Pollution Prevention at Exploration and Production Sites in Oklahoma

Best Management Practices for Prevention and Control of Erosion and Pollution

- Oil and Gas Drillsites
- Producing Wellsites
- Access Roads
- Seismic Lines
- Pipeline Right-of-Ways

Water Quality Series
E-940

Cooperative Extension Service
Division of Agricultural Sciences and Natural Resources
Oklahoma State University

in cooperation with

Oklahoma Corporation Commission
Oil and Gas Conservation Division

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April 2002

Foreword

This guide was developed cooperatively by the Oklahoma State University Department of Biosystems and Agricultural Engineering, the Oklahoma Cooperative Extension Service, and the Oklahoma Corporation Commission-Oil and Gas Conservation Division. Support was provided by the U.S. Environmental Protection Agency through the Oklahoma Office of the Secretary of Environment. The illustrations and much of the information regarding road construction, maintenance, and closure were taken from OSU Cooperative Extension Service Forestry Extension Report #5, "Best Management Practices for Forest Road Construction and Harvesting Operations in Oklahoma." More detailed information on BMPs is available in the "Forest Manager's Guide for Water Quality in Oklahoma," prepared by Oklahoma Department of Agriculture — Forestry Services. Text and layout were developed by Beth Ann Fulgenzi and M.D. Smolen. Illustrations for Figures 1, 9, and 10 were provided by Belinda Donovan. The photograph on the cover is courtesy of Parker Drilling Company, Tulsa, Oklahoma.

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Introduction

Clean water is one of Oklahoma's most valuable natural resources. Oil and gas exploration and production sites can degrade this resource. Of particular concern is erosion of seismic survey lines, access roads, and drilling and production sites. However, with the application of common sense and low-cost best management practices (BMPs), these activities and production may be carried out with minimal impact on water quality. Most BMPs are not mandated by regulations by rely on good stewardship and voluntary action. However, failure to prevent or control pollution could result in regulatory action.

The success of the nonregulatory approach depends on operators doing their part. BMPs should be used throughout the exploration and production process, from the initial seismic surveys to the abandonment of wells. Cooperation among the seismic contractor, operator, drilling contractor, pumper, and surface owner is critical to ensure that BMPs are applied to the land.

Runoff and erosion of exploration and production sites may come under EPA Sormwater Regulations. After March 2003, operators of sites larger than one acre, including access roads and right-of-ways, must file a Notice of Intent (NOI) with the U.S. EPA before any land-disturbing activities occur. The operator must also have a pollution prevention plan on site.

This guide presents BMPs for road construction, erosion control, and pollution prevention at typical exploration and production sites in Oklahoma. Additional assistance is available from conservation districts in every county, the National Resources Conservation Service (NRCS), and the Cooperative Extension Service.

Impact of Oil and Gas Activities on Water Quality

Oil and gas exploration and production can affect water quality through accelerated erosion and spillage of muds, brines, or hydrocarbons. Operators should apply BMPs to prevent or control erosion and pollution.

Erosion can occur on access roads, seismic lines, pipelines, drillsites, and production sites. The sediment produced by erosion disrupts aquatic ecosystems, kills fish, and destroys habitat. Sediment decreases the ability of streams to carry water, which results in increased flooding in some areas. It also fills reservoirs, reducing capacity and shortening their lifespan. Allowing sediment to pollute water is a violation of the Clean Water Act.

Erosion also causes a loss of topsoil, which contains most of the soil's organic matter and plant nutrients. This loss of topsoil takes away the most productive soil for plant growth.

Water quality may also be degraded by other pollutants such as salt water, oil, drilling mud, or other substances associated with exploration and production activities.

Erosion

The erosion process starts when wind or raindrop splash disturbs the soil surface. Sheet erosion occurs when a thin layer of soil is removed by runoff water. When runoff water concentrates and gains velocity, it detaches more soil, cutting rills and gullies. Gullies can become deep channels and gorges when the slope length and gradient increase the velocity of runoff water. This erosion process produces sediment which is a pollutant (Figure 1).

To minimize erosion:

- Keep the soil covered to protect from raindrop splash.
- Do not allow runoff water to cascade over cut or fill slopes.
- Stabilize surfaces with vegetation, gravel, or mulch as soon as possible.

