

United States
Department of
Agriculture

Forest Service

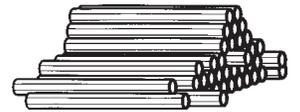
**Technology &
Development
Program**

2400—Timber
September 1996
9624 1206—SDTDC

THE PLASTIC ROAD



THE PLASTIC ROAD



Jeffry E. Moll, P.E.,
Senior Project Leader,
San Dimas Technology & Development Center

Reky Hiramoto, Engineering Assistant
San Dimas Technology & Development Center

September 1996

Information contained in this document has been developed for the guidance of employees of the Forest Service, USDA, its contractors, and its cooperating Federal and State agencies. The Department of Agriculture assumes no responsibility for the interpretation or use of this information by other than its own employees. The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others that may be suitable.

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, large print, audiotape, etc.) should contact the USDA Office of Communications at 202-720-2791.

To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, DC 20250 or call 202-720-7327 (voice) or 202-720-1127 (TDD). USDA is an equal employment opportunity employer.



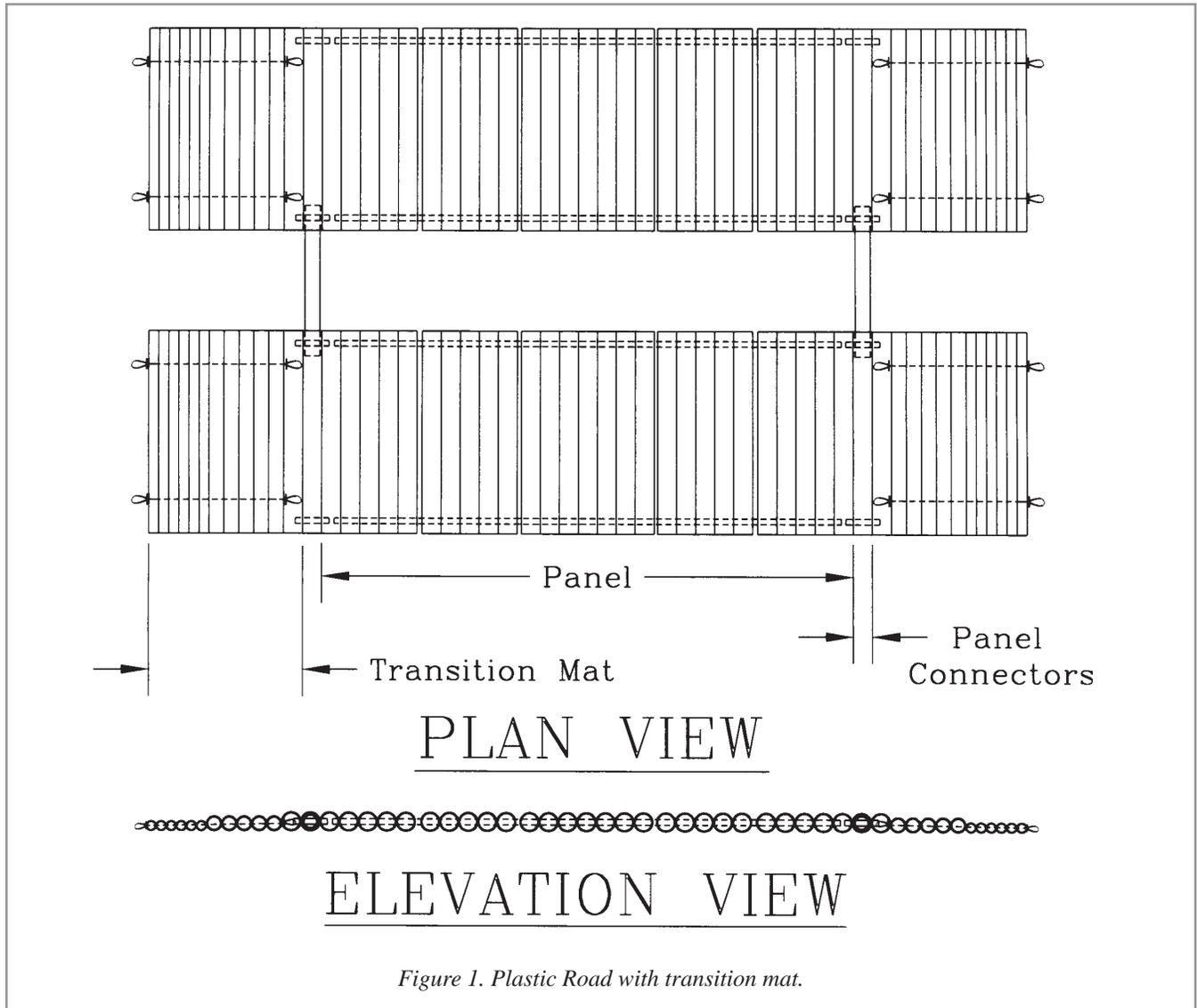
CONTENTS

- INTRODUCTION** 1
- THE PLASTIC ROAD FOR SHORT TERM ACCESS** 2
 - Transition Mats 3
 - Use of The Plastic Road 3
 - Plastic Road Field Tests 4
 - Areas for Improvement 4
- MOVING AND DISASSEMBLY OF THE PLASTIC ROAD** 5
- CONCLUSIONS** 5
- MATERIALS AND TOOLS REQUIRED FOR THE PLASTIC ROAD** 5
- FABRICATION OF THE PLASTIC ROAD** 7
- ASSEMBLY OF THE PLASTIC ROAD** 8
 - Assembly of Panels (2 required per 10 LF of Plastic Road) 8
 - Assembly of Panel Connectors (2 required) 9
 - Assembly of Transition Mats (4 required) 10
 - Assembly of 10 LF of Plastic Road with Transition Mats 11



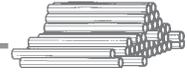
INTRODUCTION

Many forest activities require short term access for vehicles and equipment over sensitive sites or soils with low bearing capacity. Likewise, many projects in the forest benefit from work schedule extensions or seasonal adjustments that allow increased sensitivity to wildlife. Temporary access over environmentally sensitive sites is facilitated by effective crossing systems that are economical as well as easily installed, moved within project, and removed. The "plastic road" is one such system (see figure 1).



