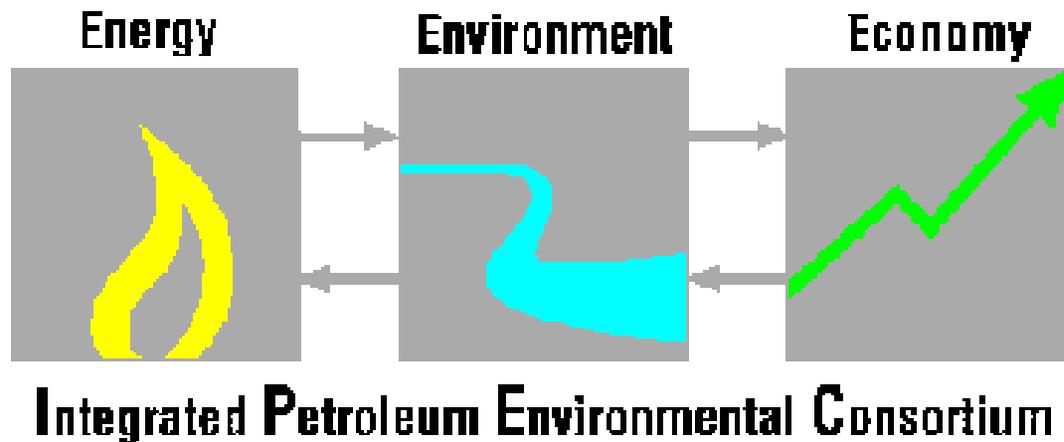


# Tools and Resources to Enhance Environmental Compliance by Small Independent Oil and Gas Producers

Kerry Sublette  
University of Tulsa



# Integrated Petroleum Environmental Consortium (IPEC)

**O** *the university of*  
**OKLAHOMA**

**OSU**

  
**THE**  
**UNIVERSITY**  
*of* **TULSA**

  
**UNIVERSITY of ARKANSAS**  
**STATE**

# **Integrated Petroleum Environmental Consortium (IPEC)**

IPEC is funded by the  
U.S. Environmental Protection Agency  
Office of Research and Development  
as an EPA Research Center  
through  
Congressional mandate

# Mission

To increase the competitiveness of the domestic petroleum industry through a reduction in the cost of environmental compliance



# How IPEC Accomplishes This Mission

- Industry driven research program
  - Industry Advisory Board provides research topics and evaluates all proposals for relevance to IPEC's mission
  - Science Advisory Committee ensures scientific quality of research projects
- Industry guided technology transfer program

# **Empowerment of Independent Oil and Gas Producers is a Key Ingredient to Accomplishing IPEC's Mission**



# How Do You Empower Independent Producers?

- Lower costs
- Make the remediation process understandable
  - Technically correct
  - Produces desired end result
  - Listen every chance you get
  - Road test your material – feedback
- Build confidence that they can
  - Do it themselves
  - Choose contractors that know what they are doing
  - Evaluate vendor claims

# How Do You Get More Regulatory Compliance from Small Independent Producers?

- Lower costs
- Make the remediation process understandable
- Build confidence that they can
  - Do it themselves
  - Choose contractors that know what they are doing
  - Evaluate vendor claims

# Achieving Empowerment Goals

- IPEC produces and distributes products which make environmental compliance and remediation easier to understand and less costly:
  - Environmental compliance checklists
  - Bioremediation guidelines
  - Brine spill remediation guidelines
  - Soil salt analysis kit
  - Chloride analysis kit for water
  - Training videos
  - Do-it-yourself and self-assessment kit

# Achieving Empowerment Goals

- IPEC provides training for independent producers and state regulatory field personnel:
  - Soil remediation
  - Waste minimization  
(in cooperation with the Texas Railroad Commission)

*Revised Guidelines for*  
**Waste  
Minimization**

---

In Oil and Gas  
Exploration and Production



# **Genesis of an IPEC Product:**

## ***The IPEC Brine Spill Remediation Guidelines***

- Soil remediation workshops
  - OK Marginal Well Commission partnership – instant audience
  - IPEC research
  - Practical remediation experience
  - Teaching experience
    - KISS
    - Lots of pictures
    - Practical examples
  - Hit the road
    - 9 workshops for producers in OK, AR, TX
    - 5 workshops for state regulatory field personnel

# Evaluation of IPEC Soil Remediation Workshops

*Rated on a scale of 1 (poor) to 5 (great)*

Was information presented useful? **4.9**

Will information be useful in your operations? **4.6**

Was the workshop worth your time? **4.8**

# **Genesis of an IPEC Product:** *The IPEC Brine Spill Remediation Guidelines*

- Draft guidelines
  - IAB/SAC Joint Tech Transfer Subcommittee
  - IPEC Executive Committee
- Guidelines issued
  - Continuous review and feedback

# Brine Spill Remediation Guidelines

- Drainage, drainage, drainage
- Soil Salt Analysis Kit
- Chloride Analysis Kit for Water
- Hay/fertilizer/tilling
- Follow with gypsum only when necessary



## IPEC GUIDELINES FOR REMEDIATION OF SMALL BRINE SPILLS



### First response to a brine spill

Routine inspections and preventative maintenance can help avoid equipment failures or line breaks. When a release occurs, first assess the situation. Always approach cautiously and resist the urge to rush in. Identify risks based on your experience, observations, and senses. Isolate the source and stop the release; contain any fluids, and recover fluids for relatively recent spills with little erosion of topsoil. Old, eroded brine spills or brine scars are beyond the scope of these guidelines. If you have this problem, we suggest that you seek assistance from a qualified professional.

