What to Do With All This Corroding CMP Storm Drain Pipe?

Presented at UCT, Ft. Worth, TX – January 29, 2019

The Environmental Protection Specialists

National Plant Services, Inc., a Carylon Company

Michelle Beason, PE

Western Regional Manager

CMP – Corrugated Metal Pipe

- CMP has been the Go-To Material for storm drain piping due to its lower cost, it's relatively light-weight, and because it can be made in large diameters.
- Riveted or Spiral (Helical) Construction
- Various Materials:
  - Galvanized – Hot rolled steel and coated in zinc; 50 year life
  - Aluminized Type 2 – Hot rolled steel coated in aluminum; 75 year life
  - Polymer – Galvanized steel with a 10 mil polymeric film laminated to both sides; 100 year life.

But constant water flow and corrosive soils can age CMP before the end of its design life:

CMP Modes of Failure:

1. The invert is usually the first to go.

2. Then failure; either:
   - The top of the pipe buckles downward
   - The invert collapses in on itself causing the pipe sections to shrink, and a path for soil entry.
3. Then a sinkhole can develop

IT'S BEST TO REHABILITATE THE PIPE BEFORE WE GET TO THESE CONDITIONS!

Rehabilitation Options

- Sliplining
  - HDPE
  - Smooth Steel Liners
  - Spiral wound/PVC
- CIPP Lining
- Centrifugally Cast Concrete Pipe (CCCP)/Spray-On Lining
- Trench and Replace

Centrifugally Cast Concrete Pipe (CCCP)

- No insertion pits – install between manholes
- Small equipment footprint
- Can adhere and conform to any pipe shape or material
- Can handle variations in pipe diameter
- Improves the flow profile of the culvert
- It's a fully structural fix with a strength of over 8,000 psi

CCCP Advantages:

- Exceptional bonds to Host Surfaces
- Early high Strength System
  - initial set 150 minutes
  - final set 240 minutes
  - compressive strength 3,000 Psi (24 hours)
  - compressive strength 8,000 Psi (28 days)
- Extremely Dense seamless Liner
  - water tight
  - no joints
- Resistance to
  - abrasion and corrosion
  - freeze/thaw cycling
  - chloride penetration
- Manning's *n value*
  - 0.014 – 0.018

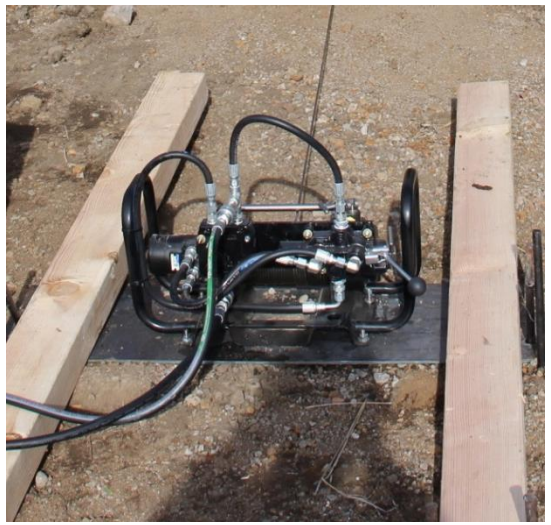
High Strength – High Density – Watertight Mortars

Installation Equipment

CentriPipe – Bi-Directional Spincaster

Mortar Mixer – Pump Assembly

CentriPipe – Retrieval Sled

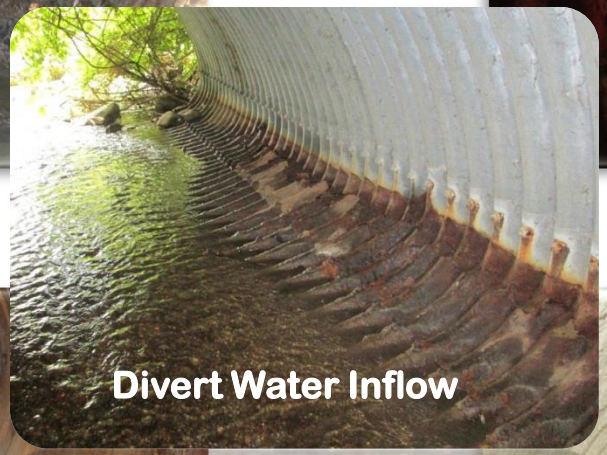


Hydraulic Cable Winch

Support Equipment
(375 CFM Compressor not Shown)

