RECYCLED PLASTICS IN HIGHWAY CONSTRUCTION AND MAINTENANCE

Construction Report

State Funded Project

By

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16. Abstract

Oregon Senate Bill 66 directed the Oregon Department of Transportation to conduct a research project to evaluate the use of recycled plastic products and composite materials containing recycled plastic in construction and maintenance. This report documents the installation throughout the state of snow poles, sign supports, fence posts, and a sound wall.

Recycled plastic materials may be more difficult to obtain than standard wood products. Upfront material and shipping costs are more expensive than comparable wood products. Handling of recycled plastic materials is similar to handling treated wood products except recycled plastic materials are heavier. Recycled materials may be more readily recyclable than treated wood products.

Recycled snow poles were easier to install than standard snow poles. Recycled plastic sign supports, fence posts, and sound wall materials, in general, were more difficult to install.

Recommendations from this study include the following:

- Additional recycled plastic material installations should be encouraged to obtain more information regarding the constructability of recycled plastic materials;
- Recycled plastic fence posts for installations in areas with dense soils should be ordered with a point at one end;
- Recycled fence posts should be installed by pushing with steady pressure rather than driven with repeated blows; and
- Recycled plastic boards used for sound wall facing should have tongue and groove joints to insure proper interlocking and to reduce the amount of bowing.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

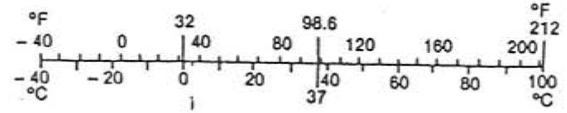
Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F



* SI is the symbol for the International System of Measurement

(Revised April 1989)

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DISCLAIMER

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1.0 INTRODUCTION

1.1 BACKGROUND

The Oregon public and Oregon Legislature have great interests in the use of recycled waste products. The costs of waste disposal continue to increase as existing landfills approach maximum capacity forcing development of additional landfills. In 1991, the Oregon Legislature passed Senate Bill (SB) 66, which in part directs the Oregon Department of Transportation (ODOT) to conduct a research project to evaluate the use of recycled plastic products and composite materials containing recycled plastic in construction and maintenance. The project is to take place between July 1, 1991 and June 30, 1995.

To meet the directives of the Senate Bill, the Research Unit, with guidance from a Recycled Plastics Technical Advisory Committee, developed a research study proposal which details the tasks and identifies the materials to be evaluated to meet the needs of SB 66. Members of the Technical Advisory Committee are listed in Table 1.1. The research will include an evaluation of snow poles, fence posts, sign posts, and a noise barrier (sound wall).

Table 1.1 Technical Advisory Committee

Wayne Cobine	Operations Support Section
Mike Dunning	Materials Unit
Rob Edgar	Materials Unit
Sam Johnston	Specifications Unit
Keith Martin	Research Unit
Scott Nodes	Research Unit
Keith Rudisil	Traffic Engineering Section

1.2 OBJECTIVES

The objectives of the research are to install and evaluate the use and performance of the recycled plastic and composite materials in highway related construction and maintenance. The research will address the economics of recycled plastic materials including product availability and costs. In addition, environmental concerns such as handling, flammability, and recyclability will be documented. Finally, performance will be monitored through mid-1995. This report will document the findings of product installations through December 1993. Long term performance will be discussed in a later report.

2.0 MATERIAL DESCRIPTIONS, INSTALLATION LOCATIONS, AND COSTS

2.1 MATERIAL DESCRIPTIONS

In November 1991, the project Technical Advisory Committee met and selected four types of recycled plastic products to research. Materials were obtained from eleven recycled materials vendors. In addition, standard wood tongue and groove lumber was obtained as a control for a sound wall panel evaluation. One hundred snow poles, 170 fence posts, 17 sign supports, and recycled material sound wall panels from five manufacturers were installed. The snow poles, fence posts, and sign supports being evaluated are listed in Table 2.1, along with the vendor name, installation location, and associated costs. A listing of the snow pole, fence post, and sign support vendors' addresses is contained in the Appendix. The materials used for sound wall construction are listed in Table 2.2, along with the sound wall vendors' addresses.

A questionnaire was included with each recycled plastic order requesting information about the types of plastics used in each of the materials ordered. A copy of the questionnaire is included in the Appendix. The responses from the questionnaires are summarized in Table 2.3.

2.2 INSTALLATION LOCATIONS

In order to locate suitable locations for material installations, a message was sent out to District Managers offering them "free" materials. The District would provide the labor, equipment, and any additional materials needed to install the plastic and/or composite materials. Several District Managers responded and sites were selected. Figure 2.1 shows the general installation locations. The specific locations and weather information for installation locations are listed in the Appendix.

2.3 COSTS

The material costs and vendors are listed in Tables 2.1 and 2.2. The standard costs, listed for comparison in the far right column of Table 2.1, were obtained from the ODOT Storeroom, if available. Standard costs not available through the Storeroom were obtained from outside vendors. The standard cost for comparison of the sound wall panel materials is the cost of the tongue and groove lumber listed. Costs of the sound wall materials do not include the costs of the concrete and steel.

Table 2.1: Recycled Plastic Vendors and Costs

Manufacturer or Product	Vendor	Snow Poles	Fence Posts	Sign Posts	Size	Installation Location	Date Installed	Price/ Item	Shipping Costs	Total Costs	Standard Costs/Item
Dapco	Dapco Davidson Plastics	100			10' Long; 1.3" Diam.	Government Camp	Oct 92	$3.52	-0-	$352.00	$3.94-$9.98[1]
Timbrex[2]	Ecoversion Products Inc.		16		4"X4"X8'	Jordan Valley	Nov 92	$12.60	$190.00	$391.60	$6.51[3]
The Plastic Lumber Co., Inc.	VANCO Associates, Inc.		4		6"X6"X7'	Jordan Valley	Nov 92	$47.11	$100.00	$288.44	$16.42[3]
Timbrex[2]	Ecoversion Products Inc.		50		6"X6"X8'	Tillamook	May 93	$30.49	$953.00	$2,477.50	$19.08[3]
The Plastic Lumber Co., Inc.	VANCO Associates		50		6"X6"X7.5'	Tillamook	May 93	$51.16	$700.00	$3,258.00	$17.59[3]
Enviro-Lumber	Environmental Plastics		50		6"X6"X8'	Tillamook	May 93	$60.00	$166.12	$3,166.12	$19.08[3]
RPM	Traffic Safety Supply			4	4"X4"X12' (Hollow)	Portland	Mar 93	$18.00	$25.00	$97.00	$13.11[4]
Timbrex[2]	Ecoversion Products Inc.			3	4"X4"X12' (Solid)	Salem	Jun 93	$18.90	$80.00	$136.70	$13.11[4]
Timbrex[2]	Ecoversion Products Inc.			3	4"X4"X14' (Solid)	Salem	Jun 93	$22.74	$80.00	$148.22	$19.75[4]
Timbrex[2]	Ecoversion Products Inc.			2	4"X4"X14' (Solid)	Coos Bay	Apr 93	$22.05	$97.00	$141.10	$19.75[4]
Hammer Plastics	Charles R. Watt, Inc.			3	4"X4"X12' (Solid)	Salem	Jun 93	$50.43	$45.00	$196.29	$13.11[4]
Trimax	Ducks Marine Distrib.			2	6"X6"X20' (Solid)	Coos Bay	Apr 93	$84.00	$75.00	$243.00	$46.67[4]
	Total Number Installed:	**100**	**170**	**17**				**Total Costs:**		**$10,896**	

[1] No standard costs available for a 10-foot pole; ODOT Storeroom charges $3.94 for an 8-foot pole and $9.98 for a 12-foot pole.
[2] Timbrex is now called Trex.
[3] Not available from the ODOT Storeroom. Costs are average vendor charges for treated wood posts.
[4] ODOT Storeroom charges for treated timber posts.