### When can I use these guidelines?

At IPEC, we have developed a staged response to remediating small brine spills that may take a little longer than some other methods to implement but should save you money and get the job done. This process works well for relatively recent spills with little erosion of topsoil. Old, eroded brine spills or brine scars are beyond the scope of these guidelines. If you have this problem, we suggest that you seek assistance from a qualified professional.

### Soil analysis is necessary for successful remediation

When remediating a brine spill, it will be necessary to take soil samples and analyze them for salt content. Why? You need 1) to see how well you are doing overall and, 2) to identify hot spots that may need extra treatment. You can do this yourself with the IPEC Soil Salt Analysis Kit available free from IPEC. But, first, we need to talk about how to take a good soil sample.

### Soil sampling recommendations

The salt content of soil impacted by a brine or produced water spill is highly variable over the area of the spill and with depth. The photos below illustrate this important point. Here, two soil samples taken about 18 inches apart at a brine spill site were analyzed separately using the IPEC Soil Salt Analysis Kit. These two samples had very different salt contents (8.8 vs. 4.6 on the test strips) - and the sample with the lowest salt content was actually closest to the source of the spill!



Mixing of the soil by tilling helps but no practical amount of tilling will evenly distribute the salt. This variability will exist throughout an entire remediation process. We have to keep this fact in mind when we take a soil sample for salt analysis.

Whenever we analyze brine-impacted soil for salt content, it is the average soil salt content or concentration we want to know. No single soil sample will tell us that because of the variability we were just discussing.

Soil salt content can be estimated by doing what is called composite sampling. A composite sample is prepared by taking between 10 and 20 individual soil samples within the area of a spill, then mixing them together before doing a soil salt analysis.

The following are some specific recommendations for composite sampling of a brine or produced water spill site:

- It is often useful to make a sketch of the spill site. Note on your sketch any easily recognizable features such as:
  - Clearly different soil types
  - Different levels of plant kill (complete kill vs. incomplete or spotty kill)
  - Different slopes
  - Very rocky conditions

Put off the different sections of the spill area and add dimensions to your sketch so that you can estimate the areas of the sections in square feet. Turn this card over to see a sample sketch:

water and fertilizer. The decay of organic matter in the soil restores soil structure making it easier for water to cover the salt away.

every 1000 square feet  
2 inches of hay  
25 lbs of 15-15-15 fertilizer

So, start monitoring the salt content of the soil every three months or so, and fertilizer addition after about a year. Once salt concentrations are low enough, the site should naturally begin to recover. The plant roots hold the soil together and prevent erosion and also make the soil more porous so that water can get in. The weeds plants that come first will give way to grasses. It's also important to know what plants can grow on your site from the table of plant salt tolerances in the IPEC Soil Salt Analysis Kit. You may also want to work with your county agricultural extension agent to make sure plant nutrient levels are what you need. They will want to work closely with the landowner to establish what he wants on his land.

So, the job for you as a farmer is to do in the example you see below. However, if this approach doesn't entirely do the job for you as a farmer, you may sometimes continue to have some bare spots. These may be "hot spots" where the salt content is particularly high. If that is the case, these hot spots will just take longer to remediate. However, you may be able to fix them by adding gypsum to the soil. Gypsum is an excess of sodium in the soils that is often identified by a hard-packed surface and that prevents water from getting into the soil. If you have this problem, work some gypsum into the bare spot—about 13 lbs per 1000 square feet. In addition, if the spot doesn't start to regenerate the next spring.



Spring 2000



Spring 2002



Spring 2002



For a  
farm.

### Remediation is more important than cost!

Remediation process by going to gypsum application right off instead of hay and fertilizer, but you will be able to handle the large loadings of calcium (from the gypsum) can affect the availability of plant phosphorus. If you need to contact your state regulatory field technician—they will help you out!

### Watch for:

• Bare vegetation whiter and die in dry weather when vegetation in unimpacted areas still look okay! This is a sign of salt during dry weather. You might even see white salt crystals on the soil surface. What can you do?

• Soil moisture  
• Soil pH if necessary

# Soil Salt Analysis Kit

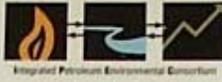
- Based on chloride analysis – Hach test strips
- Kit provides everything needed:
  - Extraction solution (Sat.  $\text{CaSO}_4$ )
  - Chloride test strips
  - Graduated plastic beakers
  - Plastic spoons/stirring sticks
- Information cards/instruction
  - Sampling recommendations
  - Photos of each step of the analysis
  - Interpretation of results in terms of plant tolerances for salt
- Validated vs. rigorous analysis by ion chromatography





# Chloride Analysis Kit for Water

- Based on Hach chloride test strips
- Kit provides everything needed:
  - Chloride test strips
  - Graduated plastic beakers
  - Plastic spoons/stirring sticks
  - Instructions for use (including dilutions)
- Hach test strips validated by USGS



**IPEC TEST STRIPS  
FOR CHLORIDE ANALYSIS IN WATER**

**INSTRUCTIONS**

1. Remove test strip from bottle and replace cap immediately.
2. Insert lower end of test strip into water to be tested. The water will begin to move up the orange wick and the wick will darken slightly as it wets.
3. Allow the water to move all the way up the strip until the yellow band across the top of the wick completely turns dark.
4. Note how far up the test strip scale the tip of the white color extends.
5. Refer to the table or chart on the back of this card to convert the strip reading to chloride concentration in the water.
6. If the chloride concentration in the sample is beyond the range of the test strip, dilute with distilled water, and repeat the test. Multiply the result by the dilution factor used. For example, 25 mL of a water sample is diluted with 75 mL of distilled water. The diluted water sample gives a strip reading of 5.0 or 366 mg/L chloride. The dilution factor is:

$$\frac{25 + 75}{25} \text{ or } 4$$

The chloride concentration in the original undiluted water sample is then 366 mg/L x 4 = 1464 mg/L.