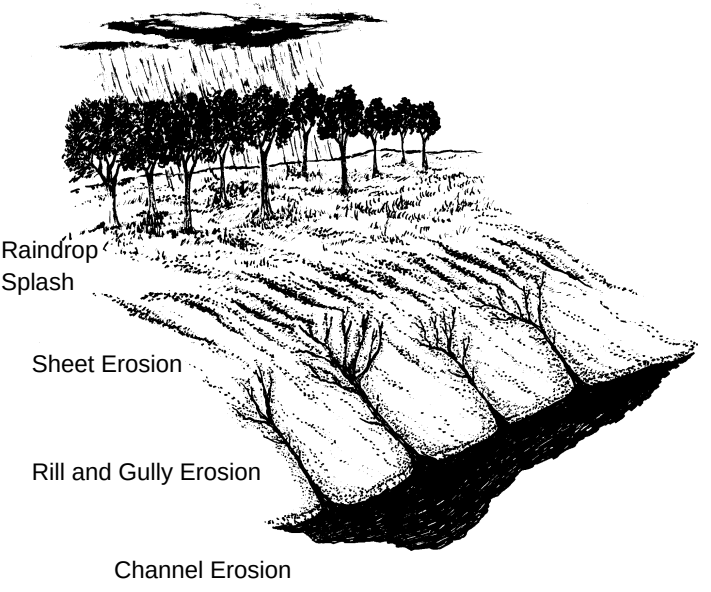

Figure 1. Sheet, rill, and gully erosion result from leaving the soil bare (adapted from the *North Carolina Erosion and Sediment Control Planning and Design Manual*).

Streamside Management

A strip of land left undisturbed between streams and construction areas is a BMP commonly known as a Streamside Management Zone. It is one of the most important practices an operator can use to maintain water quality. Extra care is needed during construction of wellsites, access roads, pipelines, and seismic lines to protect streambanks from erosion. Streamside vegetation protects banks and channels from erosion, cools stream water, and provides shelter for aquatic species. The streamside management zone also filters sediment and nutrients from disturbed areas upslope. Use the following guidelines when operating near streams:

- Leave at least 50 feet of undisturbed land from the streambank to roads, wellsites, seismic lines, or pipelines.
- Under wet conditions keep heavy equipment out of the streamside area.
- Remove construction debris from the streamside area.
- Hand drag seismic cables across the streamside area or use cableless seismic equipment.

Access Roads

Erosion from access roads is a major source of sediment from oil and gas operations. To ensure fairness to both the operator and the landowner, the road system should be part of the overall management plan. Early planning will save time and money and protect water quality.

Road planning involves decisions that are of concern to both the operator and the landowner; therefore, operators and landowners should cooperate. Planning involves making choices between permanent and temporary roads, relocation and repair of existing roads, alternative access points, and the expected use of the roads by the operator and the landowner.

Remember, too, that access roads are susceptible to abuse by recreational vehicles. If possible, access roads should be made inaccessible to unauthorized vehicles. Regardless of what type of road is constructed for oil and gas operations, the land must be left in an acceptable condition.

Existing Roads: Repair or Relocate

Some oil and gas drillsites in Oklahoma may already have roads near the site. Use existing roads whenever possible. They may, however, have erosion problems and may not meet these BMP guidelines. Generally, repairing existing roads causes less disruption and is easier and less expensive than building new roads.

- Apply BMPs to the degree possible within the limitations of the road system.
- Relocate roads only if it will result in less erosion in the long term.
- Consult your local conservation district or the Natural Resources Conservation Service for assistance.

Temporary Roads

Temporary roads may be used when installing wells, seismic lines, and pipeline right-of-ways. In general, temporary roads cost less than permanent roads. Temporary roads should be closed as soon as their use is terminated. After closure, the roads should be made inaccessible and should not leave behind existing or potential erosion problems. Areas used for temporary roads should be revegetated as soon as possible after closure.

Permanent Roads

Permanent roads are necessary to provide continued access for the production and maintenance of oil and gas wells. For example, tank batteries and saltwater disposal wells must have roads that are accessible in all weather conditions. Permanent roads are expensive, usually require a greater amount of soil disturbance during construction than temporary roads, and require regular maintenance. In the long run, investment in permanent roads may save wear and tear on vehicles and protect the environment.

