

Report No. CDOH-DTD-R-88-12

PLASTIC PIPE USE UNDER HIGHWAYS

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Final Report
May, 1988

Prepared in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Colorado Department of Highways or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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16. Abstract Plastic storm sewer pipes were used on 2 projects in Colorado in 1984 and 1985. The installation of the pipes was documented and their performance was observed for 3-1/2 years. No problems were encountered with the plastic pipes, although they were prone to float if care was not used during backfill and compaction operations. The cost savings due to reduced material costs are significant. Implementation The use of plastic pipes in highway drainage will continue on an experimental basis. Fill heights are currently limited to 15 feet. New installations will be monitored under an ongoing study.					
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PLASTIC PIPES UNDER HIGHWAYS

I. BACKGROUND

The use of plastic pipes for highway drainage shows promise of saving both time and money in highway construction. The weight of plastic pipes, as compared with steel or concrete can save time and equipment costs when placing. In addition, plastic pipes are generally unaffected by corrosive soils or water. Initial concerns that the plastic pipes would deform or fracture under loads from highways have not been substantiated.

Plastic pipes were installed on two projects in Alamosa, Colorado in September and October of 1984 and in September and October of 1985. Pipe sizes between 8 and 24 inches were used. This report describes the installation of the plastic pipes and reports on their performance over the last 3 years.

II. CONSTRUCTION

Work began on Project M-6022(1) in August of 1984. This project consisted of installing plastic sewer pipes along 6th Street between La Veta and Edison Avenues in Alamosa.

Project FR 160-2(39) followed one year later and completed similar work along State Highway 160 in Alamosa.

Please refer to Appendix A for maps of the project sites.

Total quantities of PVC sewer pipes used on the two projects were as follows:

8 in. PVC	195 lin. ft.
12 in. PVC	88 lin. ft.
15 in. PVC	2780 lin. ft.
18 in. PVC	1455 lin. ft.
21 in. PVC	480 lin. ft.
24 in. PVC	1552 lin. ft.

Specifications used for the plastic sewer pipes can be found in Appendix A.

The procedure for placing the plastic pipes was no different than that used for other pipes. In most cases the pipes could be placed in the trench by hand. The project engineer reported that the plastic pipes are more prone to damage than concrete or steel pipes but that given reasonable care the plastic pipes are sufficiently durable and in addition, are much easier to handle. The only difficulty experienced with the plastic pipes was during the backfill operation. Because of the light weight of the pipes, they tended to "float" as the backfill material was placed and tamped alongside the pipes. Tamping had to be minimized until enough fill material was on top of the pipe to weight it down. However, on these two projects, no significant deviations from the intended pipe grades occurred.

(Please see the construction photographs in Appendix B)
In this situation, the backfill soil's optimum moisture content should be carefully determined in order to reach the required compaction with minimum tamping.

III. INSPECTIONS

The plastic pipes were inspected several times after completion of the two projects. On two attempts, inspections were not possible due to high ground water and repairs to the pumping stations. Visual inspections were done from the manholes and inlets and photographs were taken when possible to document the condition of the pipes. No damage or deformations were observed during any of the inspections and the ends of the pipes all appeared in good condition with no chips or visible cracks.

IV. COSTS

The costs (per lineal foot) of the plastic pipes used on these two projects and comparison costs of other materials are shown below.

Description (Diameter)	Plastic * Pipe (\$)	Reinforced ** Concrete (\$)	Corrugated ** Steel (\$)
8 in.	5.63	NA	NA
12 in.	8.70	17.50	17.00
15 in.	11.90	22.40	22.54
18 in.	16.52	22.74	18.00
21 in.	14.50	24.14	NA
24 in.	24.65	30.30	36.00

NA Particular pipe was not included in any projects in 1984/1985

* Weighted average of pipes installed in Alamosa projects.

** Weighted average from 1984 & 1985 Colorado Cost Data Manuals.

The cost savings due to the reduced material costs on these two projects was over \$52,000. It is expected that cost savings were also realized as a result of the lighter weight and easier handling of the pipes. On the other hand, it is possible that some additional costs were incurred due to the contractors' unfamiliarity with the plastic pipes. In either case, it seems conservative to say that the material cost savings alone justify further consideration of plastic pipe use.

