EXPERIMENTAL USE OF CORRUGATED POLYETHYLENE PIPE CULVERTS AND STORM DRAINS ON ROUTE 12 MONTPELIER, VERMONT

Initial Report 85-5

Reporting on Work Plan 83-R-1

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

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Materials & Research Engineer

Date: 03-29-'85

TABLE OF CONTENTS

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ABSTRACT

Approximately 730 linear feet of culverts and storm drains manufactured with high-density resins were placed as part of the Montpelier M6400(8) roadway project. The experimental product was placed throughout the drainage network on Vermont Route 12 (Elm St.) between MM 0259± and MM 0360± in the city of Montpelier during the 1983 and 1984 construction season.

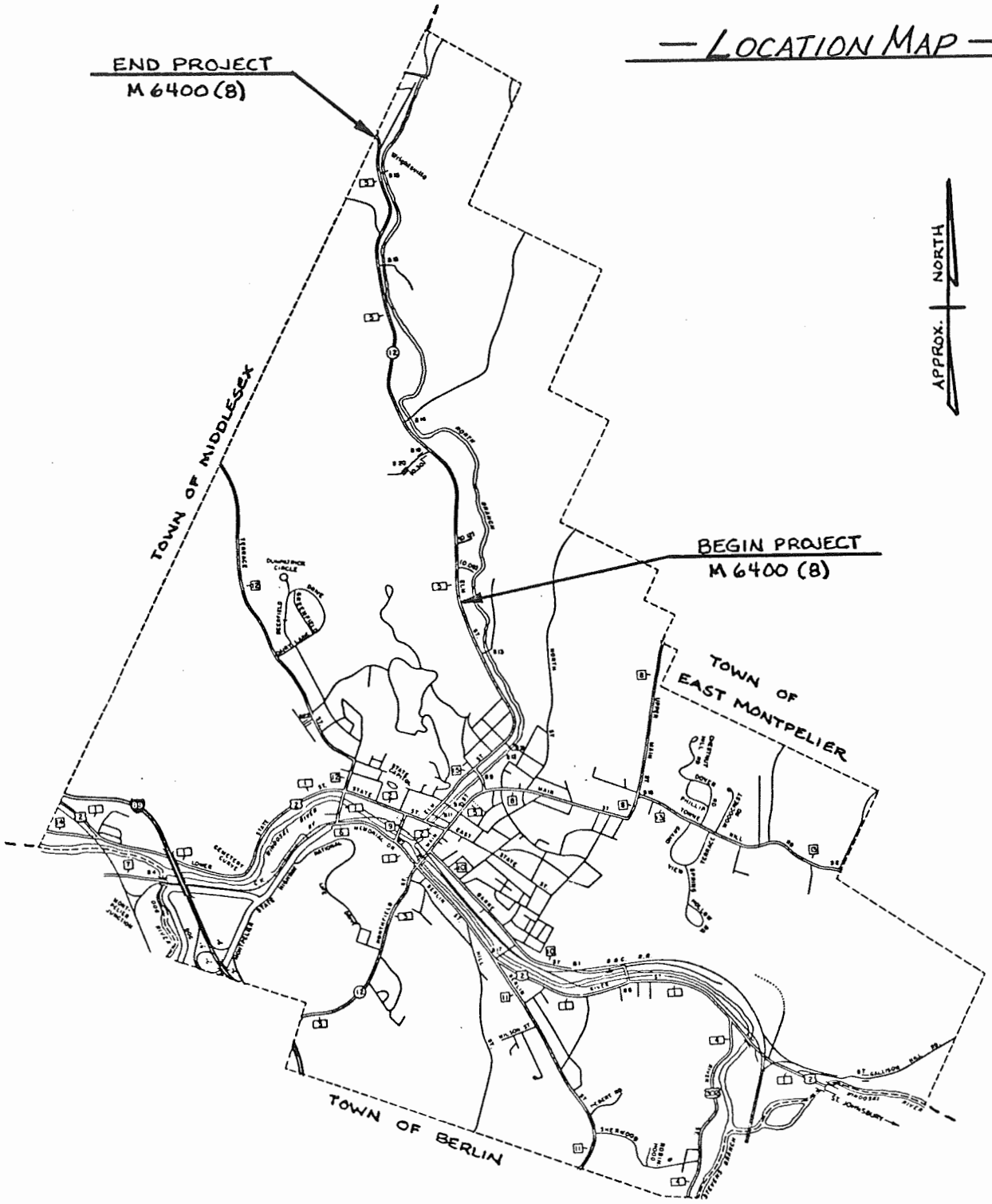
Prior to installation, a problem with cracking or separation between corrugations was experienced on the 24 inch and some of the 18 inch diameter sections. No other problems were encountered during installation. The lighter weight of the polyethylene pipes made for significantly easier handling as compared to the control system of ACCGMP and CGMP. Performance of both pipes has been satisfactory through the first 18 months of service.

