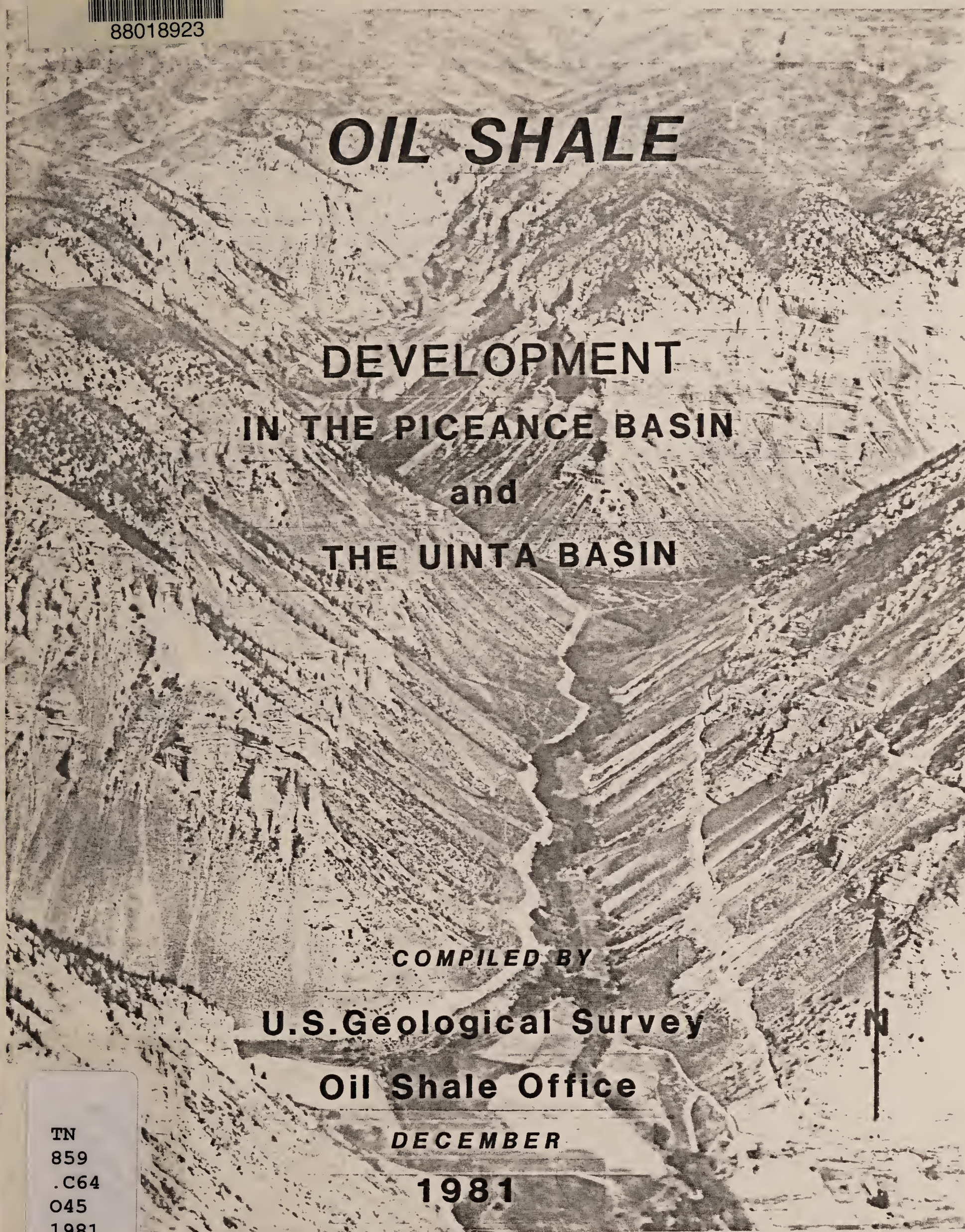
LV. Branch

OIL SHALE

DEVELOPMENT
IN THE PICEANCE BASIN
and
THE UINTA BASIN



COMPILED BY

U.S.Geological Survey

Oil Shale Office

DECEMBER

1981

PREFACE

This compilation of Western oil shale projects was prepared by the USGS-DCM-Oil Shale Office in the interest of public information. Values and statements were obtained from various journals, newsletters, company publications, and federal reports. Due to the rapidly changing status of each project, data presented may not be totally current or accurate, nor does it necessarily represent the opinion of the USGS-DCM for Oil Shale. If you have more current or conflicting information, please contact this office:

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The DCM-Oil Shale wishes to acknowledge the assistance of the companies listed in this document in providing and verifying data. Other excellent sources of information on oil shale projects include:

Cameron Synthetic Fuels Quarterly Report, 1968 forward, the Pace Company Consultants & Engineers, Inc., Cherry Creek Plaza II, 650 S. Cherry Street, Suite 400, Denver, CO 80222. (303) 321-3919.

Oil Shale Projects, 1980 forward, U.S. DOE, Office of Shale Resource Applications, 12th & Pennsylvania N.W., Washington, DC 20461. (202) 633-8660.

Shale Oil Status Report, 1981, Rocky Mountain Oil & Gas Association, Committee on Oil Shale, 465 Petroleum Bldg., Denver, CO 80202. (303) 534-8261.

Eric G. Hoffman
Environmental Scientist-Geology

FEDERAL OIL SHALE PROG.

The Federal Prototype
Oil Shale Program

The Prototype Oil Shale Leasing Program was announced by the Secretary of Interior in June 1971. The program is designed to test the technical, economic, and environmental feasibility of shale oil production on a commercial level based on the vast hydrocarbon resources of Green River formation underlying public lands in Colorado, Utah, and Wyoming. Upon completion of a programmatic Environmental Impact Statement, six tracts of 5,120 acres each were offered by the Bureau of Land Management for development under competitive lease terms. Four tracts were leased in 1974, two each in Colorado and Utah. The two tracts in Wyoming received no bids. It then became the responsibility of the U.S. Geological Survey's, Conservation Division, and more specifically the Oil Shale Office to administer the complex lease terms; to establish a cooperative interchange of plans and ideas between industry, government, and the public; to seek ways to minimize possible development effects; and to compile comprehensive environmental, economic, and operations data gathered primarily by the lessees of each tract to aid the Department of the Interior in developing future oil-shale-leasing policy.

The Oil Shale Office is organized on a team or project management basis. Overall management is by a management by objectives system. Staffing was determined by the various disciplines needed to carry out the duties mandated by lease terms and to advance the state of the art in overall oil shale technology. Generally there is only one of each discipline at the GS-13 grade level with full responsibility and authority for activities within a discipline area.

Principle duties of the Oil Shale Office include:

- Development Plan approval - a continuous process since oil shale plans change frequently and become more detailed. A rapid procedure for handling plans and revisions has been developed utilizing Oil Shale Office participation with the lessee in plan drafting and internal critical path scheduling. The Oil Shale Environmental Advisory Panel plays a very important role in achieving a quality and rapid approval procedure.

- A continuing regulation and inspection program which stresses consultation and coordination with the lessees, BLM, and all the other Federal, state and local regulatory bodies.

- A continuing program of coordination and cooperation with the many researchers in oil shale to input our needs, direct research to real problems and obtain prompt research results. This effort is accomplished primarily through individual contacts and participation on research teams or advisory groups.

- A continuing effort to reduce and provide data to interested parties by means of summary reports, hard copy printouts and most recently computer tapes.

- A continuing program to refine the design of both environmental and operational monitoring programs so that they are relevant to actual operations, cost effective, and are of sound statistical design.

- A very recent cooperative effort with private developers to coordinate data collection and formats in order to provide an improved regional picture.

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Organization Chart of the Oil Shale Office
(September 1981)

STATUS OF OIL SHALE PROJECTS

WESTERN OIL SHALE PROJECTS AND THEIR STATUS

Introduction

There are presently 15 active oil shale project sites in the tri-corner area of Colorado, Utah, and Wyoming where planning or construction of commercial facilities for extraction of oil, gas, and associated minerals from shales of the Green River Formation is under way. The following table summarizes the current status of each project. Fold out map at back of this booklet shows the geographic location of each project and the approximate route of your tour of oil shale country.

Resource

Green River Formation oil shale (Colorado, Utah, Wyoming) is technically described as a stratified fine-grained sedimentary marlstone composed primarily of dolomite ($CaMg[CO_3]_2$), calcite ($CaCO_3$), clay minerals, feldspar (Na or K, $AlSi_xO_x$), and quartz containing syngenetic kerogen, as solid organic material which yields shale oil, light hydrocarbon gases, and a carbon residue when heated to 900°F (500°C) in a closed vessel or chamber (retort).

Western oil shales were deposited in ancient lakes that inundated the tri-corner region during Eocene times some 50 to 60 million years ago. Today oil shales of the Green River Formation underlie some 17,000 square miles and contain better than 1.8 trillion equivalent barrels of oil. This vast resource is more than 50 times greater than known domestic crude oil reserves and nearly a third more than total world estimated crude oil reserves. Colorado's Piceance Creek Basin alone contains 85 percent of the western high-grade (>25 gallons/ton) oil shale which is equivalent to 10 times more oil than consumed nationally to date, or enough to last the U.S. for nearly 100 years at the 1974 Btu consumption rate.

Associated with Green River Formation shales are vast quantities of valuable sodium-carbonate minerals including: 64 billion tons of trona (Na_2CO_3), a source of soda ash in Wyoming shales; 29 billion tons of nacholite ($NaHCO_3$), a potential source of dry industrial stack gas sulfur scrubbing agent in the Piceance Basin shales; and 19 billion tons of dawsonite ($NaAlCOH_3CO_2$), a potential source of alumina also associated with Piceance Basin shales.

Western oil shale resources outside the tri-state area include the Tyler and Heath shale formations in central Montana and the Elko Formation SW of Elko, Nevada. Montana shales range as high as 19.6 gpt with an average retort yield of 10 gpt and, according to USGS, contain as much as 16 lb/st of vanadium oxide, 2 lb/st nickle, 13 lb/st zinc, 1.8 lb/st molybdenum, and 0.25 lb/st selenium. The siliceous oil shales near Elko vary greatly in grade over short vertical intervals. At present, in place and recoverable shale oil resources in the Montana and Nevada are poorly defined. Core drilling, partly funded by the USGS, will be carried out in both states during 1982.

Typical specification of
Crude and upgraded shale oil

		Typical Crude Shale Oil before treatment	Fully Upgraded Shale Oil, "Syncrude"
Ash,	ppm	300-3,000	NIL
Arsenic,	ppm	50	<1
Nitrogen,	ppm	18,000	250
Sulphur,	ppm	9,000	20
Gravity,	°API	22	37
Pour point,	°F	+60	20
Viscosity, cp at 100°F		25	5

Ownership

Nearly 72 percent of the land overlying 80 percent of the oil shale resource in Colorado, Utah, and Wyoming is in the public domain and is administered by the U.S. Department of the Interior. Remaining lands underlain by Green River Formation oil shales are either privately held (approximately 15 percent) largely as patented claims under the 1920 Mining Law, or are governed by the State as lands acquired under their statehood enabling acts. The following table presents a summary of the extent, Federal management, and oil shale resources of the tri-state area.

Project Status

Each of the 15 projects are further described on the following pages including developer, resource, mining and retorting methods, employment projections, and status. Project summaries are based on published information, open files at the office of the USGS DCM-Oil Shale, and verbal communication with the developers. Due to rapid and frequent changes in engineering design of each project, information contained in the summaries may not be totally accurate. If you know of any new or contrary data on any of the western oil shale projects, please contact the USGS, DCM-Oil Shale at (303) 245-6700 or FTS: 322-0281.

Status of Western Oil Shale Projects and Research Sites as of December 1981
(Based on published articles)

Project	Technology (MIS=Modified In Situ) (AGR=Above Ground Retort)	Status	Estimated Production (bbls/day)	Mining Zone	Water Use	Projected Peak Employment (C=Construction) (O=Operation)
Colorado Projects						
Cathedral Bluffs (Tract C-b)	Multiple level underground room & pillar mining for MIS development feeding Union B rock pump AGRs	After equipping commercial mine shafts, construction of mine support facilities will be delayed to evaluate engineering alternatives	117,000 by mid 1990's	Mahogany to top of L-5	9,900 AF/Y	C = 5,200 O = 4,400
Chevron Clear Creek	Underground room & pillar and open pit mine feeding Staged Turbulent Bed AGRs	Permit acquisition and plan review thru Colo Jt Review Prcs	100,000 by 1992	UG Mahogany Z Rf thru R-7	200-500 cfs	C = 9,700 O = 3,000
Colony	Underground room & pillar mine feeding TOSCO II rotating kiln hot ball AGRs	Completing mine bench, plant site, and worker housing	48,300 by 1985	Mahogany Zone	9,000 AF/Y	C = 3,250 O = 2,052
Equity	In situ superheated steam injection for kerogen recovery from Leached Zone	Completing initial two year field injection test	1,000 no commercial plans	Leached Zone	2,000 BPD fm leached zone	No data
Mobil	Underground room & pillar mine feeding yet-to-be-selected AGRs	Planning and environmental monitoring	50,000-100,000 by mid- to late 1990's	Mahogany Zone	No data	C = 2,200 O = 919
Multi Mineral	Rubblization stoping with undergrond nahcolite recovery and crushing with stope back stowage & MIS retorting followed by dawsonite leaching (Integrated MIS)	Submitted mine plan to USGS for sodium lease, experimental mine stoping at USBM Horse Draw site; completing 50-ton test retort at G.Jct lab	50,000 by 1988 (9,000 TPD nahcolite & 900 TPD dawsonite	Saline Zone	No data	C = 400 O = 200
Naval Oil Shale Reserve #1	Probably underground room & pillar feeding yet to be selected AGRs, if commercialized	Preparing EIS, community plan, and master development plan	50,000 to 200,000	Mahogany Zone	No data	No data
Occidental Logan Wash	Multiple level underground mining for MIS preparation	Rubblized near-commercial-scale retorts 7 & 8 to be ignited Dec. '81	Non-commercial	Mahogany thru R-6	No data	O = 450
Paraho Anvil Points	Underground room & pillar mine feeding experimental vertical shaft AGR	Completed test runs at Anvil Points that have produced more than 100,000 bbls	Non-commercial	Mahogany Zone	1/2 bbl water/bbl shale oil	O = 30 to 128
Rio Blanco (Tract C-a)	Developing MIS technology thru surface drilled blastholes. Desire to use traveling open pit mine feeding Lurgi AGRs	Completed test MIS retort #1 burn. Awaiting off-site legislation. Preparing commercializat'n plans. Testing Lurgi pilot plant.	100,000-300,000 by mid- to late 1990's	L-8 to L-00	14,000 AF/Y	O = 2,500
Superior	Retreating underground room & pillar mine feeding multi-product recovery Superior circular gate AGRs	Appealing land exchange decision	11,586 late 1980's (4,878 TPD nahcolite & 580 TPD alumina)	Lower Saline Zone	100 AF/Y	C = 1,300 O = 920
Superior Pacific	Underground room & pillar mine feeding Superior circular gate AGRs	Phase I engineering & permit acquisition	50,000 by 1989	Mahogany Zone	No data	C = 2,800 O = 1,400
Utah Projects						
Geokinetics	Shallow-burned true in situ	Burning commercial scale test retorts & securing permits for commercial operation	2,000 by 1982	Shallow Mahogany Zone	None required	O = 150
Paraho-Ute	Underground room & pillar mine feeding Paraho vertical kiln AGRs	Completing feasibility, design, and engineering study	38,250 by 1986	Mahogany Zone	2,247 gpm	C = 1,500 O = 1,300
White River (Tracts U-a & U-b)	Underground room & pillar mine feeding Superior, Tosco, & Union B AGRs	Completing development plan approval, commercial design,	113,950 by mid- to late 1990's	Mahogany Zone	22,600 AF/Y	C = 5,083 O = 3,353

	Area of Commercial Potential (acres)	Percent Federally Adminstrd (%)	Pre-1920 Oil Shale Claims	Reserves in Known Deposits: gallons/ton	Reserves in Known Deposits: Reserves (billions of bbls)	Remarks
Piceance Creek Basin, Colorado	1,800,000	79	9,000	25-65	450-500	Total recoverable: 118 billion bbls
				10-25	800	Recoverable resource largely within Parachute Creek Member of CR Fm., averaging 500' thick at basin margins to 2000' thick at depositional center. Richest shales are contained in Mahogany Zone (MZ) which averages 100' to 200' in thickness from basin margins inward. Combined MZ and Lower Zone shales averaging >25 gallons/ton (gpt) contain 2.3 million bbl's per acre.
				5-10	200	
				Total	1,500	
Uinta Basin, Utah	4,900,000	77	15,000	25-65	90	Total recoverable: 17 billion bbls
				10-25	230	Recoverable resource largely within 100' thick Mahogany Zone within 750' thick Parachute Creek Member of GR Fm. MZ shales averaging >25 gpt are approximately 90' thick and yield 162,000 bbl's per acre.
				5-10	1,500	
				Total	1,820	
Wyoming basins, principally the Green River Basin	4,300,000	62	12,000	25-65	30	Total recoverable: 4 billion bbls
				10-25	400	Recoverable resource largely within Tipton, Wilkins Peak, and Loney Member shales of GR Fm., averaging 150' to 500' thick. Where present, Tipton shales >15 gpt contain 35,000 bbl's per acre; Wilkins Peak shales >15 gpt contain 45,000 bbl's per acre; and Loney shales >20 gpt contain 130,000 bbl's per acre.
				5-10	300	
				Total:	730*	*DOE reports total resource in Green River Basin of 244 billion bbl.

OIL SHALE vs. PETROLEUM

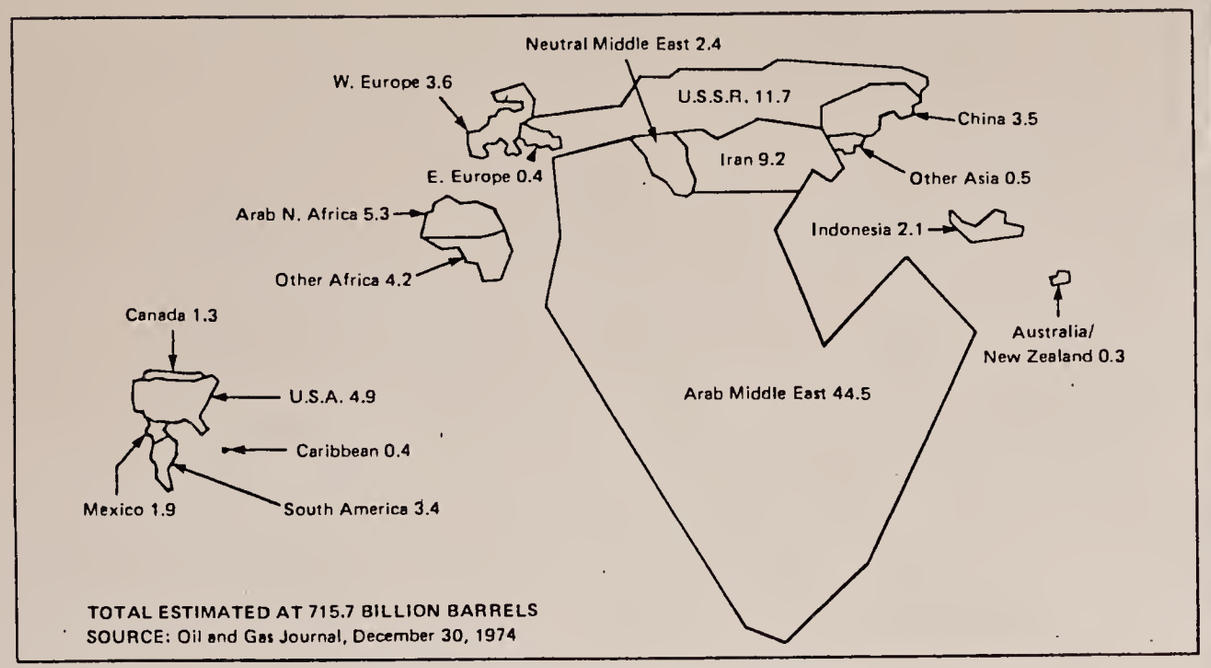


Figure 1—World Recoverable Crude Oil

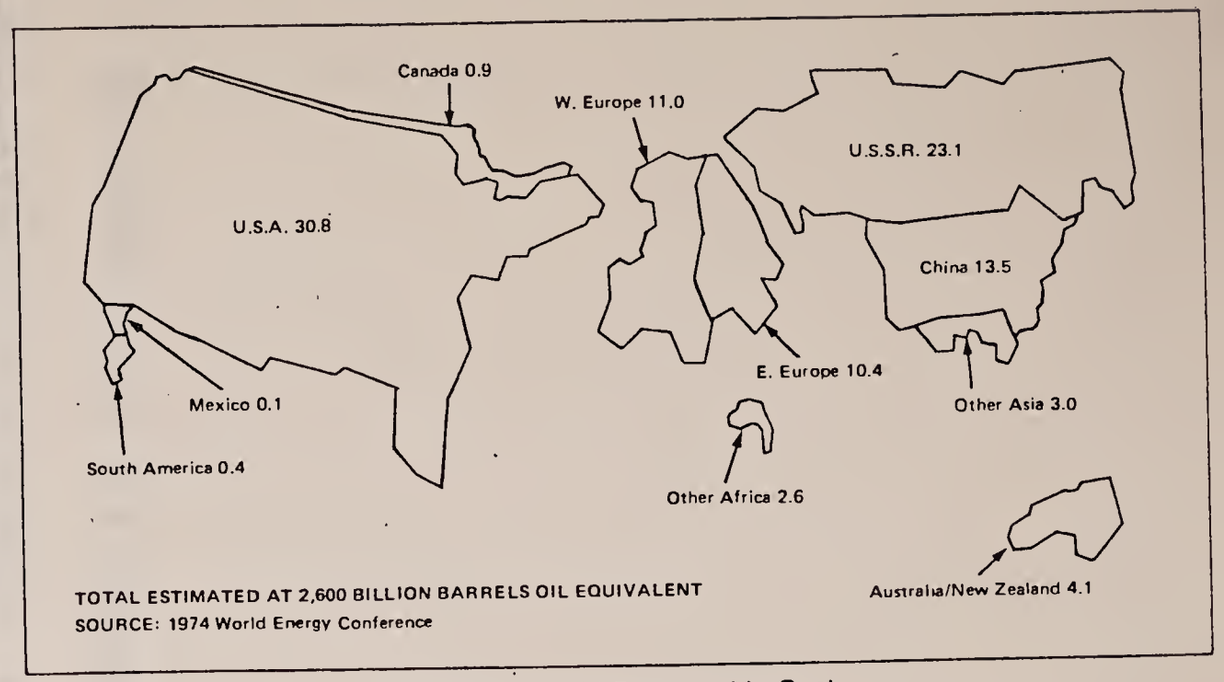


Figure 2—World Recoverable Coal

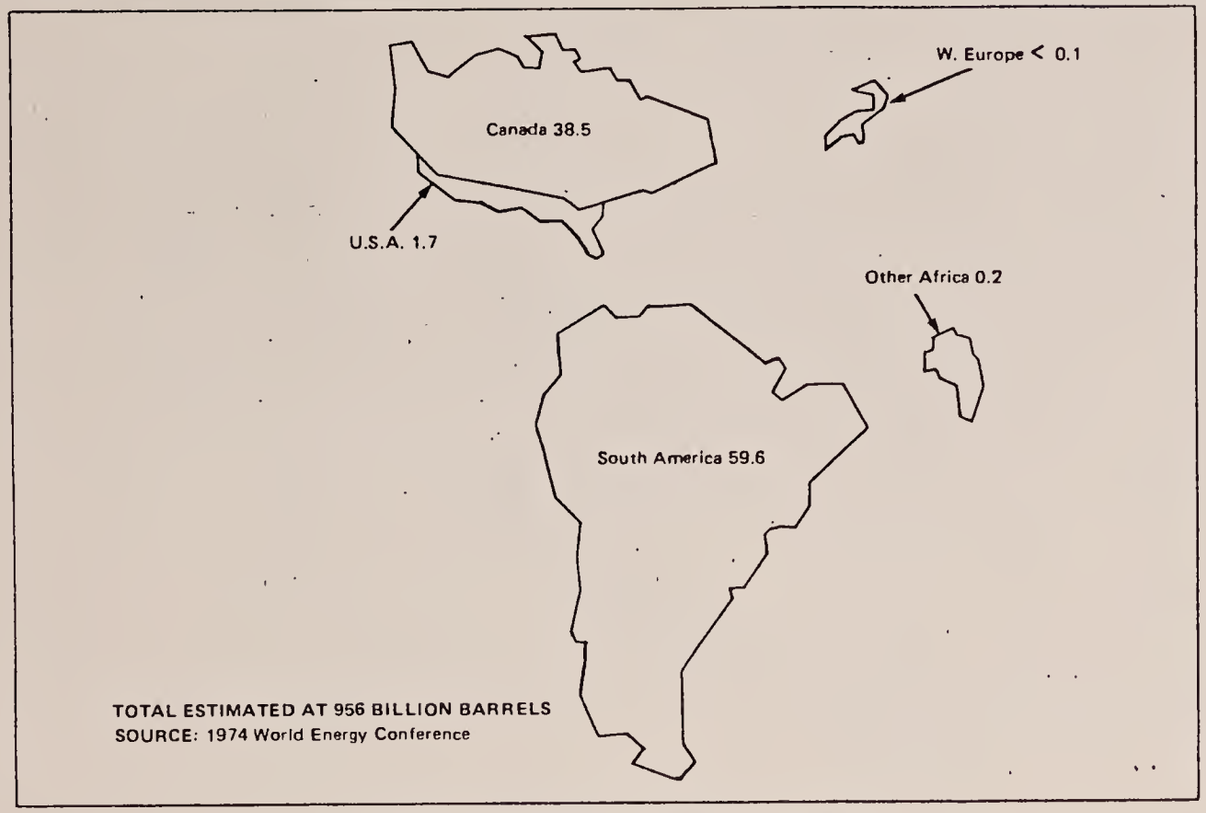


Figure 3—World Recoverable Tar Sands

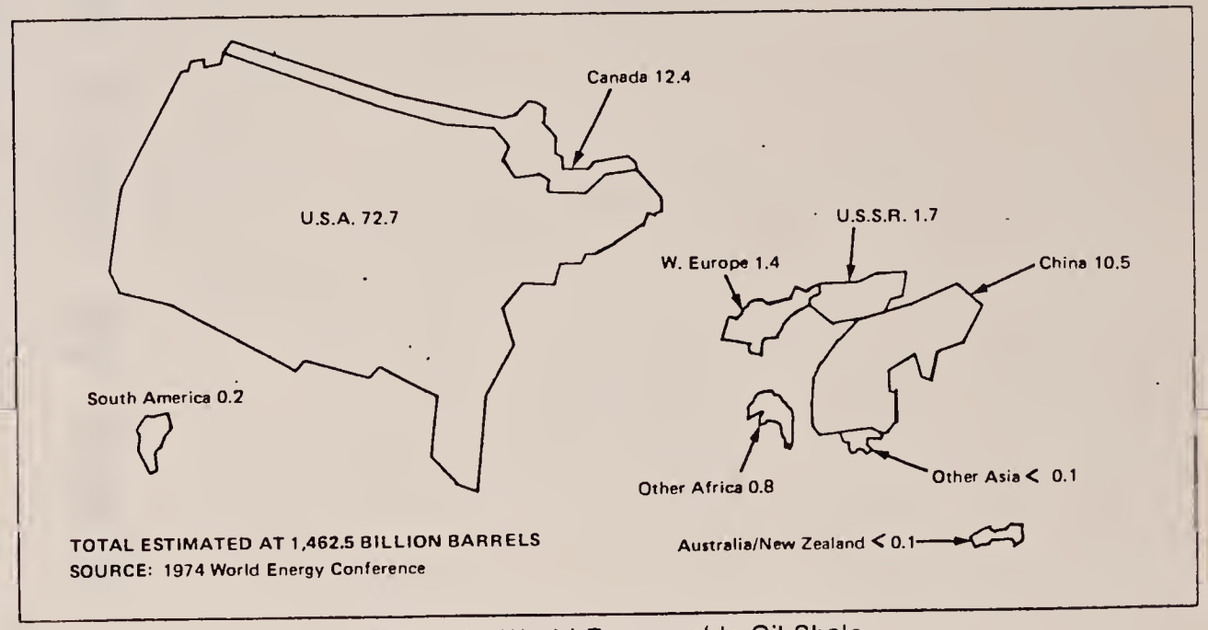
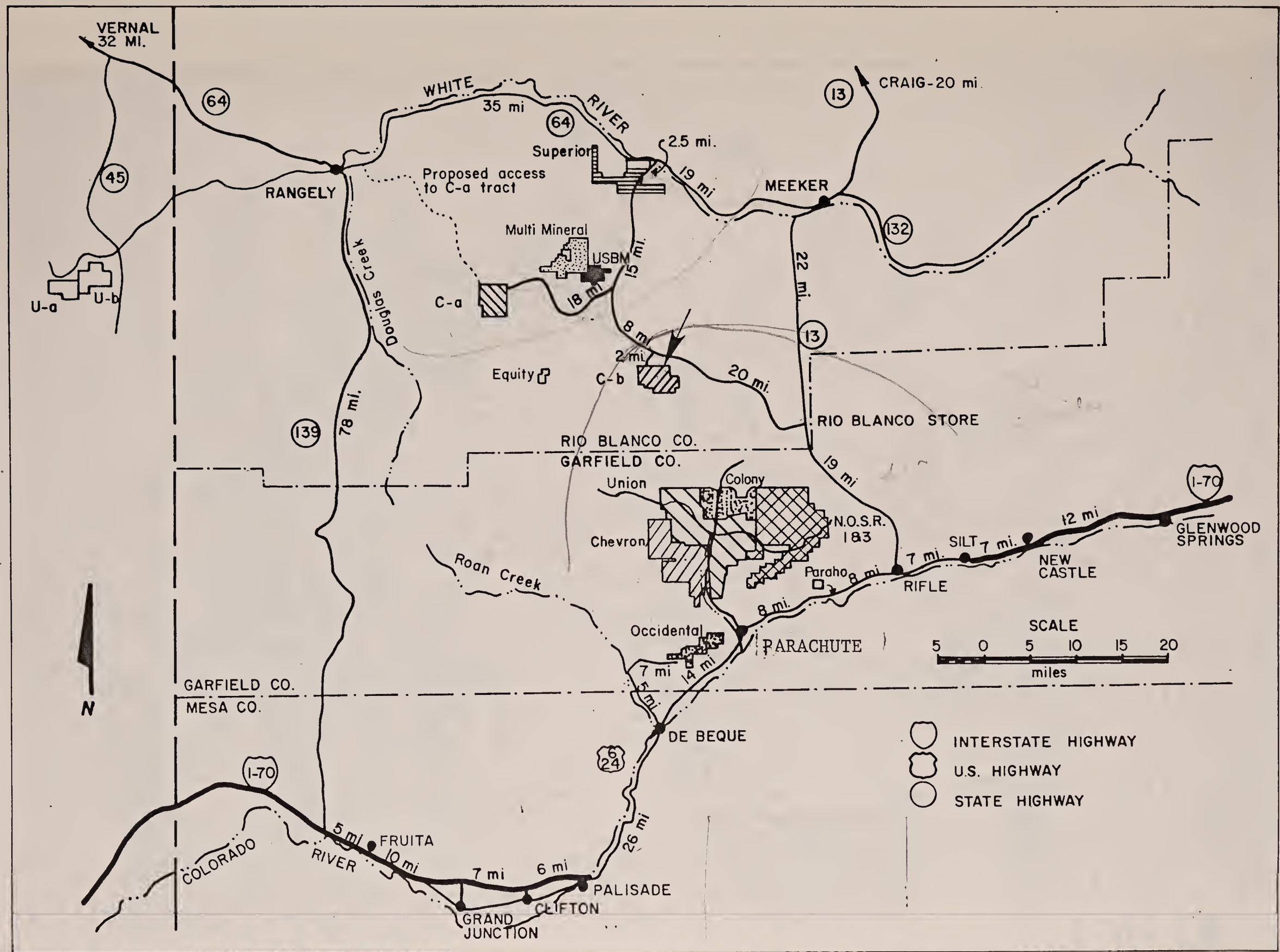


Figure 4—World Recoverable Oil Shale

PROJECTS

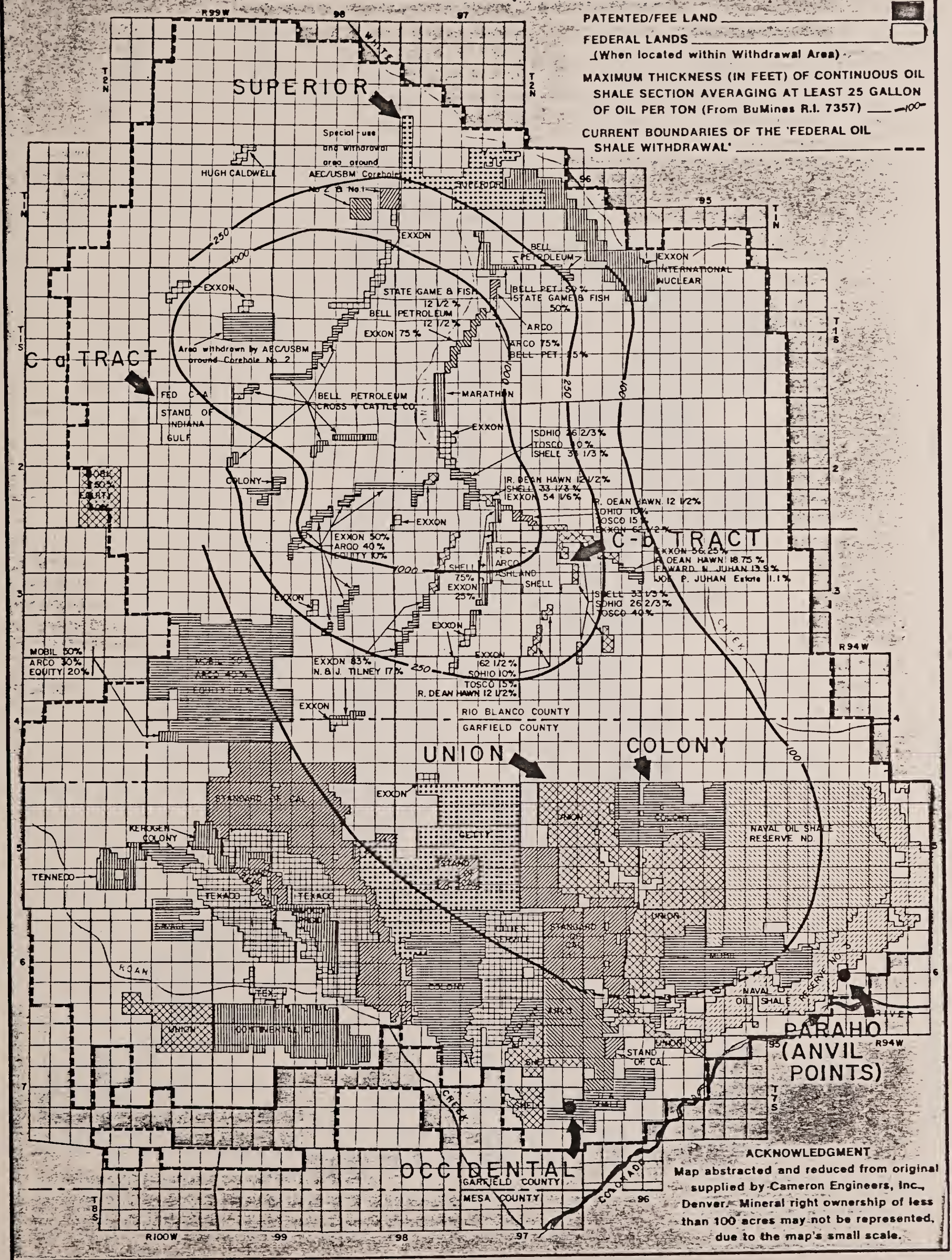
Presented in geographic order by state counterclockwise from Grand Junction, Colo.

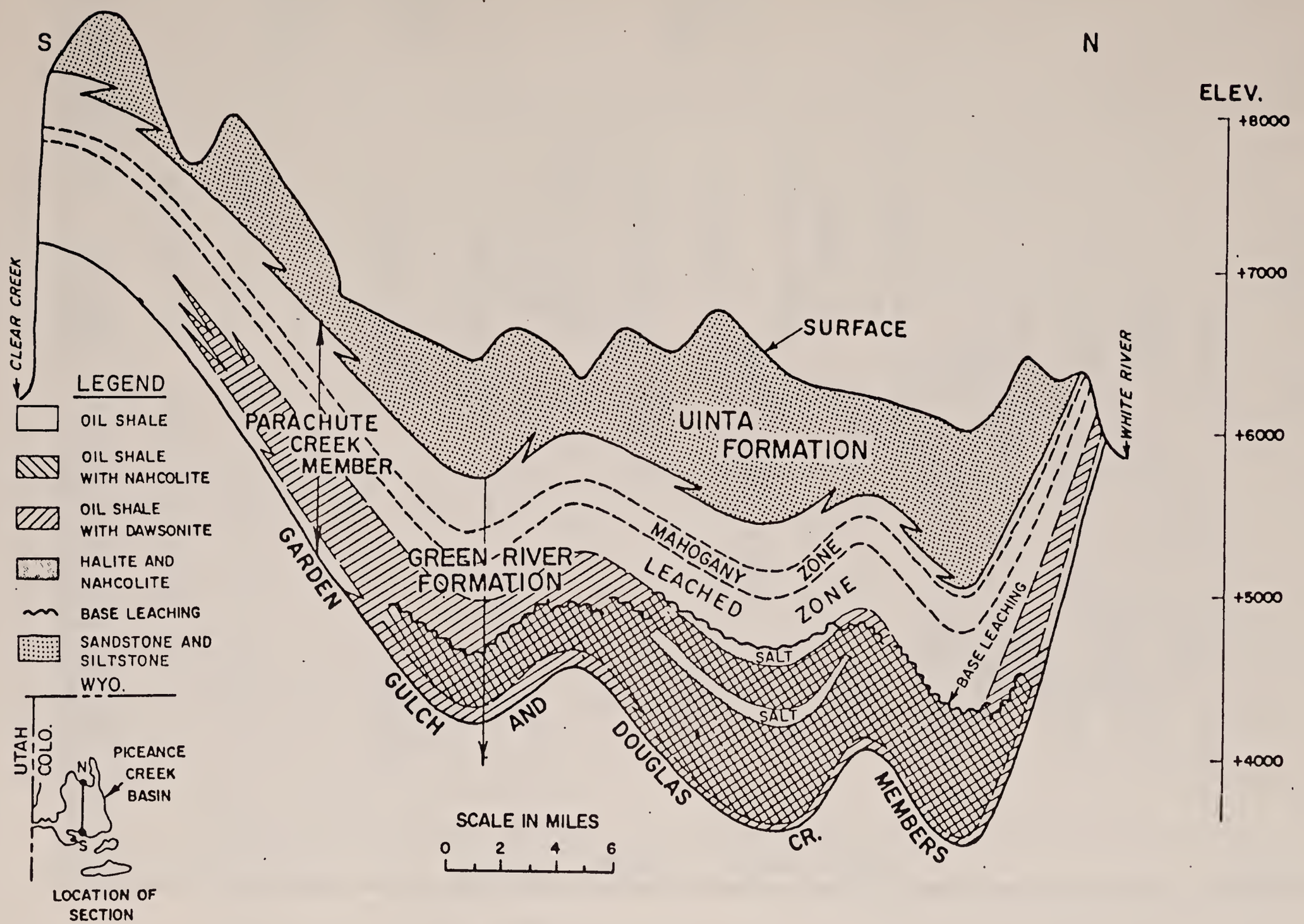


DRAWN BY VICKI SMITH
OCCIDENTAL OIL SHALE, INC.

OIL SHALE MINERAL RIGHT OWNERSHIP

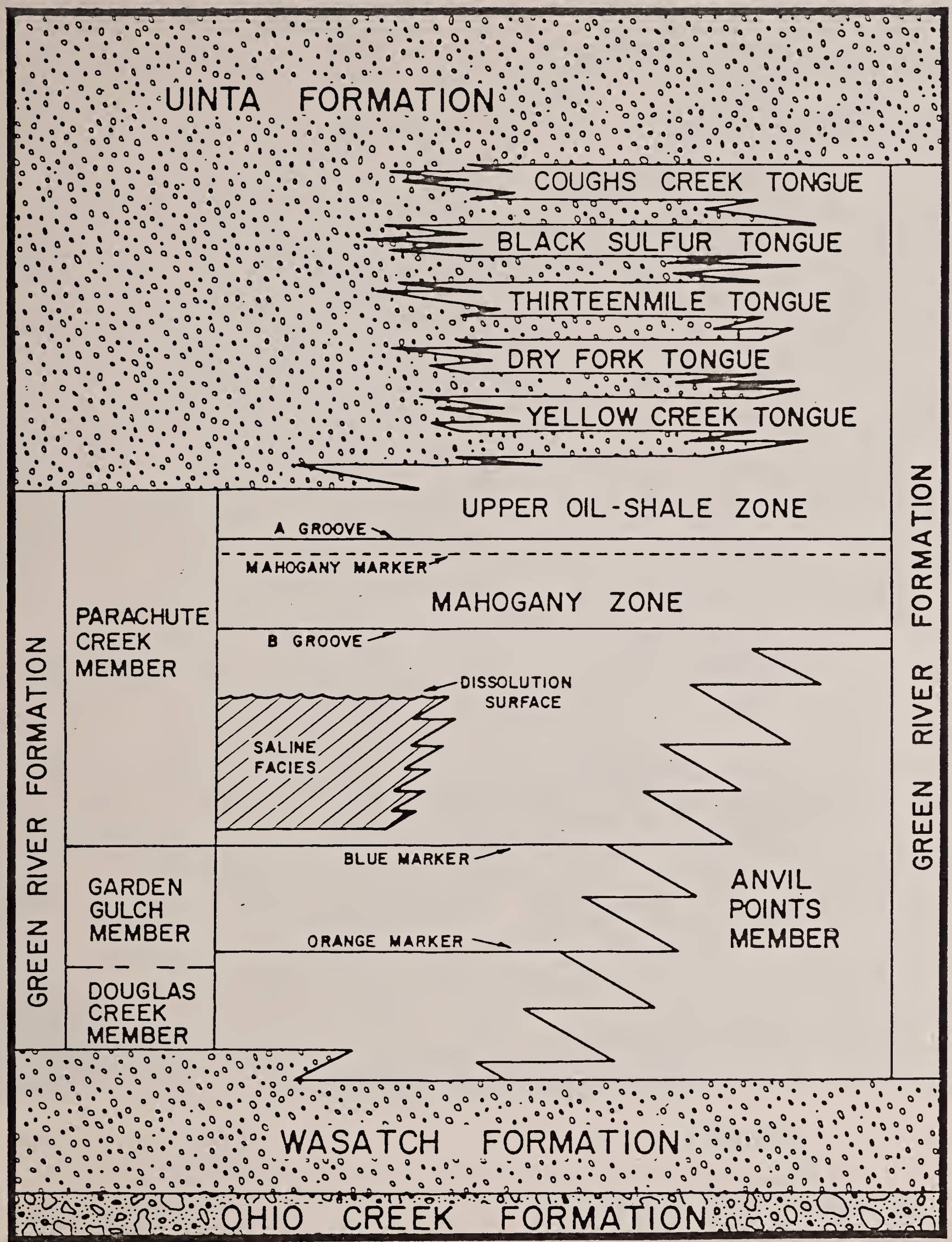
PICEANCE CREEK BASIN, COLORADO





Diagrammatic geologic cross section through the Piceance Creek basin

Source: Beard, Tait, and Smith, 1974



Stratigraphic column of tertiary rocks in Piceance Creek Basin.