Conforms to Host Shapes
Minimizing area Reduction

Estimating a Project



Ball Park Costs = $ 5.00 to $ 10.00 Inch Diameter/Foot

CASE STUDIES

Project #1: Rockland NY Interceptor, 36”, 750 feet long

- Portions of the crown were completely gone.
- Steel bands were put over the voids and secured with masonry anchors.
- Structural grout injected behind steel.
- Finished result was a new concrete pipe.

Project #2: San Mateo County Storm Culvert Repair October 2017

- Twin 60-inch CMP
- Culverts were degrading, with holes in the invert surface from rust.
- PL-8000 was used to line both culverts.


CAUTION
CUIDADO

Project #3 – Pua Nani Storm Drain Rehab
Lihue, Kauai. 800 LF OF 84” CMP
Completed September 2018

JANUARY 18, 2018

MARCH 11, 2018

Soil borings were performed to verify the Dry Soil Density

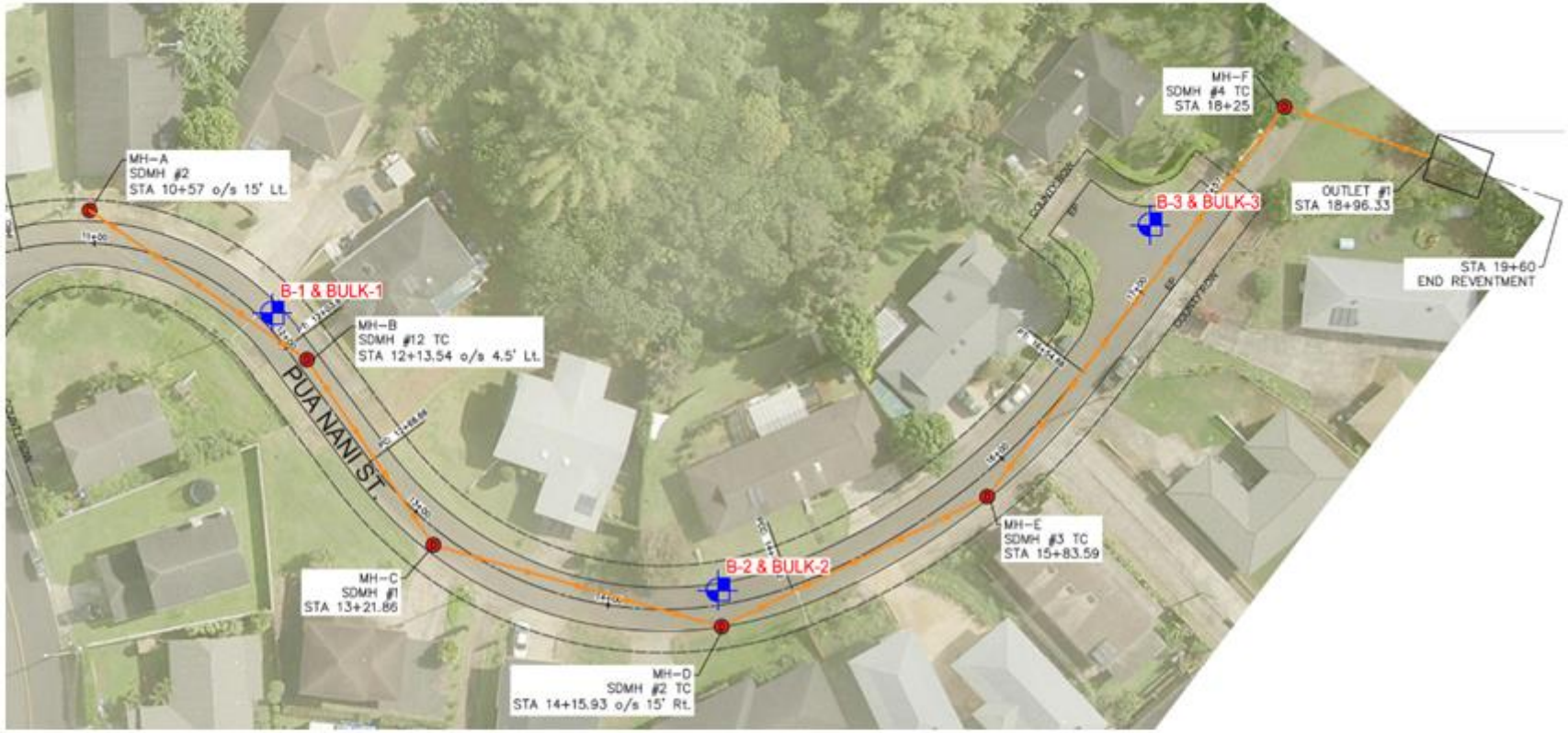


Figure 3. Boring Locations

Location	Dry Density	Optimum Moisture Content	Description
B-1	78-89.0 pcf	30%	Brown Clayey Silt with a little sand and gravel
B-2	79-86.0 pcf	28%	Brown Gravelly Silt with a little sand
B-3	89-99.0 pcf	26%	Reddish Brown with gray Gravelly Silt with some sand

Table 1. AASHTO T-99 Test Results

Once we gathered our design parameters, it was time to design our lining thickness

Design thickness ranged from ¾” in the 72-inch section, to 1.5” in the most compromised section of 84-inch pipe

CentriPipe Design Calculator — WALL THICKNESS DESIGN SUMMARY

				PIPE #1	PIPE #2	PIPE #3
1	***General Info***					
1.01	Project Name			Kauai 84-inch	Kaui 72-inch	Kauai 84-inch
1.02	Project Location			Puanani St, Lihue,	Puanani St, Lihue,	Puanani St, Lihue,
1.03	Calculations Made by			KRW	KRW	KRW
1.04	Calculations Reviewed by					
1.05	Date			01/03/18	01/03/18	01/26/18
2	***Existing Pipe***					