This system is lightweight, portable, reusable, inexpensive, and easily constructed of readily available materials. The plastic road was conceived with use on temporary roads in mind.

This report describes site conditions and operational requirements under which the plastic road may be used for short-term access into the forest. System limitations are discussed, as are areas for improvement. Using, moving, disassembling, and transporting are also described. Materials and tools required to fabricate the plastic road are listed, and step-by-step instructions for assembly and installation of the system are included.



THE PLASTIC ROAD FOR SHORT TERM ACCESS

The plastic road spreads wheel loads over an increased subgrade area, reducing rutting and disturbance to soils and vegetation (see figure 2). This helps reduce water concentrations, channeling, erosion, and the potential for damage to fish and wildlife habitat. A geotextile underlayment (see figure 3) to the plastic road further increases environmental sensitivity by separating the crossing from soil and allows water to filter through. Geotextile helps spread load, may increase soil bearing capacity, and facilitates removal of the crossing after use. Removal is quick and easy compared to that of conventional techniques for crossing soft spots and can aid in closure and obliteration of the temporary road.

The plastic road is lightweight, portable, reusable, and inexpensive when amortized over system life. Its length is tailored to site conditions in 10 foot (3 meter) increments. Plastic road panels and required accessories for 40 linear feet (12 linear meters) of crossing may be transported in a 3/4 ton pickup and assembled on a typical site by a two-person crew (see figure 4) in approximately 1 hour. This length of plastic road may be moved from site to site by chaining-to and towing with a pickup truck or logging equipment. Worn or broken PVC pipe members are easily replaced, facilitating

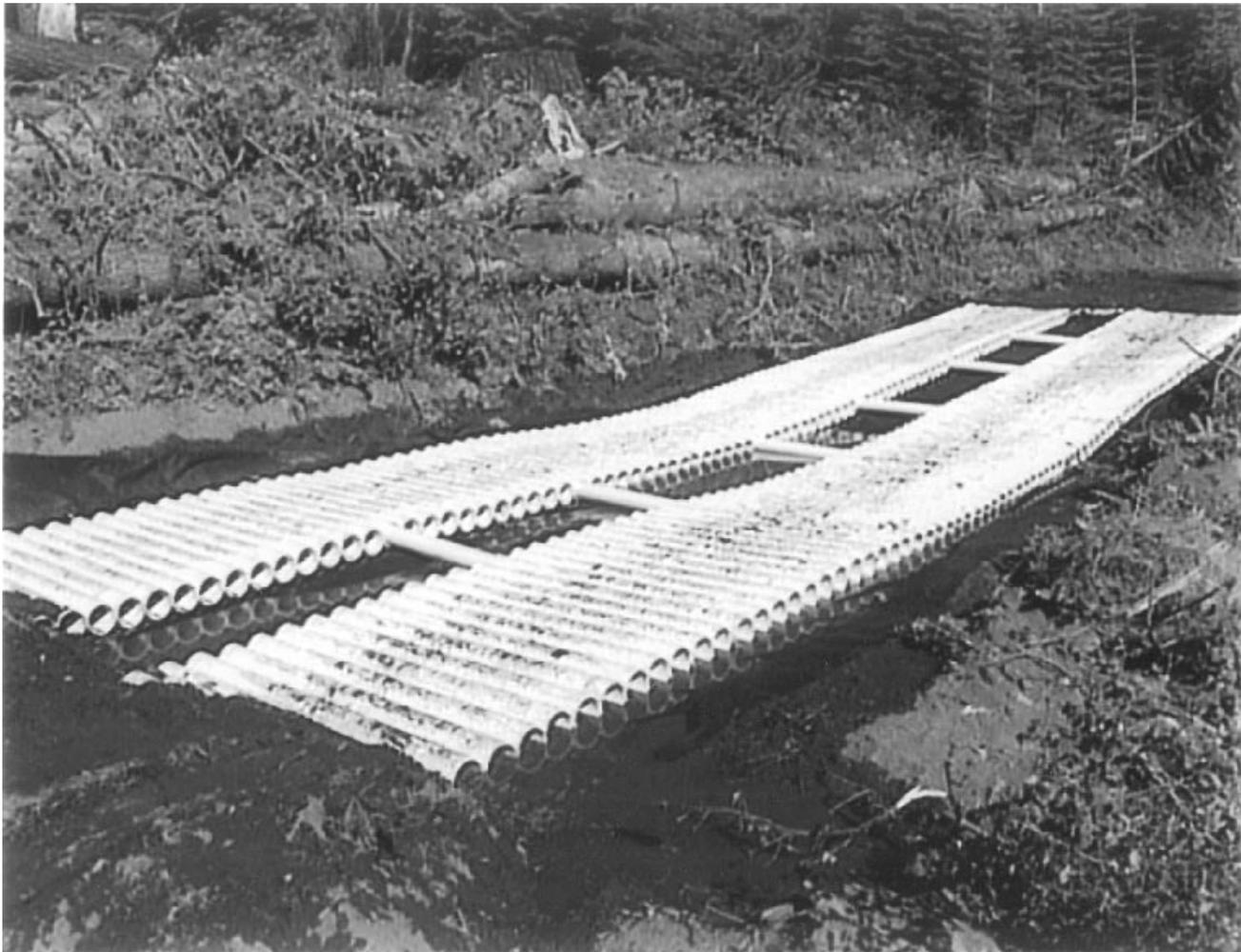


Figure 2. 40 linear foot Plastic Road installation.