Note: You can get distilled water at any supermarket.



Quantab® test strips are manufactured by Environmental Test Systems, Elkhart, IN. They were purchased from Hach Chemical Company, Loveland, CO. These test strips are provided free-of-charge as a service to small independent oil and gas producers and state regulatory personnel. For more information or to request additional test strips, contact Sheila Kumpel at the IPEC office by phone at (916) 831-3294 or by email at [skumpel@ipec.edu](mailto:skumpel@ipec.edu)



**IPEC Test Kit for  
Chloride Analysis in Water**

# Bioremediation Guidelines

- Remove the requirement for TPH analysis
- Role of moisture and dilution
- Hay/fertilizer/tilling
- Incremental fertilizer addition based on area of spill
- End point detected by smell



## IPEC GUIDELINES FOR BIOREMEDIATION OF A CRUDE OIL SPILL

### Why use Bioremediation?

Bioremediation is frequently the most cost-effective way to clean up an oil spill on soil and is endorsed by state and federal regulatory agencies. Cleaning up spills quickly will minimize future liabilities and costs by helping you maintain a good relationship with the landowner and regulatory agencies.

### When can I use bioremediation?

If you have any pooled free oil, it is important to vacuum up the free fluids and, if possible, recycle them back to the stock tank or properly dispose of them. Use absorbent material to pick up any fluid that can't be vacuumed and legally dispose of that material. When that's done, you need to ask two questions: (1) Is the contamination deeper than 8 inches? and (2) Is there shallow groundwater under the contamination?

If the answer to either of those two questions is yes, then bioremediation may still work for you but not in its most basic form. Seek assistance from your state regulatory agency's field personnel.

If you answered no to both of these questions, then a basic form of bioremediation called landfarming should work well for you.

### Basic landfarming

When you landfarm a crude oil spill, you are cultivating microorganisms in the soil to eat hydrocarbons. These microorganisms need the same things as crops: fertility, moisture, good soil structure, and warm temperatures. Follow the steps below and you will be on your way to cleaning up the spill.

- Step 1. Add fertilizer to the contaminated soil. 13-13-13 is a good choice. Add 1/2 lb per square yard of stained soil if it is a recent spill and 1/4 lb per square yard if it is an old spill. Just stop off the site to estimate the size. Don't add too much. You can have too much of a good thing. This wastes money and slows the process down.



13-13-13



One-half Pound of 13-13-13

- Step 2. Add organic matter to the contaminated soil. Organic matter builds soil structure and allows the soil to breathe. Hay or straw works well. Add the equivalent of about 5 square bales of hay per 1000 square feet.

- Step 3. Till the fertilizer and organic matter into the soil to a depth of 6 - 8 inches. Wax the soil wet with "Superseal". If no wax is used, the soil will become unconsolidated and will erode from around the edges or below the contamination during tilting. After tilling you should be left with a surface that resembles an yard.



Soil Sample of the Project Site  
Shoreline in a Location



Tractor Tilling

- Step 4. Repeat the addition of fertilizer and tilling every 30 days during the winter months (March through November) until the hydrocarbon odor is gone. Check the hydrocarbon odor in areas vegetated with native grasses to prevent erosion.

**What about moisture?** We can speed up the process of bioremediation by keeping the soil moist but most of the time we just depend on rainfall. If you do water the site, don't saturate the soil - that actually slows everything down.

**What is the best time to start a bioremediation project?** If you have a spill in December - February, go ahead and till the site to keep the hydrocarbon from moving offsite until warm weather returns. If the impacted area is sloped, it may be necessary to construct a low earthen dike at the bottom of the site to prevent runoff. If the spill occurs at any other time of year, go ahead and get started as soon as possible.

**How long does it take to bioremediate a site?** That depends on a lot of things, some you have control of and others you don't have any control over. You can speed up the process by sticking to the tilling and fertilizing schedule. But you can't control the rain. Another factor that has an effect on the rate of the process is how old the spill is. You can expect that crude oil that has been in the ground for a while will degrade slower than a recent spill. All things considered, you should see significant results in one or two growing seasons.

**What about brine?** As you know, crude oil spills often contain brine as well. If you have brine present, this presents a complication. However, cleaning up a spill of oil and brine uses the same basic method described above with one difference. The big difference is that for the first few months of remediation a lot of salt may leach from the site, and this needs to be captured and disposed of. Something like an earthen dike and a French drain on the down-slope side of the site can work well. Leachate can be collected in a bermed tank and pumped to a salt water tank if there is a tank battery nearby. Seek assistance from your state regulatory agency field personnel for help here. Another thing to remember about bioremediation of a site with brine present is that the salt slows down the microorganisms so the process of bioremediation of the oil will take longer.

For more information or to request additional copies of these guidelines, contact Steve Hall at the IPEC office at (918) 611-2237 or [stephen-hall@utmsu.edu](mailto:stephen-hall@utmsu.edu). These guidelines were developed by Kerry L. Sultem, University of Tulsa, who may be contacted at (918) 671-5083 or [kerry-sultem@utmsu.edu](mailto:kerry-sultem@utmsu.edu). Comments are welcome.

These guidelines are provided free-of-charge as a service to small independent oil and gas producers. IPEC activities are funded through a grant from the U.S. Environmental Protection Agency but may not necessarily reflect the opinions or policies of the EPA. Grant# R817015-01-1.

