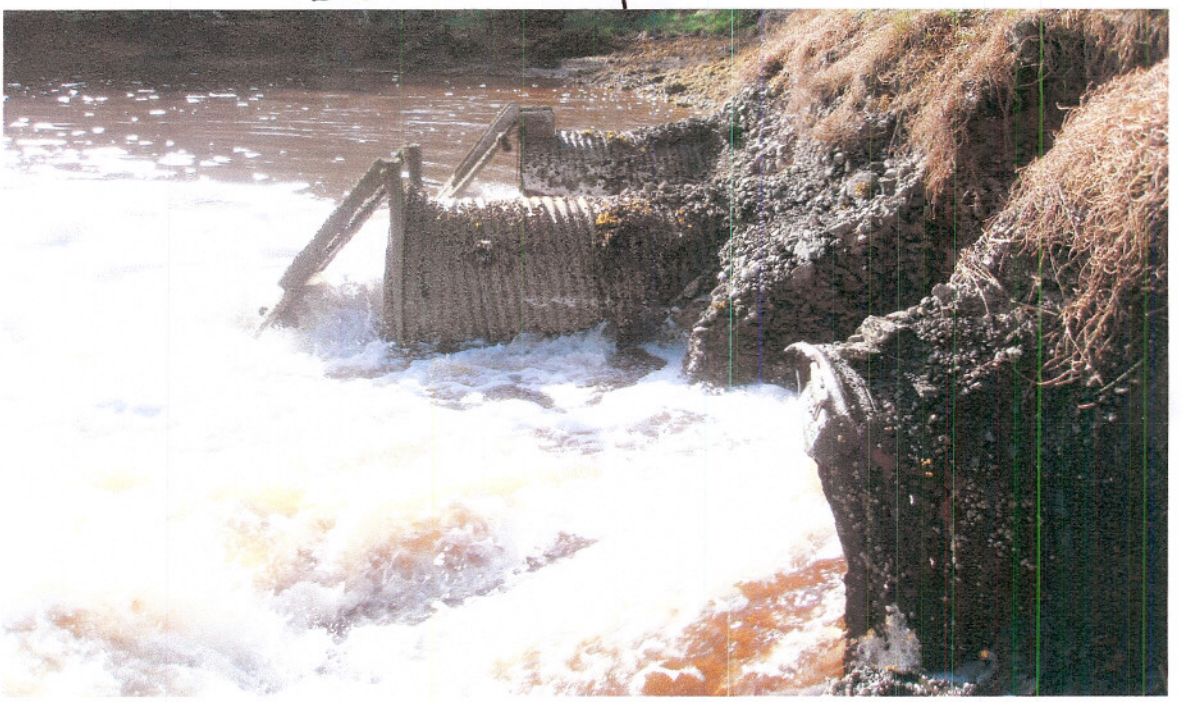
Liner Insertion Conditions: {Configuration (i)}

1. Always a minimum flow thru the pipes, with at least 9" to 16'' of flow depth;
2. Tidal fluctuations completely inundating the discharge end of the pipes;
3. Pipes open and accessible at both ends;
4. Approximately 8 lineal feet of downstream pipe had corrosion destruction holes.

Solution Elements:

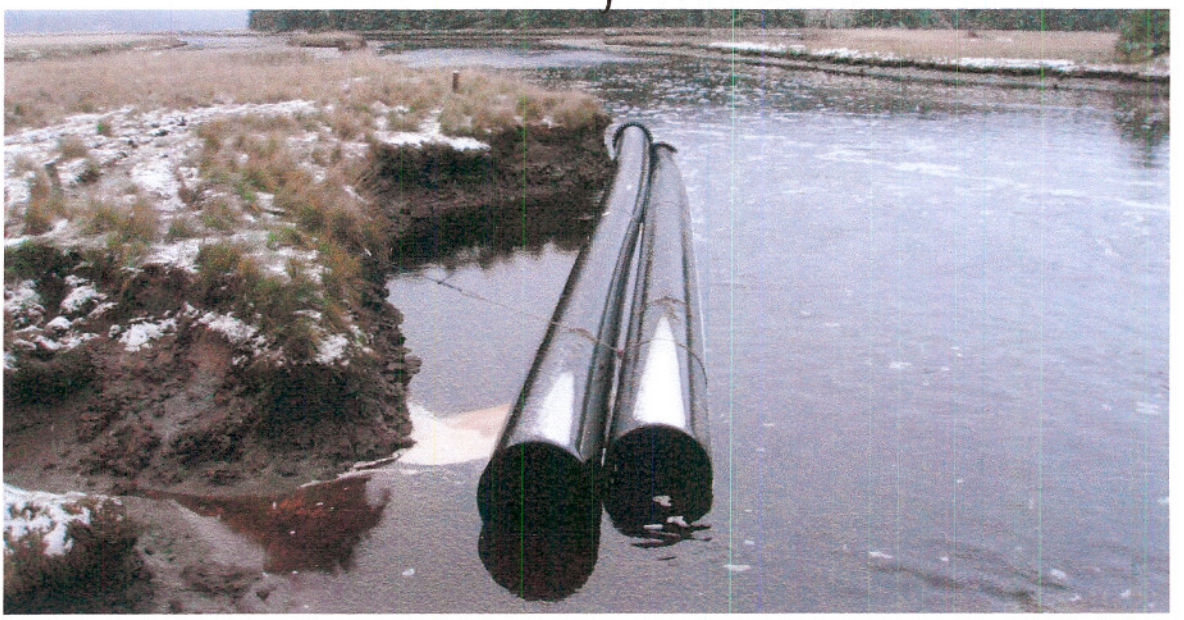
1. Liner used was 42" SDR 32.5 HDPE Pipe, each 100' long;
2. Three Plasti-Fab Flap-Gate Valves;
3. Welded 2" Dia. Nipples, onto existing Culverts, for Grout Injection and Grout venting (after trimming away bad pipe);
4. Used banded Filter Fabric Grout Seal Bulkheads (found to leak dilute Grout Slurry-Water into flowing stream).
5. Discovered Problem with rising Tide lifting Liner during insertion.

Before Repair



After Repair

Floating HDPE Liners



Tide wate Level, Backhoe Hiking Insertion

OH! NO! Rising Tide Bouyant Induced Bending

1st Liner in Place, Second being Towed Quickly

1st Liner outlet

1st Liner Inlet

Inserting Grout

venting Grout Slurry

SWANO LAKE RESERVOIR DAM
PRIMARY DISCHARGE PIPE
CORROSION REPAIR
(3-Pages of Illustration)

Dam Purpose: To create Swano Lake Reservoir.

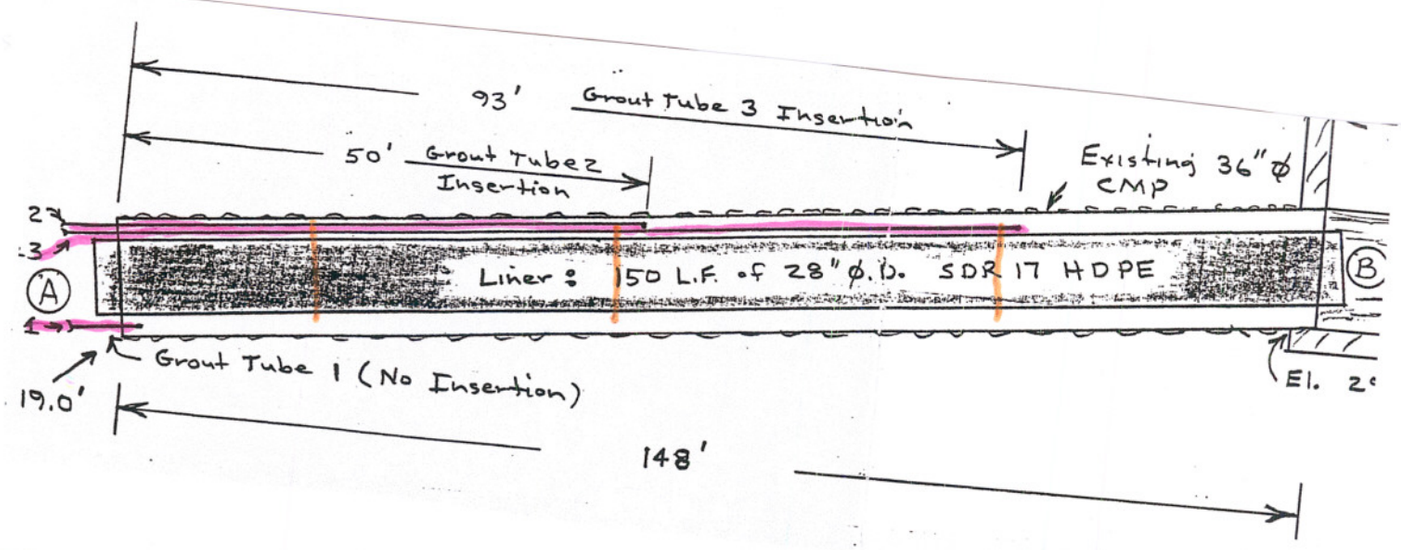
Problem: Corrosion of existing 36" CMP Pipe.

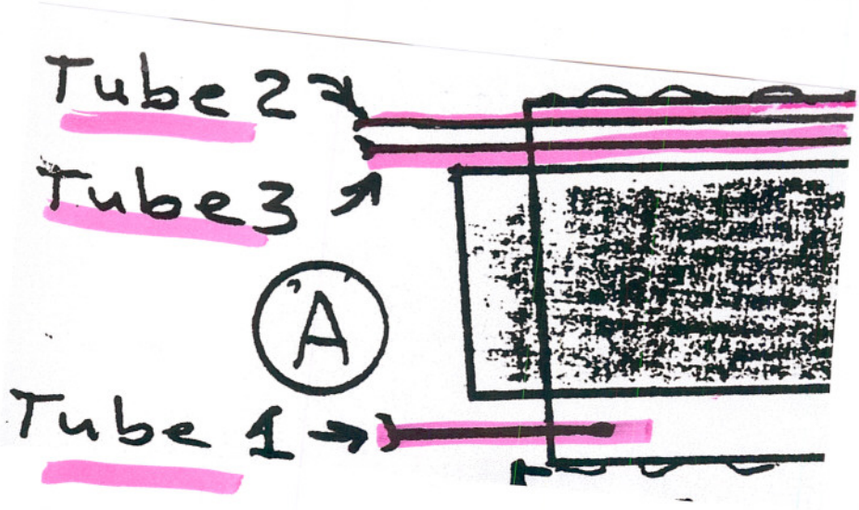
Liner Insertion Conditions: {Configuration (i)}

1. Flow could easily be diverted during repair;
2. Pipe open and accessible at both ends;
3. Flat concrete wall pipe entrance;
4. Open Discharge at pipe outlet;
5. Easy access to site.