LANDFORM UNITS

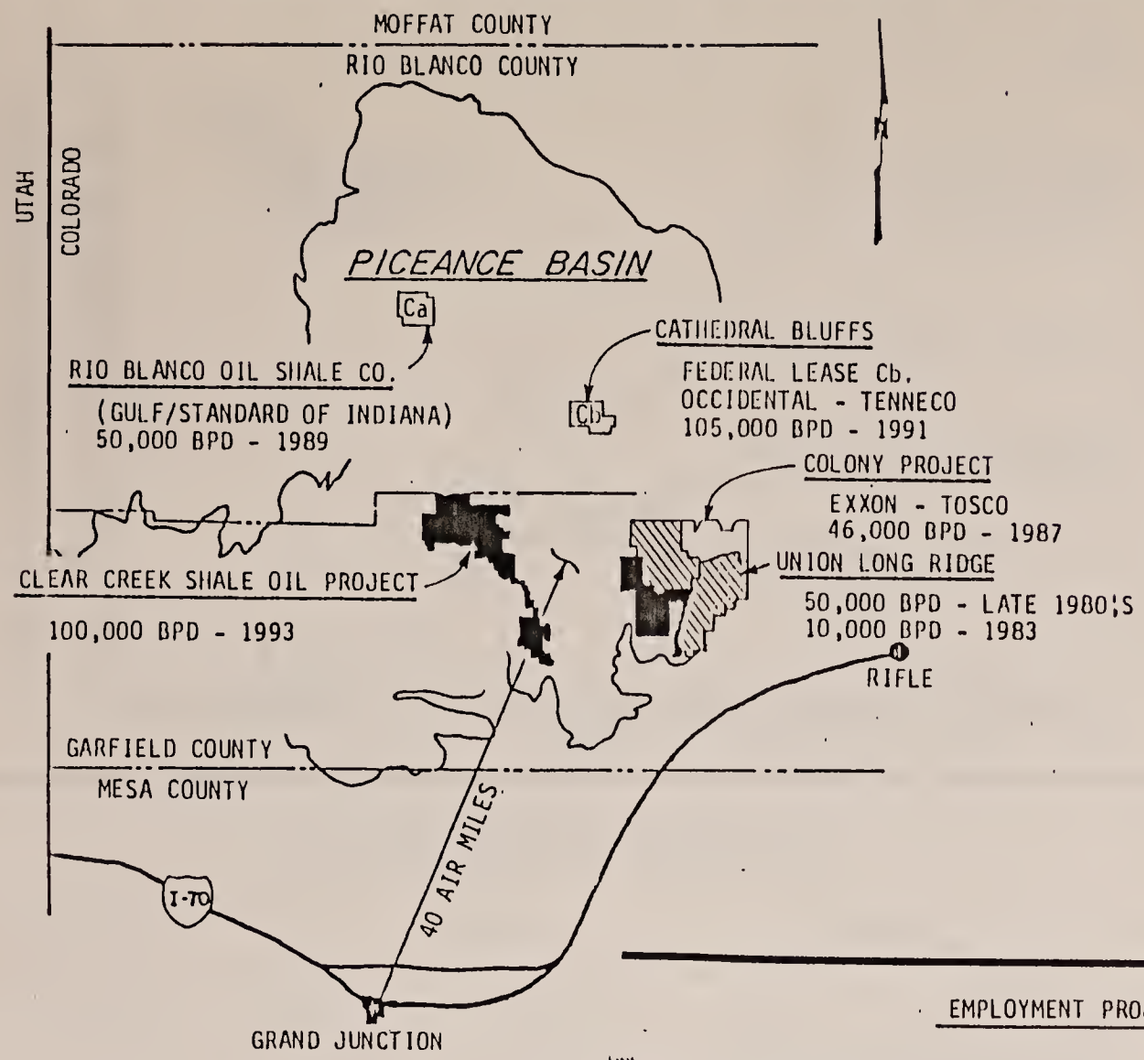
1- CLIFFS (ESCARPMENT)
2- MID-SLOPES
3- SLIP AND ROCKFALL TERRAIN (TALUS)
4- WASATCH FOOTSLOPES
5- ALLUVIAL FAN
6- CHANNEL LAND

STRATIGRAPHY

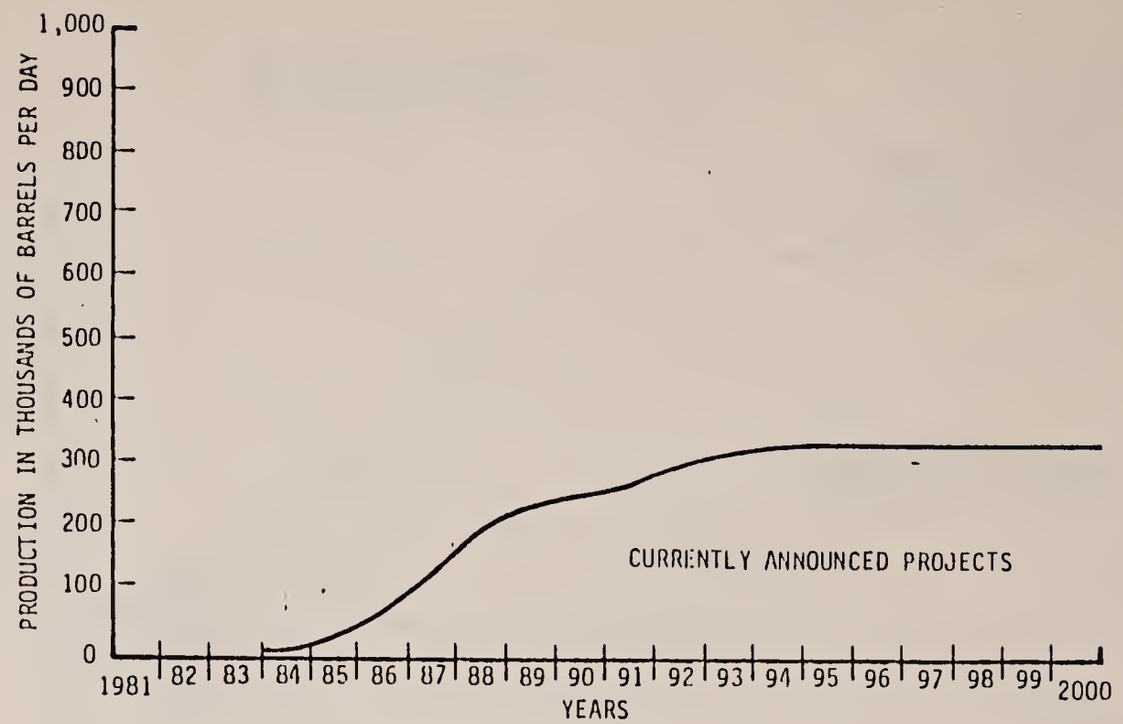
UINTA FORMATION
GREEN RIVER FORMATION
- Tgp - PARACHUTE CREEK MEMBER
- Tgg - GARDEN GULCH MEMBER
- Tgd - DOUGLAS CREEK MEMBER

WASATCH FORMATION

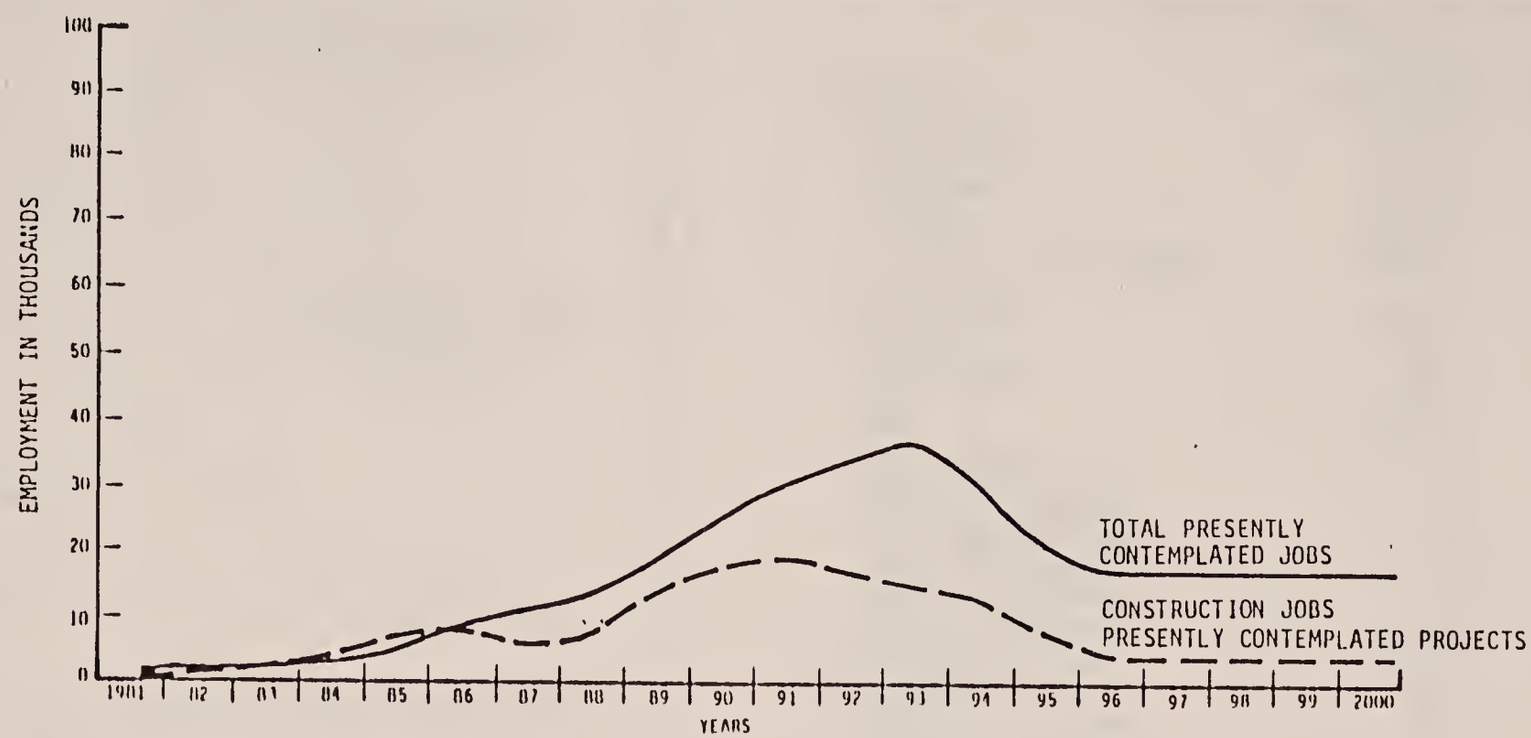
CURRENTLY ACTIVE PROJECTS



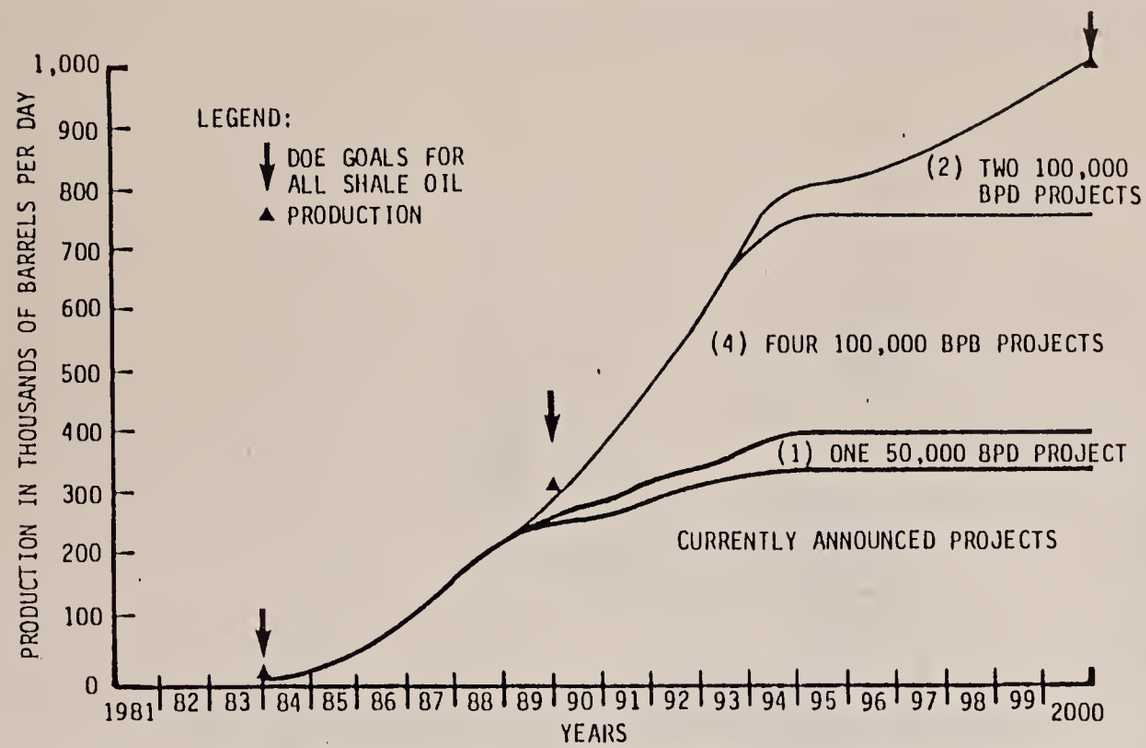
CURRENT ACTIVE PROJECTS ALL COMPANIES



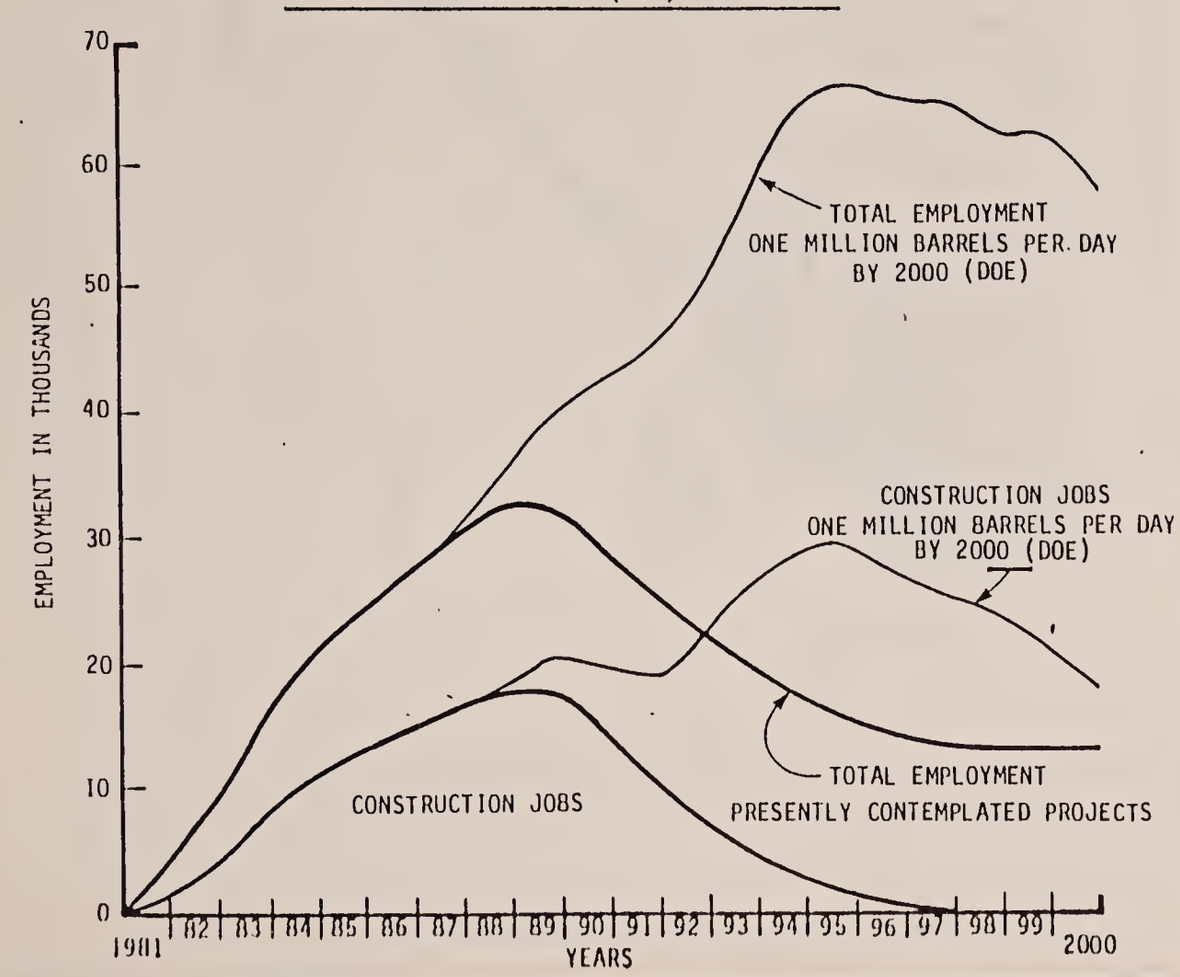
EMPLOYMENT PROJECTIONS CURRENTLY ACTIVE PROJECTS



PRODUCTION FORECASTS DOE OBJECTIVES

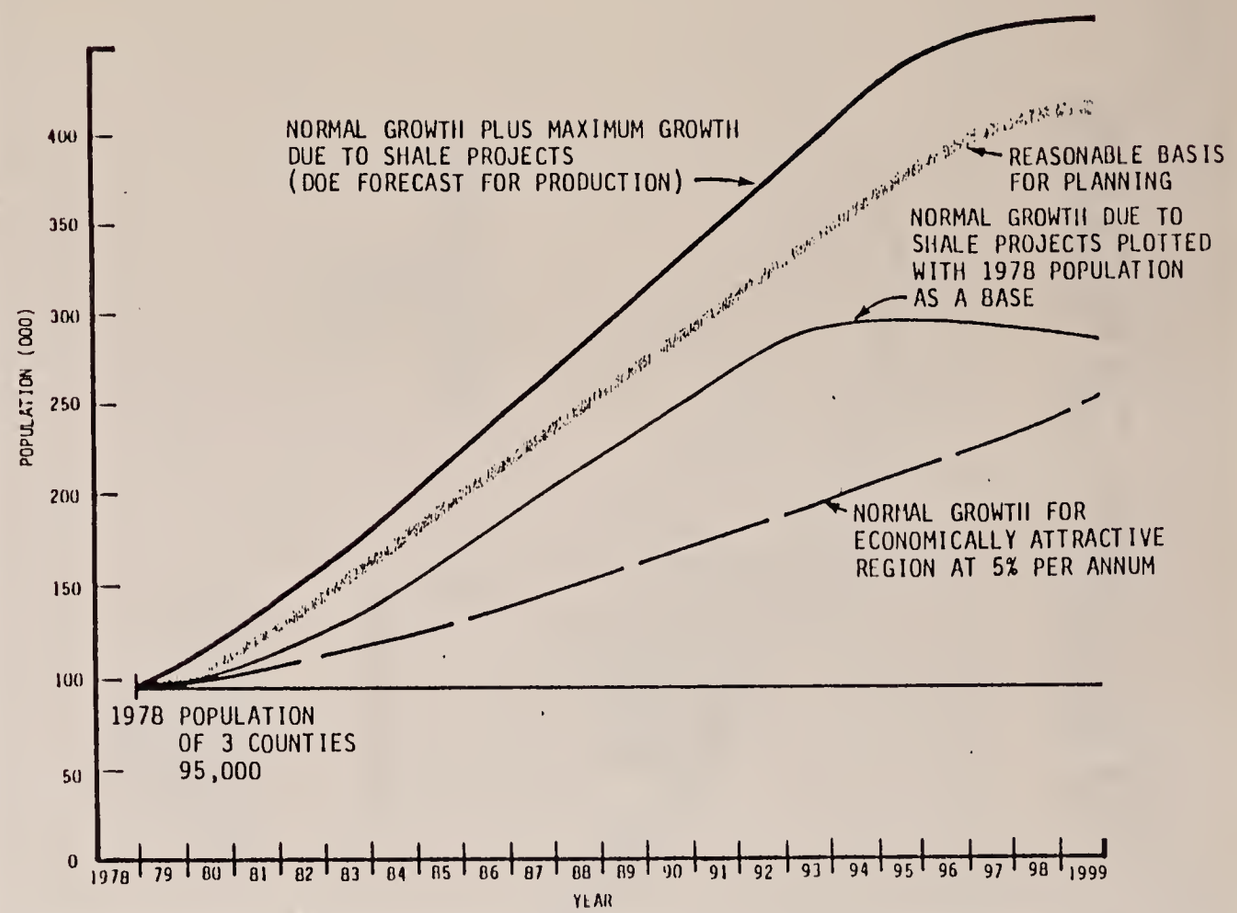


EMPLOYMENT PROJECTIONS (DOE) OBJECTIVES



ESTIMATED POPULATION GROWTH

WESTERN COLORADO "SHALE COUNTRY"



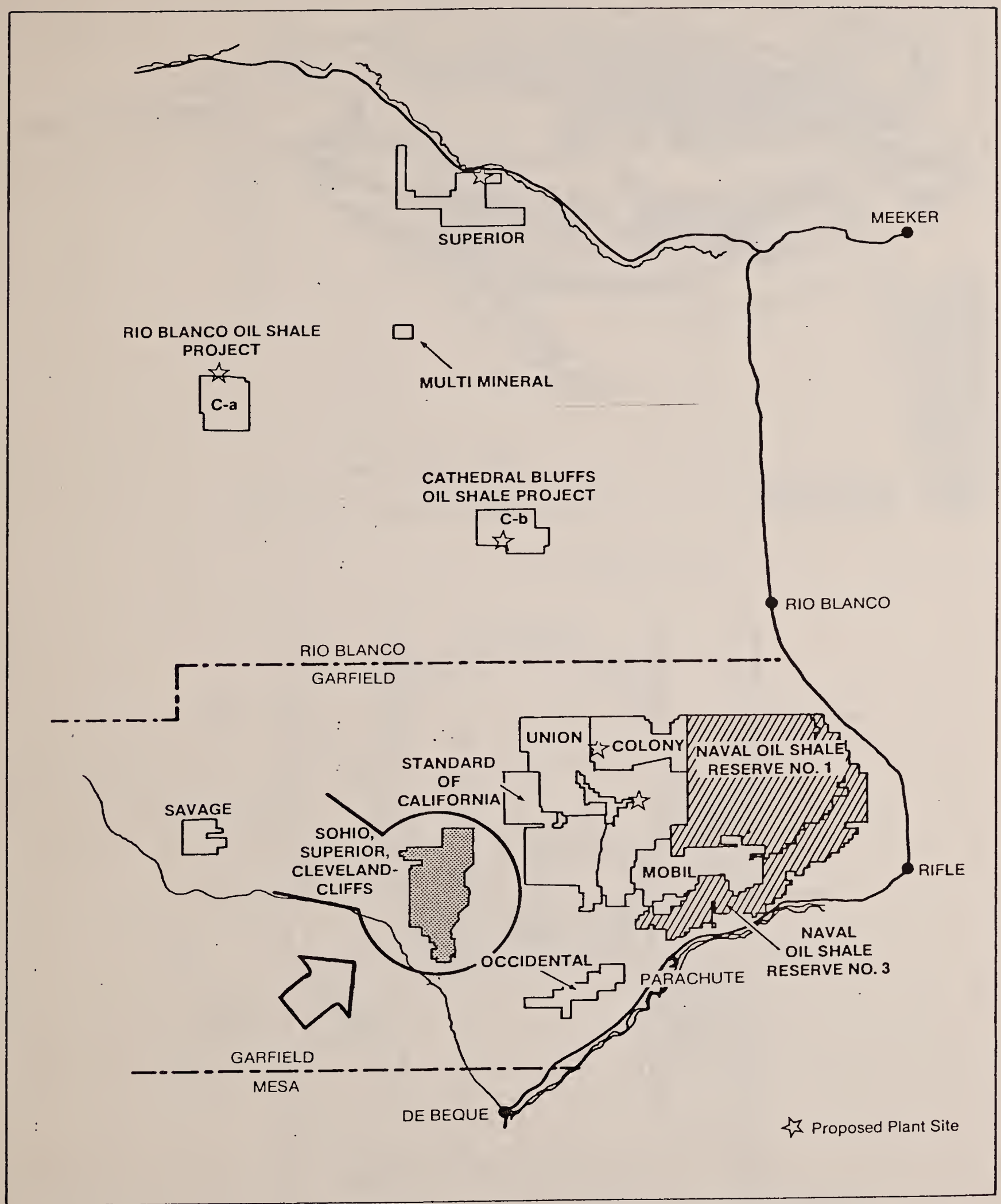
Community Facility Cost Summary

(1981 dollars)

Employment	Chevron (100,000 bpd)	Active Projects 350,000 pbd	DOE Goals 1,000,000 bpd
Construction	5,000	17,500	52,000
Super & Oper	3,000	10,500	30,000
Subtotal	**8,000**	**28,000**	**82,000**
Secondary	2,500	8,800	25,000
Total	**10,500**	**36,800**	**107,000**
Total Resultant Population	**27,000**	**91,800**	**270,000**
Housing Units			
Single Family	6,100	21,400	61,400
Multi-family	1,300	4,400	13,000
Mobile Homes	1,400	5,000	14,000
RV's	200	700	20,000
Total	**9,000**	**31,500**	**90,000**
School Facilities			
Elementary Classrooms	100	350	1,000
Elementary Buildings	5	20	50
Junior High Classrooms	50	180	500
Junior High Buildings	2	10	20
Senior High Classrooms	50	180	500
Senior High Buildings	1	5	10
Water Supply, G.P.D.	5.4×10^6	19×10^6	54×10^6
Sewage Disposal, G.P.D.	4×10^6	14×10^6	40×10^6
Hospital Beds	100	350	1,000
Fire Protection, Manpower	40	140	400
Police Protection, Manpower	60	200	600

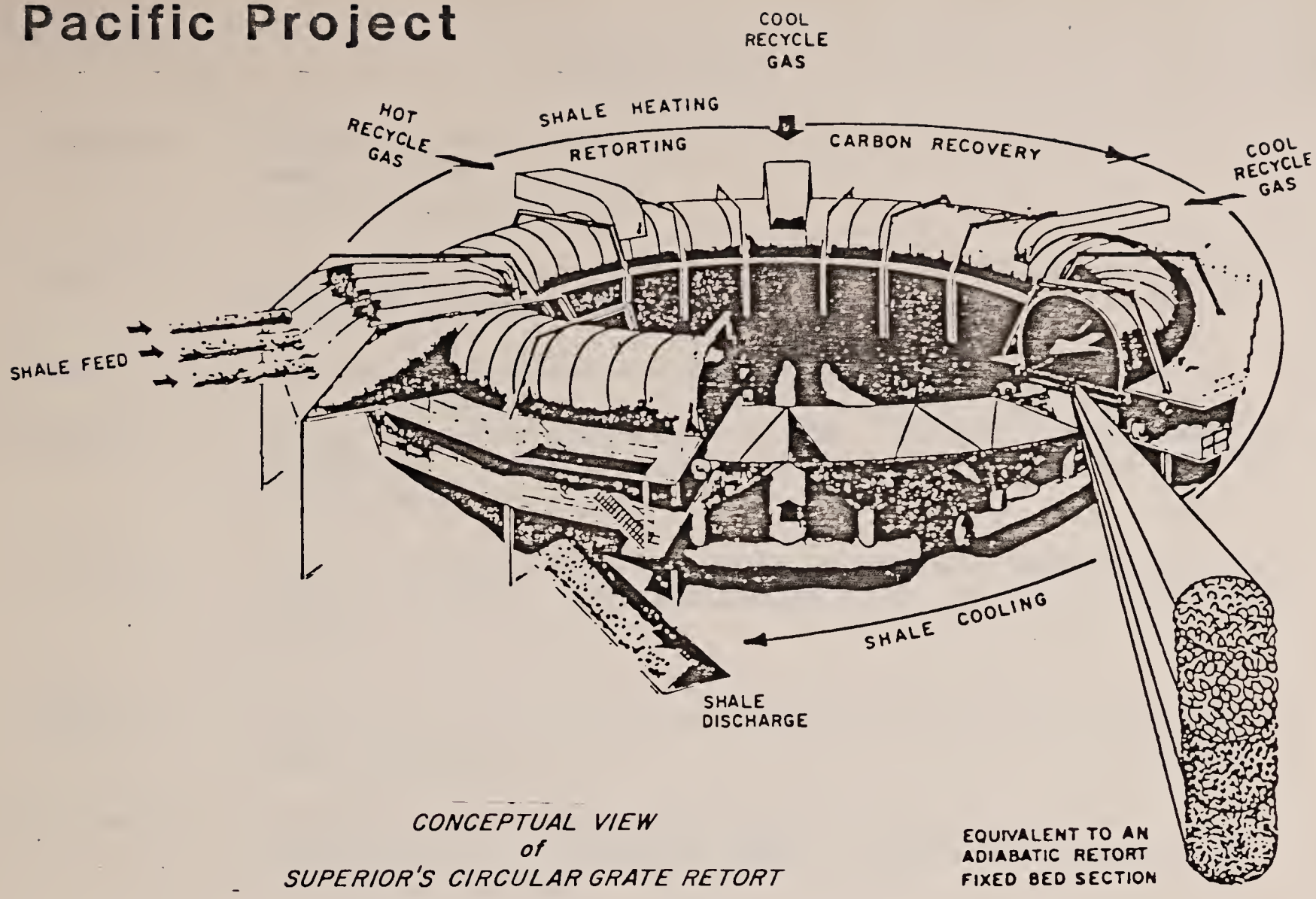
Source: Chevron Shale Oil Co.

PACIFIC PROJECT (Superior)



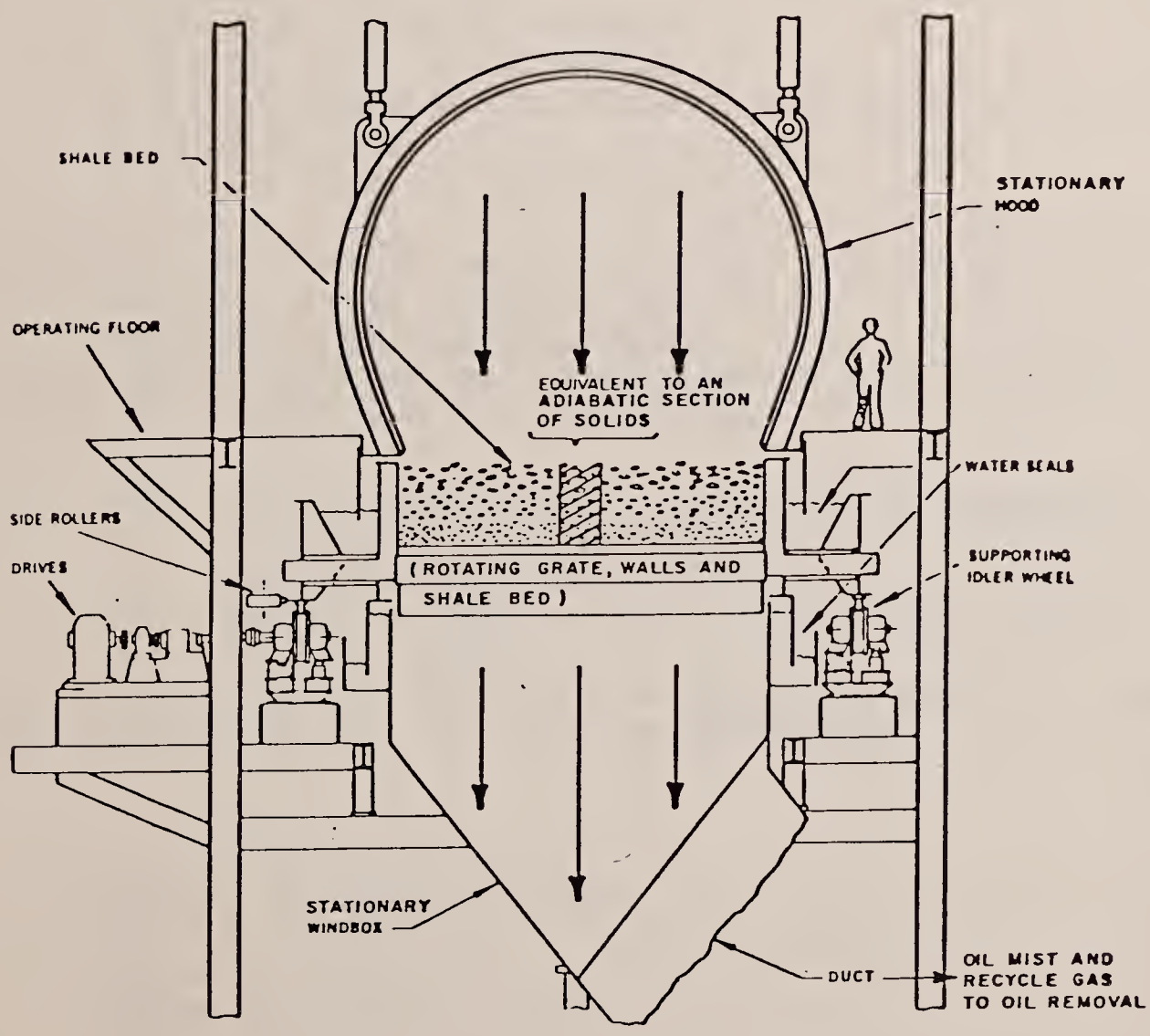
COLORADO

Pacific Project



CONCEPTUAL VIEW
of
SUPERIOR'S CIRCULAR GRATE RETORT

AFTER ARTHUR G McKEE & CO.



CROSS SECTION
of
SUPERIOR'S CIRCULAR GRATE RETORT

Pacific Project
(Commercial)

Companies: Superior - 20% (developer)
Sohio - 60%
Cleveland-Cliffs - 20%

Location: T6S, R98W; 10 miles N of De Beque, Garfield County, Colorado; east side of Clear Creek; 13,000 acres of patented/fee land.

Resource: Confidential probably averages 32 gpt

Mining: Underground room-and-pillar in the Mahogany Zone producing 22,000 TPD. Sufficient resource for 25 year project life at 30,000 TPD.

Retorting: Superior circular traveling grate retort with feed size of 1/4" to-4". At full commercialization will use three 15,000 BPD modules.

Waste disposal: Valley fill, with possible back filling of retorted shale into mined out areas.

Employment: Employment and housing under study (2,800 during peak construction of 3 modules in 1988; 1,400 during sustained 3 module production)

Cost:
- o $7.5 million cost share for basic engineering design (DOE funding $5.6 million).
- o $20 million for detailed design
- o $300 million for first module
- o Cleveland Cliffs seeking Federal loan guarantee for 75% of its share of project.
- o $1.3 billion for 50,000 BPD plant

Planning:
- o Superior - retort design and permit acquisition
- o Cleveland Cliffs - mine design
- o Davy McKee - process area design
- o Camp, Dresser & McKee - environmental control
- o H. P. Fresson - offsite facilities

Status:
- o 1979 - DOE PON with Superior for design of commercial plant
- o 1980 - Began Phase I engineering and permit acquisition for 15,000 BPD Superior retort
- o 1982 - June - Decision on Phase I engineering construction of first module
- o 1986 - Phase I, 15,000 BPD demonstration module on-line
- o 1989 and beyond - Scale-up to 50,000 BPD

Contact: J. H. Knight
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Superior Oil Company
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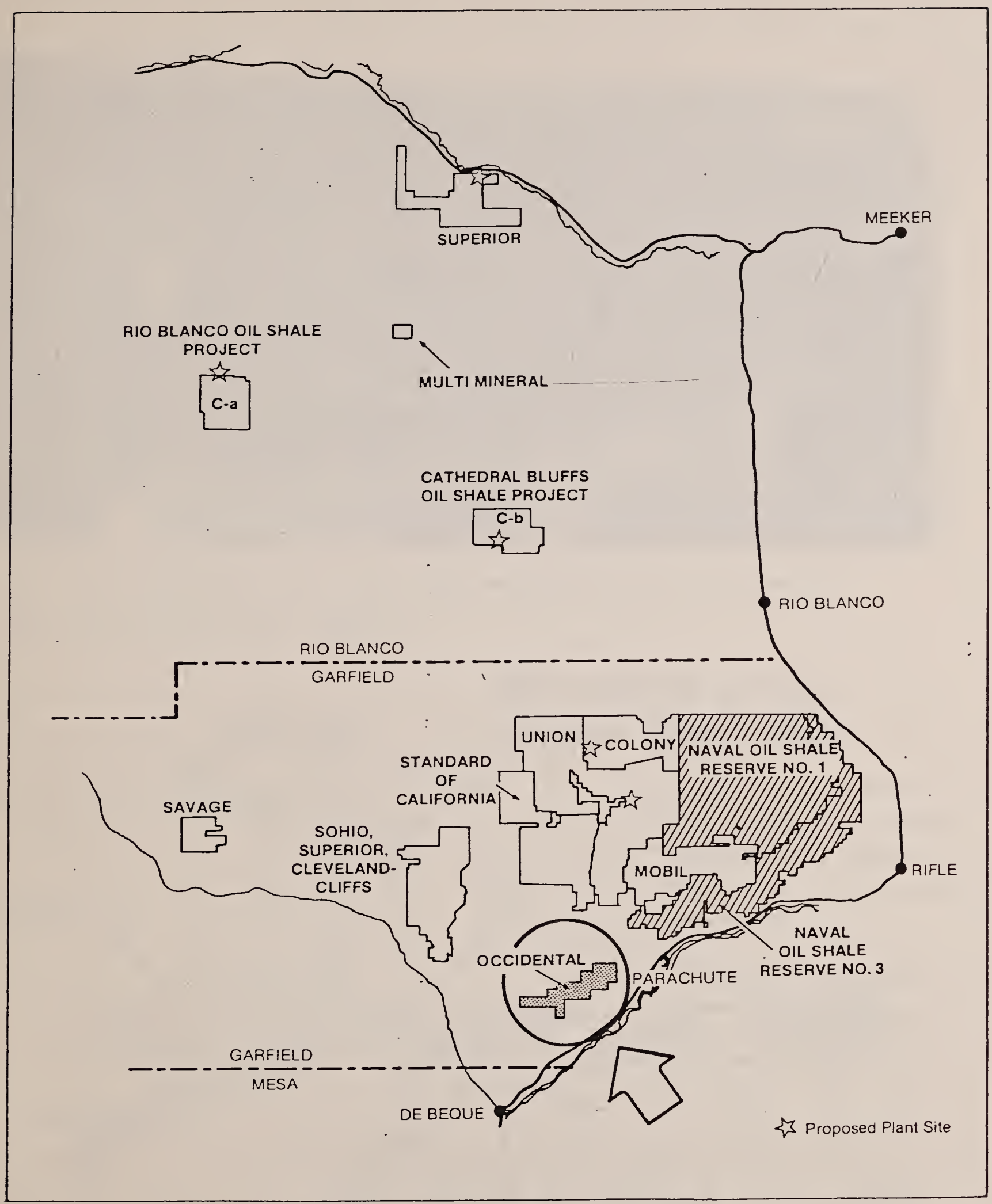
Englewood, Colorado 80110
(303) 761-5853

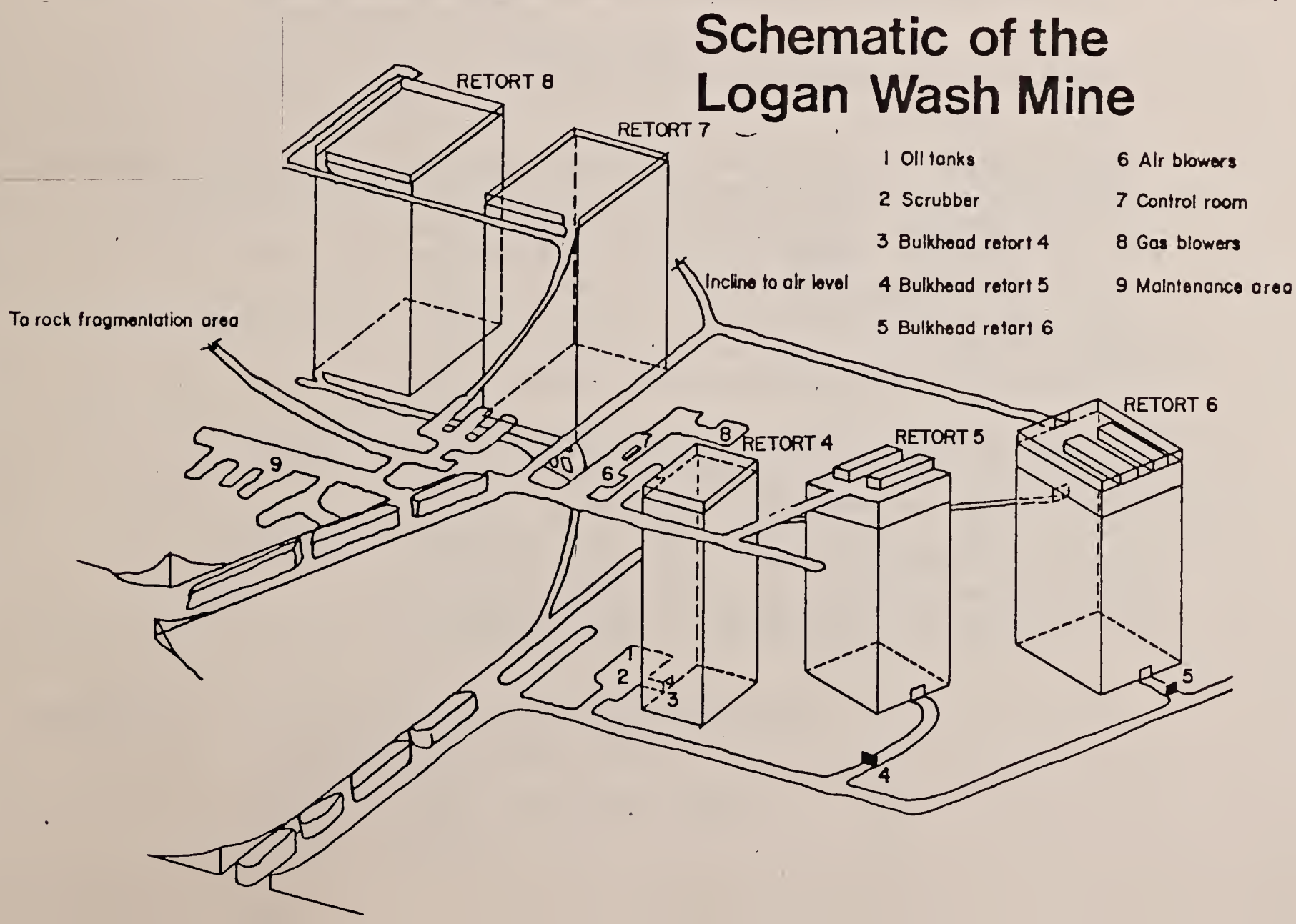
LOGAN WASH (Occidental)



COLORADO

Oxy Logan Wash

Occidental Oil Shale, Inc., Logan Wash modified in situ experimental mine. Mine entries lie above and below the interval of oil shale rubblized to form retort chambers.



Logan Wash
(Noncommercial)

Company: Occidental Oil Shale, Inc.

Location: T7S, R96 & 97W; 10 miles N of De Beque, Garfield County, Colorado, N side of Mt. Logan; 4,000 acres of private land (2,400 acres containing oil shale).

Resource: 300 million bbl of 17 gpt oil shale

Mining: Cliff entry underground room-and-pillar for modified in-situ retort development (direct mining of 20-25% of the shale deposit by volume) across the Mahogany Zone (6 yd loaders, 23 ton trucks).

Retorting: Noncommercial, experimental facility for development of modified (mine assisted) in-situ (MIS) technology. Produced 94,500 bbl's to date which were sold for refining and utility boiler fuel tests. Experimenting with ignition techniques in series of mini-retorts.

Waste disposal: Cliffside dumping of raw mined shale permitted for up to 8.8 million cubic yards.

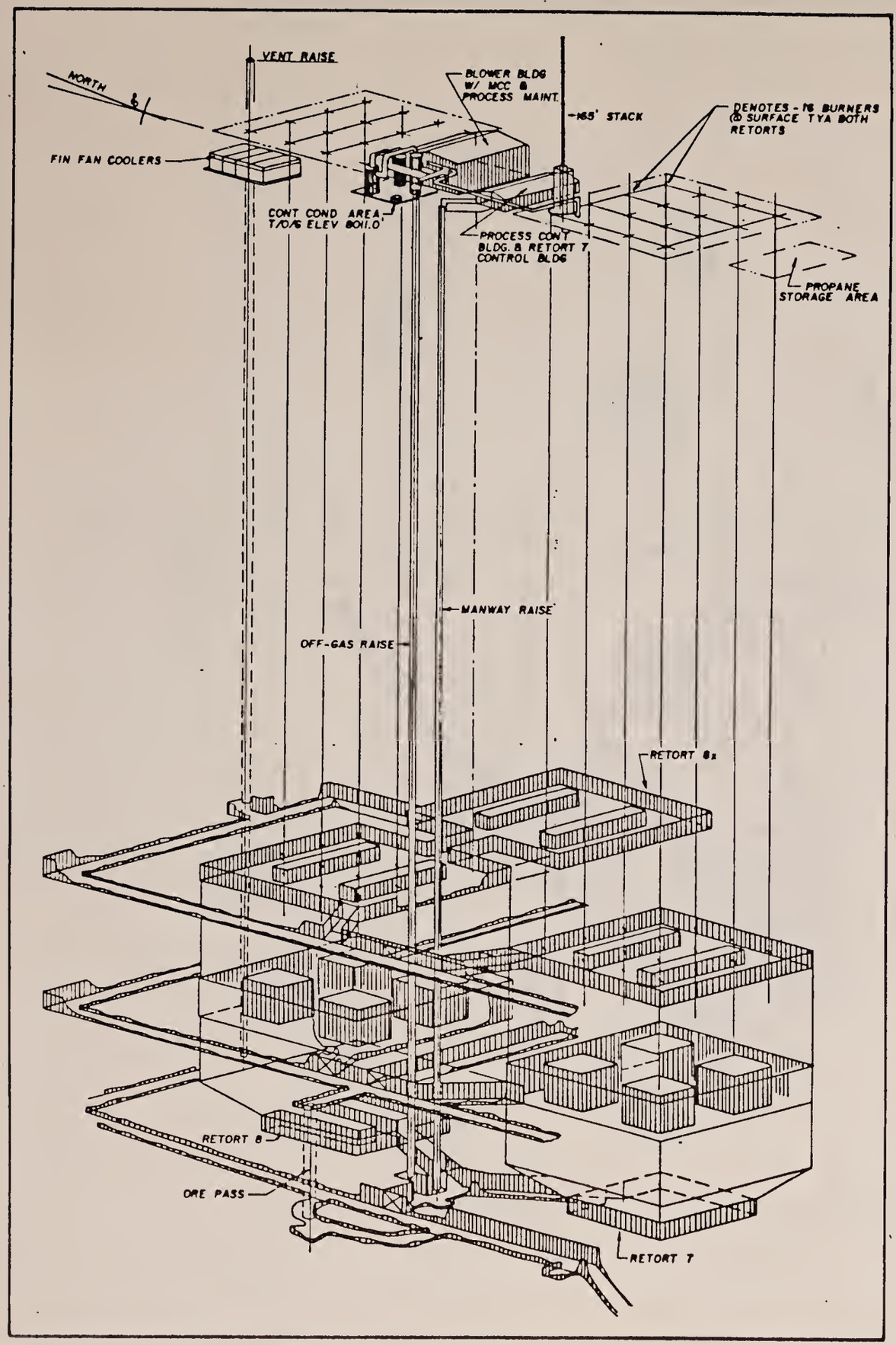
Employment: 450 during peak operation residing in Grand Junction, DeBeque, and Rifle, Colorado; declining to small maintenance crew by end of 1983 as MIS testing is concluded.

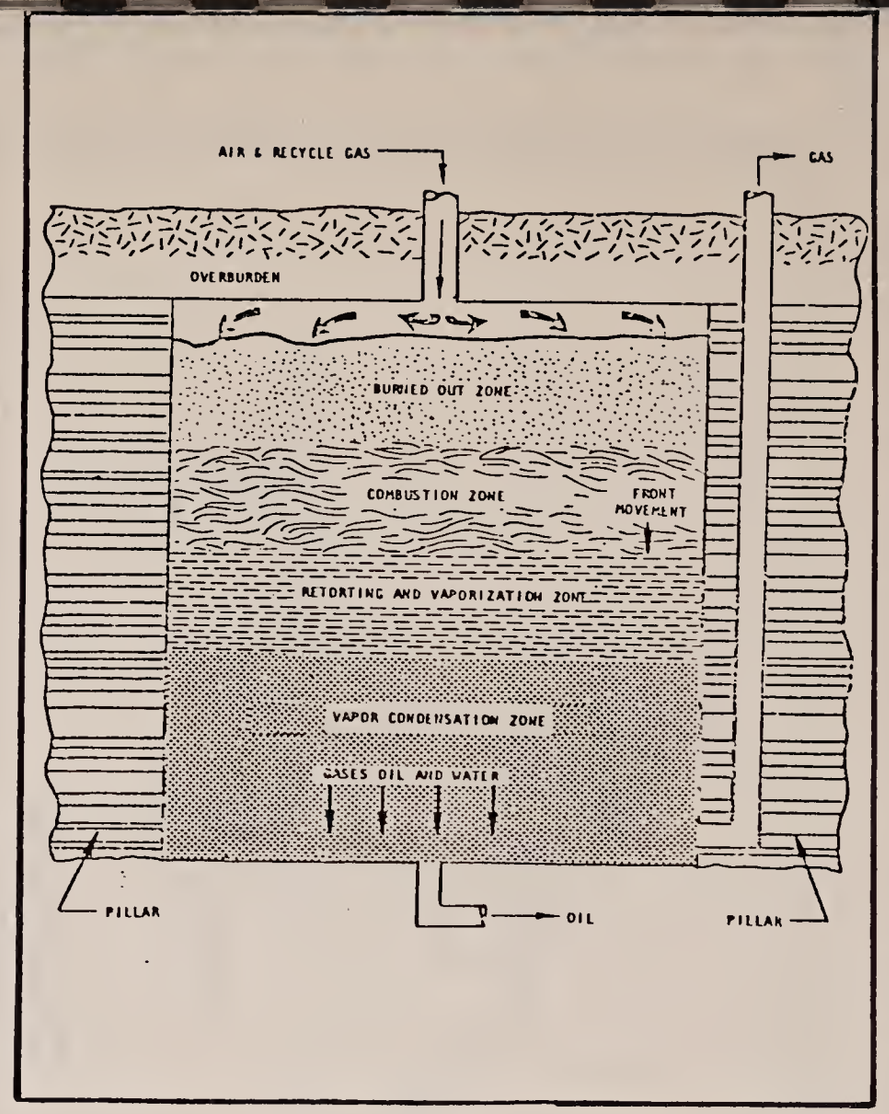
Cost:
- o $29 million for retorts 5 and 6.
- o $45 million to date.
- o Entered into $60.5 million DOE cost-share contract which was terminated in 1981.
- o $64 million for retorts 7 and 8.
- o $170 million for experimental retorting and rock fragmentation by end 1982.