Visit the IPEC web site at: <http://pec.utmsu.edu>



REMEMBER, YOU CAN CONTACT YOUR STATE REGULATORY AGENCY FOR HELP.  
SOME USEFUL CONTACT NUMBERS IN OKLAHOMA AND ARKANSAS ARE:

OCC-2343

OSR-2343  
ANR-2343  
P.O. Box 100  
Tulsa, OK  
(918) 487-4400

OSR-1343  
P.O. Box 100  
Tulsa, OK  
(918) 487-4400

OCC-2343

OCC-1343  
Tulsa, OK  
(918) 487-4400

OCC-2343  
Tulsa, OK  
(918) 487-4400

OSR-2343  
Tulsa, OK  
(918) 487-4400

OCC-2343  
Tulsa, OK  
(918) 487-4400

# IPEC Training Videos

- *Cost Effective Environmental Strategies for Improving Production Economics* - Completed and in distribution
- *Bioremediation of Oil Spills* – Animated and live action; completed and in distribution
- *Remediation of Brine Spills* – Filming
- *Remediation of Combined Spills of Oil and Brine* – In script review
- *Emergency Response Procedures* – In script review









# Integrated Petroleum Environmental Consortium



## IMPROVING PRODUCTION ECONOMICS – QUICK CHECK SITE CHECKLIST

DATE: \_\_\_\_\_

Company \_\_\_\_\_ Lease \_\_\_\_\_

Spot Loc. \_\_\_\_\_ Sec. \_\_\_\_\_ T \_\_\_\_\_ R \_\_\_\_\_

County \_\_\_\_\_ State \_\_\_\_\_

Oil Well  Gas Well  SWDW  Other \_\_\_\_\_  Active  Inactive

Signs: @ Entrance YES NO   @ Battery YES NO   @ Well(s) YES NO   BLM Lease YES NO    
 Lease Fencing   Gate   Locked   H<sub>2</sub>S present

Fencing condition P F G    Terrain Flat Moderate Steep    Soil Texture Sand Silt Clay

Adjacent Land Use \_\_\_\_\_ Downslope Direction \_\_\_\_\_

### OIL/CONDENSATE TANKS (Are there any leaks? Check appropriate boxes.)

#	Size	Loadlines		Catch Basins		Flowlines		Connections		Drains		Clean-Out Plates		Corroded	
		YES	NO												
_____	_____	<input type="checkbox"/>													
_____	_____	<input type="checkbox"/>													

Lock(s) @ Loadline? YES NO   Seals @ Tank Valves/Loadline? YES NO   Oil to Pipeline? YES NO    
 Tank(s) Need Paint? YES NO   Stairs/Walkway in good condition? YES NO   All Tanks Active? YES NO    
 Direction/Distance to Nearest Surface Water \_\_\_\_\_ Water Body Type \_\_\_\_\_  
 Comments @ Tanks/Loading Points \_\_\_\_\_  
 Proposed Remedial Action \_\_\_\_\_

### WATER TANKS (Are there any leaks? Check appropriate boxes.)

Steel Closed Top  Steel Open Top  Fiberglass Closed Top  Fiberglass Open Top

#	Size	Loadlines		Flowlines		Connections		Drains		Clean-out Plates		Netting		Corroded	
		YES	NO												
_____	_____	<input type="checkbox"/>													
_____	_____	<input type="checkbox"/>													

Tank(s) Need Paint? YES NO   Denuded Areas Present? YES NO   If Yes, Size: \_\_\_\_\_  
 Comments @ Tanks \_\_\_\_\_  
 Proposed Remedial Action \_\_\_\_\_

### CONTAINMENT (Check appropriate boxes or fill in the blanks.)

Earthen	Type		Dimensions (L x W x H)			Breaches and/or Erosion			SPCC Plan	
	Gravel	Concrete	Length	Width	Height	None	Minor	Major	Required	Completed
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	<input type="checkbox"/>				

Condition inside secondary containment: No Spillage/Leaks  Spillage/Leaks  Free Standing Fluids   
 Comments @ Containment \_\_\_\_\_  
 Proposed Remedial Action \_\_\_\_\_

**IPEC: IMPROVING PRODUCTION ECONOMICS – QUICK CHECK SITE CHECKLIST**

**PRODUCTION VESSELS**

(Are there any leaks? Check appropriate boxes.)

#	Type	Size	Active		Valves		Piping		Drains		Connections		Corroded		Condition		
			YES	NO	P	F	G										
_____	Separator	_____	<input type="checkbox"/>														
_____	Htr. Trtr.	_____	<input type="checkbox"/>														
_____	Prod. Unit	_____	<input type="checkbox"/>														
_____	DeHy	_____	<input type="checkbox"/>														
_____	Gun Barrel	_____	<input type="checkbox"/>														
_____	FWKO	_____	<input type="checkbox"/>														
_____	Circ. Pmp	_____	<input type="checkbox"/>														
_____	Disp. Pmp	_____	<input type="checkbox"/>														
_____	_____	_____	<input type="checkbox"/>														
_____	_____	_____	<input type="checkbox"/>														

Does any equipment need paint? YES  NO       HC/salt impacted soil present? YES  NO

Is there a trash container on location?        Is junk/debris present?

Comments @ Prod. Vessels \_\_\_\_\_

Proposed Remedial Action \_\_\_\_\_

**COMPRESSOR**

(Are there any leaks? Are safety devices in place? Check appropriate boxes.)