Planning Access Roads

The following guidelines are for rehabilitated roads, new roads, temporary roads, and permanent roads, except where noted.

- Avoid crossing streams and sensitive streamside areas.
- Avoid unstable and poorly drained areas.
- Locate roads along ridges wherever possible.
- Stabilize surface for traffic.
- Keep sustained grades on permanent roads to no more than 10 percent (up to 18 percent on slopes of less than 500 feet).

- Balance road cuts and fills. Don't borrow from roadside slopes.
- Install erosion control practices.
- Establish ditch lines and drainage systems.

Road Erosion Control Guidelines

The best approach to erosion control on access roads is to provide good drainage of runoff water at non-erosive velocities. To control erosion on roads:

- Shape roads to shed water into stable ditches and culverts.
- Install culverts at recommended spacings.
- Use drainage dips.
- Install water bars.
- Install turnouts and wing ditches.
- Apply vegetation, gravel, or mulch to stabilize surfaces.

Road Construction and Stabilization

Road Cross-sections

Road cross-section designs may be crowned, outsloped, or insloped (Figure 2).

Crowned roads may be used in all terrains. Water turnouts and cross-drains must be provided to remove runoff water.

Insloped roads may be used on sharp, steep turns. They direct water inward to protect the hillside. Insloped roads require properly spaced culverts to remove the water.

Outsloped roads may be built in moderately sloping terrain, such as the upper parts of long slopes. But outsloped roads are not suitable for deeply cut hillside locations where they may be eroded by water from upslope. Outsloped roads may be less safe for traffic.

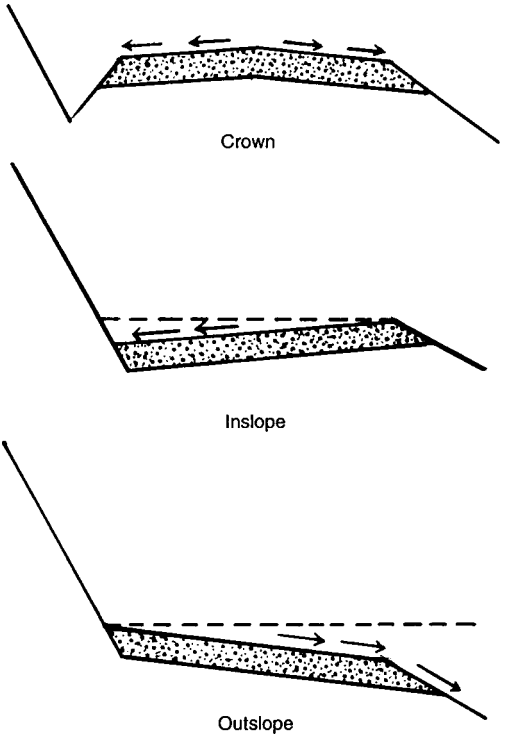

Figure 2. Road surface cross sections (road surface slope — one half inch per foot).

Cross-drain Culverts

Cross-drain culverts prevent accumulation of water in ditch lines. Factors to consider include culvert spacing and pipe size. Installation details are shown in Figure 3.

To minimize ditch erosion and prevent overflow and wash-outs, space cross-drains more closely on steeper slopes (Table 1).

Select culvert size according to the road area and hillslope area drained by the ditch (Table 2). To avoid clogging, do not use culverts smaller than 12 inches in diameter.

Table 1
Recommended Spacing
of Cross-drain Culverts

Road Grade (%)	Spacing (feet)
2-5	300-500
6-10	200-300
11-15	100-200
16-20	100

Table 2
Recommended Diameters of Culverts
Based on Drainage Area

Pipe Diameter (inches)	Area Above Pipe (acres)
12	2
15	4
18	7
21	12
24	16
30	27
36	47
42	64
48	90
54	120
60	160
66	205
72	250
78	350

Culvert Installation

- Plug the ditch immediately downhill from the culvert inlet to direct all water into the culvert. Figure 3 illustrates considerations for culvert installation.
- Extend the culvert and install riprap to prevent erosion beyond the fill slope.
- Make culvert gradients at least two percent greater than the ditch gradient.
- Locate culverts so they do not discharge directly into streams.