2.01	Pipe Shape			Deflected	Deflected	Elliptical
2.02	Pipe Material			CMP 3x1	CMP 3x1	EH CMSP
2.03	Pipe Size			84	72	88x66
2.04	Ovality		(%)	5.0	4.0	0.0
2.05	Pipe Condition			Shape Distorted	Shape Distorted	Shape Distorted
3	***Site Conditions***					
3.01	Pavement Type			Flexible	Flexible	Flexible
3.02	Pavement Thickness,	h	(in)	10	10	10
3.03	Pipe Cover Depth,	H	(ft)	20	20	20
3.04	Depth to Phreatic Surface,	z_p	(ft)	27	27	27
3.05	Embedment Soil Type			Granular	Granular	Granular
3.06	Embedment Soil			Silty Gravel	Silty Gravel	Gravel
3.07	Soil Unit Weight,	γ_s	(pcf)	120	120	130
4	***Loading Conditions***					
4.01	Live Load Type			None	None	None
4.02	Live Load Rating			N/A	N/A	N/A
4.03	Angle, Pipe & Traffic Direction,	ϕ	(deg)	N/A	N/A	N/A
4.04	Any Future Dead Load,	$\Delta\sigma_s$	(psi)	0	0	0
4.05	Total Live Load,	σ_{LL}	(psi)	0.000	0.000	0.000
4.06	Total Dead Load,	σ_{DL}	(psi)	3.603	2.913	2.984
4.07	Total Vertical Load,	σ_V	(psi)	3.603	2.913	2.984
5	***Wall Thickness Calculations***					
5.01	***Liner Thickness,***	t_L	**(in)**	**1.00**	**0.75**	**1.50**
5.02	Load Behavior Response Mode			Compression	Compression	Compression
5.03	(Inward) Radial Deflection at Pipe Crown,	$\omega(0)$	(in)	0.00309	0.00232	0.00212
5.04	Max Compressive Stress at Pipe Crown,	σ_c	(psi)	-192.42	-171.74	-126.51
5.05	Max Flexural Stress at Pipe Crown,	σ_b	(psi)	0.00	0.00	0.00
5.06	*Controlling Factor of Safety*					
5.07	In Compression	FS_C		41.58	46.58	63.24
5.08	In Bending	FS_B		NA	NA	NA
5.09	***Estimated Mortar Quantity,***	***N (sacks/lf)***		**6.9**	**4.9**	**10.6**
6	***CentriPipe FACC Systems - Physical Properties***					
6.01	Modulus of Elasticity, 28 d, ASTM C469	E	(psi)	5,260,000		
6.02	Compressive Strength, 28 d, ASTM C109	F_C	(psi)	8,000		
6.03	Flex. Tensile Strength, 28 d, ASTM C293	F_T	(psi)	1,500		