Figure 3. Geotextile underlayment to the Plastic Road.

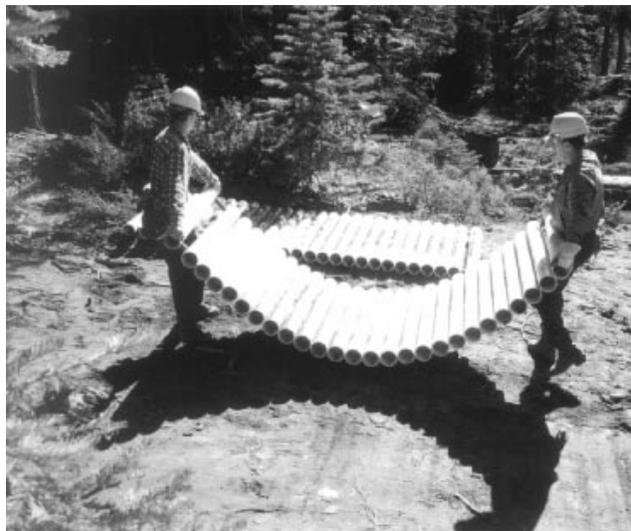


Figure 4. Two-person crew installing the Plastic Road.



Figure 5. "Borrowed" soil ramps to the Plastic Road.

maintenance and reuse of the system. Materials cost including geotextile and transition mats (see figure 1) for this length of plastic road is approximately \$2000. Adding labor to fabricate increases the cost to approximately \$2500. Materials are readily available through major hardware distributors.

Transition Mats

"Transition mats" composed of successively larger pipe (2-inch to 3-inch up to the 4-inch standard panel pipe size) ease the transition of tires from the approach onto the plastic road. Making the first 2-inch pipe in the mat to support wheel loads of Schedule 80 increases mat durability. The transition mats increase environmental sensitivity by eliminating the need for ramping up to the plastic road with soil, which usually has to be "borrowed" from somewhere (see figure 5). Use of transition mats also reduces the forces applied to the plastic road as tires roll onto it. Longitudinal forces tend to displace the plastic road in the direction the vehicle is moving, discouraging it from gaining a "set" in the soil. Absence of this set can lead to soil kneading and increased rutting as the plastic road creeps and point loads from individual pipe vary in location on the soil. Forces abruptly applied by tires to the 4-inch pipe as in use of the plastic road without ramping or transition mats can result in pipe shattering, especially in very cold environments.

Use of The Plastic Road

Vehicles negotiating the plastic road should travel at a constant 5 mph (8 kph); sudden acceleration or deceleration may cause loss of traction, especially if the plastic is wet. The system has successfully supported 18 wheel on-highway (80,000 lbs GVW, or 36,400 kg) log trucks (and other forest traffic and logging equipment) on straight alignments with grades up to 4 percent with no cross-slope. Steeper grades or the existence of cross-slope or horizontal curvature may also result in loss of traction. Traction loss may occur between tires and the PVC, or slippage may occur between the PVC and the soil or geotextile, causing it to work out of the soil ramp if so installed(see figure 6). In these latter cases a "wave" may form in the crossing system which can lead to failure if the system folds over on itself.



Figure 6. Plastic Road worked out of the soil ramp.

Experimentation with tractive surfaces applied to the PVC pipe was conducted in an attempt to reduce the potential for traction problems. Epoxy and sand was tried, as was attaching sheet grating with machine screws to individual pipe and to a series of pipes. The epoxy/sand application did not exhibit required durability, as the sand grains rolled out or were sheared out of the epoxy when subjected to wheel loads. Attaching grating was labor and time intensive and did not appear to greatly increase traction; the coefficient of friction between rubber and steel is low, causing a reliance on interlock between tire tread and grating openings for any traction increase. Successfully increasing traction between tires and plastic without anchoring the plastic road may result in displacement of the system or in a wave buildup.

Plastic Road Field Tests

A PVC pipe mat used and removed at scores of sites on the Osceola Ranger District in Florida remains serviceable after several hundred log truck passes and other heavy and light vehicle traffic. A prototype plastic road installation tested by San Dimas Technology and

Development Center has supported over 400 loaded 18-wheel log truck passes at 2 sites. Testing included several relatively high-speed passes (in excess of 10 mph, or 16 km/h), the negotiation of several passes with driver and trailer tires only partially on the plastic road, and hard breaking. Several passes were made with the plastic road located on a dry, hard, rocky subgrade, which resulted in point-loading and breakage of several 4-inch pipe.

Areas for Improvement

Areas for improvement and further testing include anchoring systems, alternative transition mats, alternative materials to resist pipe breakage (use of Schedule 80 PVC or ABS, for example), use on grades steeper than 4 percent or on cross slope, further investigation into tractive surfaces, and use on curves.

Use on curves may require anchoring, tractive surfaces, and a wider plastic road to compensate for off-tracking and curve widening. A design conforming panels to curvature and specific configurations for inside and outside panels may also be required.

Use of the plastic road to provide access across gullies or drainages merits experimentation. Loose or bundled pipe placed in the low spots might possibly provide the smooth subgrade required for subsequent installation of the plastic road. Investigation into use on skid trails as well as long term use is also warranted.