INTRODUCTION

In January, 1983, the Vermont Agency of Transportation modified the specification for Section 601, Culverts and Storm Drains for the project Montpelier M6400(8). The Special Provisions for Section 601.02 Materials, specified the testing and evaluation of corrugated polyethylene pipe manufactured by Advanced Drainage Systems, Inc. (ADS), Columbus, Ohio. With the cooperation of the contractor, Earth Construction Company of Groton, Vermont, the experimental product was installed at five locations along Elm Street in Montpelier, Vermont during the 1983 and 1984 construction seasons. The experimental test area is shown on the Location Map on page 3.

This report described the observations made during installation and initial performance through the first 18 months of service.

— LOCATION MAP —



CITY OF MONTPELIER

WASHINGTON COUNTY

— NOT TO SCALE —

R&D 1905

PRODUCT INFORMATION AND INSTALLATION PROCEDURES AS PROVIDED BY SUPPLIER (ABRIDGED)

A.D.S. heavy duty tubing is manufactured with high-density polyethylene resins. The culvert pipe is lighter and easier to handle than clay, concrete or corrugated steel, resulting in reduced labor costs. The material used on the Montpelier project was supplied by E. J. Prescott, Inc. of Montpelier, Vermont.

A.D.S. tubing is virtually a chemically inert material. The high-density polyethylene tubing won't rust or rot, is unaffected by acidic or alkaline soil conditions, is extremely resistant to abrasion and won't misalign in unstable soils. The A.D.S. tubing has the strength to withstand the heaviest loads while costing significantly less than other comparable drainage materials.

WEIGHT COMPARISON (Approximate pounds per linear foot)

Inside Diameter	ADS Corrugated Plastic Tubing	Corrugated Metal	Clay or Concrete
18"	6.6	15.8	131
24"	13.8	19.4	217

Crushed stone, gravel or compacted soil backfill material should be used as the bedding and envelope material around the culvert. The aggregate size should not exceed one inch. The minimum cover for pipes with a diameter of 10 inches to 24 inches, is one foot.

INSTALLATION OBSERVATIONS

The A.D.S. pipes were delivered to a parking lot on the project for storage until needed for installation. On June 23, 1983, the Resident Engineer discovered that the 24 inch A.D.S. pipe had cracked or separated along the seams. The 18 inch and 24 inch pipes are manufactured using a spiral wrap technique with high heat bonding; the smaller sizes are molded from a seamless continuous extruded cylinder. The cracking had occurred in approximately 30% of the seams in various places and in some instances, ran almost the entire circumfrence. The distributor was notified of the problem and all of the 24 inch sections were replaced at no charge.

The following photographs were taken on June 23, 1983 and show examples of the cracking of the 24 inch pipe.

