G100712

RESOURCE CHARACTERIZATION

MSE/001

RESOURCE CHARACTERIZATION

- CATEGORIZE KNOWN RESOURCES & EXPECTED DISCOVERIES
  - MINIMUM NUMBER OF CATEGORIES TO YIELD RELIABLE ECONOMIC MODELING
  - BASED ON CHARACTERISTICS OF KNOWN RESOURCES
- CALLED GENERIC RESOURCE CATEGORIES

MSE/002

IMPORTANT RESOURCE CHARACTERISTICS FOR GENERIC RESOURCE CATEGORIES

ECONOMIC MODEL SENSITIVE TO CHARACTERISTIC VARIATION

CHARACTERISTIC VARIES SIGNIFICANTLY

MSE/003

WORK FLOW

RESOURCE CHARACTERIZATION

COMPILE LIST OF CHARACTERISTICS

COMPILE DATA ON KNOWN RESOURCES FOR EACH CHARACTERISTIC

PERFORM ECONOMIC MODEL SENSITIVITY STUDIES

SELECT GENERIC RESOURCE CHARACTERISTICS, ASSIGN RANGES

SELECT CONSTANT OR DEPENDENT CHARACTERISTICS, ASSIGN VALUES

PLACE DISCOVERED RESOURCES IN GENERIC CATEGORIES

ASSUMPTIONS

- DATA FROM KNOWN SYSTEMS CAN BE EXTRAPOLATED
- TEMPERATURES IN USGS CIRC 790 APPLY TO ENTIRE POPULATION
- GENERIC CHARACTERISTICS DESCRIBE ESSENTIAL CRITERIA FOR VALID ECONOMIC MODELING
- CURRENT RESOURCE MODELS CAN BE USED TO PREDICT DISCOVERIES

GENERIC CHARACTERISTICS ADOPTED

- TEMPERATURE
- UNPUMPED FLOW RATE
- BRINE CONTAMINATION INDEX
- WELL COSTS
- PUMPED FLOW RATE
- MAXIMUM PRODUCIBLE ACREAGE

MSE/006

TABLE 1

VARIABLE GENERIC RESOURCE CHARACTERISTICS AND THEIR RANGES

PARAMETER	RANGES							
Range No.	1	2	3	4	5	6	7	8
Temperature (^{o}F)	=>100 <150	=>150 <200	=>200 <250	=>250 <300	=>300 <350	=>350 <400	=>400 <450	=>450
Unpumped Flow Rate (10^3 lbs/hr)	<50	=>50 <100	=>100 <200	=>200 <400	=>400 <600	=>600 <800	=>800	
Brine Contamination Index (TDS)	0 (<2000)	1 (2000-100,000)	2 (>100,000)					
Well Costs ($M)	>2	<2 =>1	<1 =>0.5	<0.5				
Pumped Flow Rate (10^3 lbs/hr)	<50	=>50 <100	=>100 <200	=>200 <400	=>400 <600	=>600 <800	=>800	
Max. Produc. Acreage	Small	Large						

MSE/007

KLAMATH FALLS, OR

3 1 1 4 4 1

200° F

<50,000 lbs/hr

1 (1000 ppm)

$100 K

300,000 lbs/hr

6000

MSE/008

KLAMATH FALLS, OR

GENERIC CATEGORY 3 1 1 4 4 1

TEMPERATURE	200° F
UNPUMPED FLOW RATE	<50,000 lbs/hr
BRINE CONTAMINATION INDEX	1 (1000 ppm)
WELL COSTS	$100 K
PUMPED FLOW RATE	300,000 lbs/hr
MAXIMUM PRODUCIBLE ACREAGE (50% prob.)	6000

MSE/009

BRADY HOT SPRINGS, NV

6 4 2 4 5 1

310° F

500,000 lbs/hr

2 (2000 ppm)

$500,000

800,000 lbs/hr

5000

MSE/010

BRADY HOT SPRINGS, NV

GENERIC CATEGORY 6 4 2 4 5 1

TEMPERATURE	310° F
UNPUMPED FLOW RATE	500,000 lbs/hr
BRINE CONTAMINATION INDEX	2 (2000 ppm)
WELL COSTS	$500,000
PUMPED FLOW RATE	800,000 lbs/hr
MAXIMUM PRODUCIBLE ACREAGE (50% prob.)	5000

MSE/011

ROOSEVELT HOT SPRINGS, UT

8 6 2 3 7 1

>450° F

700,000 lbs/hr

2 (7,000 ppm)

$1 M

>800,000 lbs/hr

6,700

MSE/012

AHUACHAPAN, EL SALVADOR

GENERIC CATEGORY 7 5 2 2 6 1

TEMPERATURE	450° F
UNPUMPED FLOW RATE	570,000 lbs/hr
BRINE CONTAMINATION INDEX	2 (18,000 ppm)
WELL COSTS	?
PUMPED FLOW RATE	800,000 lbs/hr
MAXIMUM PRODUCIBLE ACREAGE (50% prob.)	4,000

MSE/017

ROOSEVELT HOT SPRINGS, UT

GENERIC CATEGORY 8 6 2 3 7 1

TEMPERATURE	>450° F
UNPUMPED FLOW RATE	700,000 lbs/hr
BRINE CONTAMINATION INDEX	2 (7,000 ppm)
WELL COSTS	$1 M
PUMPED FLOW RATE	>800,000 lbs/hr
MAXIMUM PRODUCIBLE ACREAGE (50% prob.)	6,700

MSE/013

BRAWLEY, CA

8 5 3 2 6 2

> 450° F

500,000 lbs/hr

3 (> 100,000 ppm)

$1.4 M

800,000 lbs/hr

10,000

MSE/014

BRAWLEY, CA

GENERIC CATEGORY 8 5 3 2 6 2

TEMPERATURE	> 450° F
UNPUMPED FLOW RATE	500,000 lbs/hr
BRINE CONTAMINATION INDEX	3 (> 100,000 ppm)
WELL COSTS	$1.4 M
PUMPED FLOW RATE	800,000 lbs/hr
MAXIMUM PRODUCIBLE ACREAGE (50% prob.)	10,000

MSE/015

AHUACHAPAN, EL SALVADOR

7 5 2 2 6 1

450° F

570,000 lbs/hr

2 (18,000 ppm)

?

