4-7-86

036101
SHAUGHNESSY NO.

4/7/86

REVIEW NO.

EEB BRANCH REVIEW

DATE: IN 02/25/86 OUT

FILE OR REG. NO. 1471-70

PETITION OR EXP. PERMIT NO.

DATE OF SUBMISSION 02/13/86

DATE RECEIVED BY HED 02/14/86

RD REQUESTED COMPLETION DATE 04/25/86

EEB ESTIMATED COMPLETION DATE 04/18/86

RD ACTION CODE/TYPE OF REVIEW 315

TYPE PRODUCT(S): I, D, H, F, N, R, S Herbicide

DATA ACCESSION NO(S).

PRODUCT MANAGER NO. R. Mountfort (23)

PRODUCT NAME(S) Treflan

COMPANY NAME Elanco Products Company

SUBMISSION PURPOSE Proposed registration of use in sewer pipe gaskets, extruded netting, or similar products

SHAUGHNESSY NO.	CHEMICAL & FORMULATION	% A.I.
036101	α,α,α-trifluoro-2,6-dinitro-N,	
	N-dipropyl-p-toluidine	95%
	Inert ingredients	5%

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EEB Review

Trifluralin

100 Submission Purpose and Label Information

100.1 Submission Purpose and Pesticide Use

Trifluralin is currently registered for use as a preemergence herbicide.

The Elanco Products Company is requesting a conditional registration, under section 3(c)(7) of FIFRA, for a new use of Treflan (technical trifluralin) to control plant root encroachment into sewer pipes and/or waste burial sites where root encroachment is undesirable.

100.2 Formulation information

Active Ingredient:	
*Trifluralin	95%
Inert Ingredients:	5%

*α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine

100.3 Application Methods, Directions, Rates

Directions for Use:

End-use products manufactured employing technology developed and patented (patent pending) by Battelle Memorial Institute should be used to inhibit plant root encroachment.

Products such as sewer pipe gaskets, extruded netting for covering buried waste, or similar products manufactured in organic polymeric carriers impregnated with Treflan and used according to the manufacturers' instructions will inhibit root encroachment for extended periods of time.

Please see attachment 1 for a more detailed description of the intended use.

100.4 Target Organisms

Plant roots.

100.5 Precautionary Labeling

Environmental Hazards

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public water unless this product is specifically identified and addressed in a NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

Pesticide Disposal: Do not contaminate water, food, or feed by storage or disposal. Waste resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

For Manufacturing Use Only in Formulating Herbicides: This material may only be used for the formulation of herbicidal products labeled for use on ornamental plants, established turfgrasses, or home vegetable gardens. Active ingredient concentration cannot exceed 5 percent trifluralin by weight in granular or fertilizer-based products for dry application.

101 Hazard Assessment

101.1 Discussion

Treflan will be incorporated into a biobarrier either in the form of polyethylene extruded netting or sewer pipe gaskets. The percentage of trifluralin incorporated in the biobarrier (application rate) has not been stated by the Company. Therefore, the maximum exposure could not be calculated.

101.2 Likelihood of Adverse Effects to Nontarget Organisms

The available avian toxicity data indicate that technical trifluralin is practically nontoxic to upland gamebirds and waterfowl on both the acute oral and dietary basis (LC_{50} > 2000 mg/kg and LC_{50} > 5000 ppm, respectively). Results from avian reproduction tests indicate that technical trifluralin does not impair the reproduction of birds (mallards and bobwhite) at exposures below 50 ppm on a dietary basis.

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Based on the available acute aquatic toxicity data, trifluralin is highly toxic to freshwater invertebrates (the average 48-hour LC_{50} values range from 0.56 to 0.9 ppm, 96-hour LC_{50} values 2.2 and 2.8 ppm). Trifluralin is also highly toxic to both coldwater and warmwater finfishes (the average 96-hour LC_{50} values ranging from 41 ppb to 58 ppb for studies that support registration).

Trifluralin is highly toxic to amphibians in acute exposures (96-hour TL_{50} of 0.1 ppm).

The MATC for trifluralin was estimated to be > 2.4 and < 7.2 ppb for Daphnia magna and > 1.9 and < 5.1 ppb for fathead minnow.

Currently the available environmental fate data are insufficient to fully assess trifluralin. The data do suggest that "trifluralin is persistent and highly soil-bound. Aquatic environments could receive trifluralin through soil runoff. Sediment bound residues could desorb yielding low-level chronic exposures" (Ecological Effects Disciplinary Review, Les Touart, 1985). Therefore, there may be chronic hazards to nontarget aquatic and terrestrial organisms.

101.3 Endangered Species Considerations

The Ecological Effects Branch (EEB) has completed two clusters which have addressed trifluralin. The first cluster includes the uses: cotton, soybeans, sorghum and small grains (wheat, barley, and rye). Trifluralin, in both granular and nongranular form, has been found to exceed the listed species trigger for fish.

The second cluster includes corn. Trifluralin, in the nongranular form, has been found to exceed the listed species trigger for aquatic organisms (including the class amphibians).

Based on the expected use, endangered species are not expected to be affected; however, it will be necessary to estimate the incremental risk assessment before determining this.

101.4 Adequacy of Toxicity Data

No studies were included with the submission. The available ecological test data on the active ingredient, which include the six basic studies, meet the requirements for applying for a conditional registration.

It should be noted that the Company has submitted a required aquatic field study for review, in response to a Position Document 4 in April 1982. The results of the study have not yet been determined.

EEB believes that there is limited potential for exposure based on the proposed use, however, to perform an incremental risk assessment, it is necessary to know the following:

- Concentration of the active ingredient in the product (specifically, there is concern for aquatic toxicity; therefore, the application rate in sewer pipe gaskets is needed); and

- The potential for leaching of the active ingredient from the biobarrier (specifically the sewer pipe gaskets).

101.5 Adequacy of Labeling

The label does not specify the total concentration of the formulated product in the biobarrier.

It also should be noted that the Directions for Use should be more specific. The "or similar products manufactured in organic polymeric carriers impregnated with Treflan and used according to the manufacturers' instructions will inhibit root encroachment for extended periods of time," leads the reader to believe the product can be used anywhere.

Additional labeling restrictions may be required pending an incremental risk assessment after the necessary data are received and reviewed.

102 Classification

Presently not classified.

103 Conclusions

EEB has reviewed the proposed conditional registration of trifluralin for use in a biobarrier to be used in sewer pipes and/or waste burial sites where root encroachment is undesirable. EEB is unable to complete an incremental risk assessment (3(c)(7) finding) for this use because pertinent environmental chemistry data are lacking. In order to assess the risks associated with this use, EEB requires the data listed in 101.4.

Candy Brassard Candace A. Brassard 4/7/86
Section #3
Ecological Effects Branch/ HED

Douglas J. Urban Douglas J. Urban 4/7/86
Section Head
Section #3
Ecological Effects Branch/ HED

Michael W. Slimak M W Slimak 4/7/86
Chief
Ecological Effects Branch/ HED

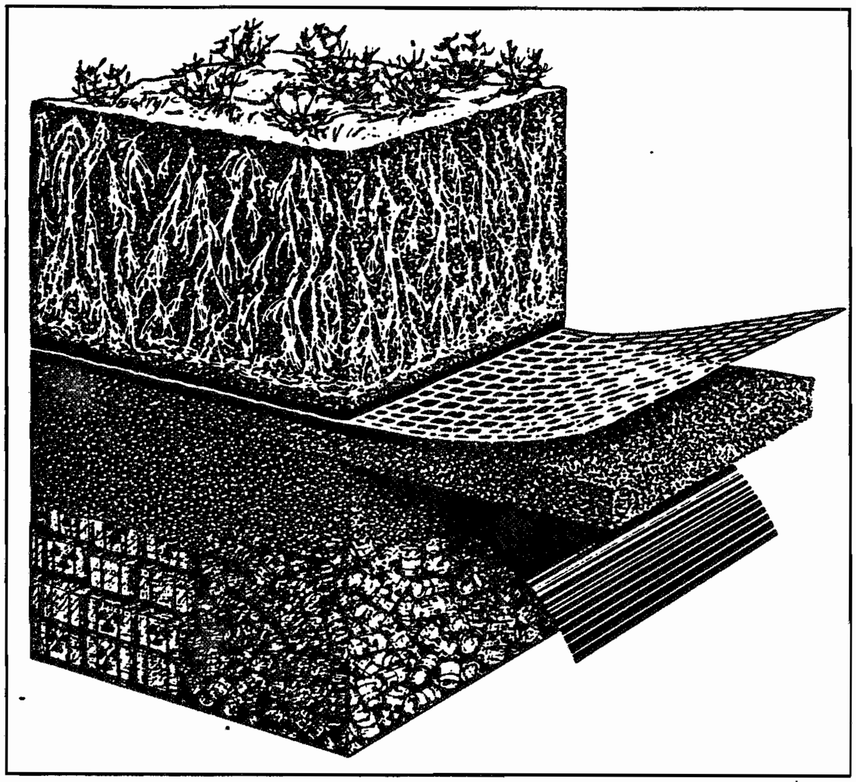
Battelle

Controlled-Release Chemicals for Inhibiting Plant Roots

Plants play an important role in protecting radioactive and hazardous waste sites. They stabilize the soil above buried wastes and control dust. Additionally, their roots decrease the chance of water-related contamination by acting as hydrologic pumps, moving water away from wastes.