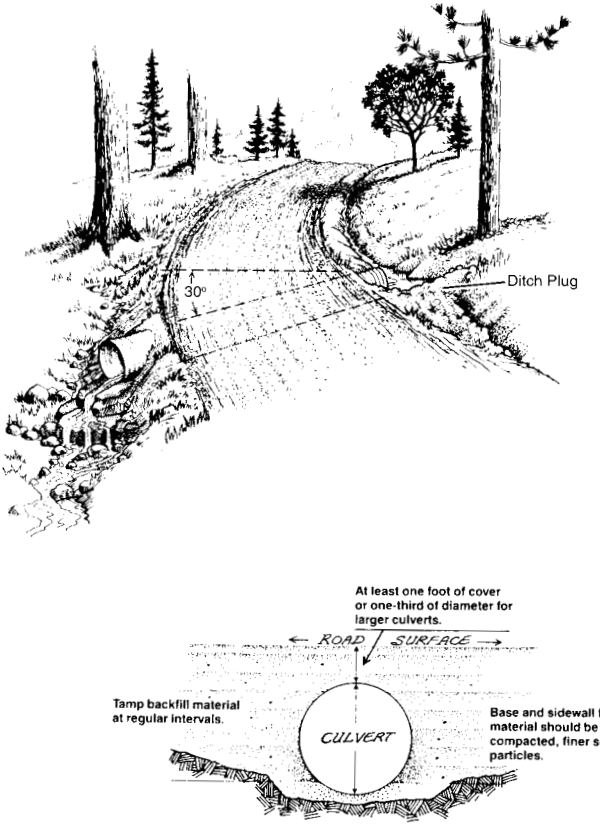

Figure 3. Design and installation of cross-drain culverts (adapted from *Montana Forestry Best Management Practices*, Montana State University).

Drainage Dips

Drainage dips remove water from road surfaces without using a cross-drain culvert. They are well suited for temporary roads. Dips must be deep enough to carry the expected flow in the direction intended. They must also be wide enough to allow the safe passage of trucks and equipment. The type of dip selected depends on expected use and type of road. The spacing of drainage dips is determined by slope steepness and local conditions (Table 3). Place rock below the outlet to prevent erosion. Drainage dips should discharge onto stable outlets.

Rolling dips (Figure 4) are best for lightly traveled temporary roads with low-speed traffic. Rolling dips resemble "stretched out" water bars. The dip is excavated out of the existing road grade.

Broad-based dips (Figure 5) are best for roads with high traffic volumes and speeds, such as main access roads. The road grade between dips is adjusted so there is a constant grade from the crest of the berm of one dip to the bottom of the next dip downslope.

Table 3
Drainage Dip Spacing

Road Grads (%)	Spacing (feet)*
2-4	300-200
5-7	180-160
8-10	150-140

**Reduce spacing on highly erodible soils*

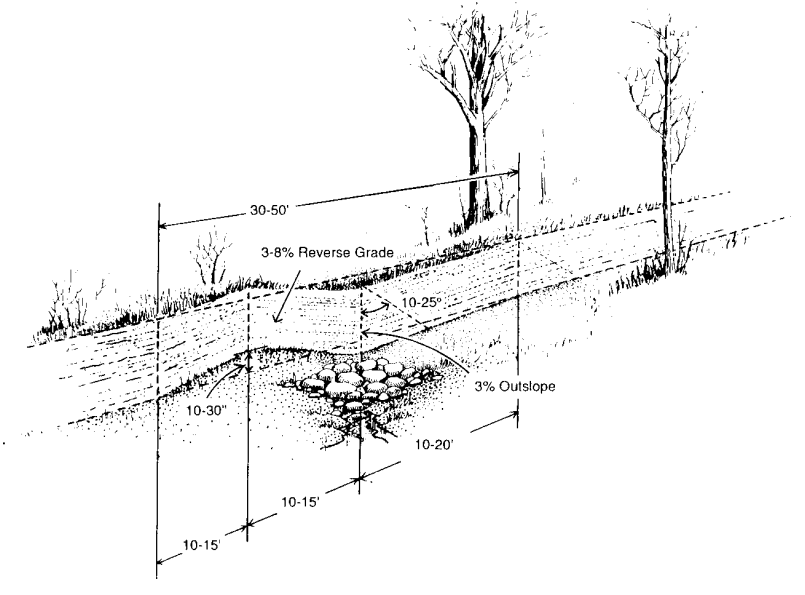

Figure 4. A rolling dip. These are best for lightly traveled roads.