800,000 lbs/hr

4,000

MSE/016

ESTIMATION OF EXPECTED DISCOVERIES 1980 - 2000

MSE/018

DEFINITION

DISCOVERY - A SITE AT WHICH A SUCCESSFUL WELL HAS BEEN DRILLED AND FLOW TESTED

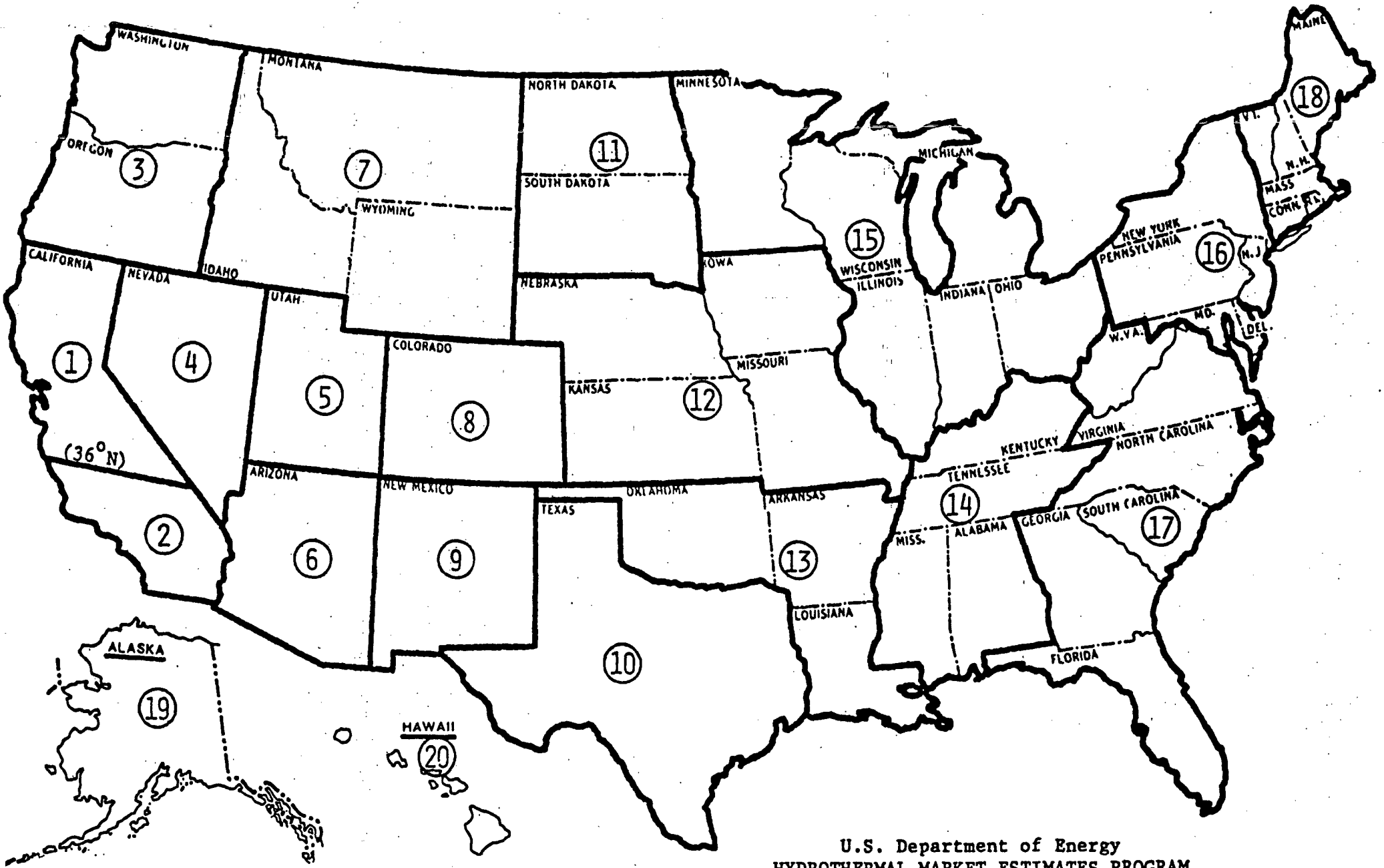
CONTRASTED WITH

PROSPECT - A SITE THAT HAS GEOTHERMAL INDICATIONS

- THERMAL SPRING OR WELL
- CHEMICAL GEOTHERMOMETERS
- ANOMALOUS GRADIENT OR HEAT FLOW
- FAVORABLE GEOLOGY, GEOPHYSICS

CONFIRMED RESERVOIR - A DISCOVERY SITE AT WHICH DRILLING AND FLOW TESTING HAVE PROVED SUFFICIENT RESOURCE TO SUPPORT ECONOMIC USE

MSE/019



U.S. Department of Energy
HYDROTHERMAL MARKET ESTIMATES PROGRAM

Map of Regional Boundaries

MSE/020

WORK FLOW

EXPECTED DISCOVERIES

PLACE KNOWN RESOURCES IN GENERIC CATEGORIES

CONSIDER DISCOVERY POTENTIAL REGION-BY-REGION

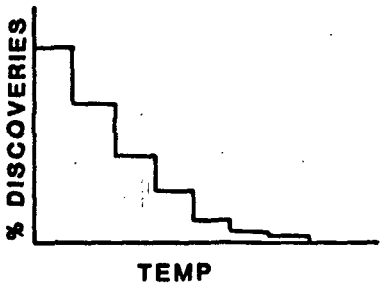
ESTIMATE TOTAL DISCOVERIES FOR EACH GENERIC CATEGORY FOR EACH REGION

ESTIMATE CO-LOCATED DISCOVERIES (NON-ELECTRIC)

ESTIMATE RATE OF DISCOVERY

DISCOVERY ASSUMPTIONS

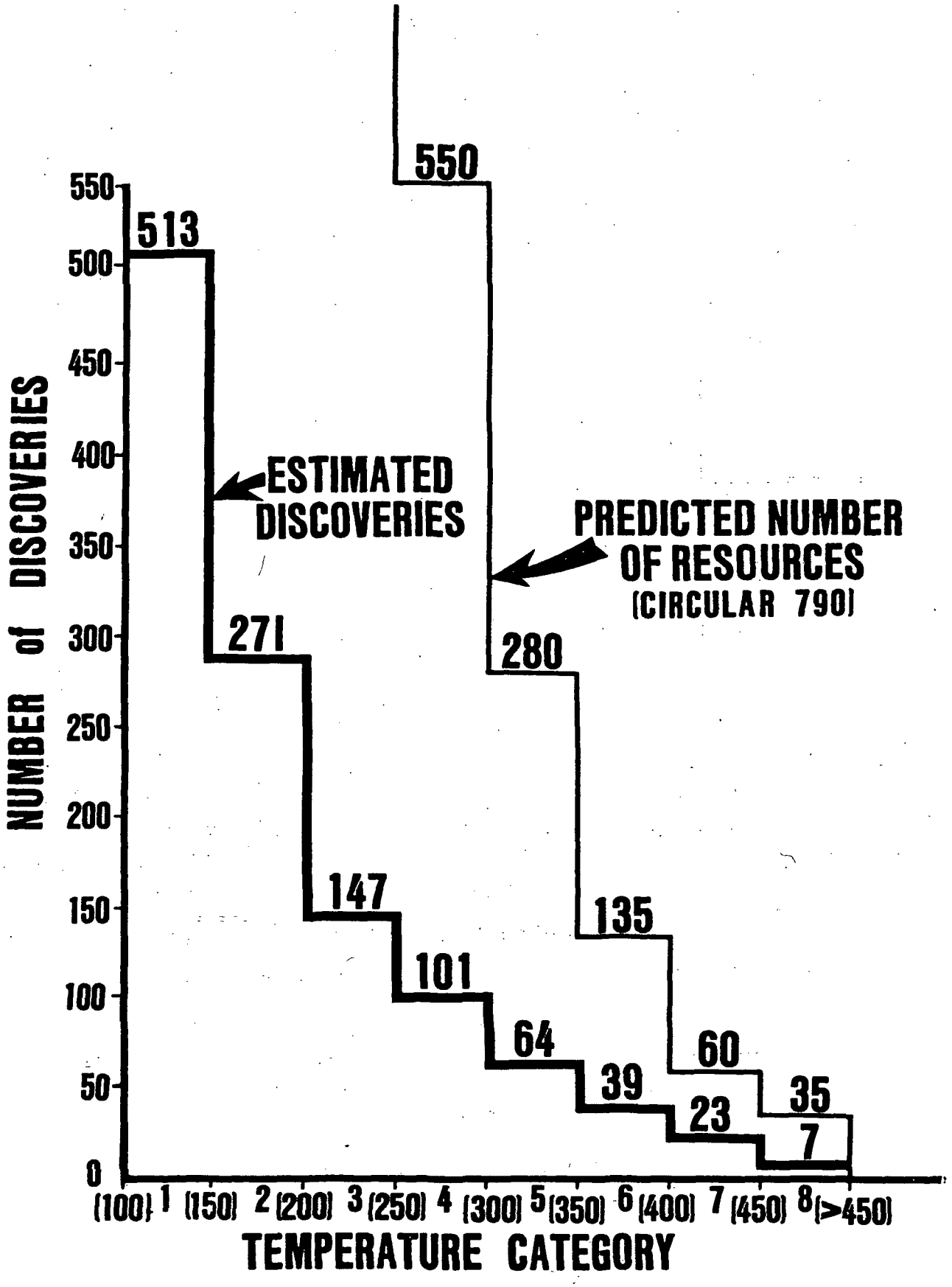
- LOGNORMAL DISTRIBUTION, SOME EMPHASIS ON HIGHER TEMPS



- MOST DISCOVERIES 1980-2000 FROM KNOWN GEOLOGIC ENVIRONMENTS
  - KNOWN RESOURCE AREAS
  - AREAS OF MOST ACTIVE EXPLORATION INTEREST
- PYRAMIDING EFFECT TAKEN INTO ACCOUNT
- ENERGY SHORTAGE WILL CONTINUE
- DOE PROGRAMS WILL CONTINUE
- INSTITUTIONAL PROBLEMS WILL BE SOLVED
  - LEASING
  - STATE & FEDERAL LAWS & REGULATIONS