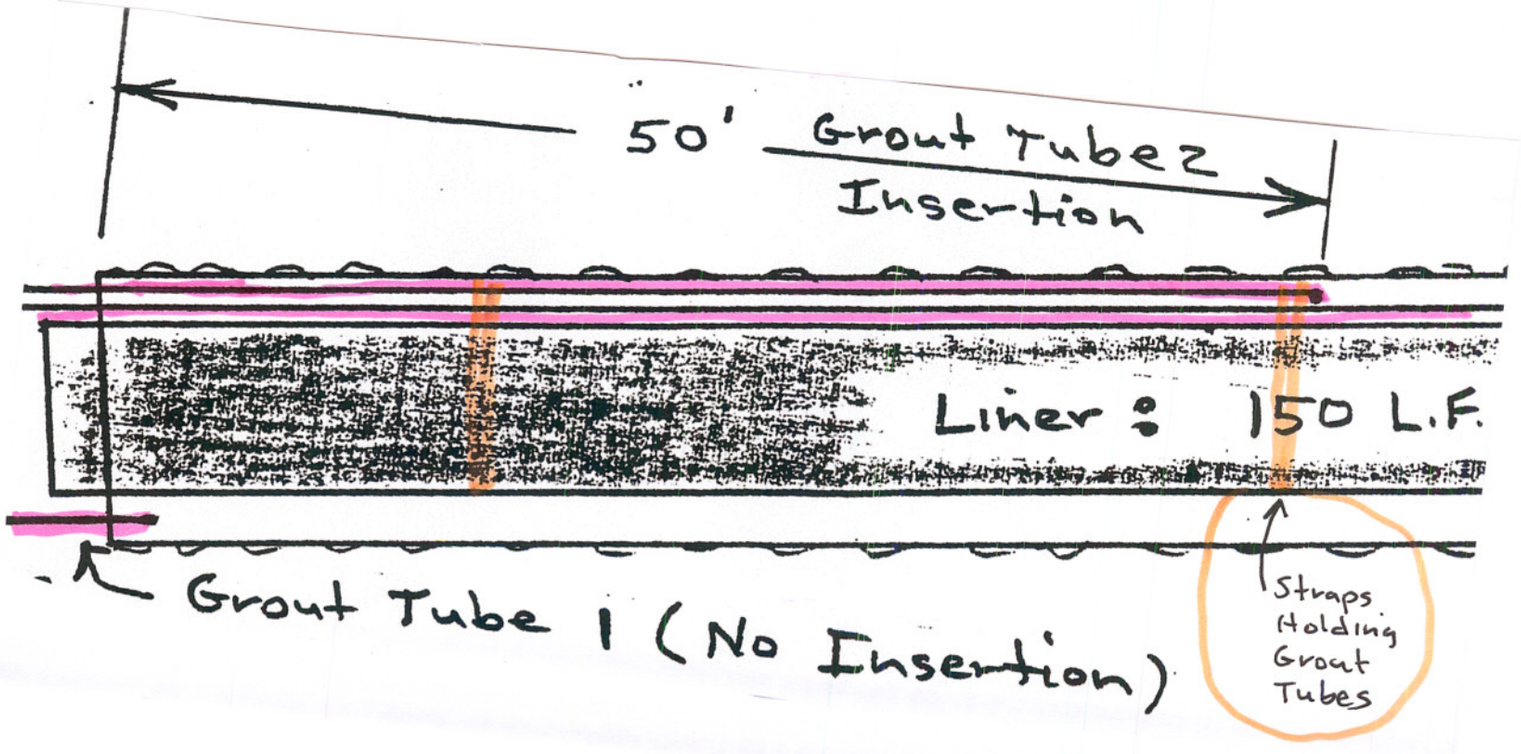
Solution Elements:

1. Liner used was 28" SDR 17 HDPE Pipe, 150' long;
2. Liner inserted, Backhoe Hiked, into host pipe from downstream end;
3. Three 2' HDPE Grout Injection Tubes inserted with liner, all placed within the annular space, for sequential grouting, to remain permanently within the completed grout seal;
4. Used Clamp-On Grout Seal Bulkhead at discharge end (Galvanized Steel for permanent attachment) and ¼" Steel Plate Grout Seal Bulkhead at entrance;
5. Pumped Grout into lower end thru the 3-Tubes until good grout exited the upper Bulkhead Vent/Breath hole.





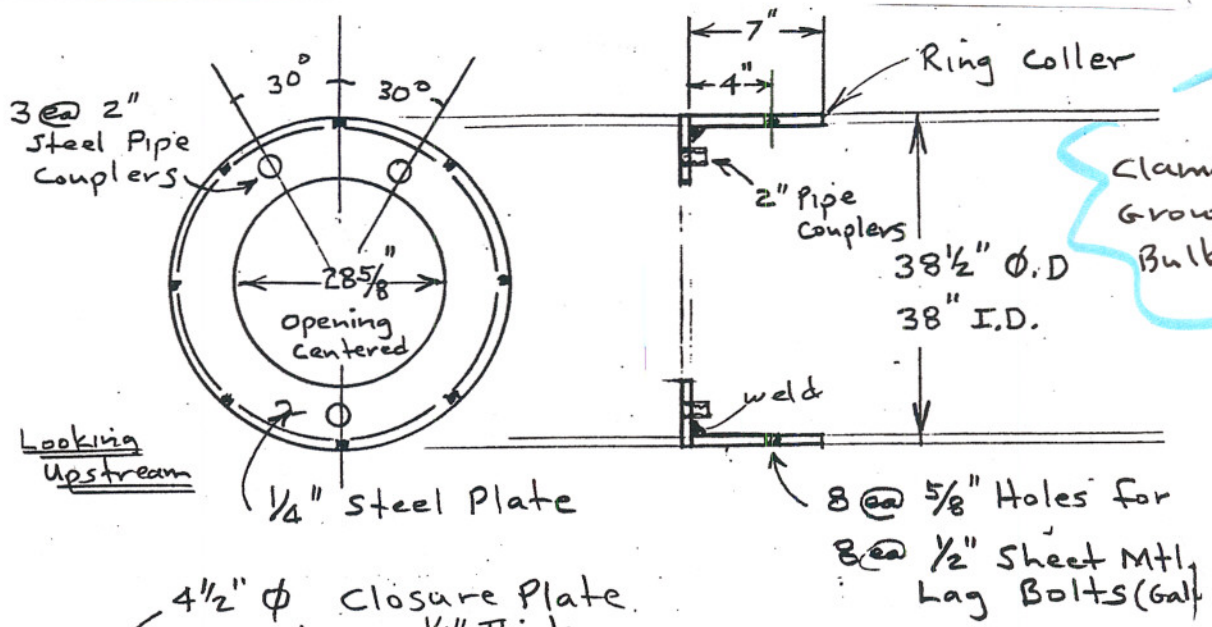
Grout tubes Placed within Annular Space



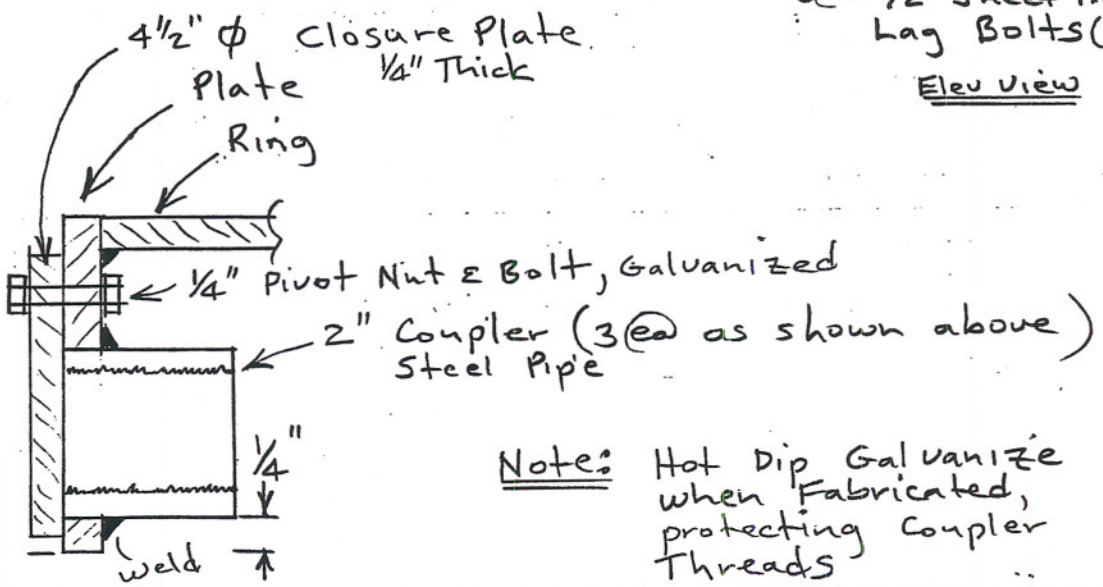
Clamp on Bulkhead

Clamp on Grout Seal Bulkhead

Grout Seal Bulkhead (A)

