COLORADO
Division of Water Resources
Department of Natural Resources

Dam Safety

Mr. Scott Hoffner
Crosby Creek Ranch
1365 Steamboat Blvd
Steamboat Springs, CO 80487
via email: scotthoffner@mac.com

When replying, please refer to:
STAMBAUGH DAM, DAMID 470220
Water Division 6, Water District 47
Construction File No. C-2082

January 22, 2018

SUBJECT: Acceptance of Construction

Dear Mr. Hoffner,

Acceptable as-constructed documentation for the above referenced project was received by our office on January 11, 2018. The project included replacing the outlet gate and lining the conduit with a cast-in-place-pipe (CIPP). Construction was completed in the fall of 2017 without plans and specifications approved by our office, despite communication of this requirement to you. We do not appreciate this apparent lack of regard for our statutory role in dam safety, as it puts our office and your engineer in the unfortunate position of having to assess the adequacy of a project without a proper design nor the opportunity to observe the quality of construction.

Stambaugh Dam is classified as a small, low hazard dam with an inundation area generally consisting of hay meadows south and east of the Crosby Creek Ranch buildings. The risk to public safety associated with the dam is low. It is for this reason we are accepting the construction, with the following comments.

1. It is standard practice for a conduit to be cleaned prior to lining, which this conduit was not. This may lead to the development of voids between the CIPP liner and the host pipe, causing seepage along this interface. Care should be taken to observe for this in the future.

2. No collar or transition was included at the upstream end of the CIPP, where it is essentially cut flush with the existing conduit at the gate. This blunt end could lead to the liner peeling away from the host pipe, impacting the conduit entrance. Periodic observations should be made here to ensure the liner has remained in place.

3. Finally, there is no documentation of CIPP curing time. It is assumed curing time was adequate, but inadequate cure time could result in decreased strength of the in-place CIPP compared to design assumptions.

The completion of this project had no impact to the dam geometry or reservoir capacity. The dam has a jurisdictional height of 18 feet and a crest length of 20 feet. The reservoir created by the dam covers approximately 10 acres and has a normal storage capacity of 139 acre-feet.

The State Engineer, by providing this construction acceptance does not assume responsibility for any unsafe condition of the subject dam. The sole responsibility for the safety of this dam rests with the reservoir owner and operator, who should take every step necessary to prevent damages caused by leakage or overflow of waters from the reservoir or floods resulting from a failure of the dam. Therefore, it is in the owner's best interest to operate and maintain the facility in a manner such that the safety of the dam and the general public are not jeopardized. We are enclosing a copy of Rules 12 and 15 of the Rules and Regulations for your reference and use. These rules pertain to general maintenance items and the owner's responsibilities, respectively.

We anticipate working together with you more successfully in the future on dam engineering and dam safety issues, and look forward that opportunity. If you have any questions, please do not hesitate to contact me or Dana Miller in our Steamboat Springs Office at 970-879-0272, ext. 6414.

Sincerely,

William T. McCormick, III, P.E., P.G.
Chief, Colorado Dam Safety

Enc: Copies of Rule 12 and 15 of the "Rules and Regulations for Dam Safety and Dam Construction"

ec: Erin Light, Division Engineer
Caid Waldron, WD 47 Water Commissioner
Dana Miller, Dam Safety Engineer
Jeremy Franz, Design Review Engineer
Jonathan Hernandez, CWCB
Brian Len, blen@nwccusa.com

FINAL CONSTRUCTION REPORT - STAMBAUGH DAM

DAMID: 470220

Water Division 6 Water District 47

Jackson County, Colorado

Prepared for:

Division 6 Dam Safety Engineer

Dana S. Miller, P.E.

505 Anglers Drive, Suite 101

Steamboat Springs, CO 80487

NWCC Job Number: 16-10519

December 1, 2017

NorthWest Colorado Consultants, Inc.

Geotechnical / Environmental Engineering • Materials Testing

TABLE OF CONTENTS

CONSTRUCTION SUMMARY

This section of the Final Construction Report has been prepared to outline/summarize the construction sequence and operations that occurred during the construction of the repairs to the Stambaugh Dam completed from October 2015 to September 2017. The dam (DAMID: 470220) is located in Jackson County, Colorado. This section has been prepared in accordance with Rules 9 and 10 of the *Rules and Regulations for Dam Safety and Dam Construction, January 1, 2007*, and has been prepared based on our review of the available information, as well as our limited observations during construction of this project.

October 2015 – Headgate and Stem Replacement

During the first week of October 2015 and after the reservoir was drained, the dam owner (Scott Hoffner – Crosby Creek Ranch) removed the existing headgate, stem and wheel on the outlet. After removal, the new headgate, stem and wheel were installed and then the stem was backfilled with the on-site sand and gravels. Photographs taken by the owner during this period are provided in Appendix A.

September 2016 – Sand Filter Evaluation

During September 2016, the dam owner contacted NWCC and requested that our firm complete a sand filter design for the dam outlet pipe. We advised the owner that a sample of the soils situated near the outlet pipe on the downstream dam face would need to be collected and evaluated before we could complete the sand filter design. The owner stated that there was no way to access the lower portion of the dam with equipment due to site constraints. We then requested that the owner obtain a sample of the soils exposed along the downstream dam face and submit the sample to our laboratory for gradation (sieve size) analyses. A sample of the soils along the downstream face was obtained and submitted to our laboratory for gradation analyses. Based on the gradation analyses, which is shown in Appendix B, it appeared the soil sample delivered to our laboratory consisted of silty sandy gravels with cobbles. These soils also classified as a GM soil in accordance with the Unified Soil Classification System.

We also requested a copy of the latest dam inspection report from Dana Miller. Based on our review of the report prepared by Ms. Miller, dated July 30, 2015, it became apparent to NWCC that the existing dam consists of a concrete core dam with rock/gravel buttress fills. The rock/gravel buttress materials appeared consistent with the classification of the soil sample obtained and delivered to our laboratory by the owner.

Based on our discussions with Ms. Miller concerning the previously noted seepage areas below the outlet; the classification of fill materials along the downstream face of the dam; the presence of a concrete core within the dam; and the site access constraints, NWCC concluded that the construction of a sand filter collar around the outlet pipe, on the downstream half of the outlet

would not be effective at collecting the seepage since the buttress materials at the downstream side of the dam appear to be permeable gravels and not cohesive soils for which a sand filter collar is most beneficial. We received an email from Dana Miller on September 20, 2016 confirming our discussions and she concurred with NWCC that they (State) would be comfortable forgoing a sand filter collar at this point.

Brian Len visited the project site on June 28, 2017 to observe the existing conditions for the first time. At the time of this visit, the reservoir was full and the outlet was flowing. We observed the opening and closing of the headgate several times and it appeared that the new headgate and stem were operating adequately. Based on our observations, we confirmed that the fill materials placed along the downstream face of the dam consisted of granular soils consisting primarily of gravels, cobbles and small boulders. The seepage conditions at and below the outlet could not be observed nor confirmed based on the amount of flow associated with the outlet discharge. Based on our observations made at the site, NWCC confirmed that the construction of a sand filter would not be beneficial and extremely difficult to construct based on site constraints.

August/September 2017 – Outlet Lining

During our site visit in June 2017, we were advised by the owner that he was going to have the outlet pipe lined later this summer or fall. We advised the owner that we would work with his installer to come up with a suitable plan for lining the pipe; however, we strongly recommended that a video inspection of the pipe be completed to verify the size and condition of the existing outlet pipe.

The owner sent Mr. Len an email on September 11, 2017 that stated Layne Inliner (Layne) was going to be at the site the next morning to start the lining of the outlet pipe. Mr. Len was out of the state and did not have access to his emails until September 16; therefore, NWCC was not on-site to observe the lining. NWCC understands the liner installation was in fact completed on September 12, 2017. Outlined below is a summary of the work completed on that date. This summary is based on the videos obtained by Layne and the owner during the video inspections and liner installation, and our discussions with the owner. Photographs provided by the owner and produced from the videos showing the inspection and lining process are shown in Appendix A.

Video Inspection Prior to Lining: Based on our review of the videos, it appears the outlet was inspected with a video camera just prior the liner installation. The camera was inserted in the upstream end of the outlet pipe and the inspection was terminated at the downstream end of the outlet pipe. A video of this inspection was produced by Layne at the time of the inspection and a copy of the video is supplied with this report in a separate thumb drive. Based on NWCC's review of the video, it appears that the interior of the existing 12-inch diameter, CMP outlet pipe is in very good condition, considering it was installed approximately 66 years ago. In the post-installation summary report prepared by Layne and provided in Appendix C, they state "the condition of the host pipe appeared excellent". Based on our review of the video, we did observe

one joint in the pipe in which water was leaking into the pipe. This section of the pipe was located approximately 20 feet downstream of the upstream end of the outlet. The seam and surrounding pipe appeared stable with the water dripping from the joint. Sediment or a buildup of organic matter was observed at the base of the joint at approximately 4 to 6 o'clock. It appeared that the interior of the pipe had narrowed somewhat; however, from the video we were not able to determine if this was some type of growth or buildup on the pipe or was it a pipe failure. It should be noted that when the outlet was video inspected after the pipe was lined, this portion of the pipe appears round and there was no sign of a bump or irregularity in the section of the pipe. Apparently the restriction in the pipe was a buildup of organic material that was most likely removed/dislodged when the liner materials were initially pulled through the outlet.

Based on our review of the video, it appears that the interior of the existing outlet (host) pipe was in satisfactory condition and we did not observe any irregularities or out of round sections of pipe or failed joints that would deem the host pipe unsuitable for the CIPP process.

CIPP Installation: Layne proceeded to install the CIPP liner shortly after the initial video inspection was completed. The CIPP liner was inserted into the inlet of the outlet pipe and then pulled through and out the outlet end of the outlet pipe using a rope and winch. Photographs copied from the video taken during this portion of the installation are provided in Appendix A.

After the CIPP liner was pulled through the outlet pipe, steam was injected into the CIPP liner at the upstream end of the outlet pipe. The steam temperature entering the CIPP liner was noted to be approximately 250 degrees F. Steam was injected into the CIPP liner and then released in a controlled manner from the downstream end. The temperature of the steam exiting the CIPP liner was monitored and once the temperature of the steam exiting the CIPP liner reached 180 degrees, the system was closed and the resins in the CIPP liner were allowed to cure.

After curing was completed, the installed CIPP liner was video inspected. A copy of this video is provided on the attached thumb drive. Based on our review of the video, it appears that the CIPP liner was successfully installed with a few very small wrinkles and non intrusions or bumps in the finished product. After the video inspection was completed, the ends of the CIPP liner were cut off to the finished edges.

NWCC understands that as an added measure to prevent separation of the CIPP liner from the host pipe at the inlet and outlet ends of the outlet pipe, hydrophilic end seals were provided at each end of the CIPP. The seals were placed between the host pipe and CIPP prior to the CIPP installation. Technical data for the "Insignia End Seal Sleeves" used for this project is provided in the last two pages of the report provided by Layne and shown in Appendix C.

Based on our measurements taken from a sample of the cured CIPP that was supposedly cut off the inlet end, it appears the thickness of the CIPP was 0.45 inches which exceeded the minimum design thicknesses of 0.31 and 0.36 inches. A sketch showing the approximate configuration of the completed CIPP installation and dam is provided in Appendix D.

CONCLUSIONS

Based on our limited site observations, our review of the video tapes made during the construction of the new outlet works by the owner, Scott Hoffner – Crosby Creek Ranch, and the CIPP Installer, Layne Inliner, as well as our review of the reports provided to NWCC after the construction was completed by Layne Inliner, it is NWCC's opinion that the installation of the new headgate and stem, as well as the lining of the outlet pipe with CIPP were constructed in general accordance with state of the art design and construction standards.