Rental Unit?	<input type="checkbox"/> YES <input type="checkbox"/> NO	Lease owned?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Type	Size	Containment	Bulk Lube Oil
		YES NO	YES NO
		<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
		Gaskets	Fencing
		YES NO	YES NO
		<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
		Overall Condition	
		P F G	
		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	

Comments @ Compressor \_\_\_\_\_

Proposed Remedial Action \_\_\_\_\_

**LEASE CHEMICALS (Attach MSDS Sheets)**

MSDS Sheets?	<input type="checkbox"/> YES <input type="checkbox"/> NO	Container Labels?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Chemical	Container Type	Size	Comments
_____	_____	_____	_____
_____	_____	_____	_____

**PITS (Check appropriate boxes or fill in the blanks.)**

No pits     Dry pits     Fluids in pits     Type fluids \_\_\_\_\_    Size \_\_\_\_\_

Comments @ Pit(s) \_\_\_\_\_

Proposed Remedial Action \_\_\_\_\_

**WELLHEAD (Are there any leaks? Are safety devices in place? Check appropriate boxes.)**

Stuffing Box Rubber	Gauges	Valves	Connections	Fencing	Overall Condition
YES NO	P F G				
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>					

**PUMPING UNIT (Are there any leaks? Are safety devices in place? Check appropriate boxes.)**

Type	Size	Gaskets	Belts	Guards	Fencing	Overall Condition
		YES NO	YES NO	YES NO	YES NO	P F G
		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>				