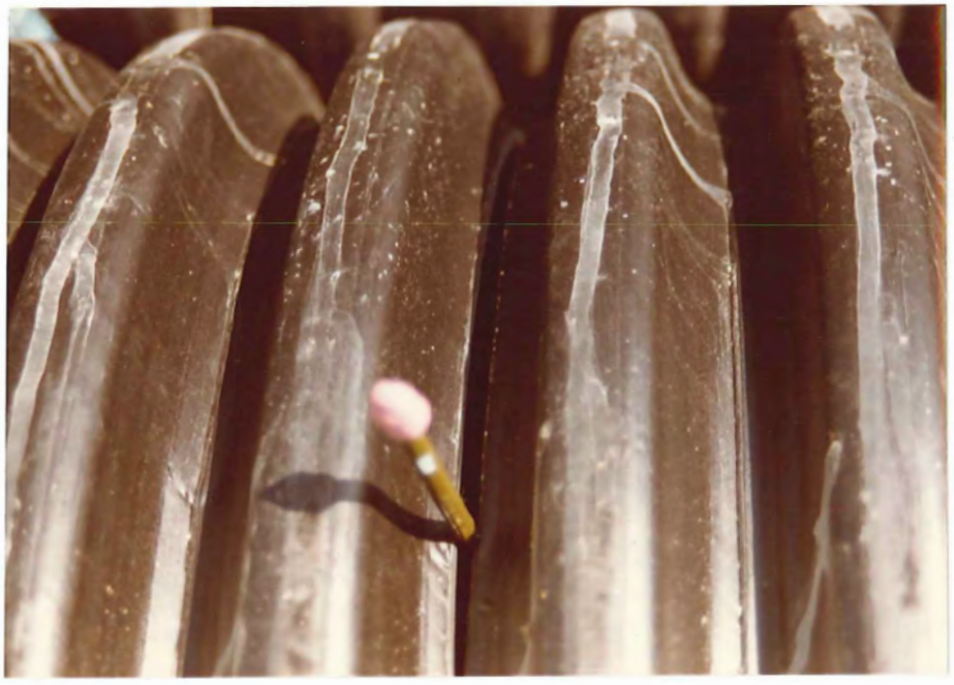


Photo #1 - 24 inch pipe with separated seam.

Photo #2 - 24 inch A.D.S. pipes with cracking along seams.

Advance Drainage Systems, Inc. was also notified of the problem and responded formally with a letter. The letter stated that the 24 inch pipe had passed all the standard tests including ASTM D2412 "Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading" and that the damage was believed due to vibration forces between interlocked segments of pipe during transportation. A copy of the letter dated July 26, 1983 can be seen in the Appendix.

Assuming the problem had been corrected, the installation and evaluation would continue as planned. The installation was done according to State of Vermont Agency of Transportation Standard Specification for Highway and Bridge Construction, Section 601, Culverts and Storm Drains and Section 605, Underdrains. There was one exception as required by the manufacturer which pertains to backfilling procedures. A.D.S, Inc. recommends that no stones in excess of one inch in diameter come in contact with the pipe while Vermont specifies three inches as a maximum. This was accomplished easily with no significant changes in the backfilling procedures. All compaction of backfill was done by means of a vibratory compactor.

Approximately five hundred feet of six inch A.D.S. pipe was placed as underdrain along the edge of the roadway between MM 0259 and MM 0269±. A six inch sand cushion was placed and compacted prior to laying the underdrain. Due to the extreme flexibility of the pipe, extra caution was needed to insure that the pipes were placed with proper alignment. Workers found it necessary to align the pipe by spot shimming and hand tamping prior to placing the first lift with a front end loader. This was accomplished without difficulty.

The sections of six inch pipe were connected using a five inch split coupling band. It was found that the coupling did not hold the pipe firmly in place and required a tape wrap to prevent the connection from separating during backfilling. An example is shown in the following photo:

Photo #3 - Workers applying tape to the split coupling for the six inch underdrains.

Backfill used for the underdrain was Sand Borrow Item 703.03. The fill was placed in one foot lifts in all areas except where a parking lot access crossed the pipe, then six inch lifts were used. The trench was backfilled to a height of approximately four feet above the pipe when the first load, a large bucket loader, crossed the pipe.

On July 19, 1983, the 24 inch ADS pipe was installed at MM 0339±. The lightweight of the ADS pipe enabled two men to easily maneuver a 20 foot long 24 inch diameter section into the trench. Splices were done using a two foot long spin-on coupling. The system did not work because the coupling band would not spin as designed. It was found necessary to screw the coupling onto the in-place pipe for half the

width of the band, then actually turn and thread the 20 foot long 24 inch pipe into the coupling. The photos below show workmen installing the 24 inch pipe.

Photo #4
Moving a 20 foot section of the 24 inch pipe to the installation site.

Photo #5
Lowering a 20 ft. long 24 inch pipe into a trench.

Photo #6
Threading the 20 foot long 24 inch pipe "into the coupling."

