EPA OIL SHALE RESEARCH/REGULATORY PROGRAM

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INTRODUCTION

The Environmental Protection Agency (EPA) and its predecessor's components have been involved in oil shale regulation and research for about 10 years. During the 1970's, enabling legislation related to environmental concerns - air, water, solid waste, noise, and toxic substances - expanded EPA regulatory jurisdiction and created an increased need for research programs. EPA is often asked the question: "How large an oil shale industry can Colorado, Utah, and Wyoming support?" Is air quality a limiting constraint? Is water quality or water availability? Are socio-economic considerations? Economics? If you think I am going to answer those questions in this paper, I am afraid I will have to disappoint you. Rather, I will describe the EPA regulatory and research activities and the philosophy which bear upon the question. This paper could perhaps be described as: Everything about EPA you never wanted to know but that you are forced to live with!

RESEARCH PROGRAM

EPA's increased emphasis on oil shale research began in the years 1974-75 with three concurrent developments: 1) Organization of the EPA Office of Energy Minerals and Industry (OEMI); 2) Effects of the Arab Oil Embargo and launching of the Federal Prototype Oil Shale Leasing Program; and 3) Implementation of a congressionally-mandated $100 million per year Interagency Energy/Environment Program. OEMI provides a focus for EPA's own Energy/Environment efforts and coordinates a comprehensive, seventeen-agency Energy/Environment program. The latter program's goals include environmental protection during every phase of accelerated development and use of energy supplies with emphasis on domestic resources; and, secondly, development of cost-effective, pollution control technologies.

In 1974, in order to insure internal coordination within EPA on oil shale research activities and needs, an intra-agency Oil Shale Work Group was formed consisting of those R & D staff members of EPA who were working on an oil shale research project. I represent the Regional Office in order to provide researchers with information on development activities, maintain: liaison with developers, determine regional regulatory needs and serve as tour guide on our annual field trips. Tables 1 and 2 show research program areas and composition of the work group. Tables 3 and 4 present a breakdown of FY 77 funding for oil shale programs, showing that EPA is involved in a 3.1 million dollar research program, with about 60 percent directly administered by EPA.

Let us consider some of the results of EPA research programs to date. Our oldest continuous program involves revegetation of processed shale and the evaluation of how the method used to dispose of processed shale affects water quality. Salt movement and leachability of USBM, TOSCO, and Paraho processed shales are being investigated at Anvil Points and a Piceance Creek

Table 1. EPA oil shale research program areas.

- Extraction and handling
- Processing
- Energy-related processes and effects
- Integrated assessment

Table 2. EPA oil shale work group.

OEMI	Washington, D.C.
IERL	Cincinnati, Ohio
EMSL	Las Vegas, Nevada
EMSL	RTP
HERL	RTP
ERL	Duluth, Minn.
ERL	Athens, Georgia
ERL	Ada, Oklahoma
IERL	RTP
ERL	Gulf Breeze
Region VIII	Denver, Colorado

Table 3. FY 77 oil shale funding summary, EPA (in thousands).

Extraction and handling	$250.9
Processing	638.0
Processes and effects	787.2
Integrated assessment	100.0
Total	$1,776.1

site. Table 5 illustrates the type of data which have been and continue to be acquired via this research project. Conclusions and recommendations reached from this program are:

1. North-aspect treatments have a better success rate than south-aspect treatments.
2. In TOSCO shale with 15 cm of soil cover, salts moved back into the leach zone via capillary action. Coarse textured USBM shale and TOSCO shale with 30 cm of soil cover did not experience this resalinization.
3. Surface runoff is greater for fine-textured than coarse-textured shales. Surface runoff from snowmelt was greater than from summer rainstorms. Sediment yield was low.

Table 4. FY 77 oil shale funding summary (in thousands).

	EPA/Interagency
Extraction and handling	$100.0
Processing	0.0
Processes and effects	864.6
Integrated assessment	396.0
Total	$1,360.6

Table 5. EPA revegetation research data availability.

Vegetation type and cover
Profile moisture
Salinity
Surface runoff and sediment yield
Surface temperatures

4. Intensive management, including leaching, nitrogen and phosphorus fertilization, mulching and irrigation, and professional attention, is needed to ensure successful rapid and long-term stabilization of processed shale.