V. IMPLEMENTATION

At this time there appears to be no reason for disallowing the use of plastic pipes in highway construction. The plastic pipes will continue to be an experimental feature until sufficient long-term data has been acquired. Several questions remain about the long-term performance of the plastic pipes:

- Do plastic pipes creep? If so, under what fill heights does this become a problem? What is the rate of creep? Will the larger plastic pipes now being manufactured (> 24") creep more?
- Are there construction techniques which can eliminate "floating" during backfill operations.
- Are connections between pipes as durable as the pipes?
- Is ultraviolet degradation (on end sections) a long-term problem?

The use of plastic pipes may prove especially cost effective in areas where corrosive soils or water are prevalent. To date, no failures of plastic pipes have been reported on any projects in Colorado.

The Colorado Department of Highway's Culvert Committee is actively seeking additional sites to place plastic culvert pipes but fill heights are currently limited to 15 feet. These new sites will be monitored under an ongoing study as they are installed. Future evaluations will consist of monitoring the construction and conducting periodic inspections of the pipe dimensions and integrity. Once the performance of the plastic pipes has been adequately documented, the choice of pipe material- concrete, steel or plastic will be largely determined by price.

APPENDIX A

Site Map for Project M-6022(1)
Plastic Pipe Specifications for Project M-6022(1)

Site Map for Project FR 160-2(39)
Plastic Pipe Specifications for Project FR 160-2(39)

See Standard Manual for STANDARD SYMBOLS

STATE DEPARTMENT OF HIGHWAYS DIVISION OF HIGHWAYS—STATE OF COLORADO

PLAN AND PROFILE OF PROPOSED FEDERAL AID PROJECT NO. M 6022(1) 6 TH. STREET, LA VETA EAST-ALAMOSA ALAMOSA COUNTY

FEDERAL AID REGION NO.	01-3-01	PROJECT NO.	M 6022(1)	SHEET NO.	1
STATE	COLORADO				

AS CONSTRUCTED		
NO REVISIONS	REVISED	VOID

REVISIONS		

INDEX OF SHEETS

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- 15-16

- Title Sheet and Tabulation of Length and Design Data.*
- Standard Plans List.*
- Typical Sections, Curb & Gutter Detail, Traffic Legend 2004 DNV and General Data.*
- Summary of Approximate Quantities.*
- Removal of Existing Surfacing, Surfacing Plan and Summary of Earthwork Quantities.*
- Curb, Gutter, Concrete Pavement Tabulation & Construction Control Devices.*
- Structure Quantities.*
- Plan and Profile Sheets.*
- Typical Manhole Connections, Modify Manhole and Cross Section of Typical Precast Manhole.*
- Detail of Manhole Special.*
- Drainage Plan.*
- Detention Pond 2, Outlet Detail and Safety Rack.*

SCALES OF ORIGINAL DRAWINGS

ON PLAN, 1 IN. = 50 FT.
ON PROFILE, 1 IN. = 50 FT. HORIZONTAL
1 IN. = 8 FT. VERTICAL

GRADE LINE ON PROFILE IS SHOWN AS GRADE OF FINISHED ROAD

Tabulation of Length and Design Data

STATION	ROADWAY LIN. FT.		
Sta. 0+00 Begin M6022(1)	2,000.0		
Sta. 20+00 End M6022(1)			
Total	2,000.0		
Summary			
ROADWAY	LIN. FT.	MILES	
(Net & Gross Length)	2,000	0.379	
Design Data			
Maximum Degree of Curve		N.A.	
Minimum Grade		3.118 %	
Minimum S.S.D. Vertical		N.A.	
Minimum S.S.D. Horizontal		N.A.	
Maximum Design Speed		25 MPH.	
2004 DESIGN TRAFFIC VOLUME			
6TH AVE LAVETA AVE. TO WEST AVE.	ADT = 980		
	DNV = 110		
6TH AVE WEST AVE. TO EDISON AVE.	ADT = 1700		
	DNV = 210		



T.37 N., R.10 W., N.M. P.M.