The 24 inch pipe was placed on a flat bed of Sand Borrow. A three to four inch lift of Granular Back-fill for Structures was placed around the pipe and rodded with shovel handles. Additional lifts were placed & compacted at 6" for each lift for a height of 4 feet. The workers were very careful to remove stones in excess of an inch in diameter from coming in contact with the pipe. When it was found that one section of the 24 inch pipe was too long, it was easily shortened by cutting with a chain saw as seen in the photo below.

Photo #7
Cutting 24 inch ADS pipe with a chain saw.

The initial load on the 24 inch pipe was a road grader when the fill height was 4± feet. The grader was spreading the last lift of granular backfill and is shown in the photo below.

Photo #8 First load over 24 inch ADS pipe.

Photo #9 Using vibratory compactor over 24 inch ADS pipe.

On September 21, 1983, the Resident Engineer found that some of the remaining stockpiled 18 inch pipe had cracked along the seams in the same manner as the 24 inch. He stated he would not replace and install the pipe and would use ACCGMP in its place. The company was again made aware of the problem and responded with a letter which stated that the reason for the problem encountered was the same as with the earlier situation involving the 24 inch pipe. The above mentioned 18 inch pipe proposed for installation at milemarker 0302± was replaced with an 18 inch ACCGMP at the same price according to the Resident Engineer.

The remaining three sections of ADS 18 inch pipe appeared to be in good condition and were installed on September 21, 1983 at milemarker 0309±. Procedures were the same as described with the 24 inch pipe. The 18 inch pipe was installed as an outlet from a Drop Inlet and crossed under the roadway to empty into the North Branch River. The initial load to cross the pipe was a road grader with two feet of cover over the pipe. The grader placed an additional 6 inches of cover which was then compacted. When three axle fully loaded dump trucks passed over the pipe, a slight deflection could be seen when looking through the culvert. The top part of the pipe would flex down as the load crossed, then it would rebound back to its original circular shape. A plan view location sketch can be seen on page 13.

Due to their flexibility, the ADS pipes did not hold their exact shape when backfilled. The 18 and 24 inch pipes had very slight loss of alignment and some oblong characteristics. When sighting down through the pipe, minor variations in the sides and top could be seen.