Table 2.2: Sound Wall Vendors and Costs

Manufacturer or Product	Vendor	Date Installed	Material	Dimensions	Material Cost/sf	No./ Panel	No. of Panels	Material Costs	Shipping Costs	Total Costs
T&G Lumber	Disdero Lumber 1504 SE Woodward Portland, OR 97202 (503) 239-8888	6/23/93	Treated Lumber	2.5"X5.5" (T&G)	$4.71	22	3	$1,139.69	-0-	$1,139.69
Carsonite	Carsonite International 7458 Black Tree Lane Citrus Heights, CA 95610 (916) 969-5373	6/23/93	Virgin Plastic/ Rubber	8'X10' (1 piece)	$15.00	1	1	$1,200.00	-0-	$1,200.00
Trimax	Ducks Marine Distributing 18699 NE Marine Drive Portland, OR 97230 (503) 665-8348	6/23/93	Recycled Plastic	2.5"X8.75" (T&G)	$4.34	14	2	$708.40	$563.00	$1,271.40
Harbor Sales	Harbor Sales Co. 2945 SW Fairview Blvd. Portland, OR 97201 (503) 936-0500	6/23/93	Recycled Plastic	2.5"X7.5" (Ship Lap)	$7.73	16	2	$1,236.00	$251.00	$1,487.00
Trex[1]	Mobil Chemical Co. Composite Products Div. 800 Connecticut Ave. P.O. Box 5445 Norwalk, CT 06856 (203) 831-4204	10/18/93	Recycled Plastic/ Wood Fibers	2"X7.5"; 2"X5.5" (T&G)	$2.90[2,3]	17; 24	2	Donated	NA	NA
Collins & Aikman	Collins & Aikman, Corp. P.O. Box 1447 Dalton, GA 30720 (706) 259-9711	12/3/93	Recycled Plastic/ Recycled Carpet Fibers	2"X7.5" (T&G)	NA[2]	17	2	Donated	NA	NA

[1] Trex is the new name for Timbrex.

[2] Donated Materials.

[3] The cost shown is based on the manufacturer's projected cost of $1.75/board foot (actual dimensions).

Table 2.3: Types of Plastics Used for Recycled Products

Manufacturer or Product Name	% Pre-Consumer Recycled Plastic	% Post-Consumer Recycled Plastic	Types of Plastics Used[1]	Other Material Used
Dapco (Snow Poles)		10	HDPE	
Trex [2] (Fence Posts, Sign Posts, and Sound Wall Panel Facing)		50	Reclaimed grocery carrier bags and used industrial stretch film	50% Waste wood pallet scraps
The Plastic Lumber Co., Inc. (Fence Posts)		97	HDPE	3% Colorant
Enviro-Lumber (Fence Posts)		100	HDPE, LDPE, PP	
RPM (Sign Posts)		100	HDPE	
Hammer Plastics (Sign Posts)	75	23	Blended plastic including but not limited to HDPE, LDPE, Nylon, PET, Polyester, and PP.	2% Color and UV stabilizer
Trimax (Sign Posts and Sound Wall Panel Facing)		80	HDPE	Fiberglass reclaim
Carsonite (Sound Wall Panel)				Approximately 4.7 lbs of scrap tire waste (per 8'X10' panel) enclosed in a fiberglass reinforced virgin plastic composite tongue-and-groove structural element.
Collins & Aikman (Sound Wall Panel Facing)		50	40% HDPE, 10% LDPE	50% Recycled carpet fiber
Harbor Sales (Sound Wall Panel Facing)		100	HDPE	

[1]PET = Polyethylene (Labeled 1)
HDPE = High density polyethylene (Labeled 2)
LDPE = Low density polyethylene (Labeled 4)
PP = Polypropylene (Labeled 5)

[2] Trex is the new name for Timbrex.

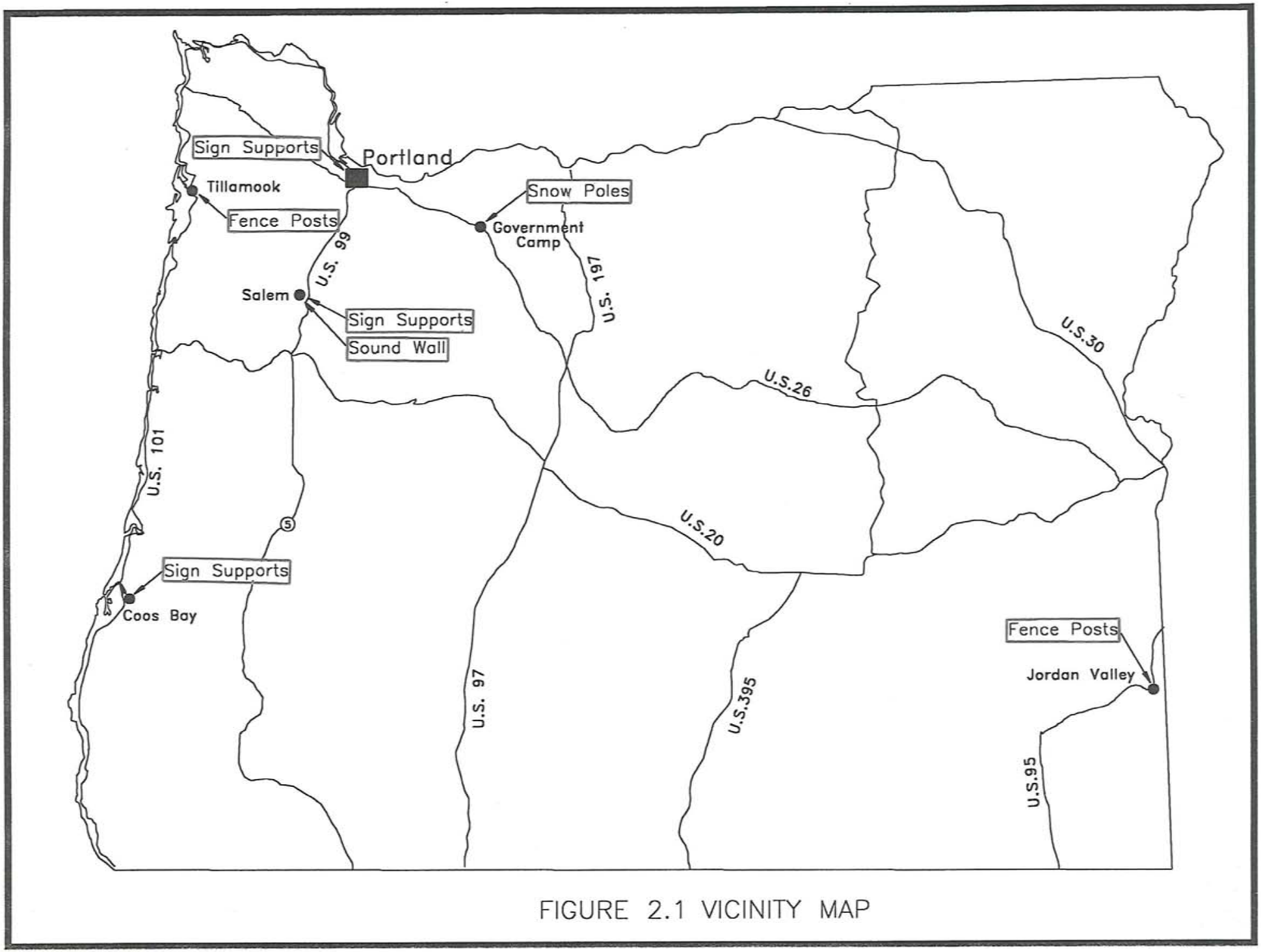


FIGURE 2.1 VICINITY MAP

3.0 ECONOMICS OF RECYCLED MATERIALS

Two components were considered in evaluating the economic effectiveness of using the recycled materials in highway construction and maintenance. The two components included product availability and material costs, including shipping and life-cycle costs.

3.1 AVAILABILITY

Two questions arose with respect to product availability: Is there a suitable, acceptable recycled product available that meets the needs of the application? If so, can it be acquired in a timely manner? References were available through the ODOT New Products Coordinator for possible vendors of recycled materials. The State Qualified Products List contained information on snow poles and hollow sign posts. An additional reference, Recycled Products Guide, distributed out of Ogdenburg, New York listed several other types of recycled products including plastic and composite materials. Calls were made to obtain availability and purchase price information. Within two months, when the purchase orders were prepared, a second call was made to verify the purchase prices. At that time, it was discovered that prices had changed, in some cases drastically from the originally quoted price.