A second study, dealing with extraction and handling, conducted by IERL-Cincinnati, has quantified fugitive dust emissions from mining and handling of oil shale. A report is in publication.

In the processing area, under contract managed by IERL-Cincinnati, TRW and DRI have produced 21 reports on various subjects for EPA publication (table 6). This effort has put the potential environmental impacts of an oil shale industry in perspective, has presented state-of-the-art information on process and pollution control technology; and has compiled data from field source sampling of the Paraho process at Anvil Points. Two separate sampling efforts were conducted.

EMSL-Las Vegas is managing a project aimed at designing and building the best possible ground-water monitoring network. As a first step, a compendium of reports on processes and process effluents has been

Table 6. TRW/DRI reports.

Environmental assessments
Process technology
Control technology
  Air
  Water
  Solid waste
Oil shale trace elements
Oil shale resources

completed. Tables 7 and 8 present examples of the type of data accumulated. A second document addresses factors to be considered in the design of a ground-water monitoring network, including the type of information presented in table 9. Efforts to date have been completed in the Uintah Basin and will soon begin in the northern portion of the Piceance Basin.

The ERL-Athens oil shale effort is aimed at a characterization of retort effluent waters. Organic and inorganic compositions of potential water discharges have been characterized. Tables 10 and 11 present examples of the type of data collected under this program for selected elements, semivolatile and volatile organics in retort waters. Leachate from raw discarded oil shale has been analyzed.

The ERL-Duluth program is providing baseline information on the aquatic environment existing prior to oil shale development and is also performing bioassays on retort process waters from the Paraho operation at Anvil Points. ERL-Gulf Breeze is studying constituents of petroleum hydrocarbons that may accumulate in the marine food chain and eventually be consumed by man. The HERL-RTP oil shale research program consists of a multitude of effects studies. Carcinogenic, mutagenic, and teratogenic studies of shale oil-derived products, by-products and wastes are being performed in both in-vivo and in-vitro laboratory experiments. Air and Water Quality assurance programs are funded and managed by EMSL-RTP. Finally, oil shale development is one of the resources subject to a Technology Assessment, Western Energy

Table 7. Analytical results from two samples in situ retort water.

Parameter	Concentration (ppm) Sample 1	Sample 2
COD	20,000	12,500
BOD	5,500	250
NH_3-N	4,790	-
Organic-N (dissolved)	1,510	-
Phosphorous	0.26	19.0
NO_3-N	38	-
TOC	3,182	19,000
Chloride		1,560
Iodide	0.003	1.3
Bromide	0.46	0.01
Sulfate (S)	59	930
Phenols	169	2.2
CaCO	16,000	4,200
Sulfide (S)	16.1	15.4
K	3.5	-
Na	312	-
Mg	48.4	16.4
Ca	14.9	4.63
Fe	3.3	3.75
Zm	1.6	2.8
Cu	5.6	0.94
Silica (Si)	-	78.3

Table 8. Total soluble materials in retort water.

INORGANICS 67-75 (% WT)	CATIONS 15-25 (% WT)	Na^+ 1000 PPM Mg^+ 100 PPM K^+ 50 PPM Ca^+ 10 PPM NH_4^+ 8000 PPM
	ANIONS 40-55 (% WT)	HCO_3^- 20,000 PPM $CO_3^=$ 5,000 PPM Cl^- 4,000 PPM $SO_4^=$ 1,000 PPM NO_4^- — $S^=$ — F^- —
	TRACE METALS	Pb, Zn, Cu, U. Cr, Fe, Mo, As, ETC.
ORGANICS 25-33 (% WT)	ACIDIC ORGANICS 10-15 (% WT)	SHORT-CHAIN CARBOXYLIC ACIDS $C_1 - C_{11}$ LONG-CHAIN CARBOXYLIC ACIDS $C_{16} - C_{24}$ PHENOLS
	NEUTRAL ORGANICS 3 - 5 (% WT)	SUBSTITUTED BENZENES N-ALKANES
	BASIC ORGANICS 7-10 (% WT)	NITROGEN BASE ORGANICS (QUINOLINE, PYRIDINES, MALEMIDES, SUCCINIMIDES, ETC.) ORGANIC-SULFUR COMPOUNDS (THIOPHENES, SULFIDES, DISULFIDES, ETC.)