MSE/022

HISTOGRAM OF ESTIMATED DISCOVERIES



MSE/023

EXPECTED DISCOVERIES

SUMMARY

REGION	DISCOVERIES	REGION	DISCOVERIES
1	85	11	174
2	98	12	10
3	117	13	2
4	123	14	2
5	66	15	25
6	41	16	11
7	141	17	21
8	40	18	2
9	86	19	35
10	88	20	35

MSE/024

IMPACT OF FEDERAL PROGRAM
on
POST-DISCOVERY RESOURCE DEVELOPMENT

ELEMENT	IMPACT DEVELOPMENT RATE WILL BE _% LESS IF NO PROGRAM ELEMENT
FEDERAL STREAMLINING	15
STATE LAW	10
LEASING & LAND USE	10
INDUSTRY COUPLED	5
GEOSCIENCES TECHNOLOGY	5
TOTAL	45

MSE/025

USE OF GEOTHERMAL FLUIDS IN TERTIARY OIL RECOVERY

DEPENDENT UPON:

PROXIMITY OF GEOTHERMAL AND HEAVY OIL RESOURCES

COMPATABILITY OF GEOTHERMAL FLUIDS WITH CHEMICAL AND PHYSICAL PROPERTIES OF THE PETROLEUM

MSE/026

COLOCATION OF HEAVY OIL FIELDS AND GEOTHERMAL RESOURCES

SURVEY OF HEAVY OIL FIELDS

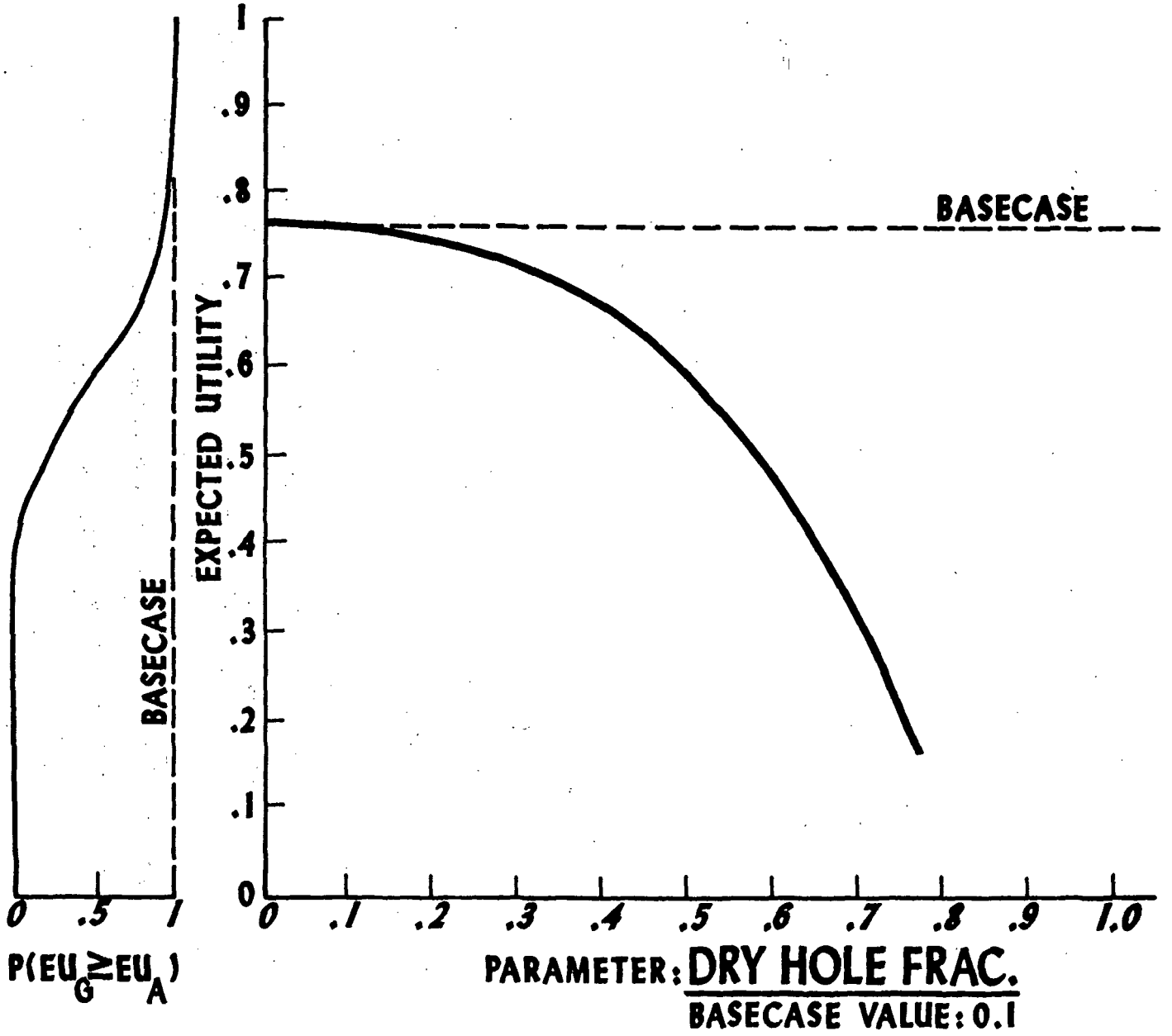
- $>$ 10 million barrels
- $\leq$ 25° API gravity oil

IDENTIFICATION OF COLACATED HEAVY OIL AND GEOTHERMAL RESOURCES

- Southern California
- Texas - Gulf of Mexico
- Eastern Nevada
- Northeastern Utah

