



Environmental Evolution of the Petroleum Industry

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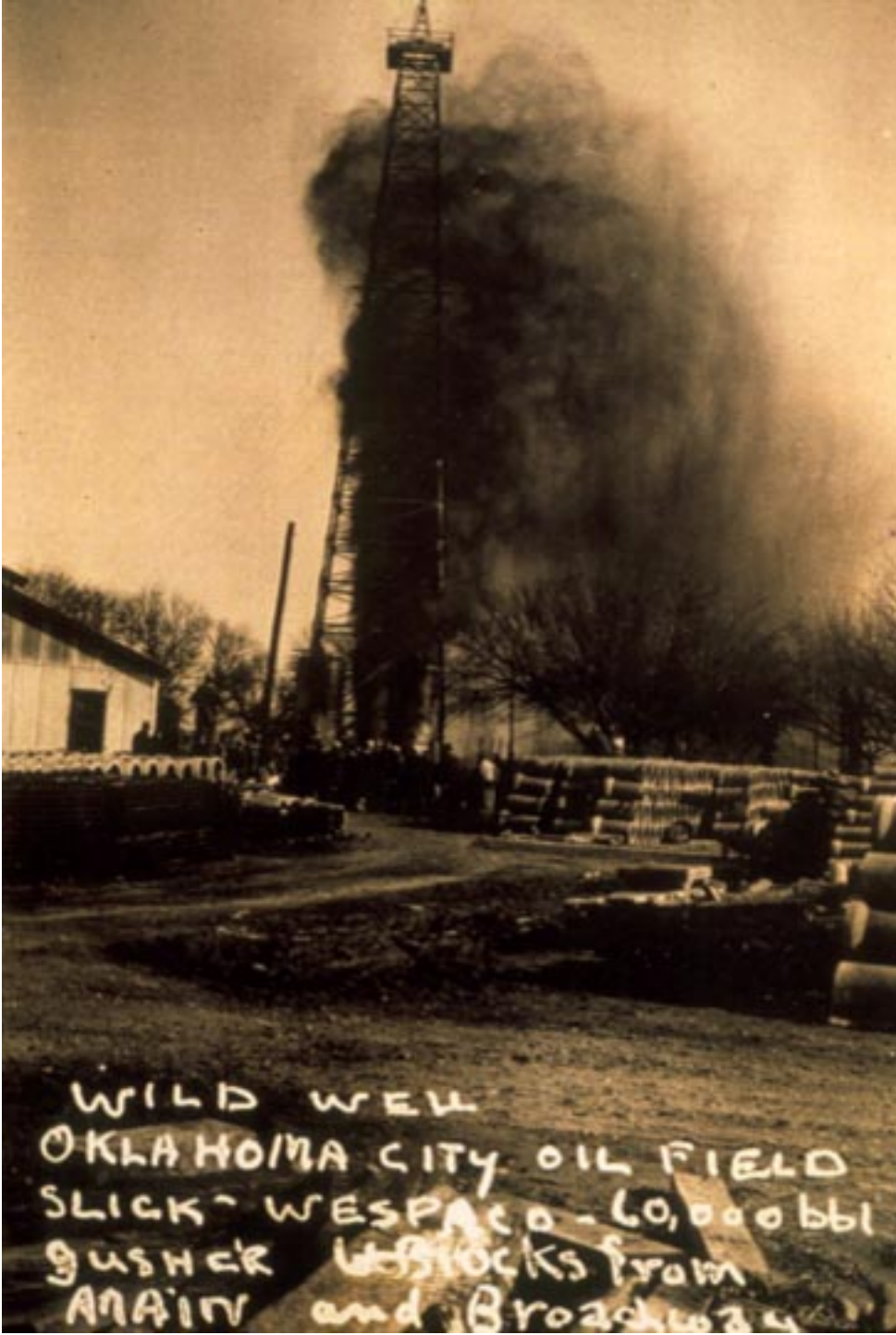


SOCIETY DEMANDS A PRISTINE ENVIRONMENT.
THE MERE PRESENCE OF SOCIETY PRECLUDES
A PRISTINE ENVIRONMENT.