DIVISION OF HIGHWAYS	
APPROVED:	7-18-84
<i>W.P. [Signature]</i>	DATE
for CHIEF ENGINEER	

AS CONSTRUCTED INFORMATION	
CONTRACTOR _____	ENGINEER _____
(Project or Resident)	
PROJECT STARTED _____	
PROJECT COMPLETED _____	
AS CONSTRUCTED PLANS APPROVED _____	
TITLE _____	DATE _____

July 18, 1984

REVISION OF SECTION 604
STORM SEWERS
COLORADO PROJECT NO. M 6022(1)

Section 604 of the Standard Specifications is hereby revised for this project as follows:

Subsection 604.02 shall include the following:

Plastic Pipe Sewer (Polyvinyl Chloride) and fittings shall conform to the following:

Pipe diameters of 15 inches or less shall conform to ASTM D 3034 with an SDR 35 wall thickness. Eight inch diameter pipe conforming to AWWA Standard C 900 will be allowed.

Pipe diameters greater than 15 inches shall conform to ASTM F 794.

Pipe shall not be exposed to the sun's direct rays during shipping or storage.

High Density Polyethylene Pipe shall be "Spirolite", Class 100 as manufactured by Spiral Engineered Systems, 4094 Blue Ridge Industrial Parkway, Norcross, Georgia 30071. Pipe joining shall be according to the manufacturer's recommendations for storm sewer systems.

Subsections 604.03, 604.04 and 604.06 shall include the following:

Installation of Plastic Pipe Sewer (Polyvinyl Chloride) of High Density Polyethylene Pipe shall conform to ASTM D 2321.

Subsection 604.08 shall include the following:

Pay Item	Pay Unit
" Plastic Pipe Sewer (Polyvinyl Chloride)	Linear Foot

July 18, 1984

ALTERNATIVE MATERIALS
COLORADO PROJECT NO. M 6022(1)

This project contains bid items for Plastic Pipe Sewer (Polyvinyl Chloride) in 8-inch, 12-inch, 15-inch, 18-inch, 21-inch and 24-inch diameters. The following materials may be substituted for the plastic pipe sewer (polyvinyl chloride) on an equal diameter basis.

1. High Density Polyethylene Pipe conforming to the Revision of Section 604.
2. Concrete Pipe conforming to Section 604.

The substitution shall be complete in place at the prices bid for Plastic Pipe Sewer (Polyvinyl Chloride).

Only one type sewer pipe in diameters greater than 8 inches shall be used on the project. The Contractor shall state at the preconstruction conference the type of pipe he intends using.

See Standard M-100-1 for STANDARD SYMBOLS

STATE DEPARTMENT OF HIGHWAYS DIVISION OF HIGHWAYS—STATE OF COLORADO

PLAN AND PROFILE OF PROPOSED FEDERAL AID PROJECT NO. FR 160-2(39) STATE HIGHWAY NO. 160 ALAMOSA COUNTY

SHEET NO.

FEDERAL ROAD DISTRICT NO.	DIVISION	PROJECT NO.	SHEET NO.
	COLORADO	FR 160-2(39)	1

AS CONSTRUCTED			
NO REVISIONS	REVISED	VOID	

REVISIONS			

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- 2) STANDARD PLANS LIST
- 3) TYPICAL SECTIONS
- 4) GENERAL NOTES
- 5-7) SUMMARY OF QUANTITIES
- 8-9) STRUCTURE QUANTITIES
- 10) TABULATION OF STORM SEWER SYSTEM
- 11) TABULATION OF CONCRETE CURB, GUTTER, SIDEWALK AND PAVEMENT, HANDICAP RAMPS, BITUMINOUS SLOPE AND BITCH PAVING, HARBOR AND VALVE BOX ADJUSTMENTS AND CONSTRUCTION TRAFFIC CONTROL DEVICES
- 12) TABULATIONS OF REMOVALS AND LIGHTING, SURFACING PLAN, SUMMARY OF EARTHWORK QUANTITIES AND METTING QUANTITIES
- 13-16) PLAN AND PROFILE SHEETS
- 17) DETAIL OF SPEED CHANGE LAKES AND INTERSECTION TRAFFIC DATA
- 18-19) LIGHTING PLANS