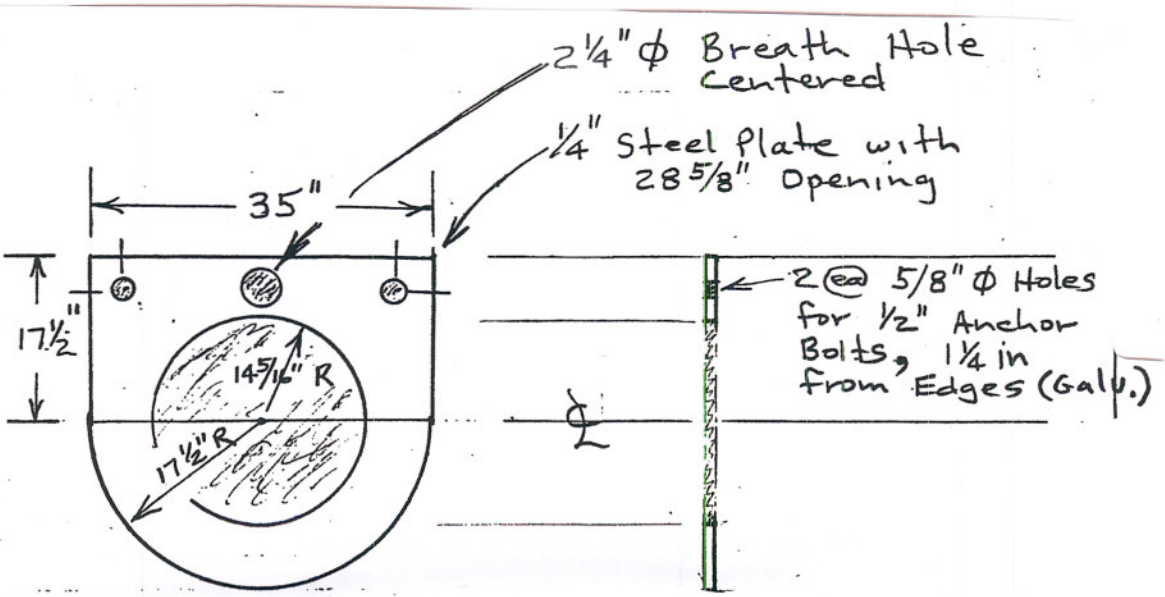


Elev View



Note: Hot Dip Galvanize when Fabricated, protecting Coupler Threads

Grout Seal Bulkhead (B)



TIMBER LAKE RESERVOIR DAM
VALVED, BOTTOM DRAIN PIPE
CORROSION REPAIR
(2-Pages of Illustration)

Dam Purpose: To create Timber Lake Reservoir.

Problem: Corrosion of existing 18" CMP Drain Pipe.

Liner Insertion Conditions: {Configuration (ii)}

1. Normally no flow thru pipe;
2. Pipe open at downstream end only;
3. Upstream end in deep water, closed by Slide Gate Valve that remains in good condition;
4. Natural stream channel regime downstream, therefore the liner pipe staging area was on adjacent roadway, requiring towing/jockeying of liner to feed into discharge end of host pipe.

Solution Elements:

1. Liner used was 14", SDR 11 HDPE Pipe, 200' long;
2. Liner inserted, Backhoe Hiked, into host pipe from downstream end;
3. Inflatable Bladders were fabricated for use as Grout Seal Bulkheads. The outlet end was accessible. The upstream/inlet end required a specially fabricated Aluminum Insertion Head. This head allowed the Bladder Bulkhead to be recessed, until inflated. Both the Air Tube and Grout Vent Tube were attached inside the liner with fabricated Pull-Away Connections that were as flush to the inside of the liner as possible
4. The 2", HDPE Grout Injection Tube was attached to the inside of the liner near its outlet. Its connection employed drilling and tapping the liner for a short 2" Nipple. A Quick-Disconnect Clamp fitting was fabricated to allow the Grout Tube to be disconnected by pulling on an attached cable, as were both the upstream Air Tube and 1.5" Grout Vent Tube;
5. A 150 lb Flange was attached at the downstream end of the liner to allow a Blind-Flange to be attached. An 8-inch Valve was attached to the Blind-Flange. This 8-inch valve can be used to halt flow, if future repairs to the upstream Slide Gate Valve become necessary (of course, the Flange/Valve assembly can be removed at any time, necessary).

Timber Lake Dam
(18"ϕ CMP)

18"ϕ Outlet End Before Starting

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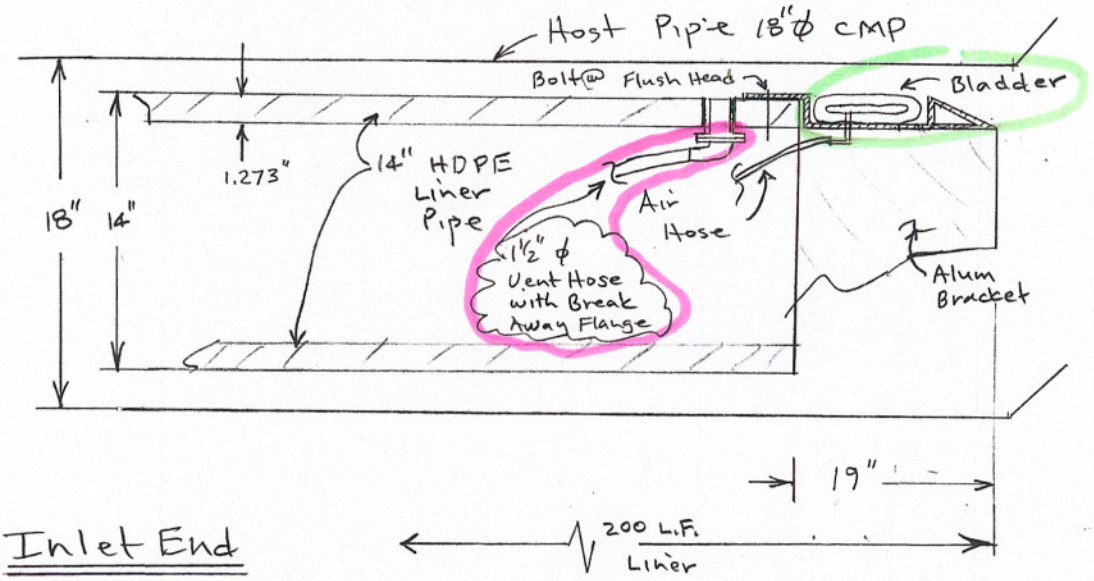
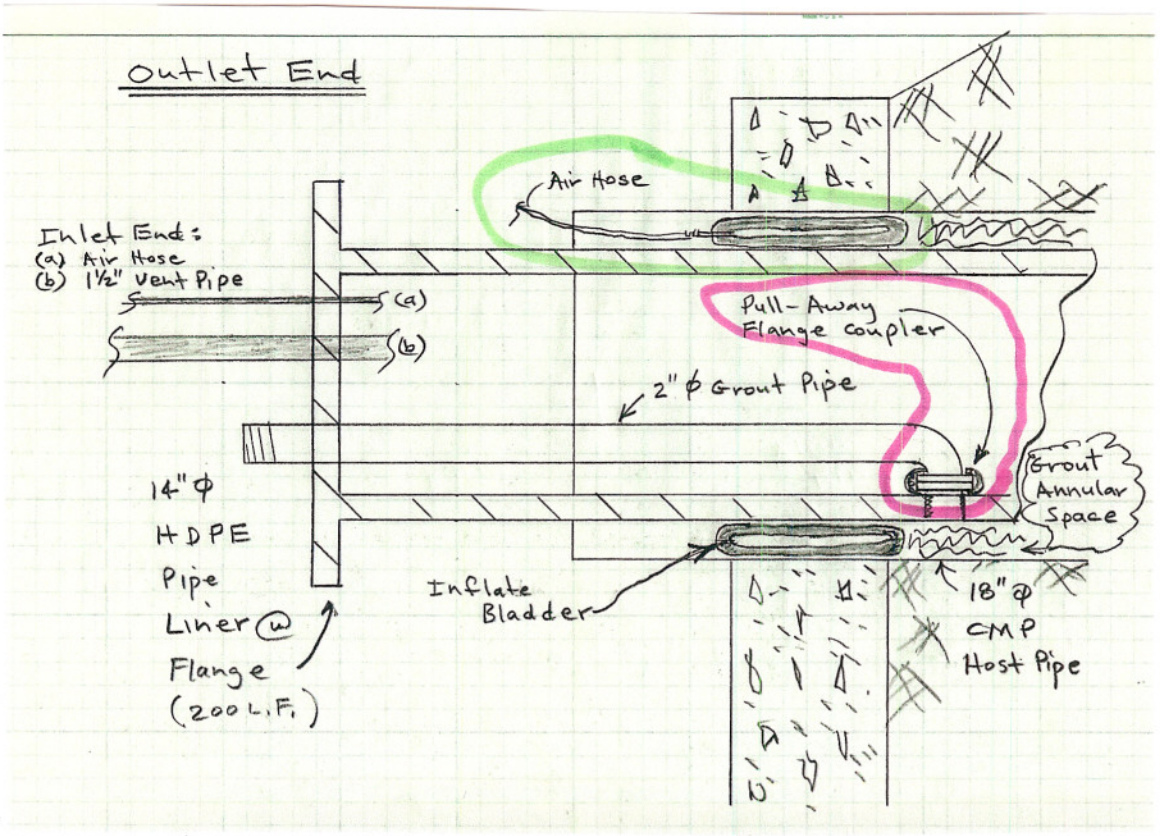
To: Jon
8/19/03



Inlet End



SWANO LAKE RESERVOIR DAM
EMERGENCY SPILLWAY PIPES
SETTLEMENT & JOINT CORROSION REPAIR

(10-Pages of Illustration)

Dam Purpose: To create Swano Lake Reservoir.

Problem: Settlement and Joint Corrosion of the three existing 48", CMP Drain Pipes.

Liner Insertion Conditions: {Configuration (i)}

1. Normally no flow thru pipes;
2. Pipes open and accessible at both ends;
3. Flat concrete wall pipe entrances;
4. Open discharge at pipe outlet;
5. Steep pipe slopes, creating higher Hydrostatic Grout Pressure when Grouting the Annular Spaces.

Solution Elements:

1. Liners used were 42", SDR 32.5 HDPE Pipe, 80' long;
2. Liners inserted into host pipe from downstream end by rigging, at the upstream end, that allowed them to be pulled into place;
3. Inflatable Bladders were fabricated for use as Grout Seal Bulkheads;
4. The 2", Grout Injection Tube was attached to a 2" nipple that protruded into the annular space at the downstream Bladder Grout Bulkhead. This nipple was sealed into place by the Bladder itself. The same technique was used at the upstream end for Grout Venting into an environmental containment pond;
5. Inflatable Water Ballast Plugs ware used to allow the inserted liners to be filled with water, when the Grout was being injected;
6. A specialty sub-contractor was used to supply and inject the grout.