MOVING AND DISASSEMBLY OF THE PLASTIC ROAD

Up to 40 linear feet (12 linear meters) of plastic road can be moved from site to site by attaching a chain to the transition mat cable loops (see figure 1), or around the panel spacer. Washers and double clips are installed on the loops to provide strength expressly for this purpose. A pickup truck or logging equipment may be used to drag the plastic road to the new site. Care should be taken in tugging the plastic road out of its “set”, especially if it is deeply sunk into the soil and/or if soil has migrated into the pipe ends. Well-set plastic road installations may require disassembly prior to moving to prevent damage or breakage. The distance and surface over which the plastic road is dragged should also be evaluated to avoid excessive wear or breakage.

Disassembly of the plastic road after use or for transport to another site is easily accomplished by pulling quick pins in the panel connectors. This reduces the assembly into its component parts: panels, panel connectors, and transition mats. Forty linear feet (12 linear meters) of plastic road components fit into a 3/4 ton pickup truck or on a flatbed for transport. The geotextile material is removed unless a biodegradable type was used allowing it to remain in place. Shaping of the site may be required if the set resulted in depressions which might lead to channeling or concentration of water.

CONCLUSIONS

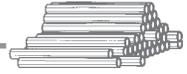
The plastic road is available to aid short term access for vehicles and equipment into the forest. This system is lightweight, portable, reusable, inexpensive, and constructed of readily available materials. The plastic road reduces rut depth and has provided satisfactory service over sensitive sites and soils of low bearing capacity on relatively flat road grades free of cross slope and horizontal curvature. Testing usage outside these constraints and further development effort to optimize performance is warranted.

MATERIALS AND TOOLS REQUIRED FOR THE PLASTIC ROAD

Plastic road fabrication requires the following parts (see figure 7):

- 4-inch PVC Schedule 40, four foot lengths
- 3-inch PVC Schedule 40, four and three foot lengths
- 2-inch PVC Schedule 40, four foot lengths
- 1-inch PVC Schedule 80, ten foot lengths
- 1-inch PVC Schedule 80, eight inch lengths
- 3/8-inch diameter quick pins
- 3/8-inch cable
- Cable clips for 3/8-inch cable
- 3/8-inch washers

Nonwoven, needle-punched polypropylene or HDPE geotextile materials of low (3 oz./sq. yd, or 100 gm/sq. meter) to medium weight (6 oz./sq. yd, or 200 gm/sq. meter) have performed adequately, as have biodegradable “poly-jute” materials.



To fabricate the plastic road you will need the following tools:

- Drill press
- 13/32-inch drill bit
- 1 3/8-inch drill bit
- Power saw (abrasive, table, or radial arm)
- Hammer
- Pry-bar to fit 13/32-inch hole
- Sander

Use of geotextile is optional and dependent on the soil and site conditions.

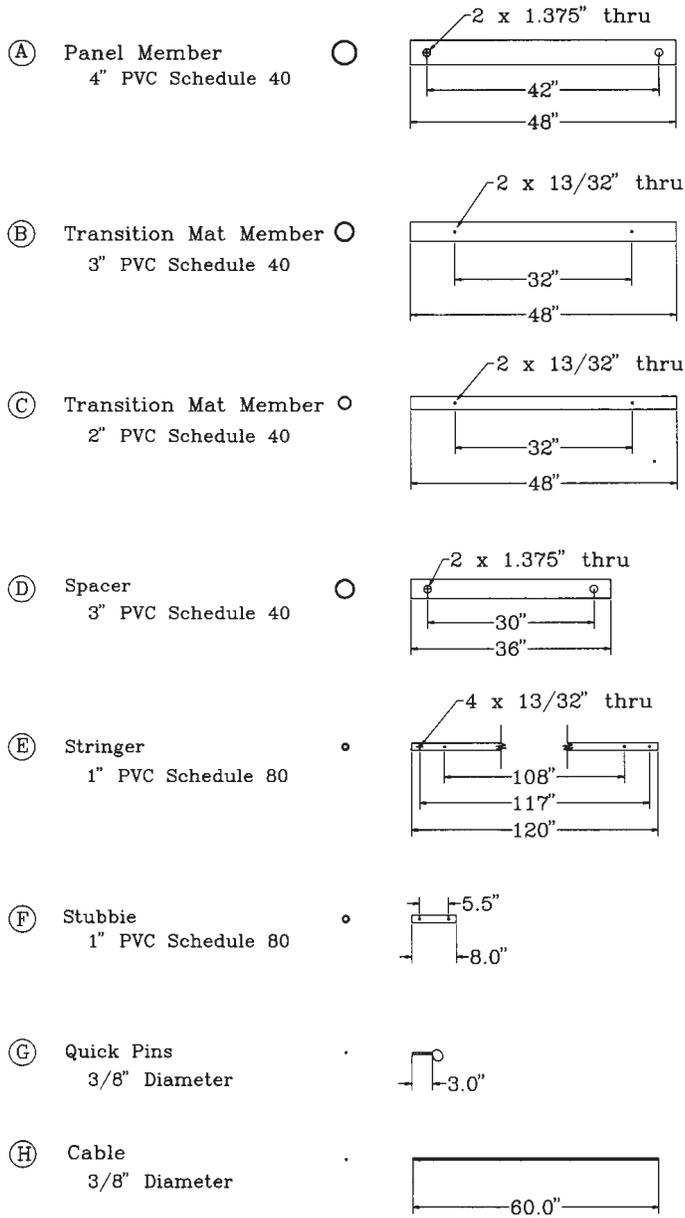


Figure 7. Parts of the Plastic Road.



FABRICATION OF THE PLASTIC ROAD

To produce parts A, B, C, D, E, and F, cut PVC stock into the specified lengths and drill the appropriate hole sizes into the pipe as specified in table 1. Bevel ends of parts E and F to enable easy installation into part A.