No warranties expressed or implied are given on the content of this report.

If you have any questions regarding this report, please contact the undersigned.

Sincerely,

NWCC, Inc.

COLORADO LICENSED
BRIAN D. LEN
25750
PROFESSIONAL ENGINEER

12/1/17

Brian D. Len, P.E.
Principal Engineer

cc: Scott Hoffner – Crosby Creek Ranch

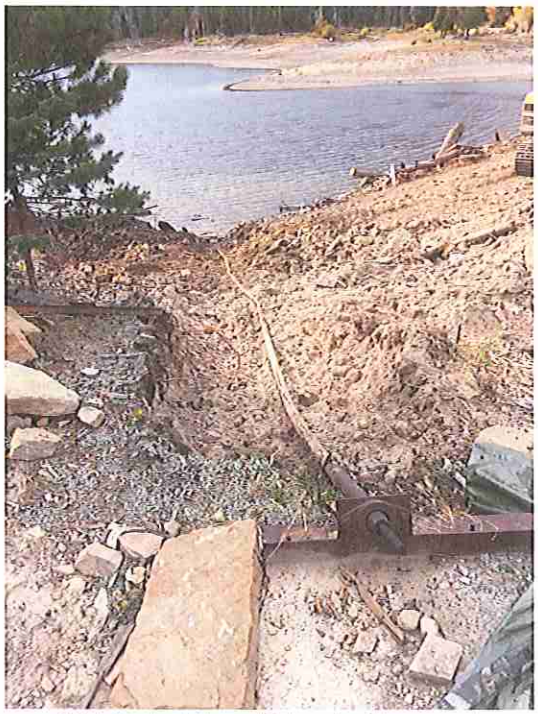
APPENDIX A

PROJECT PHOTOGRAPHS

Old Headgate Prior to Removal

Exposing Old Gate Stem

Old Headgate Prior to Removal
Note: Date of Installation July 13, 1951

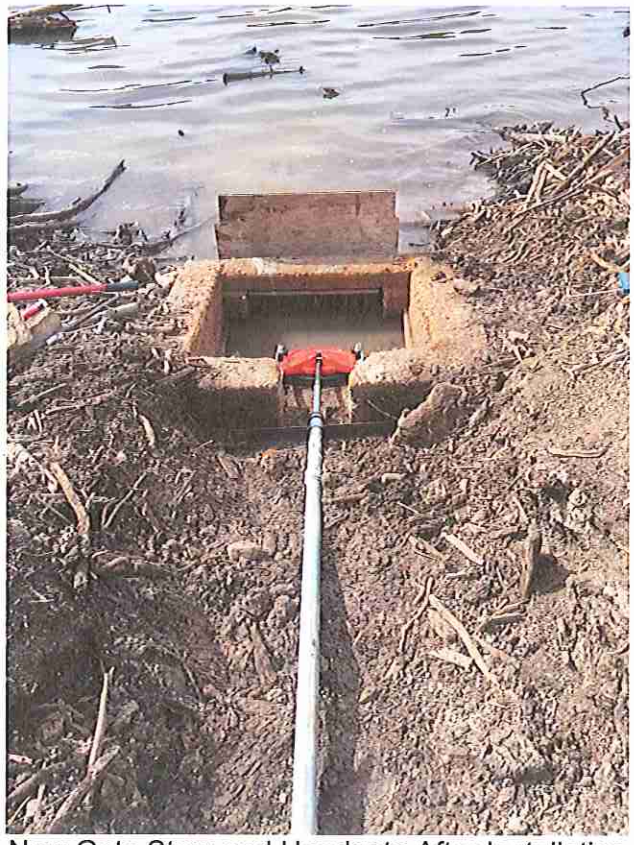


Old Gate Stem Prior to Removal

Inlet Basin After Removal of Old Headgate

New Gate Stem and Wheel After Installation

New Headgate After Installation



New Gate Stem and Headgate After Installation

Backfilling New Gate Stem

Construction of New Trashrack

Video Inspecting Outlet

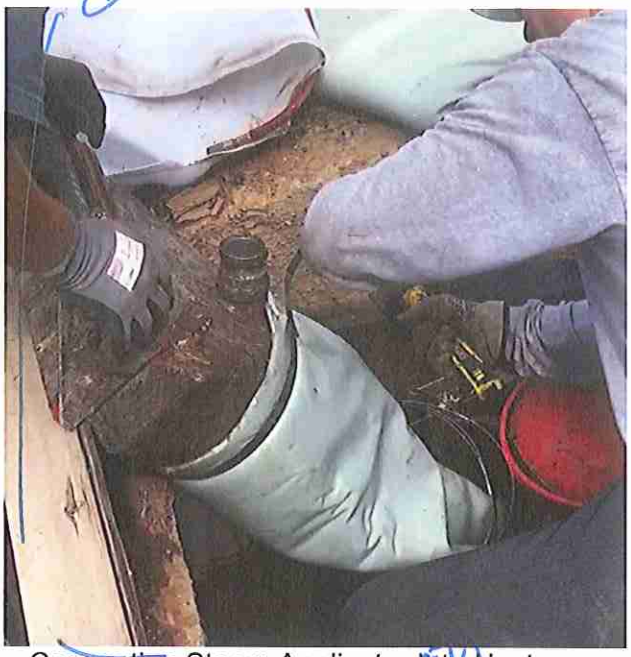
New Trashrack After Installation

Unloading Liner Materials

Pumping Reservoir Down Prior to Liner Install

Starting Liner Installation at Inlet

Pulling Liner Out Of Downstream End of Outlet



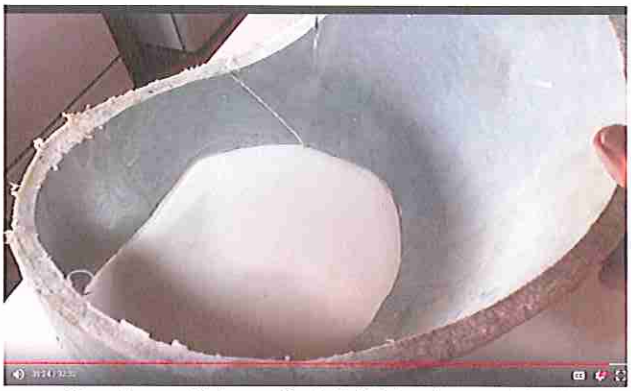
Connecting Steam Applicator Into Upstream End of Outlet Liner – Note New Headgate

Cathead Winch Used To Pull Liner

Injecting Steam (250 degrees F) Into Upstream End of Outlet Liner

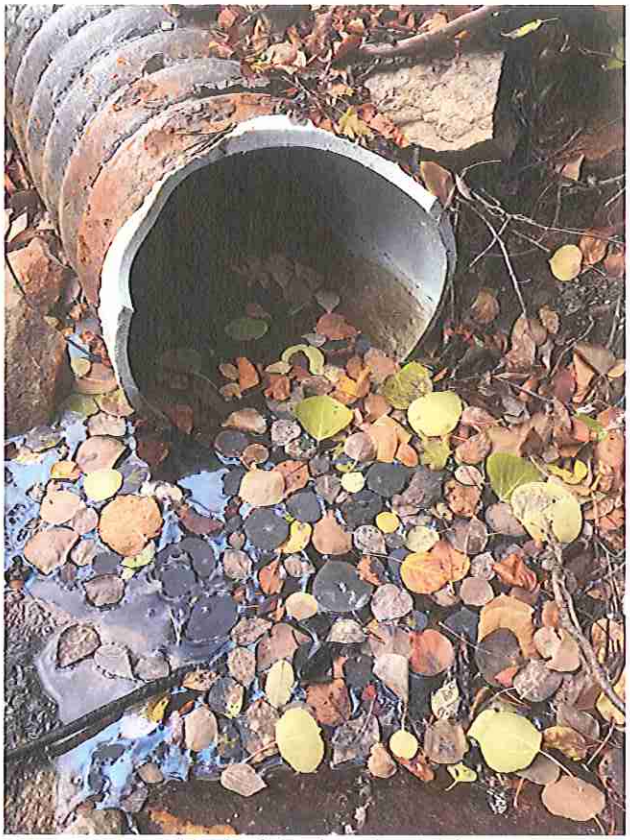
Releasing Steam From Downstream End of Outlet Liner and Verifying Temperature Has Reached 180 degrees F