After ordering the products, the second question of timely delivery became a major issue. Two products originally ordered and considered available were not delivered. In one case, after waiting five months for recycled plastic sign posts, the manufacturer responded that "...due to equipment limitations, we are unable to provide you with a usable product at this time." The second product, a recycled composite material, was to be shipped to the vendor for milling to tongue and groove boards for the sound wall. The first order that was shipped to the vendor was reported to contain metal particles that could present a safety hazard during milling. It was rejected by the vendor. While waiting for the second shipment, the manufacturer was changing their distribution system and phasing out the smaller vendors. The manufacturer was willing to provide the material to finish the sound wall, however, it would have been necessary to purchase more boards than were needed. The boards were sold in 40-piece bundles. The wall required 44 boards. To obtain the 44 boards, it would have been necessary to purchase 80 boards. The order was canceled; an alternative recycled plastic lumber selected, and the issue was resolved after four months.

Locating products and continually checking on their availability took a considerable amount of time. Also, after it was determined that two of the products could not be delivered, alternative products had to be located and obtained. As the market for recycled materials grows and stabilizes, the availability issue should be less of a concern.

After the first eight sound wall panels were installed, the Research Unit was contacted by two vendors interested in donating additional material for the sound wall. The material was accepted and installed several months after the first panels.

3.2 SHIPPING AND MATERIAL COSTS

Shipping and material costs for the products being evaluated are included in Tables 2.1 and 2.2. No costs are included for the Collins & Aikman wall material since it was donated. Since shipping rates are usually charged as a flat rate per load, one method to compare shipping costs, in general, is to look at the number of boards transportable in one standard load. The maximum legal load a 28-foot trailer can haul is 24,000 pounds. The unit weight of a 6"X6"X8' treated timber post is about 67 pounds. The unit weight of a 6"X6"X8" recycled plastic post is about 92 pounds. With this information, 358 treated timber posts or 260 recycled plastic posts could be shipped in a single load. If ODOT was to order these materials in bulk, the Agency would pay, on average, more on a per unit basis for recycled plastic materials than for standard wood posts due to the extra weight.

Graphs comparing material costs of recycled plastic fence posts and sign posts to treated timber posts are included in Figures 3.1 and 3.2. Figure 3.3 presents the comparative costs for the sound wall materials. With the exception of the Trimax recycled plastic lumber used in the sound wall, all the products being evaluated were more expensive than the standard wood products. The recycled plastic fence posts' costs ranged from 60% to over 200% more than the comparable wood product cost. The recycled plastic sign posts' costs ranged from 12% to 285% more than the comparable wood product. The boards used for the sound wall panels ranged in price from 8% less to 218% more than the standard wood tongue and groove material used.

Because of the number of variables involved in comparing the life-cycle costs of the posts, a simple economic comparison was done to determine how long a plastic post would have to last to be economically equivalent to a wood post. Installation costs, maintenance costs, and potential salvage values were disregarded for the simple analysis. Assuming a standard treated wood post would last twenty years, with an interest rate of 4%, the annual cost for a 6"X6"X8' fence post would be $0.64. Assuming an annual cost of $0.64, the comparable Timbrex fence post would have to last about 27 years to have an equivalent cost and the comparable Enviro-Lumber post would have to last about forty years. For wooden sign posts, with a 20-year life and an interest rate of 4%, the annual cost for a 4"X4"X12' post would be $0.44. The comparable RPM sign post would have to last about 25 years to have the equivalent cost and the comparable Hammer Plastics post would have to last about 44 years.

Recycled manufacturers most commonly state that the plastic posts should last at least twenty years. The elements that could deteriorate the post include sunlight and continued freeze-thaw exposure. The posts have been treated with UV stabilizers, however, it is unknown how long the treatment might be effective. Continued research will be necessary to monitor the life expectancy and breakdown mechanism of the plastic posts.

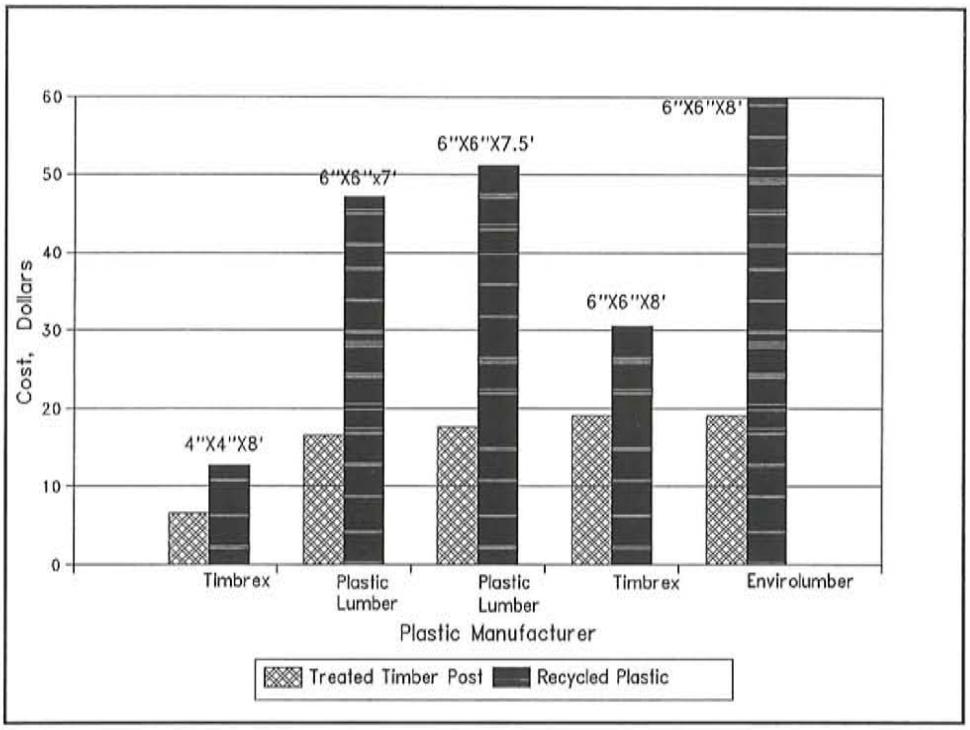


Figure 3.1: Recycled Plastic Fence Post Costs by Manufacturer.

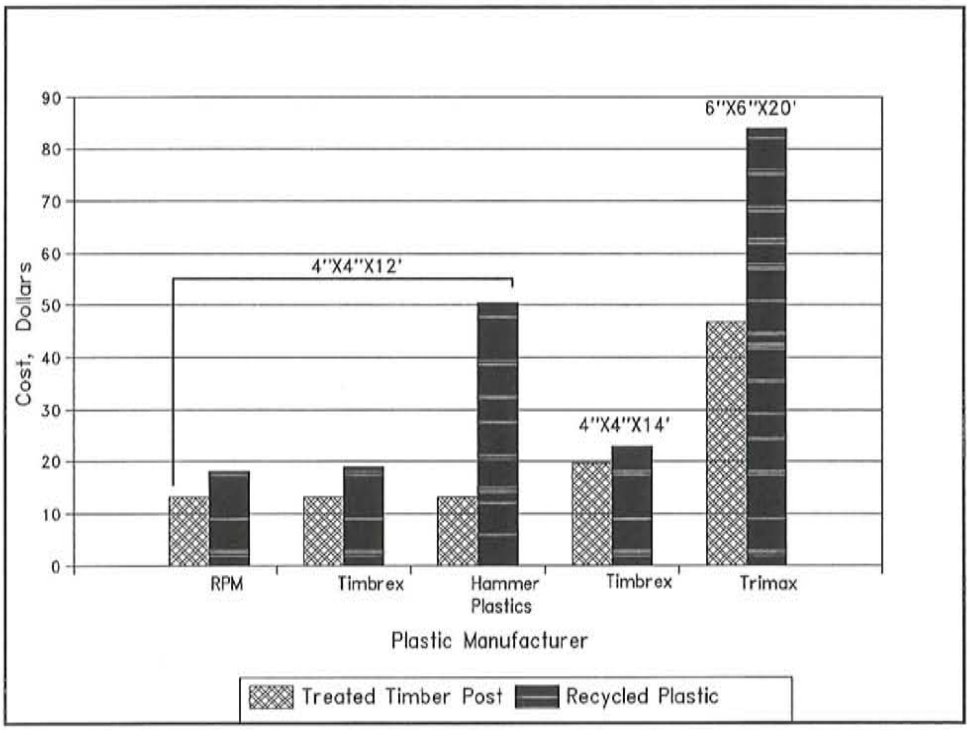


Figure 3.2: Recycled Plastic Sign Post Costs by Manufacturer.