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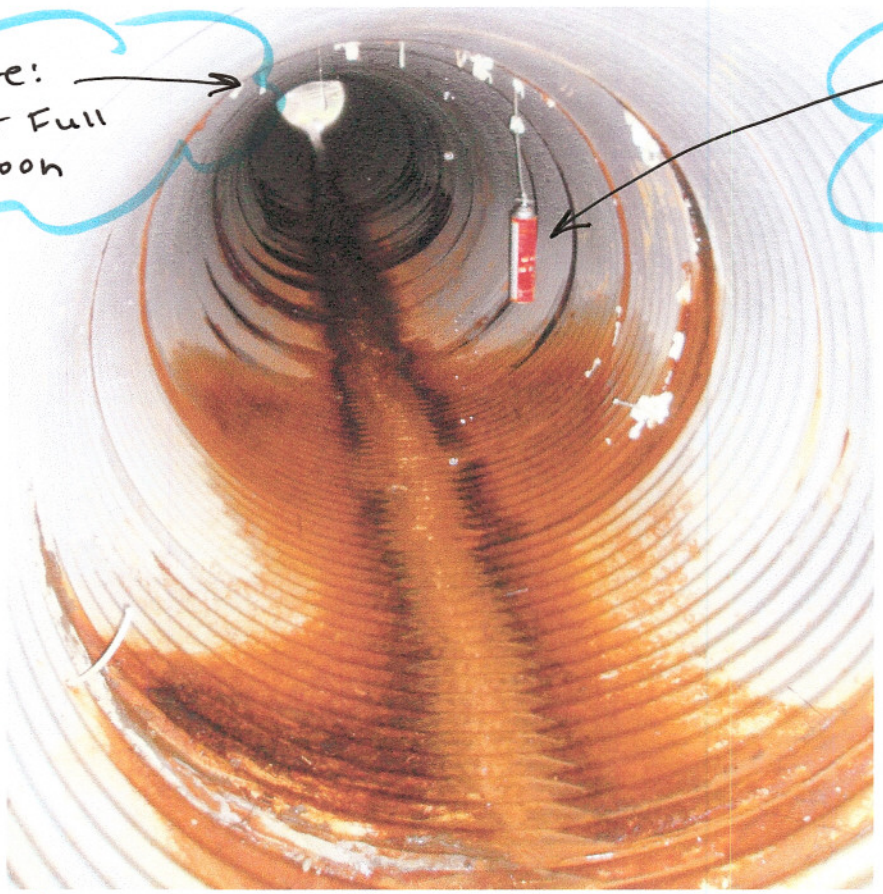
November 7, 2007

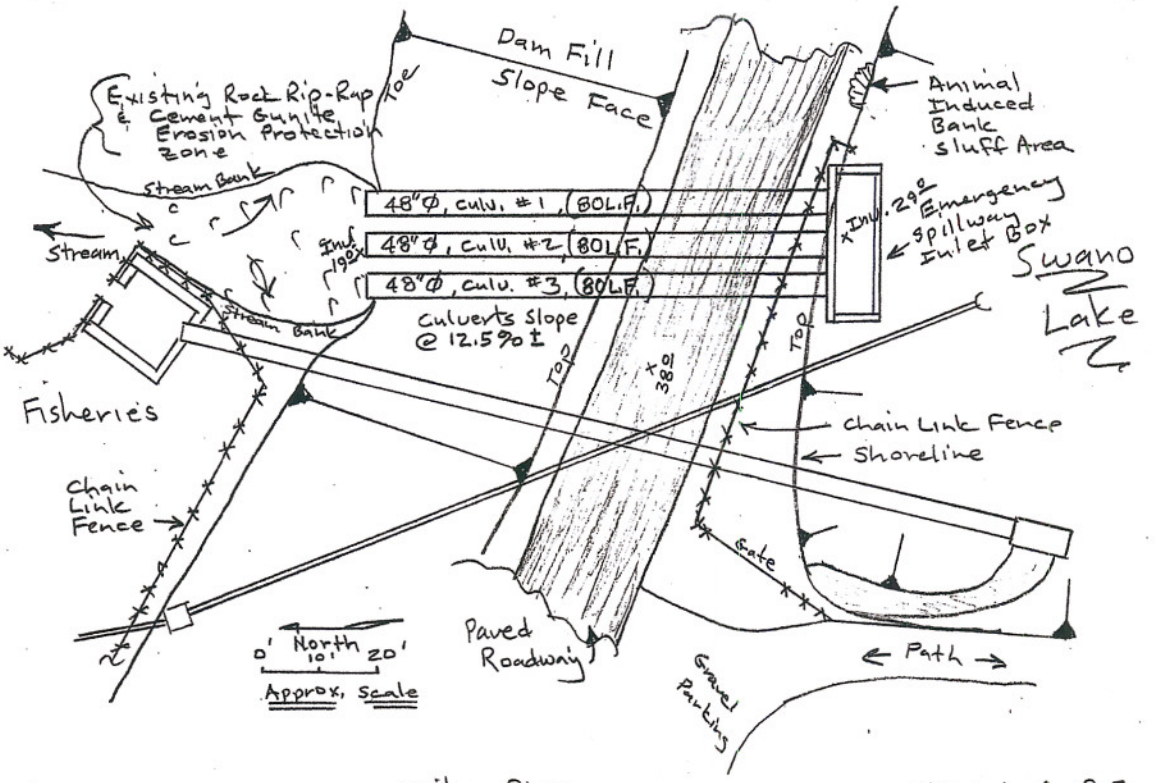
GRAYS HARBOR COLLEGE
SWANO LAKE DAM
EMERGENCY REPAIRS
TO EMERGENCY SPILLWAY PIPES

COMPLETED CONSTRUCTION
ACCEPTANCE REPORT

ENGINEER
Kenneth W. Martig, Jr. PE



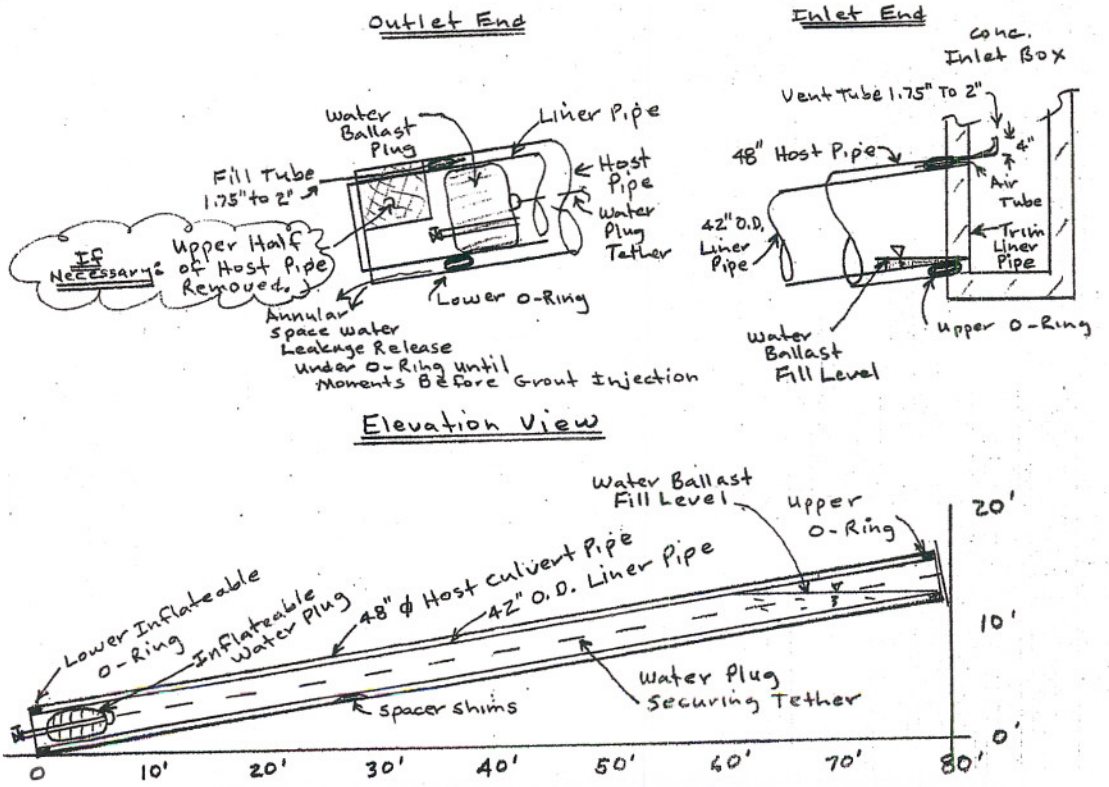
Upper two settled culvert sections



Site Plan

Sketch 1 of 2
Martig Engineering

Sketch 2 of 2
Martig Engineering



B. CONSTRUCTION SEQUENCE DOCUMENTATION

1. Liner Pipe:

Photo #1: Liner Pipe 42-inch diameter, SDR 32.5 HDPE (42.0" O.D. with 39.3" I.D.)