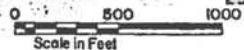
SCALES OF ORIGINAL DRAWINGS
ON PLAN, 1 IN. = 50 FT.
ON PROFILE, 1 IN. = 50 FT. HORIZONTAL
1 IN. = 5 FT. VERTICAL
GRADE LINE ON PROFILE IS SHOWN AS GRADE OF FINISHED ROAD
GROSS LENGTH OF PROJECT, 4500 FT. = 0.852 MILES
NET LENGTH OF PROJECT

Sta. 94+00 End FR 160-2(39)
Sta. 49+32.90 ON C 30-0010-14
MP 231.70

Sta. 49+00 Begin FR 160-2(39)
Sta. 49+00 ON C 30-0010-14 MP 232.55

LENGTH AND DESIGN DATA

STATION	ROADWAY	
	LINEAR FEET	MILES
49+00 BEGIN FR 160-2(39) - 49+32.90 ON C30-0010-14, R.P. 232.55	4500.00'	0.852'
94+00 END FR 160-2(39) - 49+32.90 ON C30-0010-14, R.P. 231.70		
TOTALS	4500.00'	0.852'
SUMMARY	LINEAR FEET	MILES
ROADWAY NET AND GROSS LENGTH	4500.00'	0.852'
DESIGN DATA		
MAXIMUM DEGREE OF CURVE	14° 33' 30"	
MAXIMUM GRADE	0.85%	
MAXIMUM 150' HORIZONTAL	1.70%	
MAXIMUM 150' VERTICAL	> 1.70%	
MAXIMUM DESIGN SPEED	35 MPH	
2005 DESIGN TRAFFIC VOLUME	ADT=1,710	
	ADT=15,400	



T.37N., R.10E.

DIVISION OF HIGHWAYS

APPROVED: Robert Z. Chynoweth 6-24-85
CHIEF ENGINEER DATE

AS CONSTRUCTED INFORMATION

CONTRACTOR A.S. CONCRETE CO.
FRAT. ENGINEER Ed Eugene Zilak
(Project or Resident)

PROJECT STARTED 2-1-85
PROJECT COMPLETED 5-28-85

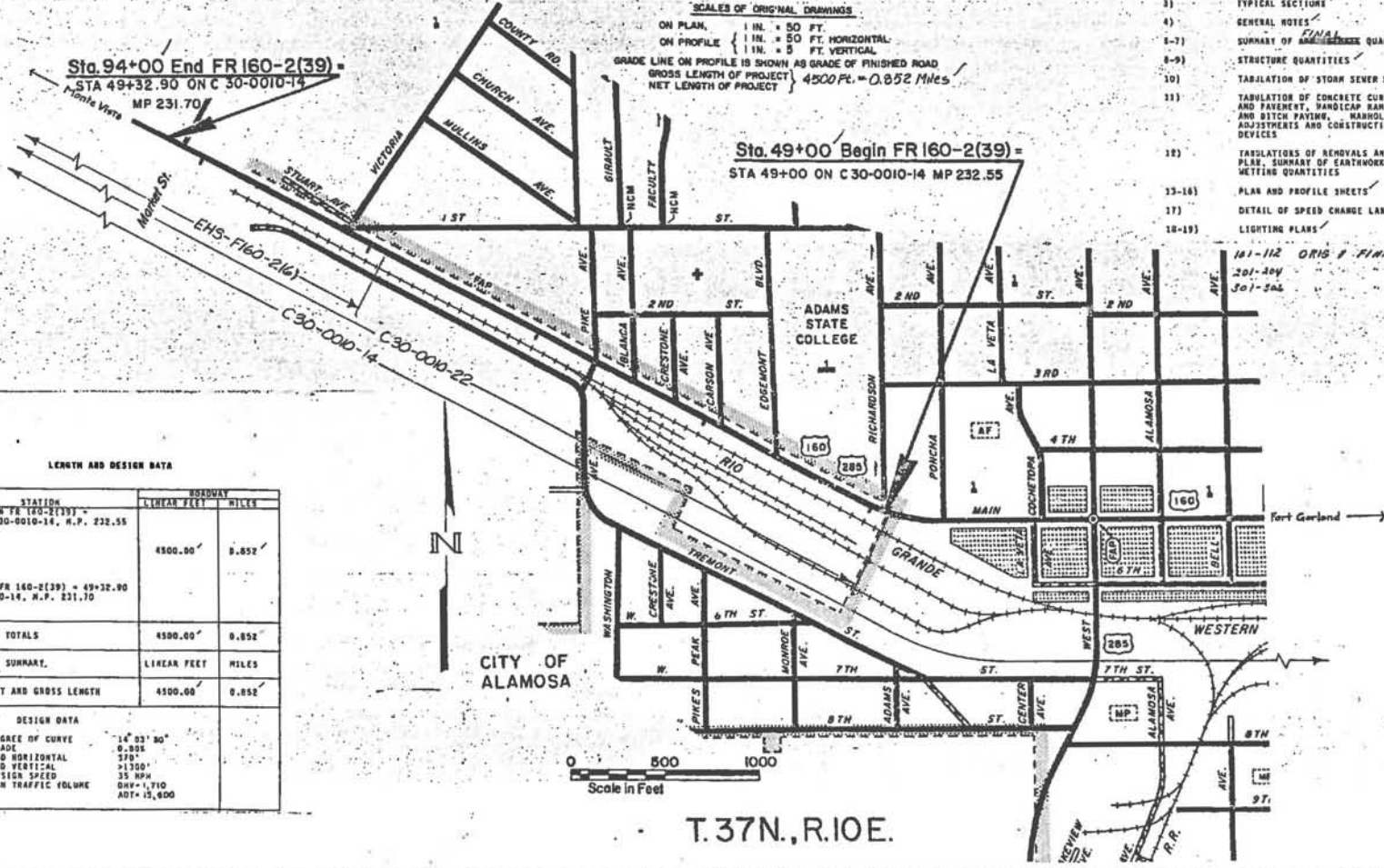
AS CONSTRUCTED PLANS APPROVED OP
Dick Cochrane 6-24-85
TITLE DATE