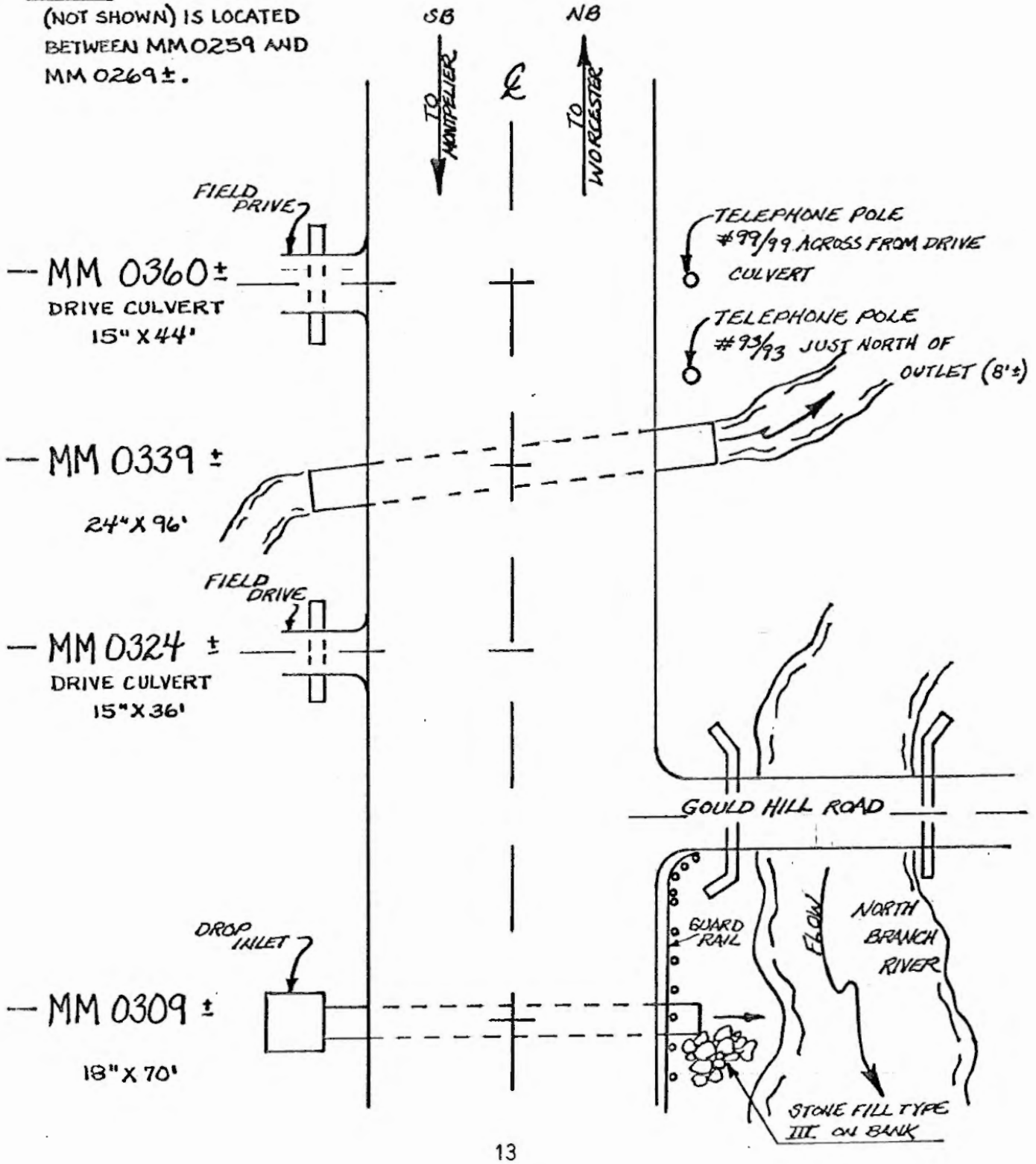
VERMONT AGENCY OF
TRANSPORTATION
RESEARCH & DEVELOPMENT

BY : NED HOUSTON
DATE : 9·21·84

PROJECT : MONTPELIER
PROJECT NO : M 6400(8)
ROUTE : VT. RTE. 12
(ELM ST.)

A.D.S.
PLASTIC PIPES
LOCATION SKETCH
-NOT TO SCALE-

NOTE: 6" UNDERDRAIN (NOT SHOWN) IS LOCATED BETWEEN MM 0259 AND MM 0269±.



During installation it was evident that the workers became more comfortable as they learned about the experimental ADS pipes. All seemed to enjoy the lightweight characteristics and preferred the splices to the ACCGMP. Even with the extra work involved to keep the pipes aligned, they felt they were easier to work with than standard pipes.

The ADS 15 inch culverts were installed in the spring of 1984. Both were installed at field drive locations. The pipe at milemarker 0324± was damaged by construction equipment which backed over it with minimum cover causing the top to cave in slightly in two locations. The amount of cover was not recorded by the inspector who was monitoring the installation for the Agency. The Resident Engineer felt that the damage was not significant enough to justify removal or replacement of the culvert. The culvert at milemarker 0360± was installed without any problems.

COST INFORMATION

Special Provisions called for the ADS pipes as a substitute for steel culverts at certain locations. The cost of the experimental feature was higher than what could be expected on the open market. The following prices were obtained from distributors in the Montpelier area as of Feb., 1985.

Size	Cost of Metal Pipes	Cost of ADS Pipes
24 inch	$11.12/lf.	$15.25/lf.
18 inch	$ 8.75/lf.	$ 7.25/lf.
15 inch	$ 5.35/lf.	$ 5.70/lf.
6 inch	$ 2.00/lf.	$ 0.64/lf.

POST CONSTRUCTION OBSERVATIONS

The ADS pipes were inspected in August of 1984 after one winter in place. The two drive culverts were in place only for the summer. On the night of June 6, 1984, the Montpelier area received heavy rains which caused the Winooski River to reach the ten year flood level. This was the first significant rainfall experienced in the project area since the installation. No significant problems were encountered as a result of the heavy rainfall.

The inspection on August 19, 1984 revealed the ADS pipes to be in good condition. There were some areas of the 24 and 18 inch pipes which were still slightly out of round, as found during the installation. The 18 inch had sediment built up along the invert line but was dry at the time of inspection. The 24 inch had a small amount of water flowing through it.

No significant problems were noted during the inspection of the 18 and 24 inch ADS pipes. There was no change noted in the condition of the drive pipe which was damaged during placement. None of the pipes show any affect of scour due to sediment load or ultra-violet degradation.