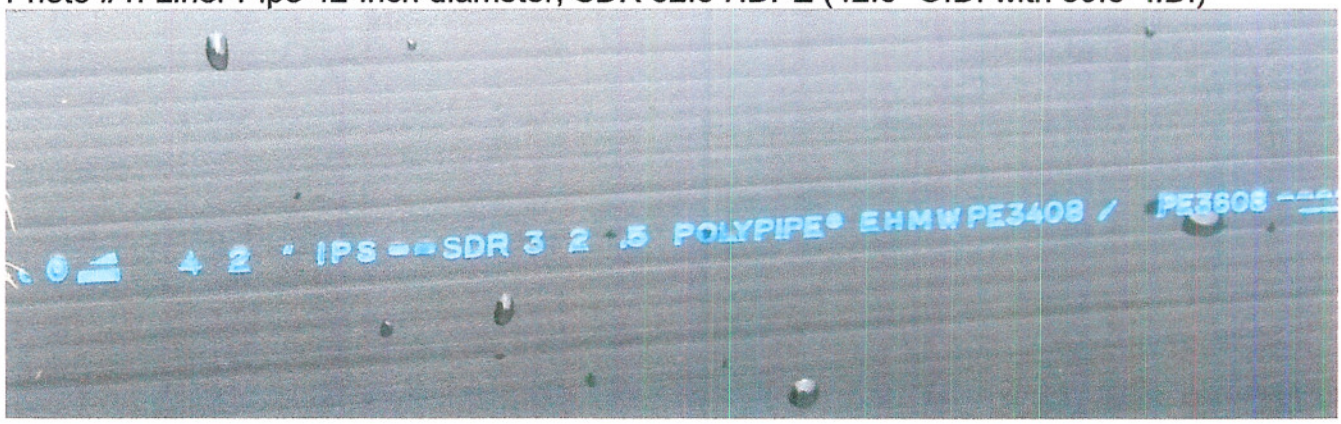


Photo #2: Shows 20-feet lengths being secured by fusion welding

2. Liner Installation:

Photo#3: Shows the three culverts ready for liner insertion

Photo #4: Liner Pulling Head

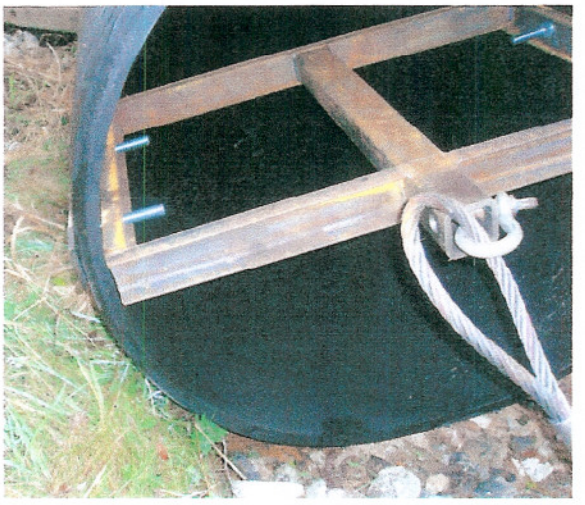


Photo #5: Pulling System at Culvert Inlet

Photo #6: Positioning Liner for Pulling Into Culvert No. 3

Photo #7: All three Liners in place

3. Annular Space Seals:

Photo #8: Uninflated O-Ring

Photo # 9: Wedge with 2" Injection Tube

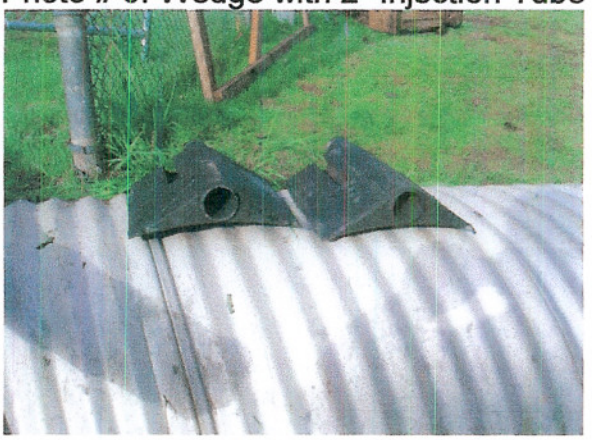


Photo #10: Inflated O-Ring in Position, Securing Injection Tube (1 of 6 Locations)

4. Water Ballast:

Photo #11: Pipe Plug in place at lower end for filling Liner with water

Photo #12: Three Plugs in place

5. Grouting:

Photo #13: Portland Cement Mortar Truck Delivery

Photo #14: Pacific International Grout Co. Mixing Equipment

Photo # 15: Grout being injected thru lower end O-Ring Tube

Photo #16: Water, Air, & Pure-Grout discharged into bucket

Photo #17: Discharging dirty water & Pure-Grout from bucket into containment trap

Photo #18: Lower end Grout Seal without O-Ring (Top)

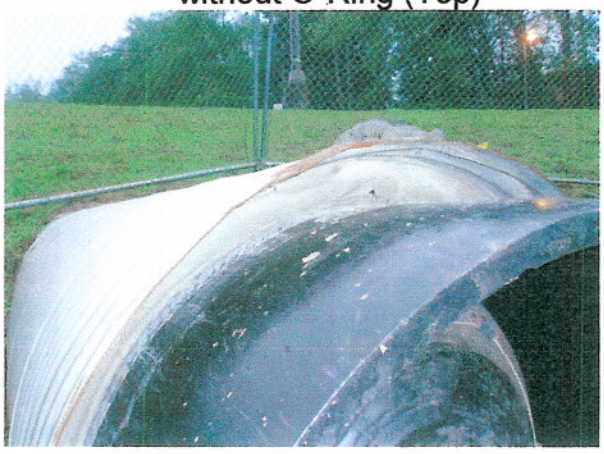


Photo # 19: Lower end Grout Seal without O-Ring (Btm)

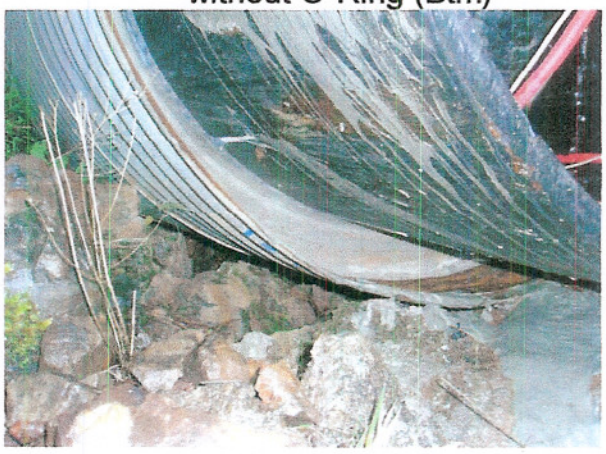
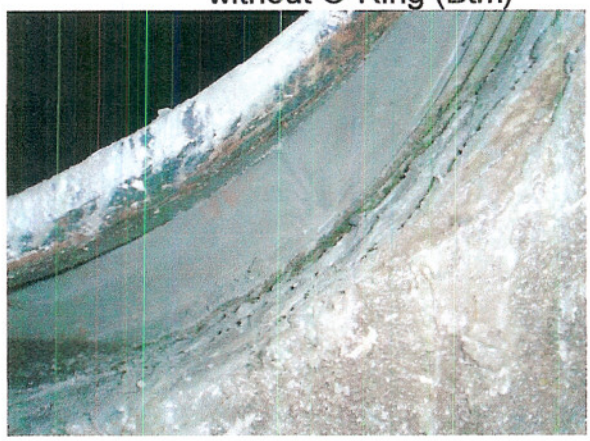


Photo #20: Upper end Grout Seal without O-Ring (Top)

Photo # 21: Upper end Grout Seal without O-Ring (Btm)



6. Finished Grouting (Jet-Set Portland Cement Mortar filling of O-Ring void):

Note that visible, thin/minor shrinkage cracks exist between the end of liner and the placed Jet-Set grout at the upper end due to the cooling of the HDPE liner (the liner loosing its thermal expansion, gained from the Heat-of-Hydration during the curing of the injected grout). This crack is of no consequence and no water leaking occurred before or after the Jet-Set mortar was placed to fill the voids formed when the O-Rings were removed.

Photo # 22: Typical finished Lower End

Photo # 23: Typical finished Upper End

LAKE LIMERICK RESERVOIR DAM
VALVED BOTTOM DRAIN PIPE
BROKEN SHUTOFF VALVE & CORROSION REPAIR

(3-Pages of Illustration)

Dam Purpose: To create the Lake Limerick Reservoir.

Problem: The 36" Drain entrance shut-off Slide Gate Valve was Broken. A temporary steel plate had been fabricated and placed to halt flow thru the 36", CMP Drain Pipe. Additionally, the Culvert Pipe was badly corroded.

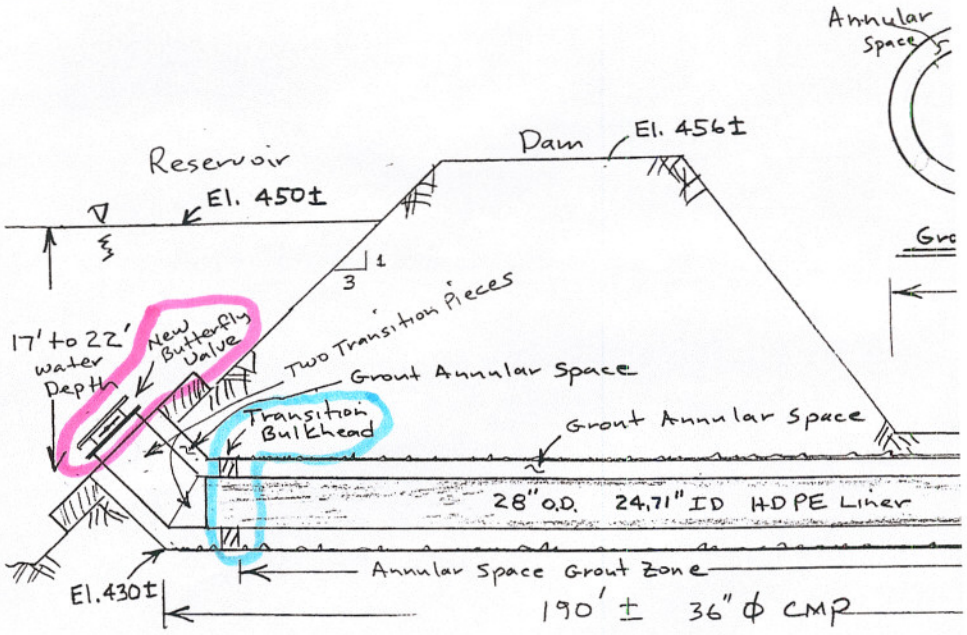
Liner Insertion Conditions: {Configuration (iii)}

1. Normally, no flow thru pipe;
2. Pipe open and accessible at downstream end only;
3. Upper end of pipe is in deep water and has an elbowed configuration with a broken shutoff valve;
4. The lower 40'of existing culvert pipe has to be removed to provide access for the insertion of the liner into the host pipe;
5. A skilled Diving Team would be required;
6. This repair was completed 20-years ago when times, video inspection equipment, and access requirements were quite different.