Table 1. Parts Specifications

Part	Name	Description	O.D.	Length	Drilled Hole Dia.	X-X on Center
A	Panel Member	4" PVC Sch. 40	4.5"	48" (-)	1.375"	42"
B	Mat Member	3" PVC Sch. 40	3.5"	48" (-)	13/32"	32"
C	Mat Member	2" PVC Sch. 40	2.375"	48" (-)	13/32"	32"
D	Panel Spacer	3" PVC Sch. 40	3.5"	36"	1.375"	30"
E	Stringer	1" PVC Sch. 80	1.315"	120" (-)	13/32"	108, 117"
F	Stubbie	1" PVC Sch. 80	1.315"	8"	13/32"	5.5"
G	Quick Pin	Steel Pins	3/8"	3"	--	--
H	Cable	Cable	3/8"	5'	--	--
I	Cable Clip	Cable Clip	--	--	--	--
J	Washer	Washer	--	--	--	--
K	Geotextile	Geotextile	--	--	--	--

(-) indicates true length will be less than that tabulated due to saw blade width loss



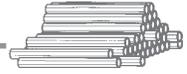
The number of parts and stock items necessary for 10 LF of plastic road with transition mats are displayed in table 2.

Table 2. Parts for 10 LF of Plastic Road with Transition Mats

Part	# of Parts necessary for the:			Total Quantity	Stock Items
	Panels	Connectors	Transition Mats		
A	54	4	4	62	13 @ 20' Joint (+) 4" Sch 40
B	0	0	20	20	4 @ 20' Joint (-) 3" Sch 40
C	0	0	24	24	5 @ 20' Joint (+) 2" Sch 40
D	0	2	0	2	1 @ 6' 3" Sch 40
E	4	0	0	4	2 @ 20' Joint (-) 1" Sch 80
F	0	8	0	8	1 @ 6' 1" Sch 80
G	8	16	0	24	24 @ quick pins
H	0	0	8	8	8 @ 5 ft length of cable
I	0	0	32	32	32 @ 3/8-inch cable clips
J	0	0	16	16	16 @ 3/8-inch heavy duty washers

(-) indicates true length will be less than that tabulated due to saw blade width loss

(+) indicates some materials will be left over.



ASSEMBLY OF THE PLASTIC ROAD

Assembly of Panels (2 each required per 10 LF of Plastic Road)

Materials needed for each panel:

- 27 A
- 2 E
- 4 Quick Pins

Steps:

- 1) Lay 2 E's parallel to each other, approximately 42" apart.
- 2) Slip-fit an A onto the two E's, see figure 8 (a).
- 3) Repeat step 2 until 27 A's are on the 2 E's, see figure 8(b).
- 4) Arrange the A's on each end such that the E protrudes only halfway through as shown in figure 8(c).
- 5) Insert quick pins in the holes in the ends of each E as shown in figure 8(c). This requires sticking your hand into each end A, and results in an open hole to accept the F part of panel connector (see figure 9). The E's have extra holes at 108-inches on center for prying, if required.
- 6) Repeat steps 1) through 5) for the other panel.