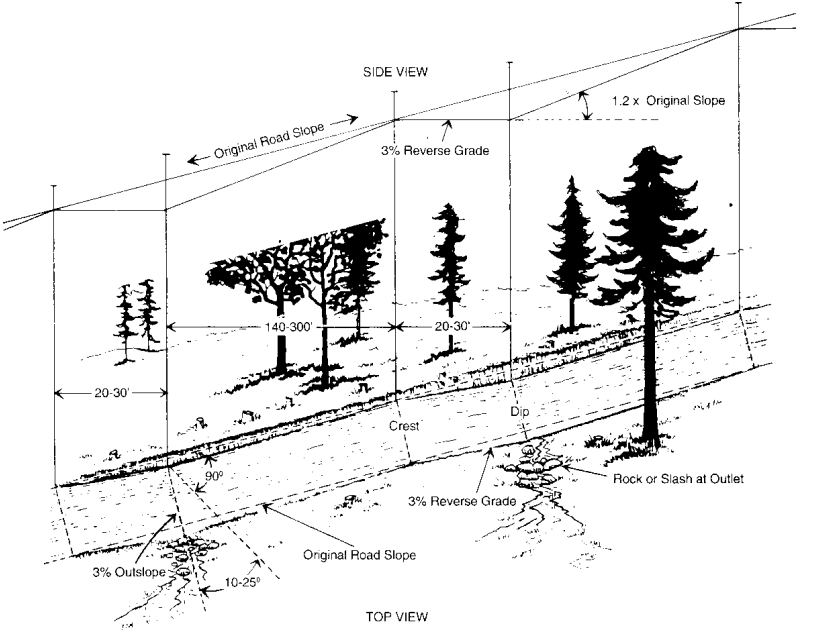

Figure 5. A broad-based dip may be suitable for a main access road.

Water Bars

Water bars (Figure 6) prevent erosion on seismic survey lines and other right-of-ways. Table 4 gives recommended water bar spacing for roads.

Use the following guidelines for water bar installation:

- Install water bars at a 10- to 25-degree angle downslope.
- Provide a cross-drainage grade of one to two percent.
- Place rock at the outlet.
- Space water bars more closely on steeper slopes.

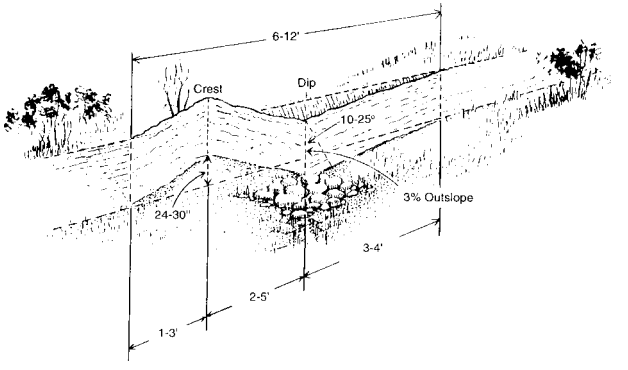

Figure 6. Design of water bars.

Table 4
Recommended Water Bar Spacing for Roads

Grade of Road (%)	Water Bar Spacing (feet)
2	250
5	135
10	80
15	60
20	45
25	40
30	35
40	30

Turnouts or Wing Ditches

Turnouts (Figure 7) release water from road ditches near ridges, points of ridges, and gentle sideslopes. On flat roads, turnouts provide drainage and help the road dry out. Turnouts are most effective if there is little slope.

Use the following guidelines for turnout installation:

- On sloping roads, use the spacing guidelines for cross-drain culverts (see Table 1).
- Slope turnouts one to three percent from the bottom of the road ditch.
- Turn at a 30- to 40-degree downslope angle (with respect to the roadbed).
- Turnouts should discharge onto stable outlets.
- Place rock at the outlet to prevent erosion where needed.
- Do not discharge turnouts directly into stream channels.