SUMMARY

1) Workmen on the project preferred the light weight characteristics and ease of installation of the ADS pipes as compared to the standard metal pipes.

2) The backfilling procedures required some extra attention to insure proper alignment of the six inch underdrain pipes.

3) Two pipe sized (18 & 24 inch) cracked or separated at the seams while in storage on the project. Advance Drainage Systems, Inc. related this problem to shipping procedures.

4) With the exception of damage during installation to the 15 inch drive culvert, no significant problems were encountered during installation and performance over eighteen months of service.

FOLLOW-UP

The experimental ADS pipes will continue to be monitored for the following items:

- separation of pipe at the seams
- effect of ultra-violet on exposed areas
- failure due to traffic loads
- possible abrasion due to scour

The metal pipes will be checked for section and coating loss.

ADS
ADVANCED DRAINAGE SYSTEMS, INC.
2375 BENNINGHOFEN, HAMILTON, OHIO 45015 (513) 863-1384

July 26, 1983

Mr. Ronald Frascoia
Research & Development Supervisor
Vermont Agency of Transportation
Materials and Research Division
133 State Street
State Administration Building
Mountpelier, Vermont 05602

Re: Advanced Drainage Systems, Inc.
24 - Inch I.D. Corrugated Polyethylene Tubing

Dear Mr. Frascoia:

Mr. Norm Bryan has related the unfortunate experience you encountered with our 24" I.D. tubing that cracked. Our investigation of the tubing has revealed the following findings.

1. The raw material used was of the proper specifications.

2. The tubing surpassed 40 Psi at 5% deflection and 30 Psi at 10% deflection when testing a 24" length section using the method described in ASTM D2412 "Test for External Loading Properties of Plastic Pipe by Parrallel - Plate Loading".

3. The tubing withstood an impact of 2000 foot pounds with no cracking or other damage.

After reviewing our records, we now feel this product may, at times, be susceptible to the type of damage you encountered due to shipping conditions. To eliminate this possibility, we are now requiring our plants to place a sheet of plywood between the horizontal layers of the tubing during shipment. This will prevent the corrugations of the tubing from nesting and, we feel, should dampen enough vibration to prevent cracking. In addition, we are exploring potential methods to reduce the stress concentration areas produced by the laminate overlaps.

I apologize for any inconvenience this situation may have caused you. I feel our 18" and 24" I.D. corrugated polyethylene tubing offers advantages that tubing made of other materials cannot match. As I have indicated above, it appears that, although these products can withstand a substantial impact, the vibrations encountered during shipping can sometimes have damaging effects. We will be closely monitoring future shipments of these products to determine if further steps need to be taken.

Thanks for your interest in this matter. If you have further concerns regarding this matter, please feel free to contact me.

Sincerely,

DEAN S. CARPENTER
Quality Control Manager

DSC/swl

cc: Mr. Norm Bryan

ADVANCED DRAINAGE SYSTEMS, INC.

3300 RIVERSIDE DRIVE P. O. BOX 21307 COLUMBUS, OHIO 43221 (614) 457-3051 TELEX NO. 245-461

August 12, 1983

Mr. Ronald Frascoia
Research & Development Supervisor
Vermont Agency of Transportation
Materials & Research Division
133 State Street
State Administration Building
Montpelier, Vermont 05602

Dear Ron:

It was a pleasure to speak with you on July 20. As we discussed, I checked with our lab personnel in Hamilton, Ohio about the cracked pipe discovered on the Elm St. project in Montpelier. I believe you have received a letter from our Dean Carpenter concerning the problems with this particular shipment of pipe.

I can appreciate your concern over the potential of the replacement pipe developing the same problem; however, since the problem has been very intermittant in nature and since I have been advised by our plant personnel that improved shipping requirements were instituted prior to shipment of the replacement pipe; I have no reason to expect any problems with the replacement pipe.

It is my understanding you may be attending the installation on September 20 of the pipe we furnished to your Bennington personnel; I will look forward to seeing you there. If I can be of any assistance until then, please feel free to contact me.

Best regards,

Norman T. Bryan, Jr., P.E.
Marketing Engineer

CC: R. Slicker
R. Tartaglia

NORMAN T. BRYAN, JR., P.E.
MARKETING ENGINEER

1125 FLORIBUNDA LANE
MECHANICSBURG, PA 17055
(717) 766-0009

1-800-628-6050

ADS
ED DRAINAGE SYSTEMS, INC.