96 PALLETS DELIVERED IN 8 CONTAINERS VIA SHIP (5,376 bags!)

CLEAN CULVERT AND STABILIZE WORST SECTIONS

COMPLETE REINFORCEMENT IN INVERT

POUR NEW CONCRETE INVERT;
ONCE WE DID, WE FOUND VOIDS BEHIND PIPE THAT HAD TO BE STABILIZED BEFORE SPINCAST.

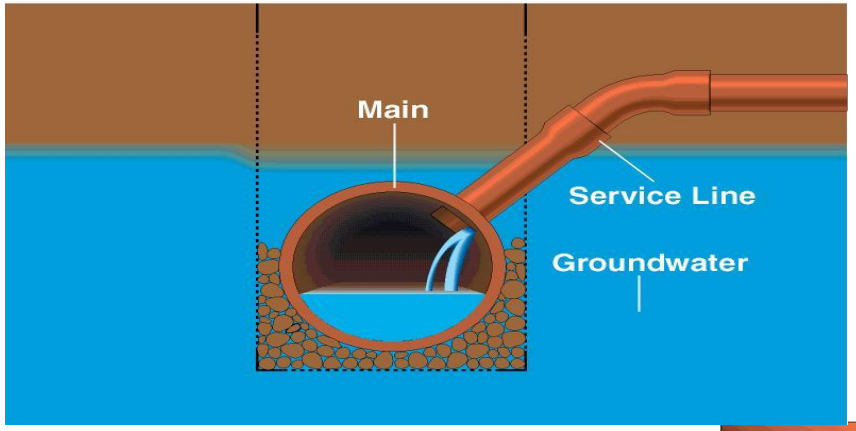
TWO TYPES OF GROUTS WERE REQUIRED FOR THIS PROJECT:

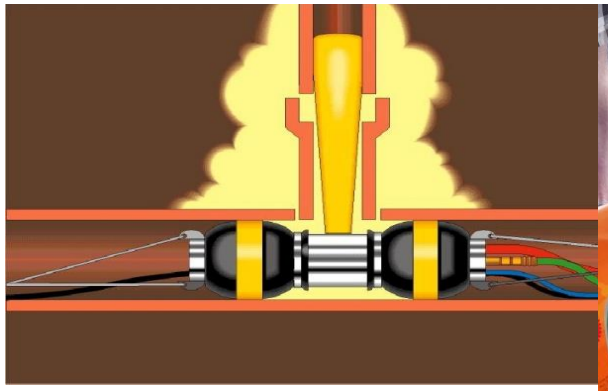
Avanti AV-100 Acrylamide Grout

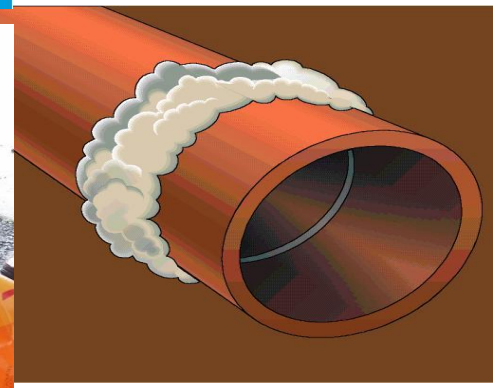
Avanti AV-275 Foam Grout

GROUT FIRST TO STOP LEAKS

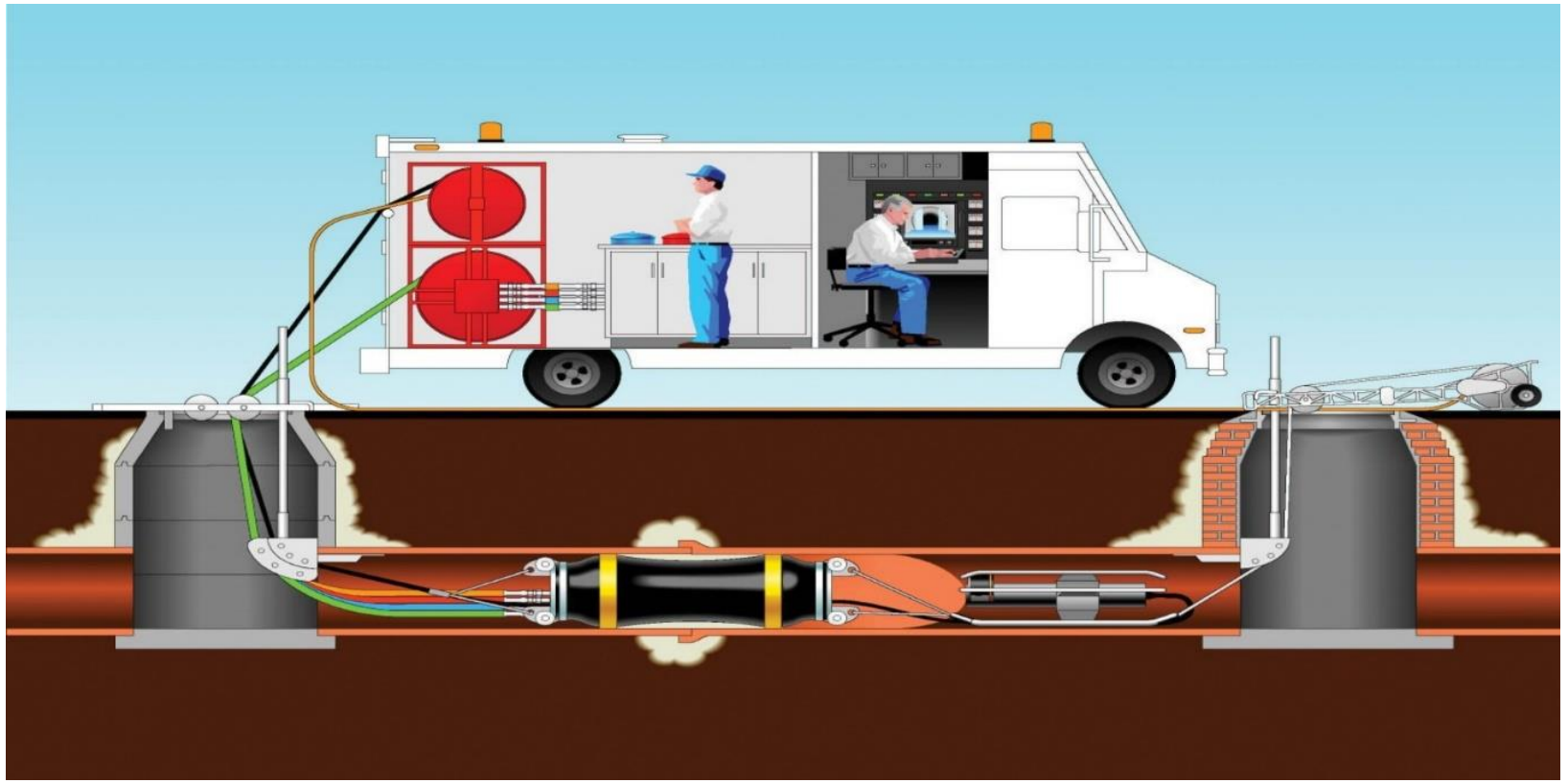
Injection Grouting







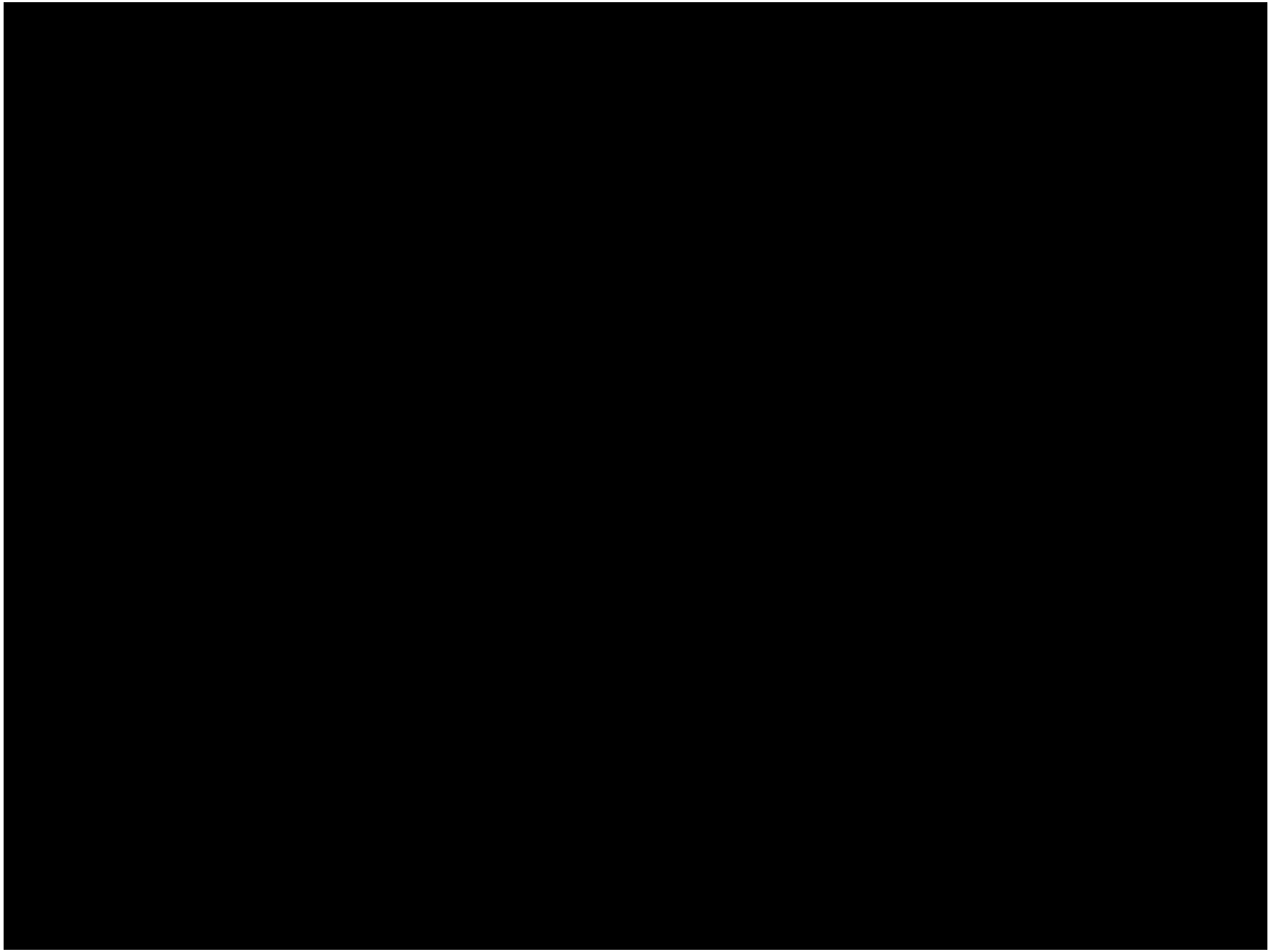
TESTING AND SEALING TO STOP INFILTRATION



Testing and grouting of pipe joints

MANUAL GROUTING

VIDEO OF THE SPINCAST PROCESS



Mortar can also be hand sprayed

Self-Healing Concrete from Crystal X additive

Cementitious Coatings – Keys to Success

- Know the groundwater conditions, and assume the worst!
- Make sure bedding around the pipe is sound, or add a contingency for stabilizing it.
- Ensure all cleaning, prep-work, and grouting is done prior to coating.
- Ensure bypass is in place and in good working order.
- Set guide wires or screws to ensure design thickness is reached.
- Set up a containment system to ensure silica dust is captured and doesn't migrate to the public.
- Use a sealing/curing compound after the last coat to provide a slower cure with slower water loss to reduce cracking.
- Make C109 cube samples per the standard requirements and perform 24 hr, 7 day, and 28 day break tests to ensure material meets specifications.

THANK YOU !

Questions

MICHELLE BEASON, PE

NATIONAL PLANT SERVICES, INC.

A Carylon Company

925-262-7366

MBEASON@NATIONALPLANT.COM