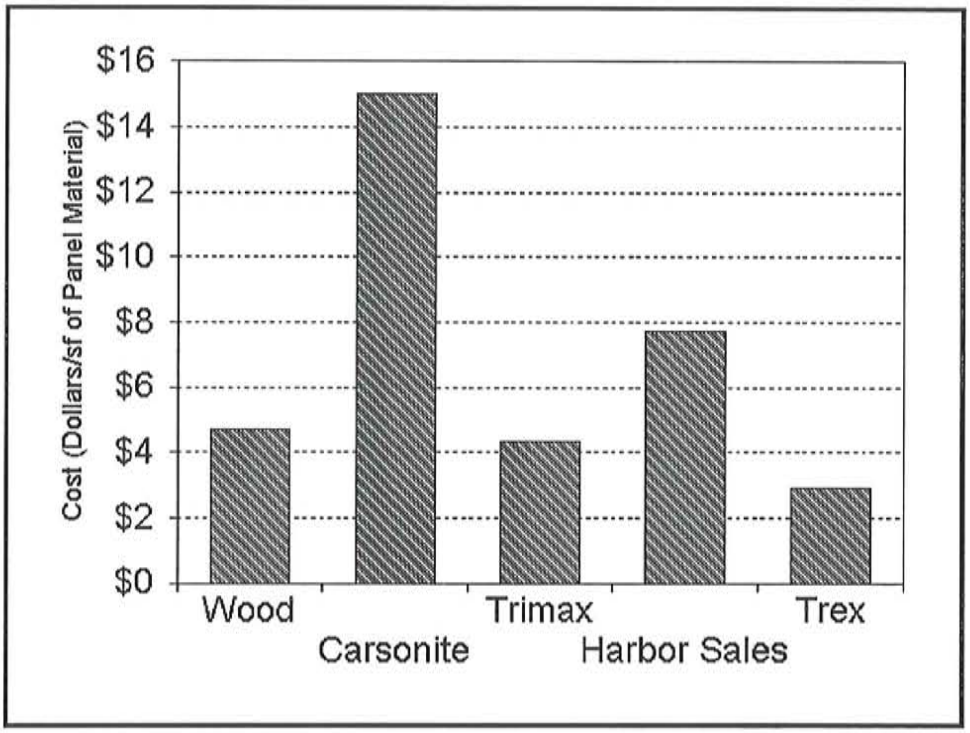


Figure 3.3: Recycled Plastic Wall Panel Material Costs by Manufacturer.

4.0 ENVIRONMENTAL CONCERNS

Environmental concerns to be addressed include handling, flammability, and product recyclability. For comparison, Table 4.1 presents the fire and handling guidelines for three products: Trimax (80% recycled plastic), Timbrex (composite wood/plastic), and for comparison, treated wood posts. The wood posts most commonly used by ODOT are treated with ACA (ammoniacal copper arsenate) or ACZA (ammoniacal copper zinc arsenate). The information included in the table is from the manufacturer's published literature. In general, the information is representative of the materials being evaluated.

Table 4.1: Fire and Handling Data

Manufacturer or Product Name	Fire and Explosion Hazard Data	Handling
McCormick & Baxter Creosoting Co. (Treated wood)	Flashpoint: >200° F Extinguishing Media: Water spray	After working with the wood and before eating, drinking, and use of tobacco products, wash exposed areas thoroughly. Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When power-sawing and machining, wear goggles to protect eyes from flying particles.
Trimax (Plastic)	Flashpoint: ~658° F Extinguishing Media: Water spray, dry chemicals, foam or carbon dioxide.	Material should be handled with gloves to avoid abrasions and possible skin irritation. Dust from sawing may be an irritant to skin and eyes. It should be scrubbed off the surface of any finished part that could come in contact with bare skin during use, with soap and water. Safety glasses, goggles or face shields should be worn in such a manner that dust or chips will not get into the eyes. Material should be handled with gloves to avoid abrasions and possible skin irritation.
Trex (Previously Timbrex) (Plastic and wood fiber)	Flashpoint: >430° F (estimate) Extinguishing Media: carbon dioxide, foam, dry chemical. Exposure to fire can generate highly toxic fumes. High dust levels may create potential for explosion.	Effects of overexposure: Inhalation of fines, if any, can cause irritation of nose and throat. Dust may be irritating to respiratory tract. Repeated exposures to certain wood dusts can produce allergic responses in some sensitive individuals. Safety glasses with side shields, or goggles, should be worn to protect against dust particles. No special equipment required for skin protection, however, good personal hygiene practices should always be followed.

Based on a review of the handling information as shown in Table 4.1, there is little difference in the recommended handling of wood and plastic products.

A check on product recyclability indicated that the majority of the recycled plastic suppliers would recycle any of their own damaged materials. In some cases, the manufacturers are in the process of establishing a buy-back process whereby credit is given for returned materials. The only consideration for returning the materials is that they be relatively clean and free of staples and nails. Treated wood posts, however, would be more difficult to dispose of. The manufacturer recommends disposing of the treated wood by ordinary trash collection or burial. The recommendations go on to say that the treated wood should not be burned in open fires or in stoves, fireplaces or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (e.g. construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and Federal regulations.

5.0 CONSTRUCTION

Recycled plastic snow poles were installed near Government Camp. Sign supports were installed near Portland, Salem, and Coos Bay. Fence posts were installed near Tillamook and Jordan Valley. The locations of the products are shown in Figure 2.1 and listed in the Appendix, Table A.3, Recycled Plastic Product Installation Locations.

5.1 SNOW POLES

The recycled plastic snow poles (10 feet long) were installed by fastening the base of the poles to existing traffic delineator posts along the roadside with two pieces of 10 gauge wire. The standard snow poles were two-inch diameter PVC pipe, which had to be fastened to the outside of the delineator posts. The recycled snow poles, however, were only about 1-1/4 inches in diameter and fit in the gap between the reflector and the delineator post, requiring only one piece of wire for fastening. The installations went quickly with each pole taking only about one to two minutes to install. The recycled snow poles were alternated with the standard snow posts to give a good comparison of performance. Figure 5.1 includes a photograph of an installed recycled plastic snow pole.

ODOT's initial experience with the snow poles was that the poles sag under the weight of heavy snow, while the standard poles remain straight. This may be due to a softer plastic in the recycled poles and/or the smaller section used (1-1/4" diameter) versus a standard pole (2" diameter).

5.2 SIGN SUPPORTS

All sign supports were installed behind a guardrail or out of the way of traffic since the posts have not been crash tested.

Two types of sign supports were used including solid core posts and hollow core posts. The sign supports varied in length from twelve to fourteen feet. All sign posts were installed manually in a 3-foot deep post hole. The signs on the hollow core supports were easily attached with a nut and bolt. Lag bolts with washers were used to attach the signs on the solid core posts. The hollow posts were only used with smaller (18" x 24") signs since there was concern about the post stability with heavier loads and/or high winds.

The District 3 Sign Crew reported problems with the solid posts. They found that the bolts would not snug up when trying to attach the sign. The District 7 Sign Crew reported that the solid posts were heavy and hard to work with. Mounting the signs was time consuming because a pilot hole had to be drilled into each post to accommodate the lag bolt or an impact

wrench had to be used to screw in the lag bolt. The largest sign attached to the plastic posts was 5'X4', made of plywood. Photographs of the sign supports are included in Figures 5.2 and 5.3.

Two additional 6" diameter round solid posts, 12' long were ordered and delivered to District 2A. The posts were not used because they were found to be too heavy and bulky to handle without the assistance of a boom truck.

5.3 FENCE POSTS

Fence posts from four suppliers were installed in Tillamook and Jordan Valley (see Figure 2.1). The fence posts were either 4"X4" or 6"X6" and varied in length from seven to eight feet.

The fence posts installed at the District 14 maintenance property (Jordan Valley) were placed in augured pilot holes about 3' deep and 6" in diameter. The 6"X6" posts were used for the corner gate posts. The posts were pushed into the ground with the bucket of a large front end loader until about 4' of the post was left above the ground. The first two posts (north end) were pushed into harder soil. This was made easier by a point constructed with the use of a hand ax. The remaining posts were driven into the ground with the flat end being pushed into the soil. The holes were then backfilled using the removed soil. While trying to plumb one of the posts during backfilling, one of the crew pulled too hard and snapped the post at the base. According to the crew, this probably would not have been a problem if the post had been made from wood.