Table 9. Ground water monitoring network.

Potential pollutants
Hydrogeologic framework
Ground water use
Existing ground water quality
Infiltration potential
Mobility and attenuation in the saturated and unsaturated zone
Prioritization of pollutants and sources

Table 10. Inorganic elements, oil shale retort waters (ppm).

	In Situ Retort Water	Raw Shale Leachate
Antimony	0.24±0.16	1±0
Arsenic	0.025±0.005	15±2
Barium	0.009±0.001	180±10
Beryllium	0.001±	0.3±0
Boron	1.5±0.5	53±18
Cadmium	0.001	0.8±0.1
Chromium	0.001±0.001	125±35
Copper	0.045±0.025	48±14
Fluorine	8±2	Major
Lead	0.035±0.005	19±16
Mercury	0.0009	-
Molybdenum	0.3±0	6±3
Nickel	-	15±0
Selenium	0.003±0	1±0
Vanadium	0.015±0.005	135±45
Zinc	0.02	35±32

Table 11. Volatile organic components, oil shale retort waters (ppb).

	In Situ Retort #1	In Situ Retort #2
Benzene	14.5±7	133.9±3
Toluene	300±100	6.7±1.1
O-Xylene	7±1	5.6±2.8
Phenol	2±0.5	-
Ethyl-benzene	11±2	2.1±0.1
Naphthalene	75±32	29±18

Resource Development, sponsored by OEMI. Environmental residuals; effects; technical, political, and legal constraints are all being considered in the development of policy alternatives.

The Interagency Pass-Through Program and projects managed by Region VIII are also providing information needed to assess potential impacts of development of oil shale. EPA's research and development labs manage specific pass-through projects. Region VIII's researchers are performing:

1. Upper air meteorological data collection at C-b and UaUb.
2. Ambient air quality data collection at Rangely, Rifle, Meeker, and Grand Junction.
3. An assessment of how representative the upper air data collected on the Federal lease tracts are.
4. An assessment of potential air emissions from surface retorts.

Region VIII also coordinates surface and ground-water quality data collection programs being performed in the oil shale area by the USGS, using EPA pass-through funds. Table 12 provides a summary of the entire EPA oil shale research program.

Future EPA research activities include continuation of most current programs with new starts in the areas of: 1) demonstration of air and water pollution control technology; 2) correlation between mineralogy and predicted ground water quality; 3) environmental residuals from shale oil product utilization; 4) air quality modeling of an oil shale industry; and 5) visibility measurements if appropriate details can be worked out with potential oil shale developers.

REGULATORY ACTIVITIES

The comprehensive research program provides a data base on which EPA can rely when fulfilling its regulatory responsibilities. EPA is responsible for various regulatory activities that affect construction and operation of oil shale facilities. These regulatory activities serve to protect the environment while allowing development and reasonable growth of an oil shale industry. Enabling legislation and implementing regulations in the form of the Clean Air Act Amendments of 1977 (P.L. 95-95); the Clean Water Act Amendments of 1977 (P.L. 95-217); the Safe Drinking Water Act of 1974 (P.L. 93-523); the Resource Conservation and Recovery Act of 1976 (P.L. 94-580); the Toxic Substances Control Act of

Table 12. Current program status summary.