Solution Elements:

1. Liner used was 28", SDR 17 HDPE Pipe, 200' long;
2. Liner Backhoe Hiked into host pipe from downstream end, until it threaded the Transition Bulkhead and was located 8-inches downstream from the Crown Break Point of the Elbow;
3. The annular space from the transition bulkhead to the open trench was then Grouted;
4. The downstream end of the liner was closed off with a Blind Flange with two affixed valves;
5. Once the Grout (within the annular space of the repaired horizontal section) was cured, this lower section of liner was filled with lake water using the two valves (air bleed & water shutoff valves);
6. Now, with NO FLOW POSSIBLE thru this existing pipe that is being repaired, especially upstream from the Transition Bulkhead, we could remove the temporary steel plate from the entrance and proceed with lining the elbow area and install a new valve;
7. The liner material upstream of the Transition Bulkhead is Galvanized Steel, placed in three sections;
8. The new valve is a 30", Air-Piston Actuated, Normally Spring Closed, Butterfly Valve. It is air pressure opened and air bleed closed, using two compressed air hoses that run to a control box at the Lake's Shore.

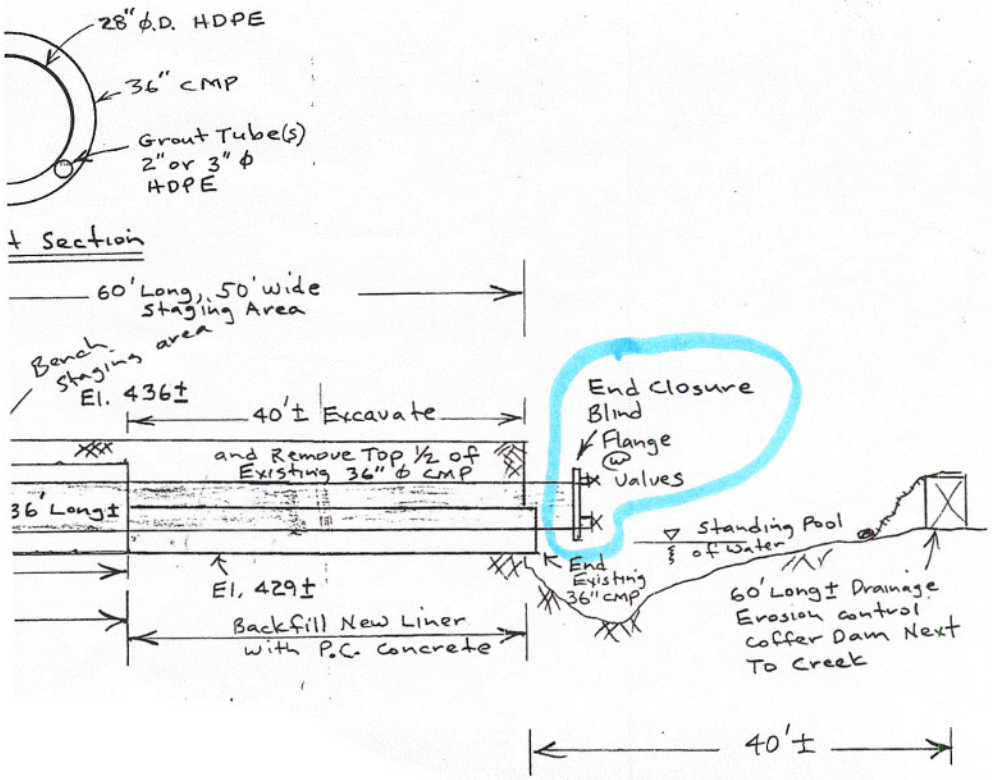
Lake Limerick Dam
(36" CMP)

