Cured in Place Pipe (CIPP) liners-- – A Montana Dam Safety Program Perspective. (High hazard dams)

- Our experience as reviewers (not designers).
- Our observations from a few installations.
- Considerations & Requirements when considering CIPP.
- Disclaimer: We are not promoting CIPP as the best alternative for every circumstance.

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Consider

1. CIPP is a great option for lining pipes. Or repairing pipes which are too small for human entry. 6" drains to 63" outlet conduits are typical. CIPP is fast. --Larger diameter pipes can be more challenging, and certainly more expensive. Other alternatives may be better if a person can enter the pipe to make repairs.
2. Access and reservoir operation during construction is challenging.
3. Requirement! A filter diaphragm must be included with CIPP.
4. Requirement! CIPP requires DNRC approval according to our Design Review Process. (We recommend early coordination with your engineer and CIPP contractor, and DNRC.)

1. CIPP IS FAST

- CIPP is a good option when the cost to excavate and replace the conduit is too expensive and/or will take too long.
- CIPP is usually more expensive than other sliplining techniques, but speed may offer savings or at least partially balance the budget.
- Cold weather installation is possible.

  -Can be done in the off season. - No challenges associated with grout or flowable fill, as with traditional sliplining, nor the weather challenges with an excavation/ replacement project.

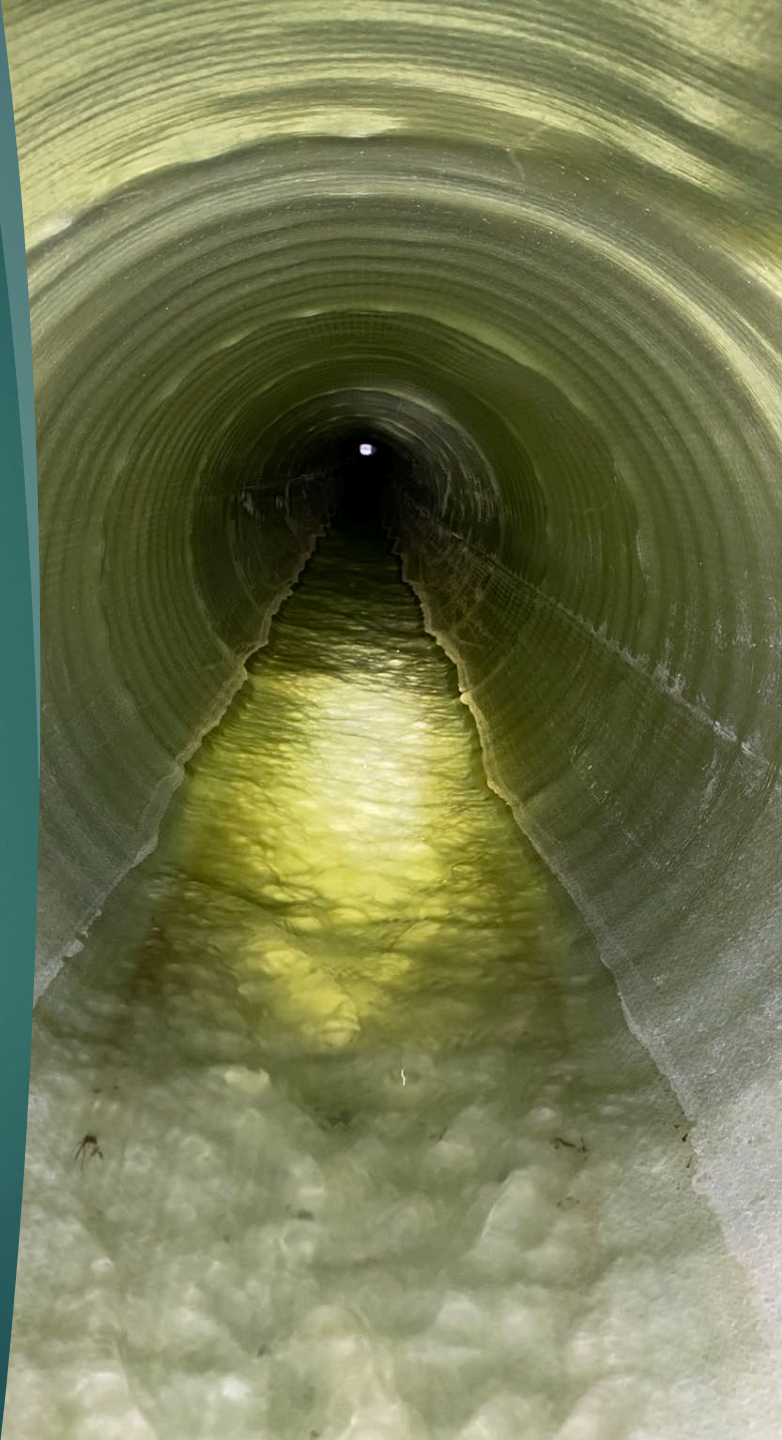
24" CIPP Lining
Upper Taylor Dam
Deer Lodge
County (2007)