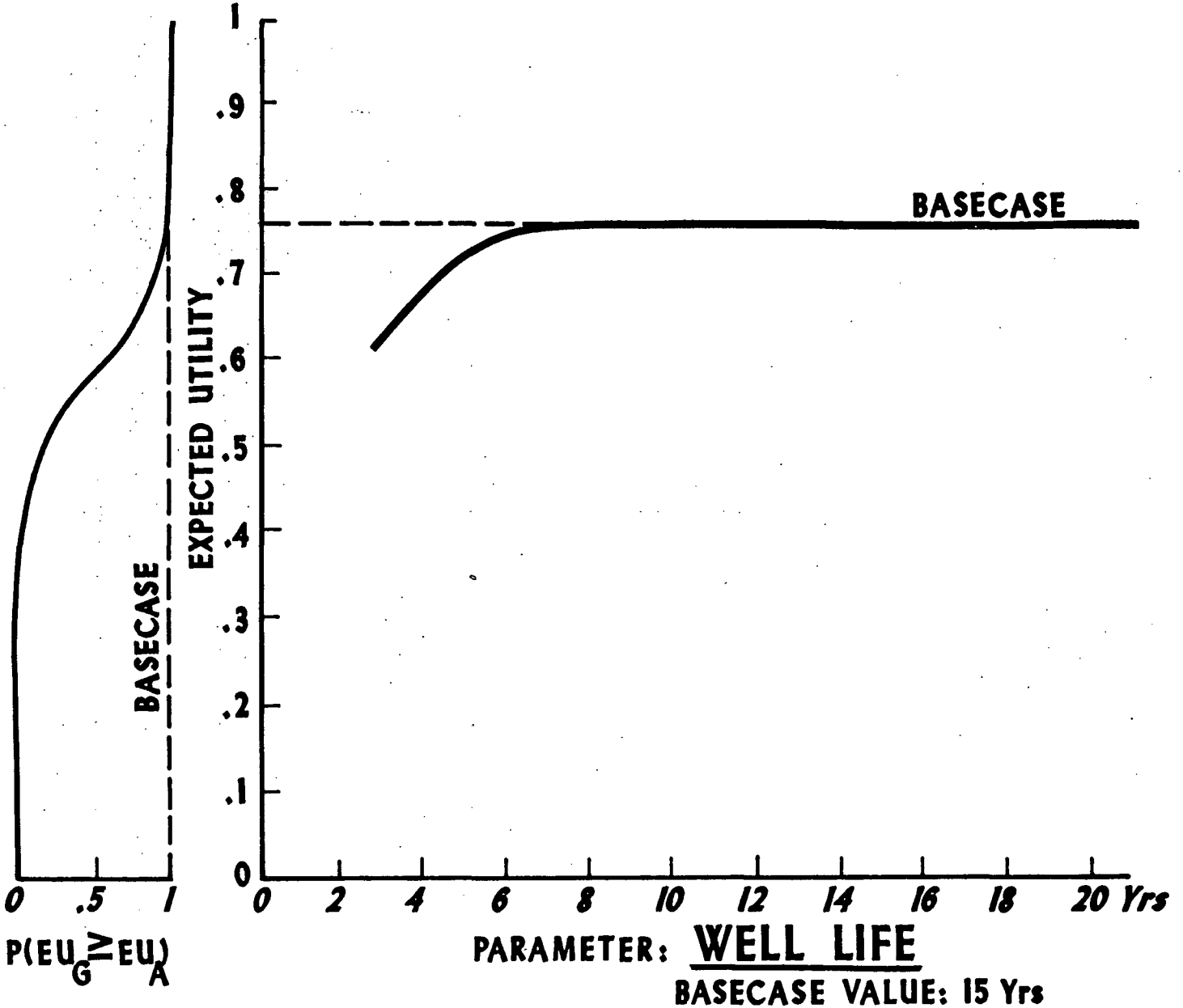
MSE/027

PARAMETRIC SENSITIVITY EVALUATIONS



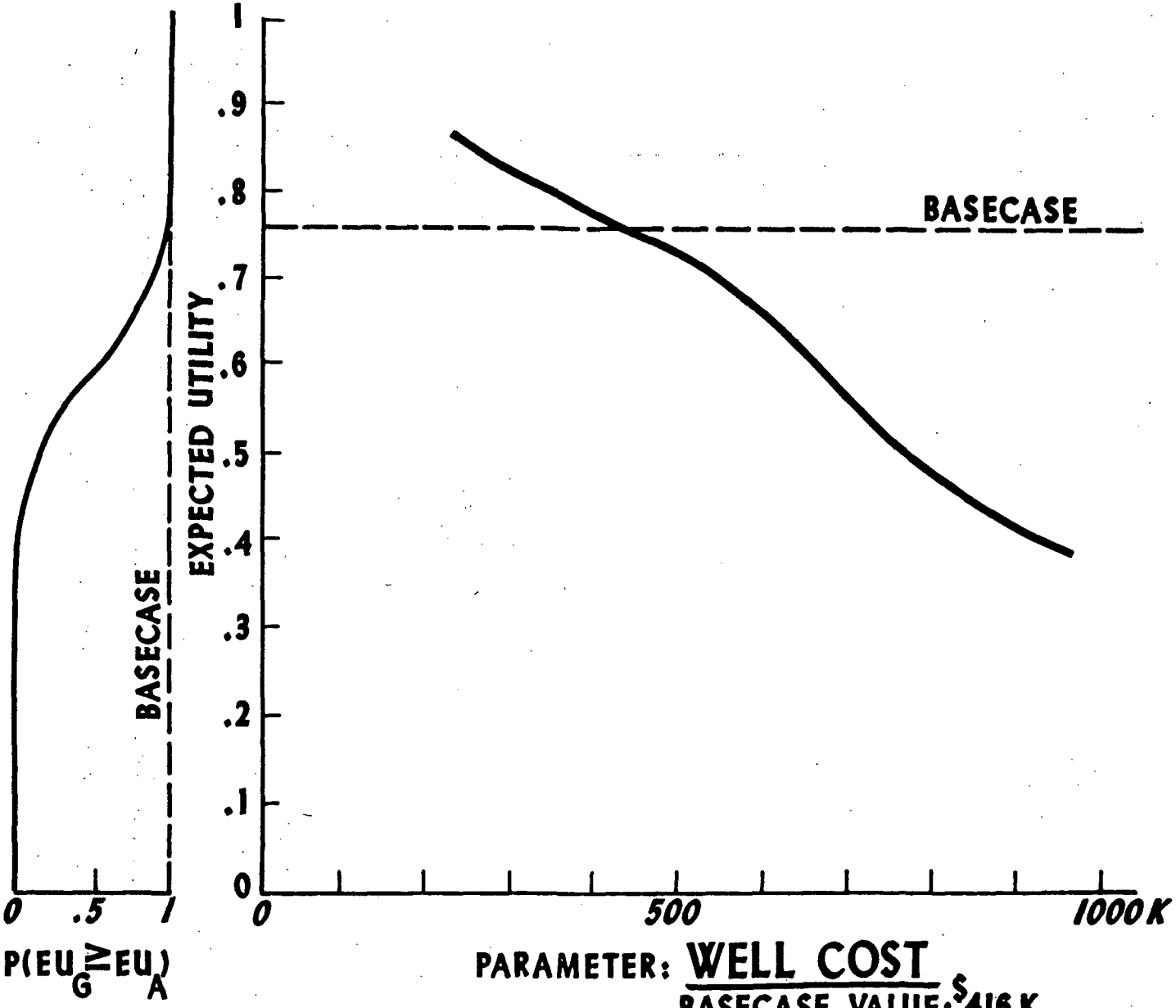
MSE/028

PARAMETRIC SENSITIVITY EVALUATIONS



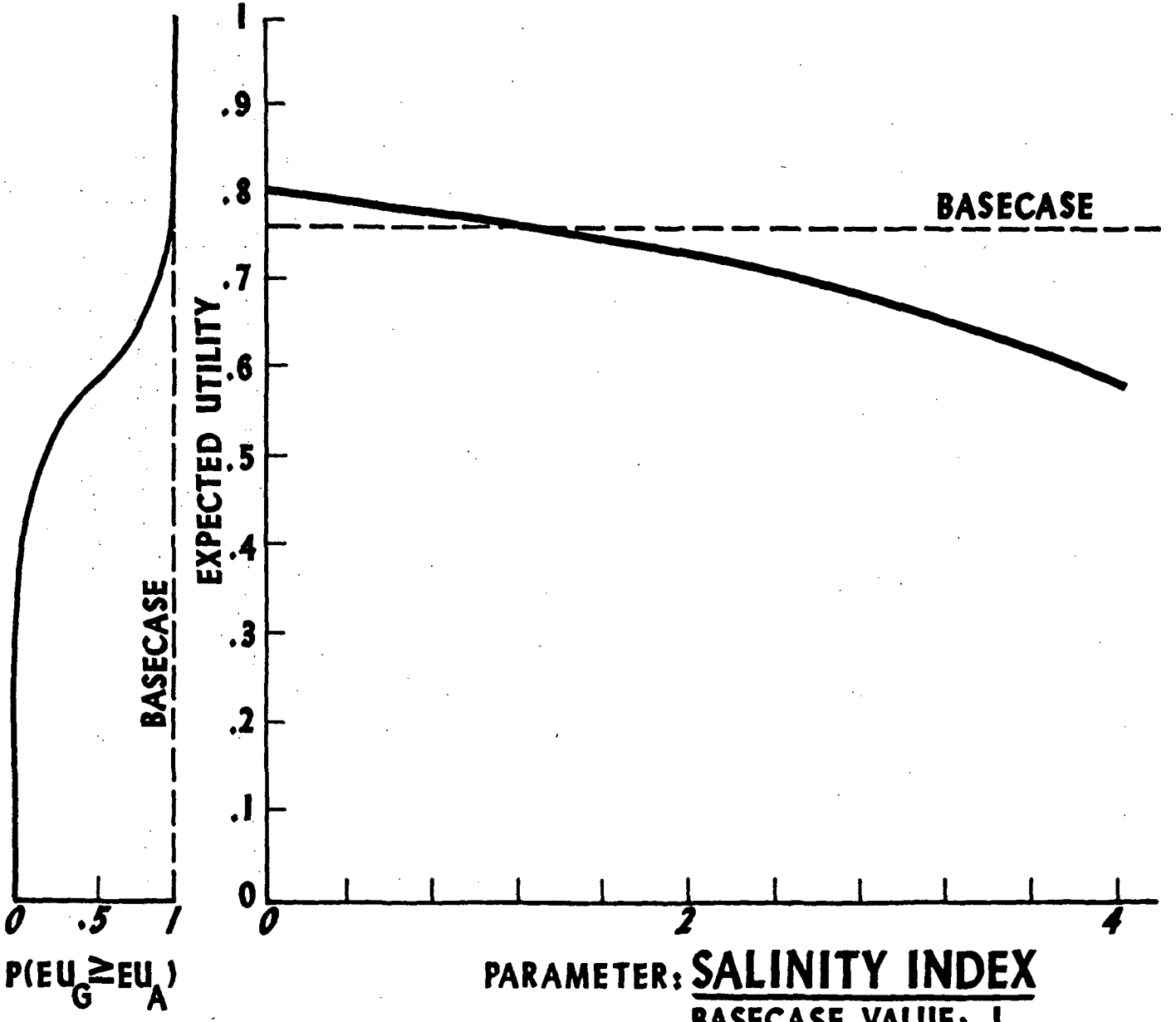
MSE/029

PARAMETRIC SENSITIVITY EVALUATIONS



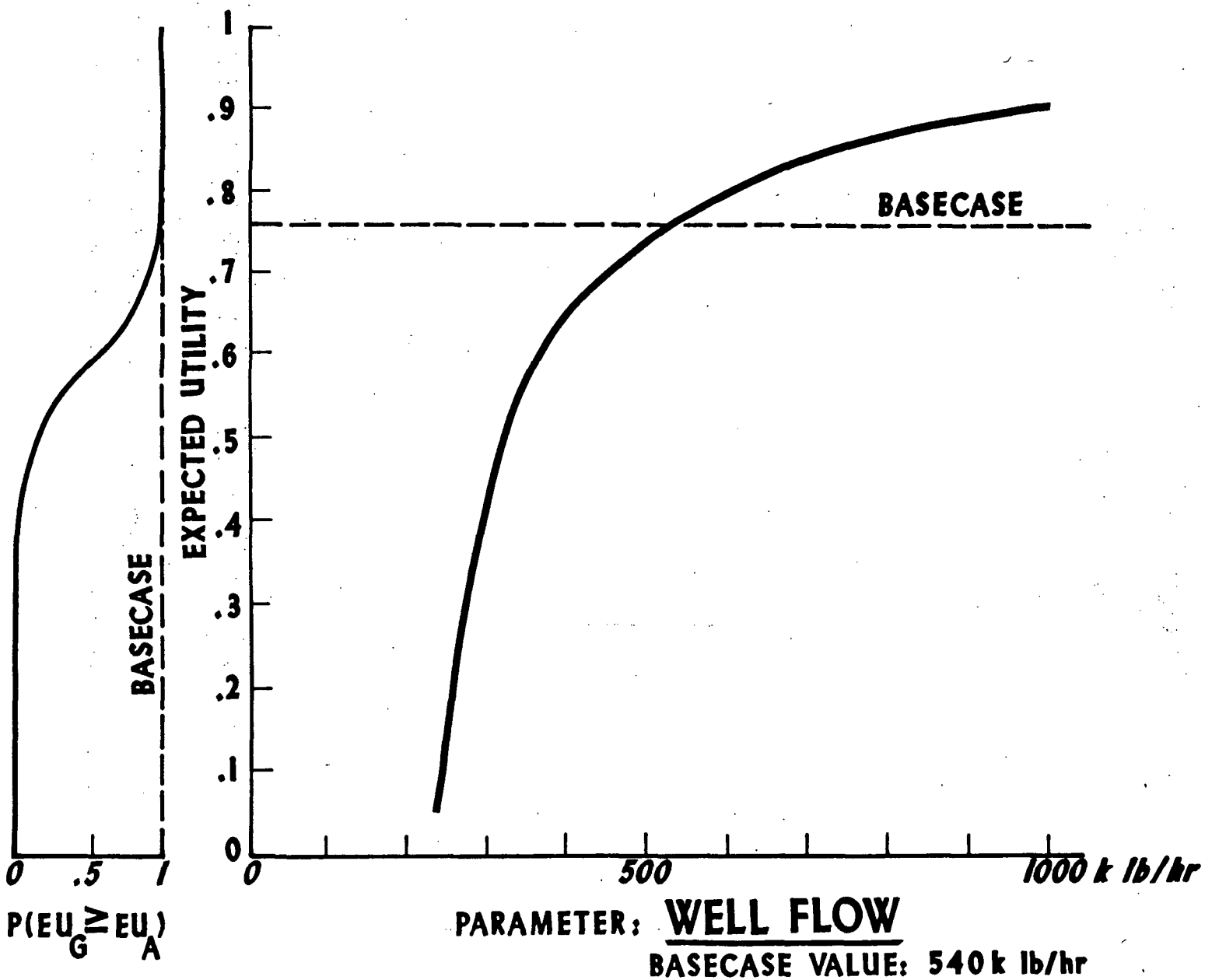
MSE/030

PARAMETRIC SENSITIVITY EVALUATIONS



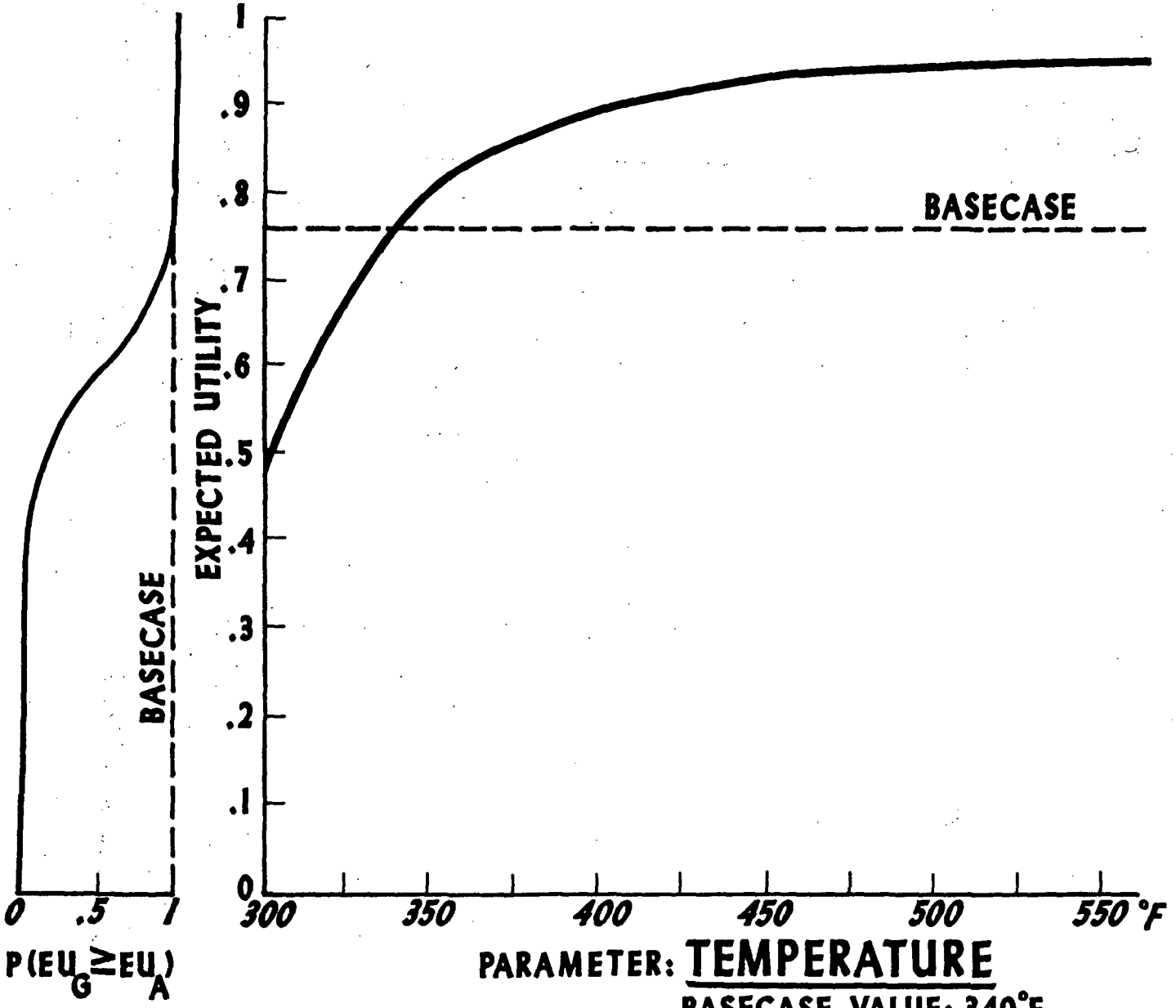
MSE/031

PARAMETRIC SENSITIVITY EVALUATIONS



MSE/032