Cutting Off Upstream End of Outlet Liner



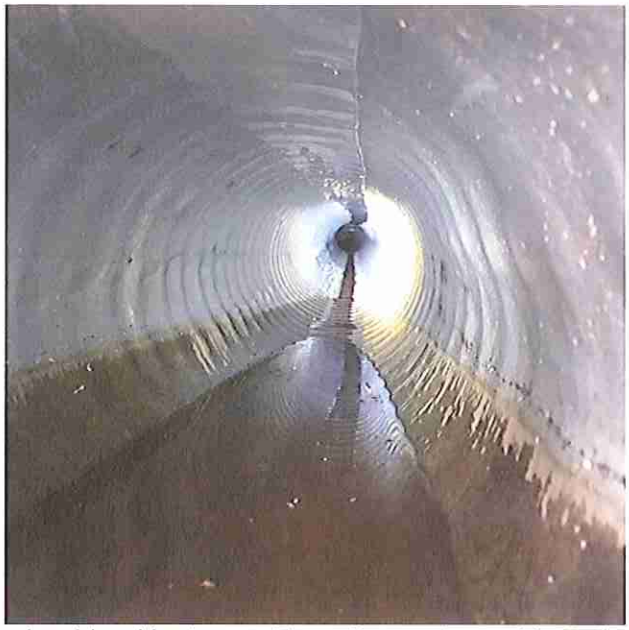
Section of Liner Cut Off Upstream End

Cutting Off Upstream End of Outlet Liner



Downstream End of Outlet Liner After Trimming

Upstream End of Lined Outlet



Looking Upstream From Downstream End of Outlet

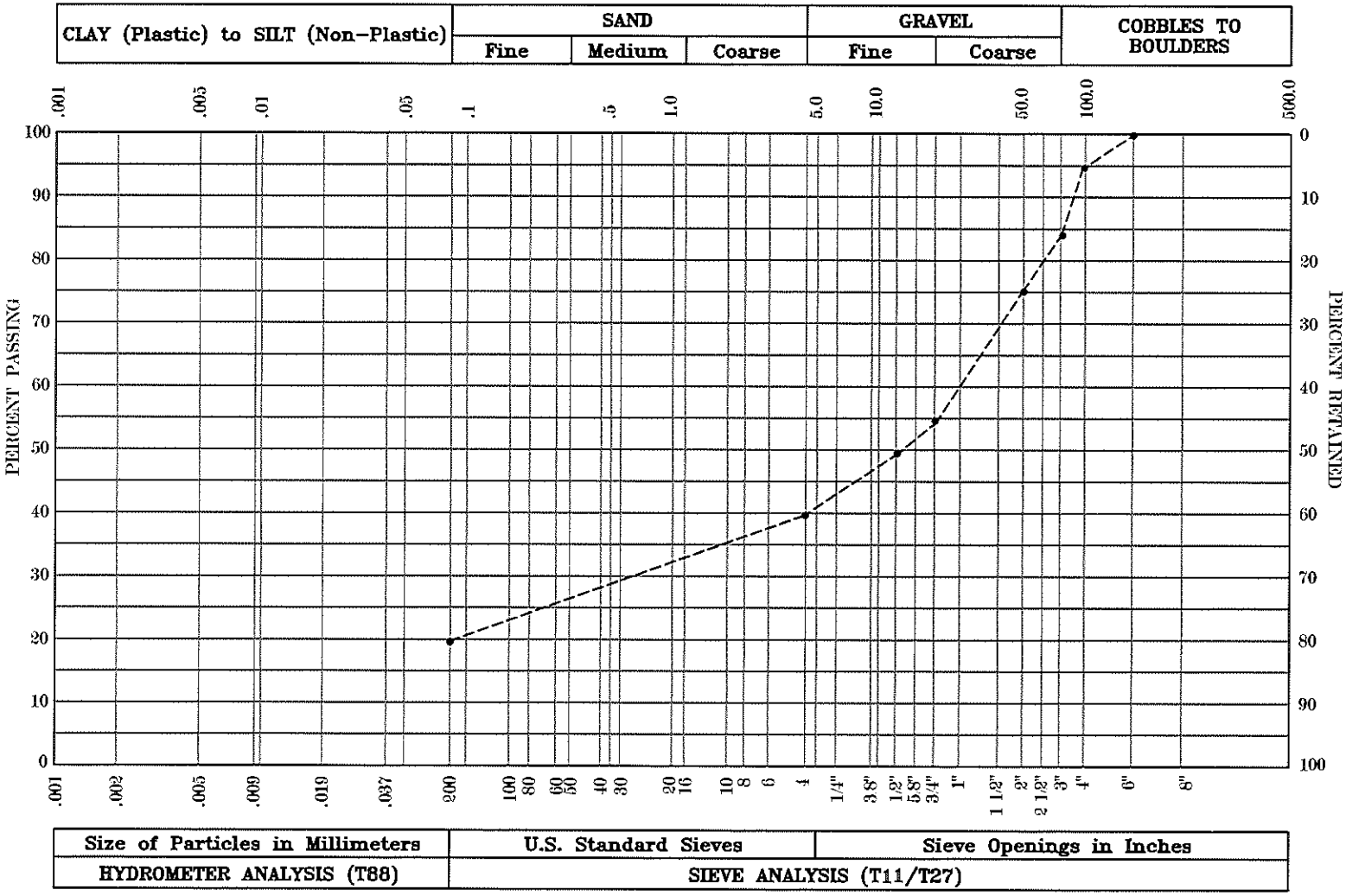
APPENDIX B

LABORATORY TEST RESULTS

SAMPLE NO.	SOURCE
1G	Downstream Dam Face

JOB NAME & LOCATION
Stambaugh Dam Crosby Creek Ranch Jackson County, CO

Material Description
Silty Sandy Gravel With Cobbles (GM)



Size of Particles in Millimeters	U.S. Standard Sieves	Sieve Openings in Inches
HYDROMETER ANALYSIS (T88)	SIEVE ANALYSIS (T11/T27)	

SIEVE SIZE	PERCENT PASSING	SPEC. LIMITS
6"	100	–
4"	94	–
3"	84	–
2"	75	–
3/4"	54	–
1/2"	49	–
NO. 4	41	–
NO. 200	20	–

* = OUT OF SPECIFICATION

LL	PI	PL
AASHTO T89	AASHTO T90	
18	3	15
		SPEC. LIMITS

GRADATION ANALYSIS

MATERIAL SORT BY WEIGHT

Job No.	Date:	Technician:	FINES	SANDS	GRAVELS	COBBLES BOULDERS
16-10519	9/19/16	JS	20 %	21 %	43%	16 %

NWCC
North West Colorado Consultants, Inc.
Geotechnical / Environmental Engineering · Materials Testing
(970)879-7888 · Fax (970)879-7891
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487

APPENDIX C

LAYNE INLINER REPORTS AND TECHNICAL DATA

October 23, 2017

Crosby Creek Ranch, LLC
3379 Jackson County Road No. 1
Walden, Colorado 80480

Attention: Mr. Scott Hoffner

Reference: Stambaugh Reservoir Dam Line
Cured-in-place Pipe Reconstruction

Gentlemen:

The following information is offered in regards to the reconstruction of the dam drain line under the Stambaugh Reservoir Dam. The design parameters were gathered from the drawings provided and an inspection of the site and existing pipe structure. The following is a summary of the design considerations.

Host Pipe The existing pipe is corrugated metal pipe of a nominal diameter of 12-inches. Inspection of the pipe confirmed both the diameter and the design factor of ovality (the out-of-roundness of the pipe) being less than 5%. The condition of the host pipe appeared excellent from an internal inspection yet is not conclusive as to the condition of the exterior of the pipe. The design basis for the host pipe in view of the Cured-in-place pipe (CIPP) as a fully-deteriorated host pipe. Though the existing pipe is not fully-deteriorated by any estimation, the CIPP is designed for a fully-deteriorated condition ensuring the integrity of the CIPP over its useful life even if the host pipe becomes fully-deteriorated.

Site Conditions Based on the plans and site inspection the following table of information was utilized for the purpose of designing the CIPP.

Design Parameter	Value
Nominal host pipe inside diameter	11.8-inches (measured)
Maximum host pipe ovality	5.0%
External groundwater to pipe invert	25 vertical feet
Soil cover to top of pipe	25 vertical feet
Design safety factor	2.0
Soil modulus	1,000 PSI
Soil density	120 pounds/cubic foot
Live loading	HS-20 Highway (single truck passing)

CIPP Material Design Factors The following material values were used in the design of the CIPP. Resin material specification are attached to this report.

Design Parameter	Value
Short term flexural modulus	400,000 PSI
Short term flexural strength	4,500 PSI
Property retention factor for long term design	50%
Long term flexural modulus	200,000 PSI
Long term flexural strength	2,250 PSI

The design calculations were made in accordance with ASTM F-1216 (latest version) design for cured-in-place pipe. A copy of the design calculations is attached and certified by Denise McClanahan, a Professional Engineer registered in Colorado.

Wall Thickness Design The resultant minimum wall thickness design in accordance with the above listed parameters is 0.31-inches or 7.9 MM.

CIPP Utilized for Installation The design thickness chosen by Layne Inliner, LLC for the CIPP installation at the Stambaugh Dam Drain Line was a nominal 10.50 MM. The tube construction for the installation was a fully encapsulated statured tube. The tube consisted of a polyurethane coating on both the inside and outside of the resin saturated polyester felt tube allowing the tube to be pulled into place and cured without loss of resin during installation or cure. It should be noted that the thicker liner, 10.50 MM was chosen to ensure integrity and provides a Factor of Safety of 2.5 (versus the standard design 2.0). The design calculations showing the conditions for which the thicker-wall CIPP will accommodate are attached. The tube installed complies with the following engineering values:

Design Parameter	Minimum Design Value
Nominal host pipe inside diameter	11.8-inches (measured)
Maximum host pipe ovality	5.0%
External groundwater to pipe invert	25 vertical feet
Soil cover to top of pipe	25 vertical feet
Design safety factor	2.5
Soil modulus	1,000 PSI
Soil density	120 pounds/cubic foot
Live loading	HS-20 Highway (single truck passing)

CIPP End Terminations The CIPP fits tightly inside the host pipe as evidenced by the post-installation video. As an added measure of project quality (though not required) Layne Inliner, LLC provided hydrophilic end seals at each end of the CIPP. The seals were placed between the existing pipe and the CIPP prior to the CIPP installation. If any moisture comes in contact with the hydrophilic material the seal swells preventing water from tracking alone any annular space between the host pipe and the CIPP. Product information for the seals is attached to this report.

Please review the above information and attachments and feel free to have the dam design engineer contact me if there are any questions.

Sincerely yours,

Layne Inliner, LLC

Mark Slack
District Manager

Attachments:
Pipe design per site conditions
Pipe design with additional factor of safety
Resin information
End seal information

Project ID:	Stambaugh
Segment ID:	Dam Drain
Location:	Walden, CO
Designed By/Date:	MES 8.16.17
Approved By/Date:	

CIPP Thickness Design by ASTM F1216-09 for Gravity Flow Pipelines

Design Criteria

Pipe Condition:	Fully Deteriorated
Nominal Pipe Diameter:	11.8 inches
Maximum Ovality:	5.0 %
External Groundwater, to invert:	25.0 feet
Soil Cover, to top of pipe:	25.0 feet
Factor of Safety:	2.0
Soil Modulus:	1,000 psi
Soil Density:	120 lbs/ft^3
Live Loading:	HS-20 Highway - Single-Wheel Load

CIPP Liner Properties

Short-term Flexural Modulus:	400,000 psi
Short Term Flexural Strength:	4,500 psi
Property Retention Factor for Long-Term Design:	50 %
Long-term Flexural Modulus:	200,000 psi
Long-term Flexural Strength:	2,250 psi

ASTM F1216 Equation Solutions

Resistance to Hydrostatic Loads:	0.26 in	or	6.5 mm
Bending Stress in Ovalized Pipes:	0.30 in	or	7.5 mm
Soil, Water and Live Loads:	0.31 in	or	7.9 mm
Minimum Stiffness Requirements:	0.17 in	or	4.2 mm

Design Case

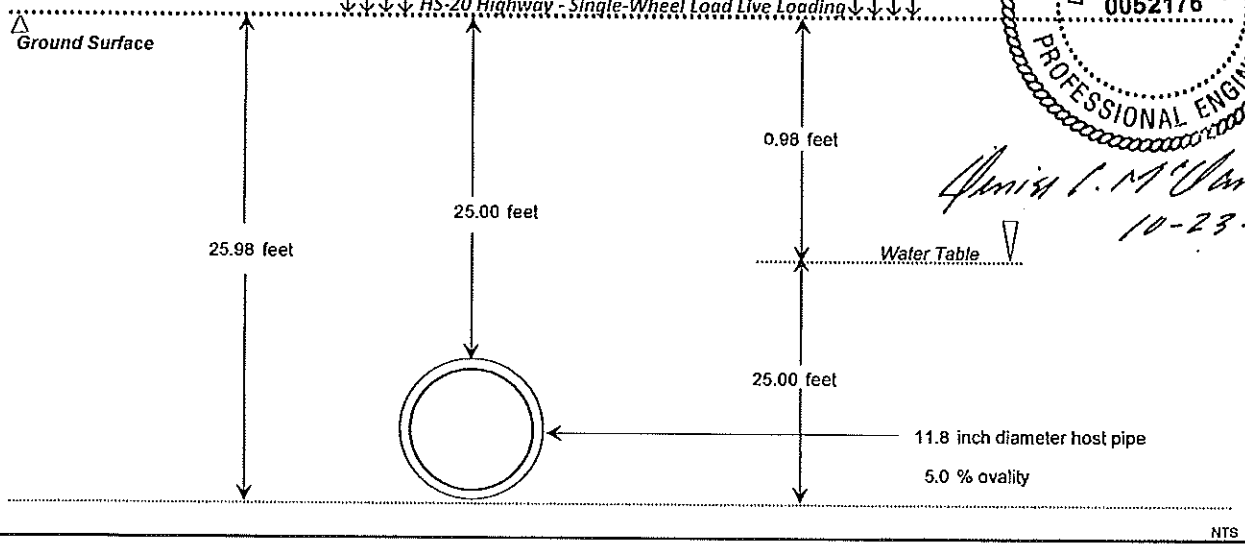
Fully Deteriorated

Required Installed Thickness: 0.31 in or 7.9 mm = 38 DR

COLORADO LICENSED
DENISE McCLANAHAN
0052176
PROFESSIONAL ENGINEER

Denise L. McClanahan
10-23-17

Design Parameter Sketch



Comments/Assumptions

These calculations have been prepared using accepted engineering principles for the design of underground piping. They are based on the information provided in the contract documents with assumptions noted.