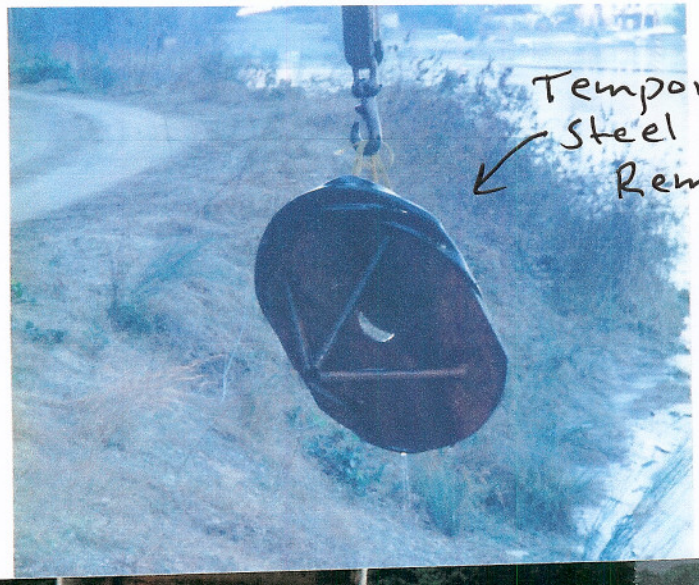


Section Thru Dam

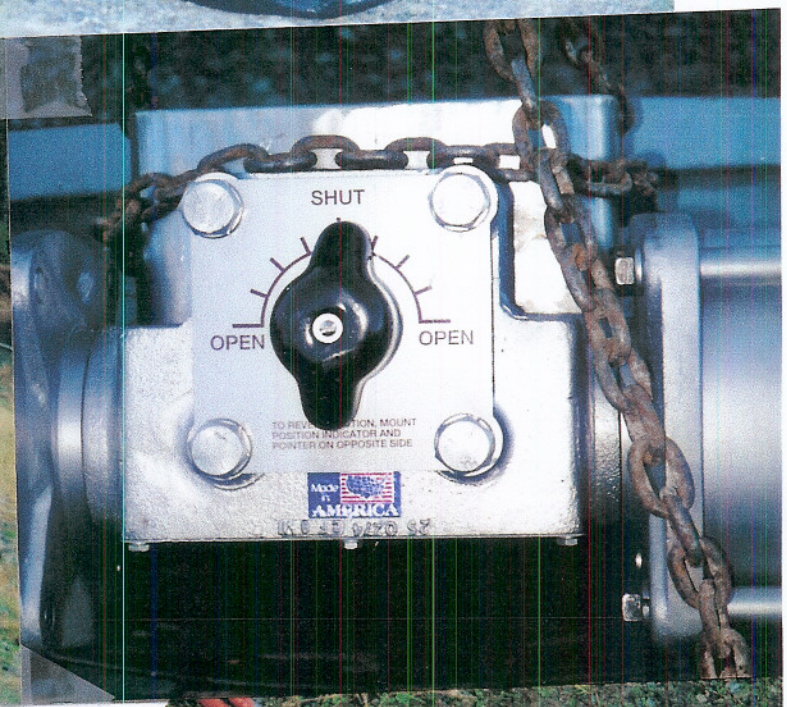
KWM
8/11/94

FAX



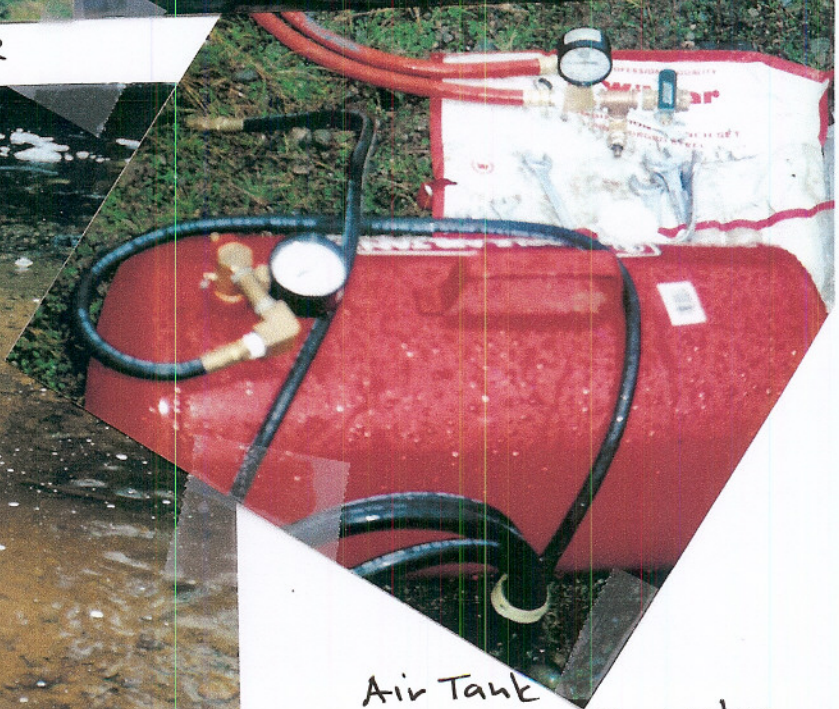


Temporary Steel Plate Removed

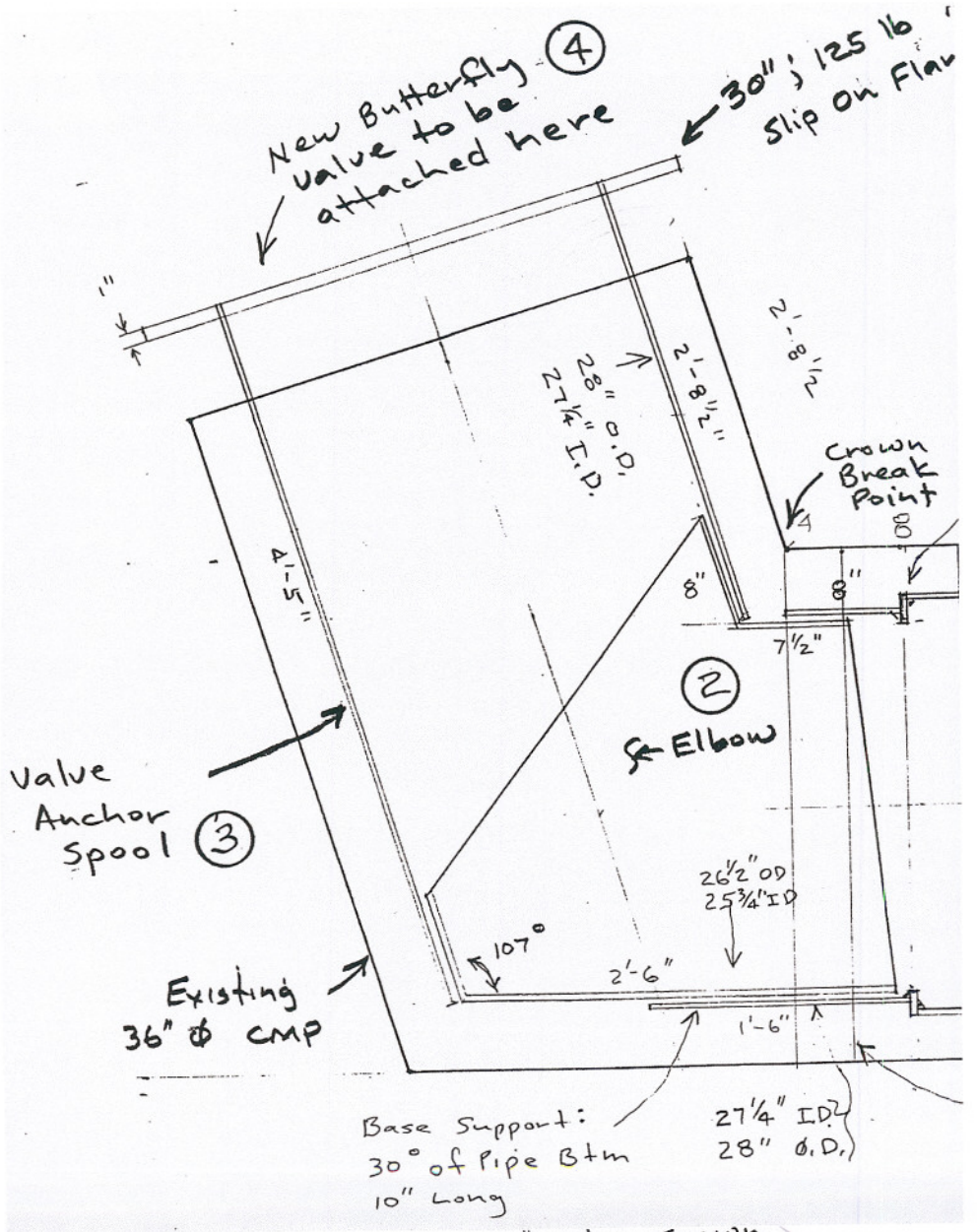


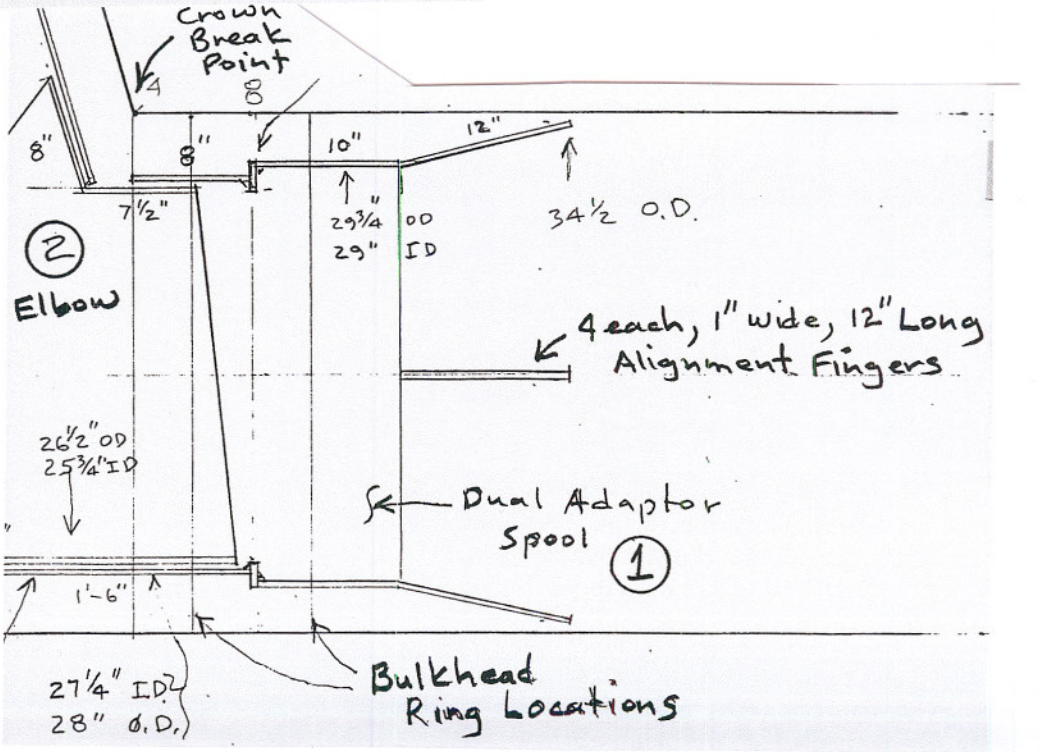
30" Butterfly Valve

End Closure Blind Flange



Air Tank for Butterfly Valve (Portable, when needed)


New Butterfly Valve to be attached here
4
30" ; 125 lb
Slip on Flan
1"
2'-8 1/2"
28" O.D.
27 1/4" I.D.
2'-8 1/2"
Crown Break Point
4
8
8"
8"
7 1/2"
2
Elbow
4'-5"
Valve Anchor Spool
3
26 1/2" OD
25 3/4" ID
107°
2'-6"
1'-6"
Existing 36" Ø CMP
Base Support:
30° of Pipe Btm
10" Long
27 1/4" ID
28" O.D.


Crown Break Point
4
8
8"
8"
10"
12"
7 1/2"
29 3/4" OD
29" ID
34 1/2 O.D.
2
Elbow
4 each, 1" wide, 12" Long Alignment Fingers
26 1/2" OD
25 3/4" ID
Dual Adaptor Spool
1
1'-6"
27 1/4" ID
28" O.D.
Bulkhead Ring Locations

TUCK LAKE RESERVOIR DAM
PRIMARY DISCHARGE PIPE
CORROSION REPAIR
(2-Pages of Illustration)

Dam Purpose: To create Tuck Lake Reservoir.

Problem: Corrosion of existing 36" CMP Pipe.

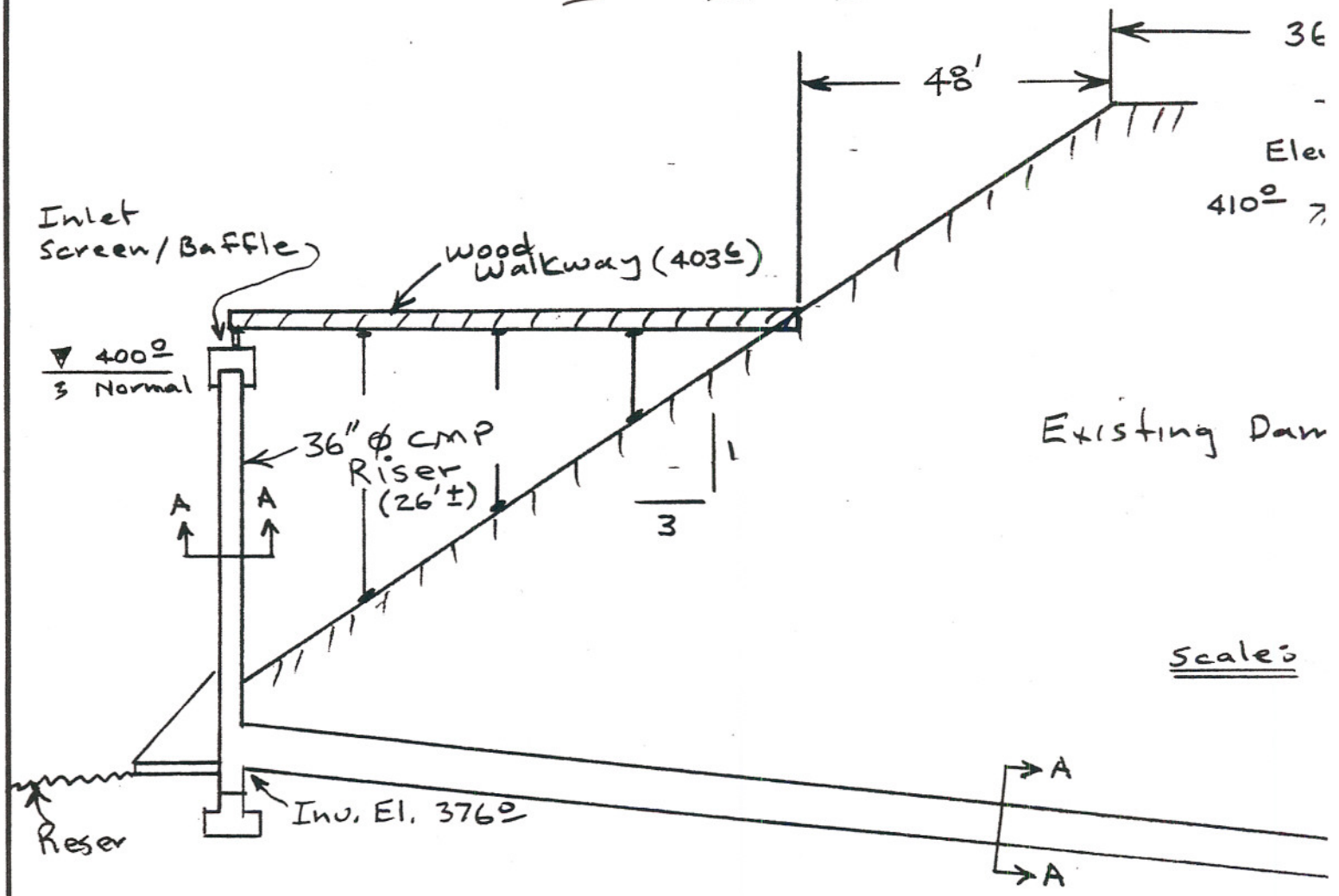
Liner Insertion Conditions: {Configuration (iv)}