However, the roots of these same erosion-controlling plants can cause cracking in the caps and liners that surround buried wastes. If this occurs, hazardous radioactive gases may escape; and surface water may enter the site, mix with wastes, and contaminate goundwater. The plants may also translocate wastes to the surface where they become biologically available, creating further environmental problems. Many herbicides are available to control plant roots, but most either kill groundcover, have a limited active period, or are mobile in the soil.

Now, in a unique marriage of polymer and root-growth inhibitor, researchers at Pacific Northwest Laboratory (PNL) have created a long-term, controlled-release device that establishes a barrier zone in which plant roots cannot grow. Called a *biobarrier*, the device excludes plant roots for up to 125 years.



The biobarrier isolates buried wastes from invasion by troublesome roots for up to 125 years without destroying beneficial groundcover.

The Right Combination of Chemical and Carrier

The biobarrier technology combines a polyethylene carrier and the root-growth inhibitor trifluralin. It was originally developed to control root penetrations in buried waste sites. In this application, the biobarrier (in the form of plastic pellets) was placed on top of buried radioactive wastes and covered by a foot or more of soil. Tests show that the devices released trifluralin at a uniform rate, maintaining sufficient soil concentration to prevent root-growth through the barrier zone.

PNL researchers conducted extensive studies with various combinations of herbicides and polymers before choosing the trifluralin/polyethylene combination.

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Elanco Regulatory Services
Elanco Products Company
A Division of Eli Lilly and Company

Lilly Corporate Center
Indianapolis, Indiana 46285
Telephone (317) 261-3221

ELANCO

February 13, 1986

Mr. Richard F. Mountfort
Product Manager (23)
Office of Pesticide Programs (TS-767-C)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Mountfort:

RE: TREFLAN® FOR THE INHIBITION OF PLANT ROOT ENCROACHMENT

In answer to your letter of October 29, 1985, we have amended the supplemental label to include only sewer pipes and waste burial sites.

Five (5) copies of the supplemental label are enclosed for your review. We have also included an application per your instructions.

Sincerely,

ELANCO PRODUCTS COMPANY

L.E. Peterson

L. E. Peterson, Product Registration Manager
Elanco Agrichemicals Regulatory Services Division

LEP:rc

Enclosures

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Supplemental Labeling

ELANCO

Elanco Products Company A Division of Eli Lilly and Company P.O. Box 1750 Indianapolis, Indiana 46206

TREFLAN® for the Inhibition of Plant Root Encroachment into Sewer Pipes and/or Waste Burial Sites where Root Encroachment is Undesirable.

EPA Registration No. 1471-70

Directions for Use:

End use products manufactured employing technology developed and patented (patent pending) by Battelle Memorial Institute should be used to inhibit plant root encroachment.

Products such as sewer pipe gaskets, extruded netting for covering buried waste, or similar products manufactured in organic polymeric carriers impregnated with TREFLAN and used according to the manufacturers instructions will inhibit root encroachment for extended periods of time.

TREFLAN® - trifluralin, Elanco Products Company, a Division of
Eli Lilly and Company, Indianapolis, Indiana 46285

241c

Form Approved
OMB No. 158-R0066

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PESTICIDE PROGRAMS *(WH-567)*
WASHINGTON, D.C. 20460

APPLICATION FOR AMENDED PESTICIDE PRODUCT REGISTRATION

(Read instructions on last page before completing) B

1. REFERENCE CODE

2. EPA USE ONLY

3. REGISTRATION NO.: 1471-70

4. PRODUCT MANAGER: Mr. R. F. Mountfort

5. NAME AND ADDRESS OF REGISTRANT *(Include Zip Code)*

ELANCO PRODUCTS COMPANY
A Division of Eli Lilly and Company
Lilly Corporate Center
Indianapolis, Indiana 46285

☐ CHECK HERE IF THIS IS A NEW ADDRESS

6. TYPE OF AMENDMENT

	CHANGE IN PRODUCT NAME
	MINOR CHANGE IN FORMULATION
	REQUEST FOR ADDITIONAL BRAND NAMES
	REQUEST FOR MULTIPLE INERT FORMULATION PER PR NOTICE 74-2
	DELETION OF LABEL TEXT
X	ADDED USES
	GENERAL REVISION OF LABEL

7. PRODUCT NAME: TREFLAN TECHNICAL

8. EXPERIMENTAL PERMIT NO.

9. SUBJECT OF AMENDMENT *(See instructions)*

Add Supplemental Label

12. TYPES OF DATA SUBMITTED

			FOR EPA USE ONLY					
X	01 NONE	1201						
	02 PRODUCT CHEMISTRY	1202						
	03 RESIDUE CHEMISTRY	1203						
	04 ENVIRONMENTAL CHEMISTRY	1204						
	05 EFFICACY	1205						
	06 PHYTOTOXICITY	1206						
	07 HUMAN SAFETY	1207						
	08 DOMESTIC ANIMAL SAFETY	1208						
	09 FISH AND WILDLIFE SAFETY	1209						
	10 BENEFICIAL INSECT SAFETY	1210						
	11 ACCIDENT EXPOSURE EXPERIENCE	1211						
	12 OTHER *(Specify)*	1212						
	13 OTHER *(Specify)*	1213						

13. METHOD OF SUPPORT *(See instructions)*

☐ Required Supporting Data Attached. *(2A)*
☐ Required Supporting Data is Submitted by Reference. *(2B)*

14. CONTACT POINT

Complete items directly below for identification of individual to be contacted, if necessary, to process this application.

15. DATE APPLICATION RECEIVED *(Stamped)*

OFFER TO PAY STATEMENT

I hereby offer to pay reasonable compensation to the extent provided under Section 3(c)(1)(D) of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, and in accordance with the Regulations and Guidelines published thereunder for use of any test data which has been submitted to the U.S. Environmental Protection Agency in support of an application for the registration of a pesticide for the first time on or after January 1, 1970 and which may be used in support of the registration application for the subject pesticide.

NAME: L. E. Peterson

TITLE: Product Registration Mgr.

TELEPHONE NO. *(Include Area Code)*: (317) 261-2114

16. SIGNATURE: L E Peterson

17. TITLE: Product Registration Mgr.

18. TYPED NAME: L. E. Peterson

19. DATE SIGNED: February 11, 1986

EPA Form 8570-11 (Rev. 4-76) PREVIOUS EDITION IS OBSOLETE.

036101

C. Brassard
EEB

APR 28 1986

Mr. L.E. Peterson
Elanco Products Company
Lilly Corporate Center
Indianapolis, IN 46285

Dear Mr. Peterson:

Subject: Directions for Impregnating Sewer Pipe Gaskets
and Extruded Netting For Covering Buried Waste
Trifluralin Technical
EPA Registration No. 1471-70
Your Submission Dated February 13, 1986

We have completed a review of the proposed uses concerning potential impact on nontarget organisms. The Ecological Effects Branch staff, Hazard Evaluation Division, considers that there is limited potential for exposure. We are requiring the following information, however:

a. Concentration of the active ingredient in the final product, especially sewer pipe gaskets. A concentration, or range of concentrations, should be included in instructions or background materials accompanying or part of the supplemental labeling.

b. Describe the potential for leaching of the trifluralin from the final product (in particular sewer pipe gaskets).

A copy of the review is enclosed.

Sincerely yours,

Richard F. Mountfort
Product Manager (23)
Fungicide-Herbicide Branch
Registration Division (TS-767C)

Enclosure

89772:Mountfort:MF-5:KENCO:4/25/86:5/5/86:eg:VO

244

1987

Mr. Michael E. Dewsbury
E.I. du Pont de Nemours & Company, Inc.
Textile Fibers Department
Engineered Nonwoven Structures Division
Centre Road Building
Wilmington, DE 19805

Dear Mr. Dewsbury:

Subject: Biobarrier
Your Letter Dated December 17, 1986

We have examined the materials submitted with the above letter. We believe the prospective use of the Biobarrier with Typar geotextiles would be consistent with the approved uses of trifluralin under EPA Registration No. 1471-70 (accepted labeling August 28, 1986).

Sincerely yours,

Richard F. Mountfort RFM
Product Manager (23)
Fungicide-Herbicide Branch
Registration Division (TS-767C)

90614:Mountfort:MF-12:KENCO:1/5/87:1/15/87:eg:VO

CONCURRENCES

SYMBOL								
SURNAME								
DATE								

Fibers Marketing Center
December 17, 1986

Mr. Richard Mountfort
Registration Division
(TS767C)
EPA 401M St. SW
Washington, DC 20460

Dear Mr. Mountfort:

Biobarrier

Pursuant to our conversations, I have enclosed a concept sample picture (no Treflan) of our product to be called "Biobarrier". I have also enclosed literature and samples of our standard Typar® geotextile product line.