Once all the posts were installed, the steel wire fence was attached to the steel post supporting the gate and pulled tight at the other end of the fence. The wire was then fastened with U-shaped nails hand driven into the recycled posts. It was a crew member's opinion that the nails were harder to drive in the recycled posts than wood posts.

The fence posts in District 1, near Tillamook, were installed with two people using a front end loader to push the posts into the ground. Preparation of the plastic posts was to include cutting the ends with a chain saw to create a tip. After cutting a few posts, the chain saw was dulled so not all posts were pointed. Cutting the Plastic Lumber Co. posts revealed a "spongy" looking center, so only two sides were cut to create a tip. The pointed posts were used selectively in difficult (hard ground) installation areas. One of the Timbrex posts broke during installation when it was pushed into gravel. It appeared to have broken in a weak (air pocket) location.

The fence was attached to the posts using 1-1/2" staples. The crew was concerned about losing staples since cattle may eat the discarded staples which could adversely affect their health. During cold weather, the crew installed the Enviro-Lumber posts. They found the posts very hard. To insure proper staple installation, the holes were pre-drilled using a template and the staples placed in the holes. The Timbrex and Plastic Lumber Co. posts were installed during warmer weather than the Enviro-Lumber posts, so the staples were installed normally. The foreman said it was difficult to tell if installing the Enviro-Lumber posts on a warmer day would have made a difference with the staples. The most temperature susceptible posts noticed while stapling seemed to be the Plastic Lumber Co. posts. The colder the temperature, the more difficult they were to staple.

The foreman for the District 1 fence estimated the plastic posts took 2 to 3 times longer than the wood posts to install. They were more difficult to push in, since the majority of posts were not pointed, and were more difficult to attach to the fencing. Recycled plastic fence posts are shown in Figures 5.4 and 5.5.

5.4 SOUND WALL

5.4.1 INITIAL SOUND WALL CONSTRUCTION

The initial sound wall construction along I-5 in Salem was done by the Region 2 Bridge Crew. The crew consisted of six people with a boom truck. The sound wall was constructed by first erecting nine W8X18 steel posts set in 6'X6'-6" holes filled with concrete. The concrete was allowed to cure for seven days. Sound wall panel material including tongue and groove wood, recycled plastic--both tongue and groove and shiplap, and a plastic shell filled with shredded tire rubber, was then inserted horizontally between the posts. The panel material is held in place by angle irons welded to the vertical posts on the back side of the wall. The relative location of the panels within the wall is shown in Figure 5.12. The original plans are included in the Appendix. The tongue and groove treated lumber, Harbor Sales, and Trimax boards are shown in Figure 5.6.

The wood panels were easily constructed since the tongue and groove boards could be handled by one person. After the first two wood panels were constructed, it was discovered that the last panel was short 3 boards. The reason for this was that the posts were slightly taller (10'-3" versus 10'-0") than the design. Three 3"X6" boards were provided from the maintenance yard and placed on the bottom of the south panel.

The Carsonite panel (plastic shell filled with shredded tires) was placed using the boom truck. It was easily placed between the posts, however, the finished dimensions of the one piece panel were 8'X 9'-8". Because of the taller posts, this made the gap at the bottom over 7". To improve the appearance, a berm was constructed at the base of the panel to cover the gap.

The first few Trimax tongue and groove boards were placed by hand, however, the upper boards required the assistance of the boom truck due to the weight and bulk of the boards. The Trimax boards appeared to be straight, not bowed, however, the lengths varied slightly.

Shiplap joints were used on the Harbor Sales boards which presented a problem since the boards were very flexible and did not lock together. When the boards were placed on top of each other in the panel, they appeared to be bowed as much as one inch. To create a flat face, on one panel, an angle iron was bolted on to the center of the back of the wall to effectively straighten the boards. Figure 5.7 includes a photograph of the angle iron attached to the back of the Harbor Sales boards. On the second panel, lag bolts were installed horizontally through the shiplap joints. This method was more difficult since after the bolt passed through one board and hit the second, the top board had a tendency to move up under the resistance. On two occasions, the bolts were removed and redrilled because of the gap left after the board moved. While drilling one of the lag bolts, the board split near the bottom edge, similar to what would be expected from wood. By exerting strong pressure, the bolts were installed satisfactorily halfway up the center of the back of the panel. The upper portion of the panel is held in place with only the angle irons attached to the steel posts. A picture of the bowing problem associated with the Harbor Sales boards and shiplap joint is shown in Figure 5.8.

Finishing the Harbor Sales panels required ripping the top boards so the tops of all the panels would line up horizontally. The boards were ripped using a circular saw with a carbide blade. After ripping one of the boards, a plastic splinter remained along most of the length of the board. To remove the excess plastic, a 6" grinder was used which tended to mark up the board. Finally, an Exacto knife was used to smooth the edge.

5.4.2 TREX AND COLLINS & AIKMAN PANEL CONSTRUCTION

Construction of the two Trex panels and two Collins & Aikman panels provided an opportunity to evaluate composite materials that include recycled plastics. The materials were used on separate dates for panel construction.

Construction of the two Trex panels took place October 18, 1993. One panel was constructed with 2"X8"X8' boards and another with 2"X6"X8' boards. The materials were easy to handle and sawed much like wood.

Originally, the materials were placed using a boom truck. A C-clamp was used to hold the boards which were then lifted and moved into place. After placing a couple of boards, the crew discovered the material was fairly easy to work with. The remaining boards were placed without boom truck assistance. For the panels used in the initial sound wall construction, the majority of the recycled plastic materials required mechanical assistance for placement due to the weight and bulk of the materials.

During installation, a couple of warped boards were noticed. The boards were included in the panel and held in place with the angle iron welded on the back. A small gap was still noticed at the joint for these boards and will be monitored over time.

The top boards for each panel were ripped to be in line with the top of the other panels. The boards were quickly and easily ripped with a circular saw. The edges were clean and did not require any additional finishing.

The Trex panels are variable in color: gray and brown. The boards are expected to weather out to a uniform color. Figure 5.9 includes a photograph of the finished Trex panels.

Construction of the two Collins & Aikman panels took place December 3, 1993. Both panels were constructed with 2"X8"X8' boards. The materials were easy to handle and sawed much like wood.

The two panels were constructed in less than two hours. The short time frame was attributable to the ease of handling the boards. The boards were set between the posts by one person up to a height of about 5 feet. From there, a boom truck was used to raise a person up above the wall with several boards. The boards were then dropped and maneuvered in place. The last step included welding angle irons to the vertical steel posts to snug the boards up to the face of the steel post.

The Bridge Crew reported that the boards varied by as much as 3 inches in length. Also, some of the boards were cupped and some were warped. The warping could have been from the way the boards were tied to be shipped.

The boards had a rough, mottled appearance. One of the boards was ripped. Unlike other materials we have studied, no voids were discovered in the cut face. Figure 5.10 includes a photograph of the completed Collins & Aikman panels.

The finished sound wall is shown in Figure 5.11.

Figure 5.1: Recycled plastic snow pole at Government Camp.

Figure 5.2: Wood sign support (left) and Timbrex sign support (right) at Salem.

Figure 5.3: Back side of RPM (hollow) sign support at Portland.

Figure 5.4: Standard wood and Timbrex fence posts at Tillamook.

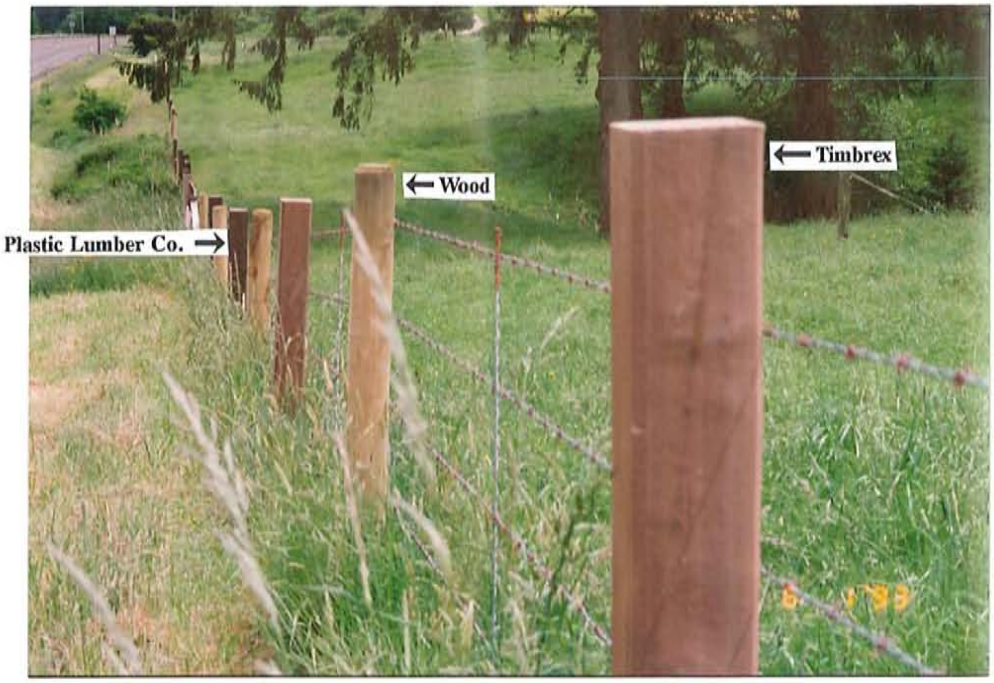


Figure 5.5: Timbrex, wood, and Plastic Lumber Co. fence posts at Tillamook.