Title	Sponsor	Performing Organization	Duration
EXTRACTION AND HANDLING			
Technologies for Controlling Adverse Effects of Mining on Forest, Range, and Related Freshwater Ecosystems	EPA Pass-through to USDA	USDA	4 years
Water Quality Hydrology Affected by Oil Shale Development	IERL-CIN	Colorado State University	12 months
Fugitive Dust from Oil Shale Extract	IERL-CIN	TRW	12 Months
Vegetative Stabilization of (TOSCO and USBM) Spent Oil Shale	IERL-CIN	Colorado State University	12 months
Vegetative Stabilization of Paraho Spent Oil Shale	IERL-CIN	Colorado State University	12 months
PROCESSING			
Environmental Impact of Oil Shale Development	IERL-CIN	TRW/DRI	24 months
Sampling and Analysis of the Paraho Surface Retort	IERL-CIN	TRW/DRI	1976-continuing
Program Support in Environmental Assessment and Control Technology Development for Advanced Fossil Fuels	OEMI	Cameron Engineers	2 years
ENERGY-RELATED PROCESSES AND EFFECTS-Ecological Effects			
Toxic Effects on the Aquatic Biota from Coal and Oil Shale Development	ERL-Duluth	ERL-Duluth	3 years
ENERGY-RELATED PROCESSES AND EFFECTS - Environmental Transport Studies			
The Mineralogy of Overburden as Related to Groundwater Chemical Changes in Strip Mining of Coal, In Situ Coal Gasification, and Oil Shale Development	Kerr-ERL	Kerr-ERL	4 years
ENERGY-RELATED PROCESSES AND EFFECTS - Measurement and Monitoring			
Oil Shale Area Meteorological Data Analysis	Region VIII	CUM Limnetics	
Air Quality and Surface Wind Monitoring in Colorado	Region VIII	Colorado Department of Health	2 years
Upper Air Meteorological Data Collection	Region VIII	Aeromet	5 years
Monitoring the Impact of Western Coal Strip Mining and Oil Shale Extraction on Groundwater Quality	EMSL-LV	General Electric	5 years
Energy-Related Water Monitoring Data Integration	EMSL-LV	EMSL-LV	5 years
Water Quality and Geochemistry of Shallow Aquifers of Piceance Creek, Colorado	EPA pass-through to USGS	USGS	5 years
Water Quality Monitoring on White River, Parachute Creek and Logan Wash in Oil Shale Areas in Western Colorado	EPA pass-through to USGS	USGS	5 years
Collection of Geochemical Data in the Piceance Creek Structural Basin of Colorado	EPA pass-through to USGS	USGS	2 years
Potentiometric Surface of Shallow Aquifers in Piceance Creek Structural Basin	EPA pass-through to USGS	USGS	3 years

Title	Sponsor	Performing Organization	Duration
Instrumentation and Methods for Characterizing Aqueous Effluents from Oil Shale	EPA pass-through to DOE	Oak Ridge National Laboratory	1976-continuing
Identification of Components of Energy-Related Wastes and Effluents	ERL-Athens	Gulf South Research Institute	3 years
Quality Assurance and Instrumentation in Air and	EPA pass-through to NBS	NBS	4 years
Energy-Related Western/Southwestern Regional Air Monitoring	EMSL-LV	EMSL-LV	5 years
Quality Assurance Program	EMSL-RTP	EMSL-RTP	5 years
Energy-Related Processes and Effects - Health Effects			
Establishment of a Chemical Repository for Alternate Energy Source Material for Toxicity Testing	EPA pass-through to DOE	Oak Ridge National Laboratory	3 years
Air, Water, and Multi-Route and Health Effects from Pollutants Associated with Energy Development	HERL-RTP	HERL-RTP	12 months
Air, Water, and Multi-Route Exposures and Their Effects: Pollutants Associated with Energy Development	ERL-Gulf Breeze	ERL-Gulf Breeze	12 months
Effect of Alternate Energy Source Material on Whole Animal Carcinogenesis by Percutaneous Application of Extracts and Fractions to Mice	EPA pass-through to DOE	Oak Ridge National Laboratory	2 years
Morphological Variants in Damaged Sperm	EPA pass-through to DOE	Lawrence Livermore Laboratory	5 years
Detection of Early Changes in Lung Cell Cytology by Flow Systems Analysis Techniques	EPA pass-through to DOE	Los Alamos Scientific Laboratory	1976-continuing
Mortality, Morbidity, and Industrial Hygiene Study of Oil Shale Workers	NIOSH	NIOSH	2 years
Determination of the Influence of Mineral Cofactors in Conjunction with Carcinogens from Energy-Related Materials	HERL-RTP	Northrop Services	32 months
In Vivo Screening for Gene Mutation in Mouse Germ and Somatic Cells	EPA pass-through to DOE	Oak Ridge National Laboratory	1976-continuing
Determination of the Effects of Material from Alternate Energy Sources on Upper Respiratory Tract Clearance Mechanisms	HERL-RTP	Ball State University	42 months
Quantitative Mutagenesis Testing in Mammalian Cellular Systems	EPA pass-through to DOE	Lawrence Livermore Laboratory	5 years
Development of Cytochemical Markers for Cell Transformation and Carcinogenesis	EPA pass-through to DOE	Lawrence Livermore Laboratory	5 years
Somatic Cell Genetics	EPA pass-through to DOE	Los Alamos Scientific Laboratory	2 years
Analysis of the Effects of Energy-Related Materials to Karotype Stability in Mammalian Cells	EPA pass-through to DOE	Los Alamos Scientific Laboratory	1976-continuing