Comments @ Wellhead/Pump Unit \_\_\_\_\_

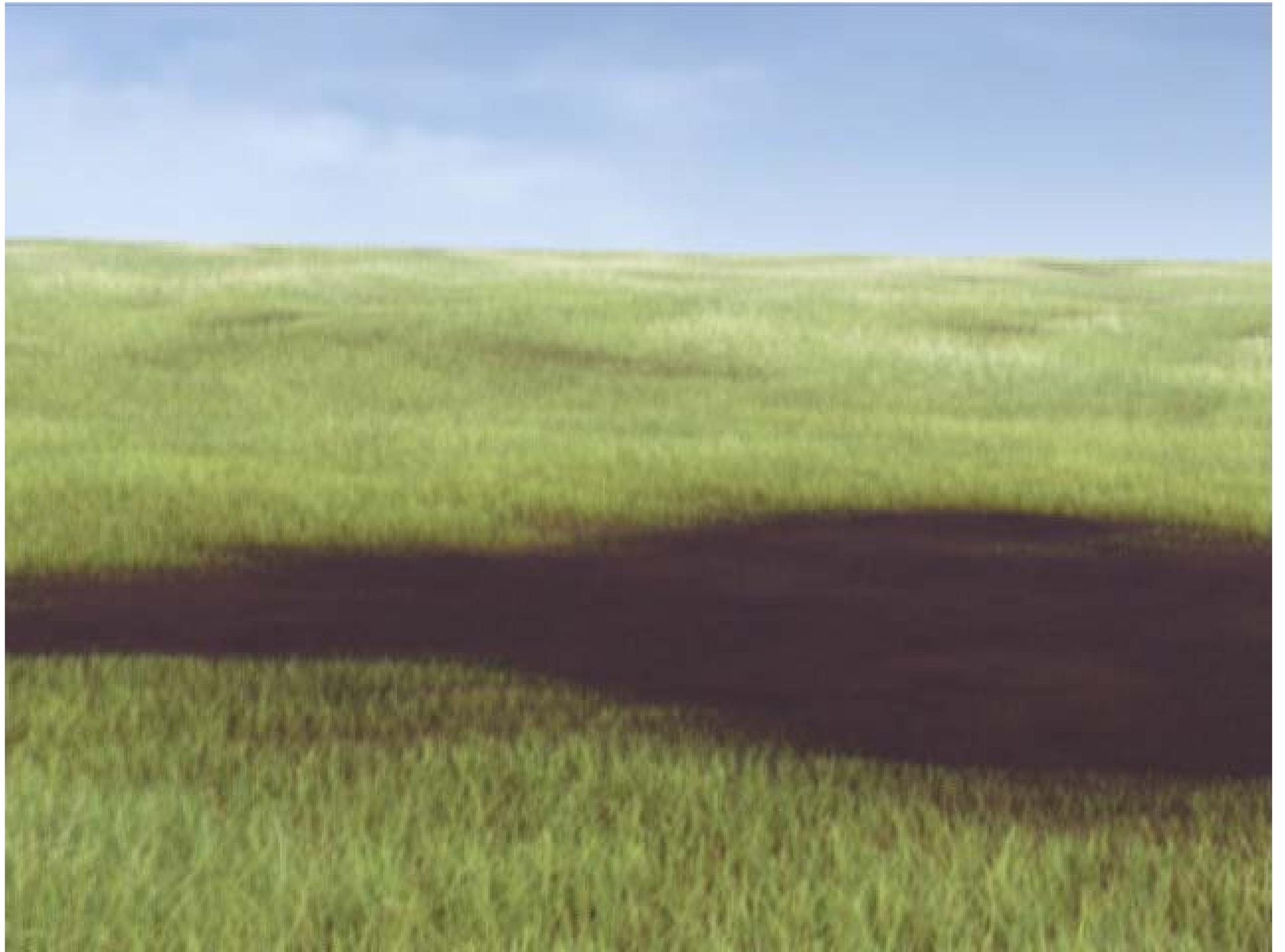
Proposed Remedial Action \_\_\_\_\_

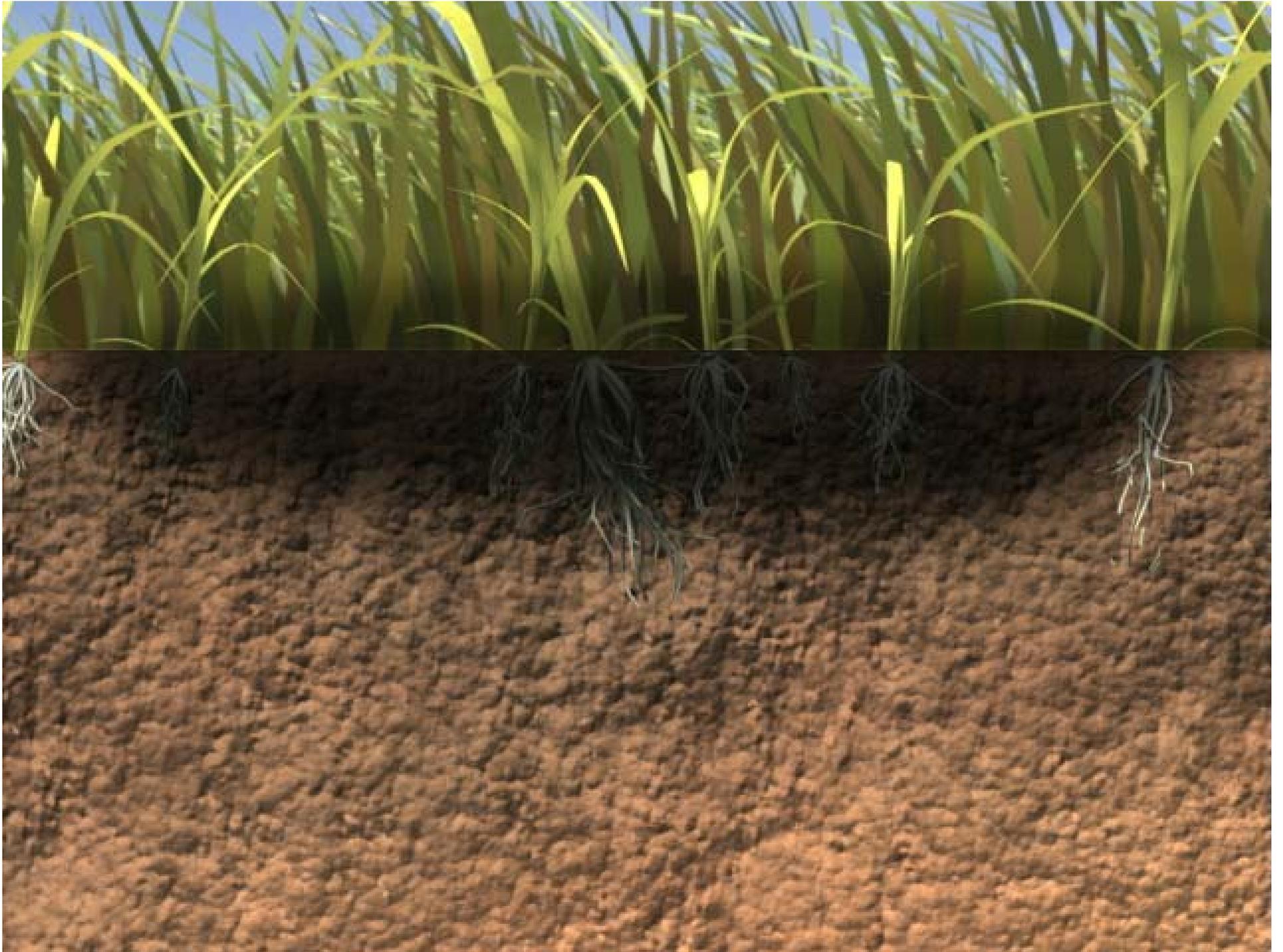


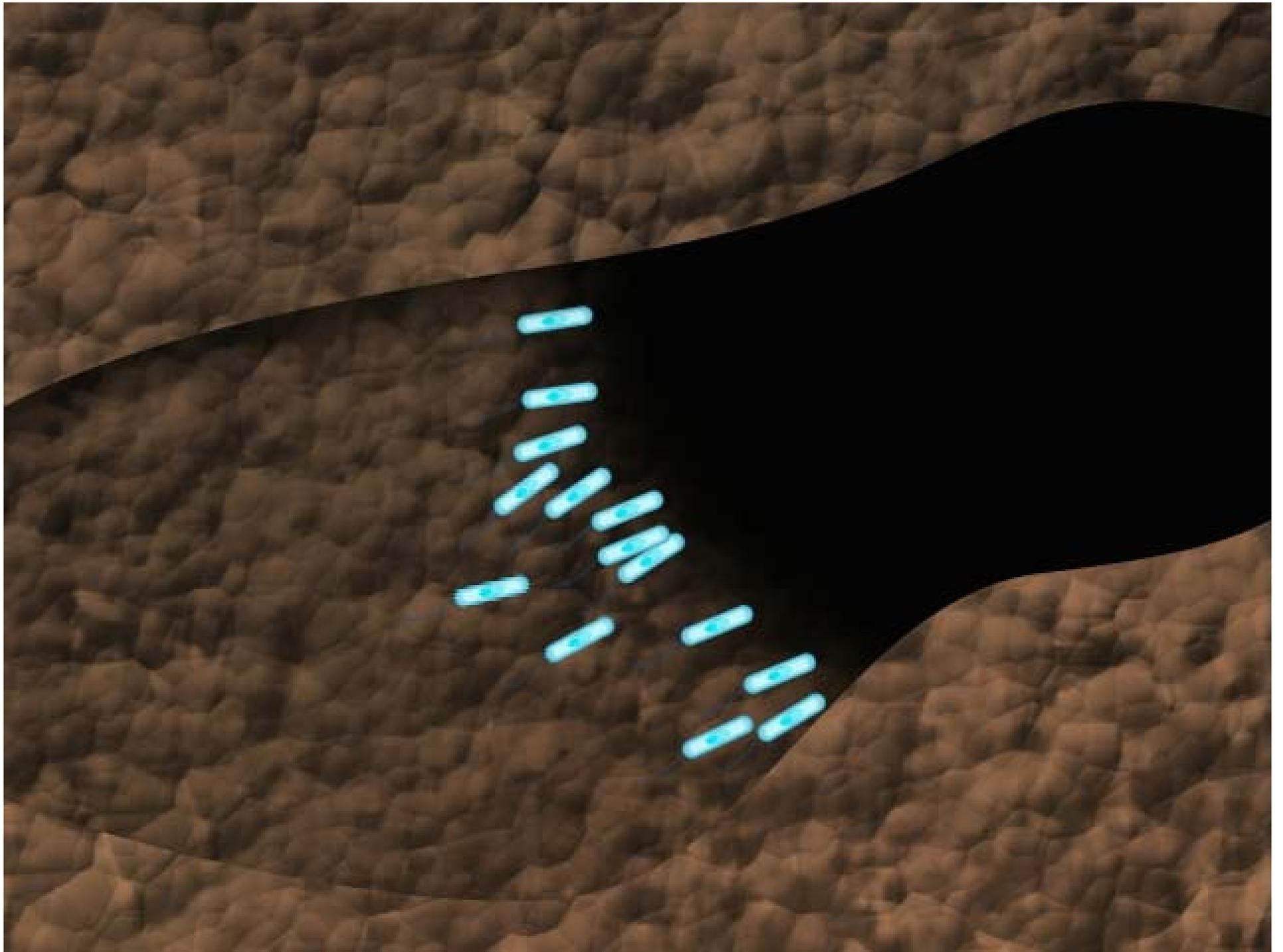


# **Bioremediation of Oil Spills in Soil**



















# IPEC Do-It-Yourself Kit for Independent Oil & Gas Producers

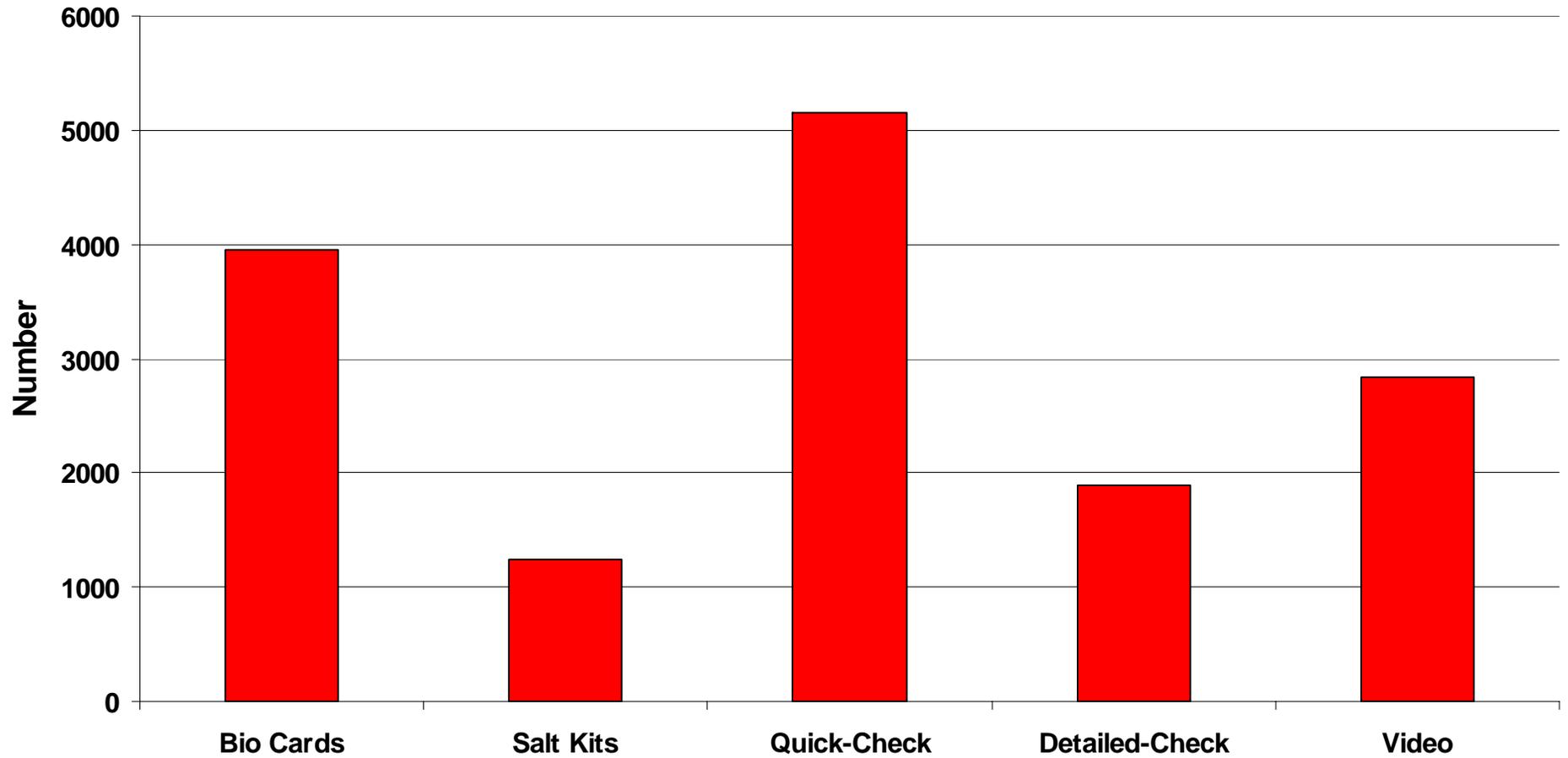
- *Cost Effective Environmental Strategies for Improving Production Economics* (video)
- Intro to IPEC
- Economics of site maintenance
- Self-assessment checklists
- Guidelines for emergency response
- Blank form for spill response team
- Spill reporting numbers
- Workshop information
- Remediation guidelines for oil and brine spills
- OK and AR regulatory contact numbers
- IPEC product list for ordering tools