Figure 7. Installation and design of turnouts.

Vegetation Guide

The most effective way to prevent erosion and stabilize surfaces is with vegetative cover. Factors to consider in planning vegetative cover include:

- Preparing the seedbed
- Planting the vegetation
- Mulching
- Inspecting and repairing

Preparing the Seedbed

The soil on a disturbed area must be prepared before planting. The soil should be loose enough to allow water infiltration and root penetration. Soil pH must be within a tolerable range. Add fertilizer to ensure adequate nutrients for plants. In acid soils, add lime to raise pH. Liming also makes other nutrients more available to plants and prevents aluminum toxicity.

A rough seedbed with clods and stones helps hold water, seed, and fertilizer. During final grading of fill slopes, the last 4-6 inches should be roughened.

On steep slopes tracked machinery can be operated up and down the slope to leave horizontal depressions (Figure 8).

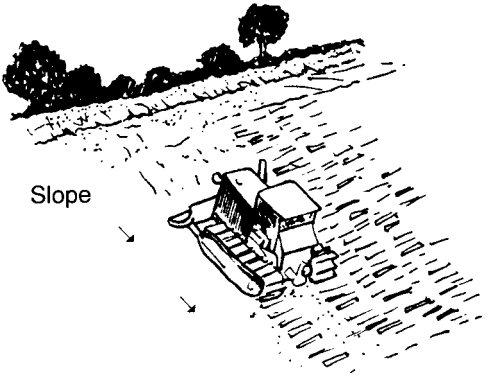

Figure 8. Horizontal depressions from tracking (adapted from *Michigan Soil Erosion and Sedimentation Guide*).

Planting the Vegetation

The climate, soil, and topography of an area are the major factors determining plant selection. The desired appearance, level of maintenance, steepness, and mowing requirements of the site will also affect plant selection. Vegetation is planted by seeding, sprigging, or sodding. Table 5 gives recommended dates for seeding and planting operations. For information and assistance on vegetation for your area, contact your local conservation district office or Cooperative Extension office.

Table 5
Recommended Dates for Seeding and Planting Operations

Species	Dates
Native grass mixture-warm season	Dec 1 - May 15
Native grass mixture-cool season	Sep 1 - Mar 31
Introduced: Caucasian, King Ranch, El Kan, Plains, and other old world bluestems	Mar 1 - May 31
Bermuda grass-Southern Oklahoma	Dec 1 - May 31
Bermuda grass-Northern Oklahoma	Feb 1 - May 31
Weeping lovegrass/lespedezas	Apr 1 - May 31
Tall fescue	Mar 1 - Apr 30 Sep 1 - Oct 31
Woody vegetation: hardwoods, conifers, and shrubs	Dec 1 - Mar 15

Mulching

Apply mulch to protect the soil surface from erosion and foster plant growth. A number of things—such as straw, wood chips, and shredded bark—can be used for mulch. Organic mulches may also include locally available materials such as animal manure, peanut hulls, or hay.

Mulch should be applied properly and secured in place if subject to wind or runoff. A hydroseeder/mulcher assures uniform application of mulch. Tackifiers such as emulsions or dispersions of vinyl compounds or rubber mixed with water can keep mulch in place for most applications. Straw mulch should be anchored immediately after spreading. Anchoring can be done with a crimping tool or a liquid mulch binder or tackifier.

Synthetic materials such as mats, fabrics, or netting are also available. Netting holds mulch in place on waterways and slopes subject to wind or runoff. Mats are used to promote seedling growth and are useful in establishing grass in channels and waterways. They are available in a variety of synthetic and organic materials and are considered protective mulches. Some materials such as erosion control fabric may be used with mulch or stone in place of vegetation. Nets and mats must be installed to have a firm, continuous contact with the soil.

Inspecting and Repairing

Vegetation and soil should be inspected periodically and after rainstorms for erosion, dislocation, or failure. If erosion is observed, repair, reseed, or replant, and apply additional mulch.

Road Maintenance

Roads that are not maintained properly are susceptible to erosion. It is the operator's responsibility to maintain roads. Follow the guidelines below for road maintenance:

- Repair eroding ditch lines. Use check dams, turnouts, or erosion control fabric to prevent further erosion.
- Seed eroding areas and apply mulch.
- Inspect ditches, culverts, turnouts, dips, and water bars regularly. Remove any blockage and restore to working condition.
- Grade road surfaces only when necessary to eliminate rutting and surface erosion channels. Grading loosens road surface materials, causing erosion.