1. CIPP IS FAST

- Traditional sliplining with a smaller solid pipe (HDPE, steel) leaves a smaller diameter conduit than CIPP, resulting in less flow capacity.
- Host-Pipe deformations may be obstacles to grouting the annular space around the new liner pipe.
- Minor host-pipe deformations are not a problem with CIPP.

1. CIPP IS FAST

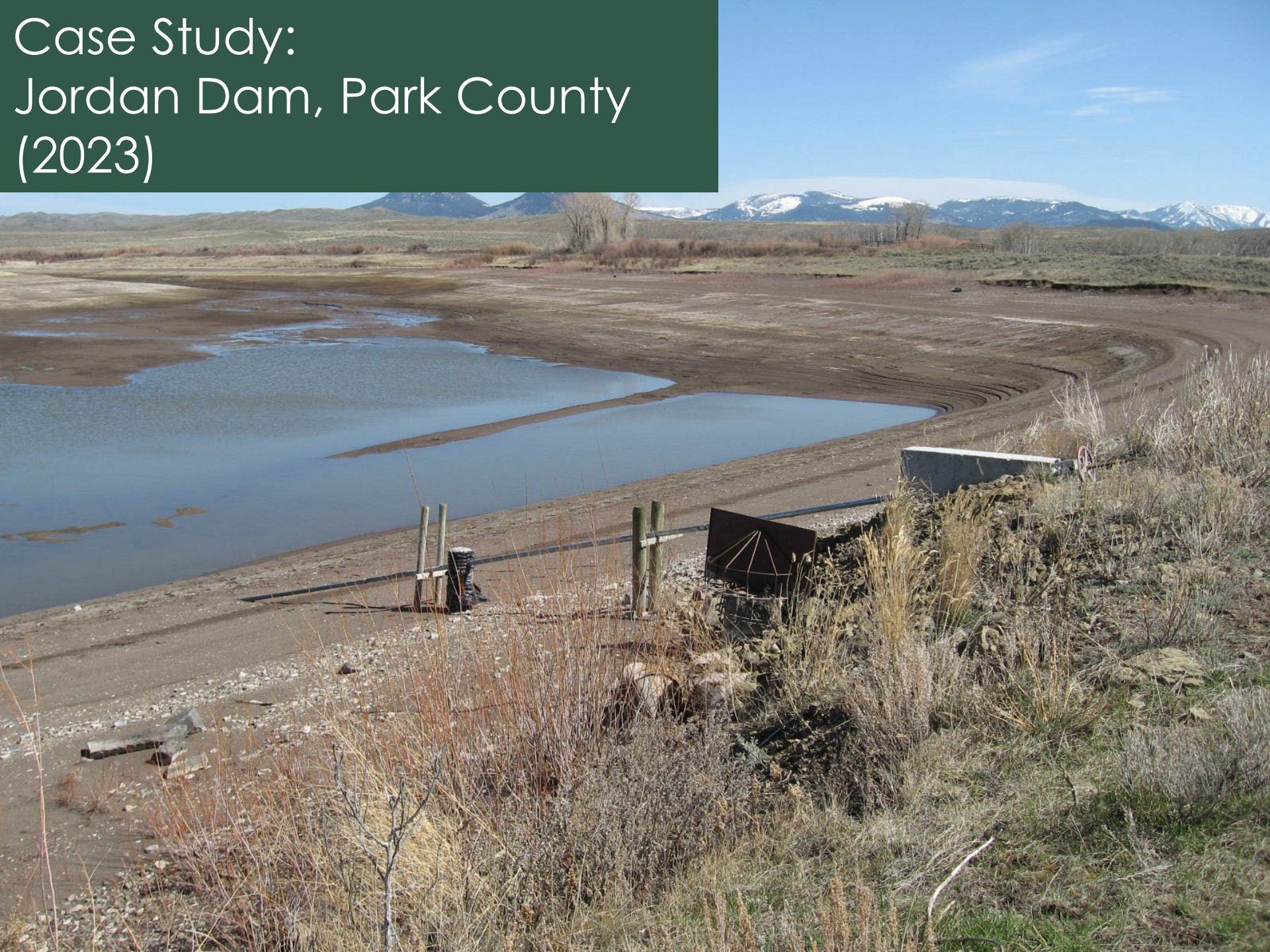
- CIPP avoids deformation or perforation problems because it molds to the shape of the host pipe.
- CIPP reinforces the host pipe and can even be designed to restore the structural strength entirely.