WHAT CHOICES DO WE WANT TO MAKE?

LCG, 1989

Oklahoma City Gusher



WILD WELL
OKLAHOMA CITY OIL FIELD
SLICK - WESPACO - 60,000 bbl
gusher - 1000 ft from
MAIN and Broadway

Regulatory Premises

- Prevention of waste
- Conservation of the resource
- Protection of corollary rights
- Environmental protection

Produced Fluids

- **Oil**
- **Gas**
- **Water (saline or fresh)**
- **Nitrogen**
- **Other gases (H_2S , He)**

(characteristics controlled by geologic settings)

Regulatory Oversight on Petroleum E & P

- State regulations and permitting (primary, direct)
- Clean Water Act (operations)
- Clean Air Act (operations)
- NEPA (access, operations)
- ESA (access)
- Antiquities Act (access)
- OSHA (operations)
- Federal and state land managers policies (secondary, indirect)

Environmental Issues

● EXPLORATION

Site access
Seismic

● PRODUCTION

Produced water
Hydrogen sulfide
Casinghead gas venting
Oil spills
Migratory birds

● DRILLING AND COMPLETION

Area of land use
Drilling fluids
NORM
Blowouts
Protection of ground water
Protection of aqueous environments

● POST-PRODUCTION

Plugging depleted wells
Salt dissolution
Reclamation

Issues and Answers

OLD

STANDARD

ADVANCED

EXPLORATION

Seismic	None	Invasive	Non-Invasive
Endangered species	None	Modified operating	International
Land withdrawal	None	Private minerals	International
Antiquities	None	Mitigation	International

DRILLING

Land use	Extreme impact	Mod. Impact	Small footprint (multiple bores)
Groundwater protection	None	Surface casing	Cement off
Reserve pit fluids	Seeped, evap.	Injected	Re-used
Cuttings	Left in pit	Left in pit	Grind & inject
NORM	Unrecognized	"Safe disposal"	
Blowouts	Lived with	Blowout preventers	
Drilling technology	Cable tool	Rotary, horiz.	"Three-D" coiled tubing
Aqueous env.	No notice	Minimal discharge	Zero discharge (diapers)

The Old: 1920's El Dorado Field, KS



EXPLORATION HAS CHANGED





For Sensitive Areas,
Helicopter Operations



Even the Drillers Wear Suits

Small Impacts on Ranchland



Tarr Farm, PA, 1862



But Nature Heals: Tarr Farm, 1991, same view



Drilling has changed, from the turn of the century,



A 60 FT WATER WELL TURNED TO A 200 BARREL OIL WELL
ON MANOR PROPERTY 1/2 BLOCK EAST 1/2 BLOCK SOUTH OF SCHOOL HOUSE
IN TOWANDA KANS