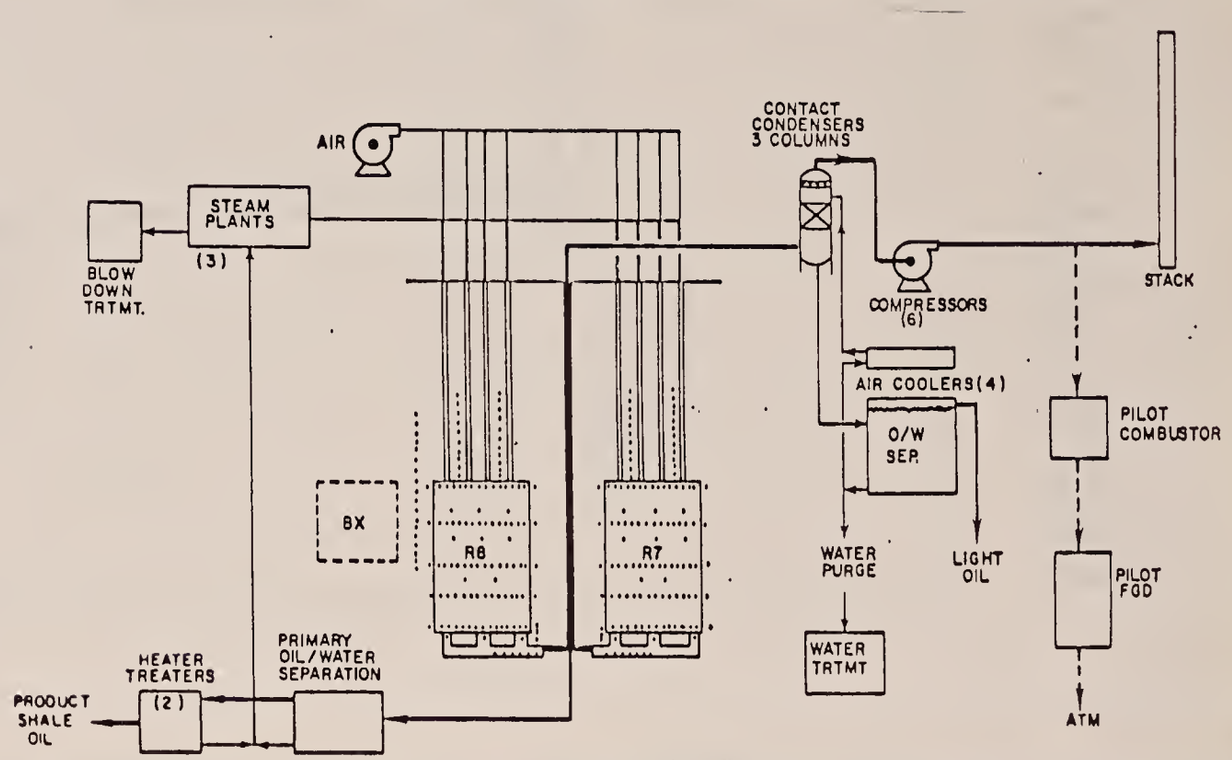
Status:
- o 1972 - Oxy purchased Logan Wash site and began mining.
- o 1972-75 - Experimented with three small MIS retorts (32' x 32' x 72' to 113'h) producing 1200-1600 bbl each.
- o 1975-76 - Rubblized and burned commercial size MIS retort 4 (120' x 120' x 271'h) producing 27,500 bbl.
- o 1976-78 - Scale-up retorts 5 and 6 (the largest being 162' x 162' x 337'h) rubblized and burned under cooperative DOE agreement (EIS prepared) producing 66,287 bbl total.
- o 1979 - Obtained PSD for MIS retorts 7 & 8 (modified 6/27/80).
- o 1979 - DOE cooperative agreement for five 1/4-scale mini-retorts to define rubblization and ignition techniques
- o 1981 - Rubblized full-scale MIS retorts 7 and 8 (165' x 165' x 246'h) to be burned simultaneously from December through July 1982 (1' per day burn rate) producing 97,000 bbl. 1983 - Completion of testing program

Contact:
R. Nelson, V.P. and General Manager
Occidental Oil Shale, Inc.
P.O. Box 2687
Grand Junction, Colorado 81502
(303) 244-3000

OXY

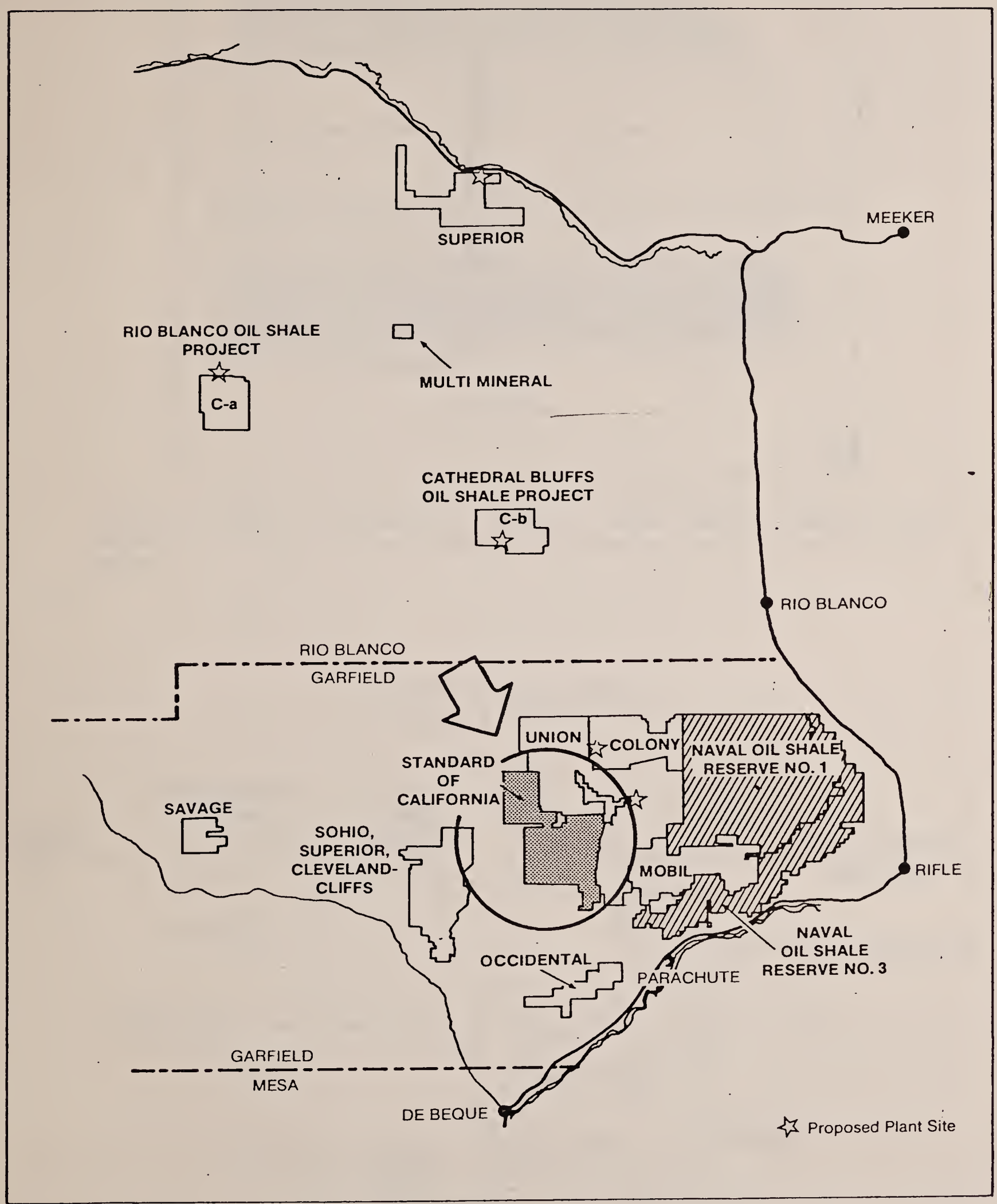






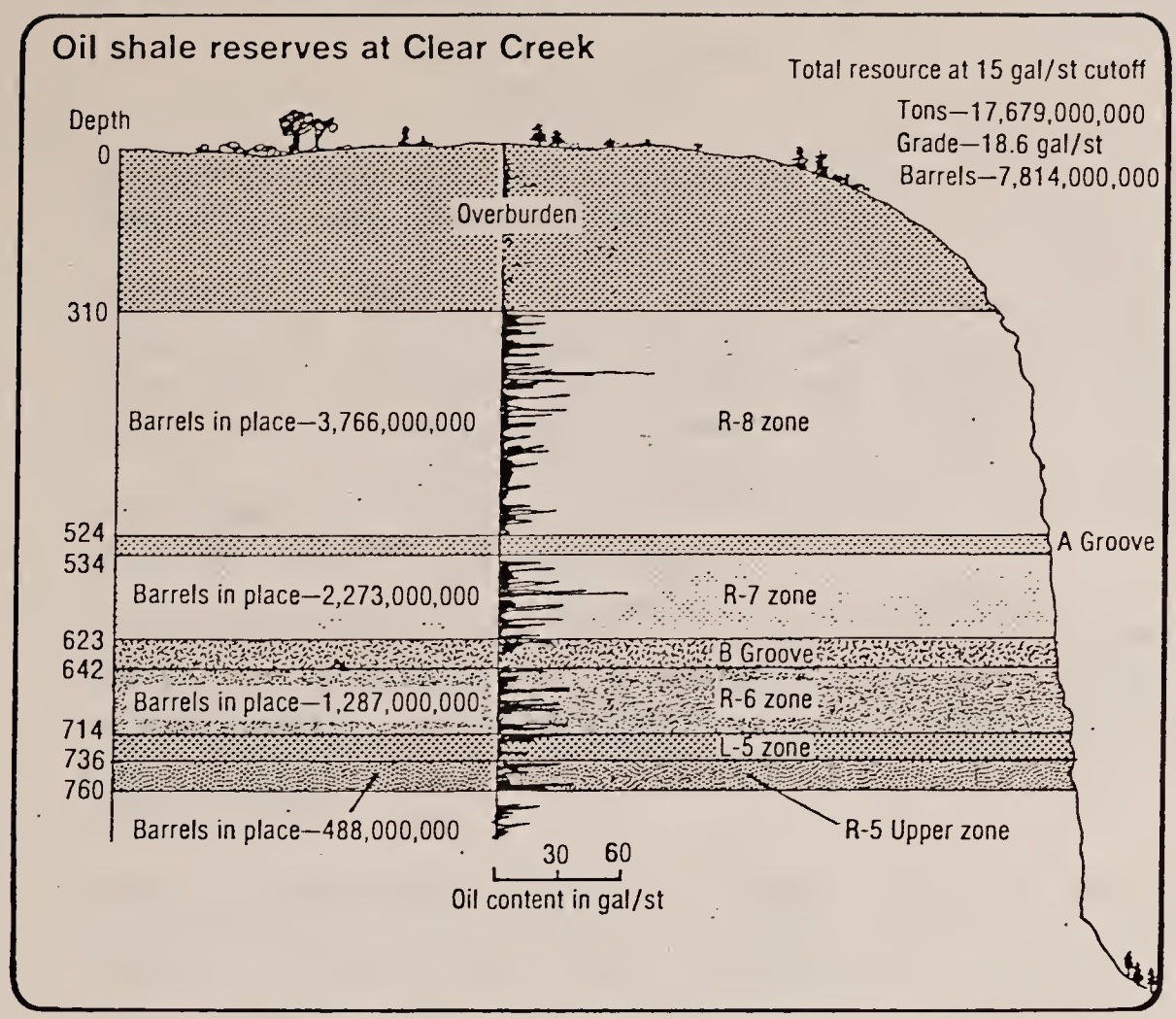
RETORTS 7 & 8 PROCESS DIAGRAM

CLEAR CREEK PROJECT (Chevron)



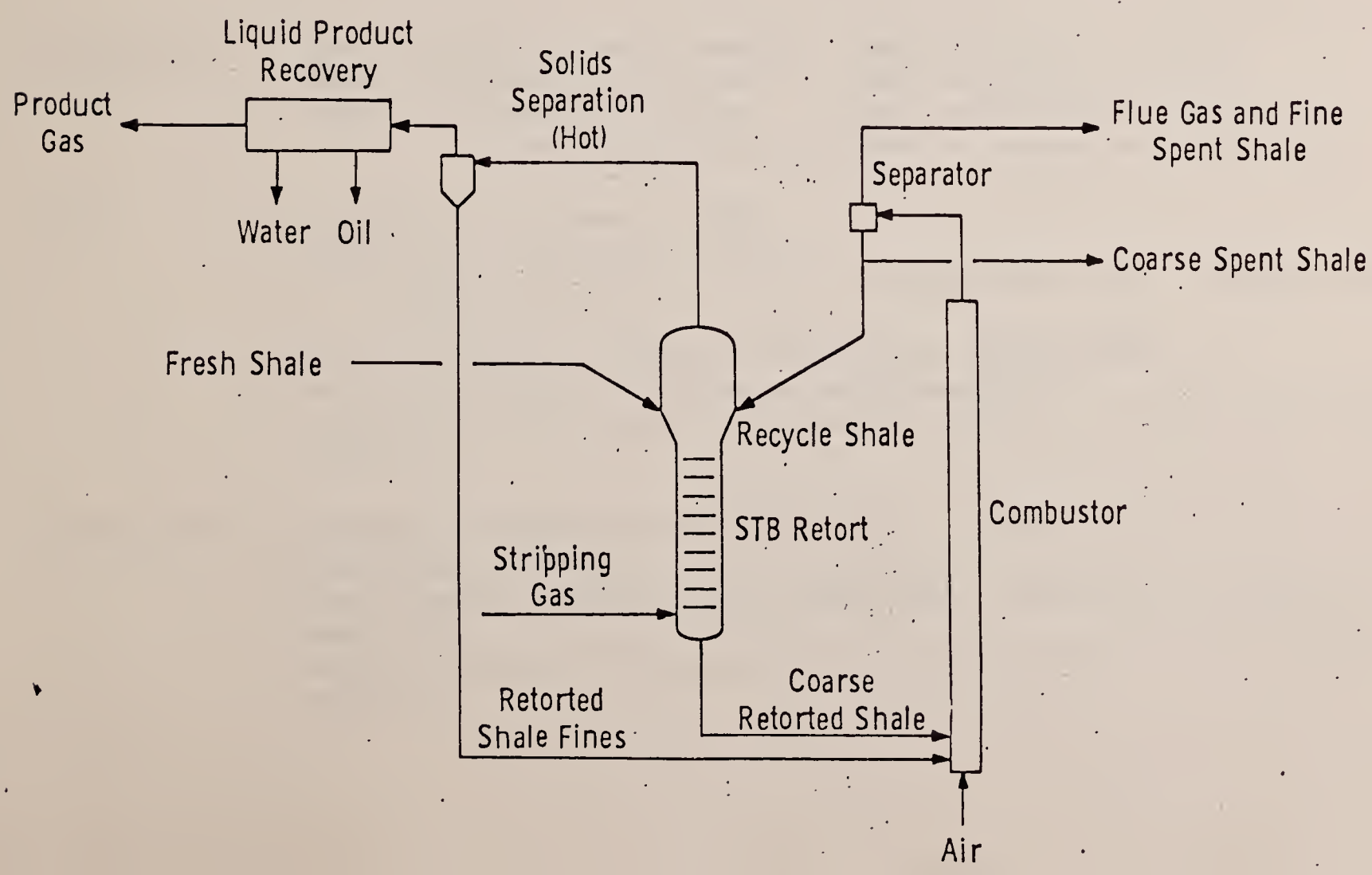
COLORADO

CHEVRON CLEAR CREEK



Chevron's Clear Creek site at head of Clear Creek. Access road zig-zags to ridge top environmental monitoring and core hole drill sites.

PROCESS FLOW SCHEME
STB RETORT



Clear Creek Project
(Commercial)

Companies: Chevron (Standard of California) Oil Shale Company, and Conoco; seeking third partner.

Location: T5S, R98 & 99W; 26 miles N of De Beque, Garfield County, Colorado, on Clear Creek; 28,000 acres on Clear Creek (43,000 acres total on both Clear Creek and Parachute Creek) of fee land (Chevron the largest private landholder in shale county).

Resource: Confidential (Mahogany Zone averages 80' - 100' thick, at 25 gpt, for 150,000 bbl per acre).

Mining: Underground room-and-pillar (31 gpt ore) and surface open pit (19 gpt ore) mining on the Mahogany Zone (90' thick under 600' of overburden) reaching 275,000 TPD in 1990's. Will begin with small underground mine trucking ore to Salt Lake City semi-works retort.

Retorting: Chevron's recently patented Staged Turbulent Bed retort previously tested in 1 TPD pilot plant and to be further evaluated at 350 TPD (200 BPD) semi-works at Chevron's Salt Lake City refinery with -1/4" feed size. Full 100,000 BPD would require ten to twelve 20-story high, 9000 TPD retort units with on-site upgrading. Also evaluating Paraho and Lurgi technology.

Water: Will pump 200-500 cfs from Colorado River near De Beque to Clear Creek Reservoir under industrial water rights.

Waste disposal: Initial overburden and processed shale disposed of in Willow Creek Canyon followed by open pit backfilling.

Employment:
- o Phase I planning and research - peak mid-1983 at 1,000
- o Phase II demonstration plant - peak mid-1986 at 3,750
- o Phase III commercial plant - peak construction 1992-3 at 9,700, declining to 3,000 for operation after 1996

Cost:
- o $5 million expended in 1979
- o $20 million expended in 1980
- o $5-7 billion for total project through 1990's for 100,000 BPD (1981 dollars)
- o $677 million for community facilities through 1995
- o No Federal funding assistance being sought.
- o $100 million for shale oil research facility at Salt Lake City refinery.

Contractor:
- o Morrison-Knudsen with Foster-Wheeler: mining and process feasibility studies
- o Environmental Research and Technology: baseline environmental monitoring
- o Morrison-Knudsen: engineering and construction of SLC research facility.

Status:

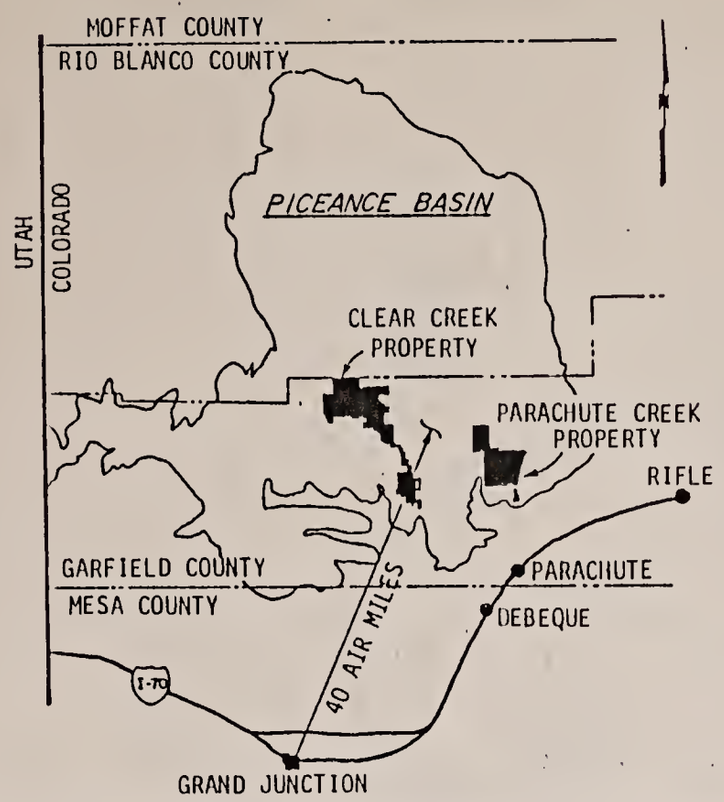
- o Late 1970's - Chevron Oil Shale Company formed
- o 1980 - Conducting site environmental monitoring and planning at Clear Creek
- o 1981 - Negotiated with Conoco as 30% second party in trade for selected coal properties
- o 1981 - Applied for Colorado Mined Land Reclamation permit for 5/82 through 1986
- o 1981 - Agreement with BLM, Colorado Department of Natural Resources, and Garfield County to have development plans reviewed by Colorado Joint Review Process.
- o 1982 - Decision on ROW EIS
- o 1984 - Obtain necessary permits including County Special Use Permit
- o 1982 - 1984 - 350 TPD semi-works plant at SLC refinery and Clear Creek test mine.
- o 1983 - 1990 - 10,000 to 25,000 TPD demonstration plant at Clear Creek
- o 1987 - 1990's - 95,000 TPD (60,000 BPD) four retort commercial plant
- o 1992 - 275,000 TPD (100,000 BPD) eight retort commercial plant

Contact:

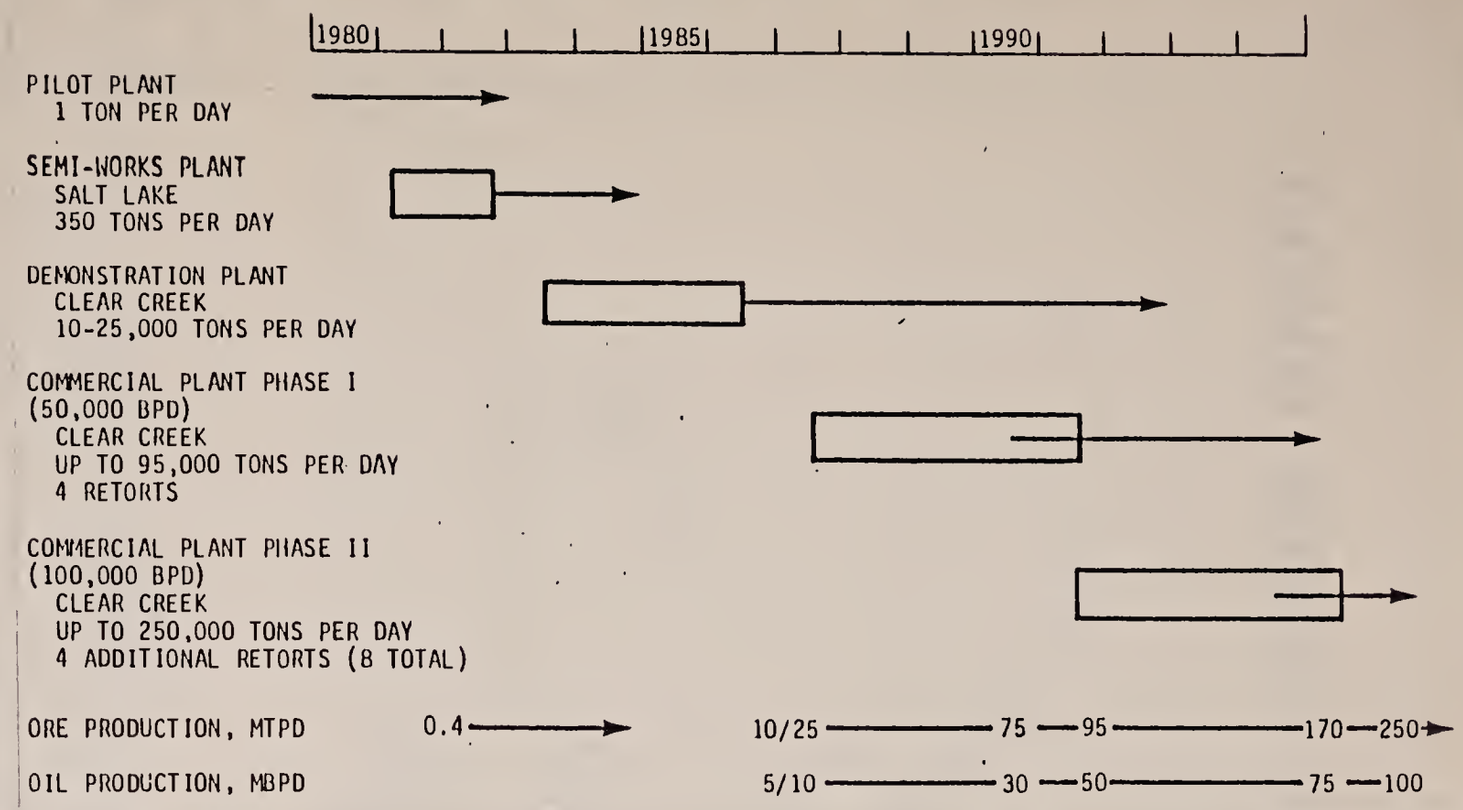
D. Roger Loper, President
Chevron Oil Shale Company
595 Market Street
San Francisco, California 94105
(415) 894-5983

Clear Creek Shale Oil Project

LOCATION MAP



RETORT DEVELOPMENT

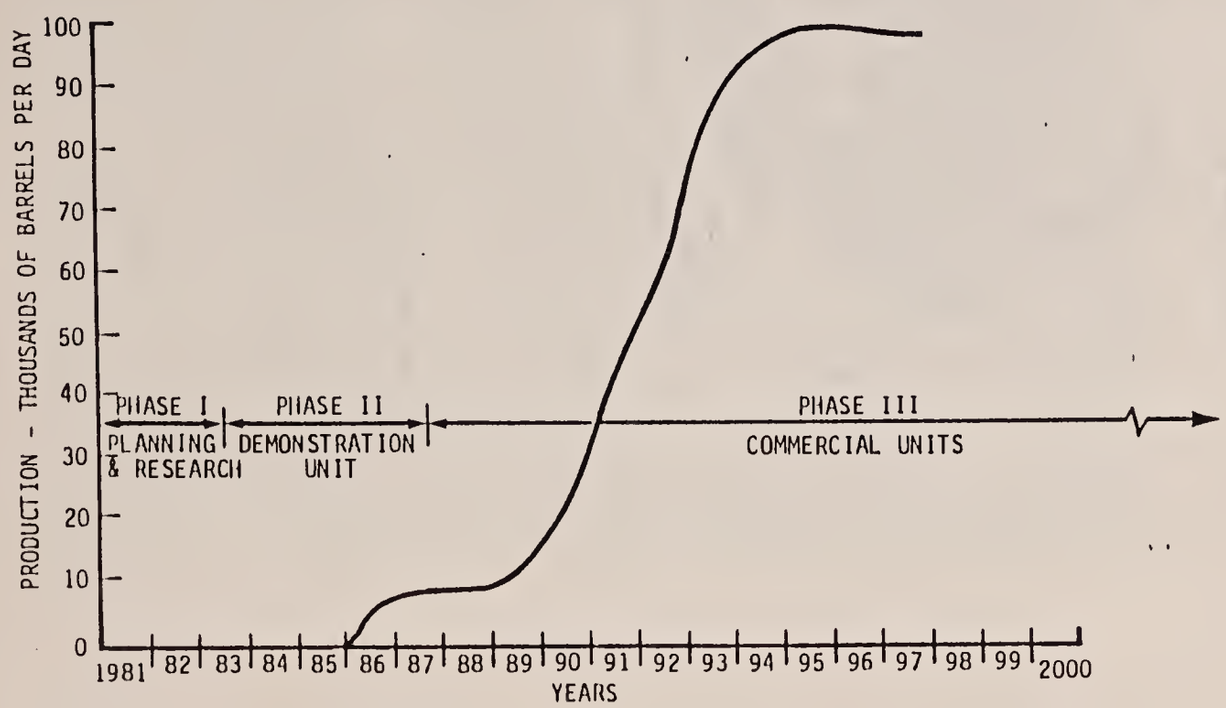


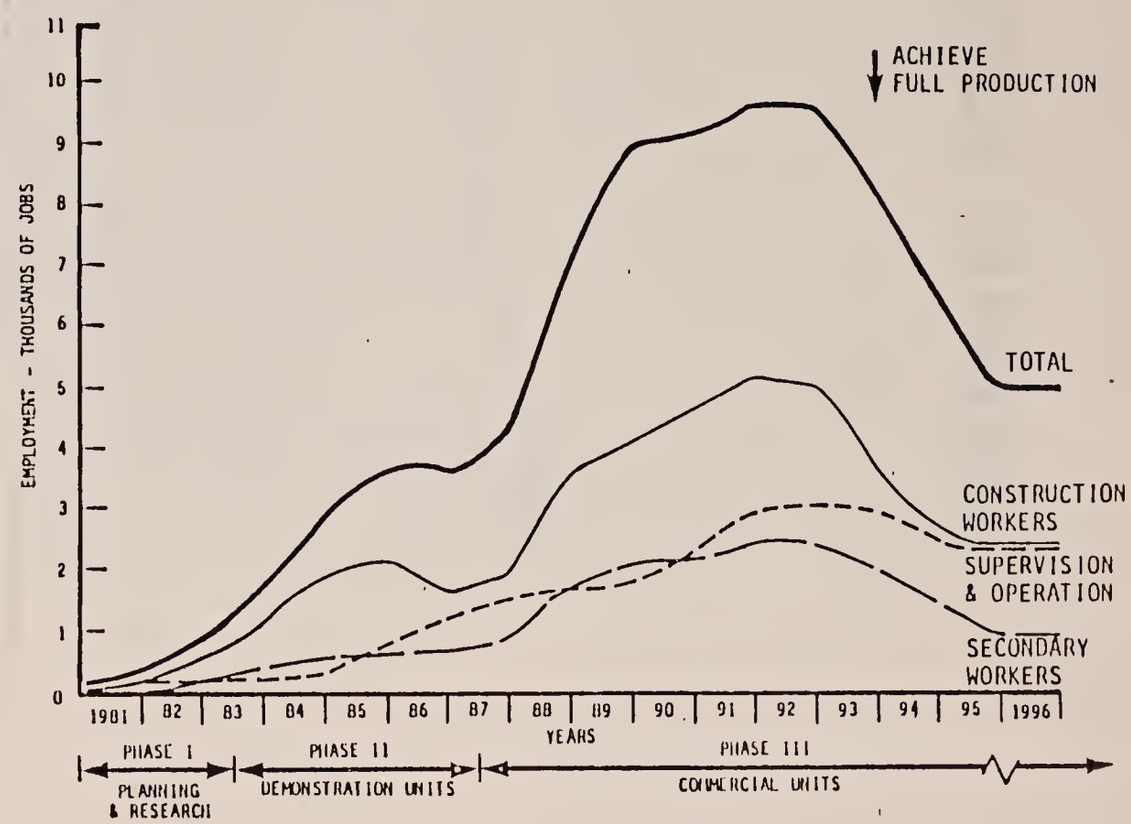
CHEVRON

MANPOWER REQUIREMENTS

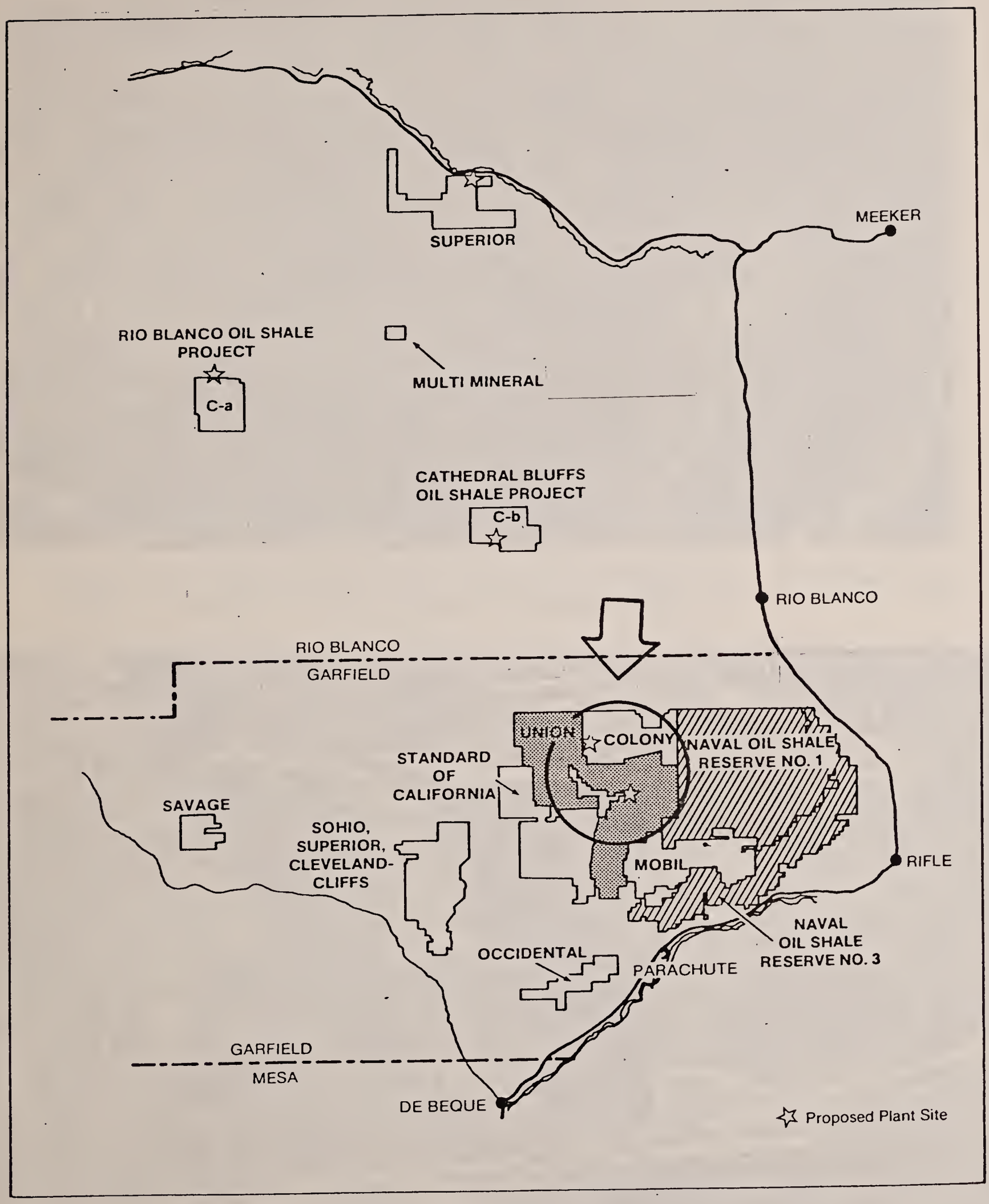
100,000 BPD PROJECT

PROPOSED PRODUCTION





LONG RIDGE PROJECT (Union)



COLORADO

Union Long Ridge

Union 5-acre mine bench on the south side of Long Ridge. Processed shale will be conveyed to valley bottom fill below bench.

This sketch shows Union's experimental oil shale project during operations. Crushed and screened shale will move from the underground mine onto a five-acre bench site, then be fed into the retort to extract the shale oil. The shale oil flows into storage tanks and retorted shale moves by conveyor to the enclosed chute end down to the bottom of the valley for spreading and vegetation. A drainage pond (lower left) will capture runoff water from the spent shale deposits along with rain and snow for use in the retorting process. East Fork Parachute Creek (lower right) will be protected from recycled water and other contaminants.

Long Ridge Project
(Commercial)

Company: Union Oil Company

Location: T5S, R95 to 96 W; 11 miles N of Parachute (formerly Grand Valley), Garfield County, Colorado, astride Parachute Creek. Long Ridge development site along north side of the East Fork of Parachute Creek. All fee land consisting of 20,000 acres of oil shale resource and 10,000 acres of bottom land (oldest project in the basin).

Resource:
- >15 gpt = 18 billion bbl's
- >25 gpt = 2 billion bbls
- Mahogany Zone 120' thick averaging 26 gpt, with 1.6 to 2 billion bbl's of recoverable shale oil (enough for 25 years of 150,000 BPD production).

Mining: Cliff entry at Mahogany Zone outcrop, room-and-pillar mine (55' x 60' rooms with 50' x 100' pillars), underground screening producing 68,000 TPD at 50,000 BPD capacity achieving 70% recovery across 60' high mining interval in Mahogany Zone that averages 31 gpt. Presently mining 4000 TPD to develop underground space for maintenance, warehousing, offices, and ore crushing.

Retorting: Plant on 5-acre bench excavated in cliff 1000' above valley bottom. 67,500 TPD (50,000 BPD) from six Union B, vertical up-flow, externally heated, rock pump retorts with 10' diam. pistons requiring <2" to >1/4" feed size. Start with 10,000 BPD (12,000 TPD) prototype facility with offsite upgrading facility near Parachute, Colorado. Sell upgraded oil for military fuels fabrication. Union B process produces high quality off-gas averaging 800 Btu/ft^3. Technology will be licensed to other companies.

Water: Will need up to 8000 AF/Y to be drawn from on site wells and from long-standing 62,000 AF/Y rights on Colorado River and impounded in reservoir on Parachute Creek.

Waste disposal: Valleyside fill in East Fork of Parachute Creek

Employment:
- 1,526 as of September 1981 (19% living in Grand Junction, 13% in Parachute, 28% in Rifle)
- 4,650 during peak construction in 1986
- 1,110 during sustained operation after 1988

Cost:
- $ 60 million to alleviate socioeconomic impacts through 1983 ($47 million housing, $12 million for community assistance
- $ 12 million annual payroll during construction
- $ 4 million annual payroll during operation
- $100 million for Phase I 10,000 BPD prototype module
- $2 to 5 billion for Phase II 50,000 BPD commercial plant
- Granted purchase price support for first 10 years of operation

- Granted $4 million from DOE for upgrading unit
- $400 million DOE price guarantee for 33 million bbl's fuel from 1983-93 at prevailing market price.
- Seeking $35 million in IDB's from Garfield County for pollution control equipment.

Contractor:
- Flour - design for upgrading facility
- Morrison-Knudson - mine development
- Stearns-Roger - retort design

Status:
- 1920 - Began acquiring oil shale holdings
- 1950's - Operated 50 TPD pilot retort in California.
- 1955 - Began test mining at Long Ridge property
- 1958 - Completed 1200 TPD (800 BPD) Union up-flow retort test run
- 1961 - 15,000 bbl's raw shale oil processed into fuel at Fruita, Colorado.
- 1970's - Process comparisons and economic evaluation
- 1974 - Announced Long Ridge Project to produce up to 150,000 BPD
- 1979 - Obtained conditional PSD and Colorado Mined Land Reclamation Board permits
- 1980 - Started mine and process bench construction and applied for 10,000 BPD PSD for upgrading plant
- 1981 - Granted DOE purchase price support effective in 1983 for 10 years at up to 3.3 million bbl's per year for Department of Defense use beginning at a base price of 42.50/bbl.
- 1981 - September: County approved Special Use Permit
- 1981 - October: Accepted for participation in Colorado Joint Review Process.
- 1983 - Start up of Phase I 10,000 BPD prototype retort and upgrading facilities
- 1987 - Commence Phase II 50,000 BPD commercial operation.
- -- - Scale up to 100,000 BPD.

Contact:

John M. Hopkins
President-Energy Mining Division
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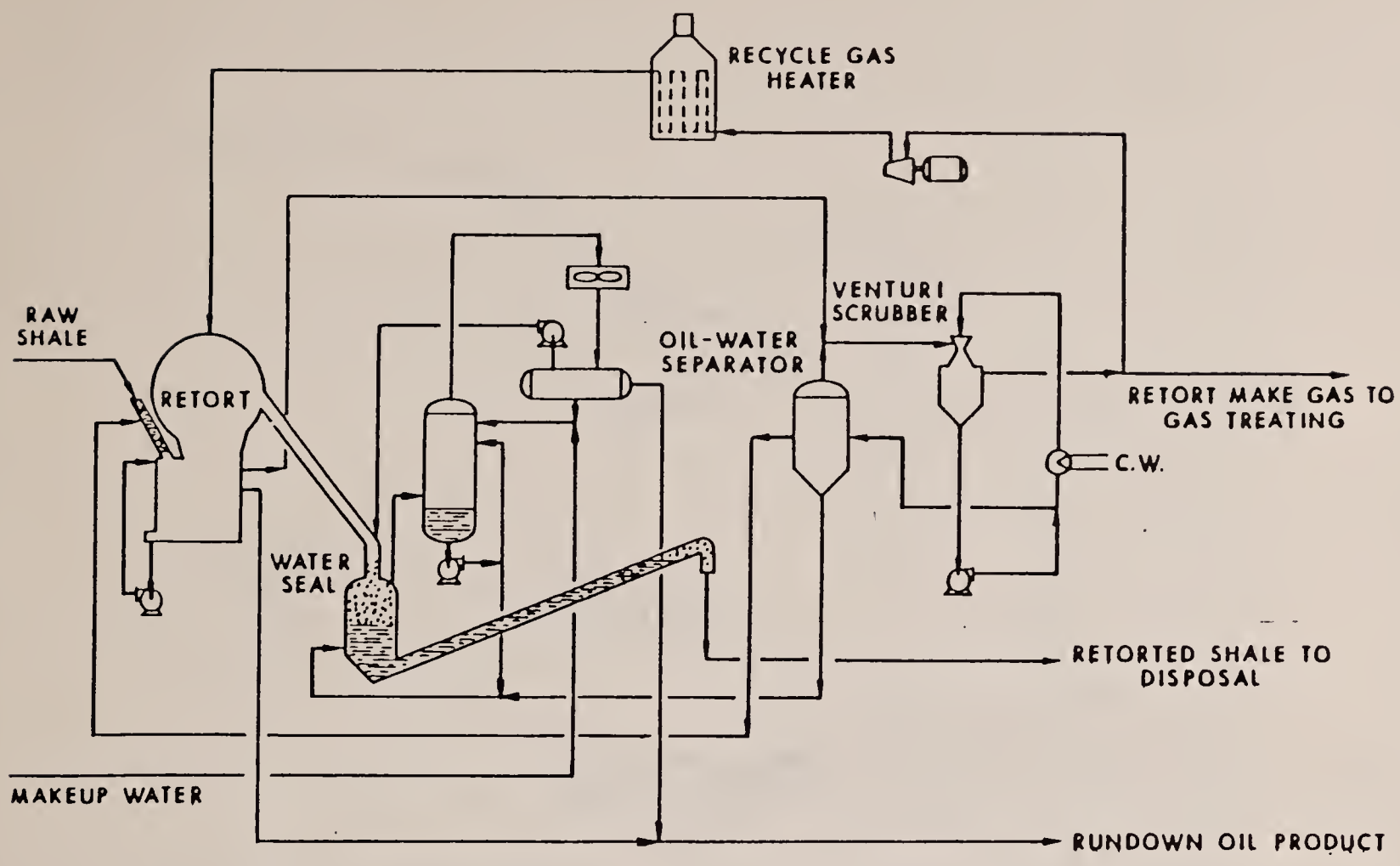
(213) 977-6437

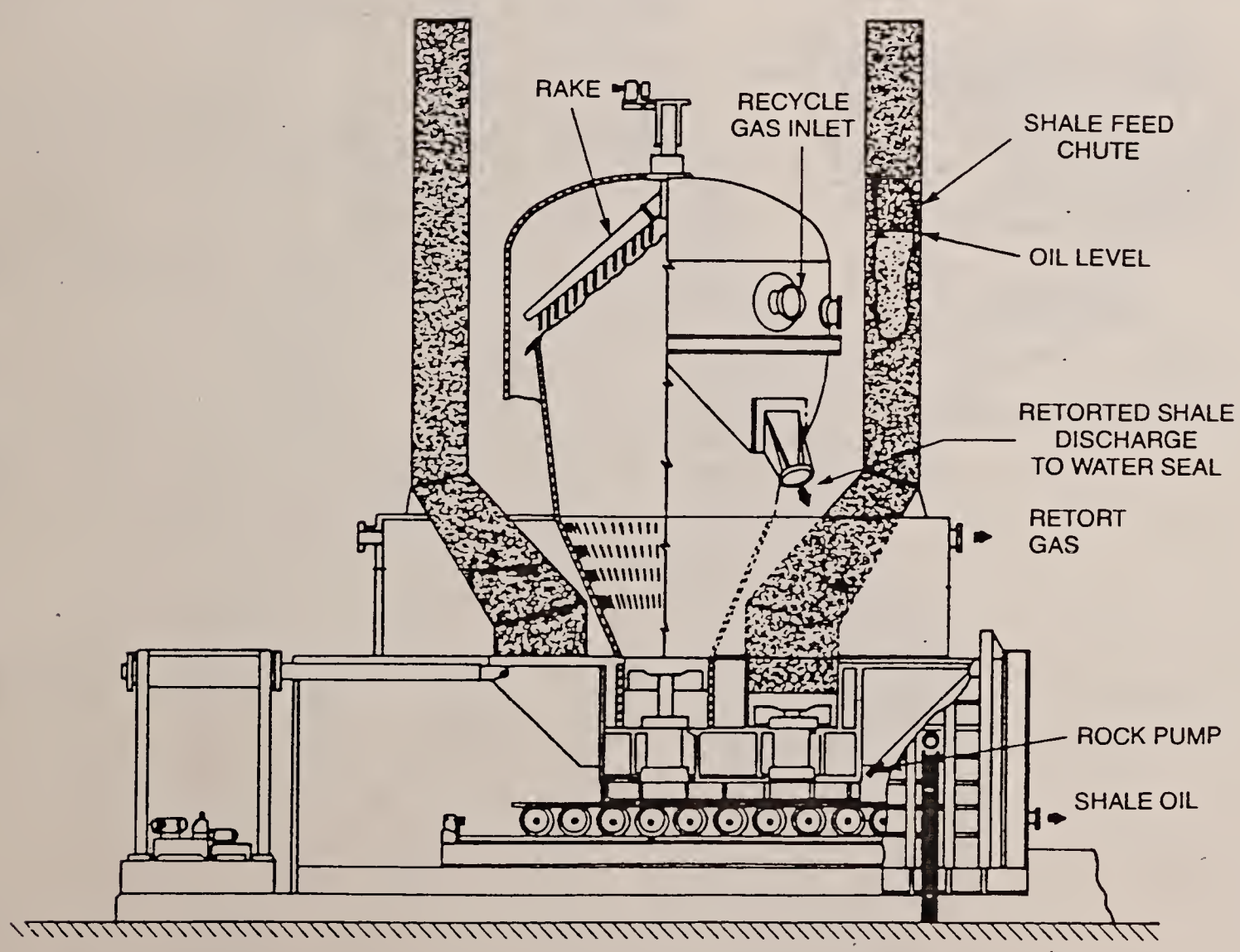
or

Nancy Poloski
Public Relations
Union Oil Company
2777 Crossroads Blvd., Suite 100
Grand Junction, CO 81501
(303) 243-0112

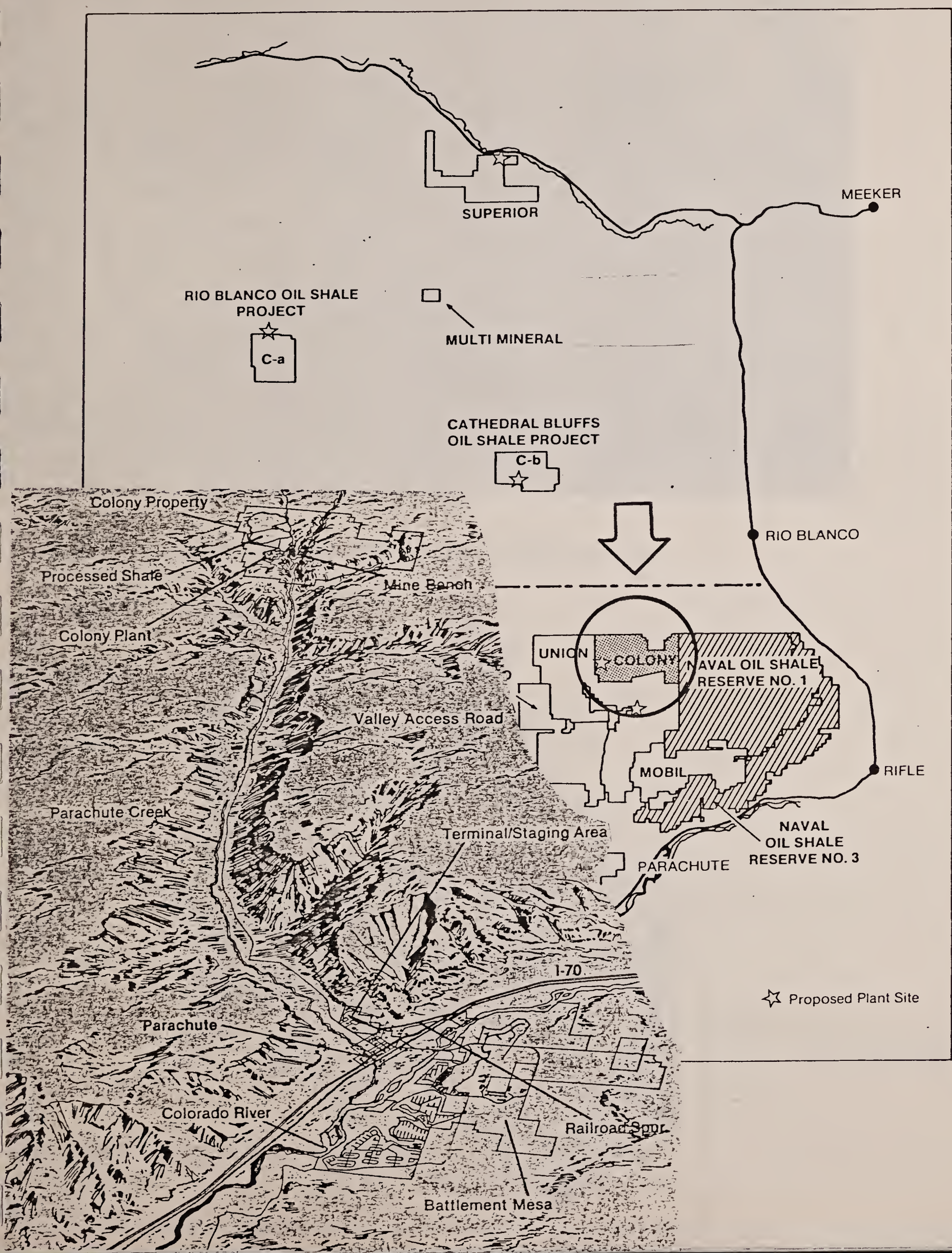
UNION RETORT B FLOW DIAGRAM



The Union Oil "B" Retorting Process

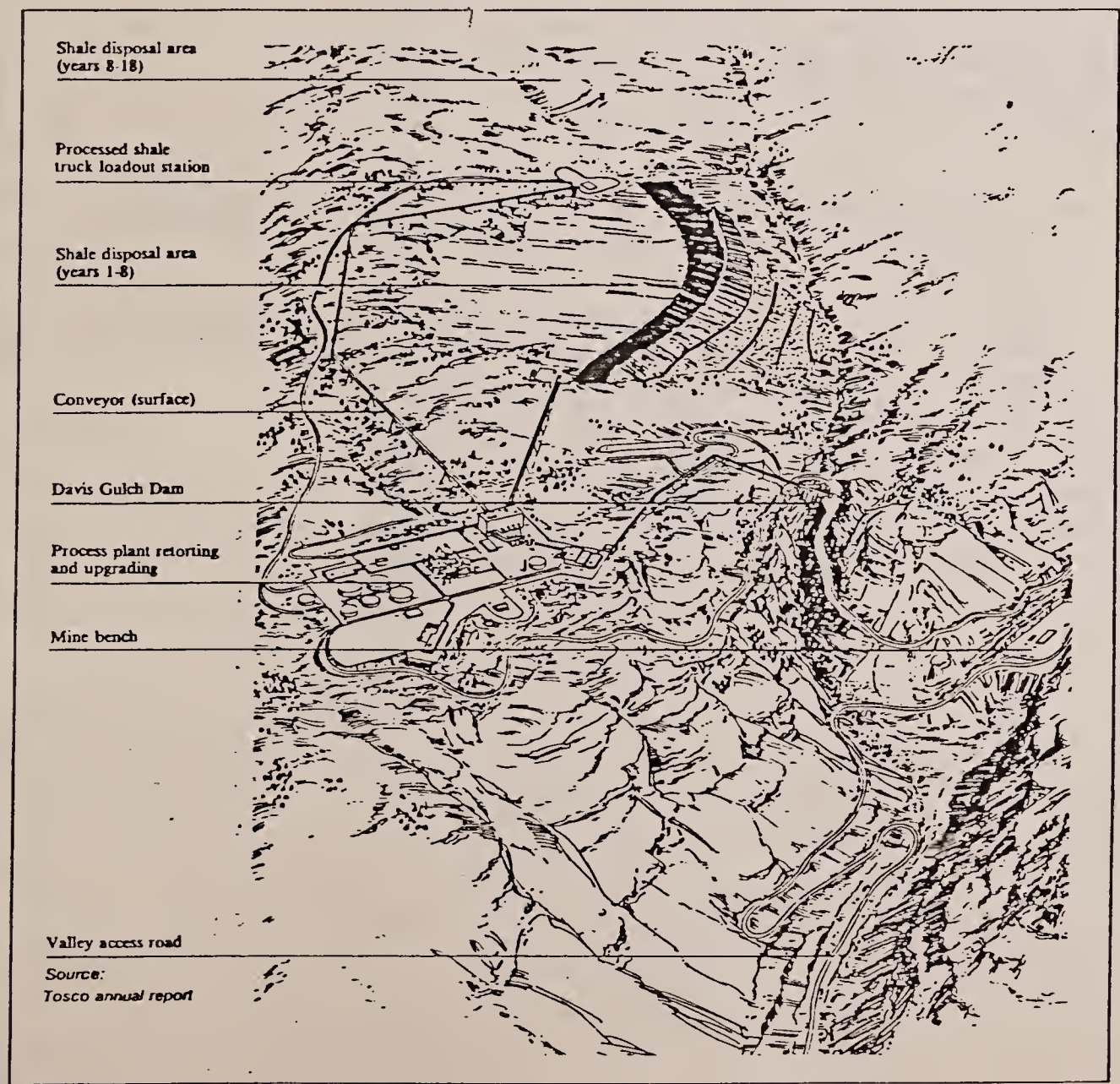


COLONY (Exxon & TOSCO)



Colony development site at head of Parachute Creek. Terraced cliffs near mine entry. Mined shale will be conveyed to process area being cleared on ridge top.

Colony project on schedule for 1985 startup



Source: Tosco annual report

Colony

Colony Development Operation
(Commercial)

Companies: Exxon USA (60%), TOSCO (40%)

Location: T5S, R95W; Dow West property, 16 miles N of Parachute (formerly Grand Valley), Garfield County, Colorado; at the head of Parachute Creek 3 miles north of Union's Long Ridge Project; 5,480 acres of fee land.

Resource:
- o 4,763 acres of oil shale resource (4,500 acres to be developed)
- o Mahogany Zone: 130' averaging 27 gpt (2.5 billion bbl)
- o R-6 and R-4 Zones: 1.5 billion bbl's
- o 634 million bbls recoverable.

Mining: Six adit cliff face entries on Majogany Zone outcrop at 7,100' elevation, 60'h x 55'w room-and-pillar, producing 66,000 TPD of shale averaging 34.7 gpt by late 1985, from a 60' thick section of Mahogany Zone with a planned recovery of 70% from beneath 500' to 1,000' of overburden. Mined shale will be crushed on mine bench and conveyed to ridge top stockpile and retort units.

Retorting: Six 11,000 TPD (8,000) BPD TOSCO II, externally heated recirculating hot ball (1/2-in ceramic) rotating kiln retort trains yielding 48,300 BPD with on-site upgrading (hydro-treated) by late 1985 (22 year life = 347 million bbl) from ridge top plants. Upgrading will also yield 50,000 st/yr ammona, 57,000 st/yr sulphur, 270,000 st/yr coke. Product oil will be pipelined to Casper, Wyoming.

Water: Require 9,000 AF/Y from commercial direct diversion rights on Colorado River (less than 1% flow in Colorado) and from purchased options on Green Mountain and Ruedi reservoirs.

Waste disposal: 800 acre valley fill in Davis Gulch in NW portion of property using topsoil replacement method.

Employment:
- o 669 as of June 1981
- o 3,250 during peak construction in 1984
- o 2,052 during sustained operation after 1987.
- o Developing new town of Battlement Mesa (300 mobile homes and 175 RV sites installed as of August 1981. 675 single-family homes to be installed in $60,000 to $200,000 price range. Will also include golf course, convenience store, apartments, recreation center, and nine schools).