Jordan Dam
Park County
(2023)

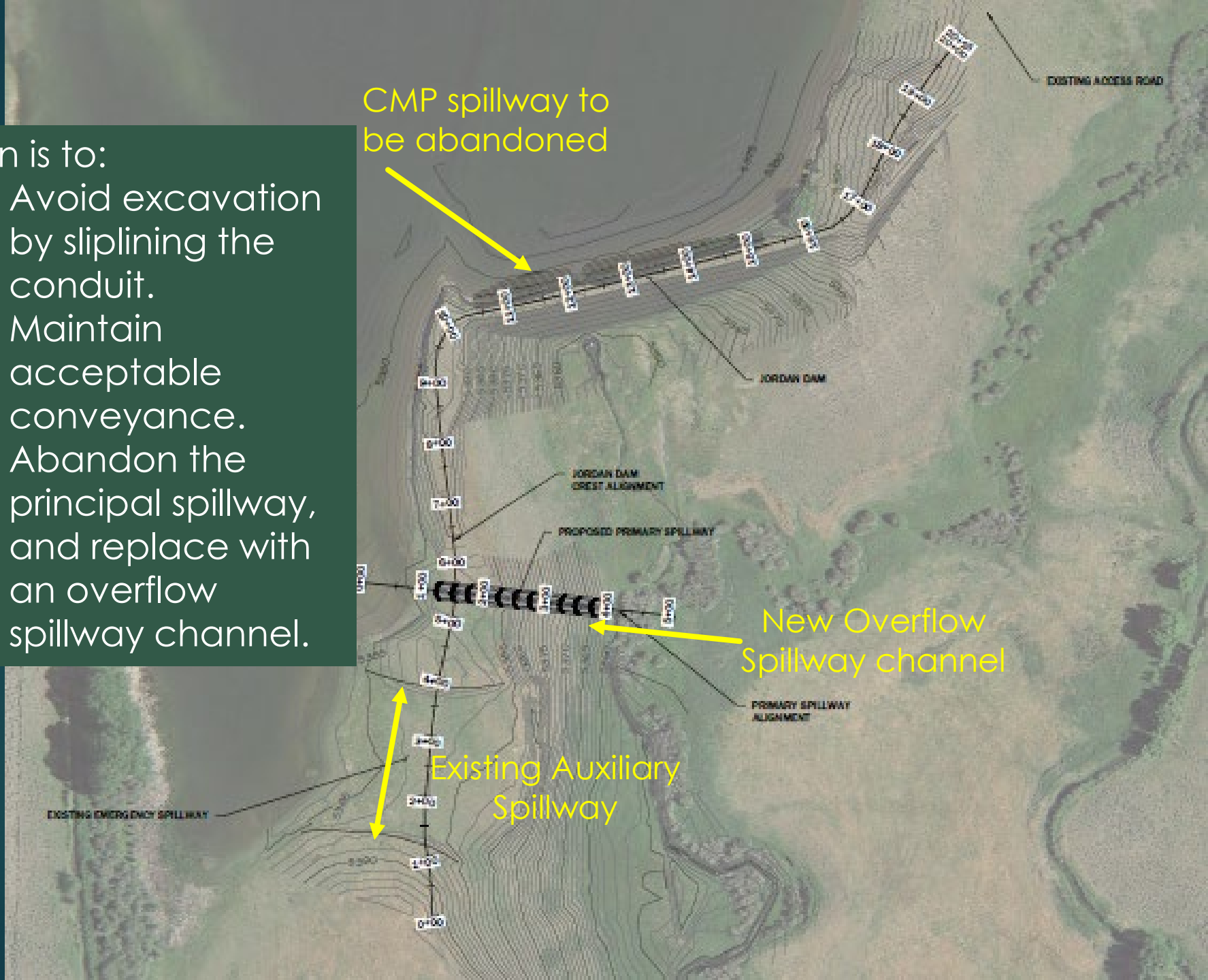
Case Study:
Jordan Dam, Park County (2023)