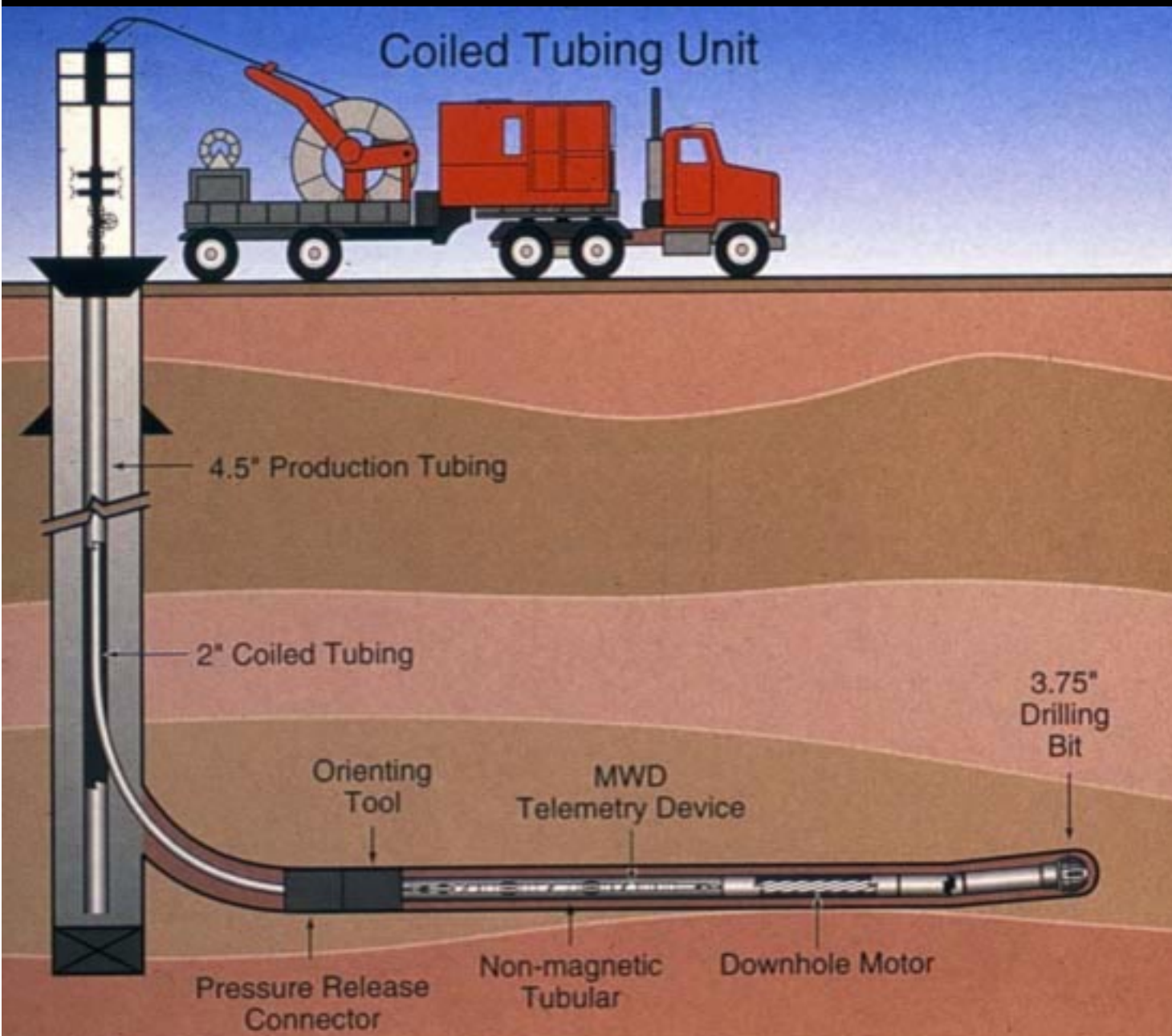
To the 1970's,



To Fully Diapered Rigs,



To
Advanced
Drilling
Systems...



Issues and Answers

	<u>OLD</u>	<u>STANDARD</u>	<u>ADVANCED</u>
<u>PRODUCTION</u>			
Produced water	Surface flowed	Injected	Re-used
Oil spills	Natural	Soil removal	Microbial
H ₂ S	Vented	Vapor & sulfur recovery	
Casinghead gas	Vented	Flared	Re-injected
Migratory birds	None	Nets	Eliminate pits
<u>POST-PRODUCTION</u>			
Plugging	Non, “dump stuff”	Set plugs	Reduce verticals
Salt dissolution	Not a problem	Better design	M.I. test
Site reclamation	None	Moderate	Total

This Was The Old, and it Met the Standards of its Time.....



Modern Production Facilities Meet the Standards of Their Time...