Closure of Roads and Seismic Survey Lines

Close all roads that are no longer needed. Closing roads saves on maintenance costs and reduces liability. Roads that should be closed include those to wells that have been plugged and all seismic lines. Follow the guidelines below for road closure:

- Construct water bars at recommended spacings to reduce surface erosion.
- Seed and mulch to protect highly disturbed areas.
- Close access points with a large ditch and berm or other structure.

Drilling and Production Sites

Pollution of surface and subsurface fresh water is expressly forbidden by Oklahoma Corporation Commission Rules 165:10-3-12, 165:10-3-13, 165:10-7-4, and 165:10-7-16. Erosion control and prevention of water contamination should be considered when planning, constructing, and operating oil and gas facilities. Roads, pads, pits, and tank batteries should be constructed, maintained, and closed according to OCC rules.

Containment for Tank Batteries and Pits

Dikes should be constructed around storage tanks for spill containment (Figure 9). Section 311 of the federal Clean Water Act Amendments requires oil and gas facilities to prepare a Spill Prevention Control and Countermeasure Plan. Requirements are listed in 40CFR Part 112 and operators are urged to consult this source for up-to-date information. The diked area should be large enough to contain at least the volume of the largest tank in the facility. A splash pad/apron should be constructed at the unloading area of any disposal well pit. Follow all applicable regulations concerning site facilities and containment for tank batteries and pits.

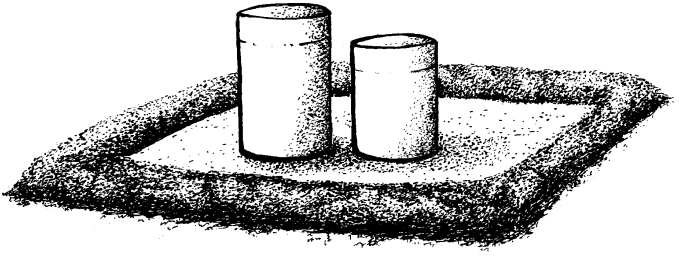

Figure 9. Spill containment is a key part of a Spill Prevention Control and Countermeasure Plan.

Surface Stabilization

Protect dikes from erosion by using vegetation, gravel, plastic, concrete (in highly populated areas), or other suitable materials. Periodically inspect the dike and perform any necessary maintenance.

Drillsite Pits and Disposal of Drilling Mud

Reserve mud pits and completion/fracture/workover pits must be constructed and lined according to OCC rules. At least 24 inches of freeboard must be maintained at all times to prevent overflow and the release of drilling mud or other fluids.

Drilling mud must be disposed of properly. It may be recycled, injected into the well, disposed on-site or hauled to a commercial disposal site. Check with OCC for permit requirements. On the drilling/reentry permit (OCC Form 1000), the operator must indicate the proposed method for disposal of drilling fluids and cuttings.

Closure of Pits

Pits must be properly closed to prevent pollution of surface water or ground water, and/or danger to wildlife. This means taking extreme care to assure that pit contents don't escape.

If the pit contents are to be consolidated in place, the pit must be completely dewatered before trenching, stirring, or otherwise disturbing the bottom of the pit. Trenching or stirring is prohibited for certain categories of pits.

A minimum of three feet of soil cover must be applied over any remaining pit contents. Stockpiled topsoil should be applied last. The soil should be mounded and shaped to ensure runoff without erosion. Vegetation should be planted and diversion terraces constructed, if necessary (Figure 10).

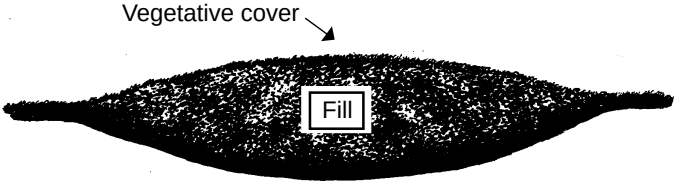

Figure 10. The soil cover on a pit should be mounded and vegetated to shed water.