Case Study: Jordan Dam, Park County (2023)



Plan is to:

1. Avoid excavation by sliplining the conduit.
2. Maintain acceptable conveyance.
3. Abandon the principal spillway, and replace with an overflow spillway channel.



Inserting the liner.

Curing the liner.

Jordan Dam
Park County
(2023)

Crossing the drop-inlet, principal spillway.

Jordan Dam
Park County
(2023)

A tough sleeve is wrapped around the liner, to protect it from edges in the CMP.

The sleeve prevents bulging of the liner during inflation.

Abandon the riser by filling it with suitable material.


GO CONTROL

Upstream gate and inlet structure.

Case Study using CIPP in small conduit: 12” riveted steel, encased in concrete.

CIPP for Spot Repairs?

Ackley Lake Dam, 2008
(Judith Basin County)

Larger diameter pipes take more effort and may be challenging.

-----48" diameter pipe, using hot water cure

----- 290-ft pipe

-----2 sections, upstream/downstream, each inserted through the gate tower.

Hot water is circulated through the liner to stimulate curing. But, here the liner is football-shaped and not forming to the host pipe.

Ackley Lake Dam, 2008
(Judith Basin County)

A case for not using CIPP in large pipe:

-Flood Control Dam, Town of Baker (Fallon county, 2018)

-Every joint in the concrete pipe needed patching.

-CIPP may have been a reasonable choice.

-Joint filler and HYDROTITE bands were selected.

2. ACCESS AND RESERVOIR CONTROL:

Lower the reservoir to access the upstream side.

Dewater the construction site with pumps and/or a cofferdam.

Pre-construct a firm level work surface at the upstream end of the dam.

-Pumps for dewatering

Jordan Dam
Park County
(2023)