Rev 0 - 10-3-13

Project ID:	Stambaugh
Segment ID:	Dam Drain
Location:	Walden, CO
Designed By/Date:	MES 8.16.17
Approved By/Date:	

CIPP Thickness Design by ASTM F1216-09 for Gravity Flow Pipelines

Design Criteria

Pipe Condition:	Fully Deteriorated
Nominal Pipe Diameter:	11.8 inches
Maximum Ovality:	5.0 %
External Groundwater, to invert:	25.0 feet
Soil Cover, to top of pipe:	25.0 feet
Factor of Safety:	2.5
Soil Modulus:	1,000 psi
Soil Density:	120 lbs/ft^3
Live Loading:	HS-20 Highway - Single-Wheel Load

CIPP Liner Properties

Short-term Flexural Modulus:	400,000 psi
Short Term Flexural Strength:	4,500 psi
Property Retention Factor for Long-Term Design:	50 %
Long-term Flexural Modulus:	200,000 psi
Long-term Flexural Strength:	2,250 psi

ASTM F1216 Equation Solutions

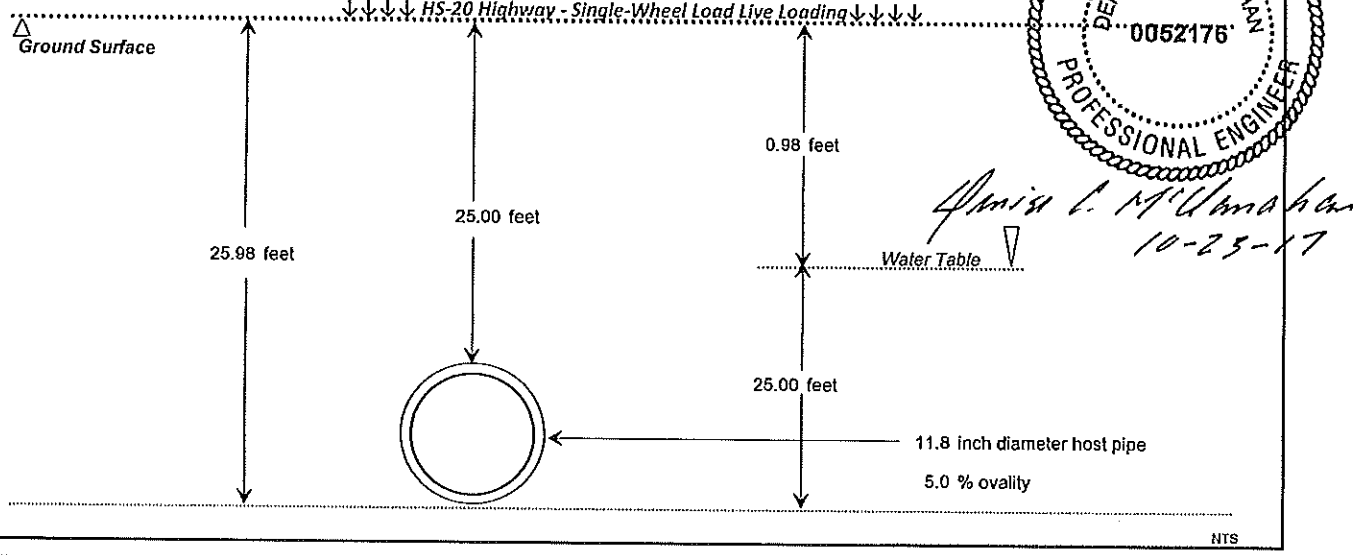
Resistance to Hydrostatic Loads:	0.27 in	or	7.0 mm
Bending Stress in Ovalized Pipes:	0.33 in	or	8.3 mm
Soil, Water and Live Loads:	0.36 in	or	9.2 mm
Minimum Stiffness Requirements:	0.17 in	or	4.2 mm

Design Case

Fully Deteriorated

Required Installed Thickness: 0.36 in or 9.2 mm = 32 DR

Design Parameter Sketch



COLORADO LICENSED
DENISE McCLANAHAN
0052176
PROFESSIONAL ENGINEER

Denise L. McClanahan
10-25-17

Comments/Assumptions

These calculations have been prepared using accepted engineering principles for the design of underground piping. They are based on the information provided in the contract documents with assumptions noted.

Rev 0 - 10-3-13

LAYNE INLINER ENHANCED POLYESTER RESIN SUBMITTAL

InTech 72-20 as supplied by AOC

Included Information:

- Inliner Technical Data Sheet
- AOC Product Information Sheet
- Safety Data Sheet (SDS)
- ASTM F1216 One Month Chemical Resistance Testing
- ASTM D5813 One Year Chemical Resistance Testing and ASTM D2990 Data Analysis
- Infrared Spectra

INLINER TECHNICAL DATA SHEET

1468 West Hospital Road
Paoli, Indiana U.S.A. 47454-9215
voice: 812/723-0704
fax: 812/723-5998
internet: www.inliner.net

TECHNICAL DATA SHEET – INTECH™ 72-20 Enhanced Polyester Resin

INTECH™ 72-20 is a physical strength enhanced, promoted, thixotropic, rigid, corrosion resistant, polyester resin. It is specifically formulated to resist various chemical solutions, as well as municipal sewage and water when manufactured according to cured-in-place techniques for the relining of pipes. This resin has been tested and has passed the requirements for retention of physical properties and weight gain when exposed to corrosive media to ASTM test procedures D5813 and F1216. It has also been tested according to ASTM D-2990 for Flexural Creep. Data on these tests and any corrosion recommendations will be supplied upon request. Resins manufacturers for Inliner meeting this specification are as follows: AOC LLC, Ashland Specialty Chemical Company, Interplastic Corporation and Reichhold Inc.

TECHNICAL DATA

LIQUID RESIN PROPERTIES

Viscosity, Brookfield Model RV @ 77°F (25°C), #4 spindle @ 20 rpm, cps	4,000-6,000
Thixotropic Index	4.0 – 5.0
Gel time run in a 140°F (60°C) water bath, catalyzed with 0.1 phr of Perkadox 16 and 0.5 phr of Trigonox 42S, minutes	8-14
Stability at: 72°F (22.0°C)	≥ 24 hours
Non-Volatile, %	65 – 70
Specific Gravity	1.2 – 1.3

TYPICAL PROPERTIES OF A 6 MM FELT LAMINATE

Flexural Strength, ASTM D-790	7,000 psi	48 MPa
Flexural Modulus, ASTM D-790	625,000 psi	4,309 MPa
Tensile Strength, ASTM D-638	4,200 psi	29 MPa
Tensile Modulus, ASTM D-638	700,000 psi	4,826 MPa
Tensile Elongation, ASTM D-638	0.8 %	0.8 %
Barcol Hardness (934-1), ASTM D-2583	35 - 45	35 - 45

Issued: January 2, 2013

AOC PRODUCT INFORMATION SHEET

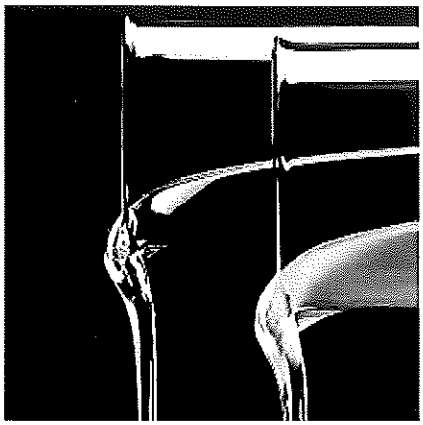
AOC

World Leader in Resin Technology

Vipel®
L721-LTA Series
Polyester Resin

Product Information

Vipel Isophthalic Based Resin for Underground Sewer Pipe Liners



TYPICAL FILLED LIQUID RESIN PROPERTIES* (1) see back page

	Nominal
Viscosity @ 77°F/25°C, RVF Brookfield Spindle #4 @ 20 RPM, cps.	6,200
Thix Index 2/20	2.7+
Color	Opaque
Specific Gravity @ 77°F/25°C	1.255
Styrene, %	32
Gel Time @ 140°F with (1.0% Di-(4-tert-butyl-cyclohexyl) peroxydicarbonate and 0.5% Trigonox® KSM), minutes	14
Pot Life @ 77°F/25°C (1% Di-(4-tert-butyl-cyclohexyl) peroxydicarbonate and + 0.5% Trigonox® KSM), hours	40

Trigonox is a trademark of Akzo Nobel Chemicals

TYPICAL FILLED CAST MECHANICAL PROPERTIES* (2) See back page

		Test Method
Tensile Strength, psi/MPa	7,220/50	ASTM D 638
Tensile Modulus, psi/GPa	690,000/4.8	ASTM D 638
Tensile Elongation, %	1.8	ASTM D 638
Flexural Strength, psi/MPa	12,300/85	ASTM D 790
Flexural Modulus, psi/GPa	700,000/4.8	ASTM D 790
Heat Distortion Temperature, °F/°C @ 264 psi	237/114	ASTM D 648
Barcol Hardness	42	ASTM D 2583

*Typical properties are not to be construed as specifications.

DESCRIPTION

The Vipel L721-LTA Series is a high molecular weight isophthalic/ unsaturated polyester resin. The Vipel L721-LTA Series provides the corrosion resistance, durability and toughness that is required for cured in place pipe applications.

BENEFITS

- Excellent catalyzed pot life
- Superior mechanical properties
- High molecular weight

Vipel®
L721-LTA Series
Polyester Resin

PERFORMANCE GUIDELINES

A. Keep full strength catalyst levels between 1.0% - 3.0% of the total resin weight.

B. Maintaining shop temperatures between 65°F/18°C and 90°F/32°C and humidity between 40% and 90% will help the fabricator make a high quality part. Consistent shop conditions contribute to consistent gel times.

STORAGE STABILITY

Resins are stable for three months from date of production when stored in the original containers away from sunlight at no more than 77°F/25°C. After extended storage, some drift may occur in gel time.

During the hot summer months, no more than two months stability at 86°F/30°C should be anticipated.

SAFETY

See appropriate Material Safety Data Sheet for guidelines.

ISO 9001:2008 CERTIFIED

The Quality Management Systems at every AOC manufacturing facility have been certified as meeting ISO 9001:2008 standards. This certification recognizes that each AOC facility has an internationally accepted model in place for managing and assuring quality. We follow the practices set forth in this model to add value to the resins we make for our customers.

FOOTNOTES

(1)

The pot life times shown are typical but may be affected by catalyst, promoter and inhibitor concentrations in resin, and environmental temperature. Variations in gelling characteristics can be expected between different lots of catalysts and at extremely high humidities. Pigment and fillers can retard or accelerate gelation. It is recommended that the fabricator check the gelling characteristics of a small quantity of resin under actual operating conditions prior to use.

(2)

Based on tests on Vipel L721-LTA Series pipe at 77°F/25° and 50% relative humidity. Ceastings were prepared using 1.0% Perkadox 16 and 0.5 Trigonox C.

AOC®
World Leader in Resin Technology

North America
northamerica@aoc-resins.com
Toll Free: +1 (866) 319-8827
www.aoc-resins.com

Global Contacts

Australia
australia@aoc-resins.com
Middle East
middleeast@aoc-resins.com
Latin America
latinamerica@aoc-resins.com
Africa
africa@aoc-resins.com
Asia\Australia
asia@aoc-resins.com
Europe
europe@aoc-resins.com

SAFETY DATA SHEET (SDS)

SAFETY DATA SHEET

Date of issue: 05/26/2015
Date of previous issue: 04/20/2015

AOC®
World Leader in Resin Technology

Section 1. Identification

Product name	L721-LTA-14
Product type	Polyester Resin Solution
Chemical family	Aromatic.
MSDS no.	NA-1504:503 (Version: 1.1)

Relevant identified uses of the substance or mixture and uses advised against

Identified uses	Used in the manufacture of thermoset plastic parts.
Uses advised against	No additional information.
Supplier's details	AOC, LLC 955 Highway 57 East Collierville, TN 38017 Website: www.aoc-resins.com Phone Number: (901) 854-2800 Hours: 8AM-5pm (Central Time) Mon-Friday
Emergency telephone number (with hours of operation)	**CHEMTREC (US):** 24 hours/7 days (800) 424-9300 **CANUTEC (Canada):** 24 hours/7 days (613) 996-6666

Section 2. Hazards identification

OSHA/HCS status

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture

Flammable liquid and vapor. – Category 3, H226
Acute toxicity – Inhalation – Category 4, H332
Eye irritation – Category 2, H319
Skin irritation – Category 2, H315
STOT-SE = Specific Target Organ Toxicity - Single Exposure – Category 3, H335
STOT-RE = Specific Target Organ Toxicity - Repeated Exposure – Category 1, H372

GHS label elements

Hazard pictograms

Signal word

Danger

Hazard statements

H226: Flammable liquid and vapor.
H332: Harmful if inhaled.
H319: Causes serious eye irritation.
H315: Causes skin irritation.
H335: May cause respiratory irritation.
H372: Causes damage to organs through prolonged or repeated exposure if inhaled.