Figure 5.6: Tongue and groove treated lumber (top), Harbor Sales (bottom left), and Trimax lumber (bottom right) for sound wall panels.

Figure 5.7: Angle iron attached to the back of Harbor Sales sound wall panel.

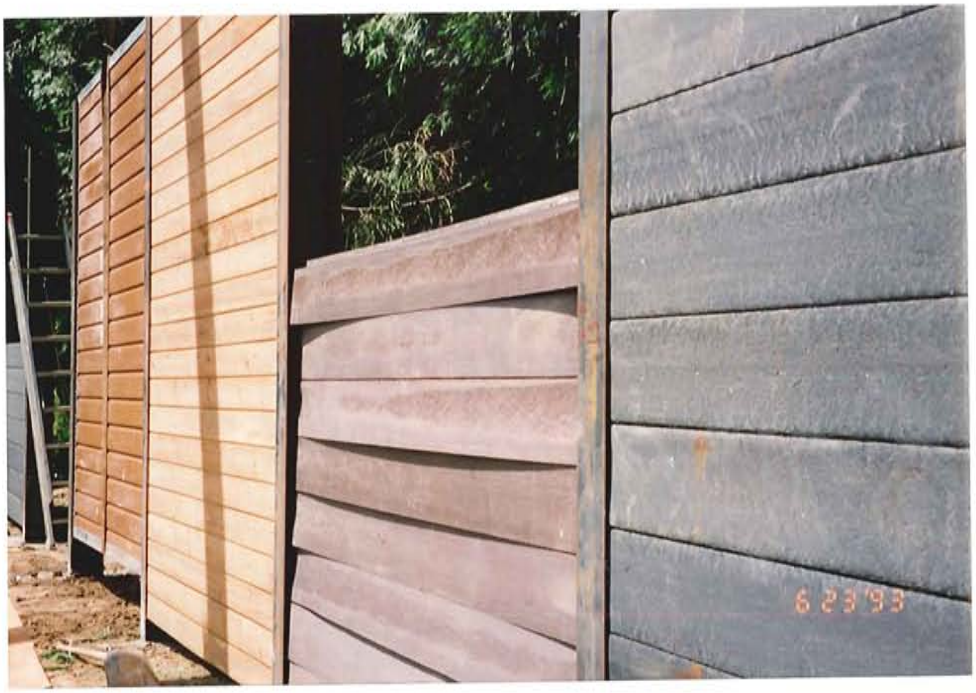


Figure 5.8: Bowing in Harbor Sales sound wall panel.

Figure 5.9: Trex sound wall panels.

Figure 5.10: Completed Collins & Aikman sound wall panels.

Figure 5.11: Completed Sound Wall.

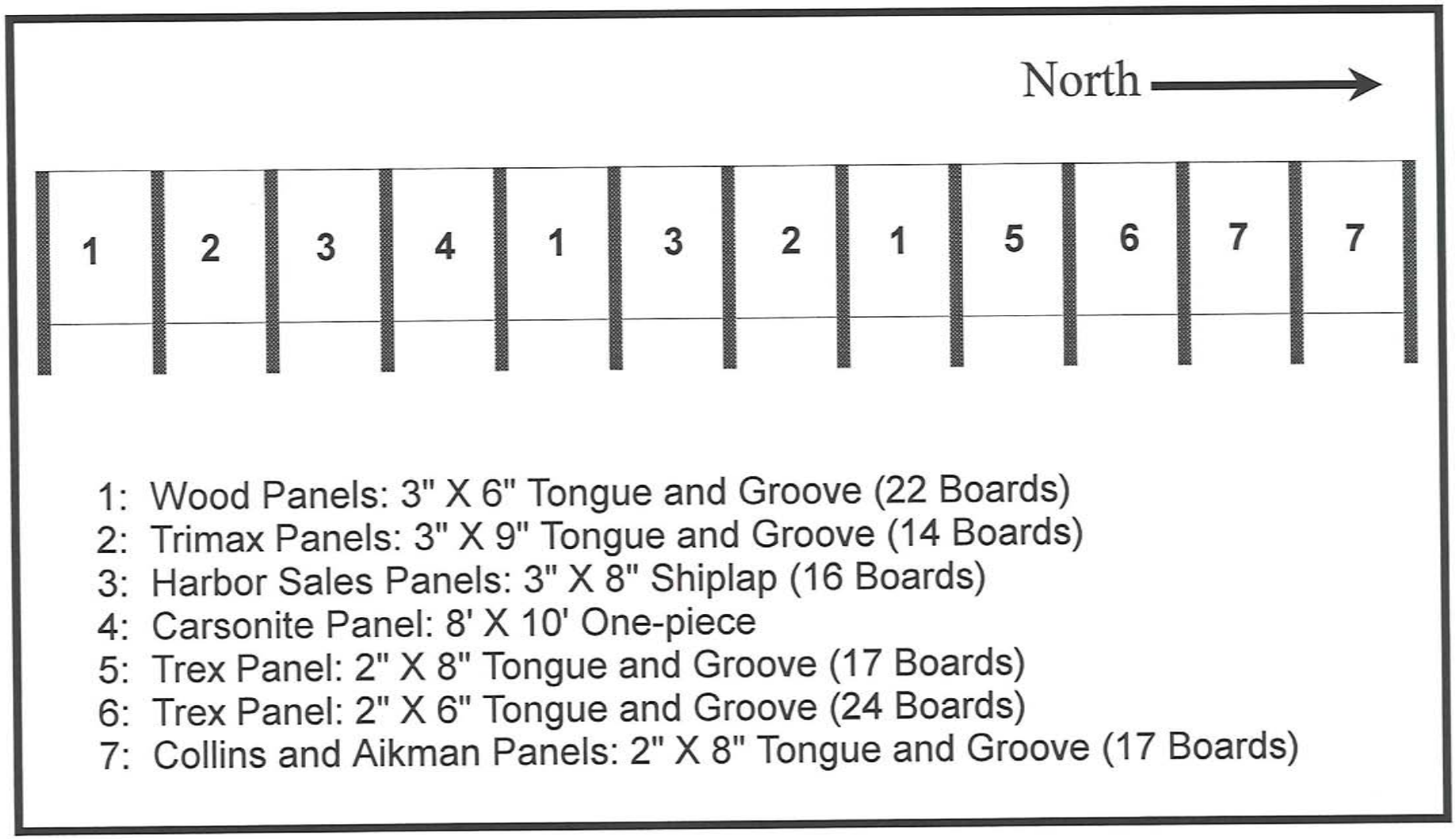


Figure 5.12. Sound Wall Panel Materials.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The following general conclusions were reached following installation of the recycled plastic snow poles, fence posts, sign supports, and sound wall:

1) Recycled plastic materials for construction and maintenance may be more difficult to obtain than standard wood products.

2) Upfront material and shipping costs are more expensive than comparable wood products.

3) The equivalent uniform annual material costs of wood and plastic products should be considered when evaluating costs of recycled materials.

4) Handling of recycled plastic materials is similar to handling treated wood products. Both materials come with recommendations for inhalation, skin and eye protection.

5) Recycled materials may be more readily recyclable than treated wood products which must be disposed of in a landfill or burned in accordance with state and federal regulations.