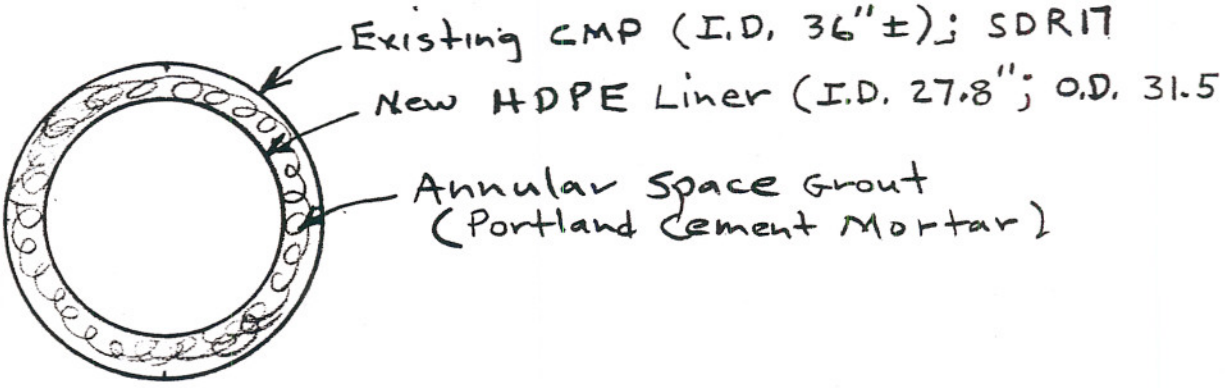
1. Flow could easily be diverted during repair;
2. Pipe is open and accessible at both ends. However, the inlet end is actually the top of a Morning-glory Standpipe, located at the end of a short Causeway. The exit is into a confined concrete Outlet Structure;
3. Open circular Morning-glory culvert pipe entrance;
4. Open Discharge pipe into confined Concrete Outlet Structure;
5. Culvert Discharge Pipe has 90-degree Elbow;
6. Easy access to location. The inlet can be reached by crane from shore. The exit requires a temporary access road. The horizontal liner was welded on the street and positioned for insertion with cable rigging.
7. Ancillary Attachments were required to be fabricated and installed.

Solution Elements:

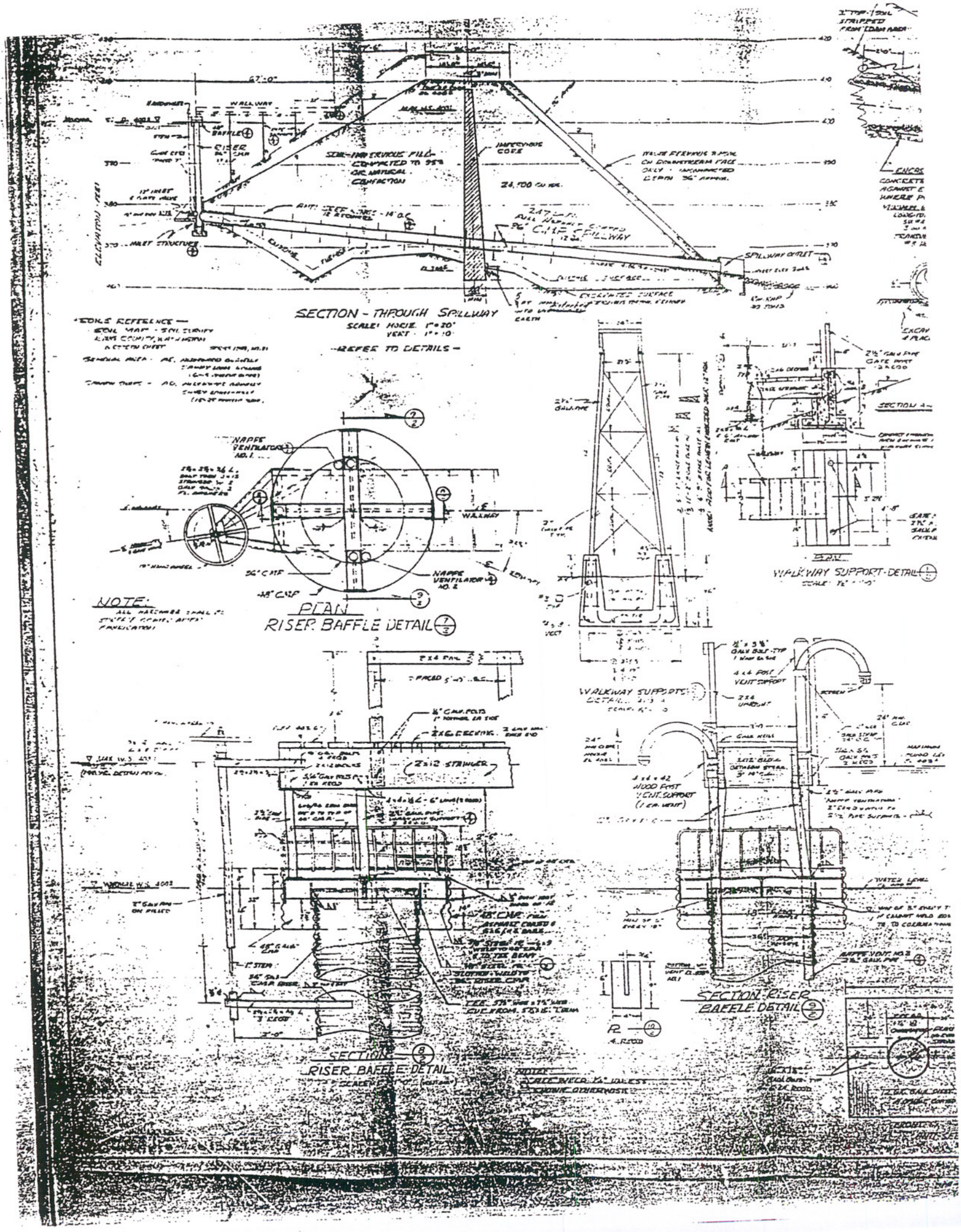
1. Liner used was 32", SDR 17 HDPE Pipe, 250' long in the horizontal and 20-plus feet high for the standpipe;
2. Horizontal Liner inserted, Backhoe Hiked, into host pipe from downstream end after installing an access road and modifying the concrete Outlet Structure;
3. Vertical Standpipe Liner inserted thru top with crane;
4. The 90-Degree Elbow was made by field cutting a notch into vertical section and form-cutting a matching point on the upstream end of the horizontal section;
5. A 12-inch side connection adaptor was fabricated (using Galvanized Steel) and installed to allow the existing 12-inch Gate Valve to remain connected to the repaired culvert system;
6. A new elbow air-vent pipe was fabricated and installed within the repaired culvert system;
7. A new Inlet screen was fabricated and installed on the repaired culvert system;

Tuck Lake Dam





Liner Repair Section A-A


SECTION - THROUGH SPILLWAY
SCALE: HORIZ. 1" = 20'
VERT. 1" = 10'
-REFER TO DETAILS-
SOILS REFERENCE
WALKWAY
RISER
IMPERVIOUS CORE
INLET STRUCTURE
SPILLWAY OUTLET
EXCAVATED SURFACE
ELEVATION FEET
NAPPE VENTILATOR NO. 1
NAPPE VENTILATOR NO. 2
WALKWAY
NOTE:
PLAN
RISER BAFFLE DETAIL
WALKWAY SUPPORT DETAIL
WALKWAY SUPPORTS
2x12 STRINGER
SECTION
RISER BAFFLE DETAIL
SECTION RISER BAFFLE DETAIL
4 x 4 POST VENT SUPPORT
4 x 4 x 42 WOOD POST VENT SUPPORT (1 EA. VENT)
NOTE:
ALL WELD 1/4" UNLESS SHOWN OTHERWISE

MATERIAL AND SUPPLIER REFERENCES

(3-Pages of Illustration)

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Prime Resins, Inc 800 321-7212

Soil Stabilization

Former Gelco Grouting (Salem OR)

Soil Stabilization

Prime Resins has been stabilizing soil for over 20 years with our Prime Flex polyurethane foams and gels. The techniques used are dependent on what you are trying to accomplish and what type of equipment you have available. There are basically two methods for stabilizing soil – Permeation Grouting and Compaction Grouting.

Permeation Grouting

Permeation grouting is a method where liquid resin is injected into the ground so that the resin permeates the soil before reacting. Once reacted, the soil and resin form a strong, solid, impermeable mass in the ground that increases the load bearing capacity of the soil.

Prime Flex 910 is a rigid hydrophobic foam that can be used for this application. A low dose of catalyst is used slowing down the reaction which allows the material to permeate loosely compacted soil. The resin is normally injected through small diameter pipes or "probes" driven into the weak or unstable soil to a specific depth. A small single component electric pump such as our Impact 540 is ideal for pumping the resin into the probes. The probes are raised at specific intervals as the resin is injected to form columns of stabilized soil.

Hydro Gel SX is a polyurethane gel that can be mixed with up to 15 parts water and injected using our M2 air operated pump. Hydro Gel SX forms a flexible gel that bonds sand and soil together to form an impermeable mass. Due to the high water to resin ratio Hydro Gel SX is very economical and can be used as a grout curtain for containment of hazardous below grade contaminates or for cutting off ground water movement.

Compaction Grouting

Compaction grouting is a method where fast setting polyurethane foam is injected into loose soil. The foam expands rapidly forming balls or columns of dense structural foam. The expansion compacts the surrounding soils and increases the load bearing capacity.

Our Precision Lift foams can be injected into soil using specialized equipment that heats the resin and speeds up the reaction. The expansive forces of the foam combined with the injection pressure from the pump compact the soil and fill voids in the area immediately adjacent to the foam.

Prime Flex 920 with a full dose of catalyst can also be used to compact soil. In this case the reaction time is accelerated so that loose soil adjacent to the probe are forced outward as the resin expands.