The Biobarrier product will be made by permanently attaching Treflan impregnated polymer deposits to the Typar® fabric. The deposits will be sized and spaced by Battelle recommendations to create a barrier zone of Treflan in the soil.

The function of the Typar® fabric is to provide a mechanism for getting the deposits spaced and keeping them spaced in the ground during and after construction. At the same time, the Typar® must not prevent free passage of soil water. Water passage in soil is a standard function of Typar® as our literature explains.

We have over 15 years of experience with this fabric in earth construction applications. It does not degrade once removed from ultraviolet radiation and has no known hazardous components (100% polypropylene approved for drinking water filtration).

The original Battelle concept was a net or grid in which the junctures contained Treflan. What Typar® does is replace the net concept.

My understanding after reading Elanco's supplemental label on EPA registration No. 1471-70 and after talking with you is that Typar® Biobarrier is covered by Elanco's registration and requires no further EPA registration. If after reading this you disagree or have further questions, please call.

Sincerely,

ENGINEERED NONWOVEN
STRUCTURES DIVISION

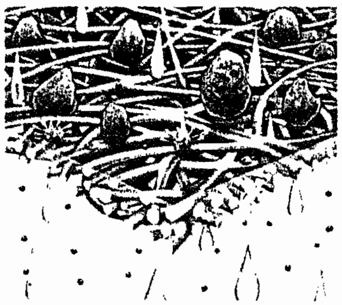
Michael E. Dewsbury

Michael E. Dewsbury

MED/cs
Enclosure

TYPAR® Improves Any Pavement Project

Du Pont TYPAR geotextile fabric can dramatically increase the life expectancy of virtually any pavement project including roads, driveways, parking lots and other paved surfaces. When placed between the subsoil and the aggregate, it provides separation, support and improved drainage preserving the integrity of the aggregate base and prolonging the life of the project.



TYPAR reduces costs and prolongs project life due to the following characteristics:

- Excellent permeability and filtering, allowing water to flow through the base while keeping soil particles out.
- Strength in all directions because soil tries to move in all directions.
- High resistance to stretch with high work-to-break toughness so it stays where it's put and helps protect pavements from failure.
- Resistance to tears, punctures, rot, mildew, insects, and most chemicals, including gasoline and oil so it lasts in the ground.
- High sheet uniformity assures consistent performance.
- Easy installation.

Put TYPAR To Work For You

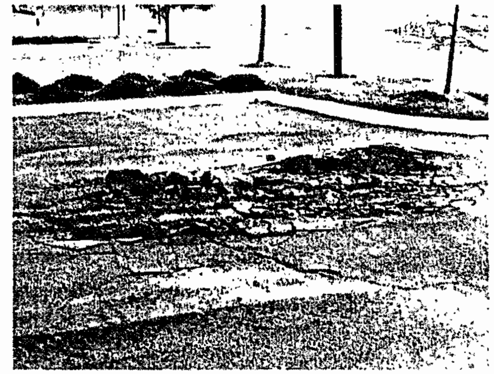
For longer pavement lifespan, significant cost savings and improved appearance you need TYPAR Geotextile Fabric. To place your order or for more information, contact your local distributor or call Du Pont toll-free at:

1-800-448-9835 and ask for your nearest distributor.

or write to:
E. I. du Pont de Nemours & Co. (Inc.)
Textile Fibers Department
ENS Division
Fibers Marketing Center
Wilmington, DE 19898

DU PONT

COMPARE!



The Difference is Du Pont TYPAR® Geotextile Fabric

For any pavement project such as roads, driveways, and parking lots TYPAR delivers:

- Longer pavement lifespan
- Significant maintenance and installation cost savings

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Require Geotextiles like TYPAR®

Premature failures of pavements are usually caused by soil contamination of the base and can be corrected by specifying TYPAR geotextile fabric. Here's how TYPAR improves any pavement project:

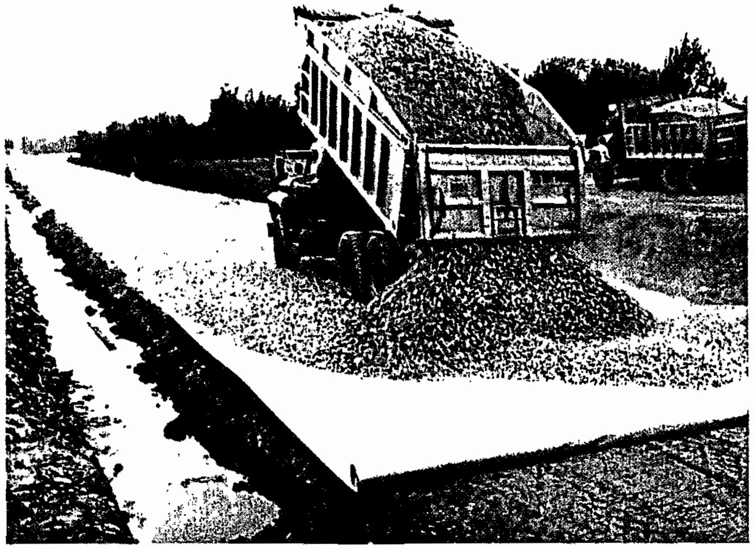
1. Base contamination caused by intermixing of the aggregate and wet or dry subsoil reduces designed load-bearing capacity and leads to cracking and potholing of the pavement surface. TYPAR effectively prevents this intermixing by acting as a strong separator between the subsoil and the aggregate base.

2. Poor drainage accelerates the mixing of the base aggregate with the subsoil reducing pavement integrity and designed load-bearing capacity as well as causing frost heaving in colder climates. TYPAR minimizes drainage problems because it allows free passage of water while holding back soil particles so the aggregate stays clean and open.

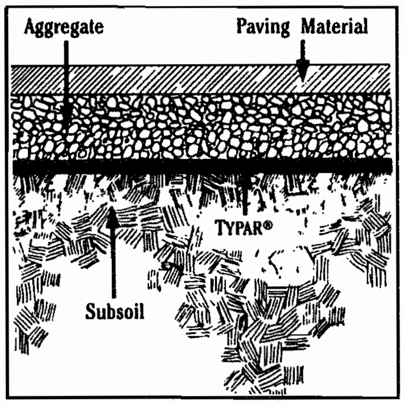
3. Soil Bearing Capacity can be exceeded by nonuniform soil conditions or unusually high loads. Under these conditions, high or even normal loads can exceed the designed strength of the base causing rutting, potholing, and cracking of the pavement surface. TYPAR enhances load bearing capacity through its high resistance to load deformation and its tensile strength.

TYPAR–A Simple, Low-cost Solution

TYPAR effectively reduces these problems by providing separation, support and drainage. The result is prolonged functional pavement life with reduced maintenance and repair costs so YOUR work looks better, longer.



TYPAR is easy to install, and withstands the rigors of the construction site.



In pavement projects, TYPAR acts as a separator between the aggregate base and the subsoil. TYPAR minimizes aggregate loss, reduces potholing, rutting, lateral aggregate movement caused by continued trafficking and decreases the amount of aggregate needed for the job.

[redacted]

2149

Three Ways

1. TYPAR Increases Pavement's Functional Lifespan

TYPAR works as a separator between the original subsoil and the aggregate to help prevent contamination and deterioration of the base. In addition, this separation maintains water drainage of the aggregate base reducing damage caused by freezing of water-logged base materials. The end product is a pavement with a greatly increased functional lifespan.

2. TYPAR Saves You Money

■ REDUCES CONSTRUCTION COSTS

TYPAR can reduce aggregate thickness needs because it spans locally soft areas and reduces aggregate loss due to subsoil intrusion. This feature of TYPAR can allow you to reduce your aggregate needs by up to 30%.