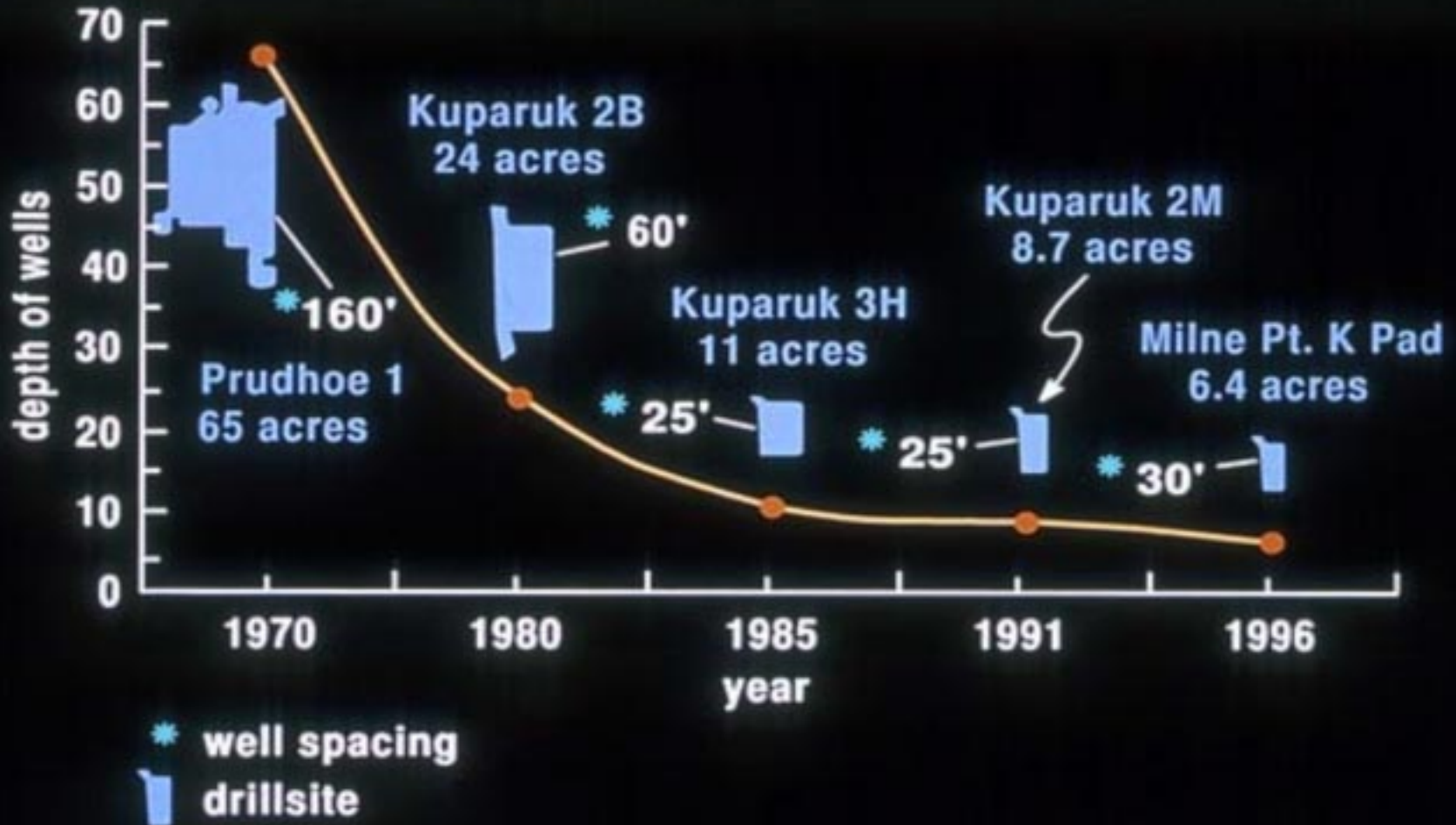


Whether in the Rockies or the Great Plains.....