2. ACCESS AND RESERVOIR CONTROL:

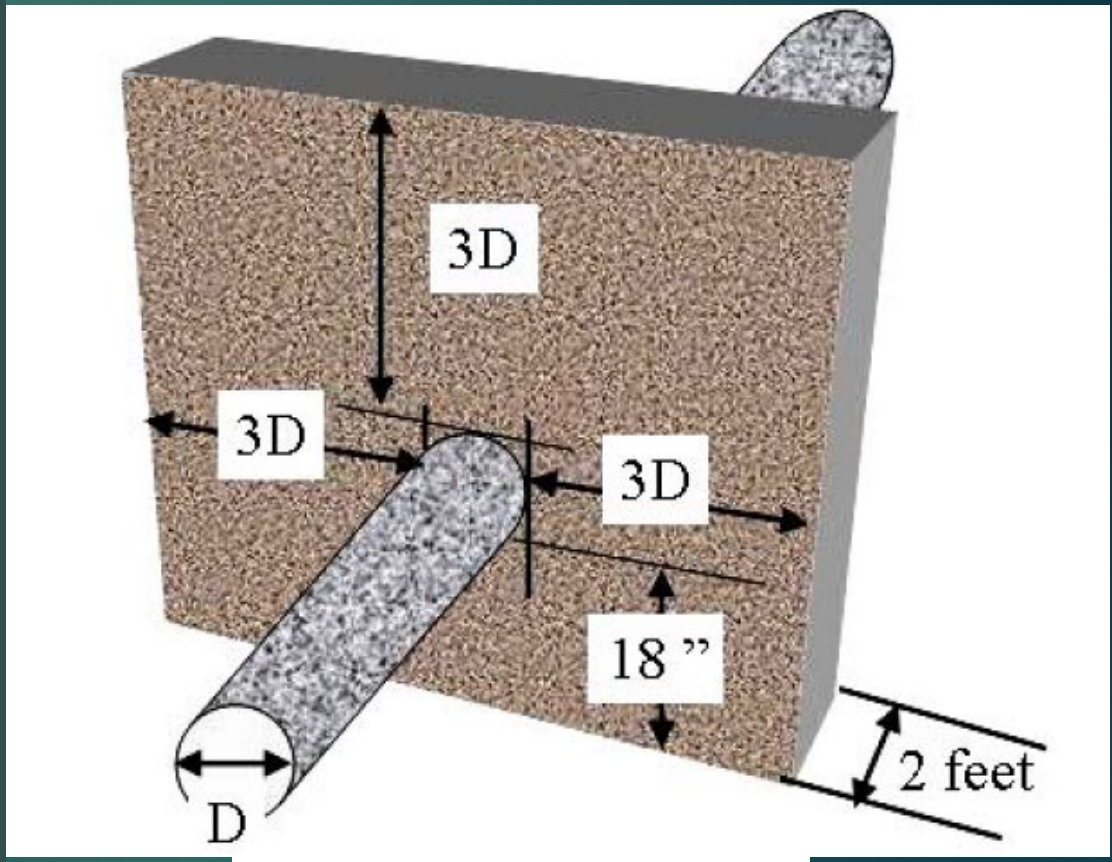
Need good access, upstream or downstream (usually both).

3. – A Filter Diaphragm is required.

Definition: A filter diaphragm is a designed zone of filter material, consisting of well-graded clean sand, constructed around the conduit.

Purpose: To prevent seepage water from carrying soil particles (fine embankment material) along the pipe. When the flow reaches the filter, the soil particles become lodged in the sand, thereby preventing internal erosion.

------The theory behind filter diaphragms is based on extensive testing performed in the NRCS' Lincoln, Nebraska laboratory. Tests demonstrated that even highly erosive clay soils would not erode further when protected by a properly designed filter layer of sand.