■ REDUCES MAINTENANCE COSTS

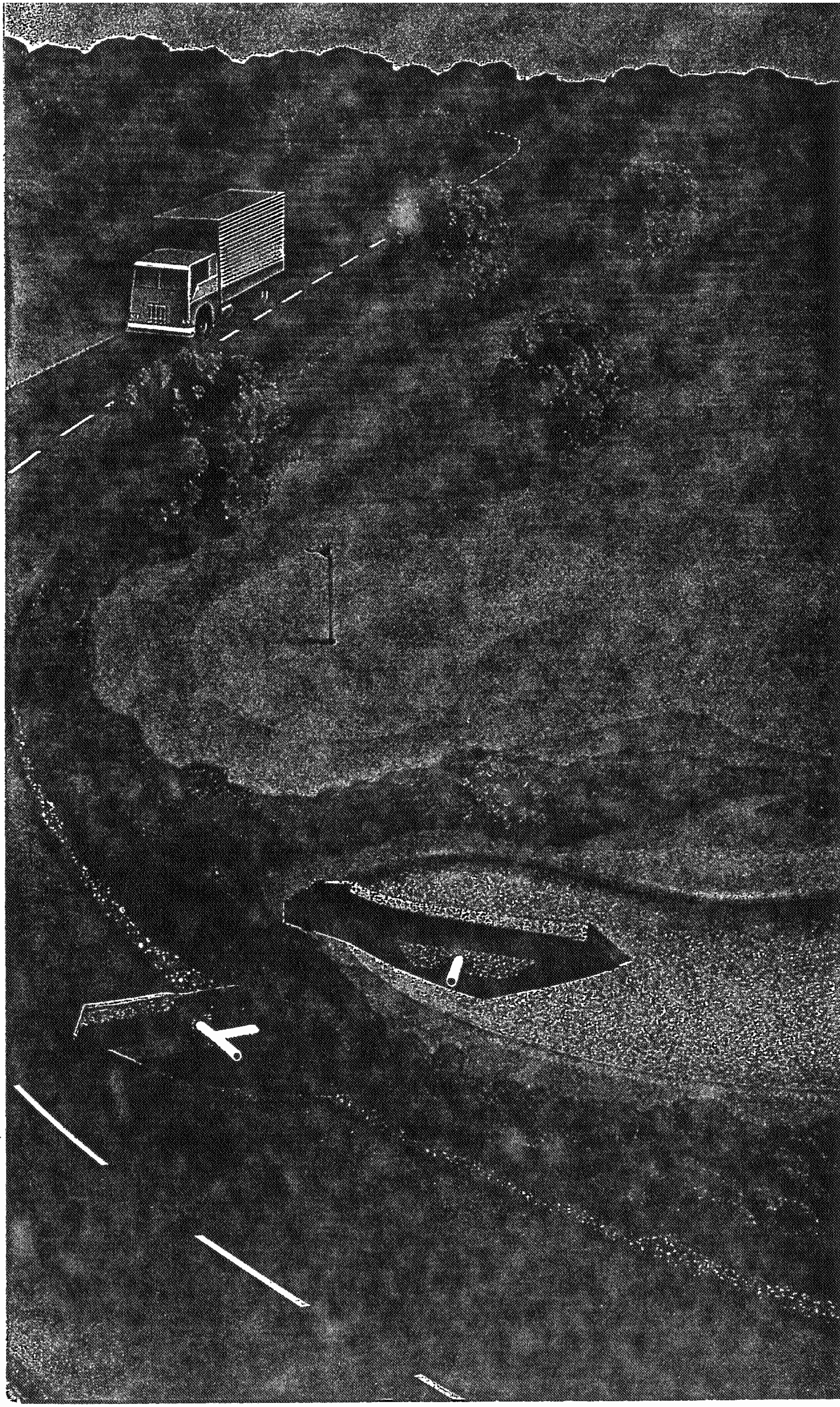
Fewer potholes, cracks and ruts mean longer pavement life and reduced maintenance and repair costs.

3. TYPAR Improves Pavement Appearance

By providing support, separation and improved drainage, TYPAR helps prevent the conditions that lead to pavement degradation so your pavement will look better and last longer–a great selling point for you.

[redacted]


TYPAR®
Proven, long-lasting performance
from a geotextile
structured for versatility.
DU PONT



Geotextiles. Engineering fabric. Reinforcing fabric. Although the names may be different, the function is the same. They are fabrics placed underground to provide drainage, support and stabilization and erosion control. Geotextiles can save time by simplifying many construction procedures and can save money by reducing the amount of aggregate or fill needed for a job. Their value has been proven in thousands of installations all over the world.

All geotextiles will perform these functions, but not all with the same degree of efficiency. The most important properties of a geotextile are long life; high modulus, for immediate support under load; strength in all directions; and excellent permeability, for drainage capability.

With most geotextiles, you must choose one of these properties at the expense of the others. Thanks to its unique structure, Du Pont TYPAR® excels in all of these properties. And that means TYPAR provides outstanding performance in a wide variety of applications.

Geotextiles differ in one major aspect—structure. And the structure of a geotextile directly influences its performance characteristics. Compare the unique structure of nonwoven, heat-bonded TYPAR® to woven and needle-punched geotextiles.

Woven

Although woven fabrics exhibit high modulus and high strength, their strength is limited to two directions—lengthwise and widthwise. To increase the strength of a woven fabric requires the use of thicker fibers and a tighter weave. This results in fewer "pores" in the material, which severely reduces permeability. In addition, because they exhibit low elongation at failure, occasional excess load could cause woven fabrics to rupture.

Nonwoven: Needle-punched

These nonwoven fabrics are constructed with fibers in all directions to provide strength. In manufacturing, filaments are looped together by mechanical needling. Under strain these loops tend to slip, resulting in a material that is not highly stretch-resistant. For this reason, a needle-punched geotextile will not go into tension and perform under load immediately—it must first be stretched up to 70%. Also, because needle-punched geotextiles are relatively thick, small particles of soil can get caught within the fabric structure, thus reducing permeability. And permeability is reduced even further when the fabric is compressed under soil loads.

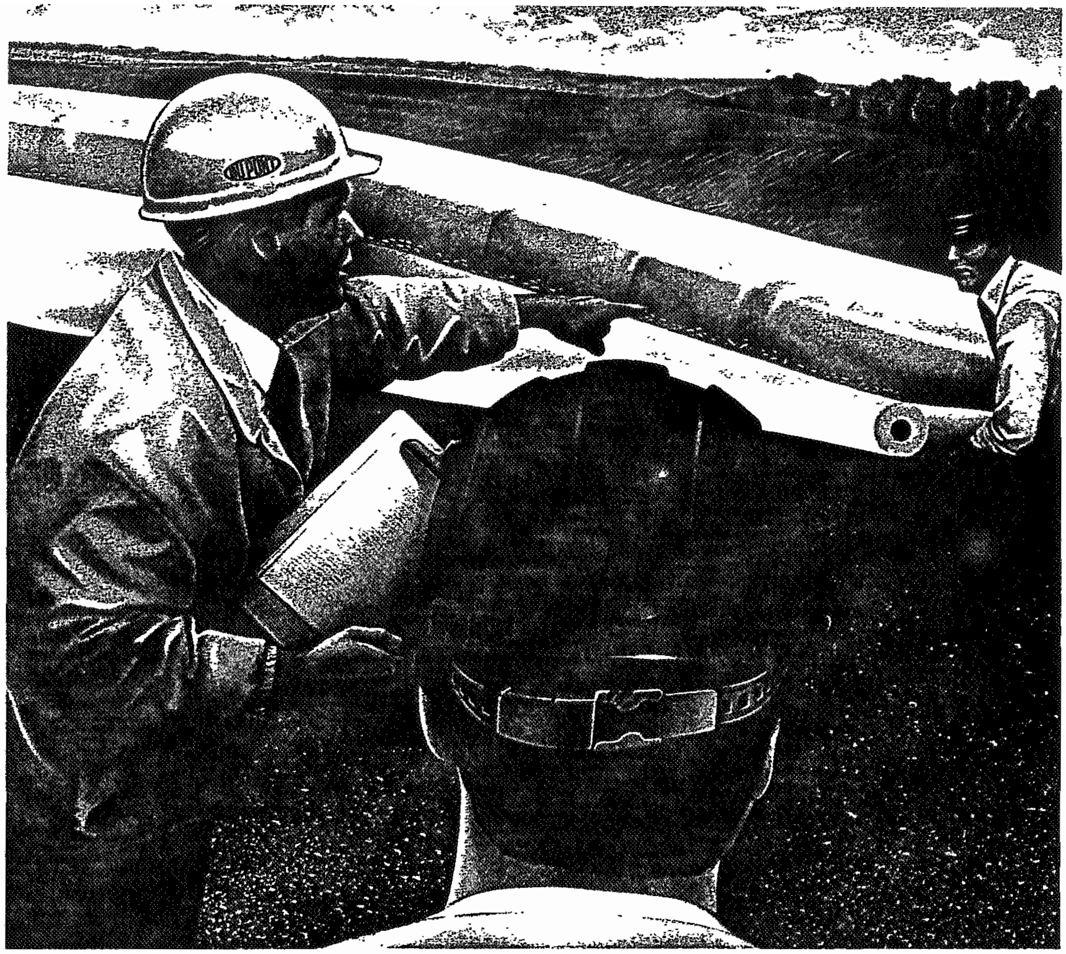
Finally, a needle-punched geotextile that gets wet at a job site will retain water. Not only will the fabric be heavy and difficult to work with, but this layer of water can be retained within the structure—which could result in buckling, cracking and potholing.