PARAMETRIC SENSITIVITY EVALUATIONS



MSE/033

ECONOMIC MODEL SENSITIVITY STUDIES

(BY TECHNECON)

- SYSTEMATICALLY VARY PARAMETER OF INTEREST, HOLDING OTHER PARAMETERS CONSTANT

- CALCULATE EXPECTED UTILITY

UTILITY IS LIKELIHOOD THAT POSITIVE INVESTMENT DECISION WOULD BE MADE

GENERIC CATEGORY

TEMPERATURE

UNPUMPED FLOW RATE

BRINE CONTAMINATION INDEX

WELL COSTS

PUMPED FLOW RATE

MAXIMUM PRODUCIBLE ACREAGE (50% prob.)

GENERIC CATEGORY

TEMPERATURE

UNPUMPED FLOW RATE

BRINE CONTAMINATION INDEX

WELL COSTS

PUMPED FLOW RATE

MAXIMUM PRODUCIBLE ACREAGE (50% prob.)

MSE/036

MADISON GROUP

1 4 2 3 5 2

140° F

250,000 lbs/hr

2 (>2000 ppm, variable)

$750 K

500,000 lbs/hr

>10,000

MSE/037

MADISON GROUP

GENERIC CATEGORY 1 4 2 3 5 2

TEMPERATURE	140° F
UNPUMPED FLOW RATE	250,000 lbs/hr
BRINE CONTAMINATION INDEX	2 (>2000 ppm, variable)
WELL COSTS	$750 K
PUMPED FLOW RATE	500,000 lbs/hr
MAXIMUM PRODUCIBLE ACREAGE (50% prob.)	>10,000