Precautionary statements

General

P101: If medical advice is needed, have product container or label at hand.
P102: Keep out of reach of children.

Section 2. Hazards identification

Prevention

P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233: Keep container tightly closed.
P240: Ground/bond container and receiving equipment.
P241: Use explosion-proof electrical/ventilating/lighting/material-handling equipment.
P242: Use only non-sparking tools.
P243: Take precautionary measures against static discharge.
P264: Wash hands thoroughly after handling.
P270: Do not eat, drink or smoke when using this product.
P271: Use only outdoors or in a well-ventilated area.
P280: Wear protective gloves/protective clothing/eye protection/face protection.
P261: Do not breathe vapor or mist.

Response

P370 + P378 In case of fire: Use DRY chemicals, CO2, water spray or foam.
P308 + P313 IF exposed or concerned: Get medical attention.
P304 + P340 + P312: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell.
P303 + P361 + P353: IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower.
P333 + P313: If skin irritation occurs: Get medical attention/advice.
P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313: If eye irritation persists: Get medical attention/advice.
P391: Collect spillage.

Storage

P403 + P235: Store in a well-ventilated place. Keep cool.
P233: Keep container tightly closed.
P405: Store locked up.

Disposal

P501: Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified

None known.

Section 3. Composition/information on ingredients

Substance/mixture : Mixture

Ingredient name	CAS number	%
Styrene	100-42-5	32.0
Talc	14807-96-6	≥10 - <25
Titanium Dioxide	13463-67-7	≥0.1 - <0.3

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Use of buffered baby shampoo will aid in removal. If irritation persists, get medical attention.

Inhalation

Move the victim to a safe area as soon as possible. Allow the victim to rest in a well-ventilated area. If breathing is difficult, give oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Skin contact

In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. If irritation persists, seek medical attention. Wash contaminated clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion

Section 4. First aid measures

Wash out mouth with water. Remove dentures if any. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Seek immediate medical attention.

Most important symptoms/effects, acute and delayed

Eye contact

Causes serious eye irritation.

Inhalation

Harmful if inhaled. May cause respiratory irritation.

Skin contact

Causes skin irritation.

Ingestion

Irritating to mouth, throat and stomach.

Over-exposure signs/symptoms

Eye contact

Adverse symptoms may include the following: pain or irritation, watering, redness.

Inhalation

Adverse symptoms may include the following: respiratory tract irritation, coughing.

Skin contact

Adverse symptoms may include the following: irritation, redness.

Ingestion

Adverse symptoms may include the following: Irritating to mouth, throat and stomach..

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician

Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media

Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media

Do not use water jet.

Specific hazards arising from the chemical

Flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. This material is harmful to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products

Decomposition products may include the following materials: carbon dioxide, carbon monoxide, sulfur oxides halogenated compounds, metal oxide/oxides

Special protective actions for fire-fighters

Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Special protective equipment for fire-fighters

Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel

No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation.

For emergency responders

If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment. See also the information in "For non-emergency personnel".

Environmental precautions

Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods and materials for containment and cleaning up

Small spill

Stop leak if without risk. Move containers from spill area. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.

Large spill

Stop leak if without risk. Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures

Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Do not breathe vapor or mist. Do not ingest. Avoid contact with eyes, skin and clothing. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene

Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities

Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Eliminate all ignition sources. Segregate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination. Refer to the product label and/or technical data sheet for further information.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient name	Exposure limits
Styrene	**ACGIH TLV (United States, 3/2012). Absorbed through skin.** TWA: 20 ppm 8 hours. TWA: 85 mg/m³ 8 hours. STEL: 40 ppm 15 minutes. STEL: 170 mg/m³ 15 minutes. **OSHA PEL Z2 (United States, 11/2006).** TWA: 100 ppm 8 hours. AMP: 600 ppm 5 minutes. CEIL: 200 ppm **NIOSH REL (United States, 6/2009).** TWA: 50 ppm 10 hours. Form: TWA: 215 mg/m³ 10 hours. STEL: 100 ppm 15 minutes. STEL: 425 mg/m³ 15 minutes.
Talc	**NIOSH REL (United States, 6/2008).** TWA: 2 mg/m³ 10 hours. Form: Respirable fraction **OSHA PEL Z3 (United States, 9/2005).** : 1 f/cc 30 minutes. Form: not containing asbestos TWA: 20 mppcf 8 hours. Form: not containing asbestos **ACGIH TLV (United States, 1/2008).** TWA: 0.1 f/cc 8 hours.
Titanium Dioxide	**ACGIH TLV (United States, 3/2012).** TWA: 10 mg/m³ 8 hours. Form: **OSHA PEL (United States, 6/2010).** TWA: 15 mg/m³ 8 hours. Form: Total dust

Appropriate engineering controls

Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Individual protection measures

Hygiene measures

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection

Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.

Hand protection

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Body protection

Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection

Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state	Liquid.
Color	Brown.
Odor	Aromatic.
Odor threshold	0.01 - 0.1 ppm (*Styrene*)
pH	*Not applicable.*
Melting point	-23.8°F / -30.6°C (*Styrene*)

Section 9. Physical and chemical properties

Boiling point	293°F / 145°C (*Styrene*)
Flash point	88°F / 31°C (*Styrene*)
Evaporation rate	< 1 (Butyl acetate = 1)
Flammability (solid, gas)	*Not applicable.*
Lower and upper explosive (flammable) limits	**Lower:** 1.1% **Upper:** 6.1% (*Styrene*)
Vapor pressure	5.0 mm Hg@ 68°F / 20°C (*Styrene*)
Vapor density	3.6 (Air = 1) (*Styrene*)
Relative density	1.1 (Water = 1)
Solubility	Slight.
Partition coefficient: n-octanol/water	Not available.
Auto-ignition temperature	914°F / 490°C (*Styrene*)
Decomposition temperature	Not available.
Viscosity	Not available.
Molecular weight	10,000 to 15,000

Section 10. Stability and reactivity

Reactivity

No specific test data related to reactivity available for this product or its ingredients.

Chemical stability

The product is stable. Stable under recommended storage and handling conditions (see Section 7).

Possibility of hazardous reactions

Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid

Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Incompatible materials

Reactive or incompatible with the following materials: oxidizing materials

Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
Styrene	LC50 Inhalation Gas.	Rat	2770 ppm	4 hours
	LC50 Inhalation Vapor	Rat	11800 mg/m³	4 hours
	LD50 Oral	Rat	2650 mg/kg	-
Titanium Dioxide	LD50 Oral	Rat	>10000 mg/kg	-

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
Styrene	Eyes - Mild irritant	Human	-	50 parts per million	-
	Eyes - Moderate irritant	Rabbit	-	24 hours 100 milligrams	-
	Eyes - Severe irritant	Rabbit	-	100 milligrams	-
	Skin - Mild irritant	Rabbit	-	500 milligrams	-
	Skin - Moderate irritant	Rabbit	-	100 Percent	-
Titanium Dioxide	Skin - Mild irritant	Human	-	72 hours 300 Micrograms Intermittent	-

Sensitization

May cause sensitization by skin contact.

Carcinogenicity

Classification

Section 11. Toxicological information

Product/ingredient name	ACGIH	IARC	NTP
Styrene	-	2B	Reasonably anticipated to be a human carcinogen.
Talc	-	1	Known to be a human carcinogen.
Titanium Dioxide	-	2B	-

1) Negative Study A published study concluded that the mechanism for producing cancer in mice exposed to styrene is not applicable in human metabolism. (June 2013 Pharmacology & Toxicology 66 (2013))
2) Negative Study A recent update to an extensive study of reinforced plastic workers from 1948-1977 concluded that there was no coherent evidence that styrene exposure increased risk of cancer (March 2013 Epidemiology Vol. 24 Issue 2)
3) Positive Study Styrene induced pulmonary toxicity and carcinogenicity in mice was shown to be caused by a metabolite of styrene, probably styrene oxide. (Dec.2001 Toxicology Vol.169 Issue 2)

Mutagenicity

No mutagenic effect.

Reproductive toxicity

Not considered to be toxic to the reproductive system.

Teratogenicity

No known effect according to our database..

Specific target organ toxicity (single exposure)

No known effect according to our database.

Specific target organ toxicity (repeated exposure)

A study of long term effects of workers exposed to styrene levels in the range of 25-35 ppm, 8 hour TWA, indicated a possible mild hearing loss.

Aspiration hazard

No known effect according to our database.

Potential acute health effects

Eye contact

Causes serious eye irritation.

Inhalation

Harmful if inhaled. May cause respiratory irritation.

Skin contact

Causes skin irritation.

Ingestion

Irritating to mouth, throat and stomach.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact

Adverse symptoms may include the following: pain or irritation, watering, redness.

Inhalation

Adverse symptoms may include the following: respiratory tract irritation, coughing.

Skin contact

Adverse symptoms may include the following: irritation, redness.

Ingestion

Adverse symptoms may include the following: Irritating to mouth, throat and stomach..

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
Styrene	Acute EC50 4.7 mg/l Fresh water	Daphnia - Daphnia magna	48 hours
	Acute LC50 4.02 mg/l Fresh water	Fish - Pimephales promelas	96 hours
Titanium Dioxide	Acute EC50 5.83 mg/l Fresh water	Algae - Pseudokirchneriella subcapitata - Exponential growth phase	72 hours
	Acute LC50 >10 mg/l Fresh water	Crustaceans - Ceriodaphnia dubia - Neonate	48 hours
	Acute LC50 5.5 ppm Fresh water	Daphnia - Daphnia magna - Juvenile (Fledgling, Hatchling, Weanling)	48 hours
	Acute LC50 >1000000 µg/l Marine water	Fish - Fundulus heteroclitus	96 hours
	Chronic NOEC 0.984 mg/l Fresh water	Algae - Pseudokirchneriella	72 hours

Section 12. Ecological information

		subcapitata - Exponential growth phase	

Persistence and degradability

Product/ingredient name	Test	Result	Dose	Inoculum
Styrene	EU	100 % - Readily - 1 days	-	-

Product/ingredient name	Aquatic half-life	Photolysis	Biodegradability
Styrene	-	-	Readily

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
Styrene	2.95	13.49	low

Mobility in soil

Soil/water partition coefficient (K_{OC})

Not available.

Other adverse effects

No known effect according to our database.

Section 13. Disposal considerations

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

Disposal methods

The generation of waste should be avoided or minimized wherever possible. Empty containers or liners may retain some product residues. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Avoid disposal. Attempt to use product completely in accordance with intended use. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions

This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

DOT / TDG/ IMDG/IMO / ICAO/IATA and National regulations.