6) Recycled plastic snow poles are easier to install than standard snow poles, but may sag during heavy snow periods.

7) Recycled plastic fence posts are more difficult to install than standard treated wood posts because of the lack of a tip or the difficulty in creating a tip to facilitate installation. Depending on the type of plastic, stapling may also be a problem with plastic fence posts.

8) Solid core recycled plastic sign posts are more difficult to install than standard treated wood posts. In general, extra effort was needed to attach the signs to the plastic sign supports.

9) Recycled plastic lumber is heavier and requires more effort to work with than comparable wood lumber as noted during fence and sign post installation, and sound wall construction.

10) Recycled plastic sound wall panel boards manufactured with shiplap joints may not lock sufficiently to prevent bowing.

Recycled plastic products provide a means for reusing pre- and post-consumer waste. The cost of recycled plastic, however, still exceeds standard material costs. When comparing costs, the life expectancy of the given product should be included in the analysis since plastic materials may last longer than wood products. As more information is available, installation, shipping, and maintenance costs should also be included in the price comparison.

A premium should be paid for recycled materials only if the products are expected to out perform standard wood products. With long term performance characteristics currently unknown, the attributes and value of recycled plastic products need to be determined.

6.2 RECOMMENDATIONS

Additional recycled plastic material installations should be encouraged. Since the materials are relatively new, some of the construction problems could be due to inexperience in handling. As the plastic materials become more common, handling and installation concerns should decrease.

Recycled plastic fence posts for installations in areas with dense soils should be ordered with a point at one end. The pointed end will facilitate installation and decrease the chance of breakage.

Recycled plastic fence posts should be installed by pushing with steady pressure rather than driven with repeated blows. Repeated blows to the recycled plastic fence posts increases the chances of breakage.

Recycled plastic boards used for sound wall facing should have tongue and groove joints to insure proper interlocking and to reduce the amount of bowing.

APPENDIX

Supporting Information

Table A.1: Recycled Plastic Vendors' Addresses and Costs

Manufacturer or Product	Vendor	Snow Poles	Fence Posts	Sign Posts	Size	Price/ Item	Ship. Costs
Dapco	Dapco Davidson Plastics 18726 E. Valley Hwy. Kent, WA 98032 (206) 251-8140	*			10' Long; 1.3" Diam.	$3.52	-0-
Timbrex[1]	Ecoversion Products Inc. 87 Stillman Street San Francisco, CA 94107 (415) 882-5515		*		4"X4"X8'	$12.60	$190.00
The Plastic Lumber Co., Inc.	VANCO Associates, Inc. 220 Main Street Edmonds, WA 98020 1-800-223-2183		*		6"X6"X7'	$47.11	$100.00
Timbrex[1]	Ecoversion Products Inc.		*		6"X6"X8'	$30.49	$953.00
The Plastic Lumber Co., Inc.	VANCO Associates		*		6"X6"X7.5'	$51.16	$700.00
Enviro-Lumber	Environmental Plastics 18574 South Hwy. 99E Oregon City, OR 97045 (503) 655-0758		*		6"X6"X8'	$60.00	$166.12
RPM	Traffic Safety Supply 2324 SE Umatilla St. Portland, OR 97202 (503) 235-8531			*	4"X4"X12' (Hollow)	$18.00	$25.00
Timbrex[1]	Ecoversion Products Inc.			*	4"X4"X12' (Solid)	$18.90	$80.00
Timbrex[1]	Ecoversion Products Inc.			*	4"X4"X14' (Solid)	$22.74	$80.00
Timbrex[1]	Ecoversion Products Inc.			*	4"X4"X14' (Solid)	$22.05	$97.00
Hammer Plastics	Charles R. Watt, Inc. P.O. Box C-70708 Seattle, WA 98107 (206) 783-8400			*	4"X4"X12' (Solid)	$50.43	$45.00
Trimax	Ducks Marine Distrib. 18699 NE Marine Drive Portland, OR 97230 (503) 665-8348			*	6"X6"X20' (Solid)	$84.00	$75.00

[1] Timbrex is now called Trex.

Table A.2

Questionnaire

OREGON DEPARTMENT OF TRANSPORTATION

RECYCLED PLASTIC PRODUCTS

Date Shipped: _____

Shipped to: _____

_____

Item: _____ Quantity: _____

Type of Recycled Plastic _____

Manufacture of Recycled Plastic Product _____

*Percent Post Consumer Recycled Plastic _____ or

Percent of Preconsumer Recycled Plastic _____

Percent of other materials _____ Identify _____

Percent of other materials _____ Identify _____

Percent of other materials _____ Identify _____

Percent of other materials _____ Identify _____

_____ _____

Name of Person Completing Form Date

_____

Title

_____

Company

*Recycled Products that have been used by retail consumers.

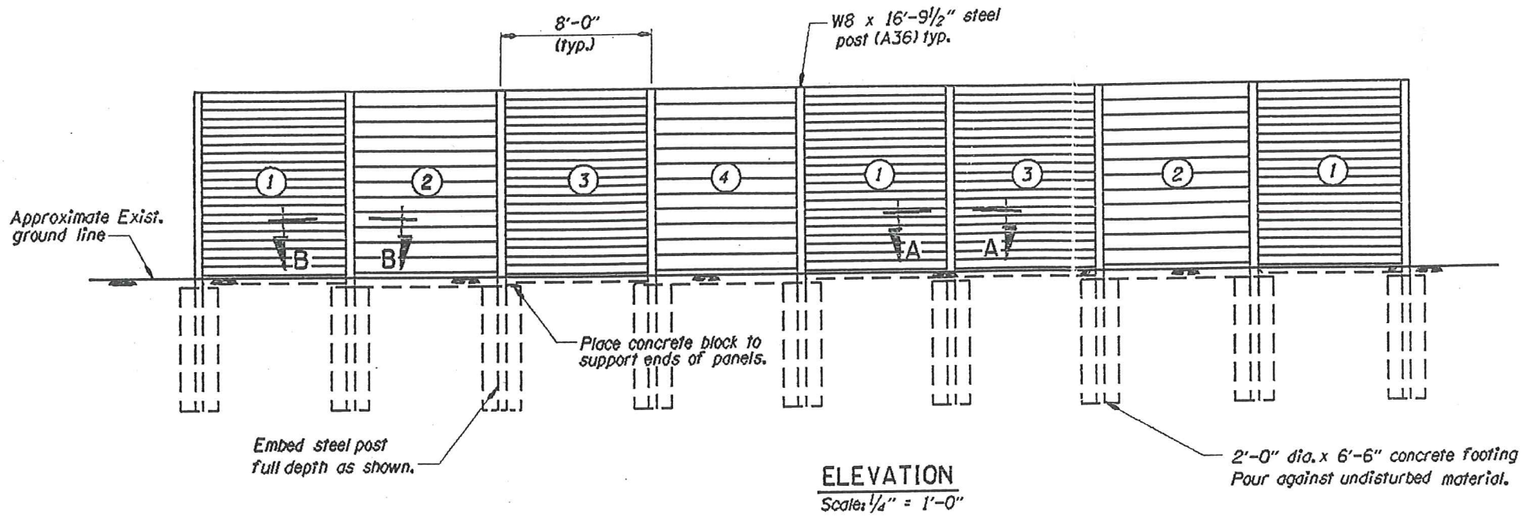
Table A.3: Recycled Plastic Product Installation Locations