MSE/038

IMPACT OF FEDERAL PROGRAMS

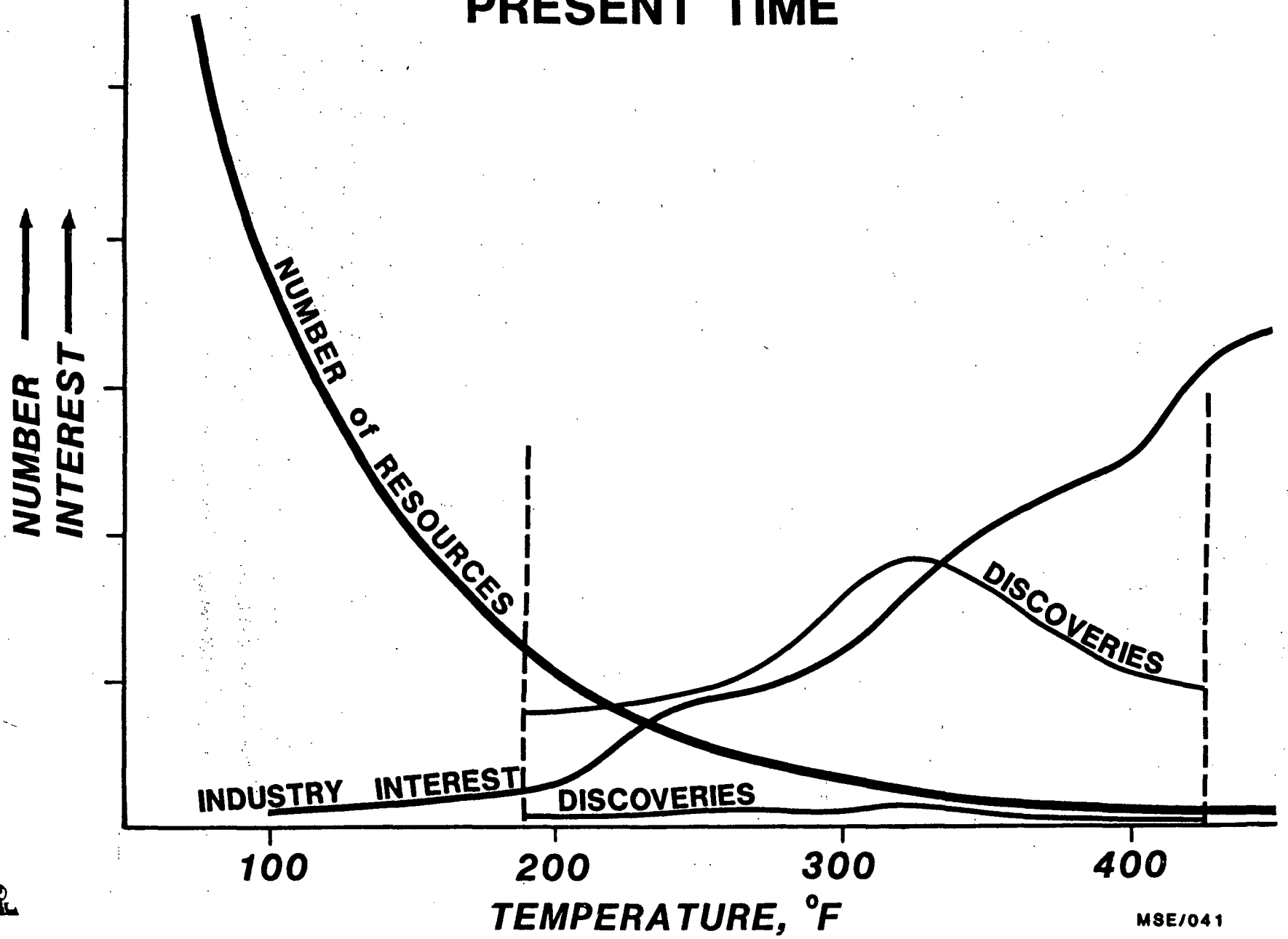
MSE/039

GEOSCIENCE ASPECTS

- FEDERAL PROGRAM ELEMENTS
- ECONOMIC MODEL PARAMETERS

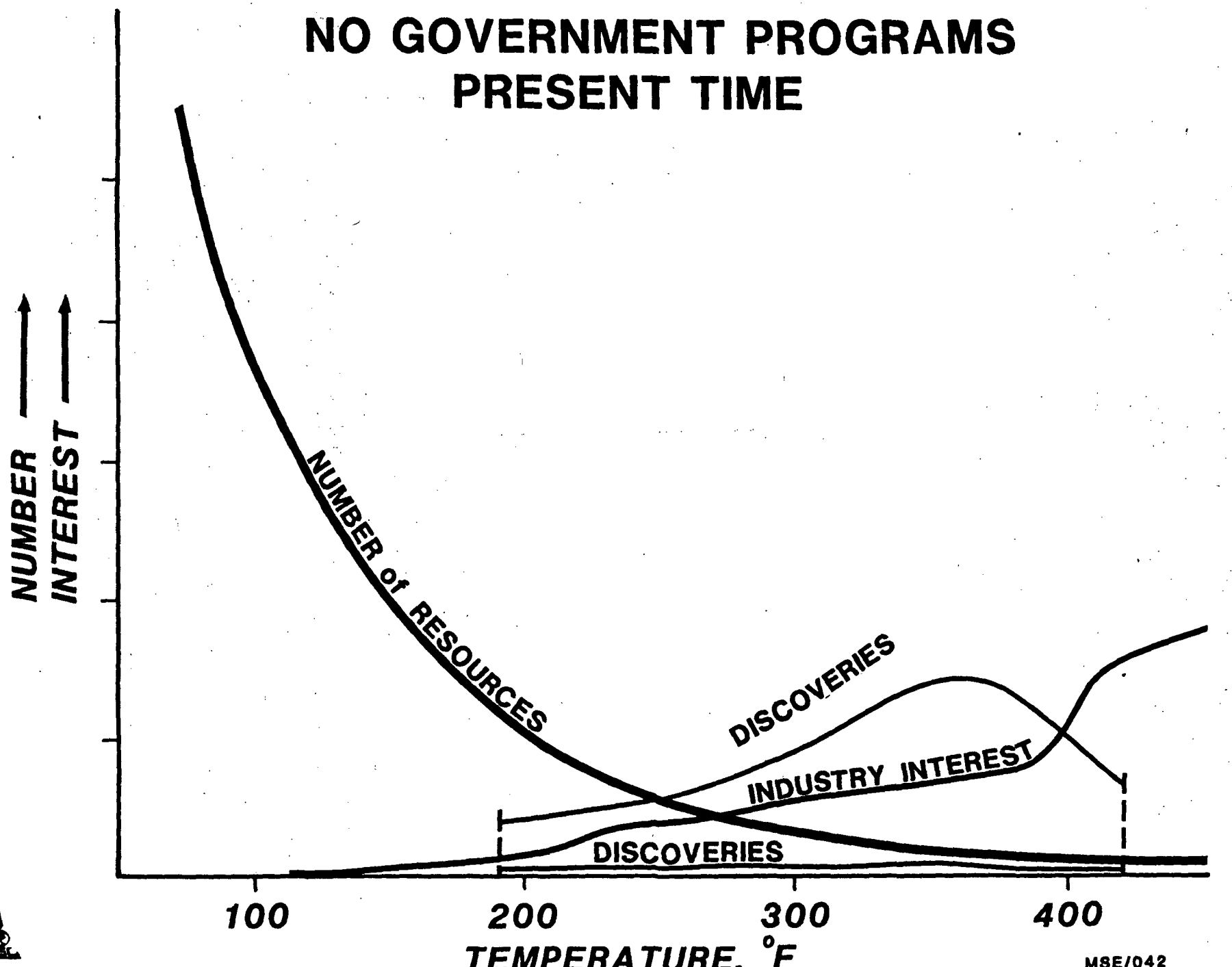
MSE/040

EXISTING GOVERNMENT PROGRAMS
PRESENT TIME



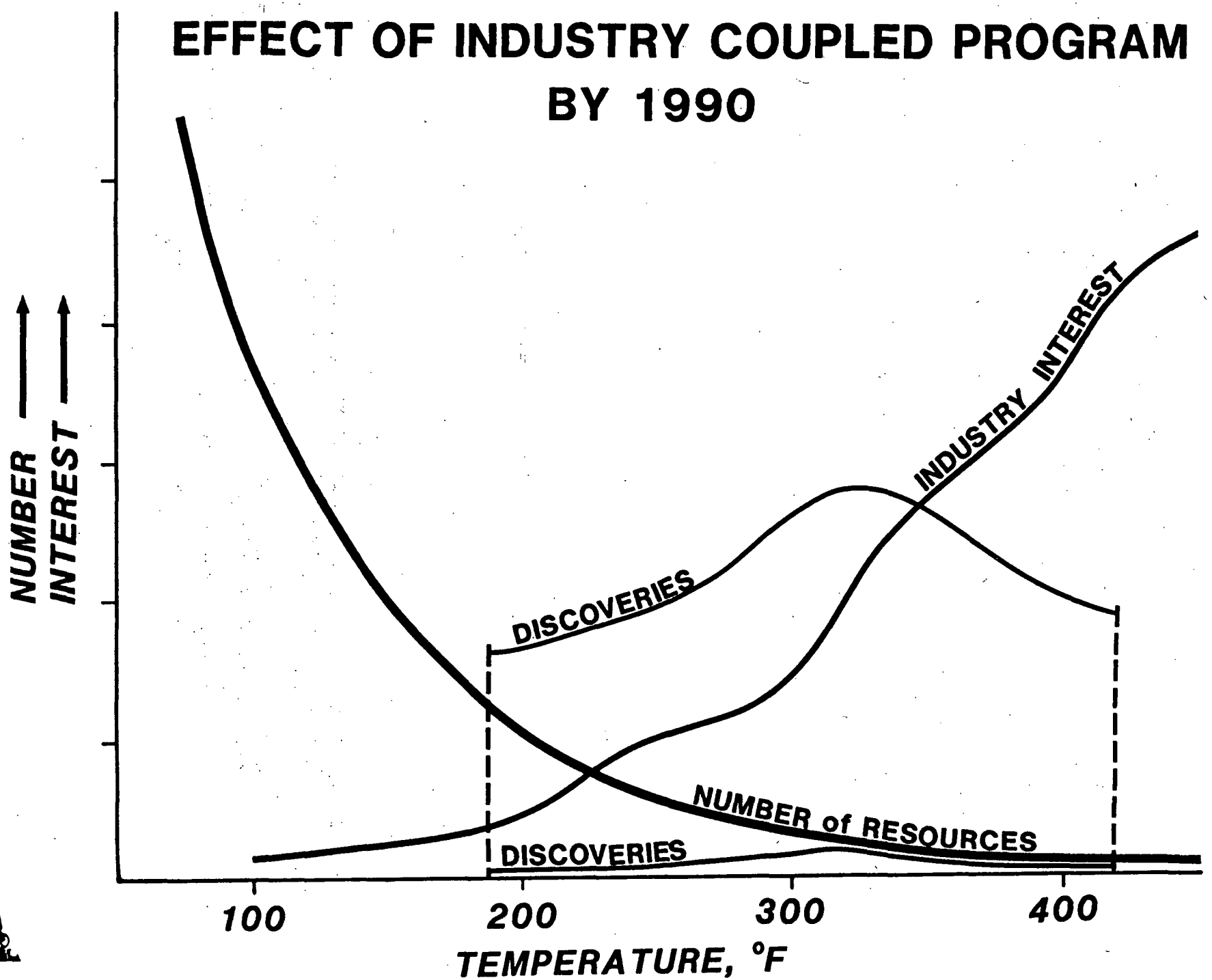
MSE/041

NO GOVERNMENT PROGRAMS
PRESENT TIME



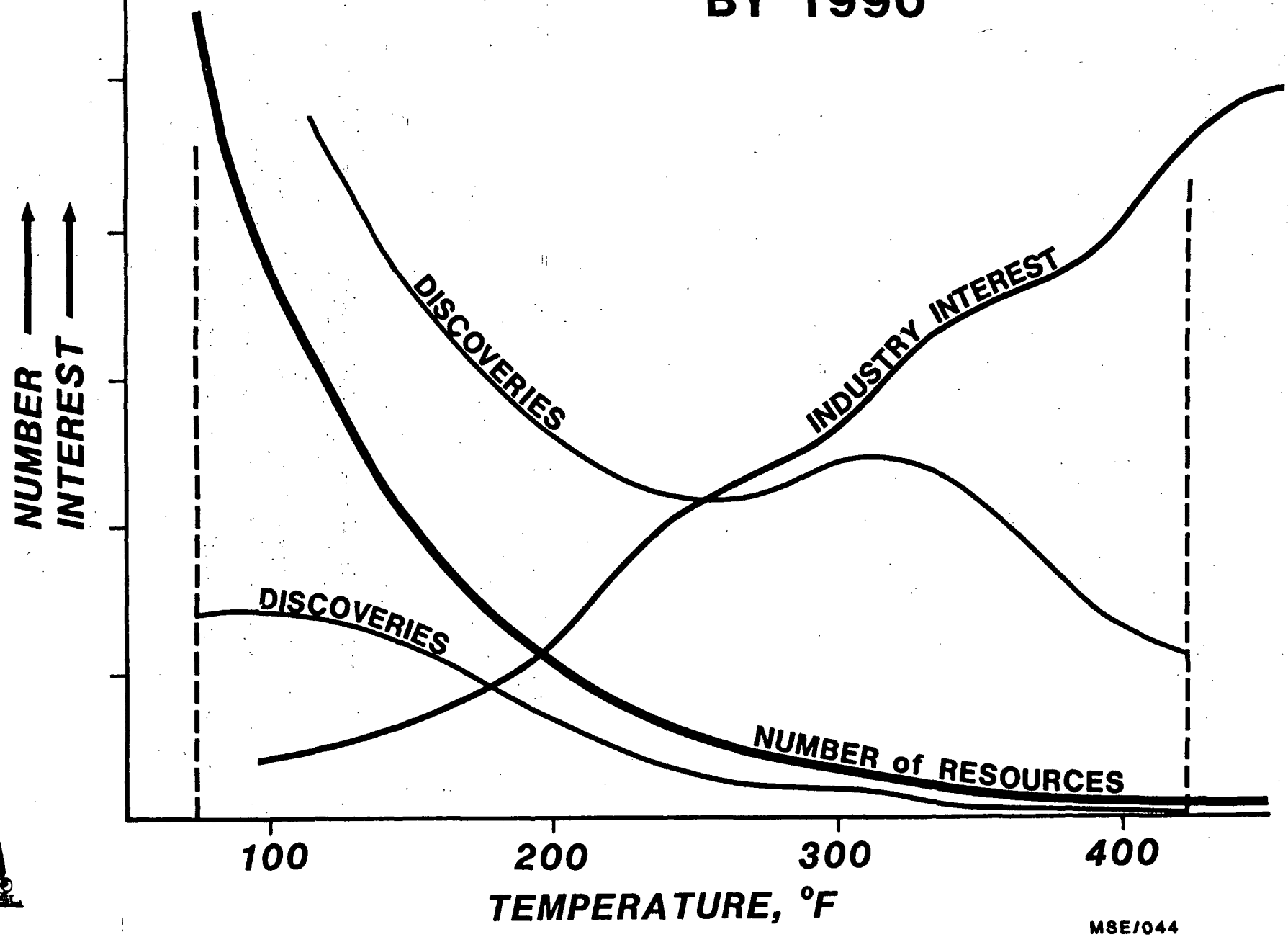
MSE/042

EFFECT OF INDUSTRY COUPLED PROGRAM BY 1990



MSE/043

EFFECT OF USER COUPLED DRILLING PROGRAM BY 1990



MSE/044

DATA PROVIDED TO ECONOMIC MODEL*

GENERIC CATEGORY NUMBER _____

WELL HEAD TEMPERATURE
MINIMUM _____
MOST LIKELY _____
MAXIMUM _____

UNPUMPED FLOW RATE
MINIMUM _____
MOST LIKELY _____
MAXIMUM _____

BRINE CONTAMINATION INDEX _____

WELL COST
MINIMUM _____
MOST LIKELY _____
MAXIMUM _____

PUMPED FLOW RATE
MINIMUM _____
MOST LIKELY _____
MAXIMUM _____

MAX PRODUCIBLE ACREAGE
@ 99% PROB _____
@ 50% PROB _____
@ 1% PROB _____

* IN ADDITION TO CONSTANT OR DEPENDENT VALUES

MSE/046

on

ECONOMIC MODEL PARAMETERS

GEOSCIENCE ASPECTS

FEDERAL PROGRAM ELEMENTS	Economic Model Parameters							