Filter Diaphragm Dimensions

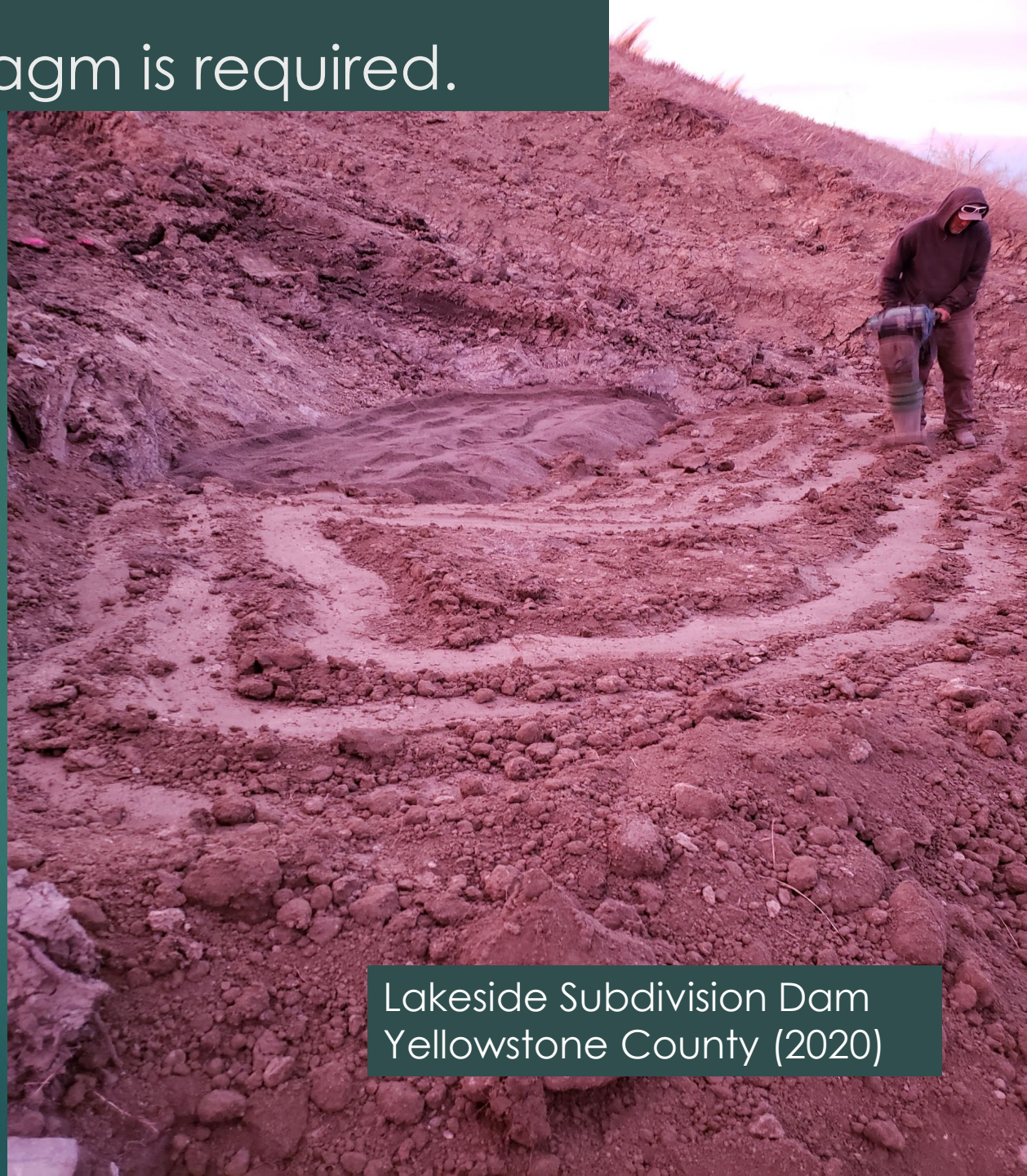
3. Filter diaphragms are required for most sliplining, including CIPP.
   - Sliplining a leaky pipe can be otherwise problematic because water may be forced through the embankment instead of where it used to pass through the pipe.

   (See the ASDSO website for this case study.)

This project did not include a Filter Diaphragm. The original CMP was perforated due to corrosion. The peforations caused the pipe to act as a drain, moving water from the embankment into the pipe, and probably some embankment material too. When the CMP was sliplined, water was forced to find another place to go. --The voids outside of the pipe provided the least resistance.

3. – A filter diaphragm is required.

- ASTM C33 sand is generally acceptable
- A filter diaphragm can be located at the downstream end of the pipe to avoid excessive excavation into embankment.
- Drainpipes are NOT required.



Lakeside Subdivision Dam
Yellowstone County (2020)

3. – A filter diaphragm is required.