Title	Sponsor	Performing Organization	Duration
Effects of Agents Associated with Coal and Oil Shale Extraction, Conversion, or Utilization on Cell-Cycle Kinetics and on Chromatin/Chromosome Structure	EPA pass-through to DOE	Los Alamos Scientific Laboratory	1976-continuing
Development of Permanent Epithelial Cell Lines	EPA pass-through to DOE	Oak Ridge National Laboratory	1976-continuing
Development of An In Vitro Assay for Co-carcinogenesis of Coal/Oil Shale Derivatives	EPA pass-through to DOE	UCLA School of Medicine	1976-continuing
Integrated Assessment			
Integrated Assessment: Socio-Economic Consequences of Coal and Oil Shale Development	EPA pass-through to USDA	USDA	39 months
Technology Assessment of Western Energy Resource Development	OEMI	University of Oklahoma	1975-1978

1976 (P.L. 94-469); and, to a lesser extent, the Noise Control Act of 1972 (P.L. 92-574) and the Federal Insecticide, Fungicide, and Rodenticide Act of 1975 (P.L. 94-140) establish the regulatory framework through which EPA operates (table 13). Of course, the National Environmental Policy Act of 1969 (P.L. 91-190) is also a significant piece of environmental legislation. Since other entities, such as the respective state agencies and the area oil shale office also have regulatory jurisdiction in similar media, EPA-Region VIII has established a close working relationship with these organizations.

Under the Clean Air Act, oil shale developers must 1) employ best available control technology (BACT); 2) insure that national ambient air quality standards (NAAQS) are not violated; 3) not cause prevention of significant deterioration (PSD) ambient air quality increments to be violated; 4) not significantly degrade visibility in Class I areas; and 5) obtain one year of baseline data before applying for a PSD permit to construct and operate. Region VIII has issued PSD permits for two developers and has received applications/requests for applicability determinations from three other developers. BACT was defined in the form of allowable emissions limits for sulfur dioxide and particulate matter for the two permitted facilities. Effective March 1, 1978, BACT limits for nitrogen oxides, carbon monoxide and hydrocarbons must also be specified in all permits. Tables 14 and 15 present the emission limits for C-a and C-b. Source monitoring, ambient monitoring, record keeping and reporting requirements are also part of the PSD permit.

The Clean Water Act contains requirements in sections 301 and 404 for potential permits for an oil shale developer. A national pollutant discharge elimination system (NPDES) permit must be obtained under requirements of section 402 if water is discharged to a navigable stream. Effluent limitations have been defined in general terms as shown in table 16. Specific effluent guidelines have not been promulgated for oil shale facilities. Table 17 gives NPDES limits on C-a's drilling and pump test activities. A Section 404 permit must be issued by the Army Corps of Engineers and concurred with by EPA if any dredge and fill operations take place in a navigable stream.

Underground injection control (UIC) regulations to be promulgated under the Safe Drinking Water Act govern the injection or reinjection of any fluids. Permits will probably be required for in-situ operations and for mine dewatering reinjection. The state of Colorado requires

Table 13. EPA regulatory activities.

Clean Air Act Amendments of 1977	PL 95-95
Clean Water Act Amendments of 1977	PL 95-217
Safe Drinking Water Act of 1974	PL 93-523
Resource Conservation and Recovery Act of 1976	PL 94-580
Toxic Substances Control Act of 1976	PL 94-469
Noise Control Act of 1972	PL 92-574
Federal Insecticide, Fungicide, and Rodenticide Act of 1975	PL 94-140

Table 14. C-a PSD permit limits.