Abandoning a Wellsite

OCC Rule 165:10-3-17 lists regulations for properly abandoning oil and gas wells or dry holes. Within 90 days of plugging, the wellsite must be cleared of all trash and debris, restored to original contour, and revegetated. This rule also applies to access roads. The lease agreement with the surface owner may require additional measures.

Response to Salt Water Spills

Respond to salt water spills immediately to prevent further damage. Salt water spills are always more difficult and expensive to repair later. In general, response should consider the following:

- Contain the spill and prevent further discharge. Minimize the area affected by diking or containing the spill in emergency pits, leak-proof tanks, or other suitable methods.
- Remove free fluids as soon as possible with the use of a vacuum removal system. Do not discharge salt water.
- Restore and revegetate the site.

In some areas, such as where standing water or wet soils are present, flushing the spill site with fresh water may aid in the removal of salt water from the soil surface. Recovered salt water fluids must be properly disposed. Soil samples can help determine whether soil removal or other measures are needed.

Salt water spills to surface water must also be corrected immediately. Confine the spill to the smallest area possible by using temporary dikes and emergency pits. Collect and properly dispose of as much of the affected water as possible. Cleanup measures are complete when evidence of contamination no longer exists.

Remediation of Historical Spills

Remediation of historical spills may require long-term measures. Contact your OCC district office for assistance in determining the level of cleanup and remediation needed.

Rights of the Landowner

Although the surface owner may not hold the mineral rights, he or she should not be overlooked in the exploration and production process. Surface owners, too, must understand that the mineral owner has the right to look for oil and gas on the property. To avoid disputes, specifications regarding surface use and repair of damage should be written into the contract between the landowner and the operator.

The surface owner is likely to be concerned about damage to crops, livestock, pasture, trees, and water. To avoid problems, the land should be left in an acceptable condition. This includes ensuring that erosion is minimized by using BMPs and revegetating seismic lines, drillsites, wellsites, pipelines, and access roads. Issues of surface damage should be worked out between the operator and landowner. They are not within the jurisdiction of the OCC.

Additional Information

For additional information or assistance contact the agencies listed below.:

Oklahoma Corporation Commission
2101 N. Lincoln Blvd.
P.O. Box 52000
Oklahoma City, OK 73152-2000
(405) 521-2500

Corporation Commission district offices:

District 1
Corporation Commission
115 West 6th
P.O. Box 779
Bristow, OK 74010-0771
(918) 367-3396

District 2
Corporation Commission
101 South 6th
P.O. Box 1107
Kingfisher, OK 73750-1107
(405) 375-5570
FAX: (405) 375-5576

District 3
Corporation Commission
1020 Willow
P.O. Box 1525
Duncan, OK 73533
(580) 255-0103

District 4
Corporation Commission
703 N. Broadway
Ada, OK 74820-3437
(580) 332-3441

Oklahoma Conservation Commission
2800 N. Lincoln Blvd., Suite 160
Oklahoma City, OK 73105
(405) 521-2384

Oklahoma Department of Agriculture
Forestry Services
2800 N. Lincoln Blvd.
Oklahoma City, OK 73105-4298
(405) 521-3864

Oklahoma Department of Environmental Quality
P.O. Box 1677
Oklahoma City, OK 73101-1677
1-800-256-2365 (24-7 incident reporting)
1-800-869-1400 (Customer Service, M-F 8:00 a.m. - 4:30 p.m.)

USDA Natural Resources Conservation Service
100 USDA, Suite 203
Stillwater, OK 74074-2655
(405) 742-1200

U.S. Environmental Protection Agency, Region 6
SPCC Plans - Emergency Response Branch
1445 Ross Ave.
Dallas, TX 75202-2733
(214) 665-6489

Samuel Roberts Noble Foundation
P.O. Box 2180
Ardmore, OK 73402
(405) 223-5810

The Kerr Center for Sustainable Agriculture
P.O. box 588
Poteau, OK 74953
(918) 647-9123

You may also contact your local Cooperative Extension Service or conservation district office for information on best management practices for prevention and control of erosion and pollution.

NOTES

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Sam E. Curl, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is issued by Oklahoma State University as authorized by the Dean of the Division of Agricultural Sciences and Natural Resources. 0402 GH Revised.