Ackley Lake Dam (2008)

3. – A diaphragm filter is required.

Deadman's Basin (2009)

3. – A filter diaphragm is required.

- Is there suitable material on-site ?
- Do you need to import sand ?

4. Plan your Design Review and Construction Scheduling Carefully when considering CIPP as an alternative.

Brief Recap of Design Review Process

Alternatives/Feasibility Evaluation (10% Design)

Preliminary Design(30% Design)

Draft Design(60% Design)

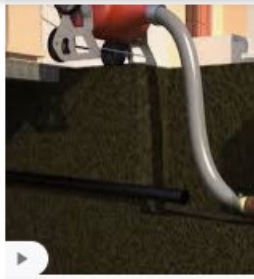
Final Design(90% Design)

Final Design and Construction Permit (100% Design)

- CIPP is in high demand. Most CIPP installers/ manufactures are booked solid, lining sewers and culverts .
- Scheduling a CIPP specialist for a dam may take a year or more.
- However, they might fit you in sooner than expected.

FAQ - Trenchless Epoxy Pipe Lining ...
trenchless-pipelining.com

Cured-in-place Pipe - Water Pipe Lining
manualrecords.blogspot.com



TrenchFree (Trenchless) - C
youtube.com

ace-Pipe Lining

CIPP Lining - Pace Municipal Maintena...
pacemt.com

Horizontal Directional Drilling ...
steverayplumbing.com

aise...

Related searches

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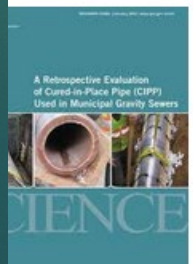
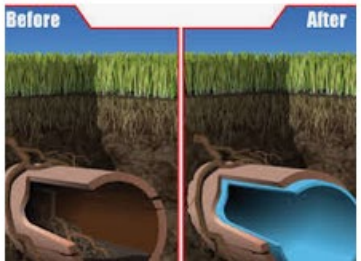
Asia Cured-In-Place Pipe (CIPP) Market ...
kenresearch.com

New York Tren
trenchlesstoda



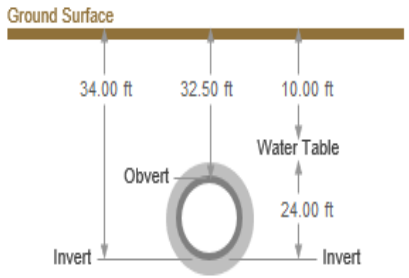


Calculations:

- Manufacturer-supplied spreadsheet calculators.
- Calculates needed strength, i.e. liner thickness.
- Recall from soil mechanics; Stresses on pipe from dams are greater than stress applied in sewer trenches.
- Double check/ justify data entries!!

PROJECT INFORMATION Design Date: Oct 30, 2024

MADCS 2024, Presentation



Existing Pipe: 18 in ID; Ovality: 2%
Fully Deteriorated Design
Required Liner Structural Thickness 6.6 mm

THE ASTM F2019-20 X1.1.2 DESIGN METHOD IS A MODIFICATION OF THE ASTM F1216 X1 METHOD AS FOLLOWS.

F1216 X1 equations X1.2, X1.4 and Note 2 are not applied. F2019-20 X1.1.2 adds 4 requirements not in the F1216, which are:
***1)** Minimum structural thickness of 3.0 mm. **2**) Ovality limited to 10% maximum for both partially and fully deteriorated design.*
***3)** For partially deteriorated design, a virtual minimum groundwater head of 60 inches over invert or 4 inches over obvert, whichever yields more water head, up to but not exceeding height of cover. **4)** Fully deteriorated design Eq X1.3 to use water head at invert.*
Note: Flexural strength is not a design input for F2019-20 X1.1.2. However sample test result is required (F2019-20, 7.1.2.1).
Other: CIPP-DESIGN-UVC makes certain assumptions related to F2019-20 X1.1.2. See discussion (A & B) on Calculation Details page 1.