	Pounds per hour	
	Particulate	SO_2
Thermal Oxidizer/scrubber*	11.0	167.1
Steam boiler	0.7	16.6
Mine vent	1.6	
Vehicular movement	5.4	
ROM handling	9.1	

*Requirement of 90.0% overall gaseous sulfur recovery and no greater than 250 ppm SO_2 on an average daily basis.

reinjection permits under existing regulations. Monitoring and mitigation measures to prevent endangering of ground-water systems will be required under these UIC regulations.

The resource conservation and recovery act (RCRA) will govern the disposal of solid wastes generated by an oil shale facility. Included in this category will probably be processed shale, spent catalysts, process sludge, and sewage wastes. Criteria for the identification of hazardous wastes are to be promulgated by EPA within the next two months. Performance standards defining safe disposal practices for hazardous wastes will also be promulgated. Processed shale is the subject of a special mining waste study that will be completed this year. Regulations will be promulgated six months after its completion. Permits requiring safe disposal

Table 15. C-b PSD permit limits.

	Pounds per hour	
	Particulate	SO_2
Mine vent	16.0	7.0
In-situ gas*	7.4	17.4
Steam boiler	16.3	3.6
Mine Shaft Transfer	1.7	
Shale Conveyor	7.7	
ROM ore handling	29.2	

* Requirement of 99.0% overall gaseous sulfur recovery and no greater than 15 ppm H_2S on an average daily basis.

Table 16. Effluent limitations.

July 1, 1977	Best Practicable Technology
July 1, 1984	Best Available Technology for toxic pollutants
	Best Conventional Technology for pollutants such as BOD, TSS, pH, fecal coliform, and thermal
Three years after promulgation of specific effluent limitation but not later than July 1, 1987	Best Available Technology for all other identified pollutants

of hazardous wastes will have to be obtained from EPA or a state by an oil shale developer.

Testing of effects, record keeping, reporting, and conditions for the manufacture and handling of toxic substances will be defined for oil shale developers under the provisions of the Toxic Substances Control Act of 1976. An inventory of all

Table 17. C-a NPDES limits.

TSS[1]	30 MG/L	30 DAY AVERAGE
	45 MG/L	7 DAY AVERAGE
TDS[1]	3000 MG/L	DAILY MAXIMUM
F[2]	3.0 MG/L	DAILY MAXIMUM
B[2]	5.0 MG/L	DAILY MAXIMUM
PH[1]	BETWEEN 6.0 AND 9.0	
OIL AND GREASE[1]	10 MG/L, NO VISUAL SHEEN	

(1) DAILY MONITORING
(2) WEEKLY MONITORING

commercially-produced chemical compounds is now being compiled. Manufacturers of new chemical substances must notify EPA 90 days before their manufacture and must also describe the proposed use, the amount produced, any by-products, disposal practices, and any test data related to potential health and environmental effects caused by the chemical's use. The manufacturer may be required by EPA to perform testing of a chemical's effects, such as epidemiological, carcinogenic, mutagenic, environmental, etc. EPA control of a chemical's use may take one of three forms: manufacture with no restrictions; a ban; manufacture with conditions placed on the handling and use of the chemical. EPA has promulgated regulations regarding one substance-PCB's. Production of PCB's is prohibited after January 1979.

The final piece of environmental legislation that the EPA administers is NEPA. EPA reviews environmental impact statements (EIS) and, in limited cases, writes EIS's when a project involves a major federal action. EPA's role as a reviewer is to comment on the environmental aspects of the project.

CONCLUSION

Some oil shale developers have tended to become frustrated by the lack of definition of clear, concise environmental requirements which they must meet. This situation has arisen in part because of relatively recent environmental legislation passed by Congress and because of the cyclic "go-no go" posture of the oil shale industry. In order to provide regulatory guidance to the industry, EPA is working on a position paper that will provide guidance on long-term requirements for the industry. This document should be completed by late 1978 or early 1979.

Because of the nation's need for domestic petroleum sources and because of the need for environmental and technology answers regarding oil shale development, EPA supports a limited development of oil shale. Judgments may then be made as to the size oil shale industry that may be developed. Regarding prototype development, EPA's philosophy is do it but do it environmentally right.