Nonwoven: Heat-bonded

Du Pont TYPAR combines both high modulus and high permeability for outstanding performance in a wide variety of applications. Nonwoven TYPAR exhibits strength in all directions, making it dimensionally stable as well as tear- and puncture-resistant. Unlike needle-punched fabrics, which can exhibit variations in uniformity and strength, TYPAR is exceptionally uniform to assure consistent performance characteristics. And because it is heat-bonded, it is thinner than needle-punched fabrics. Therefore, TYPAR does not change shape under load, and it can readily transmit the small particles of soil that can catch in a thicker material, thus ensuring long-lasting permeability. The low bulk of TYPAR also means it will not retain water—and it allows for easy transportation and installation at the job site. What's more, 100% polypropylene makes long-lasting TYPAR resistant to rot, mildew, insects and chemicals. Thus, while all geotextiles offer utility in certain applications, the unique structure of TYPAR makes it perform effectively in a wide range of applications.

TYPAR is Structured for Versatile Performance.

The unique structure of TYPAR yields the combination of excellent permeability, high modulus and strength that ensures optimum performance in a wide variety of applications. This illustration depicts the permeability of TYPAR soon after installation, when water and small soil particles pass through the fabric. The large soil particles that remain on the surface eventually form a soil filter which prevents the passage of soil particles while permitting the flow of water. Excellent permeability is crucial to effective performance in many geotextile applications, especially drainage and erosion control.



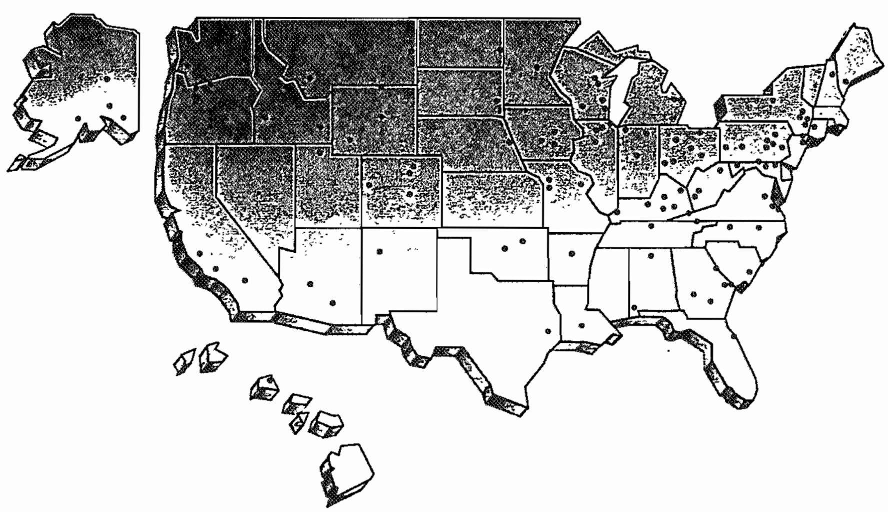
From design to delivery to installation, count on Du Pont for high quality and support.

Du Pont and our TYPAR® distributors are ready and able to help you with every aspect of your geotextile needs. Call us when you're in the early design stage. We'll show you how to get the most out of your geotextiles—from helping you specify the right type of geotextile for your application and site conditions, to getting TYPAR to your site when you need it, to technical support during installation.

Du Pont controls TYPAR from manufacture to distribution, so you can count on its availability, uniform properties and consistent high quality. In addition, TYPAR is stocked in ready supply at locations all across the country, to assure timely delivery to your site. In most cases, you can receive TYPAR within 24 hours of your order. And Du Pont's multiple manufacturing locations ensure a consistent supply of TYPAR to meet your needs.

Learn more about using geotextiles to cut construction costs and increase project life. Use the attached postage-paid card to request detailed information about how to use TYPAR for your next project.

Rely on Du Pont for Service, Supply.



Top: A Du Pont representative provides on-site technical consultation on installing TYPAR for optimum effectiveness. The extensive expertise of Du Pont's TYPAR representatives is available to assist you in all facets of your geotextiles application.

Bottom: This map illustrates the locations of TYPAR distributors throughout the United States. In most cases, TYPAR shipments can arrive at the job site within 24 hours of an order.

Please tell me how to cut costs, save time and extend project life with Du Pont TYPAR®.

Please send information on the following application(s):

☐ Drainage
☐ Erosion Control
☐ Support/Stabilization
☐ Other (specify) ______________________

____

Mail to:

NAME ______________________

TITLE ______________________

COMPANY ______________________

ADDRESS ______________________

CITY ______________________

STATE ______________ ZIP ______________

PHONE ______________________

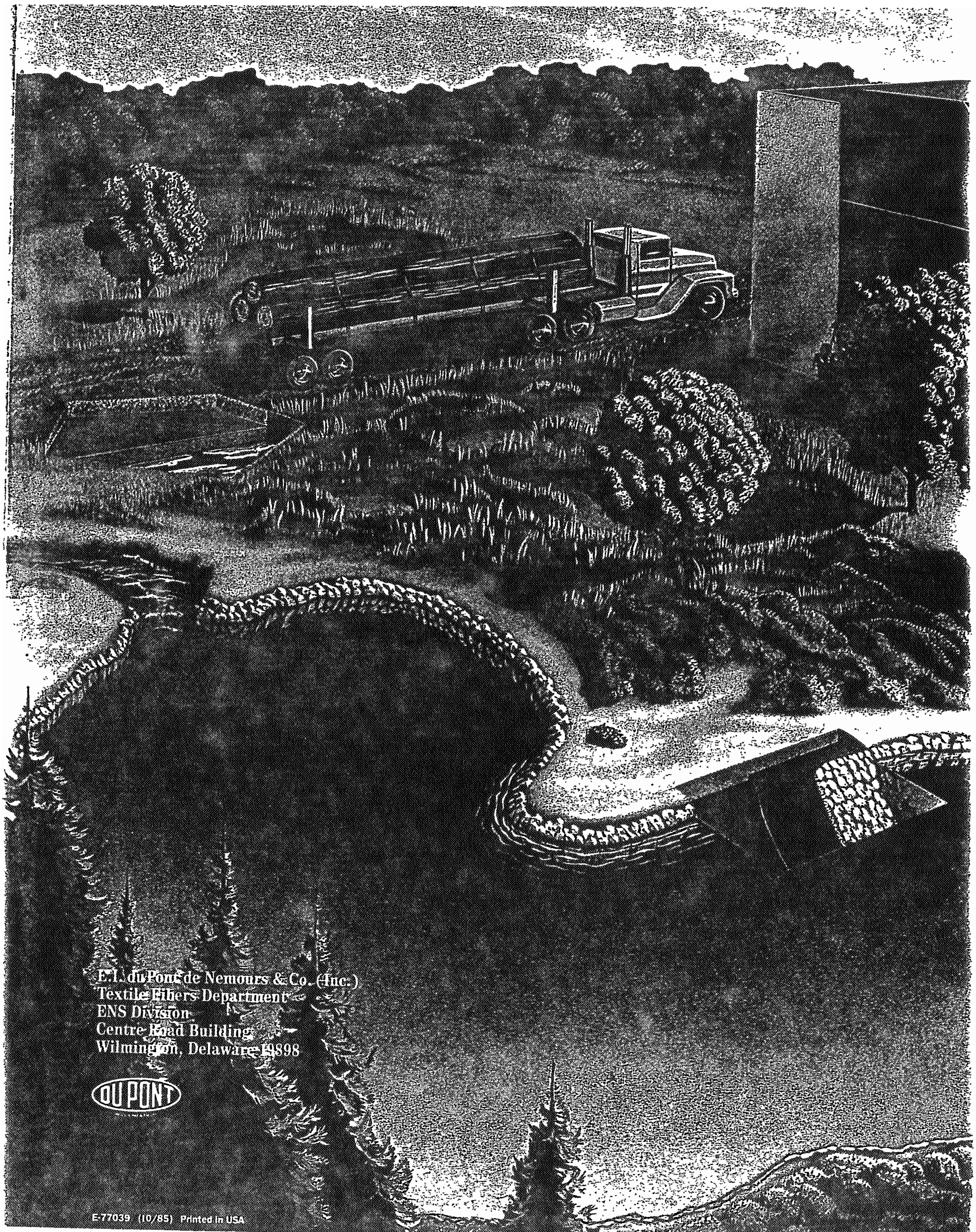
Your industry: ______________________

____

Have you ever used geotextiles in a project?
☐ Yes ☐ No

Are you currently working on a project involving geotextiles?
☐ Yes ☐ No

If yes, would you like immediate technical support?
☐ Yes ☐ No



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Textile Fibers Department
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REEMAY
a member of The InterTech Group, Inc.