Product Name	Snow Poles	Fence Posts	Sign Posts	Size	Installation Location	Date Installed
Dapco	100			10' Long; 1.3" Diam.	Government Camp, District 2: 1) 3 miles east of the U.S. Route 26-Oregon Route 35 junction on Oregon Route 35; 2) U.S. Route 26 from the ODOT Maintenance station in Government Camp, 1/2 mile east; 3) U.S. Route 26 and Timberline Rd., up Timberline Rd. for 1.2 miles.	Oct 92
Timbrex		16		4"X4"X8'	Jordan Valley, District 14: Along U.S. Route 95, enclosing the ODOT maintenance property.	Nov 92
The Plastic Lumber Co., Inc.		4		6"X6"x7'	Jordan Valley, District 14: Along U.S. Route 95, enclosing the ODOT maintenance property.	Nov 92
Timbrex		50		6"X6"X8'	Tillamook, District 1: Oregon Route 6, M.P. 3.80 to 4.07.	May 93
The Plastic Lumber Co., Inc.		50		6"X6"X7.5'	Tillamook, District 1: Oregon Route 6, M.P. 3.80 to 4.07.	May 93
Enviro-Lumber		50		6"X6"X8'	Tillamook, District 1: Oregon Route 6, M.P. 3.80 to 4.07.	May 93
RPM			4	4"X4"X12'	Portland, District 2A: 1) Farmington Road - Oregon Route 10, W/B M.P. 0.05: "Dumping Rubbish Prohibited"; 2) Oregon Route 43, S/B Riverwood Rd., M.P. 4: "Vending Prohibited"; 3) Oregon Route 99W, S/B Canterbury Lane: "Right Ln. Must Turn Right"; 4) U.S. Route 26, E/B Katherine Ln., M.P. 69.84: "No Parking: Bus Stop".	Mar 93
Timbrex			3	4"X4"X12'	Salem, District 3: Park and Ride off I-5 at Sunnyside exit: "No Parking".	Jun 93
Timbrex			3	4"X4"X14'	Salem, District 3: Park and Ride off I-5 at Sunnyside exit: "No Parking".	Jun 93
Timbrex			2	4"X4"X14'	Coos Bay, District 7: 1) U.S. Route 101, M.P. 260.50 (3'X2' plywood sign); 2) U.S. Route 101, M.P. 305.54 (30"X30" and 18"X18" metal signs).	Apr 93
Hammer Plastics			3	4"X4"X12'	Salem, District 3: Park and Ride off I-5 at Sunnyside exit: "No Parking".	Jun 93
Trimax			2	6"X6"X20'	Coos Bay, District 7: 1) U.S. Route 101, M.P. 306.05 (4'X4' plywood sign); 2) U.S. Route 101, M.P. 331.07 (5'X4' plywood sign).	Apr 93
Various	Sound Wall			~64'X10'	Salem, westside of southbound lanes of I-5, just north of the Oregon Route 22 exit ramp, ~M.P. 254.	Jul 93-Dec 93

Table A.4: Weather Information for Installation Locations

	Tillamook	Coos Bay	Portland	Salem	Government Camp	Jordan Valley[1]
Elevation (feet)	10	6	21	195	3980	4225
Ave. Daily Temperature of Coldest Month (°F)	43	45	40	40	30	26
Mean Daily Temperature Swing in Coldest Month (°F)	14	13	12	14	12	23
Ave. Daily Temperature of Warmest Month (°F)	59	60	69	67	57	67
Mean Daily Temperature Swing in Warmest Month (°F)	19	14	23	31	22	41
Average Annual Precipitation (inches)	89	63	36	39	87	12

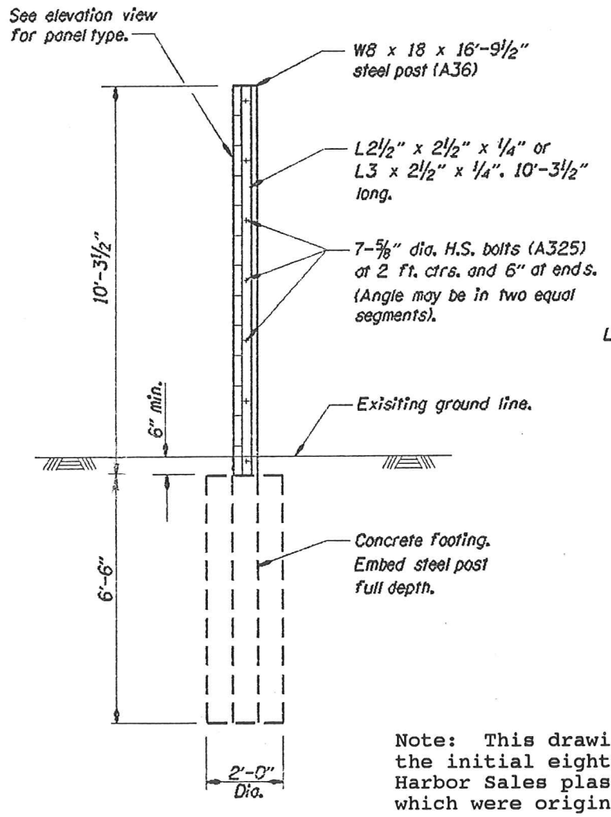
[1] No Station located at Jordan Valley. Data listed is from the Danner Station.



ELEVATION

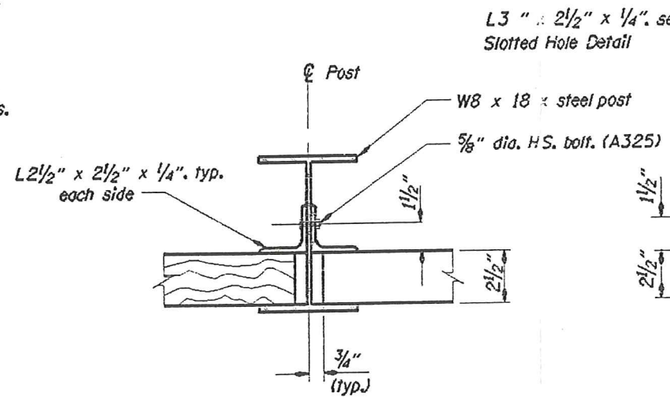
Scale: 1/4" = 1'-0"

1. 22 Wood Panels: 3 x 6 Tongue and groove (2½" x 5½")
2. ~~13~~ 14 Trimax Panels: 3 x 10 Tongue and groove ~~(2¾" x 9½")~~ (2½ x 8¾)
3. 22 Timbrex Panels: 3 x 6 Tongue and groove (2½" x 5½")
4. Carsonite Panels



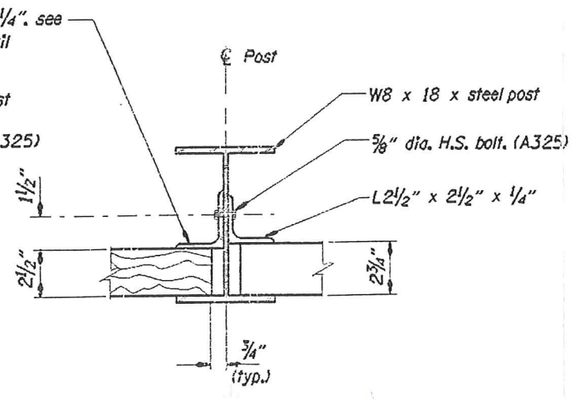
TYPICAL SECTION

Scale: ½" = 1'-0"



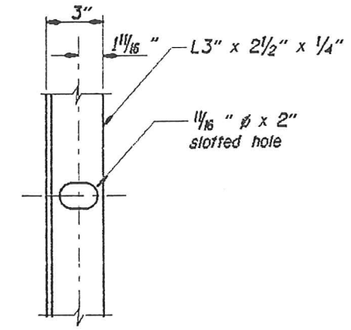
SECTION A-A

Scale: 3" = 1'-0"



SECTION B-B

Scale: 3" = 1'-0"



SLOTTED HOLE DETAIL

Scale: 3" = 1'-0"

Note: This drawing does not include the north four panels constructed after the initial eight. The additional panels were constructed as shown. Also, Harbor Sales plastic lumber was substituted for the number 3 labeled panels which were originally intended to be constructed with Timbrex lumber.

GENERAL NOTES:

Sound Barriers are designed in accordance with the AASHTO Guide Specifications for Structural Design of Sound Barriers (1989). All materials and workmanship shall conform to the Standard Specifications for Highway Construction of the Oregon State Highway Division.

Barriers are designed for a load normal to the barrier of 25 psf. This meets requirements for 90 mph wind velocity, B2 Exposure, 50 year recurrence interval.

Footing embedment lengths designed for Average Soil.

Concrete in footing shall be Commercial Concrete (Minor Structural Concrete).

All structural steel shall be ASTM Specification A36.

All fasteners shall be ASTM Specification A325.

All wood panels shall be Douglas Fir-Larch.

REGISTERED PROFESSIONAL ENGINEER 14,989 OREGON JULY 25, 1990 IN-TAE LEE

DATE	REVISION	BY

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

EXPERIMENTAL SOUND BARRIER WALL

GENERAL DETAILS

DESIGNED — PE NO. —
Richard G. Olson
DRAWN
CHECKED
REVIEWED
APPROVED

DATE November, 1992 CALC.BOOK — SHEET — OF —
BRIDGE NO. 17327 DRAWING NO. —

Figure A.1