	EXISTING PIPE PARAMETERS	ENTERED
Select>	Existing Pipe Condition	Fully Det.
Enter>	Inside Diameter, D	18 in
Enter>	Depth to Invert	34 ft
Enter>	Water Table below Surface	10 ft
Enter>	Ovality of Existing Pipe, Δ	2.0%
Enter>	Soil Density, w	130 lb/ft3
Enter>	Soil Modulus, E's	1,000 psi
Select>	Live Load, Ws	HS-20
Enter>	Other Load	0 psi
	UVC CIPP LINER PARAMETERS	ENTERED
Enter>	Design Life	75 Years
Enter>	Flexural Modulus Short-term Test, Es	1,950,000 psi
Enter>	For 75 Year Long-term Load Use	65% of Es
Enter>	Flexural Strength Short-term Test, σs	25,000 psi
Enter>	For 75 Year Long-term Load Use	65% of σs
Enter>	Enhancement Factor, K	7
Enter>	Poisson's Ratio, v	0.3
Enter>	Safety Factor, N	2

KEY FACTORS: FULLY DETERIORATED CONDITION DESIGN		
Flexural Modulus, E, 75 Year Design	1,267,500 psi	65% of Es
(E corresponds with E_L in F1216 Appendix X1)		
Minimum Diameter for Existing Pipe	17.64 in	For 2% ovality
Maximum Diameter for Existing Pipe	18.36 in	For 2% ovality
Ovality Reduction Factor, C	0.836	For 2% ovality
Water Buoyancy Factor, Rw	0.772	
Coeffecient of Elastic Support, B'	0.6739	
Water Pressure, Invert -	10.39 psi	24.00 ft Head
Total Design Pressure at Invert	**10.39 psi**	**For X1.1**
1. Water Pressure, Invert -	10.39 psi	24.00 ft Head
2. Soil Pressure, Obvert	22.65 psi	32.50 ft Cover
3. Live Load Pressure Ws, Obvert	0.00 psi	Note 1
4. Other Load Pressure, Obvert	0.00 psi	
Total Design Pressure (1+2+3+4)	**33.04 psi**	**For X1.3**

NOTES:
Note 1: AASHTO HS-20. Refer AWWA M11/M23/M55.
-
-
-

Select> F1216-16
Click above (cell A47) for explanation.

FULLY DETERIORATED DESIGN REQUIRES UVC CIPP THICKNESS SATISFY F1216-X1 EQUATIONS X1.1 & X1.3 AND A MINIMUM

Design Equation or Requirement		Required t mm	Required t in	Required DR
Minimum Structural Thickness Per requirement in ASTM F2019-20 X1		3.0 mm	0.118 in	152.4
X1.1: P = [2KE/(1-v^2)] x [1/(DR-1)^3] x [C/N] For load at invert due to groundwater hydrostatic pressure		4.9 mm	0.194 in	92.8
X1.3: qt=[1/N] x [32 x Rw x B' x E's x C x (E x I/D^3)]^(1/2) For load due to groundwater, soil & live loads	X1.3 per F1216-16	6.6 mm	0.259 in	69.5
Required in Place Liner Structural Thickness - Fully Deteriorated		**6.6 mm**	**0.259 in**	**69.5**

CIPP-DESIGN-UVC | USER GUIDE

ASTM F1216 - Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube

ASTM F1743 - Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)

ASTM D790 - Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM D2990 - Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

ASTM F2019 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Resin Pipe (CIPP)

ASTM D543 - Test Method for Resistance of Plastics to Chemical Reagents

ASTM D578 - Standard Specification Glass Fiber Strands

ASTM D638 - Standard Test Method for Tensile Properties of Plastics

Remember:

- Get early approval from the DNRC to to use CIPP.
- Consider reservoir operation, evacuation, dewatering.

- Communicate with your CIPP supplier – check availability and willingness to commit to the project, pending DNRC approval.

QUESTIONS ??

Cured in Place Pipe (CIPP) –

Montana Dam Safety Program Experience and Lessons

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