Cost:
- o $400 million paid out by Exxon for ARCO's 60% interest in project
- o $300 million for final design of six 11,000 TPD TOSCO II retorts
- o $65 million for socioeconomic impact monitoring.
- o $350 million for community development over life of project
- o $3.5 billion for total project (including interest and inflation during construction)
- o $1.1 billion DOE loan guarantee covering 75% of TOSCO's 40% share of project in exchange for sale of 10,000 BPD to DOE at prevailing market price for defense fuels.
- o No subsidies requested by Exxon
- o $75 million for research and engineering
- o $12 million for definitive engineering and cost study

Contractors:
- o C. F. Braun - final retort design for TOSCO II ($300 million)
- o Brown and Root - construction
- o Stearns-Roger - project design and construction liaison for mine support
- o Foster-Wheeler - upgrading plant design and pipeline transmission study

Status:
- o 1963 - Colony Project established as joint venture between ARCO and TOSCO
- o 1964 to 1972 - Operated test mine producing 1.2 million st of 34.7 gpt oil shale for testing.
- o 1970 to 1972 - 1000 TPD (700 BPD) semi-works processing 220,000 st (180,000 bbl)
- o 1974 - Development suspended
- o 1977 - Colony plant and pipeline EIS issued by BLM
- o 1979 - July: Obtained conditional PSD permit for commercial plant
- o 1980 - Feb: Completed land exchange to eliminate several small federal windows
  - Begin construction of Battlement Mesa community
  - Aug: Exxon acquired ARCO's 60% interest for $400 million
  - Oct: Obtained Colorado Mined Land Reclamation Permit
- o 1981 - Sept: Public hearings on La Sal common carrier pipeline to Casper, Wyoming, draft EIS
  - Aug: DOE awarded TOSCO $1.1 billion loan guarantee under ESA/DPA in return for 10,000 BPD for military fuels.
- o 1985 - Initiate commercial production scaling up to 48,300 BPD

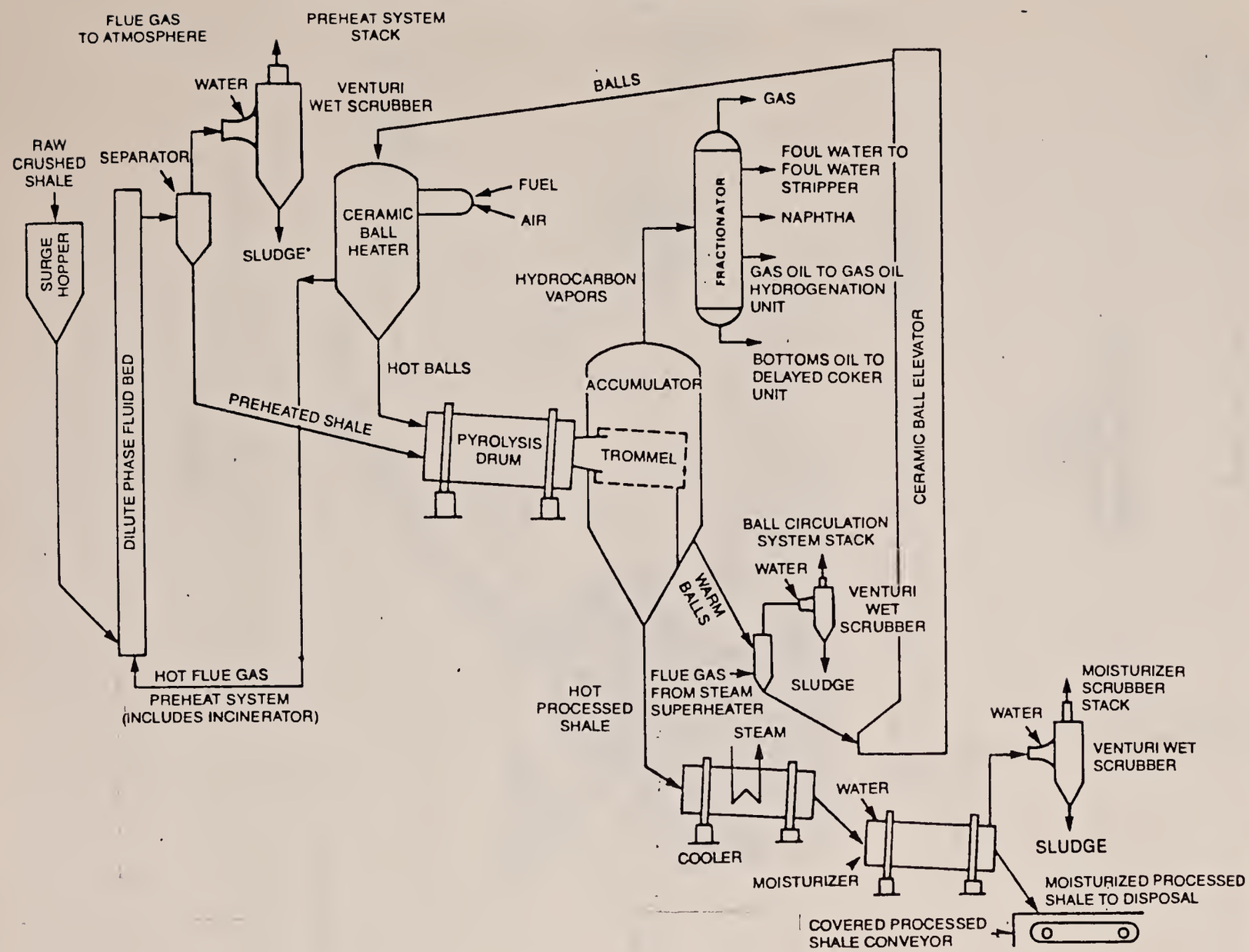
Contact:

R. A. Jarvis
Colony Shale Oil Project
P.O. Box 14342
Aurora, Colorado 80014

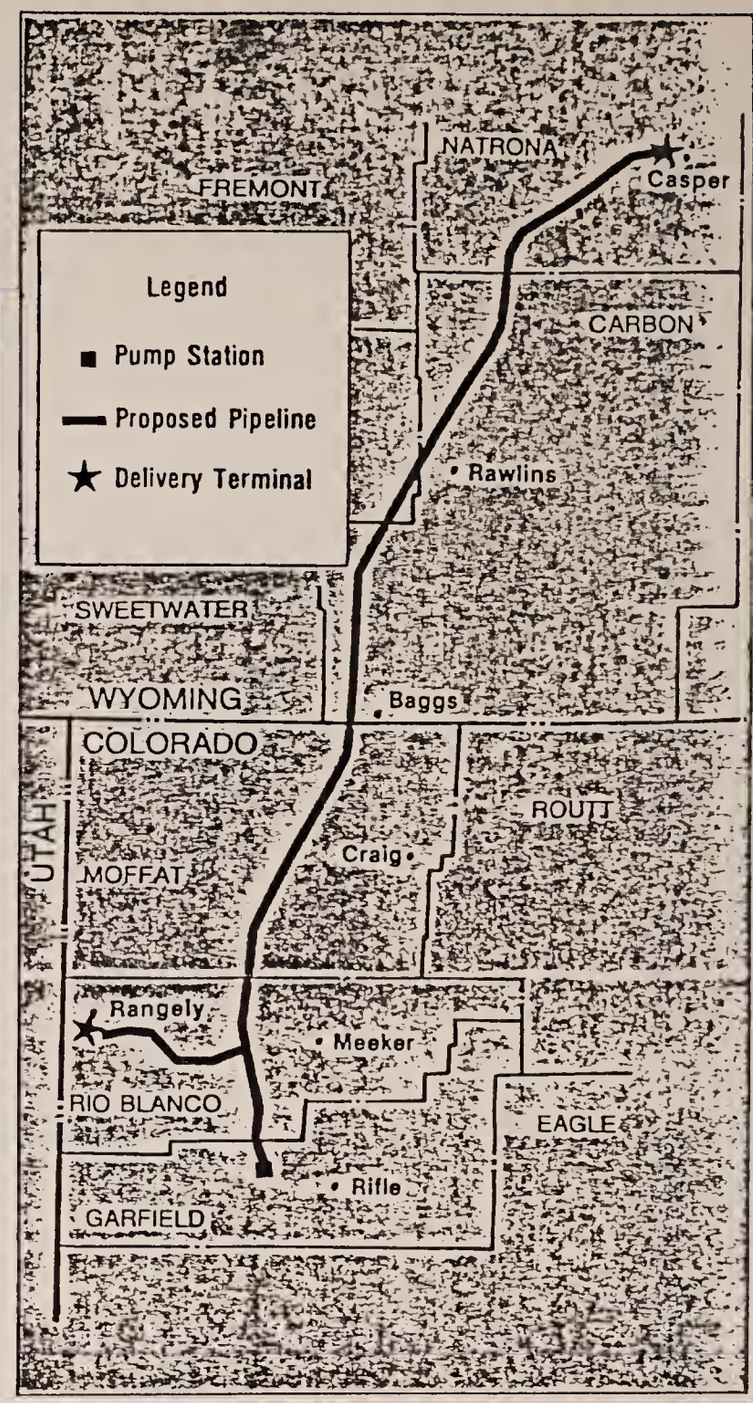
General inquiries: (303) 244-3900
Visitor Center: (303) 285-9237
Colony Mine: (303) 241-0998

Colony

Figure 44.—The TOSCO II Oil Shale Retorting System

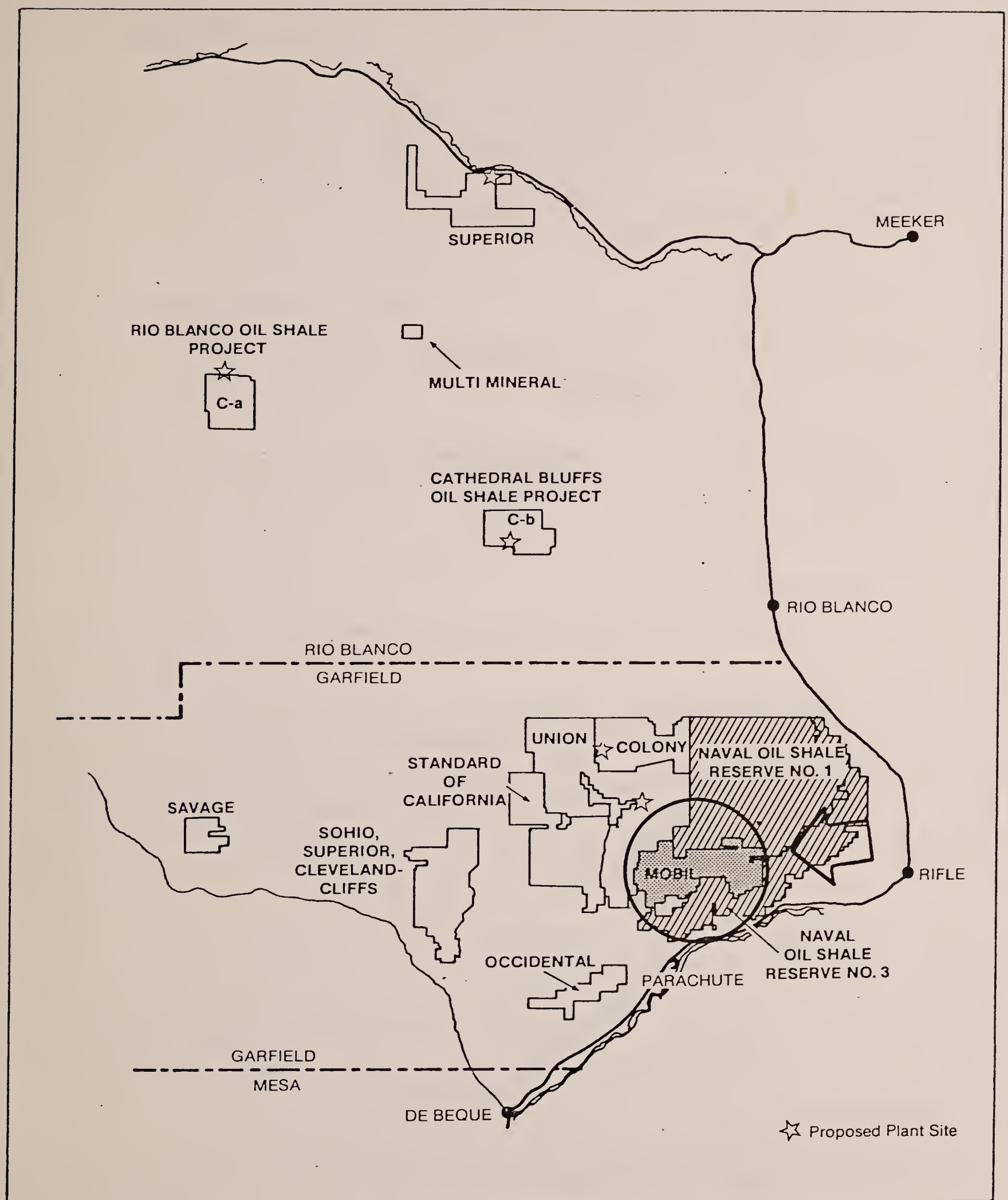


LaSal's proposed pipeline



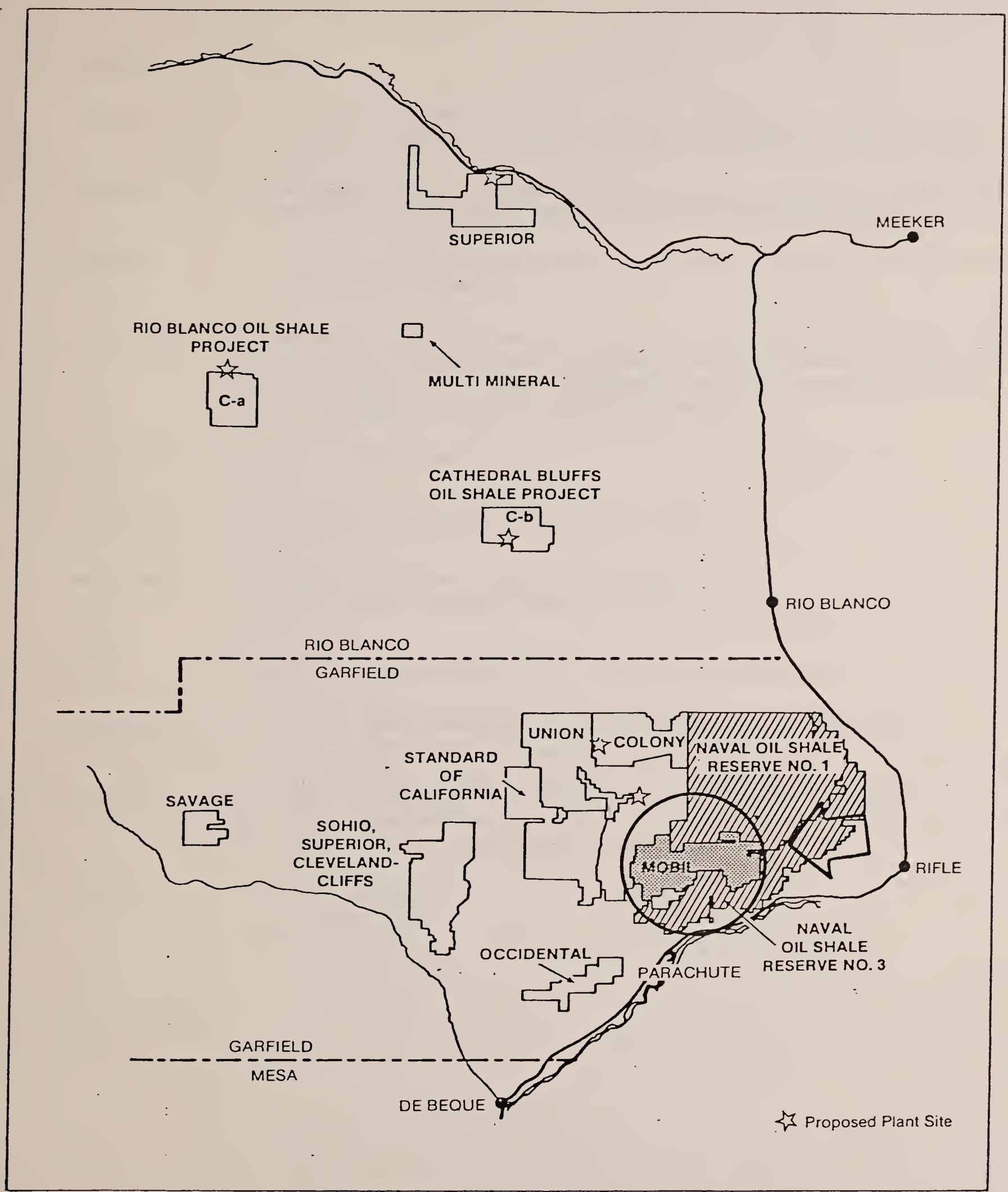
LaSal Pipeline Co., a Houston, Tex., subsidiary of the Exxon Co., USA, is seeking rights-of-way for a 16-in. pipeline to carry the crude shale oil output of the Colony project from the site in Garfield County, Colorado, 302 miles northeast to Casper refineries. The common-carrier pipeline also would be available to other customers. From Casper, crude can be moved through existing lines to the Midwest. A 12-in. spur would be built to the Rangely oilfield to gain access to existing lines to Salt Lake City. Construction will begin in 1984 if all permits are received when expected. Completion in 1986 will coordinate with the expected on-stream date of the Colony plant. Final environmental impact statement on the line is planned to be released in November, according to the Wyoming Bureau of Land Management. About 45% of the line's route follows existing pipeline and utility easements, the agency said.

PARACHUTE PROJECT (Mobil)



COLORADO

PARACHUTE PROJECT (Mobil)

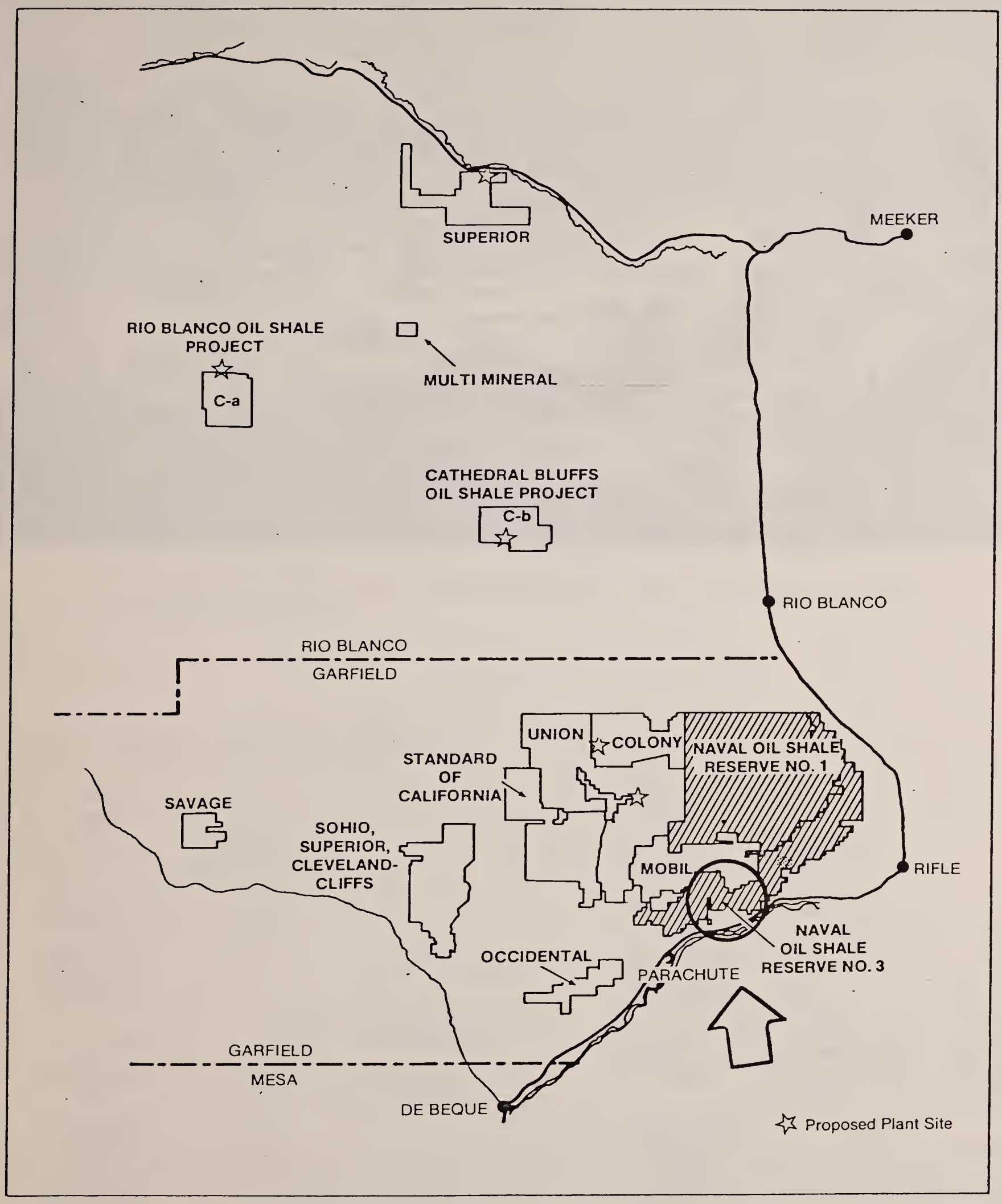


COLORADO

Parachute Project
(Commercial)

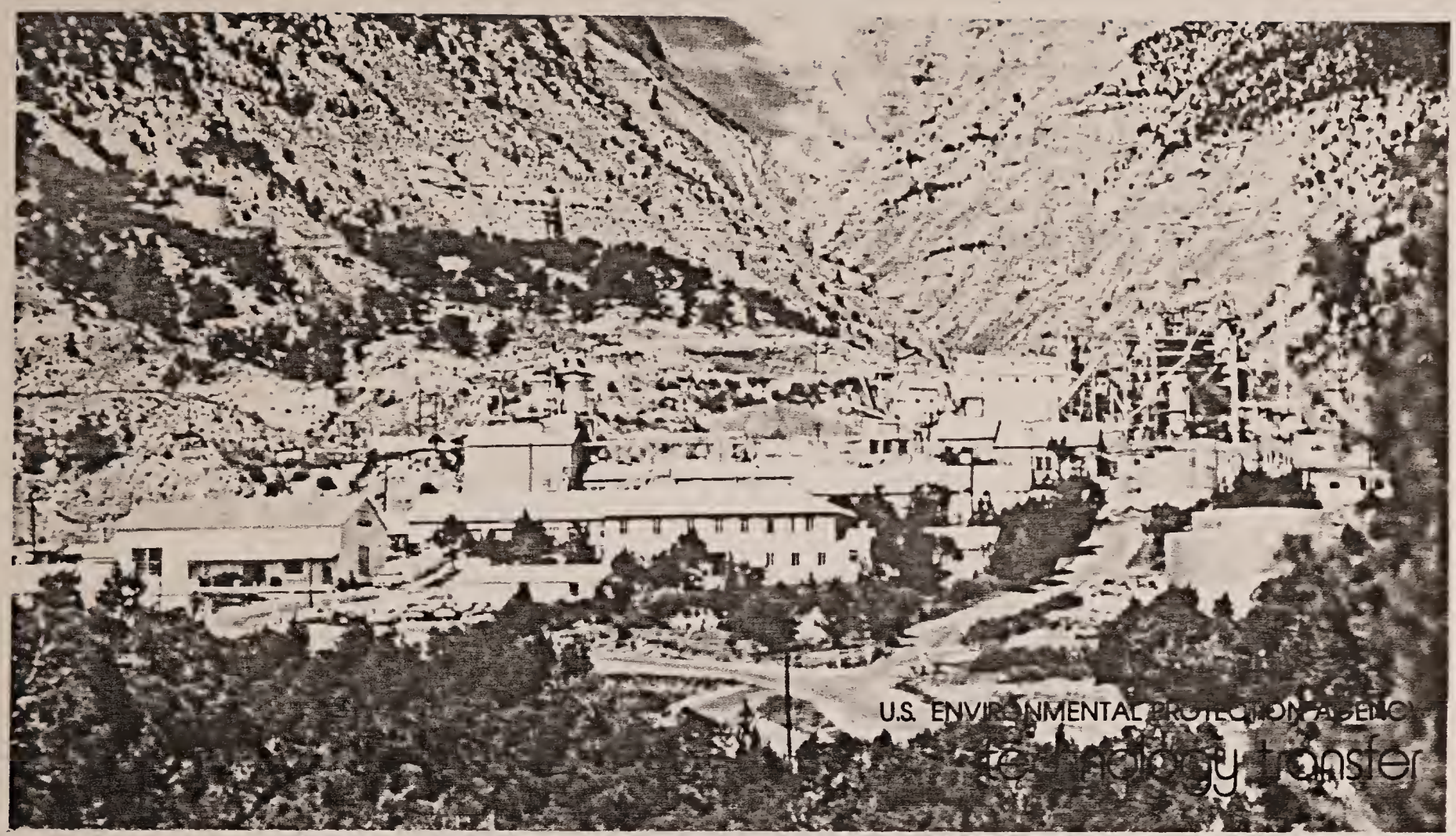
Company:	Mobil
Location:	T6S, R95 & 96W; 8 miles north of Parachute (formerly Grand Valley), Garfield County, Colorado; 8,500 acres of fee land
Resource:	Mahogany Zone approximately 100' thick, averaging 25 gpt, or 200,000 gallons/acre, mine interval averages 30-35 gpt
Mining:	Probably cliffside Mahogany Zone entry room-and-pillar with underground crushing
Retorting:	Surface retorting using Mobil's own process selected from several designs under consideration producing 50,000 to 100,000 BPD. A 12,500 BPD module would be constructed first. Considering MIS for secondary recovery.
Water:	No available data
Waste Disposal:	Probably valley fill in Wheeler Gulch
Employment:	o 2,220 during peak construction in 1989 o 919 during sustained operation after 1995
Cost:	o $4 billion total project cost o Mobil seeking Federal loan and price guarantees
Contractor:	Bechtel Petroleum Inc. - Preliminary engineering and construction permit planning
Status:	o 1980 - planning and limited environmental monitoring o 1985 - commence construction o 1990 - start of commercial production
Contact:	P. L. Fuselier P.O. Box 1772 Denver, Colorado 80217

ANVIL POINTS (Paraho)

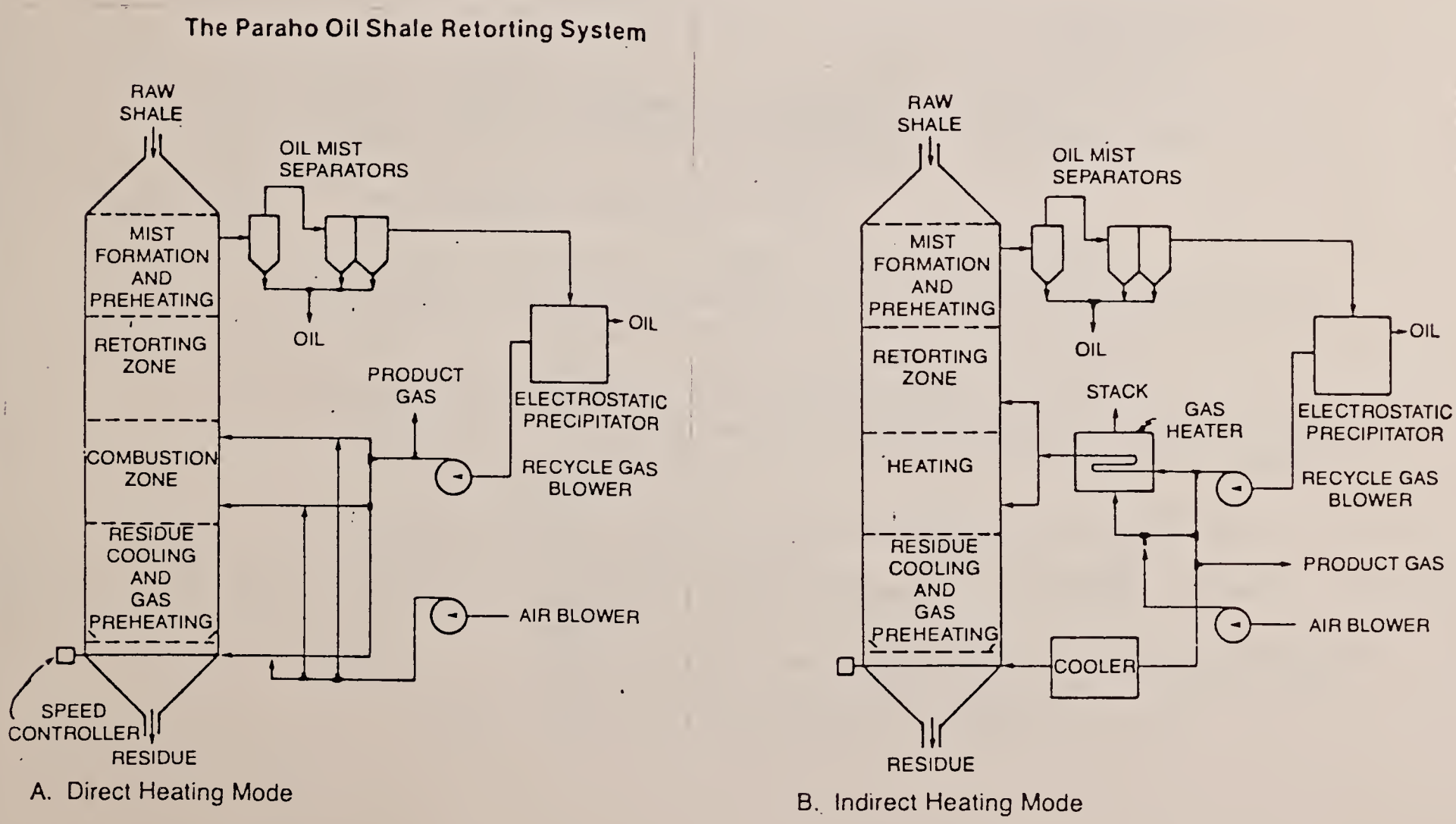


COLORADO

Anvil Points



Anvil Points/Paraho experimental vertical retort facilities on Naval Oil Shale Reserve #3.



Anvil Points
(Non-Commercial)

Company: Paraho Development Corporation representing 17 partners

Location: Southern edge of Naval Oil Shale Reserve #3, 8 miles from either Parachute or Rifle, Garfield County, Colorado; at mine and retort site developed by the U.S. Bureau of Mines beginning in 1945 and currently administered by DOE; 55,000 acres of Federal resource.

Resource: Five billion bbl's of greater than 25 gpt in 120' thick Mahogany Zone with cliff exposure.

Mining: Cliff entry at Mahogany Zone outcrop; experiment 60'x60'x60' room-and-pillar two bench advance; 1.3 million tons mined since 1945

Retorting: NTU/Paraho pant leg vertical shaft, down flow (counter current gas flow) direct/indirect heated oscillating grate retort. Produced 110,000 bbl's to date from a 20 BPD and a 200 BPD (300 TPD) semi-works retorts, of which 88,000 bbl's were refined into military fuels. Have processed bulk shale samples from Israel and Morocco.

Water: Paraho modified retort requires about 1/2 bbl water/bbl shale oil.

Waste Disposal: Valley side dump

Employment: 30 to 128 residing mainly in Grand Junction, Rifle, and Parachute

Cost:
- o $3.2 million DOE grant for 3 retort 30,000 BPD facility design
- o $25 million expended to date at Anvil Points
- o $10 million for Paraho demonstration program at Anvil Points

Contractor: Development Engineering, Inc.

Status:
- o 1916 - Creation of NOSR by Executive Order
- o 1944-45 - Experimental mine and NTU retort developed by U.S. Bureau of Mines
- o 1964-68 - Facility operated by Mobil
- o 1972 on - Facility operated by Paraho
- o 1976-78 - Production runs for DOD yielding more than 100,000 bbl's. Continuous 105 day test achieved yields of 96%.
- o 1980 - July: DOE $3.1 million grant for 30,000 BPD feasibility study.
- o 1980 - September: EIS released for 4,700 BPD Paraho module
- o 1981 - Commercialization project moved to private property near Bonanza, Utah (T10S, R25E), see "Paraho-site."

  Fall: Test run of Marathon Oil Company process

Contact: Harry Pforzheimer, Jr., President
Paraho Development Corporation
300 Enterprise Building
Grand Junction, Colorado 81501
(303) 243-9550

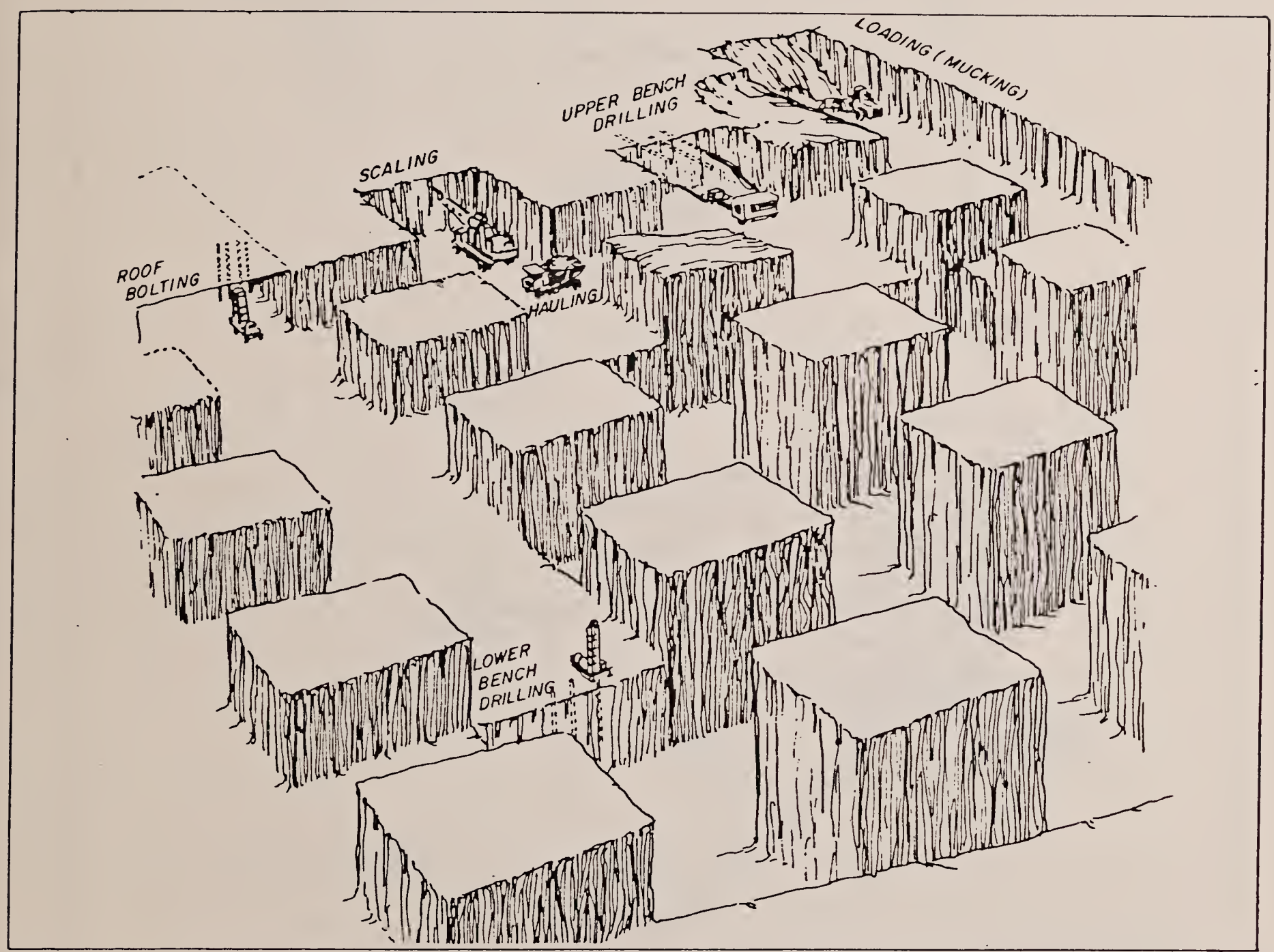
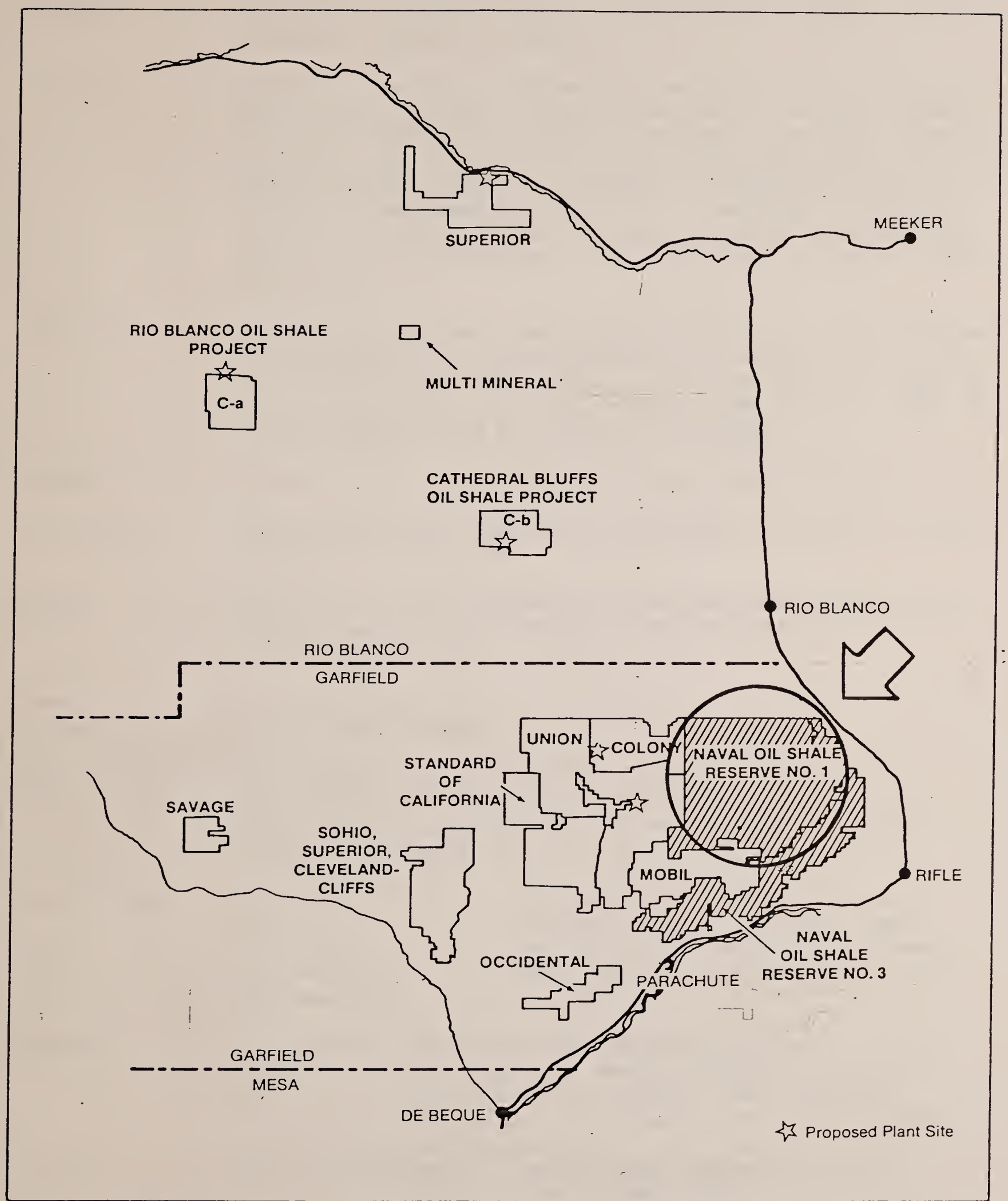


Figure 16. Room and Pillar Mining.
Source: Final EIS, Colony Development Operation Site, USDI, BLM

NAVAL OIL SHALE RESERVE



COLORADO

Naval Oil Shale Reserve Project
(Strategic Operation)

Company:	Management funded by DOE and administered by BLM, with TRW providing management support.
Location:	144,100 acres of oil shale resource in Colorado and Utah - NOSR #1 (T5S, R95W, 8 miles NW of Rifle, Garfield County, Colorado) covers 40,760 acres containing 18 billion bbl's of resource, 2.3 billion bbl's considered recoverable from the Mahogany Zone. NOSR #3, includes 14,130 acres abutting #1 along south and east and contains no commercially significant resources. NOSR #2 (50 miles south of Vernal, Carbon County, Utah) covers 90,440 acres. All Federal land except 320 acres on NOSR #2.
Resource:	At NOSR #1, Mahagony Zone averages 120' thick at 26 gpt from cliff exposure to 1000' overburden with reserves of 6 billion bbl's of >25 gpt shale and 18 billion bbl's of >15 gpt, of which 2.5 billion bbl's are considered recoverable. NOSR #2 in Utah contains 2.8 billion bbl's reserves.
Mining:	Probably cliff entry room-and-pillar at NOSR #1 and 3
Retorting:	Investigating all commercial technologies leading to 50,000-200,000 BPD production
Water:	o USGS gathering and evaluating surface and ground water data. o Pursuing perfection of Federal reserved right doctrine in Colorado water Court.
Waste Disposal:	Probably valley fill.
Cost:	o $2.16 million for 1979 and $3.9 million for 1980. o $26.3 million for Predevelopment Program o $62 million for resource, environment, technology, socio-economic assessment
Contractors:	o TRW, Inc. o TOSCO o C.F. Braun o Gulf Research o Williams Bros. All part of TRW assessment team to provide resource appraisal, shale oil production system, EIS, community plan, and master development plan.
Status:	o 1916 & 1924 - Executive Orders creating NOSR's o 1945-52 - U.S. Bureau of Mines core drilling program o 1977 - TRW selected to perform 5 year resource, technology, environmental and socio-economic assessment. o 1977 - March: Congressional approval of biotic/abiotic predevelopment program for overall commercialization strategy

- o 1978 - June: Contract awarded for NOSR development master plan
- o 1978 - Completed predevelopment core drilling program.
  - USGS completed hydrologic evaluation program.
- o 1980 - September: Draft EIS issued on government and/or industry development options
  - August: Publish Draft Conceptual Design of Shale Oil Systems for NOSR #1
- o 1981 - Final EIS adopts no-development option.
- o 1982 - DOD seeking 128,520 BPD synfuel supply

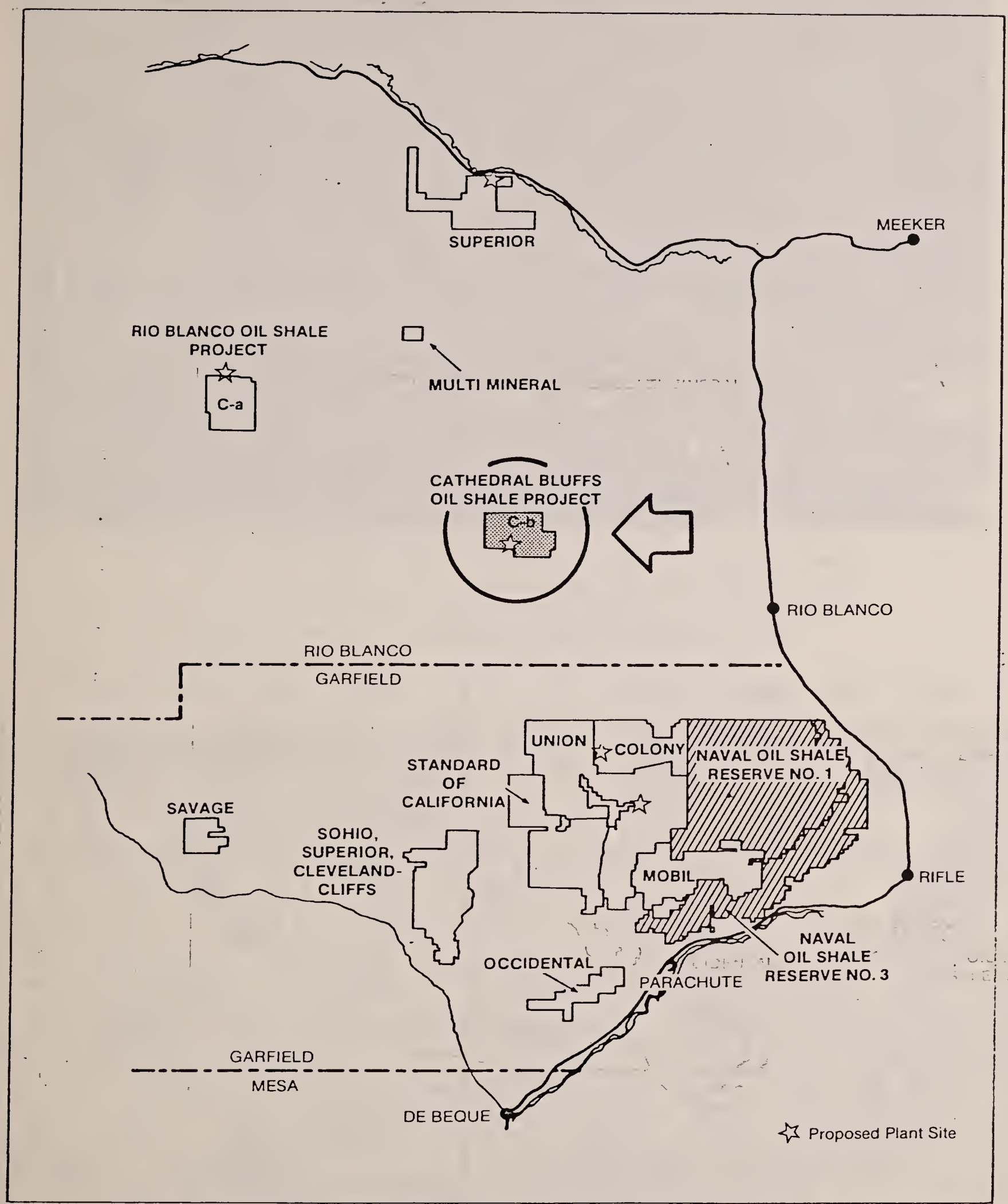
Contact:

Dan Newquist
Project Officer
Naval Petroleum & Oil Shale Reserves
800 W. Werner Court, Suite 342
Casper, WY 82601

(307) 265-5550, ext. 5161

CATHEDRAL BLUFFS OIL SHALE

(Oxy & Tenneco)

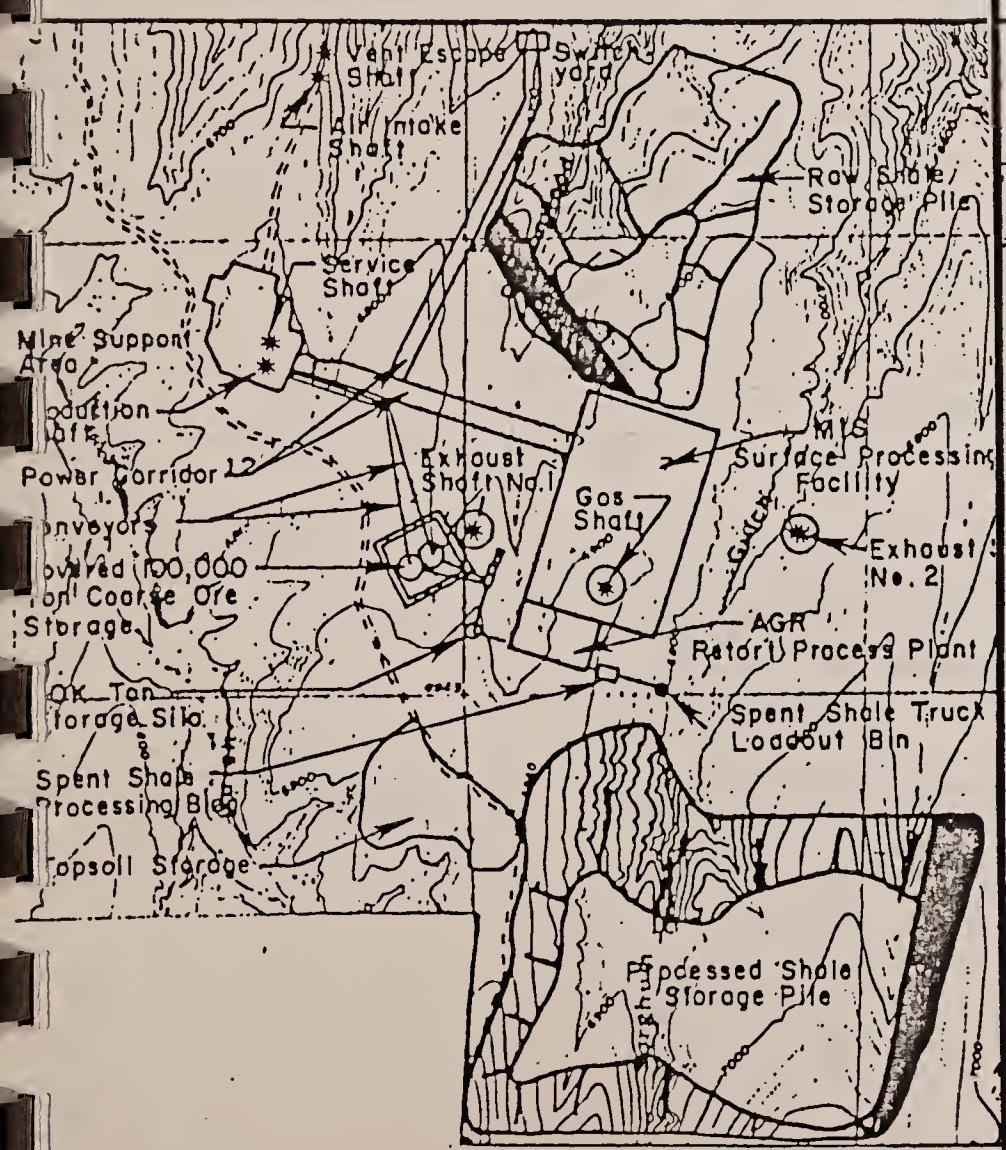


COLORADO

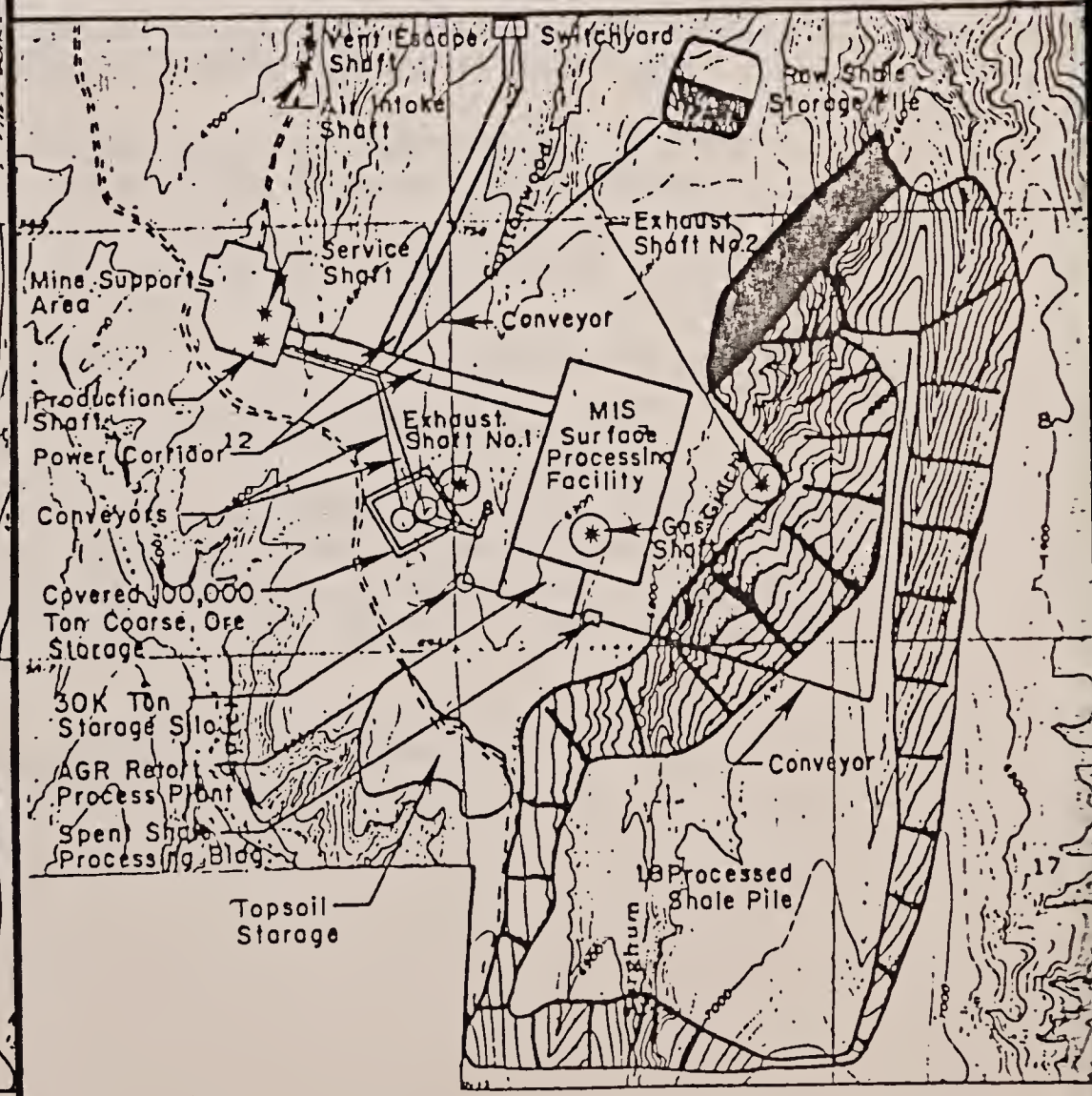
Cathedral Bluffs

Mine Support Area on Colorado Federal Tract C-b. Concrete headframes overstands Service and Production Shafts that will accommodate up to 60,000 TPD shale production. Leveled area adjacent to headframes will be occupied by office, shops, warehouses, and change houses.