DIST. 5/JLH



CITY OF ALAMOSA

-10-



June 7, 1985

REVISION OF SECTION 604
STORM SEWERS
COLORADO PROJECT NO. FR 160-2(39)

Section 604 of the Standard Specifications is hereby revised for this project as follows:

Subsection 604.02 shall include the following:

Plastic Pipe Sewer (Polyvinyl Chloride) and fittings shall conform to the following:

Pipe diameters of 15 inches or less shall conform to ASTM D 3034 with an SDR 35 wall thickness.

Pipe diameters greater than 15 inches shall conform to ASTM F 794.

Pipe shall not be exposed to the sun's direct rays during shipping or storage.

High Density Polyethylene Pipe shall be "Spirolite", Class 100 manufactured by Spiral Engineered Systems, 4094 Blue Ridge Industrial Parkway, Norcross, Georgia 30071. Pipe joining shall be according to the manufacturer's recommendations for storm sewer systems.

Subsections 604.03, 604.04 and 604.06 shall include the following:

Installation of Plastic Pipe Sewer (Polyvinyl Chloride) of High Density Polyethylene Pipe shall conform to ASTM D 2321.

Subsection 604.08 shall include the following:

<u>Pay Item</u>	<u>Pay Unit</u>
___" Plastic Pipe Sewer (Polyvinyl Chloride)	Linear Foot

June 7, 1985

ALTERNATIVE MATERIALS
COLORADO PROJECT NO. FR 160-2(39)

This project contains bid items for Plastic Pipe Sewer (Polyvinyl Chloride) in 15-inch, 18-inch, and 24-inch diameters. The following materials may be substituted for the Plastic Pipe Sewer (Polyvinyl Chloride) on an equal diameter basis.

1. High Density Polyethylene Pipe conforming to the Revision of Section 604-Storm Sewers, in these Special Provisions.
2. Concrete Pipe conforming to Section 604 of the Standard Specifications.

The substitution shall be complete in place at the prices bid for Plastic Pipe Sewer (Polyvinyl Chloride).

Only one type sewer pipe shall be used on the project. The Contractor shall state at the preconstruction conference the type of pipe he intends to use.