# How are IPEC Products Distributed?

- Through Oklahoma and Arkansas state regulatory field personnel
- At workshops
- Through the IPEC exhibit booth
- Requests generated from
  - Newsletter or web site announcements
  - Presentations by IPEC officers
  - Announcement mailings
  - Word of mouth

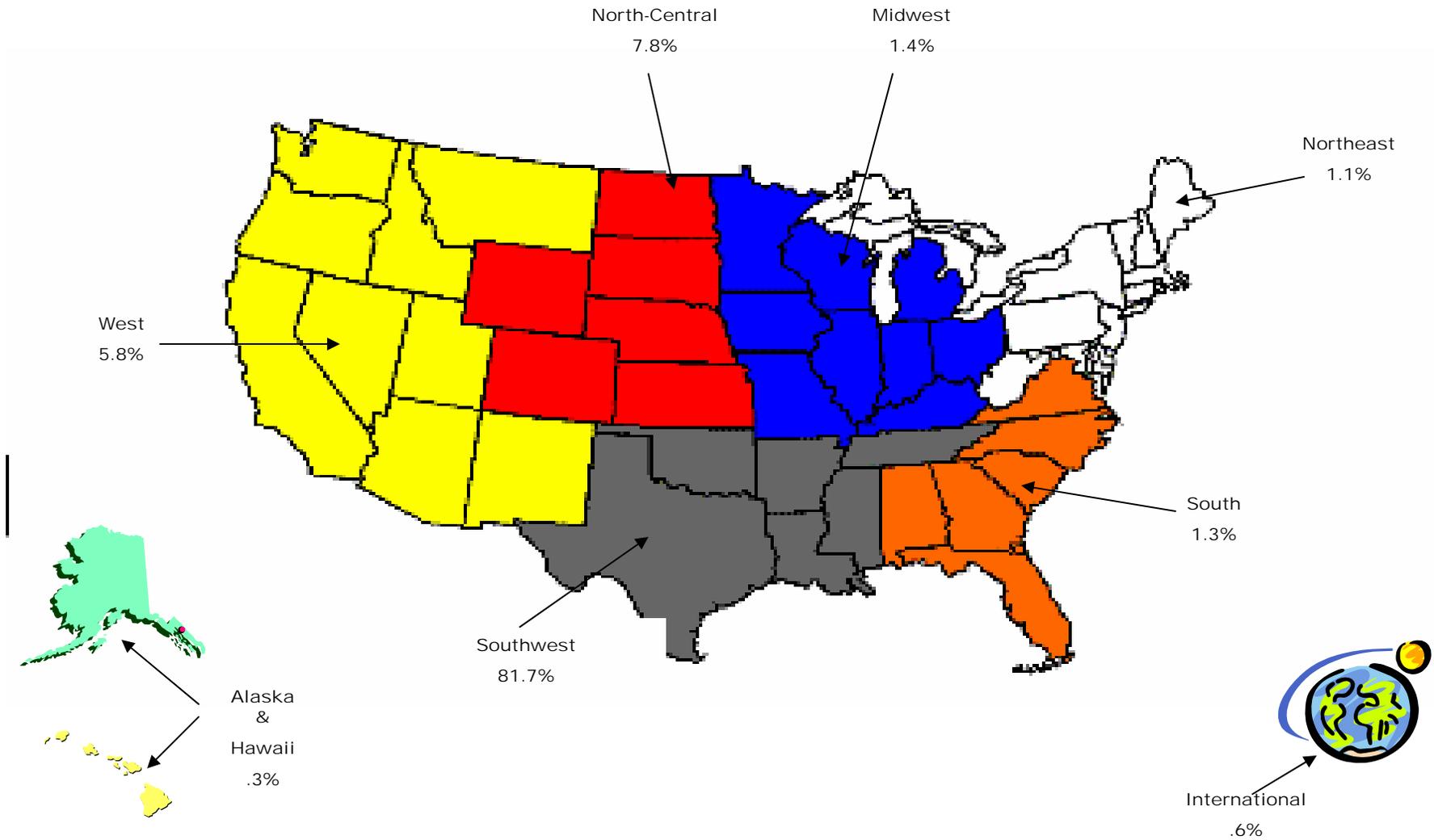


## Distribution of IPEC Tools for Independent Producers



# GEOGRAPHIC DISTRIBUTION OF PRODUCTS

as of 11-27-02



## Let's Share

- What resources do you make available to small oil and gas producers in your state to enhance environmental compliance?
- Let's work together to distribute all of these tools throughout the U.S.

# Want To Learn More About IPEC Products?

- Visit the IPEC Booth
- Get on our mailing list
- Visit the IPEC web site:  
<http://ipec.utulsa.edu>
- Contact me at (918)631-3085  
or [kerry-sublette@utulsa.edu](mailto:kerry-sublette@utulsa.edu)
- Contact IPEC's Outreach Manager (Sheila Kumpe) at (918)631-3284 or [sheila-kumpe@utulsa.edu](mailto:sheila-kumpe@utulsa.edu)