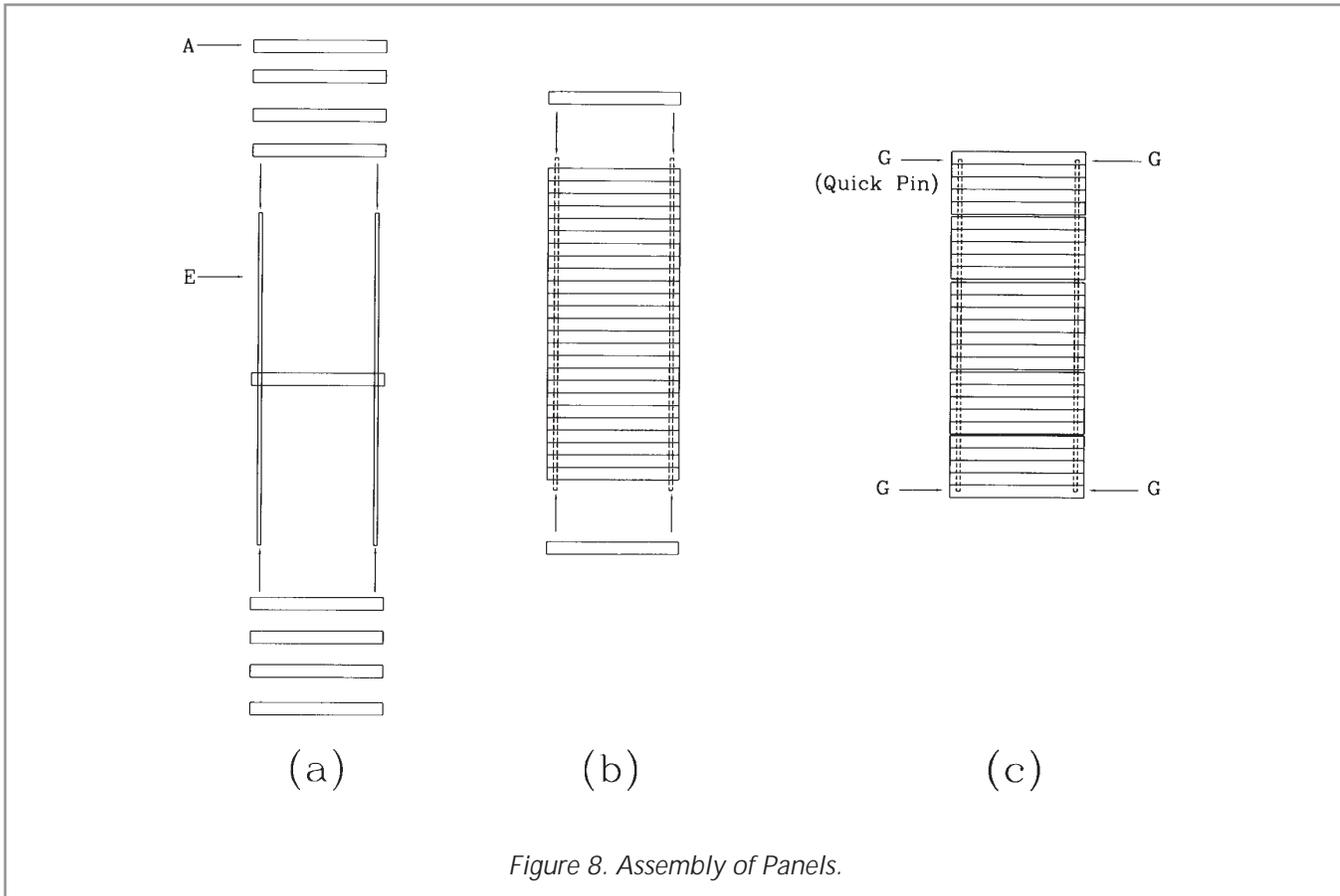


Figure 8. Assembly of Panels.

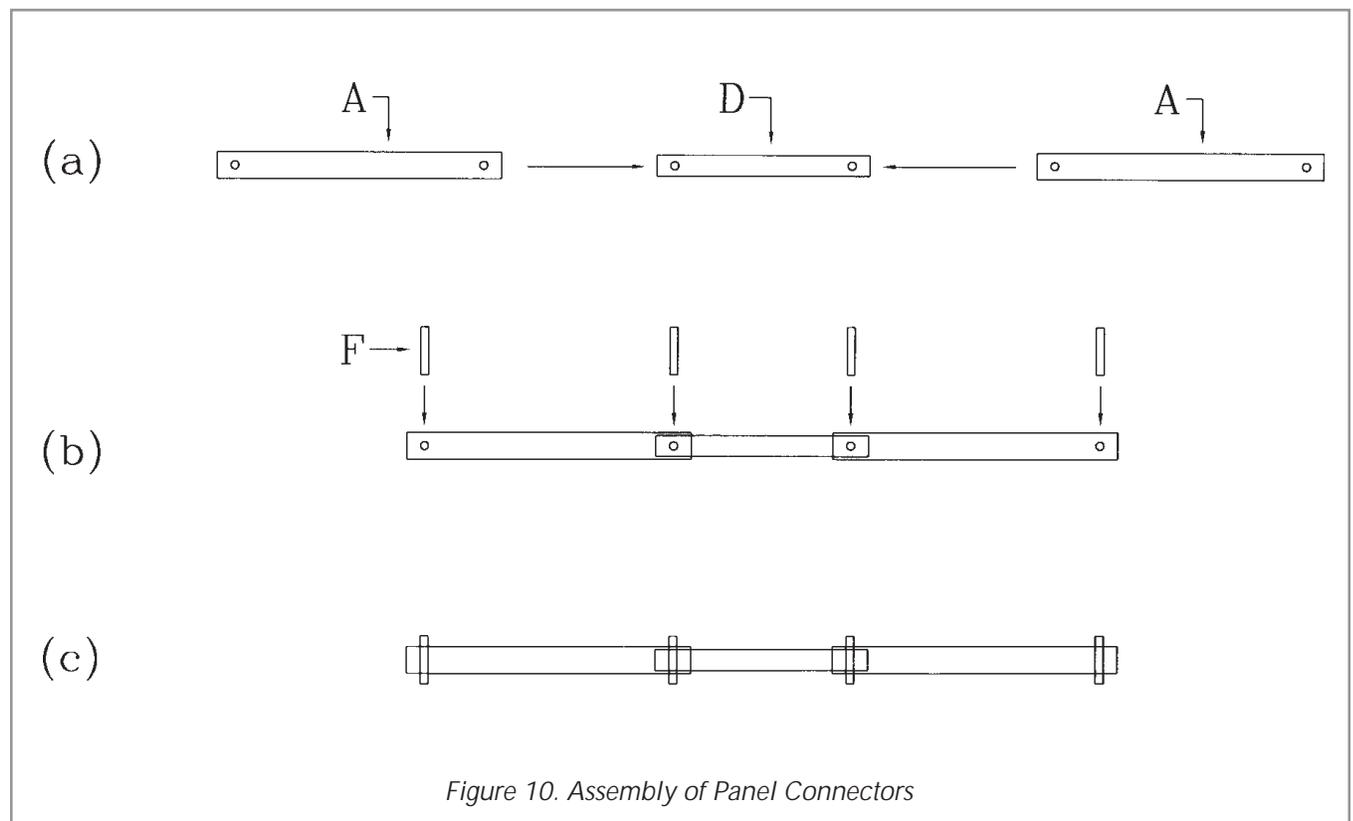
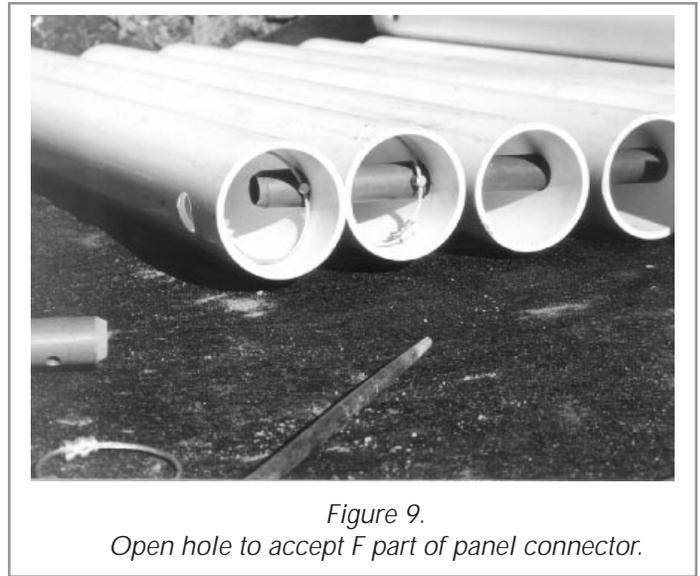
Assembly of Panel Connectors (2 each required)