DRAFT OF LABEL

TYPAR® Biobarrier T.M.
Root Control System

CONTAINS

Treflan

ACCEPTED
with COMMENTS
In EPA Letter Dated:

JUL 26 1988

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 58523-1

Typar® Biobarrier™ is a multi-year root control system consisting of herbicidal time-released nodules permanently attached to a permeable geotextile fabric which will inhibit plant root encroachment in the following areas:

Waste Burial Sites	Tennis Courts	Landfills
Sidewalks	Swimming Pools	Burial Vaults/Tombstones
Roads	Septic Fields	Underground Pipes/Cables
Building Foundations	Bike/Golf Cart Paths	Utility Substations
Curbs		

Active Ingredient:

trifluralin (α,α,α-trifluoro-2,6-dinitro-*N,N*-dipropyl-*p*-toluidine)...............	18.0%
Inert Ingredients..	82.0%

Typar® - the registered trademark for Reemay, Inc.'s Spunbonded polypropylene
Biobarrier™ - the trademark for Reemay, Inc.'s root control system
Treflan® (trifluralin) and diagonal color bar - the registered trademarks of Elanco Products Company.

Precautionary Statements

Hazards to Humans and Domestic Animals

Keep Out of Reach of Children.

CAUTION

Causes eye irritation. Harmful if swallowed, inhaled or absorbed through the skin. Avoid contact with eyes, skin or clothing. The active ingredient trifluralin may cause skin sensitization reactions in certain individuals. Use eye protection and protective clothing, such as coveralls, a long-sleeved shirt, and impermeable gloves when handling this product. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

See back page for additional precautionary statements

EPA Reg. No. XXXX - XX

EPA Est. XXXX - TN - 1

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DIRECTIONS FOR USE: READ ALL DIRECTIONS CAREFULLY BEFORE APPLYING

General Directions:

Typar® Biobarrier™ is a multi-year root control system which is strategically positioned in the soil to protect structures from plant root encroachment (see above end use sites). Typar® Biobarrier™ controls roots by establishing an in-soil barrier plane of trifluralin, which prevents root tip cell division. Roots are either stopped or redirected away from structures. Trifluralin is not systemic but can limit root mass. Typar® Biobarrier's multi-year feature is provided by a time-release mechanism which continues to meter trifluralin into the soil as the exposed trifluralin biologically and chemically degrades. Structure protection is provided by placing the Typar® Biobarrier™ fabric between the root source and the structure. Since the fabric is flexible and permeable, installation may be custom contoured to obtain the most desirable root system redirection for the application and/or to accommodate obstacles.

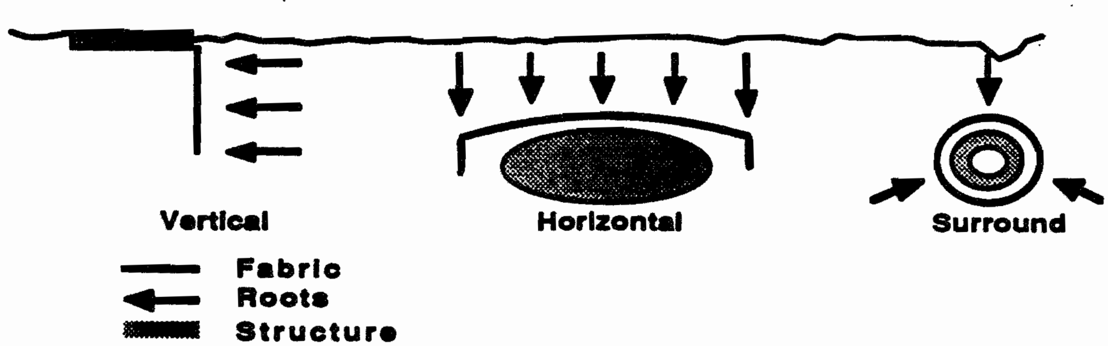
Application Directions:

Typar® Biobarrier is ready for in-soil installation as received. The fabric should be placed in soil as soon as practical after removal from the sealed shipping container minimizing exposure to direct sunlight and elevated temperatures. Prolonged exposure can reduce the effective life of the product. Store any unused portions of the product tightly resealed in the original container in a cool, dry place.

Typar® Biobarrier™ can be installed in the soil vertically, horizontally or as a surround. Vertical applications typically require standard ditch/trench digging equipment (Follow all applicable codes when digging below surface). Vertical fabric position can be maintained by suspending it at the top with hangers. Horizontal applications may require seaming or hold down pegs. Surround applications may involve a variety of holding devices to assure fabric position. In all applications, nodules must be no further than 1-1/2 in. apart in order to assure a continuous root barrier plane. Fabric should extend a minimum of 18" beyond structure area to be protected as roots can grow around edges of fabric. A minimum of 4" soil overlay should also be maintained.

Typar® Biobarrier™ used in retrofit applications, where roots are already present, require that roots be interrupted with a root pruner or equivalent device. Root control will not be effective if roots penetrate fabric at time of installation.

TYPAR® BIOBARRIER APPLICATIONS



STATEMENTS OF PRACTICAL TREATMENT

If in eyes: Flush eyes with plenty of water. Call a physician.

If swallowed: Call a physician or Poison Control Center. Drink one or two glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

If on skin: Wash with plenty of soap and water. Get medical attention if irritation develops.

If inhaled: Remove individual to fresh air. If breathing difficulty occurs, get medical attention.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish. Do not apply directly to water or wetlands (swamps, bogs, or marshes). Drift or runoff from treatment areas may be hazardous to aquatic organisms in neighboring aquatic sites. Do not contaminate water when disposing of equipment washwaters.

STORAGE AND DISPOSAL

Storage: Store in original container only. Store in cool, dry place.

PESTICIDE DISPOSAL: Do not contaminate water, food, or feed by storage or disposal. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal: Completely empty container. Then dispose of wrap and/or box in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

DISCLAIMER OF WARRANTIES

The seller makes no warranties concerning this product or its use which extend beyond the standard specifications for the products. SELLER MAKES NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER EXPRESS OR IMPLIED WARRANTY. Buyer assumes all risk and liability resulting from use of the products delivered hereunder, whether used singly or in combination with other products. All statements concerning this product apply only when used as directed.

LIMITATION OF DAMAGES

No claim of any kind, whether as to products delivered or for non-delivery of products, and whether or not based on negligence, shall be greater in amount than the purchase price of the products in respect of which damages are claimed. No charge or expense incident to any clams will be allowed unless approved by an authorized representative of Seller. Products shall not be returned to Seller without Seller's prior permission, and then only in the manner prescribed by Seller. THE REMEDY HEREBY PROVIDED SHALL BE THE EXCLUSIVE AND SOLE REMEDY OF BUYER, AND IN NO EVENT SHALL EITHER PARTY BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER OR NOT CAUSED BY OR RESULTING FROM THE NEGLIGENCE OF SUCH PARTY.

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A CONTROLLED-RELEASE HERBICIDE DEVICE FOR MULTIPLE-YEAR CONTROL OF ROOTS AT WASTE BURIAL SITES

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Based on the available data, a trifluralin-releasing device was developed with an effective lifetime of approximately 100 years. Herbicide released from the device in soil will prevent root penetration through the soil layer without harming the overlying vegetation. Equilibrium concentrations of trifluralin in soil can be adjusted (together with the theoretical life of the device) to suit specific needs. Based on early results of the field trials, concentrations of trifluralin sufficient to prevent root elongation were maintained in the soil, with minimal diffusion out of the immediate area.

INTRODUCTION

The deep roots of plants growing over waste burial sites must be prevented from contacting potentially hazardous waste to avoid translocation into plant shoots, and subsequent environmental dispersion. A previous publication [1] discussed possible applications and an approach to developing a system which would be able to function for an extended period of time — as long as 100 years. In each case, controlled-release devices are placed on 1- or 2-in. (1 in. = 2.54×10^{-2} m) centers in a layer over the hazardous waste and subsequently covered with several feet of overburden, on which a vegetative cover may be grown. The herbicide trifluralin was chosen for this application because it specifically prevents root-tip cell division (thus preventing root intrusion through the zone containing the trifluralin), and because it does not translocate within the plant. (Translocation of some phytotoxins could cause death of the plant and loss of ground cover over the site.) The minimum effective level of trifluralin in soil necessary to prevent longitudinal growth of roots was determined [1] for 13 native plant species suitable for revegetation efforts in Colorado; concentrations ranging from 0.3 to 6.4 ppm of trifluralin in soil were sufficient for this purpose. Filled polyethylene and polypropylene polymers provided suitable release rates as well as having other parameters (physical characteristics, loading ability, and cost) which were optimal for this application. In this paper we discuss approaches to fabrication of these devices, measurement of loading and release rates, and the first results of field trials conducted with the devices.

METHODS AND MATERIALS

Experimental procedures

Based on the expected release rates, the necessary concentration range and the desired period of release (100 years), calculations indicated that devices containing trifluralin in a polyethylene matrix should have dimensions approximately 9 mm in diameter and

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9 mm in length. This shape, approaching a sphere, combines a relatively large available volume with a nearly minimal surface area. Two types of polyethylene, Microthene® MN 710-20 and Microthene® MN 711-20 (USI Chemicals, New York, NY), were used in preparing the devices. The second type was used to prepare the devices for the field studies. The trifluralin used in this study was provided by Elanco, Indianapolis, IN. In addition to the polymer and herbicide, additives such as carbon black and silica were included in some formulations.