PLOT PLAN - 10th YEAR



PLOT PLAN - 25th YEAR



Federal Tract C-b
Cathedral Bluffs Shale Oil Company
(Commercial)

Companies: Occidental Oil Shale, Inc. (operator), Tenneco Shale Oil Company (partner)

Location: T3S, R96 & 97W, Rio Blanco County, Colorado; Federal lease of 5,039.9 acres, 41 miles northwest of Rifle.

Resource: 1,860' of Mahogany Zone (180'thick) downward thru R-4 Zones contain 13 billion bbl's averaging 18.6 gpt with approximately approximately 1,200' overburden. 290' mining zone (M2 to top L-5) contains 2.82 billion bbl's reserve, of which 2.54 billion bbl's potentially recoverable, while 1.08 billion will probably be produced.

Mining: MIS development from 5 mine levels across 290'-315' interval including Mahogany Zone to top L-5 using multiple level room-and-pillar methods on 3 intermediate retort development levels to mine out 20-30% of shale in each MIS retort column followed by explosive rubblization into chambers up to 168'w X 400'l X 290'-315'h, requiring up to 300,000 lb explosives per day. Three shafts sunk: 15' diam. Ventilation/Escape completed to 1617' and flooded until 1983, 34' diameter Service Shaft completed to 1757' and being equipped with permanent hoist and utilities, and 29' diameter Production Shaft at TD of 1867' and being equipped with permanent ore handling facilities for 60,000 TPD capacity.

Retorting:

- AGR - 40% of total production from 8 recirculating processed shale solids heat transfer Lurgi type retort trains handling 56,000 TPD (47,000 BPD). Considering other AGR types including Paraho.
- MIS - 60% of total production from rubblization and burn of up to 1800 MIS units across 290' interval over 40-year project life with 1' per day burn rate for 293 day life averaging 53,000 BPD from 40 to 90 simultaneously burning units.
- 117,000 BPD combined AGR/MIS protection by 1992 with pipeline transport to refinery.
- 229 TPD ammonia and 2,390,000 scf/d of low Btu gas.

Water: 10 million GPD or 2.4 bbl water/bbl oil from mine pumpage (6,400-16,000 ACF/Y, and rights on Piceance Creek and White River (52,000 ACF/Y from White River Reservoir) 9,900 ACF/Y required for retorting and 1,000 ACF/Y for stream flow augmentation.

Waste Disposal: Valley fill with reconstructed soil horizon

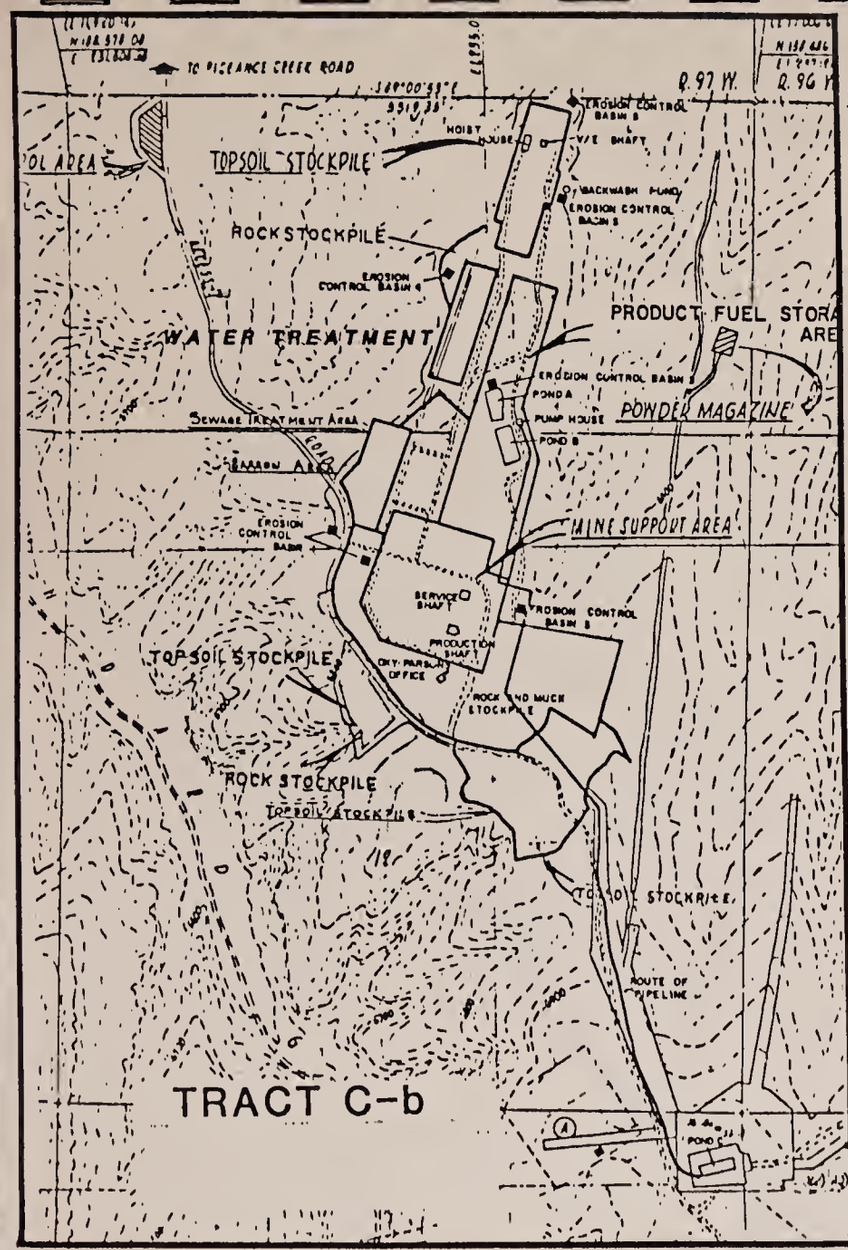
Employment
- o 560 working on tract as of August 1981
- o 5,200 during peak construction in 1988
- o 4,400 during sustained operations after 1992

Cost:
- o $117.8 million bid for Federal lease tract
- o $280 million expended to date at up to $50 million annually
- o $5.9 billion for commercialization through 1990
- o $29 to $50 million current annual development expenditure
- o Applied for Federal loan guarantee of $4.3 billion (SFC limited to $3 billion)

Contractors:
Dravo - underground engineering
Flour - managing
Bechtel - mine design
Brown & Root - construction
Gilbert - shaft sinking

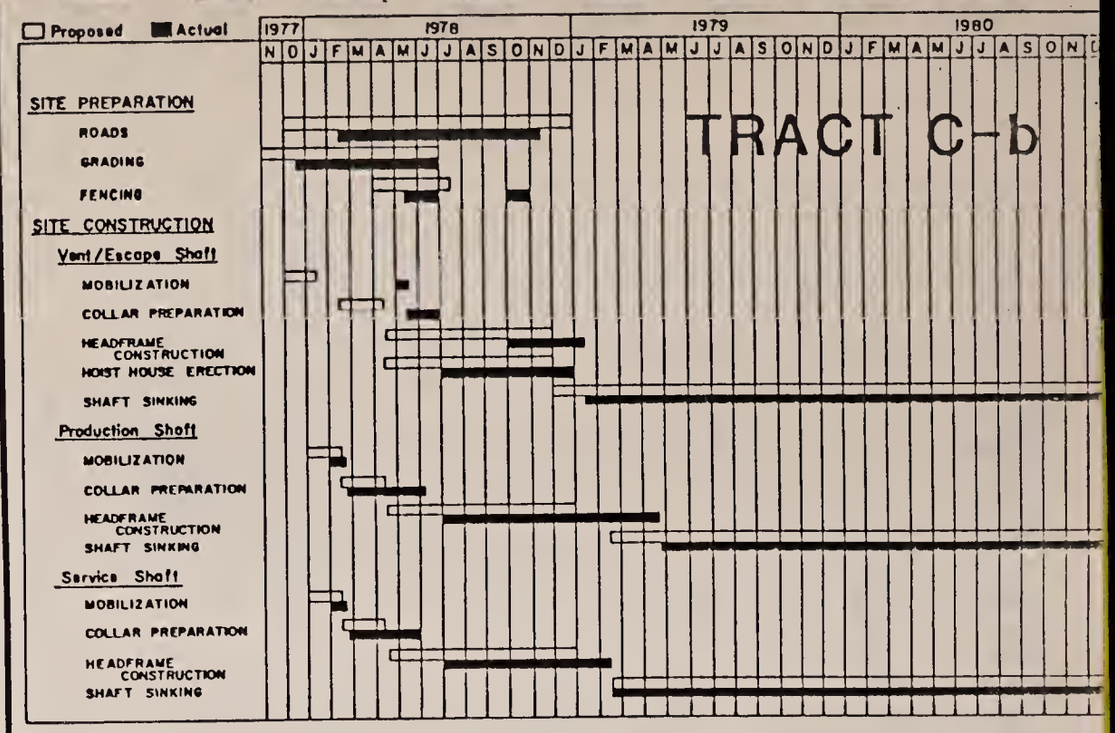
Status:
- o 1974 - Tract leased to Shell, Arco, Ashland, and TOSCO for $117.8 million
- o 1974-76 - Two year environmental baseline data gathering program
- o 1975 - Arco and TOSCO withdrew from project
- o 1976 - Shell withdrew from project
- o 1976 - March: Requested dispersion of operations (granted in August)
- o 1976 - March: Submit first DDP for room-and-pillar mine/AGR for 57,000 BPD
- o 1977 - August: DDP Modification approved for MIS development
- o 1977 - September: Suspension of operation terminated
- o 1977 - December: EPA issued conditional PSD & environmental groups seek to enjoin development
- o 1978 - August: U.S. District Court dismiss environmental suit
- o 1978 - October: Concrete head frames completed
- o 1978 - Ashland withdrew from project
- o 1979 - September: Tenneco acquires half interest in project for $110 million
- o 1981 - April: Completed sinking 34' diam. Service Shaft
- o 1981 - August: Completed sinking 15' diam. Ventilation/Escape Shaft
- o 1981 - December: Announced delay in development to reassess processing and mine configuration
- o 1982 - February: Lessees submit Final Draft DDP Revision for combined MIS/AGR development
- o 1984 - Commence Phase I commercial retort development
- o 1985 - Ignite first commercial retort
- o 1991 - Full commercial production of 117,000 BPD

Contact:
R. A. Loucks
Vice President and General Manager
Cathedral Bluffs Shale Oil Company
P.O. Box 2687
Grand Junction, Colorado 81502
(303) 244-3000

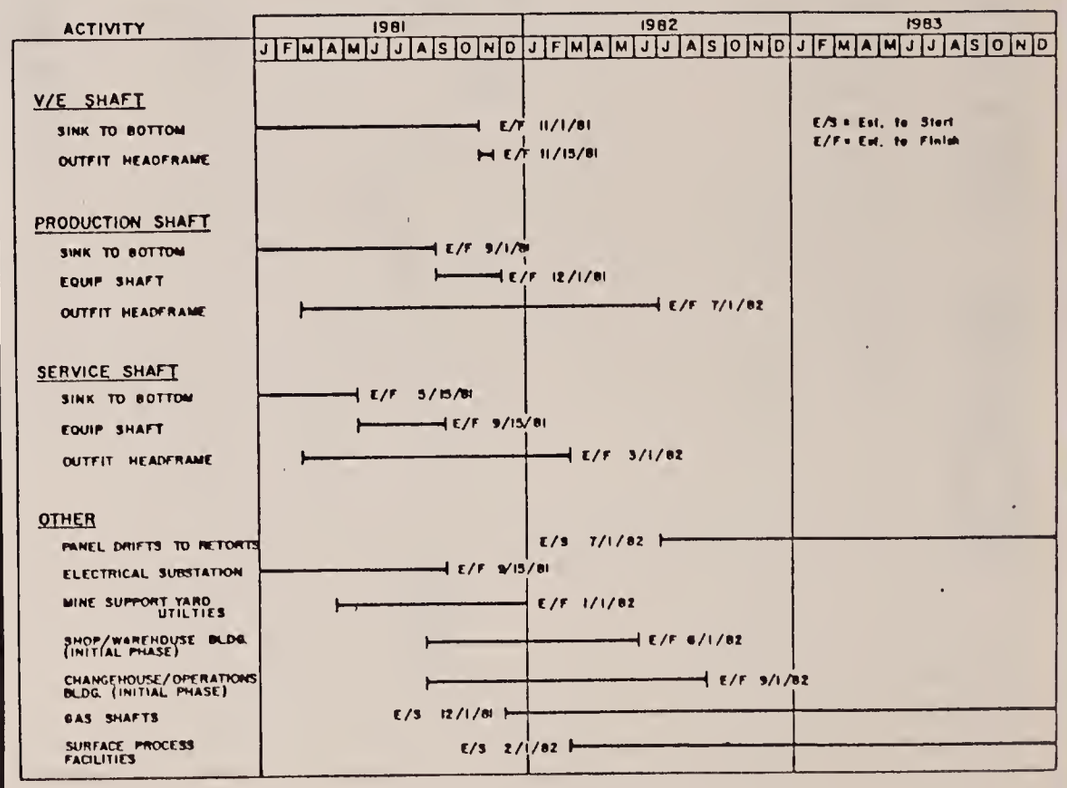


1980 C.B. Expenditures (In Thousands)

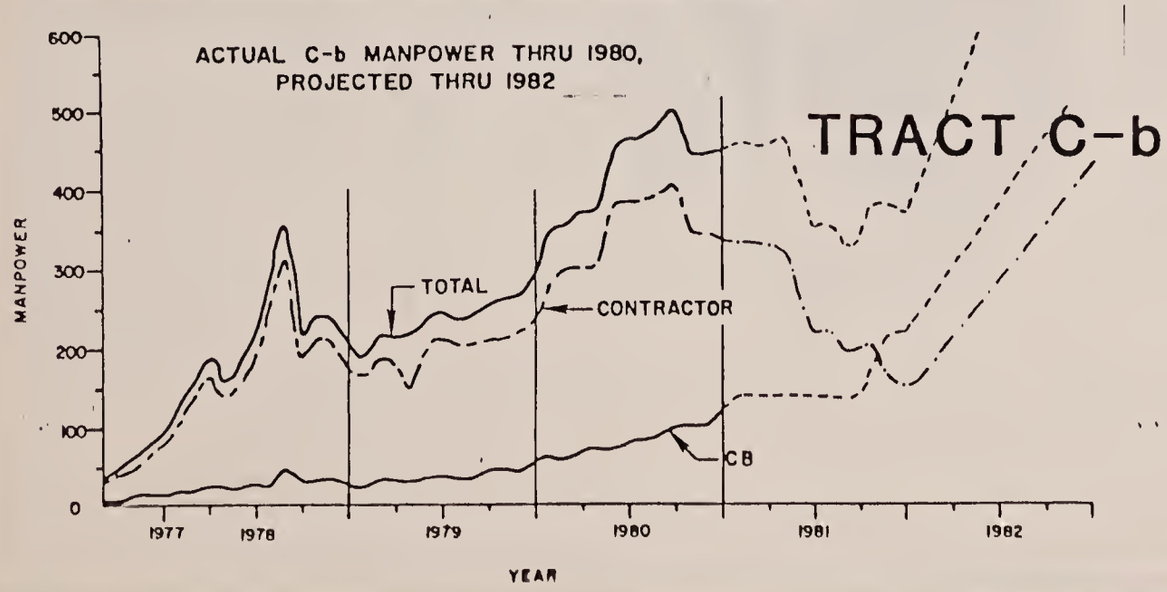
FIELD CONSTRUCTION	
Managing Contractor	$ 411.1
Shaft Sinking	22,637.8
Headframe Costs	1,355.5
Power Generating Costs	2,793.4
Site Preparation	1,897.3
Dewatering, Irrigation & Water Treatment	430.1
Mine Services	19.1
	$29,544.3
ENGINEERING COSTS	
Construction Support	2,856.6
Technical Support	3,044.7
	5,901.3
OPERATING COSTS	
Tract Operations and Maintenance	1,587.7
ENVIRONMENTAL	
Monitoring:	
Air	93.1
Water	855.4
Geology	11.7
Biology	103.1
Photography	22.2
Ecosystem Interrelationships	1.1
Reports	231.4
Permits	42.1
Water Resource Development	69.3
Reclamation	37.0
	1,466.4
OTHER PROGRAMS	
Housing	277.8
Community Relations	556.0
Busing	707.5
Insurance and Property Taxes	625.2
Land	849.6
Other	997.6
	4,013.7
GENERAL AND ADMINISTRATIVE	
Staff Costs	5,854.5
Employment Expenses	975.1
Legal and Professional	193.5
Office	519.7
Other Expense	156.3
Overhead	300.0
	7,999.1
TOTAL PROJECT	$50,512.5



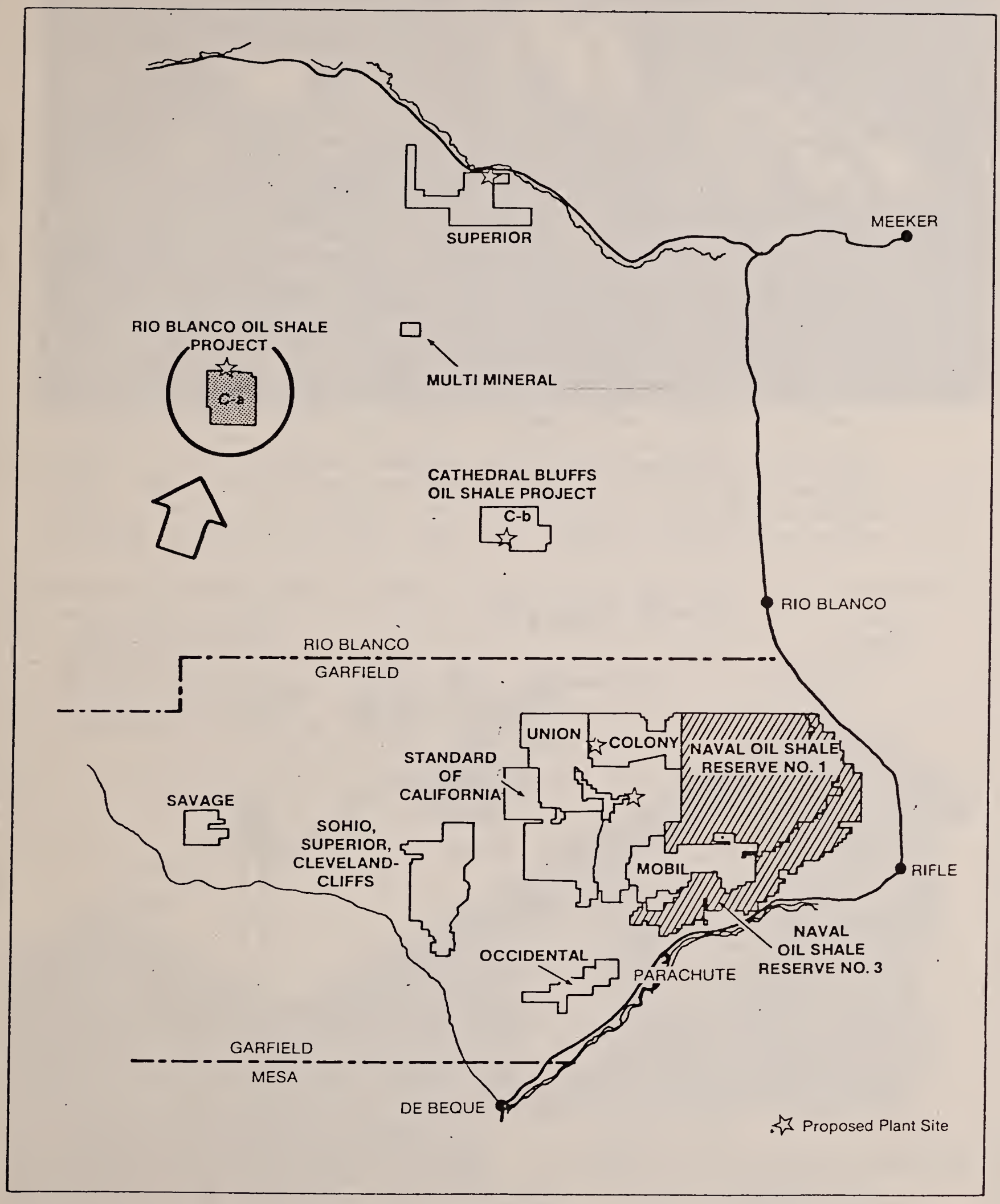
C-b PREPARATION AND CONSTRUCTION ACTIVITIES IN 1977 – 1980



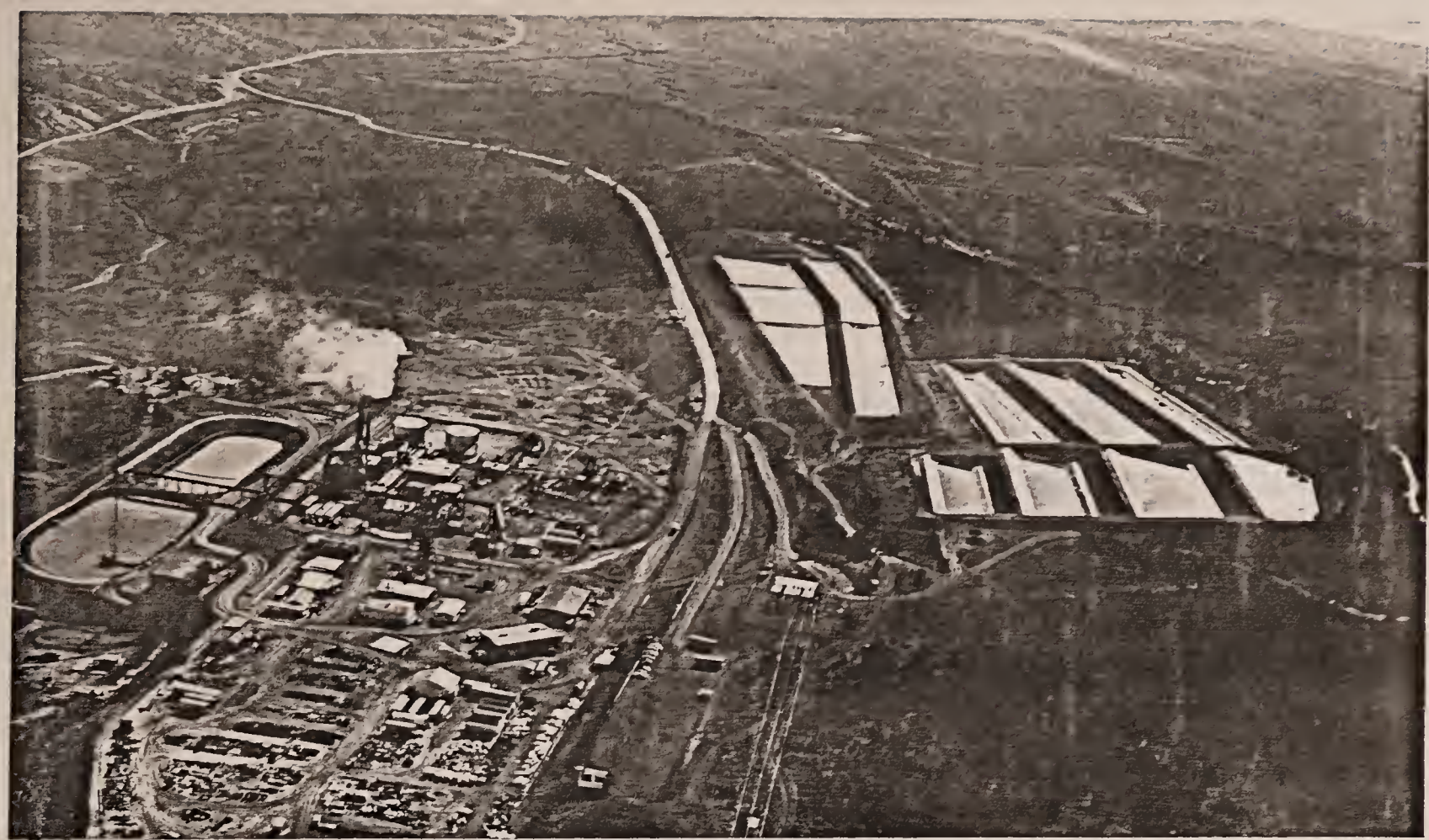
NEAR-TERM PROJECTED CB PROJECT CONSTRUCTION ACTIVITIES (1981 REVISED DOP PLAN)



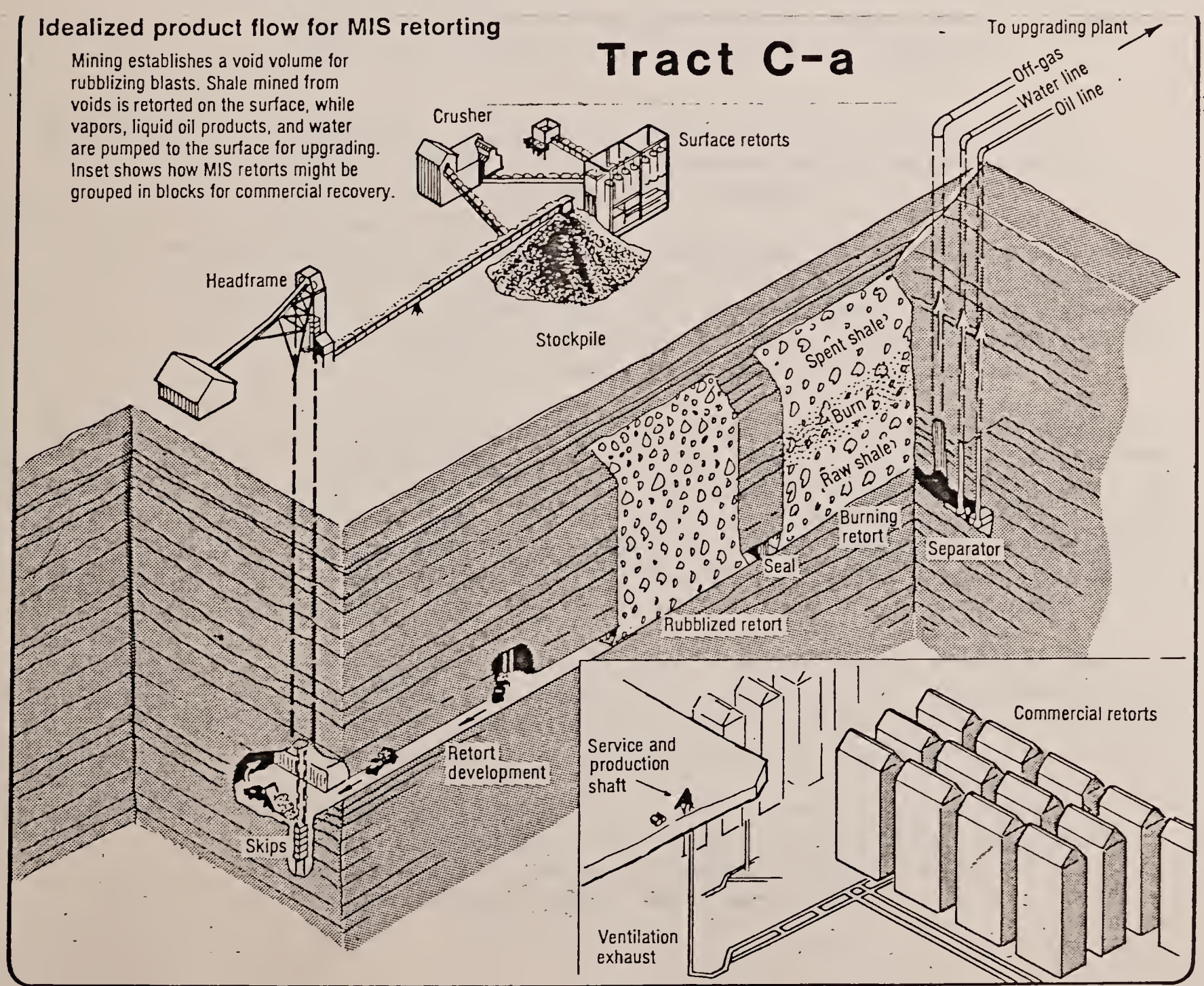
RIO BLANCO OIL SHALE
(Gulf & Standard)



COLORADO



Colorado Federal Tract C-a Mine Development Area during operation of modified in situ test Retort #1. Plume due to ammonia inject to control stack corrosion. Surface facilities consist of retort sour water solar evaporation ponds on ridge; retort off gas scrubbing plant, shale oil storage, process control, and administrative building adjacent to stack; and oval shaped process area water treatment ponds.



Federal Tract C-a
Rio Blanco Oil Shale Project
(Commercial)

Companies: Rio Blanco Oil Shale Company (RBOSC), a general partnership of Gulf Oil Corporation and Standard Oil Company (Indiana)

Location: 5,089.7 acres in T1&2S, R98 & 99W; about 20 miles southeast of Rangely, Rio Blanco County, Colorado on Corral Gulch, a tributary of Yellow Creek. RBOSC has purchased 680 acres of fee land with Federal Mineral Rights which are included in the 5,090 acre lease and surface rights to 457 acres of fee land with Federal minerals along north tract boundary.

Resource:
- o 5,090 acres of oil shale resource containing 6 billion bbl's of >25 gpt
- o 1,100' - 1,200' oil shale interval of commercial interest for open pit development. Total of 4.07 billion barrels recoverable, or 65% of in-place resource with open pit mining. With MIS technology and surface retorting approximately 1.7 - 2.5 billion barrels could be recovered, or about 20-30% of the in-place resource.

Mining: Open pit mining beginning in northwest corner of tract. Active pit would encompass about 750 surface acres at any one time with average depth of 1,400' and average overburden thickness of 450'. At a maximum production rate of 300,000 BPD, 1 million TPD of ore and waste would be mined. Production of around 100,000 BPD is more likely. Planned to start with 36 acre (3 million tons ore) open pit.

Retorting:
- o AGR-Lurgi processed shale solids heat transfer retorts. Begin with 4400 TPD Lurgi demonstration retort scaling up to more than 100,000 BPD in 1990's.
- o MIS/AGR - 76,000 BPD
- o Operated two surface drilled blast hole rubblized MIS test retorts #0 (30' x 30' x 166'h) which yield 1,750 equivalent bbl's oil and #1 (60' x 60' x 400'h) which to date has produced nearly 17,619 bbl's oil, Burn rate dramatically slowed due to off-gas scrubber vent stack deterioration.

Water: The 4,400 TPSD Lurgi test retort would consume approximately 1,350 scf per day (1600 ACF/Y for retorting and processed shale disposal. All of this will be supplied from mine water inflows and pumping from mine dewatering wells. Water requirements for a commercial Lurgi plant might be as much as 14,000 ACF/Y for 50,000 BPD. RBOSC does hold options on water from the White River.

Waste Disposal: Under open pit development, initial waste disposal would be off site. 84 Mesa is preferred site for economic and and environmental reasons. After pit has reached total depth, processed shale would be returned to the pit.

Employment:
- o Present employment is around 175 people and declining.
- o At the conclusion of test MIS retort #1 burn, employment on-tract will be about 50 people. Lurgi Demonstration Project will not begin until early 1983.

- o Construction work force for the Lurgi Demonstration will remain under 550.
- o 2,500 for operation of commercial facility.

Holleran Services Inc., is developing a long range plan to deal with housing and other socioeconomic impacts in Rio Blanco County.

Cost:

- o $210 million bid for the lease in 1974
- o $126 million paid in three installments with remaining $ 84 million offset against development expenditures.
- o $140 million for development of the Lurgi and MIS technologies on tract
- o $ 4 million for 15' diam. Service/Production shaft
- o $ 6 million for purchase of Oxy MIS technology
- o $ 29 million for 1-5 ton Lurgi pilot retort test at Harmerville, PA.
- o $330 million committed to project to date.
- o $ 4 million for Lurgi design study
- o $ 29 million for Lurgi pilot test at Harmerville, PA.
- o $160 million for Lurgi and mini pit demonstration
- o $ 1 billion + for total commercialization
- o No request for Federal price or loan guarantees

Contractors:

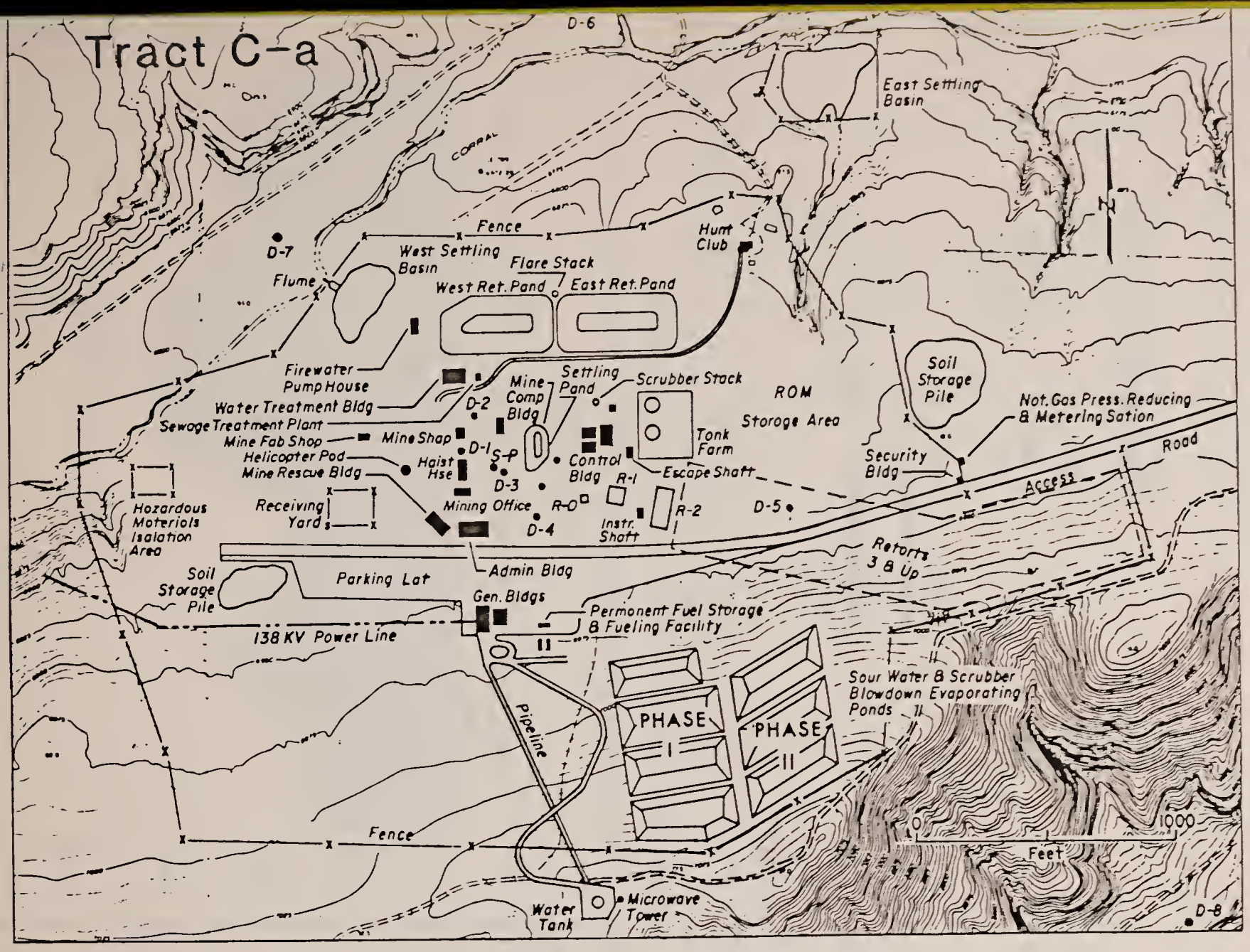
- o American Mine Services - sinking of 15' diam. Service/Production shaft
- o Morrison-Knudsen - prime contractor
- o MS&T - shaft sinking and retort development
- o TIC - general construction work on processing facilities
- o Construction Surveys, White and Sons, Wright and Kohli - specialized subcontractors.
- o C. E. Lummas - 4,400 TPD Lurgi demonstration facility (on hold)

Status:

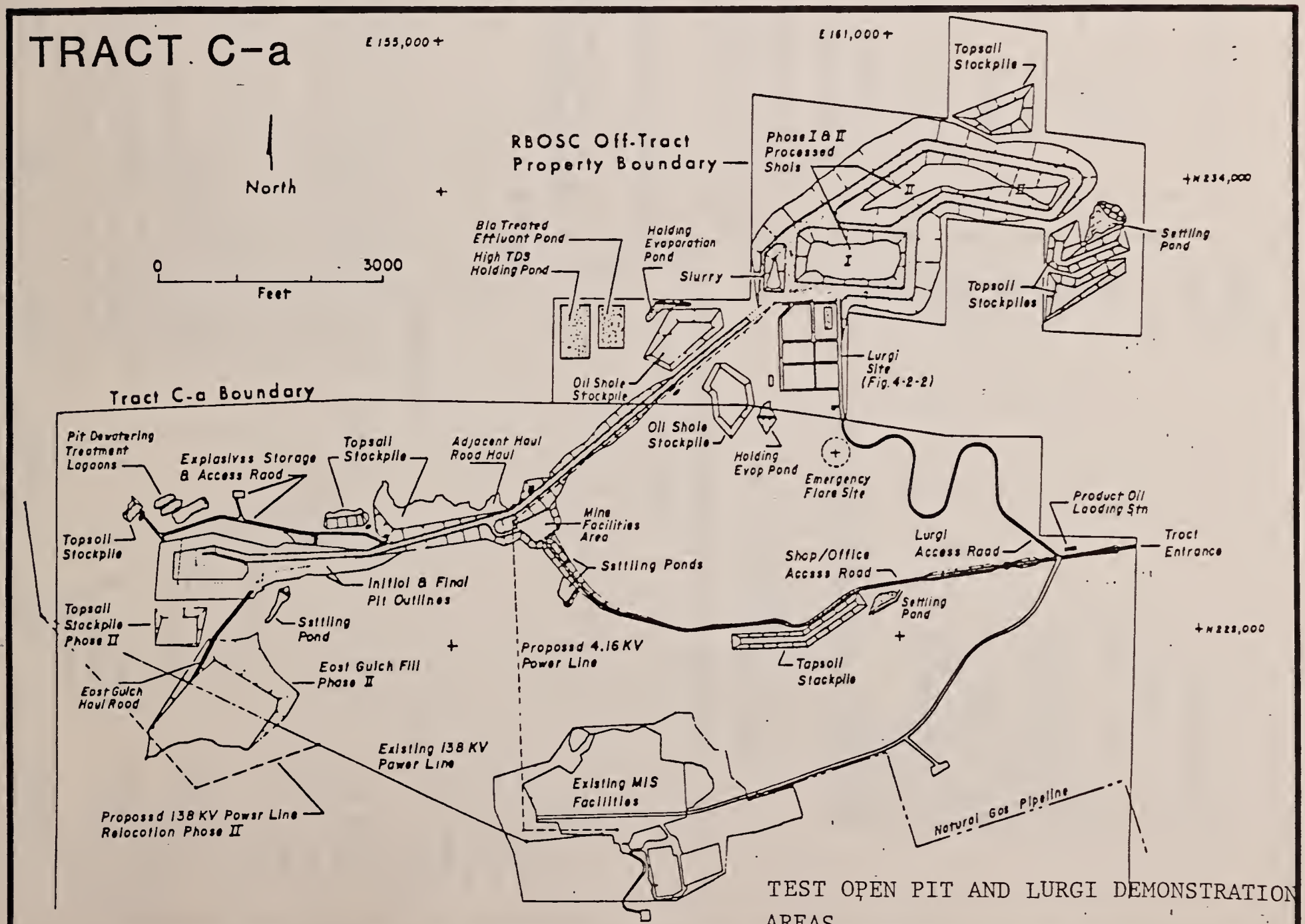
- o 1974 - Tract C-a leased to RBOSC
- o 1976 - March: Open pit with surface retorting Detailed Development Plan (DDP) submitted in March
- o 1976 - August: Granted one-year suspension of operations.
- o 1978 - Service/Production shaft head frame completed, shaft completed in late 1979
- o 1979 - Revised DDP for Modified In-situ Development
- o 1980 - MIS Retort #0 rubblized and burned
- o 1981 - MIS Retort #1 rubblized (burn is in progress; expected to produce 17,000-25,000 Bbls)
- o 1981 - DDP Modification for Lurgi Demonstration Project
- o 1981 - September: Announce plans to construct 1-5 ton Lurgi pilot plant at Harmerville, PA, to be operational by 1983.
- o 1983 - Construction of Lurgi Demonstration Module and 36-acre open pit
- o 1985 - Decision on commercial development
- o 1990's- Commence commercial production scaling up to 50,000-100,000 BPD

Contact:

Blaine Miller, President
Rio Blanco Oil Shale Company
2851 South Parker Road, Suite 500
Aurora, CO 80014
(303) 695-2400



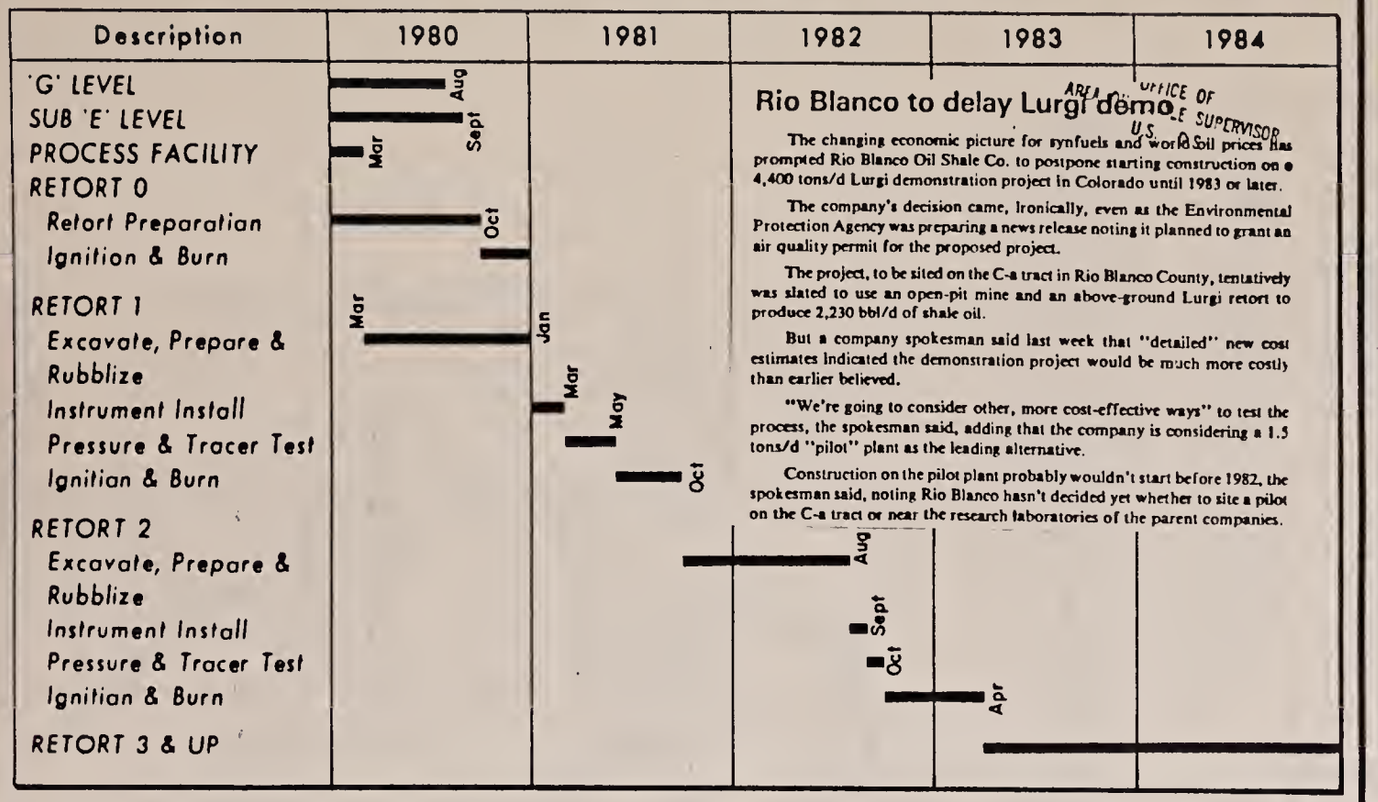
MDP CONSTRUCTION AREA, DECEMBER 1980



TEST OPEN PIT AND LURGI DEMONSTRATION AREAS

TRACT C-a

MDP Schedule Retorts 0, 1, 2, 3 & Up



Rio Blanco to delay Lurgi demo

The changing economic picture for synfuels and world oil prices has prompted Rio Blanco Oil Shale Co. to postpone starting construction on a 4,400 tons/d Lurgi demonstration project in Colorado until 1983 or later.

The company's decision came, ironically, even as the Environmental Protection Agency was preparing a news release noting it planned to grant an air quality permit for the proposed project.

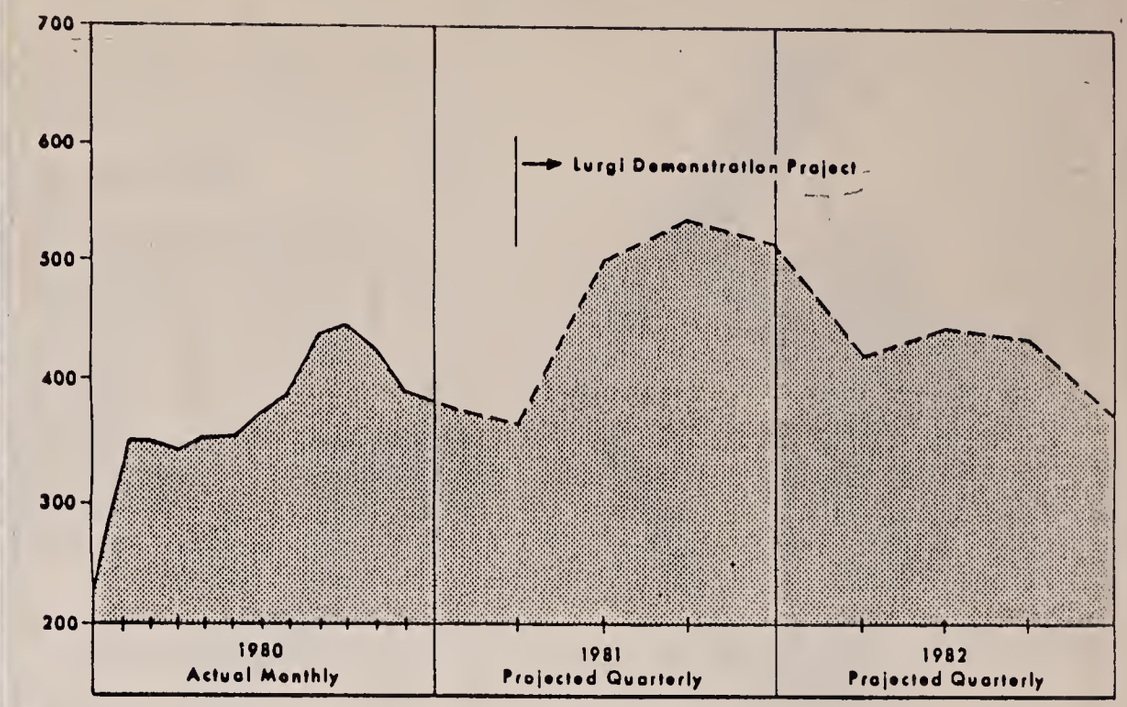
The project, to be sited on the C-a tract in Rio Blanco County, tentatively was slated to use an open-pit mine and an above-ground Lurgi retort to produce 2,230 bbl/d of shale oil.

But a company spokesman said last week that "detailed" new cost estimates indicated the demonstration project would be much more costly than earlier believed.

"We're going to consider other, more cost-effective ways" to test the process, the spokesman said, adding that the company is considering a 1.5 tons/d "pilot" plant as the leading alternative.

Construction on the pilot plant probably wouldn't start before 1982, the spokesman said, noting Rio Blanco hasn't decided yet whether to site a pilot on the C-a tract or near the research laboratories of the parent companies.