UN number	UN1866
Proper shipping name	Resin Solution
Transport hazard class(es)	3 
Packing group	III
Environmental hazards	Marine pollutant: No.
Special precautions for user	**Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.
Additional information	US regulations require the reporting of spills when the amount exceeds the Reportable Quantity (RQ) for specific components of this material. See CERCLA in Section 15, Regulatory Information, for the Reportable Quantities. **IMDG** Emergency schedules (EmS) 3-05

Section 14. Transport information

IATA No additional information.

Section 15. Regulatory information

Inventories (National and International)

United States inventory (TSCA 8b)	: All components are listed or exempted.
Australia	: Not determined.
Canada	: At least one component is not listed in DSL but all such components are listed in NDSL.
China	: Not determined.
Europe	: Not determined.
New Zealand	: Not determined.
Philippines	: Not determined.
Japan	: Not determined.
Malaysia	: Not determined.
Republic of Korea	: At least one component is not listed.
Taiwan	: Not determined.

SARA 311/312

Composition/information on ingredients

Name	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
Styrene	Yes.	No.	No.	No.	Yes.
Talc	No.	No.	No.	No.	Yes.
Titanium Dioxide	No.	No.	No.	No.	Yes.

SARA 313

	Product name	CAS number
Form R - Reporting requirements	Styrene	100-42-5

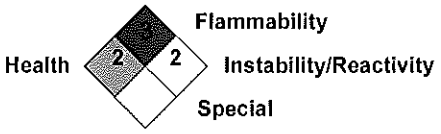
State regulations

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

Section 16. Other information

National Fire Protection Association (U.S.A.)



History

Date of issue	: 05/26/2015
Date of previous issue	: 04/20/2015
Version	: 1.1

AOC Corporate Regulatory Affairs

Section 16. Other information

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

Indicates information that has changed from previously issued version.

Notice to reader

The information contained in this data sheet is furnished in good faith and without warranty, representation, or inducement or license of any kind, except that it is accurate to the best of AOC, LLC's knowledge, or was obtained from sources believed by AOC, LLC to be reliable. The accuracy, adequacy or completeness of health and safety precautions set forth herein cannot be guaranteed, and the buyer is solely responsible for ensuring that the product is used, handled, stored, and disposed of safely and in compliance with applicable federal, state or provincial, and local laws. AOC, LLC disclaims liability for any loss, damage or personal injury that arises from, or is in any way related to, use of the information contained in this data sheet.

ASTM F1216 ONE MONTH

CHEMICAL RESISTANCE TESTING

AOC®
World Leader in Resin Technology

ASTM F1216 Test Results on 6 mm Felt Composite
L721-LT Series
One Month Results at 25°C

	L721-LT	REQUIREMENTS %	PASS OR FAIL
CONTROL SAMPLE			
FLEXURAL STRENGTH, psi	8,400		
FLEXURAL MODULUS, psi	611,000		
TAP WATER			
FLEXURAL STRENGH, psi	7,589		
STANDARD DEVIATION	106		
% FLEXURAL STRENGTH, psi RETENTION	90	>80	PASSED
FLEXURAL MODULUS, psi	552,818		
STANDARD DEVIATION	11,828		
% FLEXUARAL MODULUS RETENTION	91	>80	PASSED
5% NITRIC ACID			
FLEXURAL STRENGH, psi	7,842		
STANDARD DEVIATION	21		
% FLEXURAL STRENGTH, psi RETENTION	93	>80	PASSED
FLEXURAL MODULUS, psi	530,918		
STANDARD DEVIATION	18,842		
% FLEXUARAL MODULUS RETENTION	87	>80	PASSED
10% PHOSPHORIC ACID			
FLEXURAL STRENGH, psi	7,908		
STANDARD DEVIATION	185		
% FLEXURAL STRENGTH, psi RETENTION	94	>80	PASSED
FLEXURAL MODULUS, psi	554,846		
STANDARD DEVIATION	22,065		
% FLEXUARAL MODULUS RETENTION	91	>80	PASSED
10% SULFURIC ACID			
FLEXURAL STRENGH, psi	8,211		
STANDARD DEVIATION	14		
% FLEXURAL STRENGTH, psi RETENTION	98	>80	PASSED
FLEXURAL MODULUS, psi	559,473		
STANDARD DEVIATION	19,921		
% FLEXUARAL MODULUS RETENTION	91	>80	PASSED

AMOCO GASOLINE			
FLEXURAL STRENGH, psi	8,364		
STANDARD DEVIATION	368		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASSED
FLEXURAL MODULUS, psi	611,520		
STANDARD DEVIATION	16,450		
% FLEXURAL MODULUS RETENTION	100	>80	PASSED
VEGETABLE OIL			
FLEXURAL STRENGH, psi	7,767		
STANDARD DEVIATION	711		
% FLEXURAL STRENGTH, psi RETENTION	92	>80	PASSED
FLEXURAL MODULUS, psi	560,385		
STANDARD DEVIATION	30,103		
% FLEXUARAL MODULUS RETENTION	92	>80	PASSED
0.1% DETERGENT			
FLEXURAL STRENGH, psi	7,390		
STANDARD DEVIATION	80		
% FLEXURAL STRENGTH, psi RETENTION	94	>80	PASSED
FLEXURAL MODULUS, psi	532,793		
STANDARD DEVIATION	6,148		
% FLEXUARAL MODULUS RETENTION	87	>80	PASSED
0.1% SOAP			
FLEXURAL STRENGH, psi	7,766		
STANDARD DEVIATION	239		
% FLEXURAL STRENGTH, psi RETENTION	92	>80	PASSED
FLEXURAL MODULUS, psi	535,529		
STANDARD DEVIATION	22,084		
% FLEXURAL MODULUS RETENTION	88	>80	PASSED

January, 2014

ASTM D5813 ONE YEAR CHEMICAL RESISTANCE TESTING

AND

ASTM D2990 DATA ANALYSIS

Microbac®

TEST REPORT

CLIENT: AOC, LLC
950 Highway 57 East
Collierville, TN 38017

Attention: Bill Moore Re: P.O. #8750

SAMPLES: One sample of cured in place plastic pipe (CIPP) material was submitted and identified by the client as L721-LT. The sample was received on August 23, 2010.

TESTING: Chemical resistance testing was performed in accordance with ASTM D543-06, *Evaluating the Resistance of Plastics to Chemical Reagents*, using the guidelines set by ASTM D5813-04(08), *Standard Specification for Cured-in-Place Thermosetting Resin Sewer Pipe*, Section 8.2.1. Sets of five (5) test coupons were randomly selected and exposed to the reagents below for one year at 23±2°C. Following the chemical exposure, the coupons were tested in accordance with ASTM D790-10, *Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.* The results of the flexural properties testing were compared to those of an additional set of five (5) coupons randomly selected and conditioned in accordance with ASTM D618-08, Procedure A prior to testing.

Reagent	Concentration
Nitric acid	1%
Sulfuric acid	5%
ASTM Fuel C	100%
Vegetable oil	100%
Detergent	0.10%
Soap	0.10%

Flexural creep testing was performed in general accordance with ASTM D2990-09, *Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.* Five (5) test specimens were randomly selected and tested per Section 6.3 of ASTM D2990, *Flexural Creep*, using a three-point static-load configuration, a 3.70 inch span, and a 1547 psi testing stress (0.25% of short-term flexural modulus as determined by ASTM D790). The ASTM D2990 flexural creep testing was performed at 23±2°C and 50±5% Relative Humidity throughout the duration of the testing. The testing was started on October 11, 2010 and was concluded on December 9, 2011.

The client requested determination of the 50 year modulus. This was performed by extrapolating the most linear portion of the data set (from 100.1 hours through 10,179.1 hours duration) using linear trend line analysis contained within commercially available software (Microsoft Excel).

RESULTS: The results of the chemical exposure testing are presented in Table 1. Specimen dimensions, span length, and testing speed for flexural properties testing are presented in Table 2.

The short-term flexural properties test results are presented in Table 3. The individual creep specimen dimensions are displayed in Table 4. The raw time-displacement creep data are presented in Table 5. The creep test results through 10,179.1 hours test duration are presented in Table 6. For each specimen, flexural modulus versus time data is displayed in tabular format. Additionally, graphical data displaying the average log modulus versus log time is presented in Figure 1, and graphical data displaying the individual log modulus versus log time is presented in Figure 2.

Using the linear trend line analysis extrapolation of the most linear portion of the data set (from 100.1 hours through 10,179.1 hours duration; See Figure 1) the 50 year (438,000 hour) modulus was calculated to be 278,070 psi.

DATA REVIEWED AND REPORT WRITTEN BY:

Douglas Bert
Department Manager

REPORT REVIEWED BY:

John Hindman
Engineer II

TABLE 1
CHEMICAL RESISTANCE TEST RESULTS

Specimen Number	Flexural Yield Strength	Strain @ Flexural Yield Strength	Flexural Modulus (Tangent)
	psi	%	psi
L721-LT Unexposed			
1	8170	5.0	619000
2	8170	5.0	621000
3	8500	4.4	633000
4	8100	4.6	604000
5	8260	4.7	617000
Average	8240	4.7	619000
Std. Dev.	160	0.3	11000
L721-LT Nitric acid			
1	7040	4.1	526000
2	6750	4.8	520000
3	7010	4.6	542000
4	6930	5.0	538000
5	6490	3.4	538000
Average	6840	4.4	533000
Std. Dev.	210	0.6	9000
Percent Retention From Unexposed (%)			86.1
L721-LT Sulfuric acid			
1	7030	4.8	560000
2	6840	4.4	559000
3	7360	4.2	571000
4	7350	4.3	562000
5	7460	4.7	558000
Average	7210	4.5	562000
Std. Dev.	240	0.3	5000
Percent Retention From Unexposed (%)			90.8

TABLE 1 CONTINUED
CHEMICAL RESISTANCE TEST RESULTS

Specimen Number	Flexural Yield Strength	Strain @ Flexural Yield Strength	Flexural Modulus (Tangent)
	psi	%	psi
L721-LT ASTM Fuel C			
1	7520	4.7	590000
2	7920	4.2	573000
3	7420	4.2	575000
4	7930	4.7	591000
5	8170	4.3	606000
Average	7790	4.4	587000
Std. Dev.	290	0.3	13000
Percent Retention From Unexposed (%)			94.8
L721-LT Vegetable oil			
1	8640	4.7	632000
2	8130	4.2	630000
3	8110	4.4	622000
4	7660	4.3	651000
5	8180	4.8	637000
Average	8140	4.5	634000
Std. Dev.	320	0.3	10000
Percent Retention From Unexposed (%)			102.4
L721-LT Detergent			
1	6600	4.9	541000
2	6730	4.8	550000
3	7260	5.0	549000
4	6730	4.5	559000
5	6610	3.3	553000
Average	6780	4.5	550000
Std. Dev.	250	0.7	6000
Percent Retention From Unexposed (%)			88.9

TABLE 1 CONTINUED
CHEMICAL RESISTANCE TEST RESULTS

Specimen Number	Flexural Yield Strength	Strain @ Flexural Yield Strength	Flexural Modulus (Tangent)
	psi	%	psi
L721-LT Soap			
1	7020	4.7	552000
2	6940	4.4	563000
3	7020	4.8	555000
4	7140	4.4	545000
5	7090	4.6	550000
Average	7040	4.6	553000
Std. Dev.	70	0.2	6000
Percent Retention From Unexposed (%)			89.3

TABLE 2
DETAILS OF CHEMICAL RESISTANCE TESTING

Specimen Number	Width	Thickness
	in	in
L721-LT Unexposed		
1	0.504	0.233
2	0.506	0.229
3	0.500	0.231
4	0.500	0.232
5	0.497	0.231
Span Length (inches)		3.70
Speed of Testing (inches per Minute)		0.10