7 COLUMBUS, OHIO 43221 (614) 457-3051 TELEX NO. 245-461

3685

September 30, 1983

Mr. Ronald I. Frascoia
Research and Development Supervisor
Vermont Agency of Transportation
Materials and Research Division
133 State St., State Adm. Bldg.
Montpelier, Vermont 05602

Dear Ron:

As I explained during our phone conversation of September 27, the cracking experieiced on some of our 18 inch diameter polyethylene pipe on the Elm St. project was, I believe, the same type of problem encountered on the 24 inch diameter pipe which we replaced on this same project.

As explained in previous correspondence (July 26, 1983 from our Dean Carpenter and August 12, 1983 from me) and our phone conversation, the cracking problem has been localized and was a combination of shipping and manufacturing problems. As I explained, action has been taken to rectify these problems.

I now believe we should have replaced both the 18 and 24 inch pipe when the problem was encountered with the larger pipe; however, since no problem had been found with the 18 inch already installed, we did not anticipate this latest unfortunate incident. My apologies for this situation.

Based on the advantages of these products however, we still hope to be able to pursue an approval for inclusion in your specifications following your field evaluation of them.

If I can be of any assistance during the evaluation phase, don't hesitate to call.

Sincerely yours,

Norman T. Bryan, Jr., P.E.
Marketing Engineer

CC: R. Slicker
R. Tartaglia
S. Cortell

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

Work Plan For Category II Experimental Project

ADS Corrugated Polyethylene Pipe Work Plan 83-R-1

OBJECTIVE OF EXPERIMENT

To compare the performance of ADS Corrugated Polyethylene Pipe systems with the standard ACCMP.

PROJECT

Montpelier M6400 (8)

PROJECT LOCATION

Beginning on Elm Street 2.101 miles south of the Montpelier/Middlesex town line and extending northerly for 2.101 miles back to the town line.

EXPERIMENTAL WORK LOCATION

ADS pipes will be used at the following stations:

Underdrain 6"	137+96 - 139+94 Lt.	(20 foot straight pieces)
	139+97 - 142+95 Lt.	(coiled pipe)
Drive Culverts	172+00 - 15"x 36'	
	191+00 - 15"x 44'	
Mainline	159+89 - 18"x 70'	
	162+93 - 18"x 60'	
	179+66 - 24"x 96'	

MATERIALS TO BE USED

ADS Corrugated Polyethylene Pipe is a heavy-duty flexible plastic tubing manufactured with high-density polyethylene resins. ADS pipes to be used include:

6" Underdrains
15" Drive culverts
18" & 24" Roadway drainage pipes

ADS pipes are manufactured by:

Advanced Drainage Systems Inc.
3300 Riverside Drive
P.O. Box 21307
Columbus, Ohio 43221

INSTALLATION PROCEDURE

The installation of the pipe sections will be carried out as specified under State of Vermont Standard Specifications for Highway and Bridge Construction, section 601 - Culverts and Storm Drains.

CONTROL SECTION

ACCGMP will be used as the control material on the project.

COST

The experimental pipes will be installed at the same per lineal foot bid price as the ACCGMP. The estimated cost breakdown is as follows:

Pipe Size	Cost/Lineal Foot
24"	$18.00
18"	15.00
15"	15.00
6"	4.50

INSTALLATION

The installation will be completed prior to November, 1983.

DURATION OF STUDY

The project will be evaluated for the length of time required to obtain valid conclusions on the performance of ADS pipe systems.

SURVEILLANCE

The monitoring of ADS performance will include the following:

Handling characteristics during installation
Effect of ultra-violet light on exposed areas
Potential for cracking due to cold temperatures
Failure due to traffic loads
Possible abrasion due to scour

The ACCGMP will be monitored for section and coating loss.

REPORTS

An initial report covering installation and initial observations and a final report drawing conclusions on the effectiveness of the experimental materials will be submitted to the FHWA.

Reviewed By:

R. F. Nicholson

R. F. Nicholson, P.E.
Materials & Research Engineer

Materials & Research Division
Agency of Transportation
January 14, 1983

Date: 1-14-83