Materials needed for each panel connector:

- 2 A
- 1 D
- 4 F
- 8 quick pins

Step:

- 1) Arrange the parts A and D side by side, A-D-A as shown in figure 10(a).
- 2) Slide the end of D into the end of an A.
- 3) Line up the holes and slide an F into the holes to secure the pipes in place.
- 4) Quick pin the stubbies in place.
- 5) Repeat steps 3) & 4) for the opposite end of D and the remaining A.
- 6) Repeat steps 1) through 5) for the other panel connector.



Assembly of Transition Mats

(4 required)

Materials needed for each transition mat:

- 1 A*
- 5 B
- 6 C
- 2 H
- 8 I
- 4 J

Step:

- 1) Form a 4-inch loop in the end of the cable and secure with 2 cable clips.
- 2) Slide a washer on the cable.
- 3) Insert the free end of the cable into the 13/32-inch hole in the A from the inside (see figure 11(a)) and pull tight.
- 4) Repeat steps 1-3 for the other cable.
- 5) Slide the B's onto the cables, see figure 11(b).
- 6) Slide the C's onto the cables**, see figure 11(b).
- 7) Slide a washer on each of the two cables.
- 8) Form loops in each cable end (removing slack in the cable in the process) and secure with 2 I, see figure 11(c).
- 9) Repeat steps 1) through 8) for the other three mats.

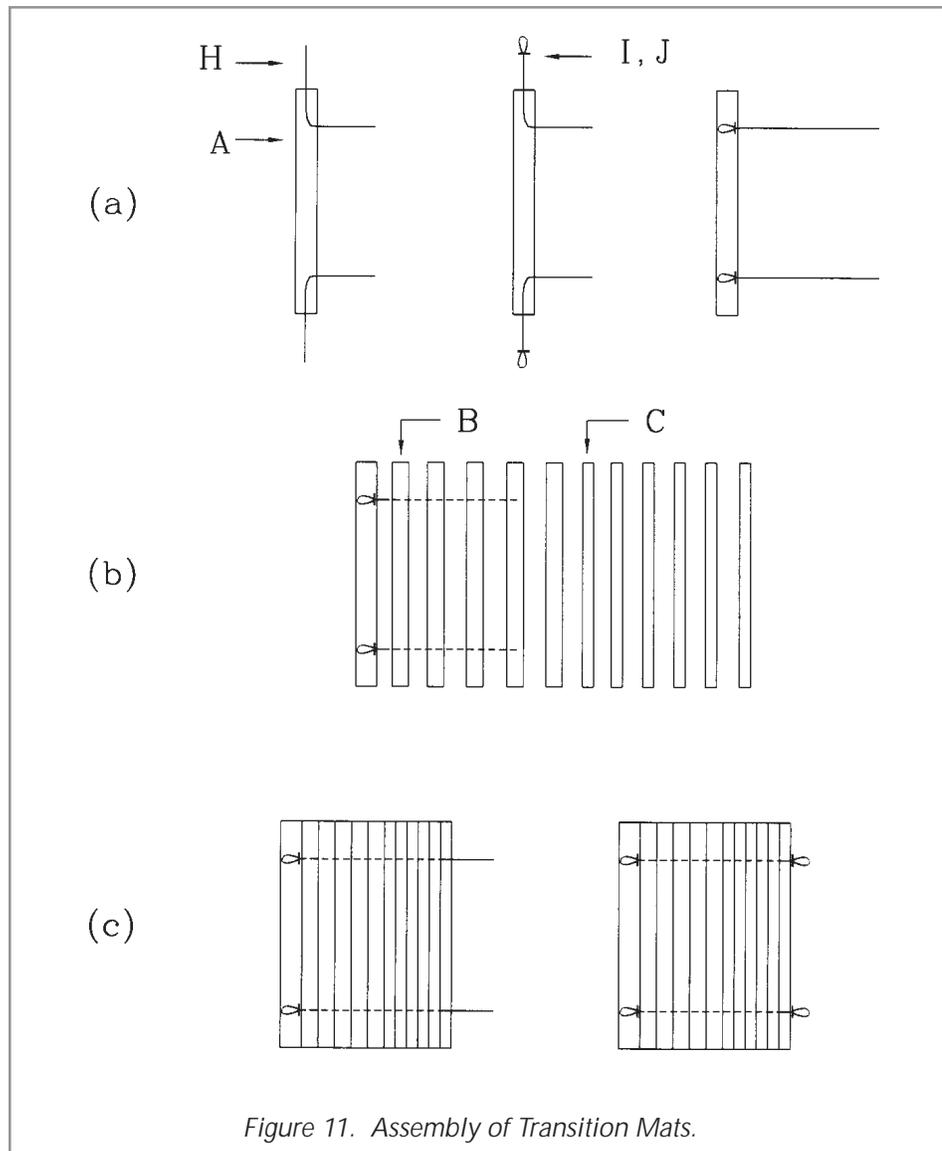


Figure 11. Assembly of Transition Mats.

*Two additional 13/32" holes must be drilled into this A. This will enable the 3/8" cable to be inserted into member without interfering with the stubbies or quick pins. The holes will be drilled with the same specifications as part B used for the transition mats. The holes in parts A, B, and C for the cable must line up in a row.