TABLE 2 CONTINUED
DETAILS OF CHEMICAL RESISTANCE TESTING

Specimen Number	Width	Thickness
	in	in
L721-LT Nitric acid		
1	0.513	0.238
2	0.500	0.220
3	0.502	0.235
4	0.501	0.233
5	0.502	0.220
Span Length (inches)		3.67
Speed of Testing (inches per Minute)		0.10
L721-LT Sulfuric acid		
1	0.499	0.234
2	0.505	0.236
3	0.500	0.233
4	0.496	0.231
5	0.497	0.234
Span Length (inches)		3.74
Speed of Testing (inches per Minute)		0.10
L721-LT ASTM Fuel C		
1	0.499	0.228
2	0.500	0.232
3	0.493	0.225
4	0.502	0.233
5	0.488	0.234
Span Length (inches)		3.67
Speed of Testing (inches per Minute)		0.10

TABLE 2 CONTINUED
DETAILS OF CHEMICAL RESISTANCE TESTING

Specimen Number	Width	Thickness
	in	in
L721-LT Vegetable oil		
1	0.507	0.233
2	0.497	0.231
3	0.494	0.230
4	0.500	0.229
5	0.501	0.231
Span Length (inches)		3.69
Speed of Testing (inches per Minute)		0.10
L721-LT Detergent		
1	0.508	0.231
2	0.499	0.232
3	0.504	0.232
4	0.499	0.216
5	0.509	0.234
Span Length (inches)		3.66
Speed of Testing (inches per Minute)		0.10
L721-LT Soap		
1	0.506	0.234
2	0.502	0.233
3	0.497	0.230
4	0.497	0.231
5	0.500	0.232
Span Length (inches)		3.71
Speed of Testing (inches per Minute)		0.10

TABLE 3
SHORT-TERM FLEXURAL PROPERTIES TEST RESULTS

Specimen Number	Width	Thickness	Flexural Modulus
	in	in	psi
1	0.504	0.233	619000
2	0.506	0.229	621000
3	0.500	0.231	633000
4	0.500	0.232	604000
5	0.497	0.231	617000
Average			619000
Std. Dev.			11000
Span (in)			3.70
Speed of Testing (in/min)			0.10

TABLE 4
INDIVIDUAL D2990 TEST SPECIMEN DIMENSIONS

Specimen Number	Width	Thickness
	in	in
1	0.500	0.231
2	0.497	0.235
3	0.498	0.230
4	0.499	0.230
5	0.505	0.228

TABLE 5
FLEXURAL DISPLACEMENT DATA

TEMPERATURE: 23°C
RELATIVE HUMIDITY: 50%
STRESS:1547 psi
SPAN LENGTH: 3.70 inches

Elapsed Time (hours)	DIAL GAGE READINGS (inches)				
	1	2	3	4	5
0.00	0.4468	0.4693	0.4535	0.4710	0.4551
0.02	0.4226	0.4444	0.4270	0.4449	0.4286
0.03	0.4221	0.4437	0.4264	0.4444	0.4284
0.10	0.4210	0.4428	0.4258	0.4440	0.4280
0.20	0.4207	0.4426	0.4255	0.4438	0.4277
0.50	0.4204	0.4422	0.4251	0.4434	0.4273
1.0	0.4201	0.4419	0.4247	0.4431	0.4270
2.0	0.4197	0.4416	0.4244	0.4427	0.4267
5.0	0.4191	0.4410	0.4237	0.4422	0.4260
19.8	0.4182	0.4401	0.4229	0.4413	0.4251
52.8	0.4173	0.4392	0.4219	0.4403	0.4241
100.1	0.4165	0.4383	0.4211	0.4395	0.4233
195.5	0.4156	0.4374	0.4202	0.4385	0.4223
334.5	0.4148	0.4367	0.4195	0.4377	0.4215
436.9	0.4142	0.4362	0.4188	0.4370	0.4209
1440.8	0.4119	0.4338	0.4169	0.4344	0.4184
2042.8	0.4110	0.4328	0.4153	0.4334	0.4174
2619.8	0.4100	0.4319	0.4146	0.4324	0.4165
3361.8	0.4093	0.4312	0.4138	0.4316	0.4158
4293.3	0.4085	0.4303	0.4130	0.4308	0.4149
4892.0	0.4080	0.4298	0.4125	0.4302	0.4144
5639.8	0.4075	0.4293	0.4120	0.4297	0.4139
6121.5	0.4072	0.4291	0.4118	0.4294	0.4135
6717.5	0.4070	0.4288	0.4116	0.4292	0.4133
7414.8	0.4065	0.4284	0.4111	0.4288	0.4128
8229.5	0.4061	0.4281	0.4107	0.4284	0.4124
9269.8	0.4057	0.4277	0.4104	0.4280	0.4120
9912.5	0.4056	0.4276	0.4102	0.4279	0.4118
10179.1	0.4055	0.4274	0.4101	0.4277	0.4117

TABLE 6
FLEXURAL CREEP DATA

TEMPERATURE: 23°C
RELATIVE HUMIDITY: 50%
STRESS:1547 psi
SPAN LENGTH: 3.70 inches

Elapsed Time	Modulus (psi)					
Hours	1	2	3	4	5	Average
0.00						
0.02	631849	603181	574173	588004	584965	596434
0.03	619059	586687	561461	576951	580583	584948
0.10	592665	566762	549299	568404	572013	569829
0.20	585853	562517	543414	564225	565750	564352
0.50	579195	554214	535760	556047	557610	556565
1.0	572687	548146	528319	550068	551657	550176
2.0	564234	542209	522872	542294	545830	543488
5.0	552013	530714	510590	532879	532700	531779
19.8	534642	514356	497241	516731	516719	515938
52.8	518331	498977	481506	499899	500050	499753
100.1	504645	484490	469617	487203	487470	486685
195.5	490088	470821	456925	472213	472609	472531
334.5	477836	460711	447517	460868	461356	461658
436.9	469042	453752	438490	451380	453262	453185
1440.8	438130	423076	415726	419314	422386	423727
2042.8	427116	411485	398314	408162	411182	411252
2619.8	415510	401583	391146	397588	401595	401484
3361.8	407753	394205	383264	389515	394442	393836
4293.3	399236	385108	375694	381764	385611	385482
4892.0	394092	380233	371112	376150	380874	380492
5639.8	389078	375480	366641	371596	376251	375809
6121.5	386130	373612	364882	368916	372634	373235
6717.5	384190	370844	363141	367151	370851	371235
7414.8	379423	367217	358858	363671	366467	367127
8229.5	375694	364544	355504	360256	363034	363806
9269.8	372038	361038	353030	356905	359665	360535
9912.5	371135	360173	351399	356077	358004	359357
10179.1	370236	358453	350590	354432	357179	358178

FIGURE 1
AVERAGE LOG MODULUS VS LOG TIME
100.1 hours to 10179.1 hours

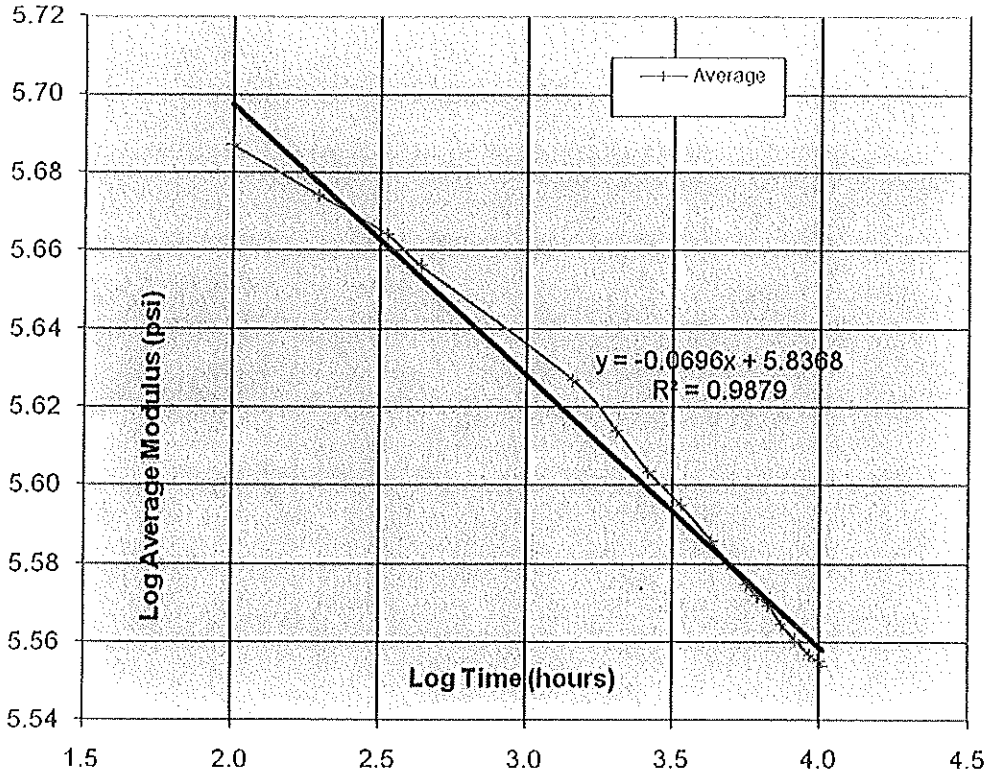
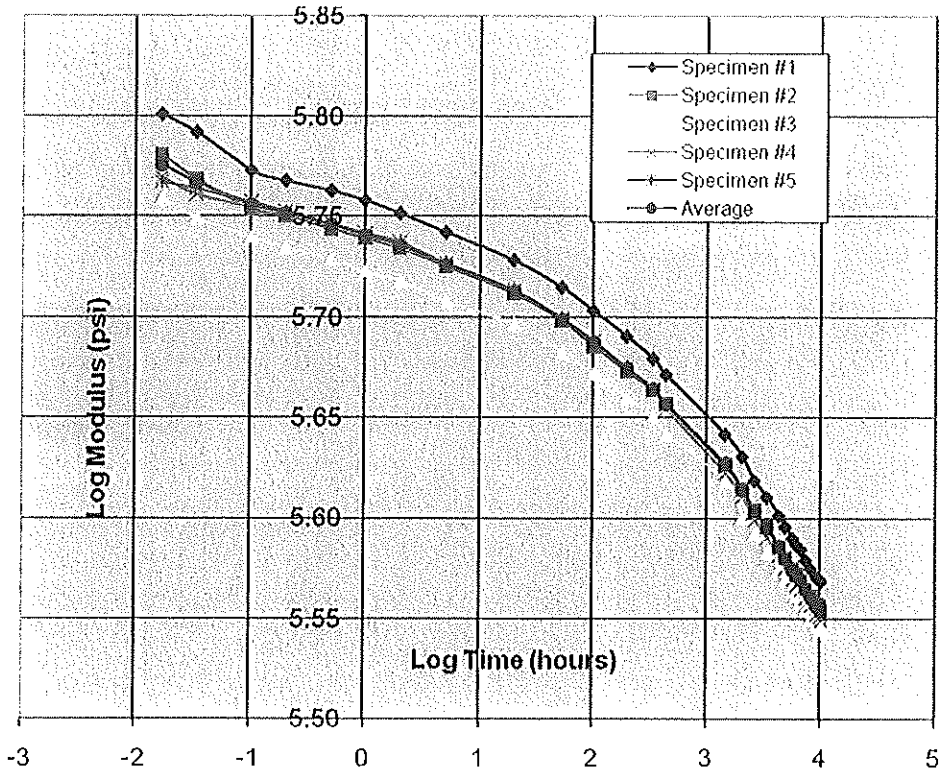
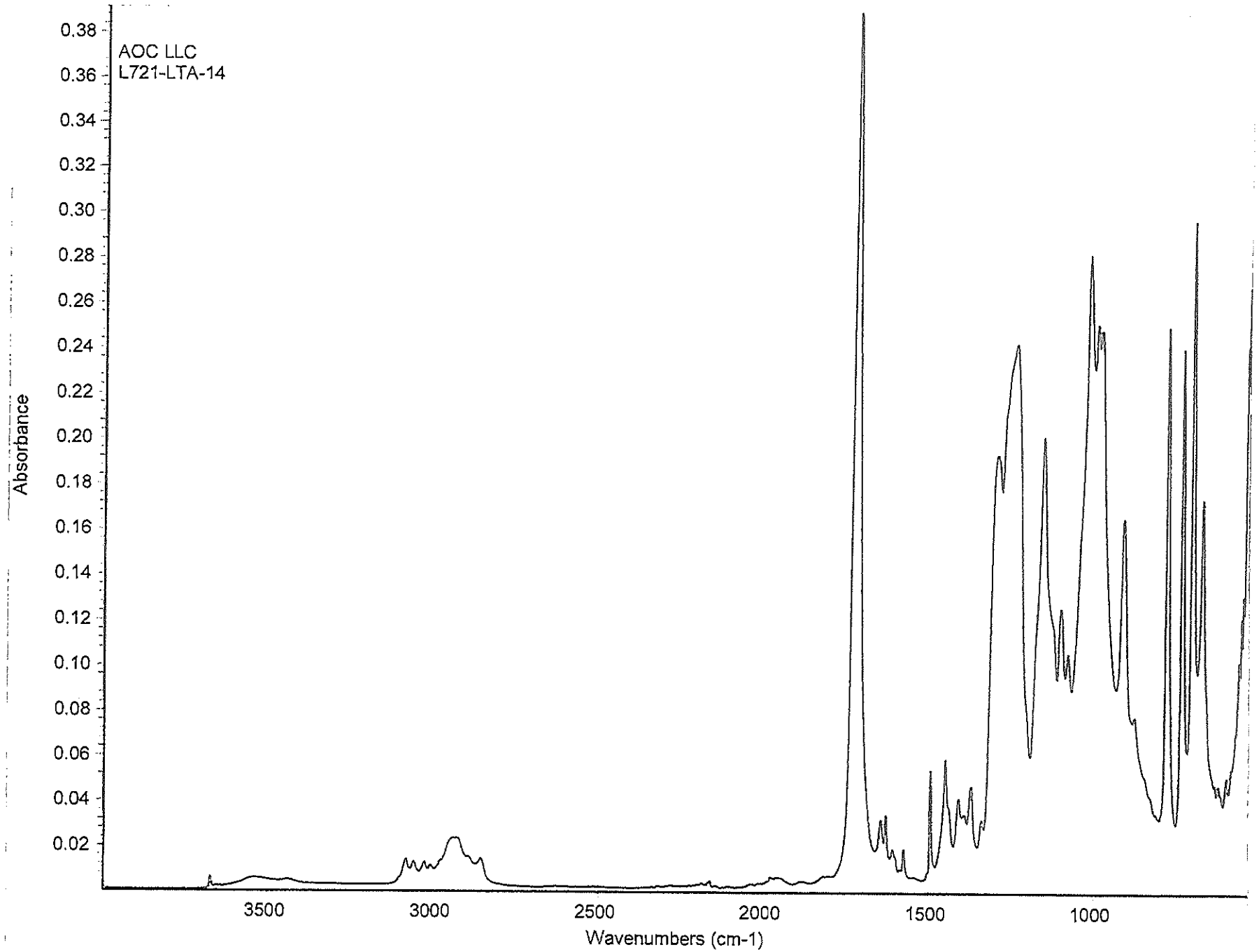