RBOSC MDP SCHEDULE



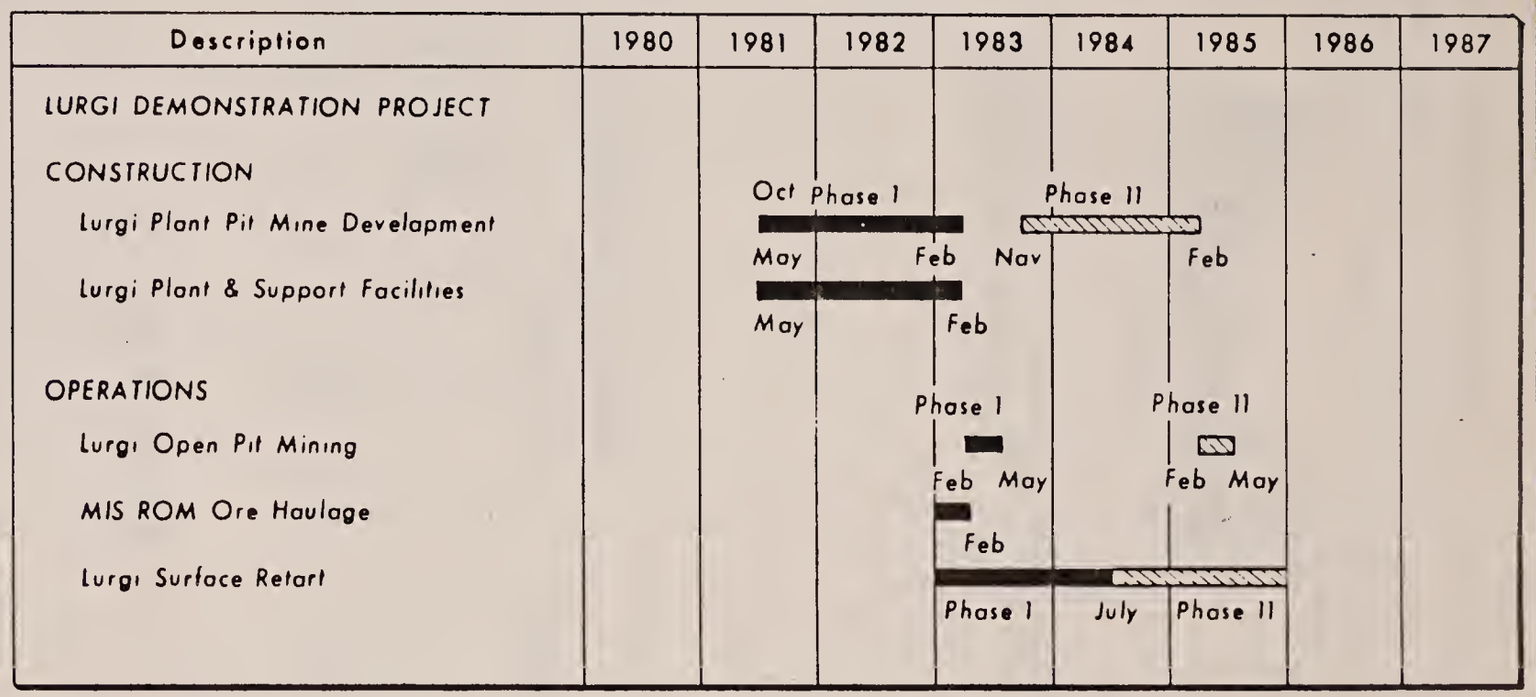
TRACT C-a WORKFORCE
RBOSC AND CONTRACTORS

RBOSC SUMMARY OF COSTS - 1980

($000)

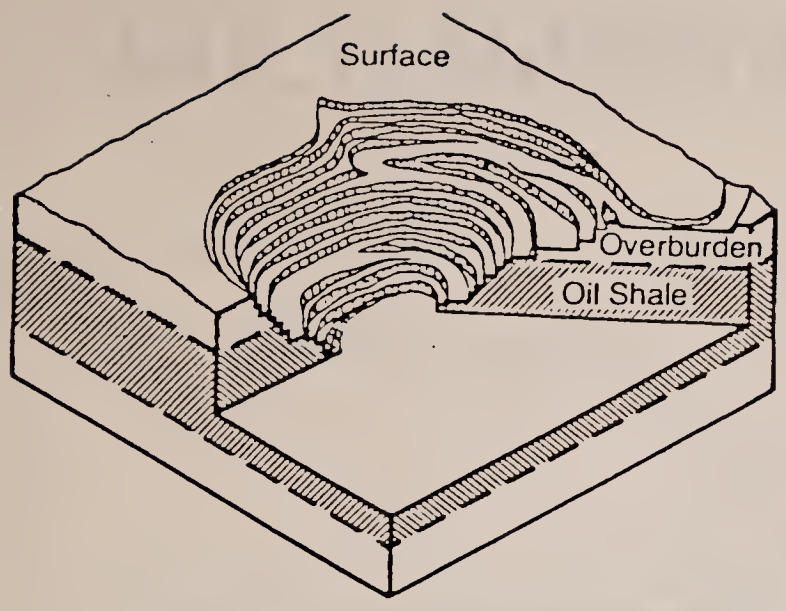
Engineering, Construction and Development	
Dewatering	1,248
Site Work	534
Power Plant	302
Processing Facility	1,441
Shaft, Hoist and Headframe	147
Mine Services	13,978
Drifting, Retorting	6,755
Operations	6,951
Managing Contractor Services	2,222
Technological Design	5,187
Environmental	283
Other	1,488
Lurgi Project - Phase I	4,102
Total Development	$44,647
Administrative	$ 3,633
Total C-a Project	$48,280

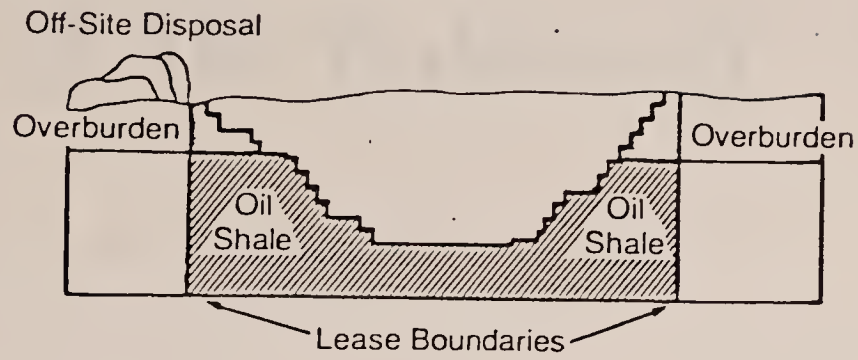
RBOSC MDP Schedule of Lurgi Demonstration Project



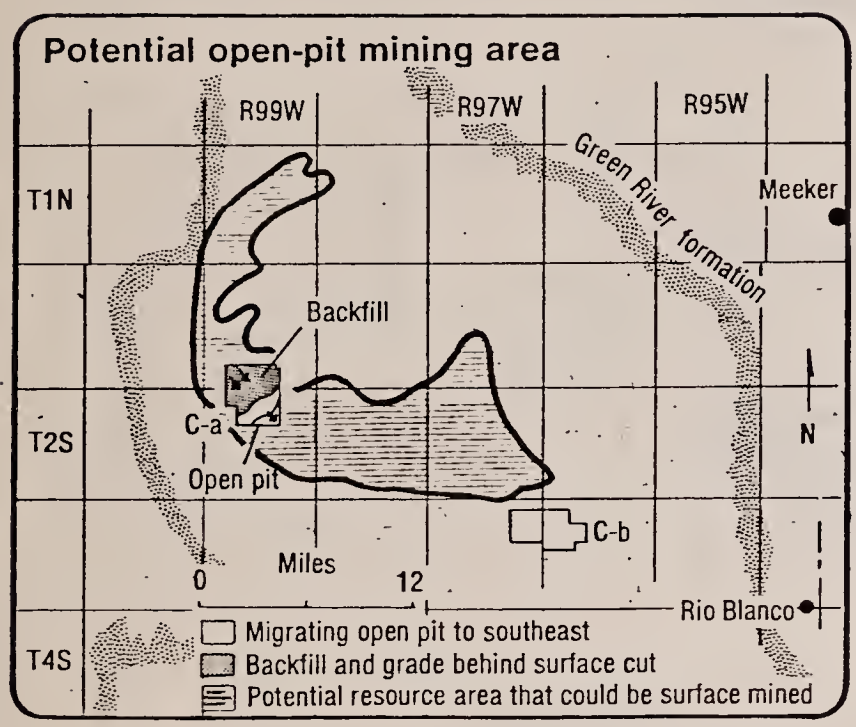
RBOSC CONSTRUCTION AND OPERATION SCHEDULE

Open-Pit Mining Concept Featuring Offtract Waste Disposal





SOURCE: *Hearings on Oil Shale Leasing*, Subcommittee on Minerals, Materials, and Fuels of the Senate Committee on Interior and Insular Affairs, 94th Cong., 2d sess., Mar. 17, 1976, p. 84.



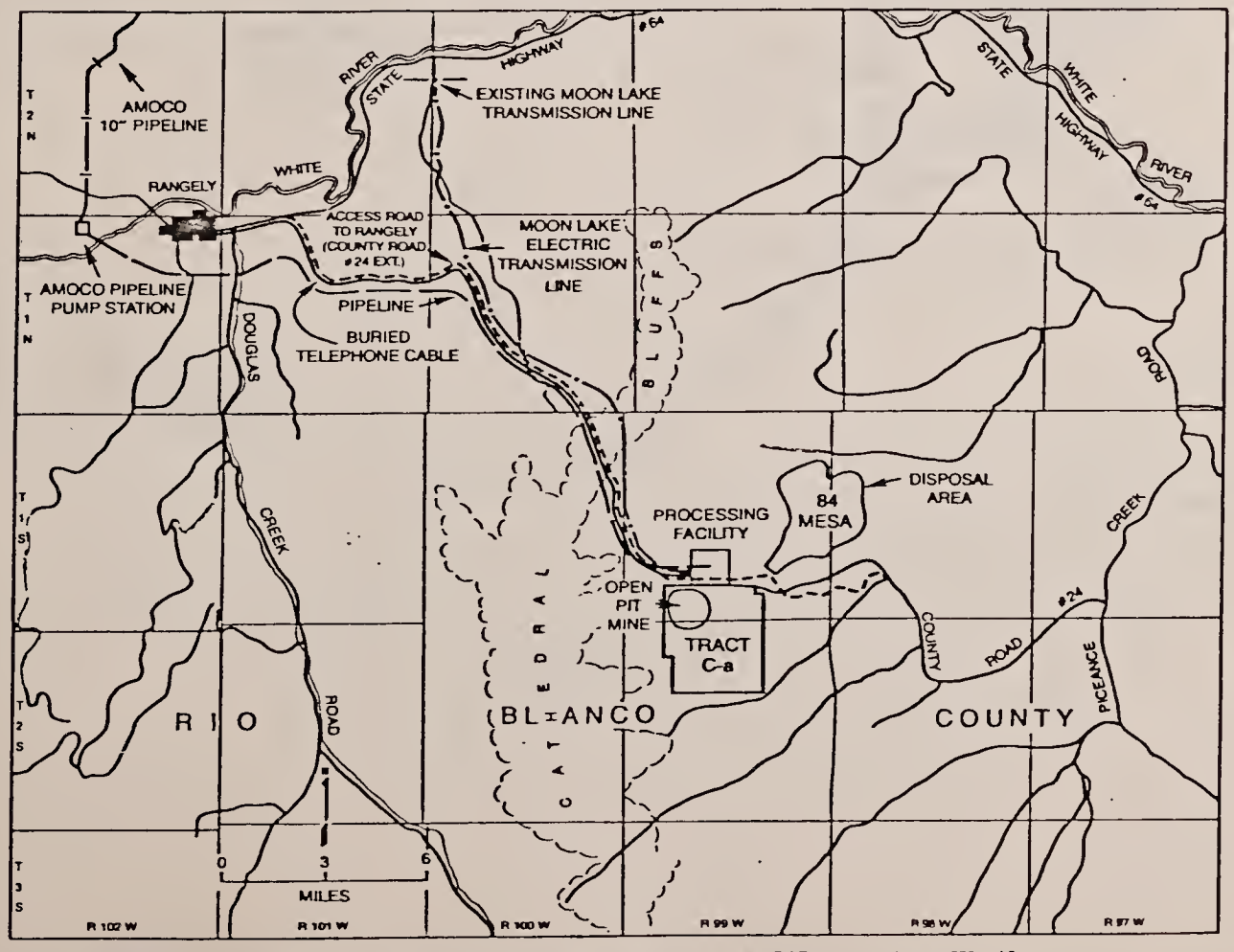
Colorado tract C-a resource

	Billions of barrels	% Recovery
Total reserves	9.0	
Room and pillar	1.1	12
Open pit	5.2	58
In situ	1.7-2.5	20-30

A migrating open-pit mining plan could yield the greatest recovery of resources under tract Ca and perhaps make resources beyond the tract commercially extractable. Such a plan, however, would require substantial off-site land for the plant as well as for stockpiling an inventory of overburden and spent shale. Backfilling would begin as the pit migrates sufficiently to the southeast to create inactive zones.

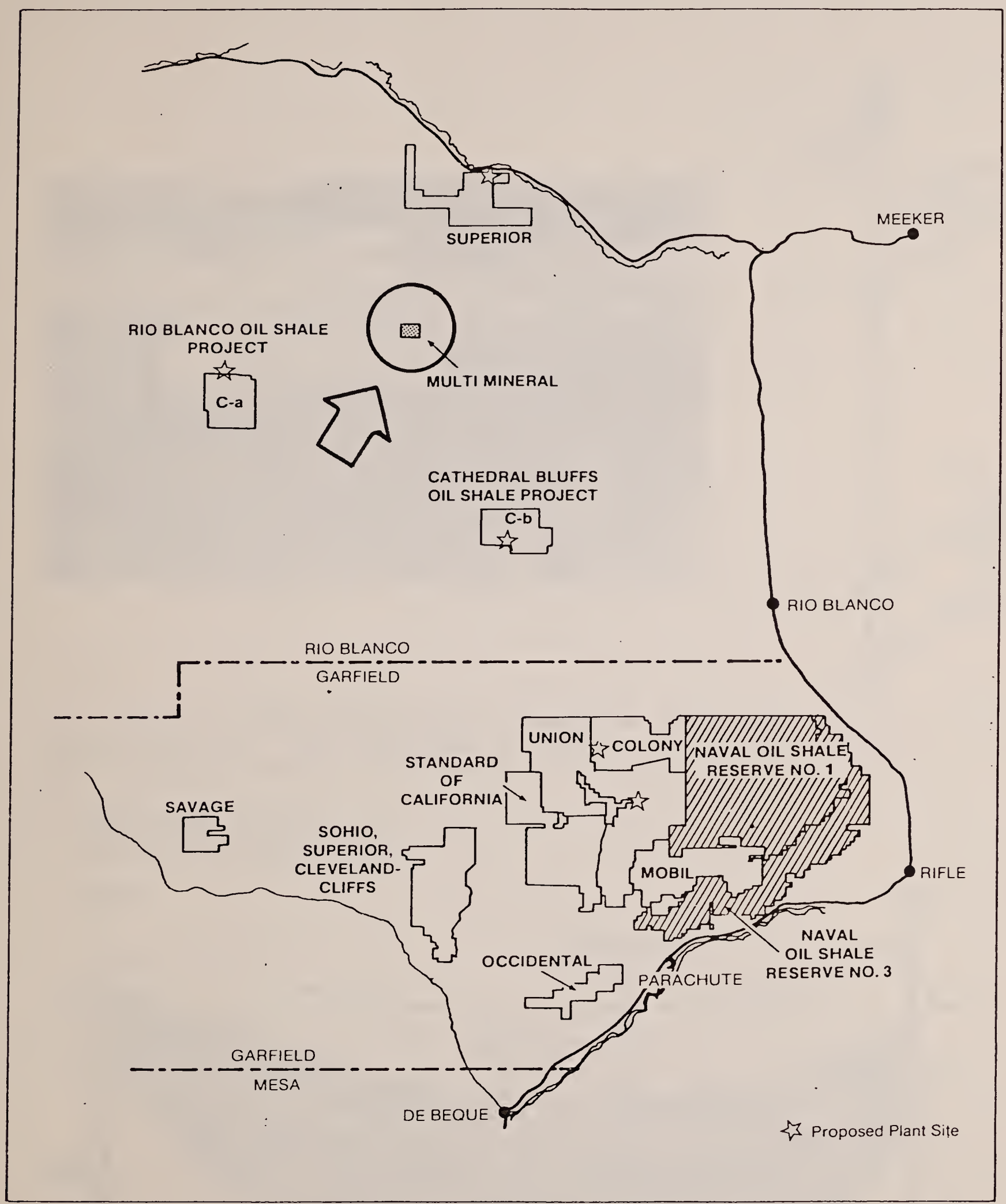
Tract C-a

Original Development Plan for Colorado Tract C-a



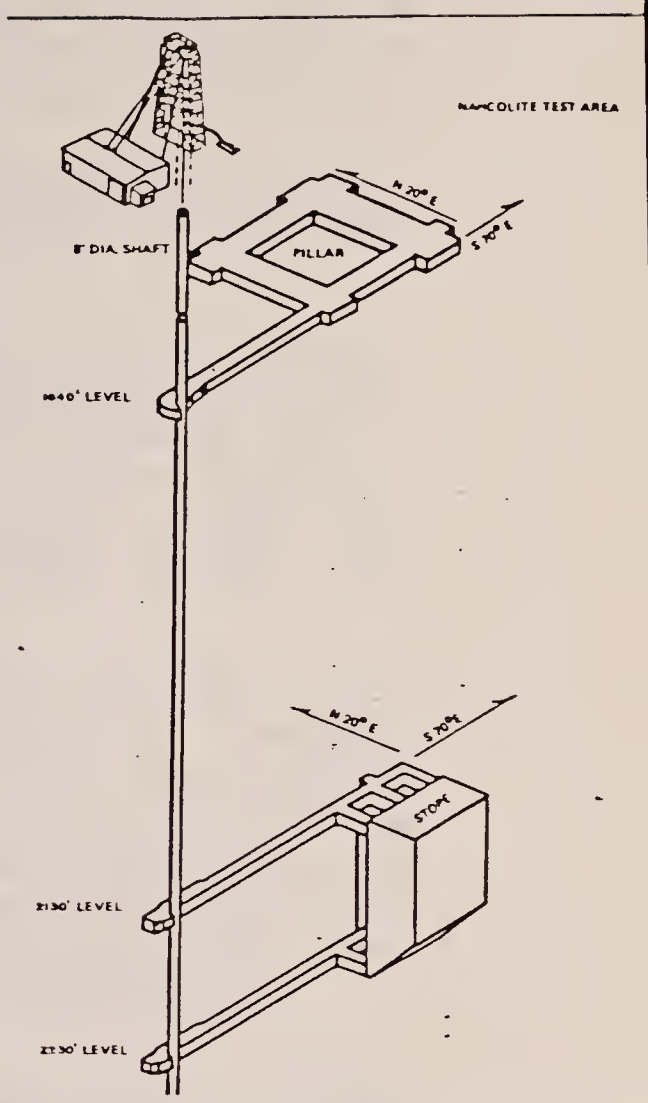
SOURCE: Rio Blanco Oil Shale Project, *Detailed Development Plan Tract C-a*. Gulf Oil Corp. and Standard Oil Co. (Indiana) March 1976, p. I-3.

MULTI MINERAL (& US BuMines)



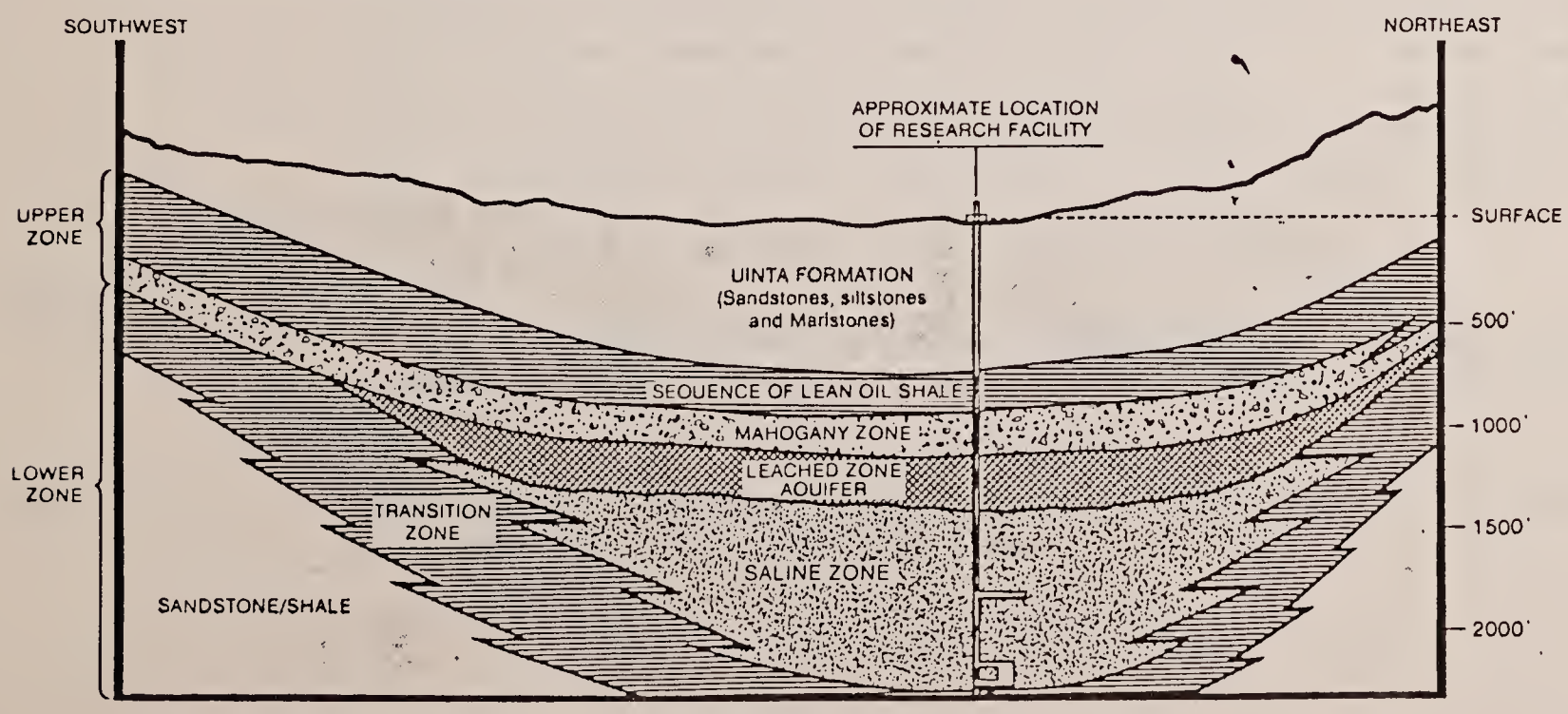
COLORADO

Multi Mineral



U.S. Bureau of Mines/MultiMineral Corporation, Horse Draw Experimental mine site. Shaft headframe at center with lay down area and bulk oil shale storage at upper right.

SCHEMATIC CROSS SECTION SHOWING OIL SHALE BEDS



PICEANCE CREEK BASIN, COLORADO

Multi Mineral and Nahcolite Mine #1
(Commercial)

Company: Multi Mineral Corporation (MMC), Partners being sought

Location:

- o T1S, R98W; 8,358.14 acres of Federal sodium leases east of Yellow Creek owned by parent company - Charter Oil; 50 miles by road northwest of Rifle, in Rio Blanco County, Colorado.
- o T1S, R97W; Bureau of Mines Horse Draw experimental oil shale mine site; 47 miles by road northwest of Rifle, in Rio Blanco County, Colorado.

Resource: 1,660' of oil shale from "A" Goove downward thru R-2 averaging 20 gpt. Mahogany Zone averages 180'-200' thick, 25 gpt, for 300,000 to 350,000 bbl/acre. Target mine zone is 500' to 1000' thick Saline Zone (L-5 thru R-2 zones) consisting of two 30' - 100' thick halite beds and several 5' - 10' thick bedded/non-bedded nahcolite zones averaging 800,000 tons nahcolite per acre.

Mining: At Horse Draw site: 1) 2,371' deep (cased to 2,352'), 10' diam., bored shaft steel lined to 8' diam.; 2) completed experimental 8' high room-and-pillar drift at 1,840' level in zone averaging 60% bedded nahcolite to recover 5,000 ton sample from Love Bed for coal-fired power plant flue gas scrub test; 3) completed mining and rubblization test stope (64' x 40' x 110'h) between 2,130' and 2,230' level (facility on standby for rock mechanics and methane monitoring).

Plan to develop 1 million TPY nahcolite mine on Federal sodium leases from 18' and 26' diam. shafts sunk to 2,500' for co-production of shale oil, nahcolite, soda ash, and alumina from surface retorting and IIS in Saline Zone.

Retorting: Integrated modified in-situ (IIS) where by mine zone is rubblized into MIS retort columns, all ore withdrawn for underground crushing, screening, and nahcolite removal, followed by refilling of retort column from top stope and operation as indirectly-heated MIS retort and subsequent water leaching to recover soda ash and alumina. 20% of mine material stored on surface. Nahcolite sold as dry reagent for flue gas desulfurization. Building 8' x 40'h 80-ton adiabatic batch type test retort at Grand Junction lab.

Waste Disposal: 3 million cubic yard on-site rubbled shale storage pile complemented by in-mine storage. No processed shale surface disposal.

Water: Claim highly conservative process with all water obtained from aquifers above the mine zone.

Employment:
- o 15 currently on-site
- o 100-150 during construction starting in 1982
- o 350 during sustained operation after 1985

Cost:
- o $8 million for bored shaft at Horse Draw site
- o $100 million for Federal sodium lease tract development
- o Requested federal price and loan guarantees

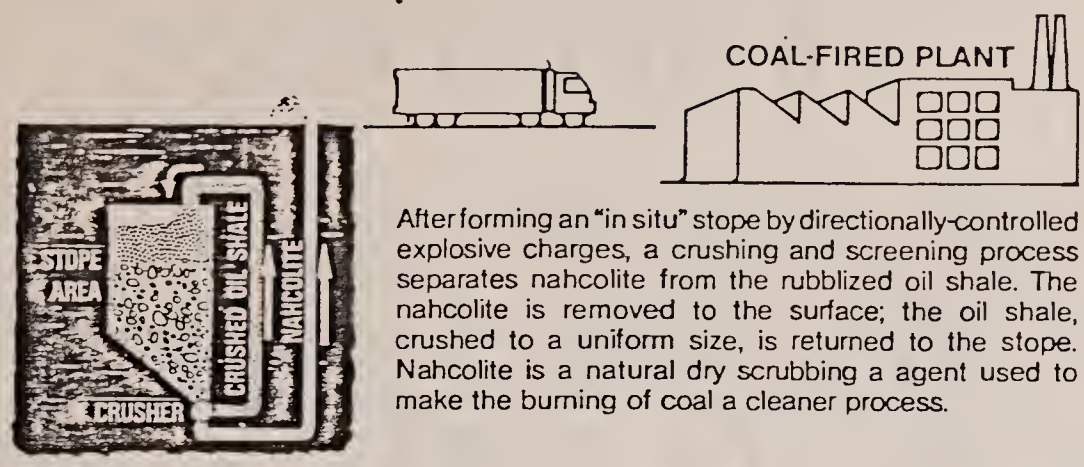
Status:
- o 1977 - October: USBM completed drilling of 12' diam. x 2,371' deep shaft, cased and cemented to 8' diam.
- o 1978 - MMC made USP to USBM and DOE for joint development of commercial module at Horse Draw site.
- o 1979 - April: MMC signed agreement with USBM to operate Horse Draw site.
- o 1979 - MMC signed agreement with Colorado Public Service to run nahcolite flue gas scrub test at Cameo plant in late 1980.
- o 1980 - Acquired sodium lease totaling 8,358.14 acres.
- o 1980 - Draft EIS for demonstration of IIS process at Horse Draw issued and withdrawn when MSHA indicated a second shaft would be required.
- o 1980 - Initiated permitting through Colorado Joint Review Process
- o 1981 - Informational core drilling of sodium leases
- o 1981 - January: submitted mining plan to USGS
- o 1981 - May: USGS completed environmental assessment
- o 1981 - Complete 8' diam. x 40'h, 80-ton adiabtaic test retort at Grand Junction lab
- o 1981 - Performing experimental mining and stoping at Horse Draw site
- o 1981 - Requested non-competitive oil shale lease for acquired sodium leases (DOI has authority to act, but seeking legislative clarification).
- o 1981 - Reduced on-tract and Grand Junction workforce until decision reached on oil shale leasing and venture partners could be obtained.
- o 1982 - Commence operation at Grand Junction research facility.
- o 1982 - Obtain all necessary permits
- o 1982 - Commence sinking 18' and 26' diam. shafts at sodium lease.
- o 1984 - Achieve 400,000 TPY nahcolite production
- o 1985 - Achieve 500,000 TPY nahcolite production increasing rapidly to 1 million TPY
- o 1990 - Achieve multi-product production of 25,000 BPD shale oil, 5,000 TPD nahcolite and soda ash, and 600 TPD alumina.

Contact:

James A. Meredith
715 Horizon Drive, Suite 380
Grand Junction, Colorado 81501
(303) 243-9406

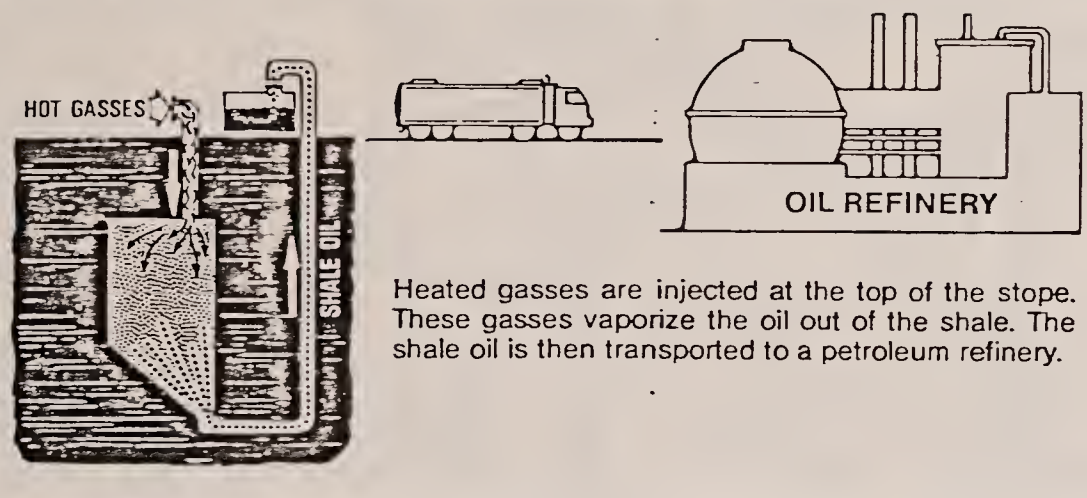
THREE STEPS TO MULTI-MINERALS

1.



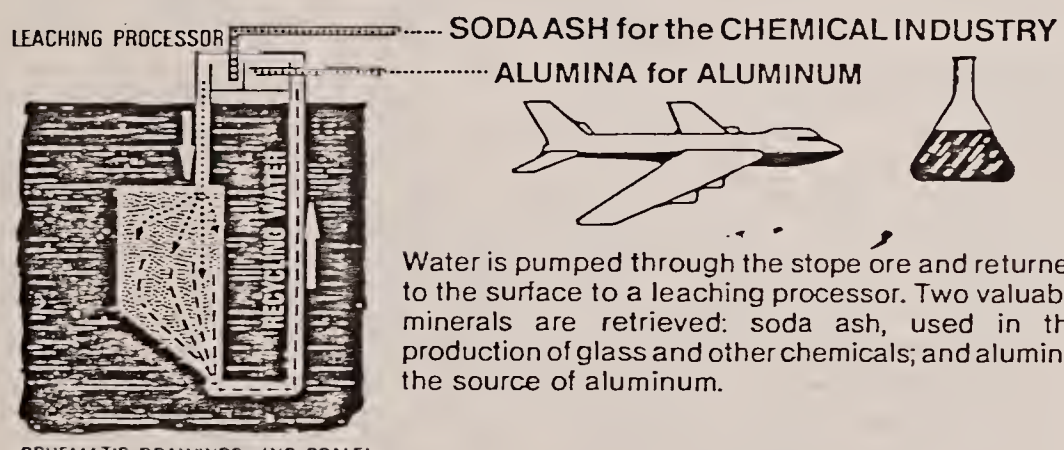
After forming an "in situ" stope by directionally-controlled explosive charges, a crushing and screening process separates nahcolite from the rubblized oil shale. The nahcolite is removed to the surface; the oil shale, crushed to a uniform size, is returned to the stope. Nahcolite is a natural dry scrubbing a agent used to make the burning of coal a cleaner process.

2.



Heated gasses are injected at the top of the stope. These gasses vaporize the oil out of the shale. The shale oil is then transported to a petroleum refinery.

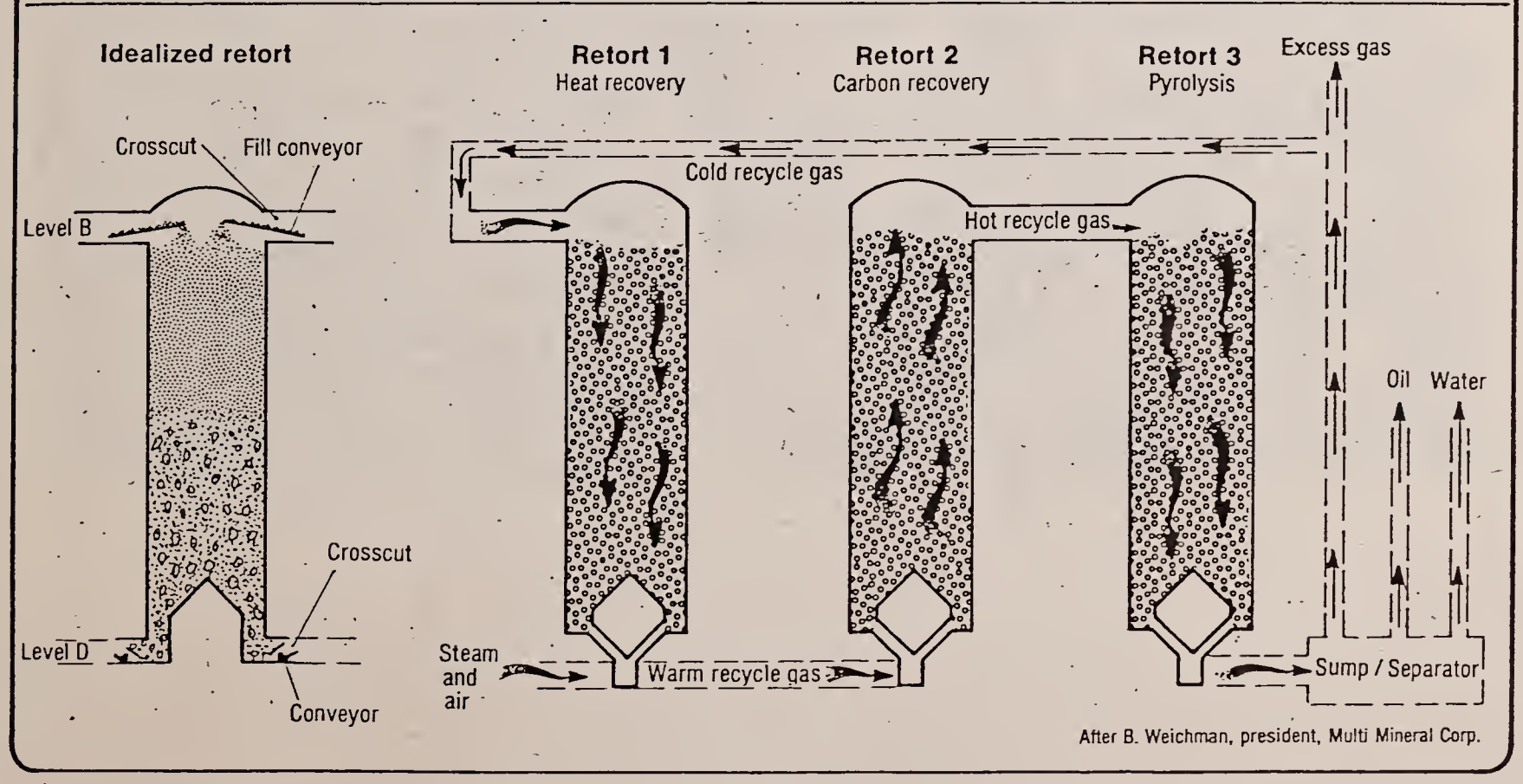
3.



Water is pumped through the stope ore and returned to the surface to a leaching processor. Two valuable minerals are retrieved: soda ash, used in the production of glass and other chemicals; and alumina, the source of aluminum.

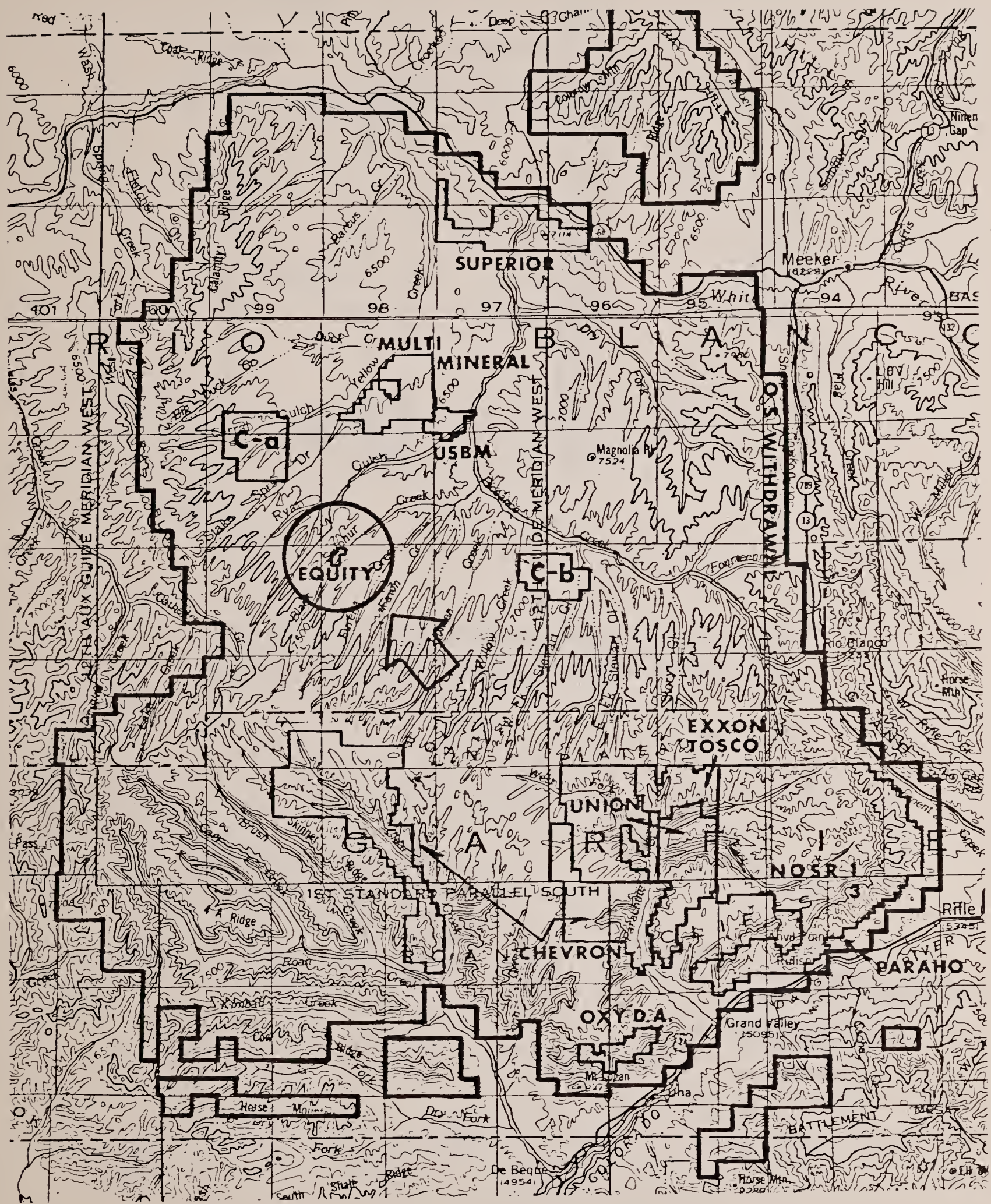
SCHEMATIC DRAWINGS (NO SCALE)

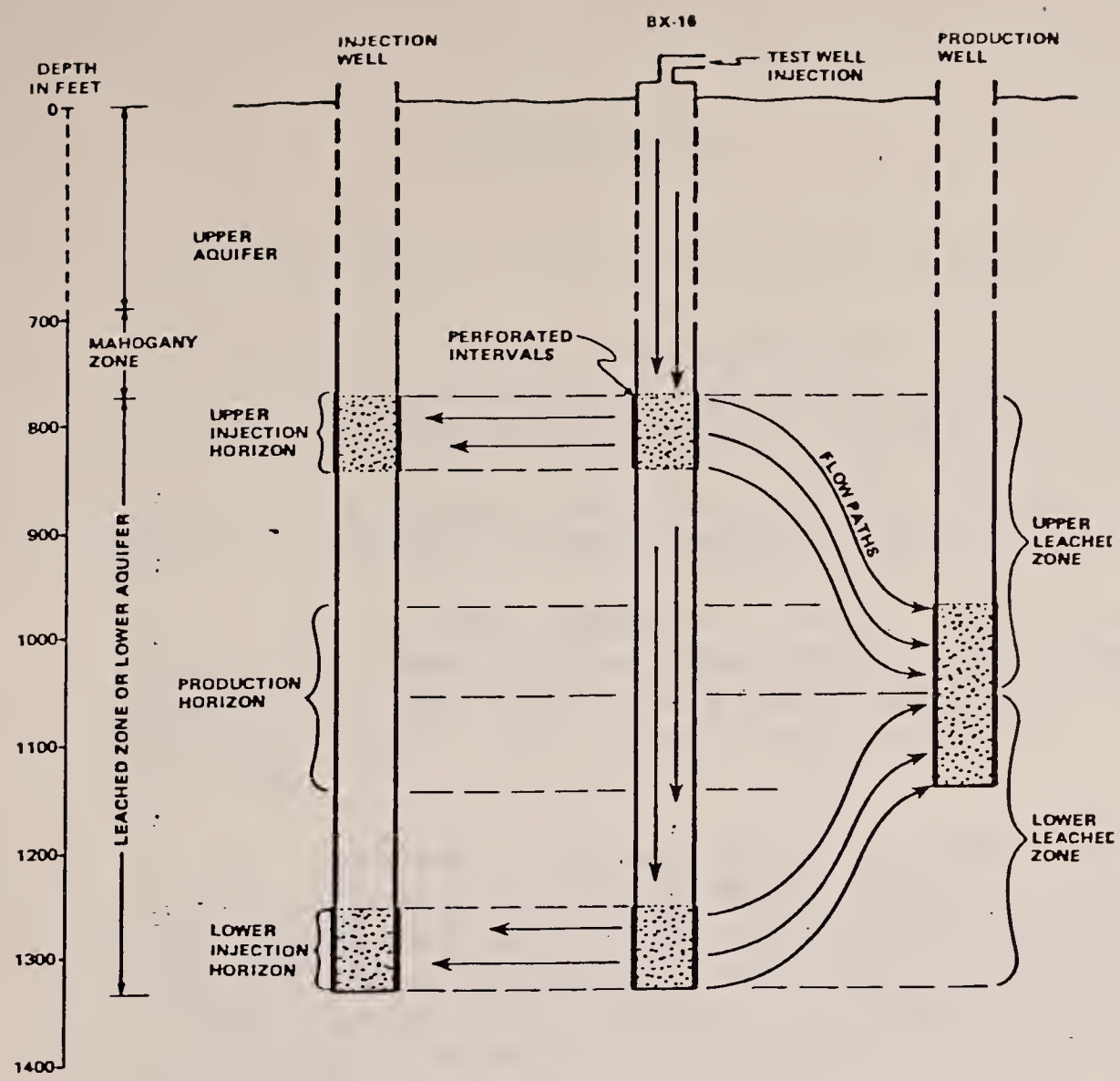
How the MMC retorts would be grouped for a commercial system



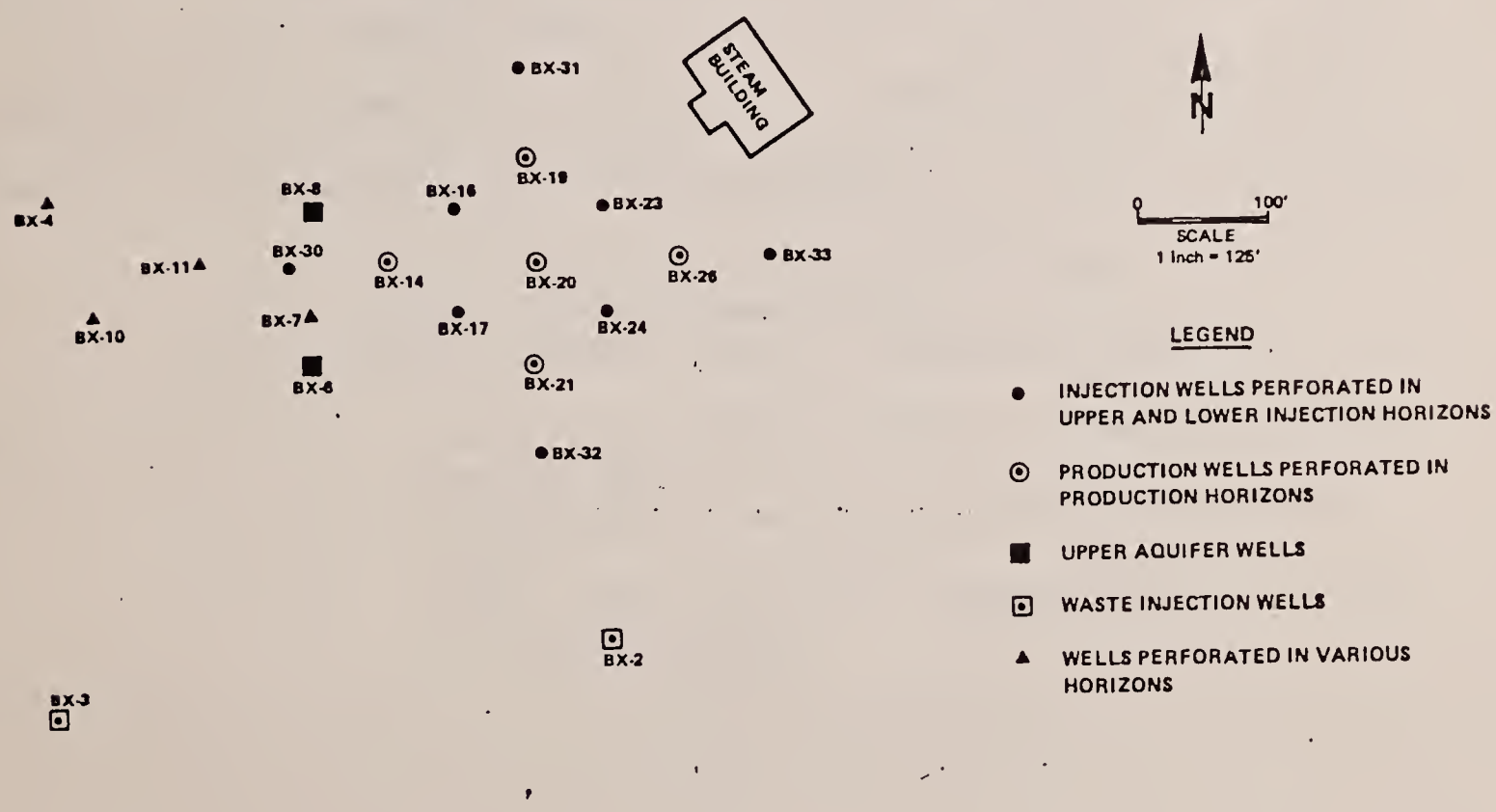
After B. Weichman, president, Multi Mineral Corp.