Or Arctic North Slope

Decreasing Development Footprint Minimizes Environment Impact



from US DOE, 1997

ENERGY PRODUCTION MEETS ENVIRONMENTAL NEEDS



Issues and Answers

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And Nature is a Willing
Helper for Solving
Old Problems



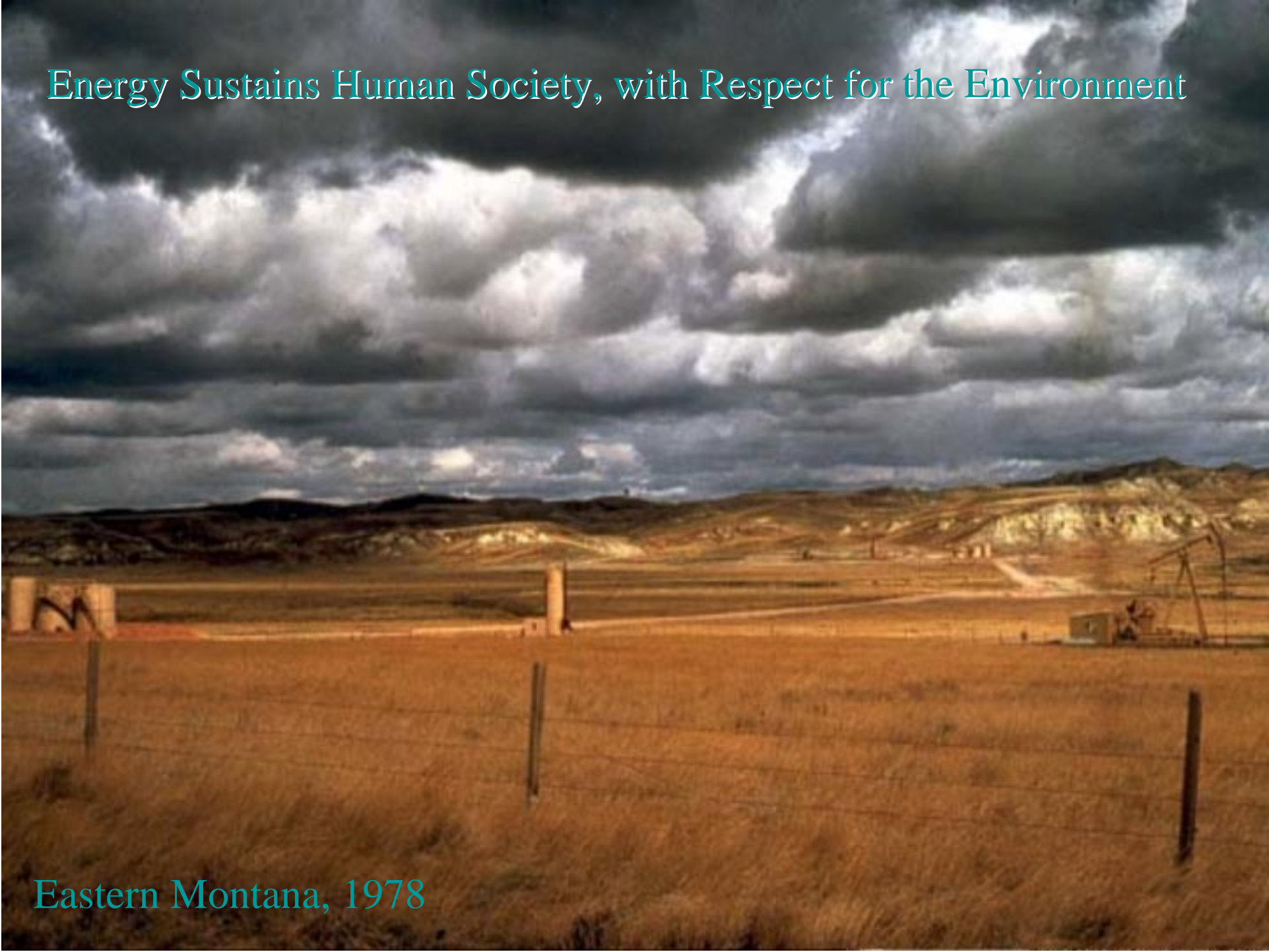
1867

Pioneer &
Funkville, PA

1984



Energy Sustains Human Society, with Respect for the Environment



Eastern Montana, 1978