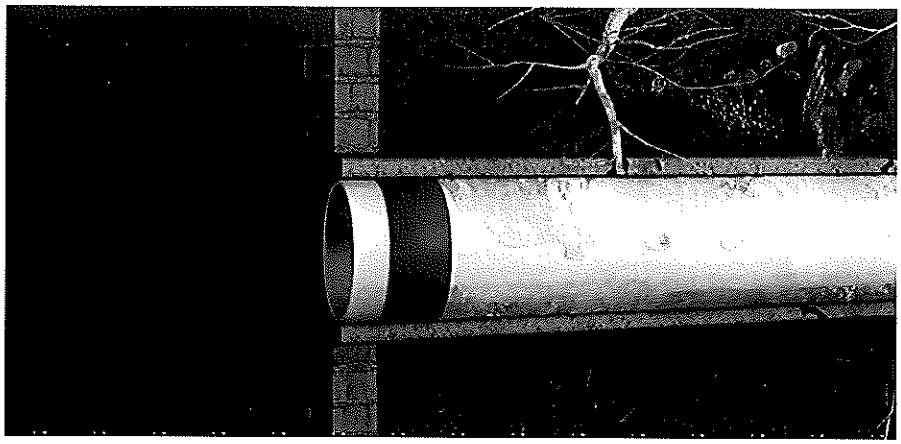
FIGURE 2
LOG MODULUS VS LOG TIME



INFRARED SPECTRA


AOC LLC
L721-LTA-14
Absorbance
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

INSIGNIA™ END SEAL SLEEVE FOR MAINLINE CIPP



The INSIGNIA Hydrophilic End Seal Sleeve is a seamlessly molded seal that provides a large sealing surface guaranteeing a uniform watertight seal. Designed for use in conjunction with CIPP mainline lining at the manhole termination ends.

- Five times more sealing surface than other sealing systems
- Swells seven to ten times original size when exposed to water in 36 to 48 hours
- Elongated cylindrical shape is more secure and stable once positioned within the pipe
- Seamlessly molded seal without any joints
- The metal retainer band secures the sleeve in place
- Compatible with all types of inverted liners and pull-in-place liners
- Seals maintain their flexibility and expansion properties while undergoing continuous hydration and dehydration cycles

Physical Properties	Test	Result
Material Composition		Hydrophilic Neoprene
Width of Seal (Dry)		3.5" (88.9mm)
Shore A Hardness	ASTM D 2240	S0 + 5 Point
Tensile Strength	ASTM D 412	1177 psi (8.1 MPa)
Elongation at Break	ASTM D 412	523%
Specific Gravity	ASTM D297	1.2
Swell Capacity in Water Contact	GRCSC	200 %

Availability:
The End Seal is available in the following sizes. Custom Sizes can be accommodated by modifying standard sizes. Contact LMK Technologies for information on custom sizes.

Pipe Inside Diameter	Pipe ID Circumference *	End Seal Thickness
6"	18.85"	.059 mm
8"	25.13"	.098 mm
10"	31.42"	.12 mm
12"	37.70"	.12 mm
15"	47.12"	.12 mm
18"	56.55"	.12 mm
21"	66.06"	.12 mm
24"	75.40"	.12 mm
27"	84.82"	.177 mm
30"	94.25"	.177 mm
33"	103.67"	.177 mm
36"	113.10"	.177 mm
42"	131.95"	.236 mm
48"	150.80"	.236 mm
54"	169.65"	.236 mm

* The actual sleeve circumference will be slightly less than stated so as to fit inside the host pipe.

End Seal Sleeve Kit Components		
Pipe Diameter	6", 8", 10", 12", 15"	18", 21", 24", 27", 30", 33", 36", 42", 48", 54"
Kit Contents	End Seal Rubber Sleeve Spring Loaded Metal Retaining Band	End Seal Rubber Sleeve Spring Loaded Metal Retaining Band Anchor Screws for Clay and Concrete Pipe

INSTALLATION:

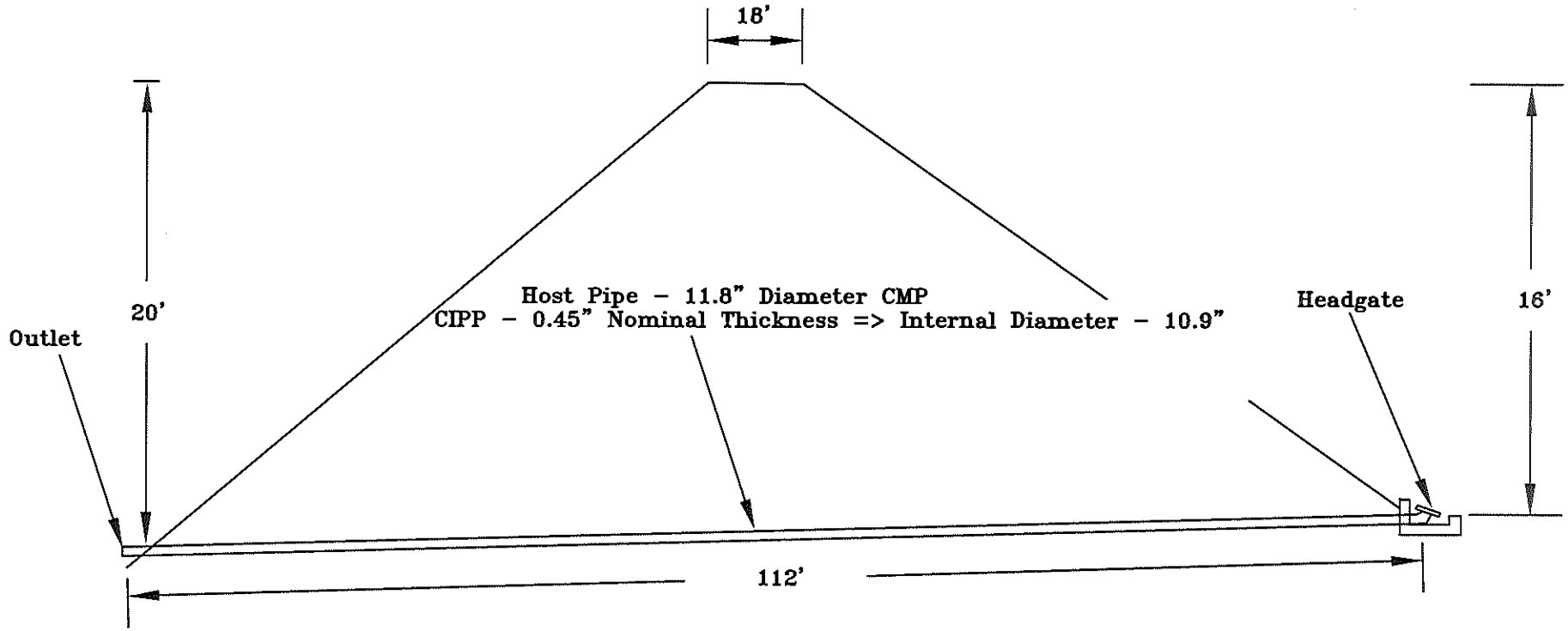
The End Seal Sleeve is manually positioned within the host pipe, from the manhole, prior to lining. The spring loaded metal retaining band is installed to prevent the sleeve from folding in. On large diameter sleeves, anchor screws are installed. The full length CIPP lining is then installed, thus embedding the end seal between the liner and the host pipe. Please see Installation Guidelines for full details.

STORAGE AND HANDLING:

Until use, store all End Seal Sleeves inside, in a dry, humidity controlled environment. The end seal sleeves will swell when exposed to moisture either direct or indirect. Shelf life is ten (10) years from date of manufacture. As with any elastomeric product, shelf life is greatly affected by the environmental conditions at which it is stored. Please see Safety Data Sheet for handling and safety information.

APPENDIX D

AS-BUILT SKETCH



* Not Drawn To Scale – Dimensions Are Approximate And Based On Information Provided By Owner

Title: AS–BUILT SKETCH	Date: 11/30/17	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing (970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Stambaugh Dam – DAMID 470220	Job No. 16–10519	
LOCATION: Jackson County, Colorado	Figure #1	