APPENDIX B

Photographs of the Construction, Project M-6022(1)

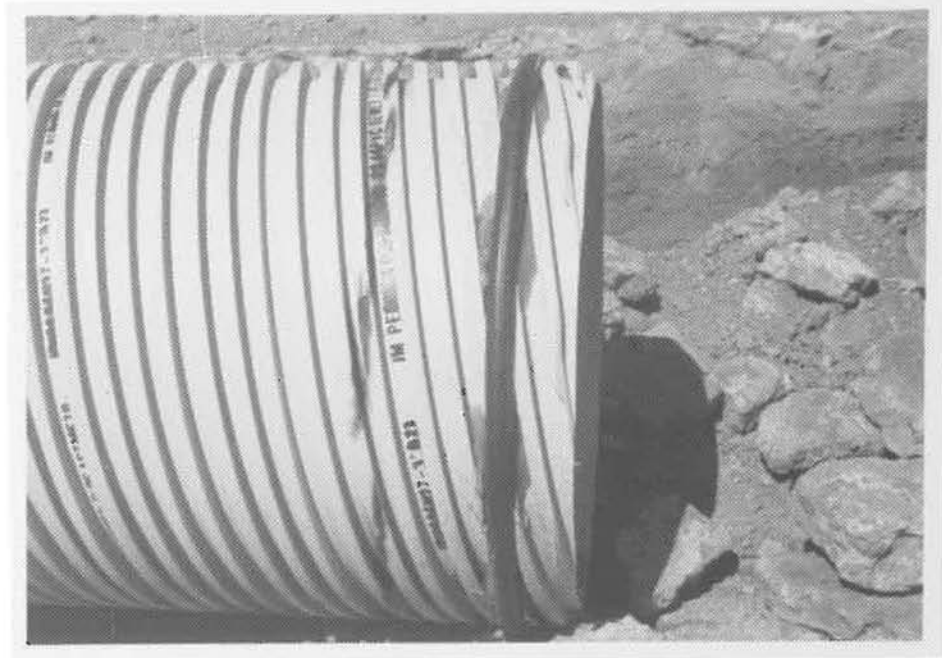


Photo 1. 21" JM PVC Sewer Pipe. Note that sealant was required to fill gaps under the gasket.

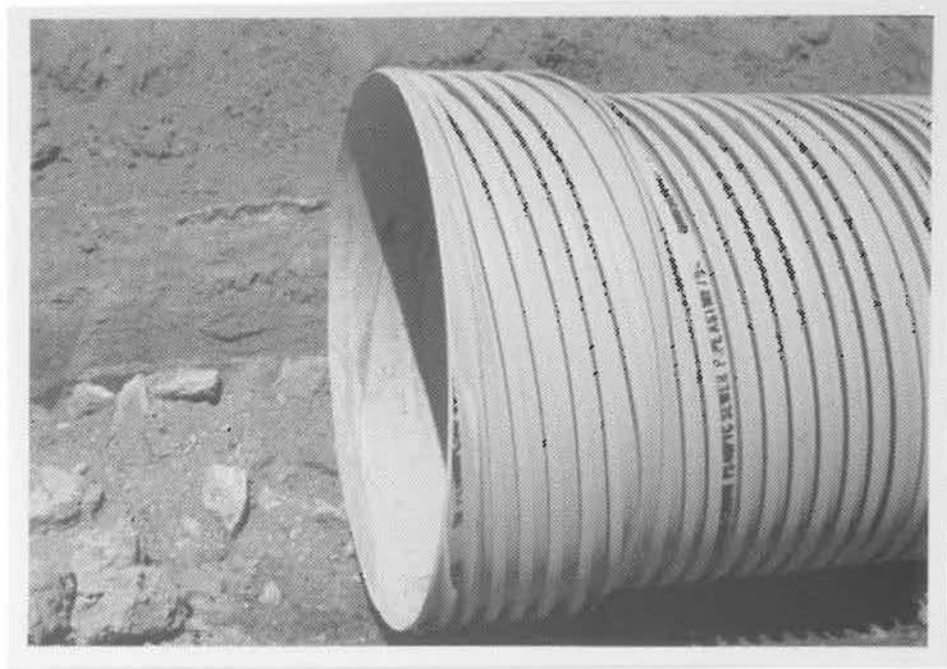


Photo 2. Bell-end of 21" JM PVC Sewer Pipe.



Photo 3. 21" JM PVC Sewer Pipe. Pipe was easily chipped if mishandled.



Photo 4. 21" Pipe at grade in bottom of trench.



Photo 5. 21" JM PVC Sewer Pipe. Backfill partially completed.



Photo 6. 21" Pipe after backfill.