The initial release rate from these devices was comparatively high until the herbicide on and near the surface of the device had been released. This initial release permits rapid attainment of the minimum effective level (MEL) of herbicide in the soil surrounding the device. Once the surface herbicide has been released, the release rate from the system will be governed by Fick's laws of diffusion. Herbicide remaining at the surface of the device reduces the concentration gradient, consequently reducing the release rate and prolonging the life of the device.

Fabrication of trifluralin-containing controlled-release devices

After initial laboratory testing of the 9 mm × 9 mm devices, which were prepared in a single-cavity mold on a laboratory-bench-scale injection molder, a 24-cavity mold was fabricated. This mold was designed to be used on a 4-oz (1 oz = 28.3×10^{-3} kg), fully automatic, injection molding system.

After a number of unsuccessful attempts to feed and mold various blends of polyethylene (powder or pellets), carbon black (powder or pellets), and ground trifluralin, a specialized preblending technique which permitted feeding and successful molding was devised: Polyethylene powder (35—50 mesh) was thoroughly mixed with carbon black (18% by weight; approximately 350 mesh), and the mixture warmed to 67—70°C in an oven. Trifluralin (melting point, 48°C) was melted in a beaker and heated to 100—110°C. The molten trifluralin (24% by weight) was then poured slowly into the warm polyethylene/carbon black blend, with constant mixing, until the required amount of trifluralin was added and the temperature of the blend had dropped below the melting point of trifluralin. A friable black powder was obtained which readily fed in the injection-molder screw-feed system and permitted rapid molding of devices in the multiple-cavity mold. A mold-cycle time of about 20 seconds was found satisfactory. Approximately 75,000 devices were produced for the field studies.

In vitro release rates

In the absence of information on the concentration of herbicide in the environment at the surface of the device (and, thus, its effect on the release rate), laboratory measurements of release rates were based on the extreme case, in which the concentration of herbicide at the surface of the device (under *in vitro* conditions) is nearly zero. The *in vitro* measurements give an estimate of the minimum effective lifetime of the device.

The device to be tested was placed in a flow cell at a temperature of 13 ± 1, 22 ± 1, or 37 ± 1°C. Details of the bathing solution, extraction procedure, and analytical procedure have been given previously [1].

Microbial decomposition and chemical degradation

Chemical and microbial processes affecting the soil half-life of trifluralin were evaluated using 400-g aliquots of Ritzville silt-loam, pH 6.8, at 18% moisture. The sample was treated with 7.5 ppm trifluralin following experimental amendments and treatments. Treatments included: (a) a sterile control, which was autoclaved twice for 20 min at 121°C and 1.03×10^5 Pa and subsequently amended with trifluralin under sterile conditions; (b) a nonsterile treatment amended with 0.1% glucose (w/w) and maintained under aerobic conditions; and (c) a nonsterile treatment amended with 0.1% glucose and maintained under N_2 to simulate anaerobic conditions. Soils were held for 72 days at 21°C, and were periodically sampled and analyzed for trifluralin by high-performance liquid chromatography. Soils (1 g) were subsampled and extracted twice with 5 ml 100% MeOH. Extracts were combined and centrifuged, and the trifluralin was quantitated, using a μ-Bondapak C_{18} column (Waters Associates, Inc., Milford, MA), developed with a mobile-phase gradient of 50% MeOH to 80% MeOH and detected at 273 nm.

Field studies

Preliminary greenhouse and laboratory studies indicated that devices placed on 2-in. centers should yield a sufficient quantity of herbicide to maintain soil concentrations that would prevent root elongation through the barrier. As a result, two densities of devices were used in the first field study: 144 devices per square foot (1 ft^2 = 9.29 × 10^{-2} m^2) (placed at 1-in. intervals) and 36 devices per square foot (placed at 2-in. intervals). As part of a study of protective seals for uranium mill tailings, the manufactured devices were placed in 200-ft^2 plots over both asphalt emulsion and multilayer earth seals at the Grand Junction Test Site in August 1981. Both densities were used over the multilayer earth seals; over the asphalt emulsion seal, density was 36 pellets per square foot. To insure precision of placement, two templates were constructed from masonite: 5/8-in. holes were punched at 1-in. intervals in one template and at 2-in. intervals in the second. (This level of precision would probably not be necessary for most applications.) Approximately 2 in. of topsoil was added over the emplaced seals, the templates were positioned, and the location of the plots was recorded. The devices were then put in place by means of the template, which was then removed, and a 6-in. layer of soil was immediately placed over the devices to prevent degradation of the trifluralin by ultraviolet rays of the sun. At a later date, two additional feet of soil were added to the area and spread by heavy earth-moving equipment.

When an inspection trench was dug over the multilayer earth seal in April 1982, the soil profile was sampled at and above the device layer. (The devices had been in place for 8 months.) The soil samples were placed in glass containers, identified as to location and position within the soil profile, and returned to the laboratory for trifluralin analysis.

A second field study is being carried out in an area of relatively high rainfall (36 in. per year) and having a clay-loam soil at Maxey Flats, KY. In this study, the herbicide-releasing devices were placed in 24-in. long × 5-in. diameter lysimeters at a device density of 144 per square foot. The bottom 3 in. of the lysimeter was filled with pea gravel, the next 5 in. with clay-loam soil, the devices were placed on this layer, and the lysimeter was filled to the top with 16 in. of clay-loam soil. The lysimeters were then buried with the top of the lysimeter level with the surrounding soil in the Maxey Flats lysimeter site. Lysimeters in this study were planted to the local fescue mix.

The first lysimeter was retrieved 29 months after initial placement. The lysimeter was returned to our laboratory, cut along both sides, and split open. The profile was examined in detail and soil samples taken from areas above and below the device layer for trifluralin analysis.

RESULTS AND DISCUSSION

To prevent physical disruption of multilayer earth or asphalt barriers by roots of surface vegetation, chemical biobarriers require (a) the presence of a sustained MEL of herbicide/antimetabolite, and (b) a phytotoxin which prevents elongation of a wide variety of roots and has minimal effect on plant growth so that it will not significantly affect revegetation efforts. After preliminary

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evaluation of a series of commercially available herbicide/antimetabolite formulations [2], trifluralin was selected for detailed examination because it prevented longitudinal root growth and did not significantly affect root and shoot dry-matter production.

Previously reported work [1] investigated the steady-state release rates of trifluralin from a variety of polymers and the MELs of trifluralin for root control of 13 plant species. The results indicated that filled polyethylene and polypropylene polymers were the best choices, providing low release rates of trifluralin (and thus long device lifetimes) while adequately controlling root elongation in the species studied.

Studies with trifluralin-amended Ritzville silt-loam [1] showed the half-life of trifluralin, under aerobic conditions, at 18% moisture and 21°C, to be approximately 50 days. Although half-life varies with soil type and field moisture conditions, this figure gives an indication of the long-term, sustained, *in situ* release rate of trifluralin required from a device in order to maintain a MEL. The decay indicated by the half-life is due to both chemical hydrolysis and microbial decomposition processes. The half-life is important in designing controlled-release devices for specific release rates and predictable periods of time. Oxygen tension also affects half-life, influencing the type of microbial decomposition (aerobic or anaerobic) which occurs. In soil held at 21°C and 18% humidity, under sterile and aerobic conditions, trifluralin has a half-life of 43 days (Fig. 1). When a suitable carbon source is added to nonsterile aerobic soil to support microbial growth, half-life decreases to 31 days. Under anaerobic conditions, half-life increases to 119 days (versus 43). Similar results have been reported previously [3]. Assuming that trifluralin losses associated with the sterile controls represent only those resulting from chemical oxidation and hydrolysis, then biological aerobic decomposition increases losses by approximately 28%. Similarly, under anaerobic conditions, the degree of microbial decomposition and chemical oxidation is reduced substantially,

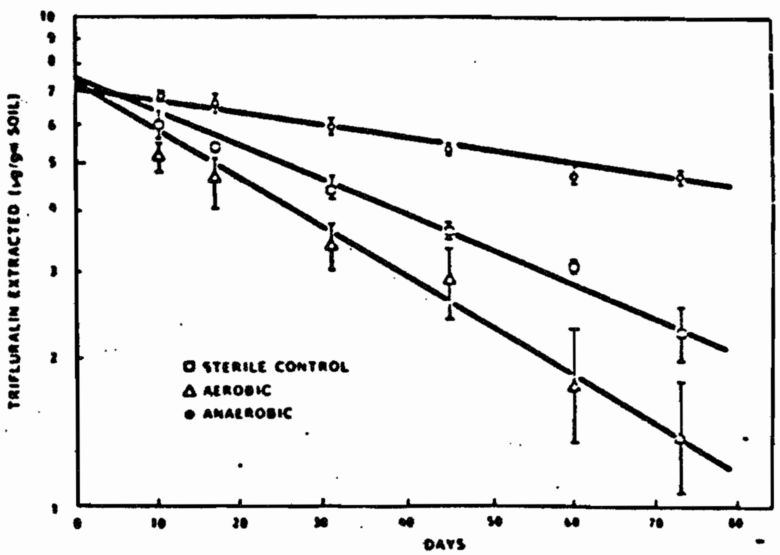

Fig. 1. Effect of microbial growth on trifluralin persistence in Ritzville soil, $\bar{x} \pm$ SD ($n = 3$).