**Making the last 'C' installed on the cable (and thus the initial pipe to support wheel loads) schedule 80 rather than schedule 40 increases mat durability.



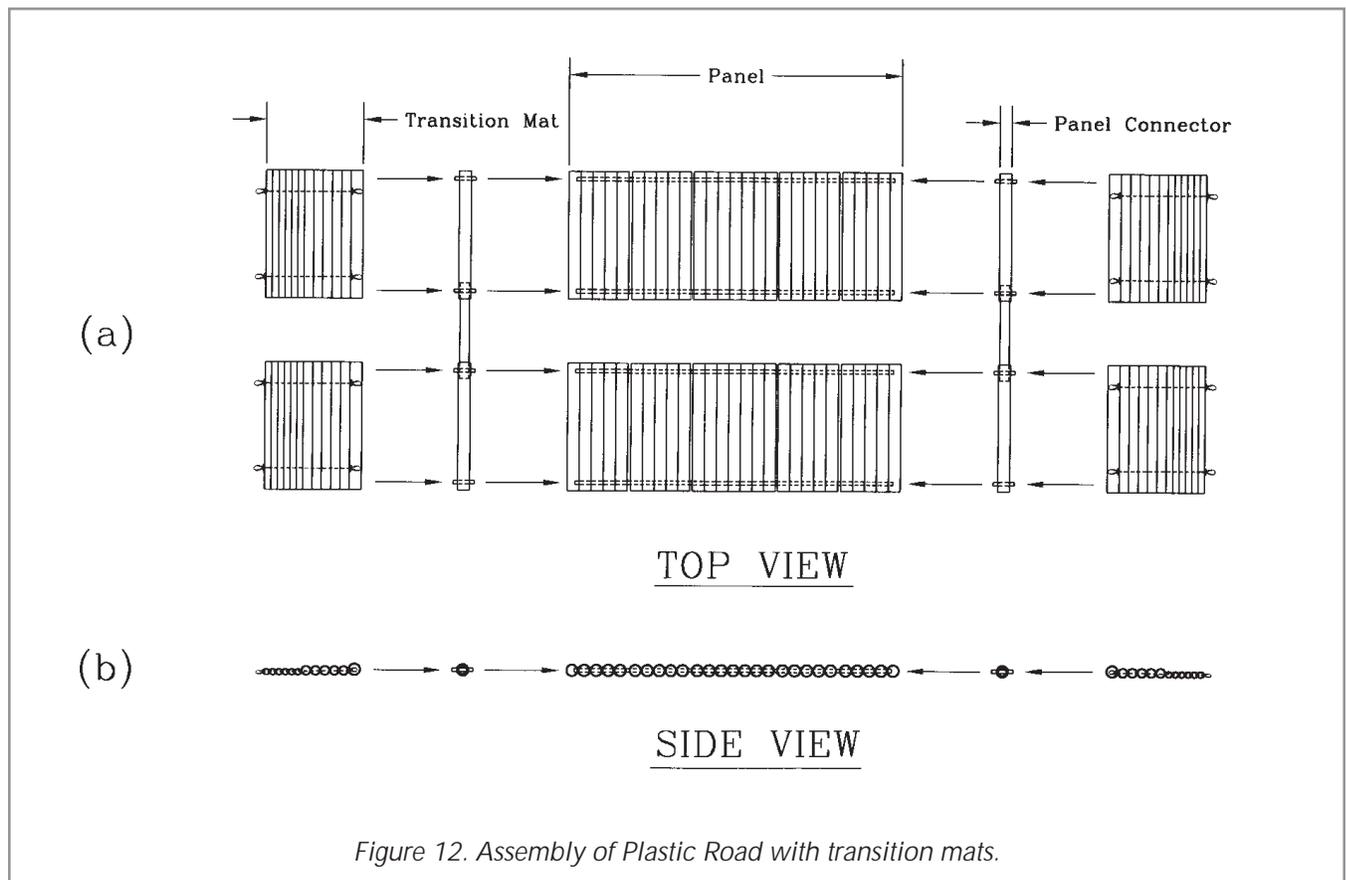
Assembly of 10 LF of Plastic Road with Transition Mats

Materials needed:

- 2 panels
- 2 panel connectors
- 4 transition mats

Step:

- 1) Arrange the two panels at the needed crossing location with a gap of approximately 2 feet, see figure 12(a).
- 2) Place the 2 panel connectors as shown in figure 12(a). Remove the quick pins, allowing the stubbies to fit into the corresponding holes in the A's in the panel ends.
- 3) Quick pin the panel connectors in place. This requires you to stick your hand into the last A at the end of each panel. Watch out for snakes!!
- 4) Arrange the transition mats as shown in figure 12(a) and quick pin as described above for the panels.



The length of plastic road can be easily increased by 10 foot increments. Required parts for each 10 foot increment are shown in table 3. Two panels and 1 panel connector are installed for each additional 10 LF increment as described in the Section entitled "Assembly of 10 LF of Plastic Road with Transition Mats." Transition mats are installed at each end of the plastic road as described in the same Section.

Table 3. Parts for Each 10 foot Incremental Increase.

Part	# of Parts needed for:		Total Quantity	Stock Items
	Panels	Connectors		
A	54	2	56	12 @ 20' (+) 4" Sch 40
B	0	0	0	—
C	0	0	0	—
D	0	1	1	1 @ 3' 3" Sch 40
E	4	0	4	2 @ 20' (-) 1" Sch 40
F	0	4	4	1 @ 3' 1" Sch 40
G	8	8	16	16 Quick Pins
H	0	0	0	—
I	0	0	0	—
J	0	0	0	—

(-) indicates true length will be less than that tabulated due to saw blade width loss

(+) indicates some materials will be left over