EQUITY DOE/BX





LEACHED ZONE GEOHYDROLOGIC NOMENCLATURES AND FLOW TEST SCHEME
OF BX IN SITU OIL SHALE PROJECT AREA, RIO BLANCO COUNTY, COLORADO



GROUND SURFACE LOCATION OF WELLS USED IN GEOHYDROLOGIC TESTING
BX IN SITU OIL SHALE PROJECT
RIO BLANCO COUNTY, COLORADO

Equity/DOE BX
(Non-Commercial)

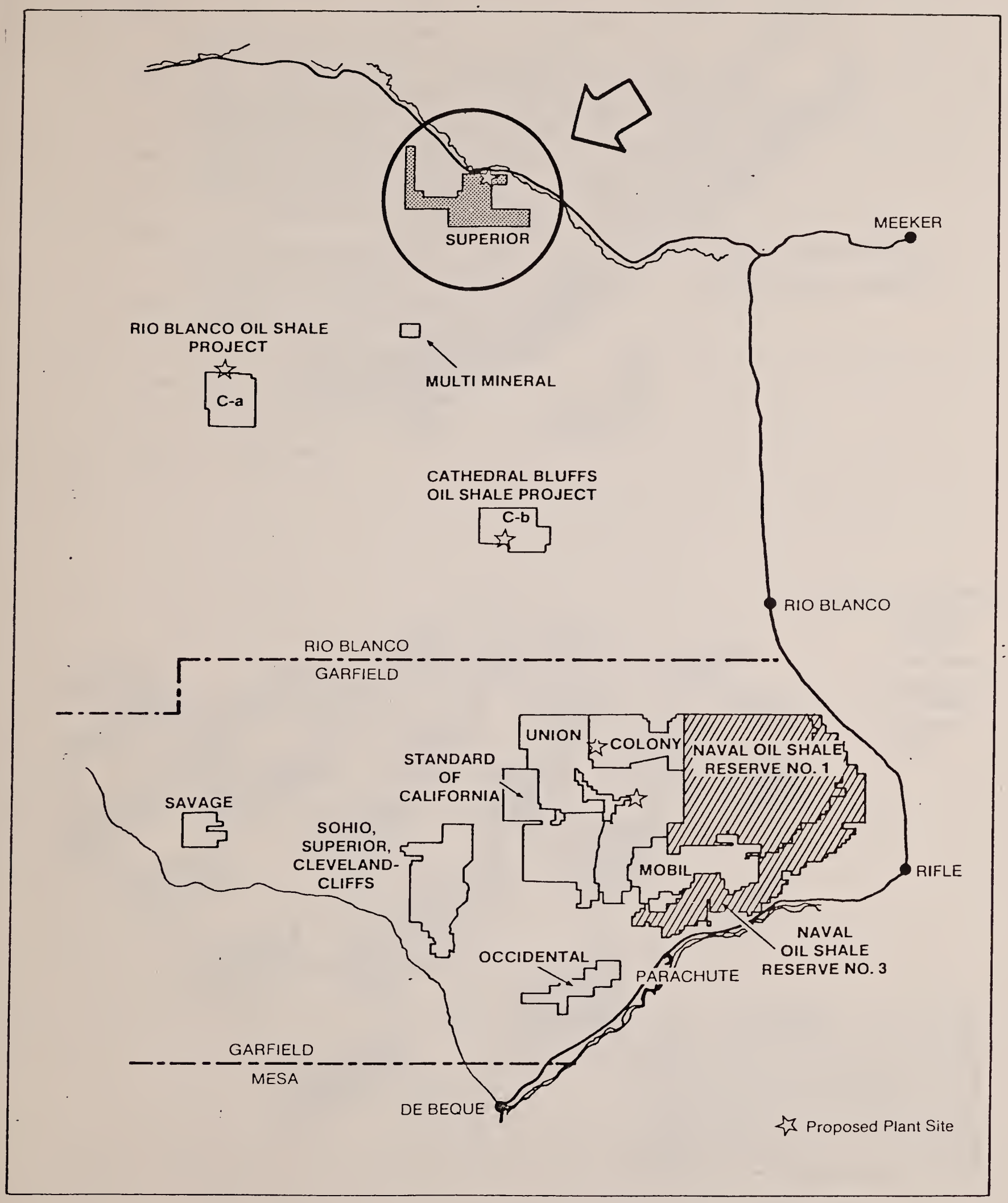
Company:	Equity Oil Company and U.S. Department of Energy
Location:	T3S, R98W, Sec. 6; 51 miles by road from Rifle, in Rio Blanco County, Colorado; on Black Sulfur Creek; 1,000 acres of fee land owned by Equity (50%) and Arco (50%).
Resource:	Leached zone contains more than 1 million bbl/acre averaging 25 gpt in central portion of Piceance Basin.
Mining:	None - true in-situ production from 540' thick zone, .7 acre in area in lower Leached Zone shales below Mahogany Zone between 775' and 1,325' where shale formation is naturally permeable due to past ground water dissolution of saline minerals.
Retorting:	In-situ superheated stream injection into Leached Zone. Planned to inject 1 trillion BTU of 1000°F stream at 1500 PSI into 8 wells laid out in 4 triangles at 46,000 lb/hr (131 bbl/hr) withdrawing water and up to 1000 BPD product oil from 5 production wells at center of triangle. Due to initial superheater problems, stream injection through June 1981 equaled only 786,000 bbl water at 764°F and 1385 PSI. During same period, 524,500 bbl fluids produced, but only since early 1981 has any oil been produced at 12-20 bbl/day. Superheaters become fully operational in October 1981.
Water:	2000 bbl/day derived by pumpage from Leached Zone
Waste Disposal:	Brines and stream generator/softener blown down injected into Leached Zone.
Employment:	Two operators 24 hr/day, six total
Contractor:	Stearns-Roger - field operation
Cost:	o $11 million total (14% equity and 86% DOE) o Not ready to proceed commercially o Requested no further Federal financial assistance
Status:	o 1960 - Laboratory studies leading to field test using natural gas o 1971 - Project plans switched to use of superheated stream o 1977 - June: DOE cooperative agreement for 4.5 yr. BX oil shale program

- o 1978 - Commenced design, drilling and construction at site
- o 1979 - September: Stream generators started and achieved sustained injection
- o 1980 - December: Install high pressure heater-treater and increase well perforations to enhance water production
- o 1981 - October: Superheated stream injection achieved
- o 1982 - January: Terminate stream injection and attempt secondary recovery of retorted oil

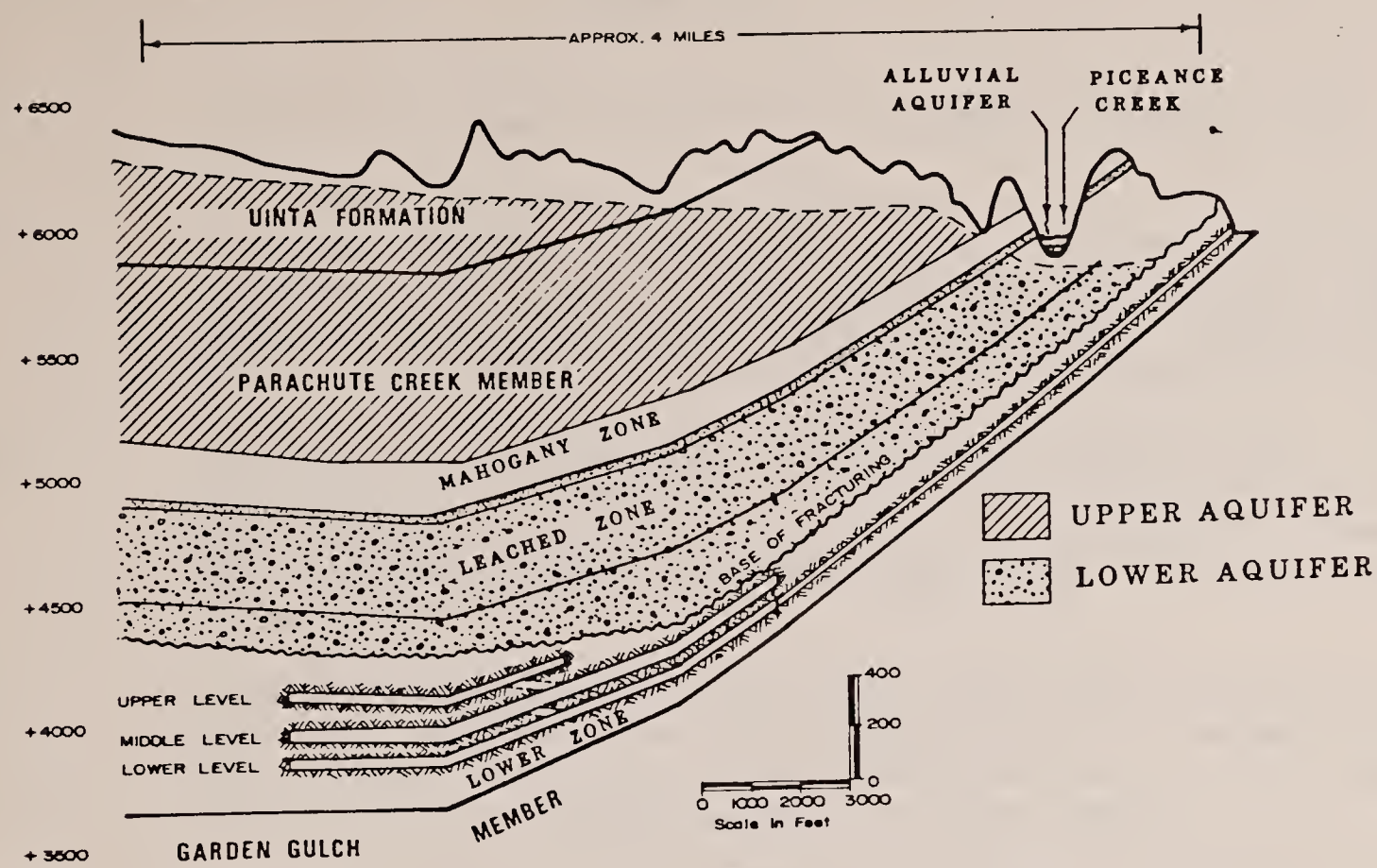
Contact: Paul M. Dougan
Suite 806, 10 West 3rd South
Salt Lake City, Utah 84101
(801) 521-3513

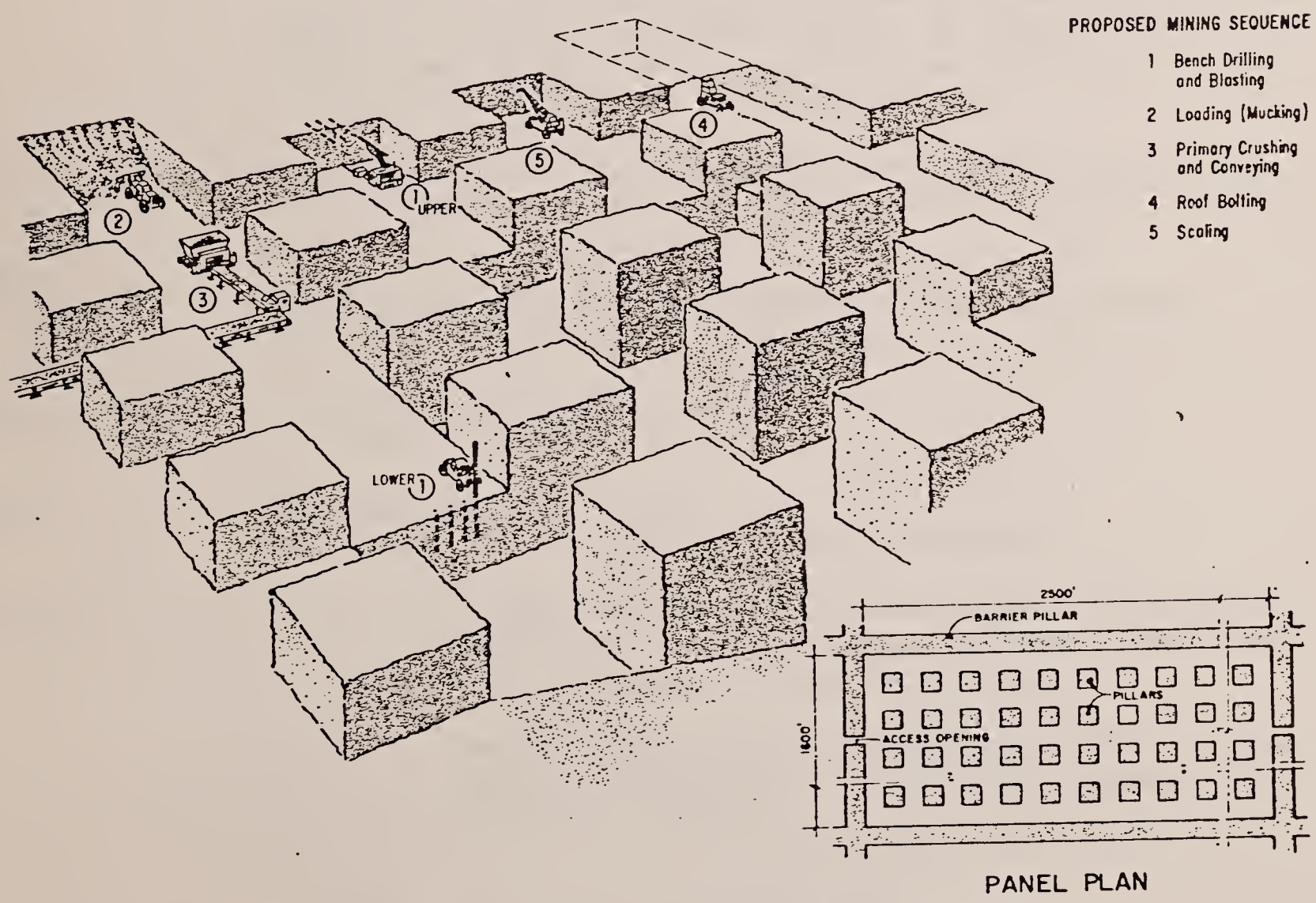
Aerial photo of Bx site with Black Sulphur Creek in foreground. The road to the top of the ridge behind the site leads to a meteorological tower. The water holding pond is on a bench below the site, and the softened water storage tanks are in a bench directly above the steam generation building. High pressure steam lines are visible going to the injection wells on the site and the oil separation building and storage tanks are to the right of the pattern wells.

SUPERIOR



COLORADO





PANEL PLAN

PICTORIAL VIEW OF THE PROPOSED MINING OPERATION

Superior
(Commercial)

Company: Superior Oil Company 60%, Sohio 30%, Cleveland Cliffs 10%

Location: T1N, R97W; 62 road miles from Rifle in Rio Blanco County, Colorado; partners hold 6,750 acres of private land near confluence of Piceance Creek along the White River, 6,000 acres of which contain oil shale. Seeking land exchange with federal government to block up logically shaped mining unit.

Resource: Mahogany Zone averages 160' to 220' thick with a grade of 20 to 25 gpt for a resource of 250,000 to 300,000 bbl's/acre. Four hundred foot thick, three level mining interval in Lower Zone unleached shales averaging 25 gpt with 20% nahcolite and 7% dawsonite.

Mining: Bottom of valley decline with three level room-and-pillar and secondary access shafts, producing 26,176 TPD on advance with back filling of retorted and leached shale on retreat. Anticipate achieving 50-70% recovery in mine levels.

Retorting: Above ground retorting using one Superior circular grate multi-product recovery unit producing 11,586 BPD shale oil, 4,878 TPD nahcolite, 580 TPD alumina, and 1,200 TPD soda ash. If successful, could triple production, except for nahcolite. Oil will be trucked to common carrier pipeline dump point at Rangely, Colorado; nahcolite trucked to Western Slope coal fired power plants for use as stack gas scrubbing reagent; and alumina and soda ash railed to smelters.

Water: 100 AF/Y from well permits on Leached Zone (90%) with supplemental diversion on Piceance Creek and White River.

Waste Disposal: Backfill retorted and leached shale after nahcolite and dawsonite removal into mined out areas.

Employment:
- o 1,300 during peak construction
- o 920 during sustained operation

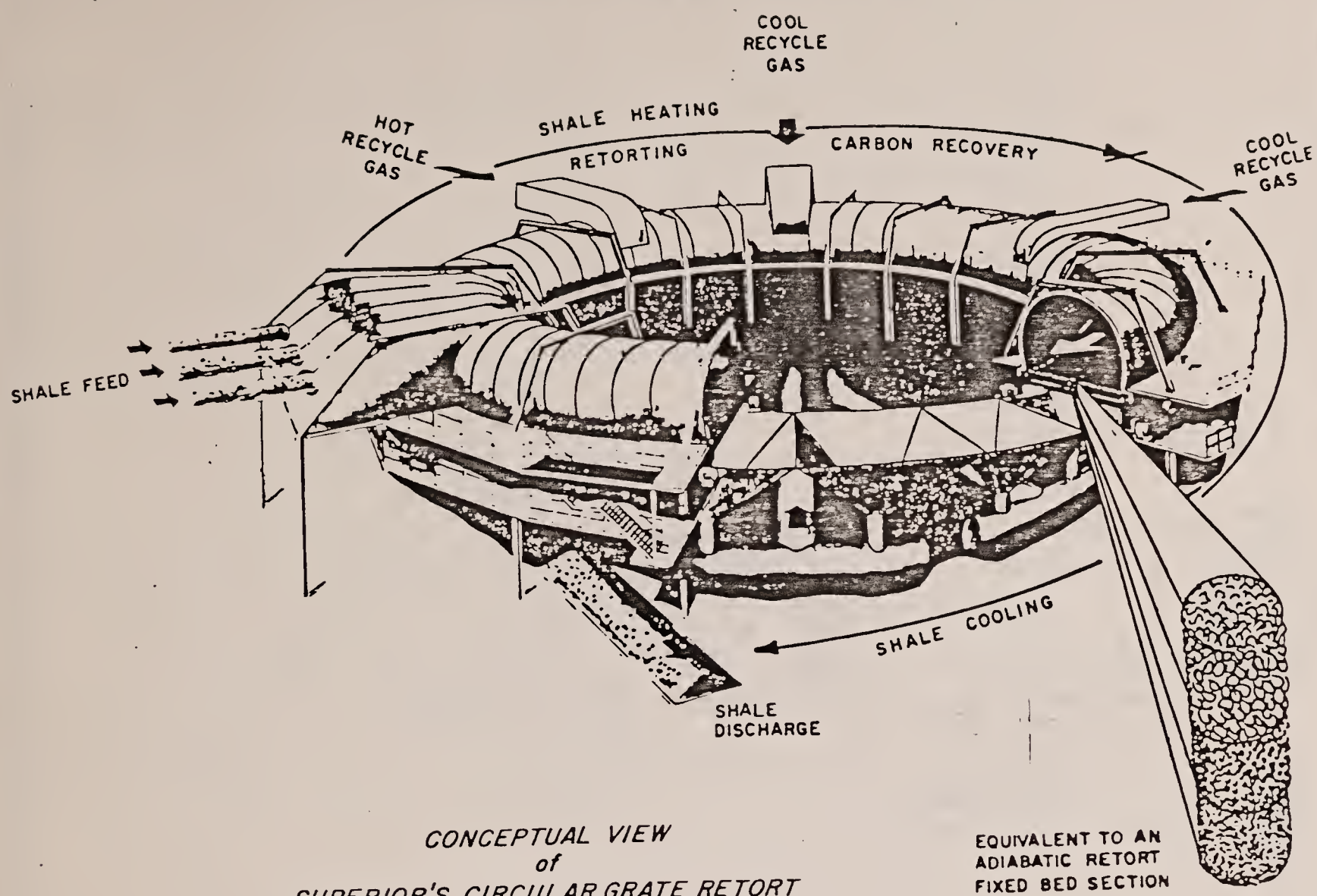
Cost:
- o $450 million total project
- o Not seeking federal loan or funding assistance

Status:
- o 1969 - Started process development program to determine feasibility of multi-mineral recovery, and core-hole evaluation of Superior property.
- o 1973 - March: Requested land exchange with BLM to block up logical mining unit (2,572 acres offered, 2,045 acres selected).

- o 1976-78 - Operated 250 TPD pilot retort unit, 4,800 lbs/day soda ash plant, and 75 TPD nahcolite separation unit.
- o 1978 - May: Provided BLM with socioeconomic data for land exchange EIS in response to requirements of Federal Land Management Act.
- o 1979 - July: Draft EIS on Superior land exchange issued
- o 1980 - April: Final EIS issued
- o 1980 - July: USGS recommended against exchange due to unequal land and resource values. Superior seeking reconsideration before DOI Board of Land Appeal.

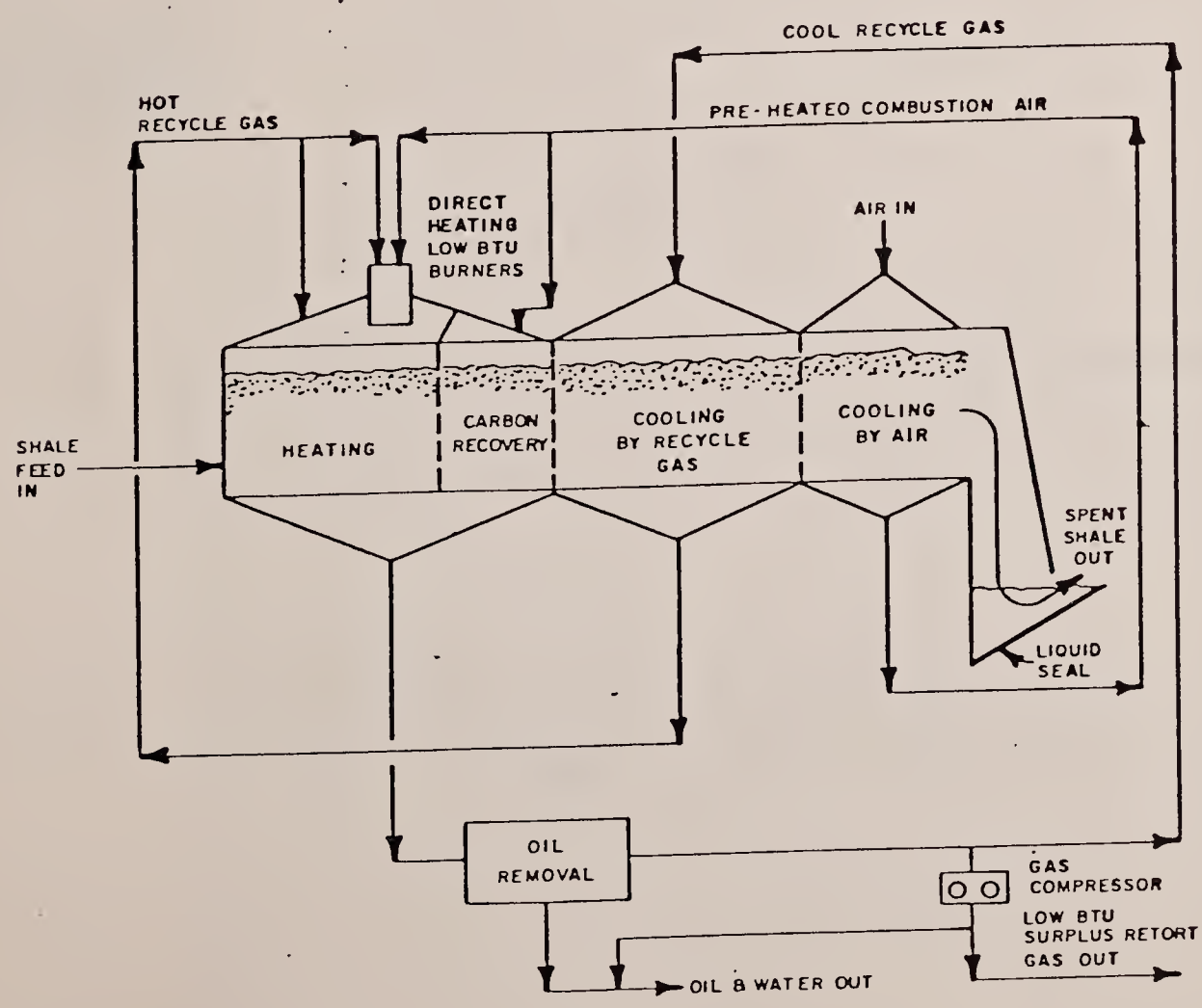
Contact:

J. H. Knight, Manager
Oil Shale Division
The Superior Oil Company
2750 S. Shoshone
Englewood, Colorado 80110
(303) 761-5853

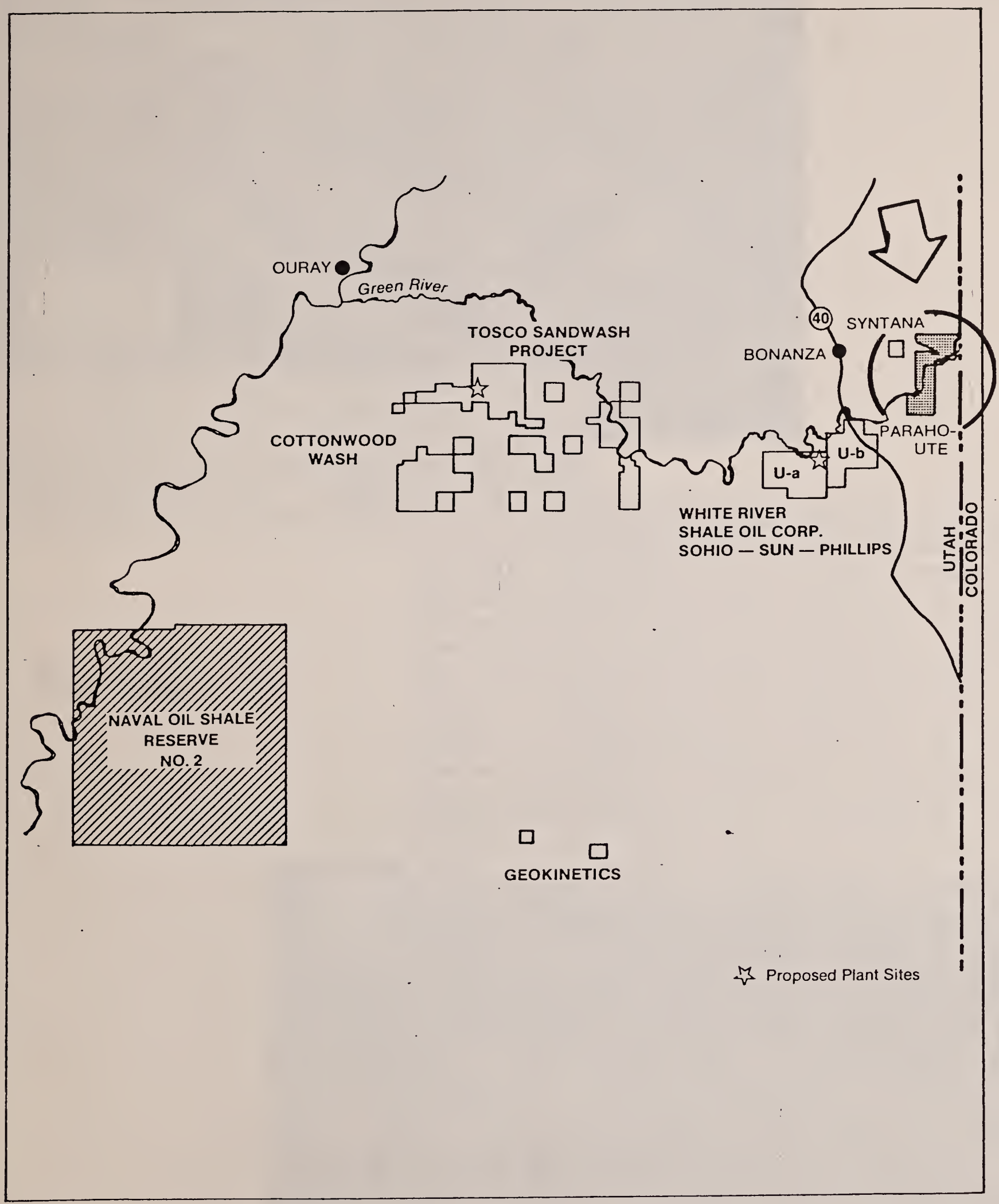


CONCEPTUAL VIEW
of
SUPERIOR'S CIRCULAR GRATE RETORT

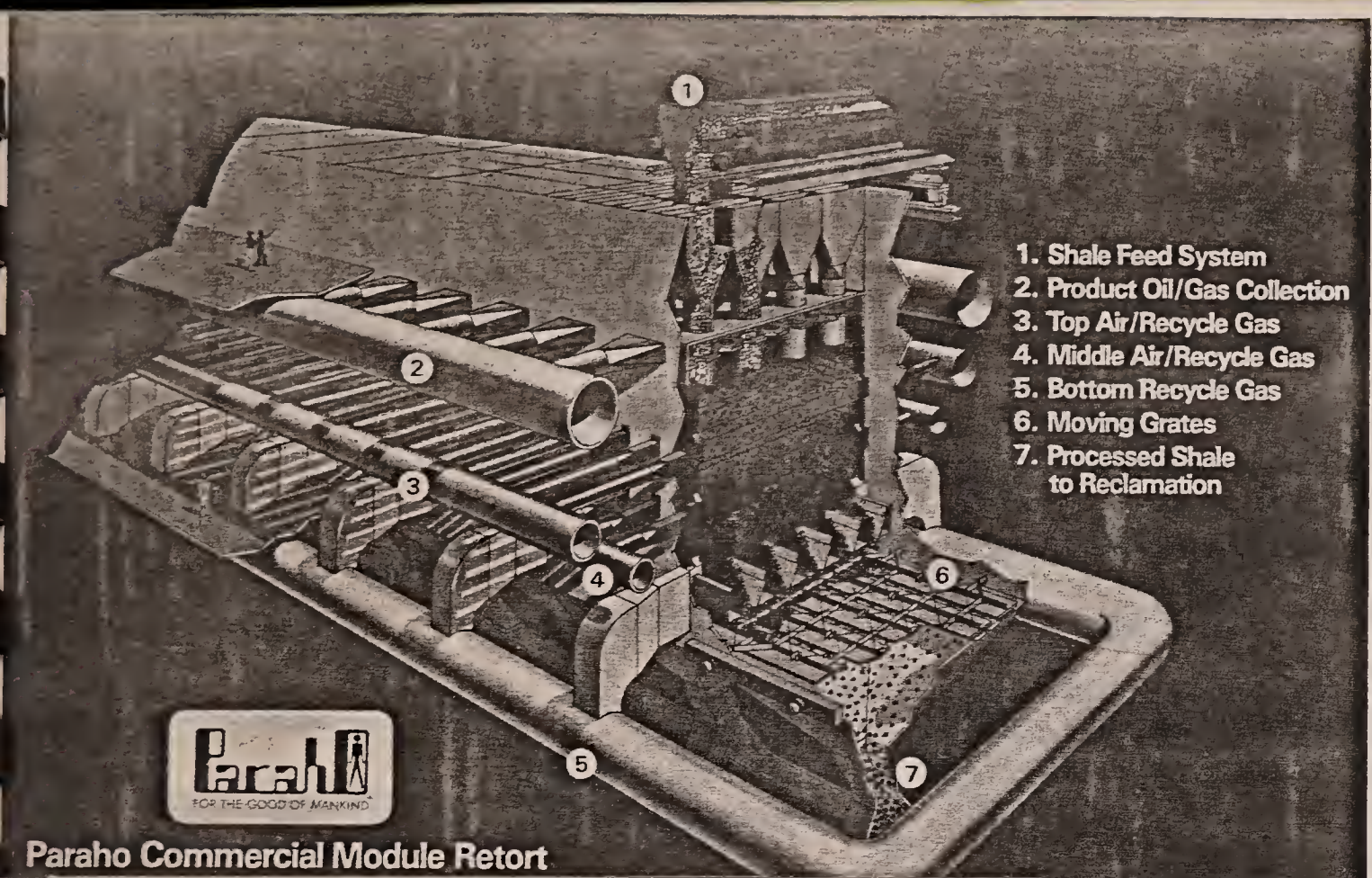
SIMPLIFIED PROCESS FLOW DIAGRAM
THE SUPERIOR OIL COMPANY'S CIRCULAR GRATE RETORT
DIRECT HEATED MODE



PARAHO-UTE



UTAH

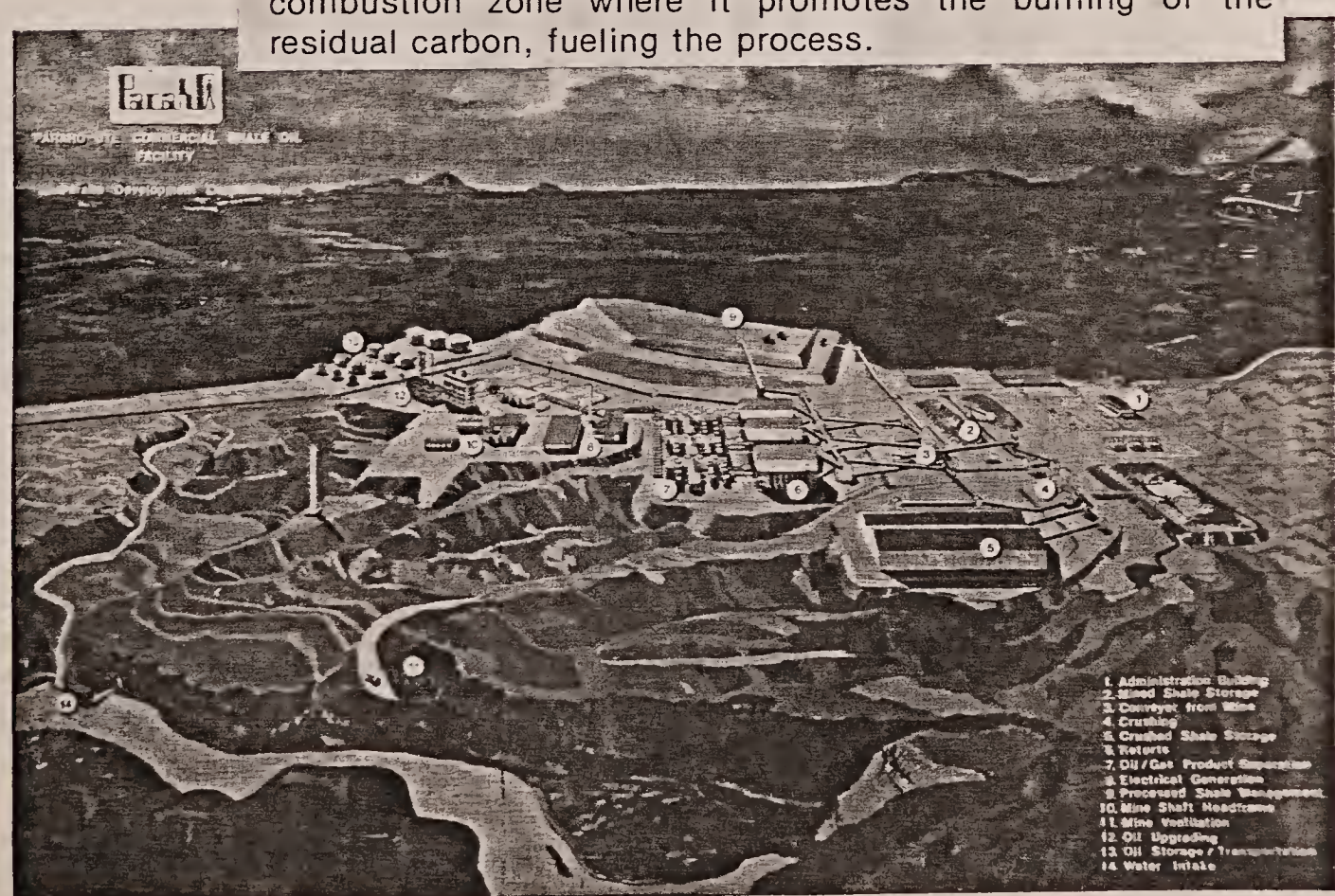


Paraho Commercial Module Retort

The Paraho retort is a vertical vessel with a fire-brick lining and a steel shell. Crushed oil shale feeds continuously into the top of the retort and moves downward by gravity, exiting at the bottom of the vessel. The oil shale moves through four zones as it descends within the retort: mist formation, retorting, combustion and cooling.

Paraho-Ute

In the center of the Paraho retort is the combustion zone. In this zone some of the residual carbon on the retorted shale is burned to provide most of the heat necessary for processing. This heat rises into the retorting zone, causing the kerogen in the shale to release oil and gas. The oil and gas rise into the mist formation zone. Here, the oil and gas are cooled by the incoming shale, forming a mist. This oil and gas mist is drawn off from the top of the vessel and separated. The shale oil product goes to storage and a portion of the gas is recycled into the retort. The recycled gas, entering the bottom of the retort, cools the processed shale before it exits from the vessel, thus eliminating the need for water. The recycled gas continues upward into the combustion zone where it promotes the burning of the residual carbon, fueling the process.



Paraho-Ute Project
(Commercial)

Companies: Paraho Development Corporation, and 14 others

Location: T9S, R25E, Sec. 32; 50 miles southeast of Vernal, Uintah County, Utah (four miles southeast of Bonanza, Utah) on 1,500 acres north of White River including state leases and private lands with additional acreage under negotiation; possible Federal land exchange to eliminate enclaves.

Resource: 120' of Mahogany Zone, with 80' mine zone averaging 28 gpt

Mining: Outcrop ventilation drift with production decline to 80' high, two-bench room-and-pillar mine interval in Mahogany Zone producing up to 22,000 TPD (20 million TPY) with in-mine primary crushing.

Retorting: Three 18,000 to 20,000 TPD (10,000 BPD) Paraho, vertical shaft, direct-heated, counter current gas flow retorts (24'w x 100'h x 128'l) with +1/2" to -3 1/2" feed size. Produce 42,000 BPD upgraded shale oil, 120-142 Btu off-gas, 80-90% residual carbon utilization, 4-6% screening undersize, 50-80 MW surplus electric power.

Water: 1.6 bbl water/bbl (2247 gpm) oil from rights on White River not including revegetation

Waste Disposal: Valley and elevation fill of processed shale moisturized to 18-22% for 215 psi cure strength. Zero water discharge. 150 TPD of various sludges.

Employment:
- o 1,500 during peak construction in 1984
- o 1,300 during sustained operation after 1986

Contractor: Davy McKee - design

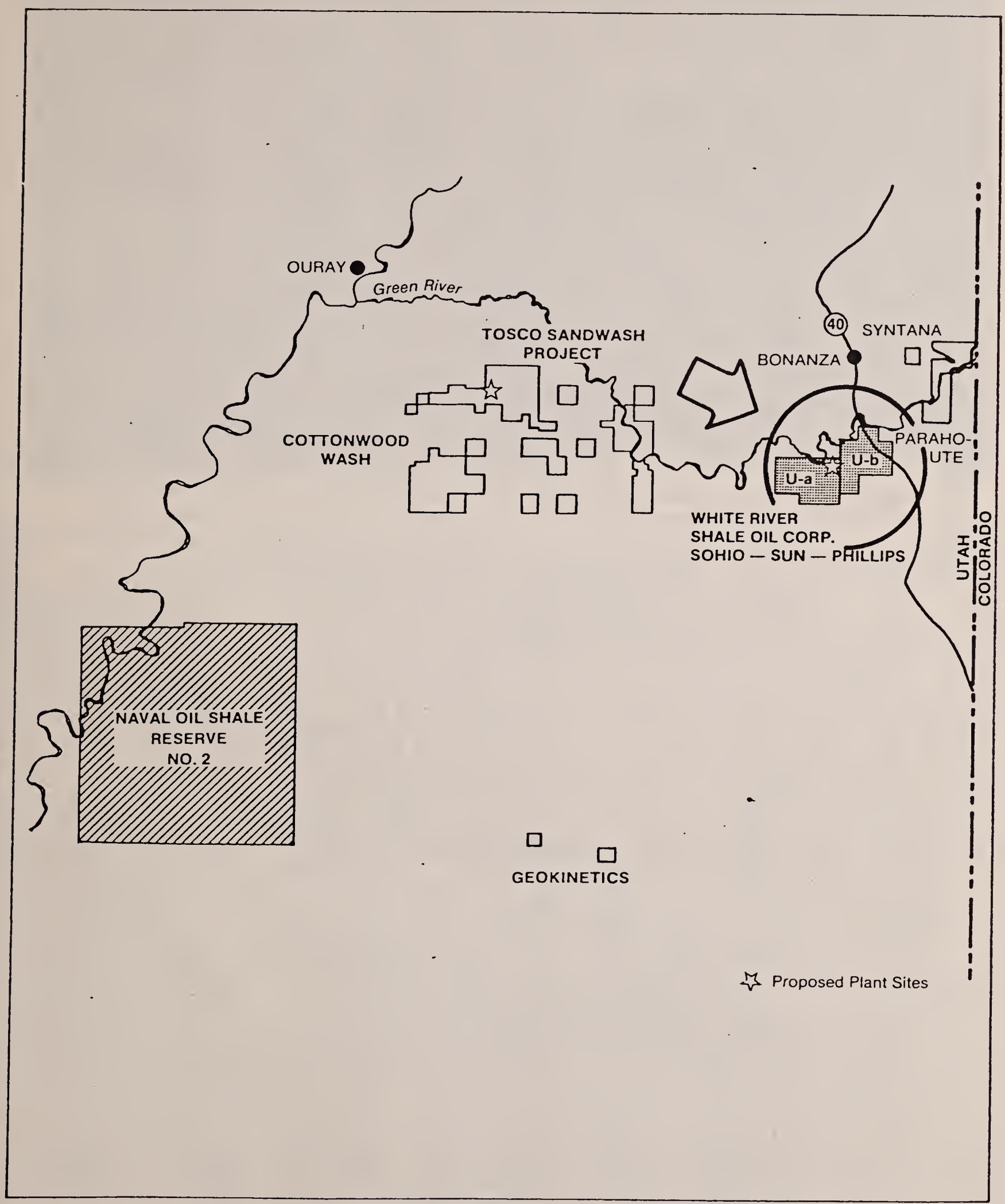
Cost:
- o $2.3 billion total project including land, capital, and interest during construction of 42,000 BPD upgrade oil capacity
- o $8.1 - $9 million for Phase I module design (54% DOE, 46% Paraho)
- o $3.2 million DOE grant for feasibility design to expand Phase I module to 30,000 BPD
- o Paraho has applied for $1.3 billion in SFC price and loan guarantees
- o $40 million for research and development leading to commercial design by end 1981

Status:
- o 1971 - Paraho organized and based in Grand Junction
- o 1974 - $10 million, 3-year, retort design and demonstration program completed in 1976

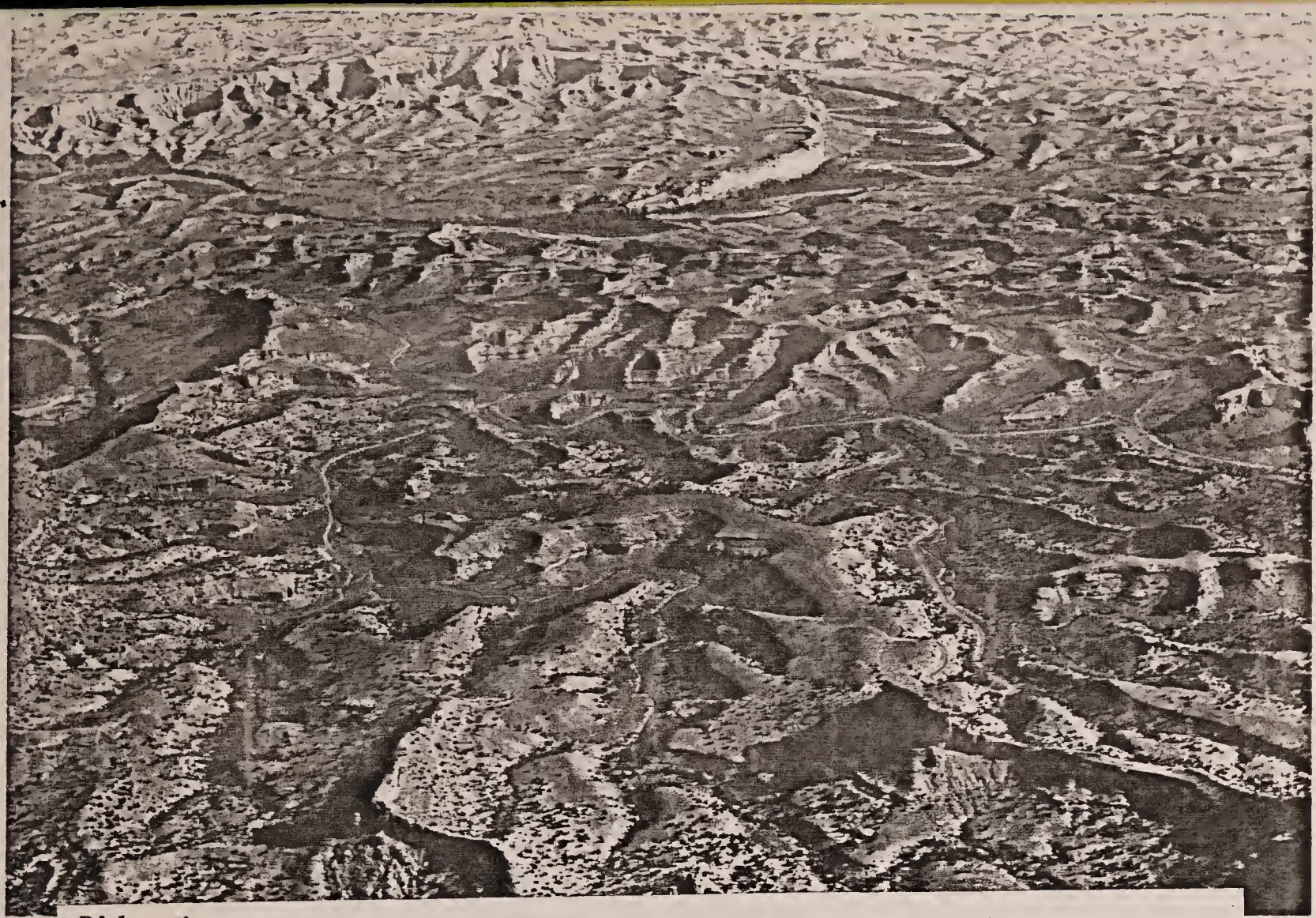
- o 1977-79- 100,000 bbl shale oil retort and refining run for DOD
- o 1979 - Pilot plant runs on Israeli and Morroccan oil shale
- o 1980 - June: Phase I 18-month design cooperative agreement with DOE that could lead to construction of 18,000 TPD (11,000 BPD) retort module.
- o 1981 - Complete Phase I feasibility, design, and engineering study
- o 1982 - Project to be evaluated in BLM's Uintah Basin Synfuels EIS
- o 1982 - Begin construction
- o 1984 - Begin retort operation at 10,000 BPD with three units on line by 1986 producing 30,000 BPD
- o 1986 - Begin operating hydrotreating upgrade unit producing 34,000 BPD
- o 1986 - Begin scale-up to 42,000 BPD

Contact: Harry Pforzheimer, Jr., President
Paraho Development Corporation
300 Enterprise Building
Grand Junction, Colorado 81501
(303) 243-9550

WHITE RIVER SHALE PROJECT
(Phillips, Sunoco & Sohio)



UTAH



Ridge in center middle ground is proposed surface retort plant site for co-development of Utah Federal Oil Shale Tracts U-a and U-b with White River meandering in distance.

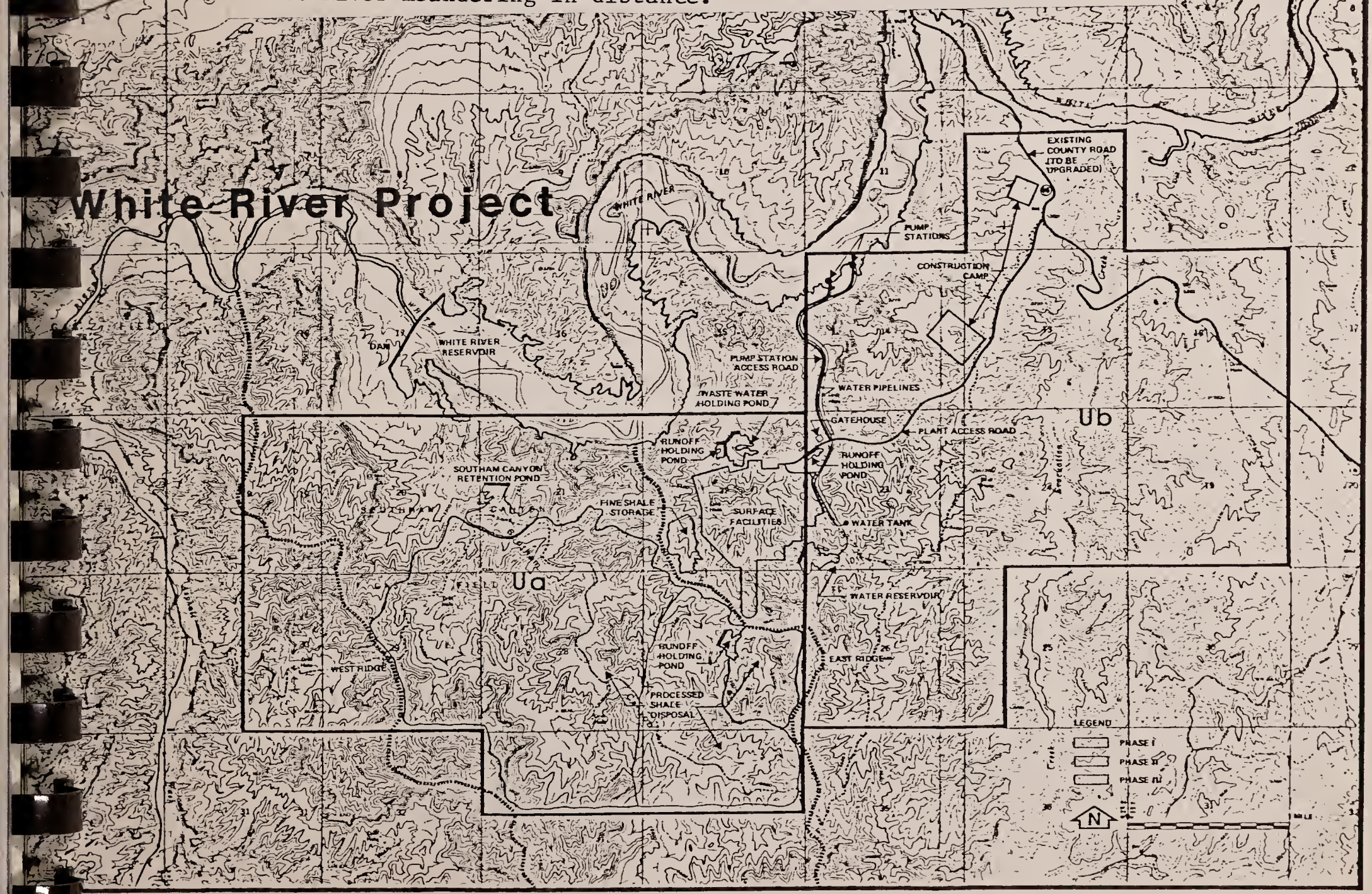


Figure 3.4-1 OVERALL SITE PLAN

Federal Tracts U-a/U-b
White River Shale Oil Corporation
(Commercial)

Companies: Phillips Petroleum Company)
Sunoco Energy Development Company) Equal Partners
Sohio Shale Oil Company)

Location: T10S, R24&25E; south of White River in eastern part of the Uinta Basin in northeastern Utah, Uintah County, 42 miles SE of Vernal, Utah; 10,240 acres (two, 5,210 acre leases).

Resource:

	U-a	U-b
Acres of oil shale	- 5,120 acres	5,120 acres
Mining zone	- 55 ft. avg. 28 gpt	55 ft. avg.28 gpt
Resource in place	- 540 million bbls	510 million bbls
63% Recoverable Resource	- 340.2 million bbls	321.3 million bbls
Overburden	- 550' to 1225'	300' to 1250'

Mining: Room-and-pillar producing 27,330 TPD in Phase I by 1987, 93,460 TPD in Phase II by 1991, then 176,740 TPD in Phase III. Primary and secondary crushing will take place underground. Tertiary crushing for the Union B retorts will take will take place on the surface.

Retorting:

o Phase I
- One 11,600 TPSD Union B indirect heated (IH) retort — 15,930 BPSD
- One 13,000 TPSD Superior direct heated (DH) retort
- Pipeline product to Salt Lake City
- 29.4 STPSD sulfur, 65.4 TPSD ammonia.

o Phase II (including Phase I)
- One 13,000 TPSD Superior DH retort
- Four 11,600 TPSD Union B IH retorts — 60,940 BPSD
- One 25,000 TPSD Superior DH retort
- One 9,400 TPSD TOSCO II fines IH retort
- 125.2 STPSD sulfur, 245.4 TPSD ammonia.

o Phase III (including Phases I and II)
- One 13,000 TPSD Superior DH retort
- Four 11,600 TPSD Union B IH retorts
- Four 25,000 TPSD Superior DH retorts — 113,950 BPSD
- One 9,400 TPSD TOSCO II fines IH retort
- One 8,000 TPSD TOSCO II fines IH retort
- 204 TPSD sulfur, 450 TPSD ammonia.

Final choices of retorts to be used in the commercial phases of project operation may change from the above, depending on evolving technology and the results of retort operation during Phase I.

Water: Require 2,700 AF/Y in Phase I, 11,300 AF/Y in Phase II and 22,600 AF/Y in Phase III. Water for Phase I will be pumped from alluvium wells and for Phase II and III from the proposed White River Reservoir.

Waste Disposal: Southam Canyon west of processing facilities in the southern part of Tract U-a using topsoil replacement method.

Employment:
- o 576 for construction by end of 1982
- o 5,083 for construction by 1989
- o 3,353 for operations in 1994 for a total population of 15,935
- o Bachelor camp (675-1,000) and recreational vehicle camp (225) will be constructed.