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TABLE 1

Effect of carbon black on trifluralin retention in polyethylene controlled-release devices

Type of polymer	Carbon black, %	Theoretical trifluralin, %[a]	Determined trifluralin, %[b]	Percent retained
MN 710-20	0	17	8	47
MN 710-20 + Novacite®	0	17	9	53
MN 710-20	0	17	11	65
MN 710-20	0	23	9	39
MN 710-20	0	23	14	61
MN 710-20	0	33	11	33
MN 710-20	18	19	16	84
MN 710-20	24	18	12	67
MN 710-20	21	26	24	92
MN 711-20	0	40	18	45
MN 711-20	24	24	22	92
MN 711-20	40	40	35	88

[a] Percent added.
[b] Percent determined in analysis.

thereby increasing half-life by a factor of 2.8 over that of the sterile controls.

A major requirement for the proposed controlled-release devices, since they must be active for extended periods of time (100 years as a target), is that the release rate should be low and the reservoir capacity as large as possible. Because trifluralin is minimally soluble in polyethylene, relatively high original concentrations of trifluralin in the premix used in initial fabrication procedures resulted in devices low in trifluralin; much of the trifluralin appeared as crystals on the surface of the device. To increase the trifluralin loading of the polyethylene, fillers, including Novacite[5] (a powdered silica) and carbon black, were evaluated. Novacite did not appear to improve the loading (Table 1), although it sharply reduced the release rate of trifluralin from these devices (to 36% of the release rate without Novacite). Carbon black enhanced retention of trifluralin (Table 1). In addition to increasing the amount retained, carbon black helped stabilize the polymer against degradation and, being inexpensive, decreased the cost of the device. Increasing the capacity (provided that the release rate does not rise proportionately) also increases the active life of the device in the soil.

Release rates were determined for a number of the polyethylene Microthene[5] MN 710-20 devices containing varying amounts of carbon black and trifluralin to determine their effect on release rate. Selected results are shown in Table 2 for devices that released trifluralin for 160–195 days (long enough to achieve a reasonably steady release). Comparison of the release rates for the first two devices indicates that adding carbon

TABLE 2

Release rates of trifluralin from polyethylene devices after 5 to 6 months release *in vitro*

Polymer loading		Release rate (at 13°C), μg/day ± SD
Carbon black, %	Trifluralin, %	
None	14	10.6 ± 1.2 ($n = 6$)
17	13	11.1 ± 1.2 ($n = 6$)
23	18	16.6 ± 2.3 ($n = 3$)

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black did not have a major effect on the release rate. Comparison of the release rates for the second and third devices indicates that the rate increased with increased loading of trifluralin, as expected.

The release rate from controlled-release devices normally increases with increasing temperature. The nominal temperature for this study was 13°C, a typical soil temperature 1 to 2 m below ground level in arid areas. However, actual temperatures that might be encountered by the devices are a function of the depth of placement and of environmental factors such as air temperature and rainfall. To determine the effect of temperature on release rate, devices taken at random from the group to be used in the field trials were tested at different temperatures in the continuous-flow system; first, for 11 days at 37°C, then for 14 days at room temperature (22°C), then 24 days at 13°C. Release rates determined at these temperatures are given in Table 3; at 37°C the release rate is 30 times that at 13°C; i.e., a single day's release at 37°C is equivalent to a month at 13°C. Therefore, at the end of the 49-day test period, the devices had released an amount of trifluralin equivalent to that released in 420 days at 13°C.

Because of interest in the release rate of trifluralin from these devices after several years in place, tests were continued at 37°C for 54 days (equivalent to 54 months at 13°C). During the final 18 days at 37°C, the release rate was determined (final column in Table 3). As expected, the surface layer of trifluralin had been released and the trifluralin now had to diffuse for some distance through the device, therefore the release rate was lower than previously. Subsequently, the temperature of the bath was reduced to 13°C to measure the release rate of a device releasing trifluralin at that temperature after 5 years (also given in Table 3). The data suggest that release rates benefit from seasonal fluctuations in temperature — that is, if the temperature around a device in the winter is lower than the average annual temperature, less trifluralin will be released (wasted). Conversely, a temperature rise during the growing season would increase the amount of trifluralin released, decreasing the possibility of root elongation in the area.

Results from the Grand Junction field trials are shown in Table 4. The concentration of trifluralin in the soil near the devices, after approximately 8 months in the field, greatly exceeded the concentration (6 ppm) necessary to stop root elongation at the barrier. Results from the Maxey Flats field trial are shown in Table 5. As in the Grand Junction trial, trifluralin in the soil near the devices, this time after 29 months in the field, greatly exceeded the trifluralin concentration necessary to stop root elongation. Grass roots in the lysimeter were observed to

TABLE 3

Release rate of trifluralin-loaded polyethylene devices as a function of temperature and age of device

Temperature, °C	Release rate for new device, μg/day ± SD	Release rate for device in use for a 5-year equivalent, μg/day ± SD[a]
37	853 ± 91 (n = 5)	198 ± 32 (n = 10)
22	131 ± 8 (n = 5)	—
13	29 ± 2 (n = 7)	13 ± 3 (n = 9)

[a]Following release of an amount of trifluralin from the device equivalent to the amount that would be released in 5 years at a constant temperature of 13°C.

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TABLE 4

Trifluralin concentration in soil samples after Grand Junction field-testing of controlled-release polyethylene devices[a]

Distance above/ below devices (cm)	Trifluralin concentration, ppm			
	Device density above clay barrier[b]			Device density above asphalt barrier
	36/ft²	36/ft²	144/ft²	36/ft²
12.7—15.2	0.1	0	0	0
10.2—12.7	0.1	0	0	0
7.6—10.2	0.4	0	0	1.7
5.1— 7.6	7.5	0.2	0.6	0.3
2.5— 5.1	5.8	7.5	3.8	4.6
0— 2.5	58.4	23.5	48.5	22.3
−2.5— 0	3.6	—[c]	—[c]	—[c]

[a]Samples were taken (April 1982) from the soil profile at Grand Junction, CO.
[b]For the 36/ft² trifluralin data, concentrations are given for samples from two locations in the trench.
[c]Not sampled.

TABLE 5

Trifluralin concentration in soil samples after Maxey Flats field-testing of controlled-release polyethylene devices[a]

Distance above/ below devices, cm	Trifluralin concentration, ppm (Device density, 144/ft²)
17	0.14
14	0.53
11	0.76
8	1.23
6	2.24
4	5.55
2	4.89
0	292
−2	15.8
−4	4.86
−6	3.11
−8	1.85

[a]Samples were taken (October 1983) from a lysimeter tested at Maxey Flats, KY.

terminate in swollen tips 9 cm above the devices.

If these concentrations continue in further testing, future devices may be modified to reduce the release rate and thereby extend the life of the device. In both field trials, the data indicate that the device is functioning as predicted: a concentrated quantity of trifluralin is maintained near the barrier layer and does not move into the soil profile, allowing a normal root zone to be maintained in the overburden.

To calculate the *in vitro* lifetime of the device at 13°C, we can use the release rate of the device and the amount of trifluralin contained. Since the device is homogenous, the release rate continually decreases with time. However, the release rate at the equivalent of 5 years is a realistic average rate for a significant portion of the life of the device. From Table 3, this is 13 μg/day ± 3 SD. The average device weighs 667.3 mg and contains 22.1% trifluralin, or a total of 146.5 mg trifluralin. At a release rate of 13 μg/day, the device would release trifluralin at a zero-order rate for 31 years. As indicated previously, this is the minimum effective life since (a) the release rate was measured *in vitro* at sink conditions where the concentration gradient is maximum and (b) the release rate will decrease somewhat with time.

To estimate the maximum possible lifetime of the device under actual conditions in the soil, we can use available data on the degradation rate of trifluralin in soil [1]. A 50-day half-life indicates that approximately 1.38% of the trifluralin is degrading each day. This amount would have to be replaced by the controlled-release device in order to maintain a constant level of trifluralin in the soil. Combining this with previously reported data [1] on trifluralin concentration in Ritzville silt-loam as a function of time, we find that when trifluralin is present at 3.8 ppm, the release rate of the devices *in vitro* is approximately 2.4 times greater than that in soil. If the device releases at this lower rate in soil, it can be expected to release for a period 2.4 times that predicted by the *in vitro* data: approximately 74 years.

Considering that the release rate of the device decreases with time, and that the initial concentration of trifluralin in the soil around the devices is well above the MEL, each of which can be expected to extend the device lifetime, it appears reasonable to expect that these devices will continue to function in a satisfactory manner for more than 100 years.

ACKNOWLEDGEMENT

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