Cost:

Phase	Capital Costs (a,b) (Million $)	Operating Costs (a,b) (Million $/yr)	Shale Oil Produced(c) (BPSD)
I	661.8	75.5	14,840
II	1,266.1	196.9	56,875
III	1,364.4	333.9	106,300
TOTAL	3,292.3	606.3	---

(a) All costs are within an accuracy of 25 percent, 1981 dollars.
(b) Estimates are based on conceptual design of the project plan as described in this Detailed Development Plan. Capital costs include owners' costs subsequent to 1981.
(c) 328.5 days per year.

Contractors:
- o Bechtel Corporation - prepared Detailed Development Plan
- o Ralph M. Parsons - Prime Contractor
- o Gibbs & Hill, Inc. - Community & Infrastructure Support

Status:
- o 1974 - June 1: Both leases went into effect
- o 1976 - November 1: Both leases suspended by Secretary of Interior
- o 1976 - August 8: U.S. Tenth Circuit Court of Appeals supported Utah's claim.
- o 1980 - May 19: U.S. Supreme Court issued 5-4 opinion upholding the Department of the Interior position in the Utah "in lieu" land case and reversing previous lower court decision.
- o 1981 - September 1: Lessee submitted Final Detailed Development Plan
- o 1981 - August 28: Applied for commercial PSD permit.
- o 1986 - Achieve Phase I production of 14,840 BPD.
- o 1992 - Commercial production of 60,940 BPSD

Contact:

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White River Shale Oil Corp.
Prudential Fed. Bldg., # 500
115 S. Main Street
Salt Lake City, UT 84111
(801) 363-1170

or

Corey W. Grua, Manager
Community Relations
1315 West Highway 40
Vernal, UT 84078

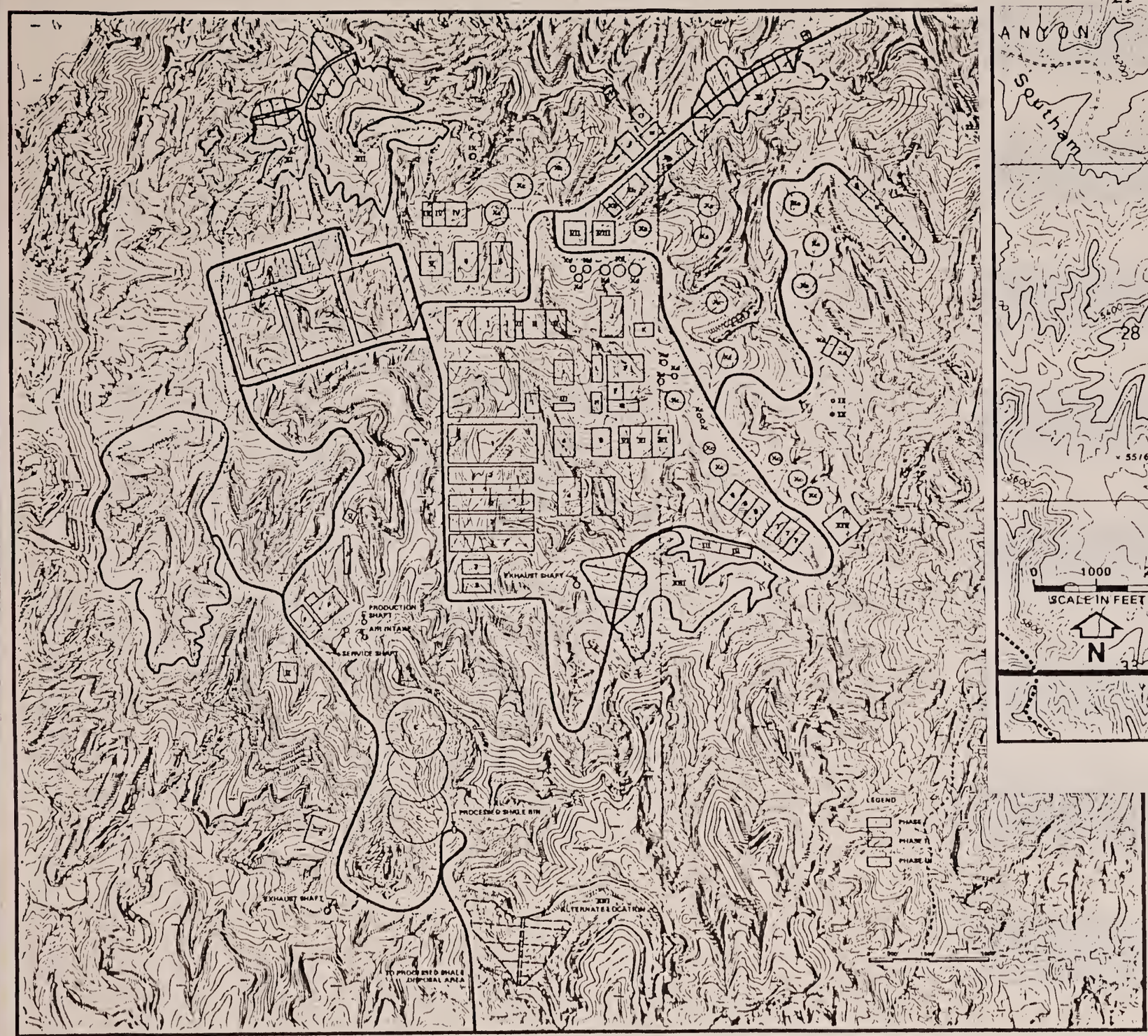
(801) 789-0571

White River

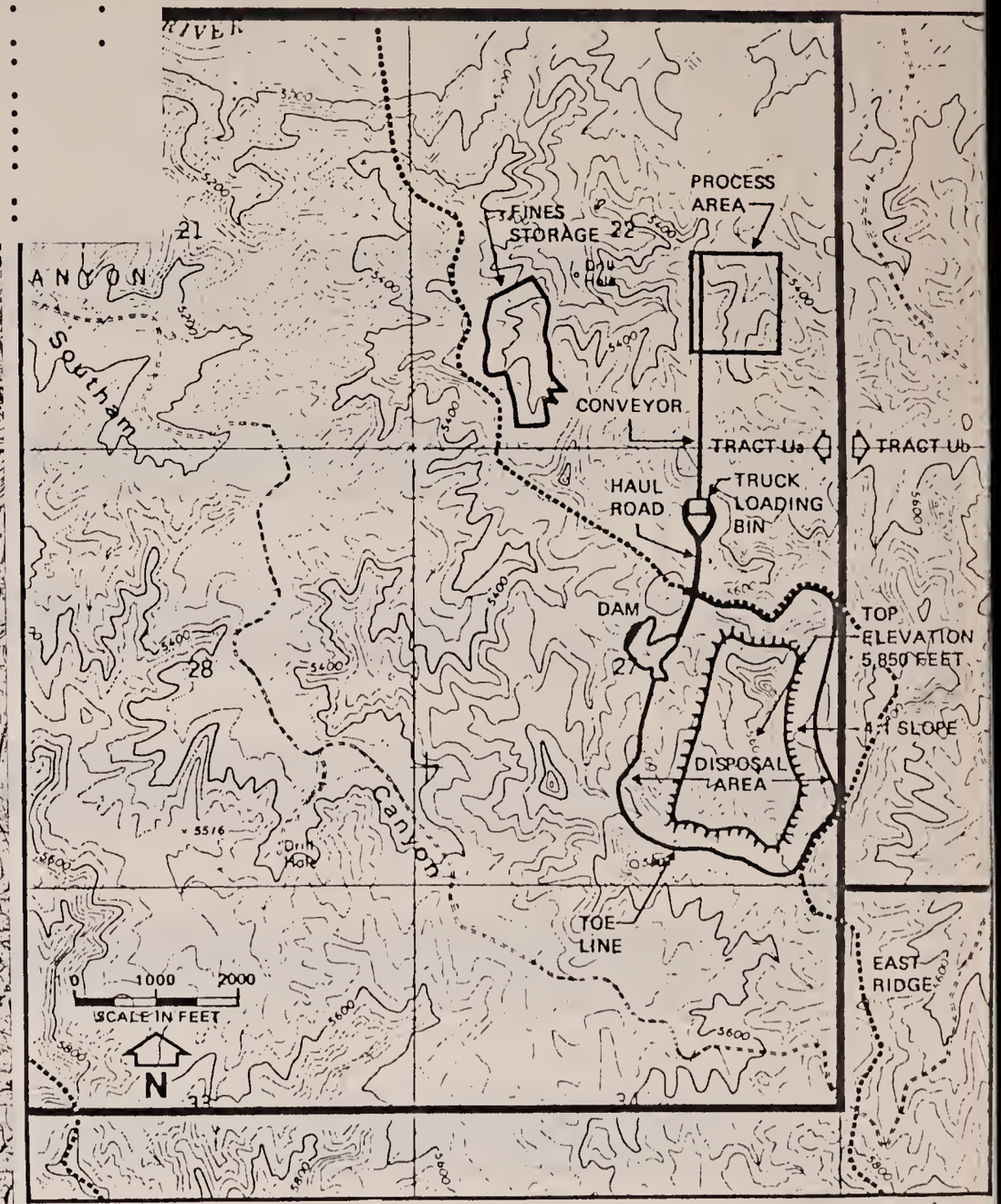
LEGEND:

PROCESS FACILITIES	PHASE I	PHASE II	PHASE III
1 COARSE SHALE RETORT: SUPERIOR	•	•	•
2 COARSE SHALE RETORT: UNION B	•	•	
3 FINE SHALE RETORT: TOSCO		•	•
4 H_2 PLANT	•	•	•
5 HTU PLANT	•	•	•
6 PROCESS WASTE WATER TREATMENT	•	•	•
7 SULFUR PLANT	•	•	•

MINING AND MATERIAL HANDLING AND OTHER FACILITIES			
A GATEHOUSE	•	•	•
B HAZARDOUS WASTE DISPOSAL SITE	•	•	•
C RAW SHALE STOCKPILE	•	•	•
D FINE SHALE STORAGE	•	•	
E EXPLOSIVES STORAGE	•	•	
F PARKING LOT	•	•	
G MULTIPURPOSE BUILDING	•	•	
H LABORATORY BUILDING	•	•	
J WAREHOUSE	•	•	
K FIREHOUSE		•	
L CHANGE ROOM		•	
M ADMINISTRATION BUILDING		•	
N HELICOPTER PAD	•	•	
O CAFETERIA		•	
P MINE SERVICE BUILDING	•	•	



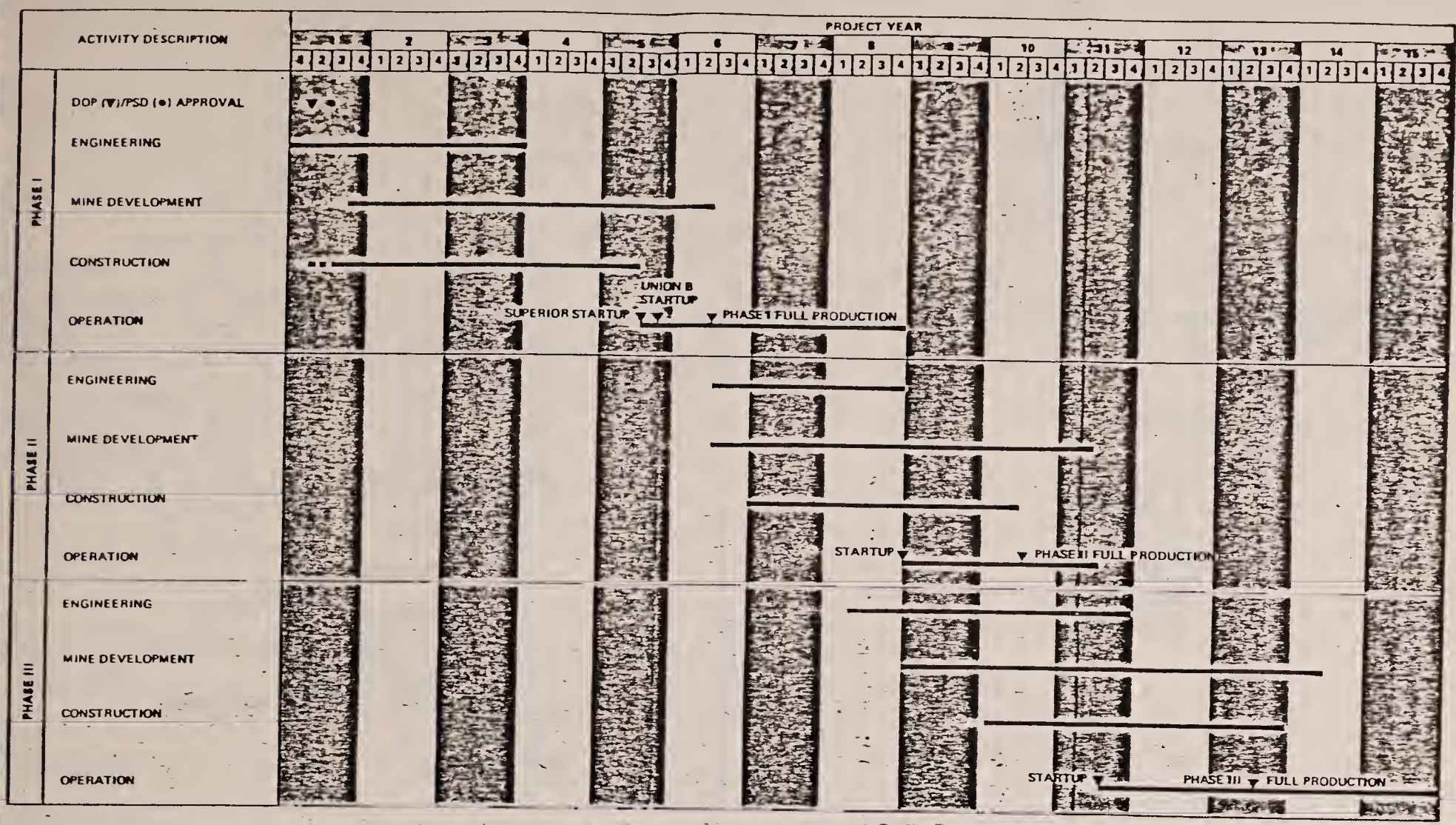
PROCESS AREA PLOT PLAN



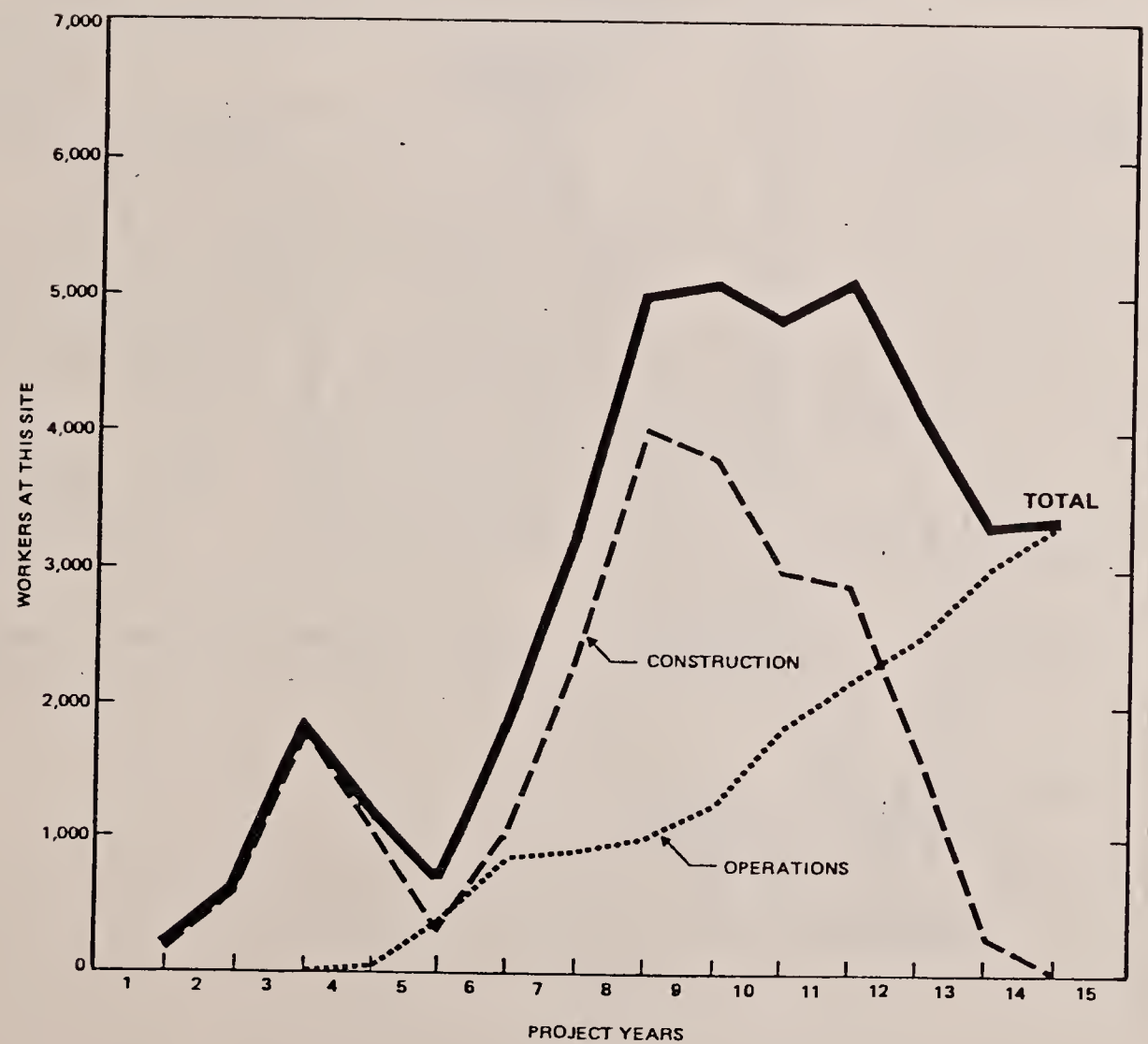
PROCESSED SHALE DISPOSAL, PHASE I

UTILITIES			
I BOILER AND POWER PLANT	•	•	•
II SUBSTATION	•	•	•
III COOLING TOWER	•	•	•
IV WASTEWATER TREATING (NON PROCESS)	•	•	•
V SEWAGE TREATMENT PLANT	•	•	•
VI RAW WATER TREATMENT PLANT	•	•	•
VII TRUCK LOADING	•		
VIII SHALE OIL PUMP STATION	•	•	•
IX FLARE	•	•	•
Xa TANK: SHALE OIL PRODUCT	•	•	•
Xb TANK: BY PRODUCT	•	•	•
Xc TANK: RAW SHALE OIL AND INTERMEDIATE PROCESS	•	•	•
Xd TANK: UTILITY	•	•	•
XI RUNOFF HOLDING POND	•		
XII WASTEWATER HOLDING POND	•		
XIII WATER RESERVOIR		•	
XIV SULFUR STORAGE PAD	•	•	•

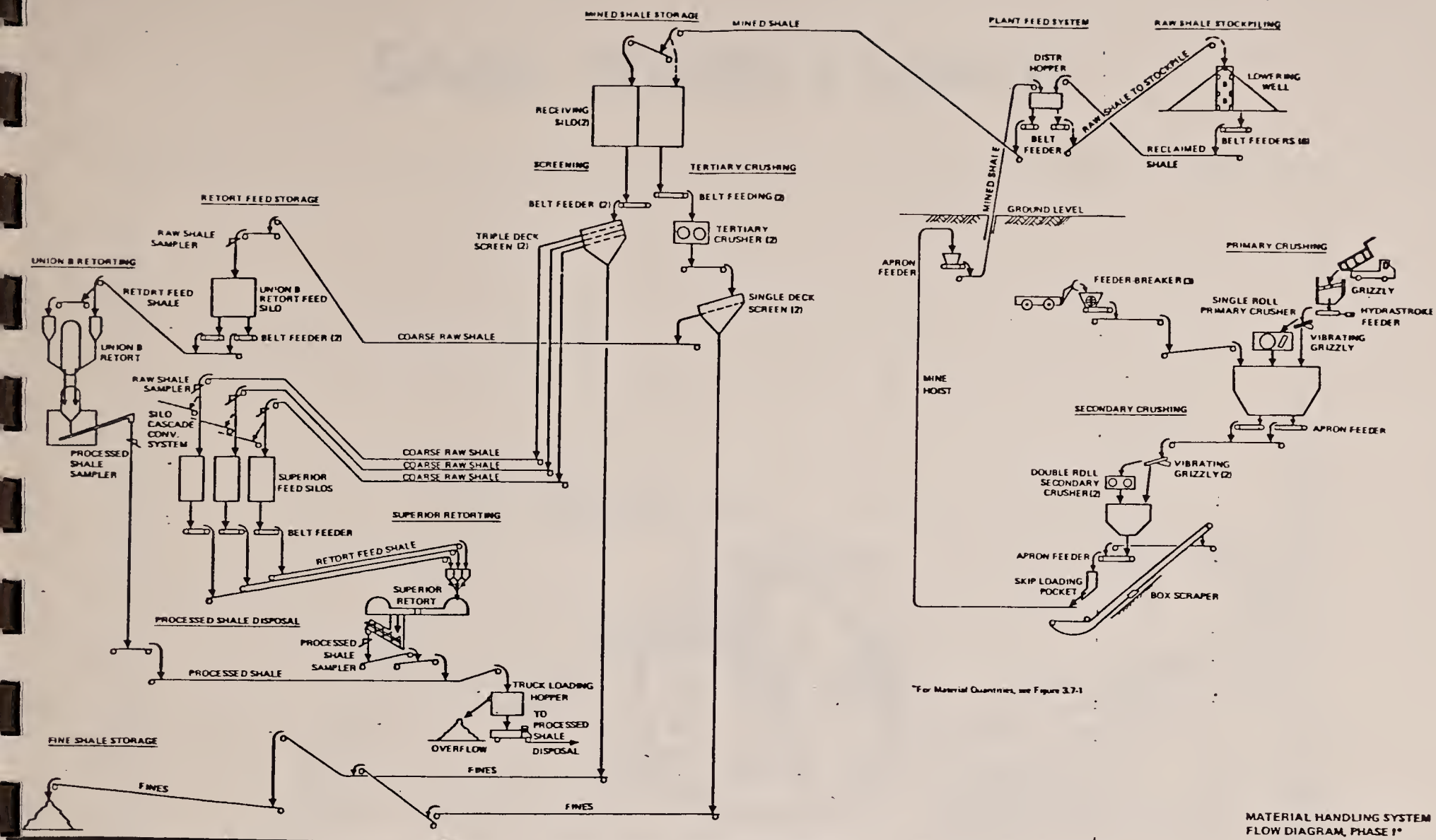
White River Project



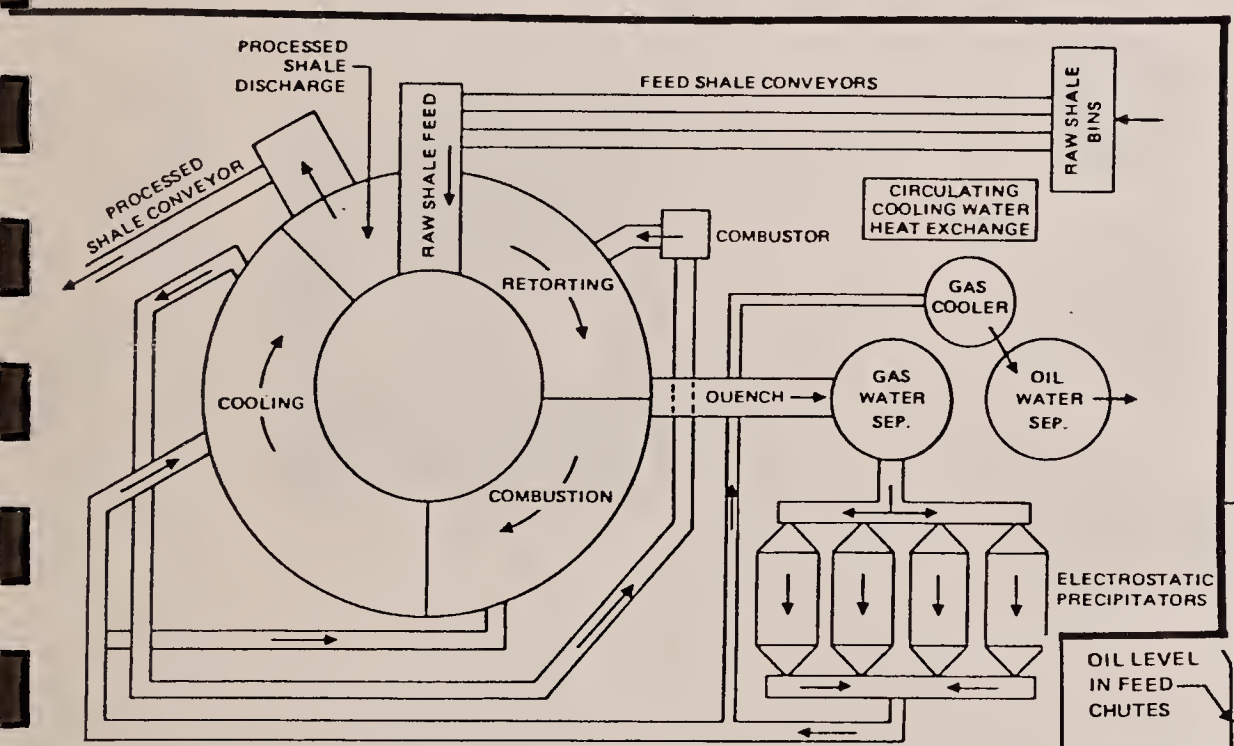
WHITE RIVER SHALE PROJECT SCHEDULE



MANPOWER SCHEDULE

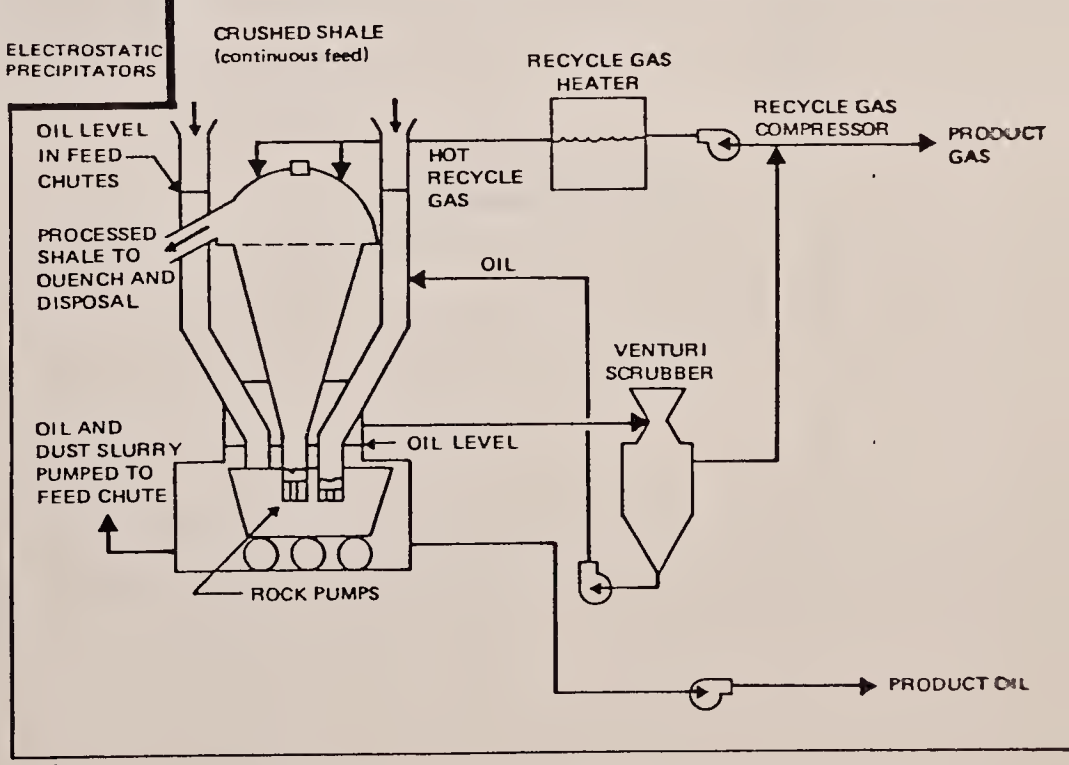


MATERIAL HANDLING SYSTEM FLOW DIAGRAM, PHASE I*



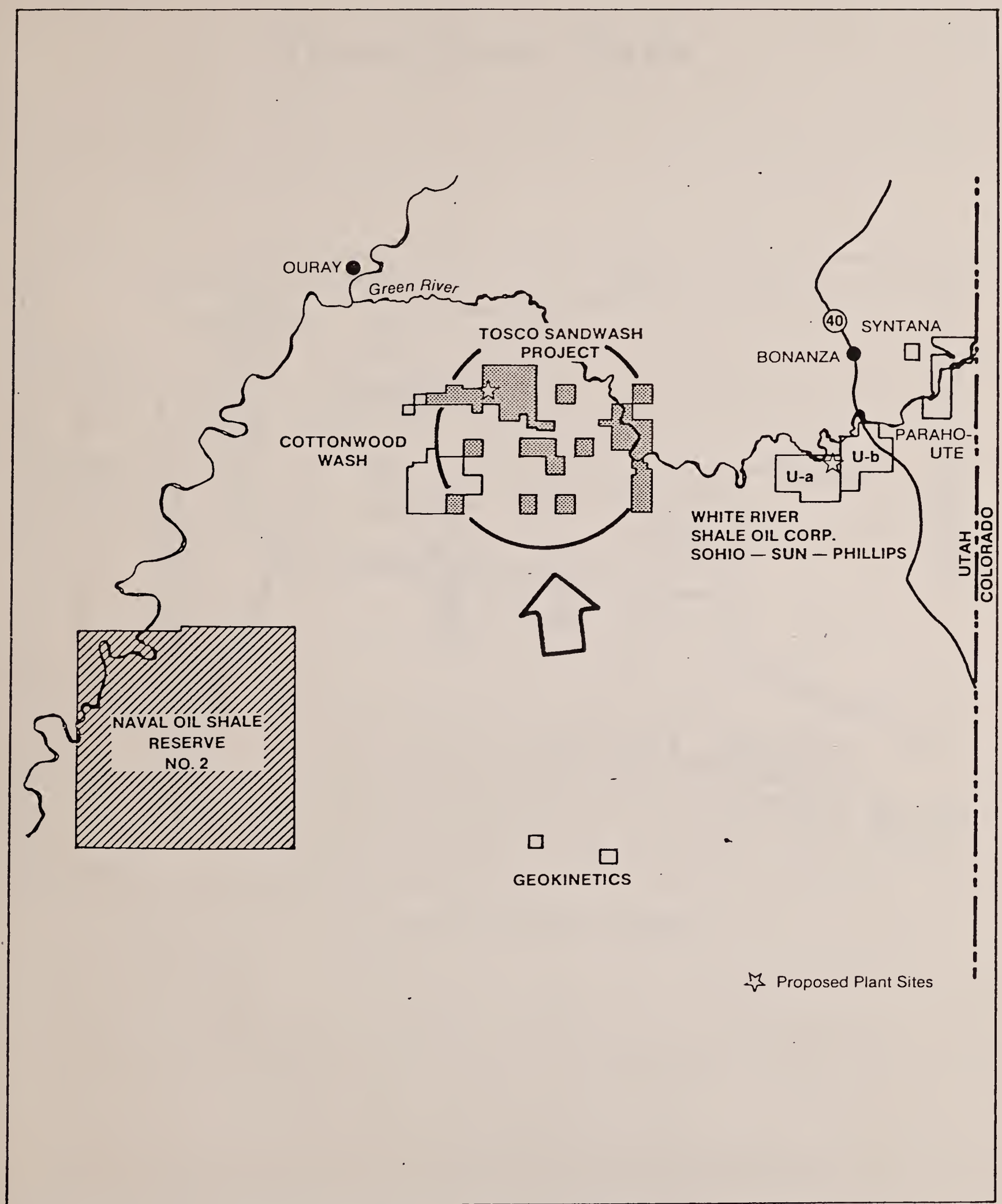
GENERAL LAYOUT, CIRCULAR-GRATE DH RETORT

White River



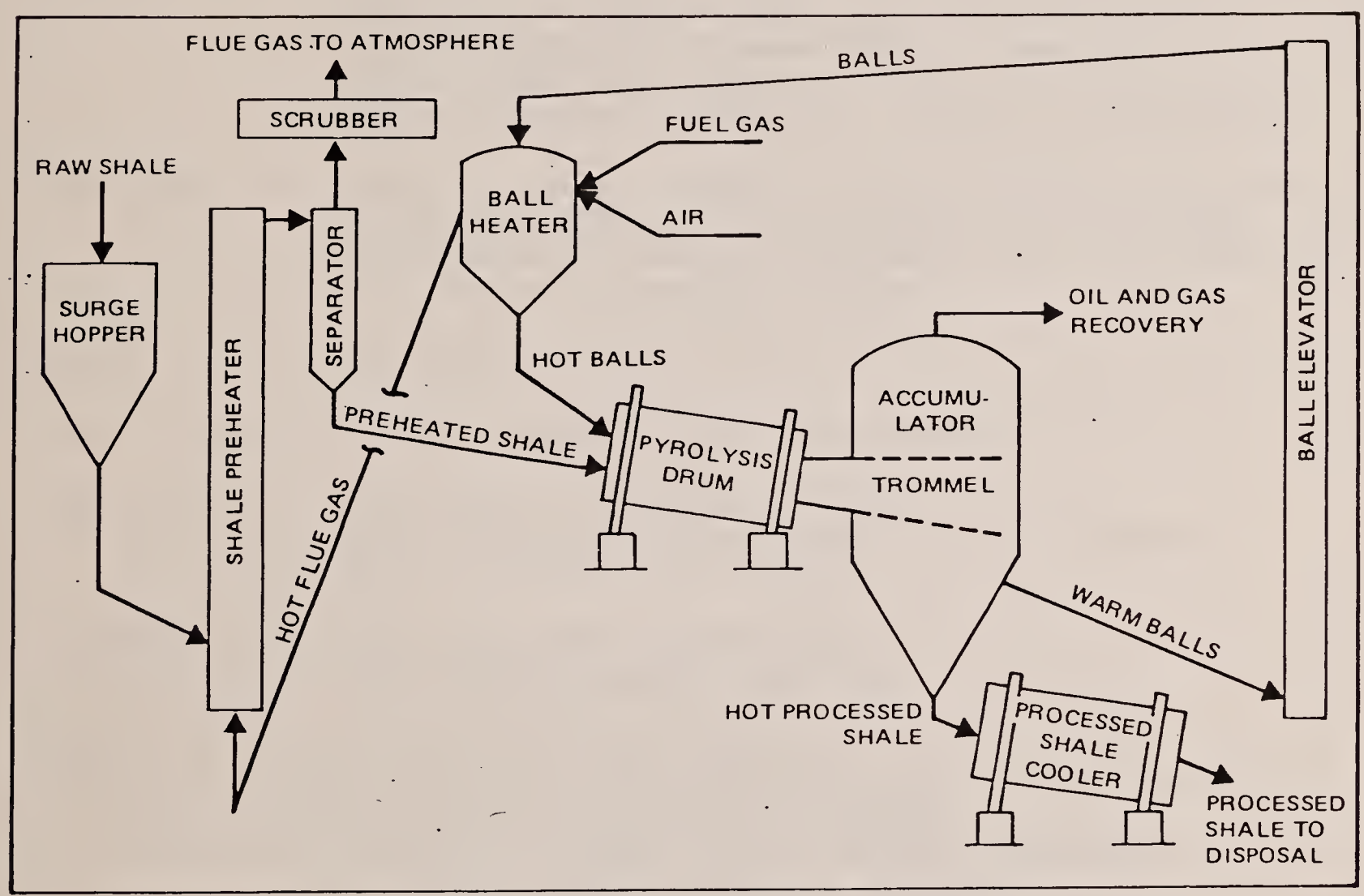
PRINCIPAL FEATURES OF VERTICAL-SHAFT UNION B RETORT

SAND WASH (Tosco)



UTAH

Tosco Sand Wash



FINES-TYPE TOSCO II RETORT

TOSCO Sand Wash Project
(Commercial)

Company: Tosco; considering seeking partner after initial development

Location: T9S, R21E; 14,688 acres mainly on 29 non-contiguous state leases, 35 miles south of Vernal, in Uinta County, Utah; south of the White River. Largest contiguous area is 7,040 acres near Sand Wash. Seeking Federal lease and land exchange to block up logical mining unit.

Resource: 75'-100' of 25-30 gpt shale in Mahogany Zone under nearly 2000' of overburden

Mining: Similar to Colony Project in Piceance Basin of Colorado: 66,000 TPD of 35 gpt shale will be mined from 30' to 40' interval within 90' Mahogany Zone by room-and-pillar methods beneath 2,000' of overburden. Will first sink pilot shaft to confirm subsurface conditions. Corehole has been drilled.

Retorting: Similar to Colony Project in Piceance Basin of Colorado: with six TOSCO II retort trains producing up to 48,300 BPD. Upgraded shale oil will be pipelined to either Salt Lake City or to Midwest via Rangely, Colorado.

Water: 12,000 AF/Y

Waste Disposal: Surface disposal of processed shale

Contractor:
- o R.M. Parson - preliminary design
- o TRW - Permitting and environmental effects analysis
- o Harrison Western - mine shafts

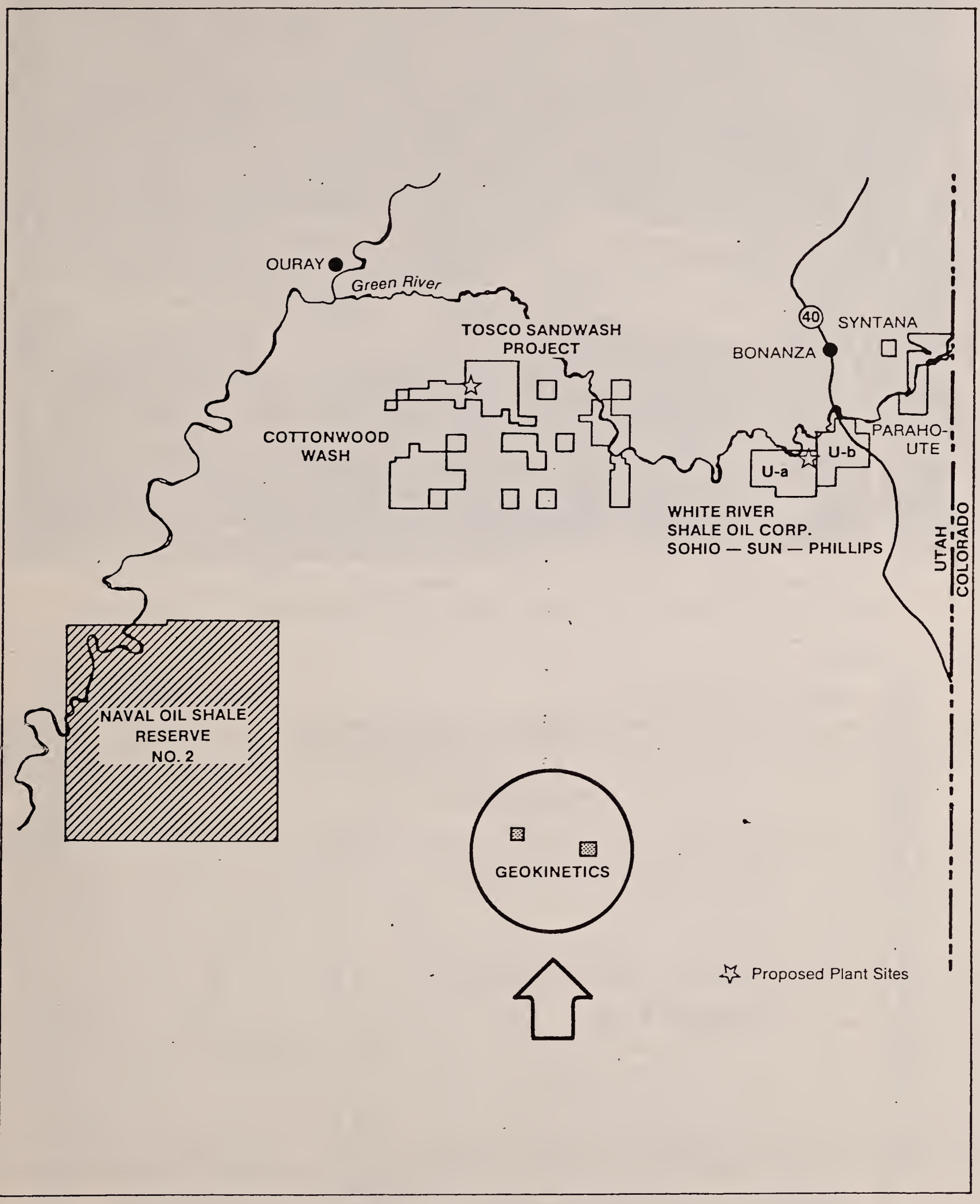
Employment:
- o 2,500 during peak construction
- o 1,200 during sustained operation

Cost:
- o $1.5 billion total project cost
- o $8 million for lease site evaluation for unitization
- o $4.3 million expended through 1980
- o $41 million through 1984 for initial development
- o No Federal funding assistance requested
- o $50 per acre minimum royalty to state by 1993

Status:
- o 1976 - January: Utah Board of State Land asked to unitize 29 leases
- o 1981 - Environmental assessment and mine and process design underway
- o 1981 - Completed pilot core hole at shaft site
- o 1982 - Project to be addressed in BLM Uintah Basin Synfuel EIS
- o 1983 - Begin plant construction and make decision whether to seek Federal loan guarantee
- o 1984 - Complete pilot shaft and mine workings
- o 1985 - Complete unitization study
- o 1988 - Achieve 47,000 - 48,000 BPD production

Contact:
George C. Kane
Project Director
1600 Broadway, Suite 1400
Denver, Colorado 80202
(303) 831-4567

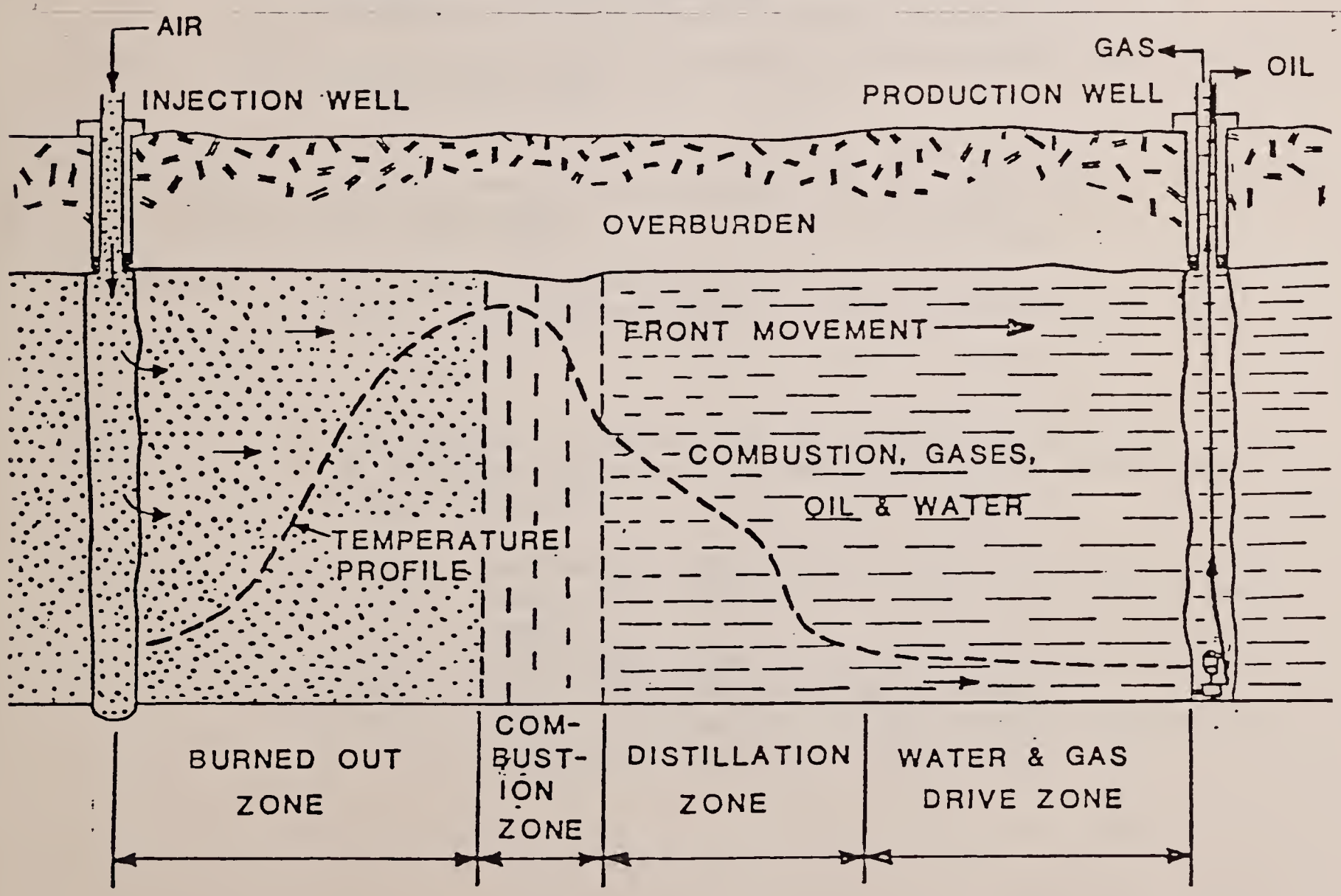
GEOKINETICS



UTAH

Geokinetics

Geokinetics true in situ test site in Southern Uinta Basin. One acre solar evaporation pond at left and retort test area at right.



Vertical Cross Section of True In Situ Retorting

Geokinetics
(Commercial)

Company: Geokinetics, Inc., with DOE support

Location: T14S, R22E, Sec. 2; 70 miles south of Vernal, Utah, in Uintah County; 30,000 acres of leased land (10,744 acres from state and 19,200 acres from private holders)

Resource: 1.7 billion bbl's in 30' zone under 50' to 400' of overburden, of which 100 million bbl's is recoverable by Geokinetics' true in-situ technology.

Mining: Planning room-and-pillar mine on 22,000 acres at Agency Draw, and true in-situ operation on ten non-contiguous state leases where shallow buried oil shale zone is explosively fractured from multiple well points.

Retorting: Horizontally burned, true in-situ developed for shallow buried oil shale beds. To date, 25 experimental retorts have been blasted increasing in size to one acre in area, 16 burned, 2 in preparation for burning, and 30,000 bbl's oil produced. Commercial scale retorts are 220' x 220' x 30' thick and are expected to yield 100 BPD + for a total of 20,000-25,000 bbl's over 6-month burn life achieving 44-50% recovery. Sustained commercial operation can be achieved at 2,000 to 5,000 BPD (15 retorts) and can be operated on non-continuous sections. Agency Draw site would use surface retorts yielding 10,000 BPD.

Water: No water is used in process other than cognate water produced during retorting.

Waste Disposal: Retort sour water is evaporated in solar pond or injected into deep well.

Employment:
- 25, most living on-site
- 50 for 2,000 BPD sustained in situ production after 1984

Contractor: No majors

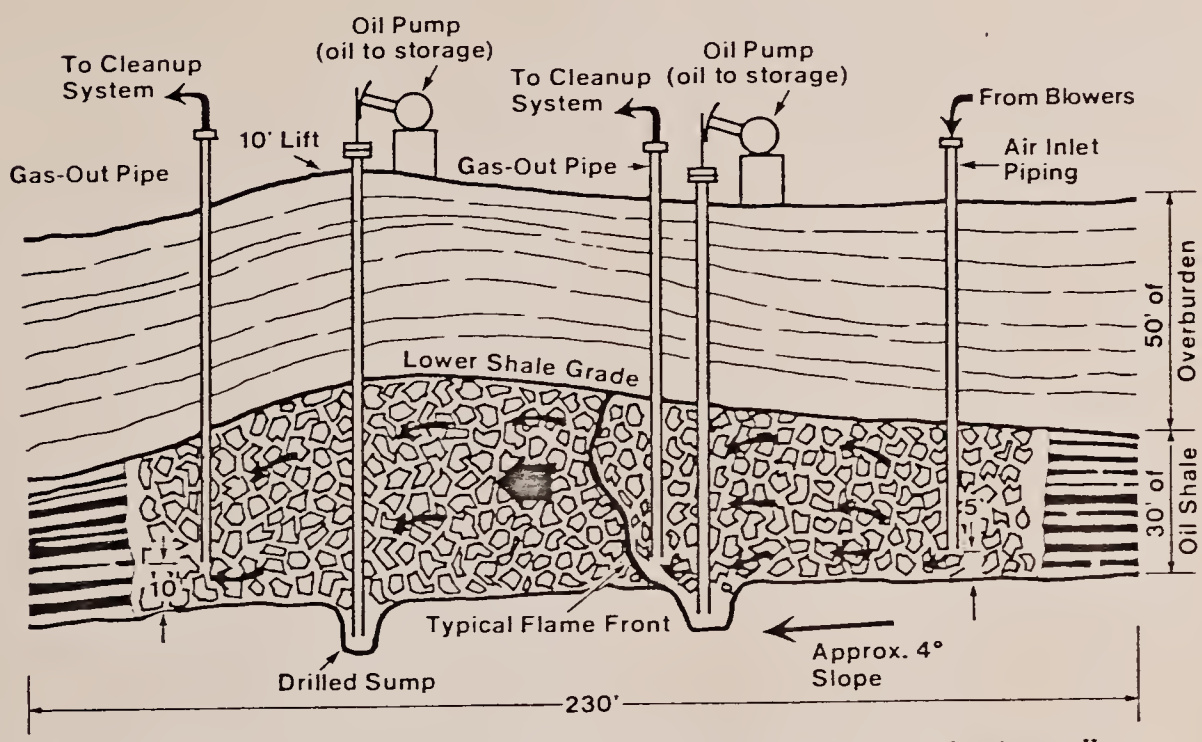
Cost:
- $10 million for engineering and development to date
- $1.9 million DOE grant for feasibility study of room-and-pillar operation

Status:
- 1969 - Geokinetics organized
- 1972 - Formed joint venture to develop true in-situ retort method
- 1974 - Small scale pilot retort tests in steel chambers
- 1975 - Began field testing in Uinta Basin
- 1979 - Scale up and product recovery testing resulting in blasting of first scale field retort

- o 1980 - Complete acquisition of 30,000 acres of leases
- o 1980 - December: Ignited first one-acre retort
- o 1981 - Began securing permits for commercial operation
- o 1981 - Ignite experimental true in-situ #23
- o 1982 - Complete R & D program and commence scale up to commercial operation-minimum of 2,000 BPD
- o 1982 - Project to be addressed in BLM's Uintah Basin Synfuel EIS

Contact:

M.A. Lekas, President
Geokinetics, Inc.
391 Chipeta Way, # D-2
Salt Lake City, Utah 84108
(801) 583-0511



Artist's conception of a Geokinetics retort depicting the burn front and production wells.