	Post-Discov. Resource Dev.	Timing of Discoveries	Well Capital Cost	Well Field Investment at Risk	Reservoir Risk Percept.	Well Life	Expl. Dry Well Fract.	Dev. Dry Well Fract.
Federal Streamlining Plan	XX	XX	-	X	X	-	-	-
State Law Proj.	XX	XX	-	X	X	-	-	-
Leasing & Land Use	X	XX	-	X	-	-	-	-
Industry Coupled Drilling	XX	XX	X	X	X	X	XX	XX
Geosciences Technology Develop.	XX	XX	X	XX	XX	XX	XX	XX

XX = Very Significant Impact

X = Significant Impact

- = No Significant Impact

MSE/046

IMPACT OF FEDERAL PROGRAM
on
TIMING OF DISCOVERIES

ELEMENT	IMPACT DISCOVERY RATE WILL BE__% LESS IF NO PROGRAM ELEMENT
FEDERAL STREAMLINING	10
STATE LAW	5
LEASING & LAND USE	10
INDUSTRY COUPLED	10
GEOSCIENCES TECHNOLOGY	10
TOTAL	45

MSE-047

IMPACT OF FEDERAL PROGRAM
on
WELL CAPITAL COST

ELEMENT	IMPACT WELL COSTS WILL BE__% LESS THAN NO PROGRAM
INDUSTRY COUPLED	1
GEOSCIENCES TECHNOLOGY	2
TOTAL	3

MSE-048

IMPACT OF FEDERAL PROGRAM
on
WELL FIELD INVESTMENT AT RISK

ELEMENT	IMPACT INVESTMENT WILL DECREASE__% PER YEAR MORE THAN NO PROGRAM
FEDERAL STREAMLINING	1
STATE LAW	1
LEASING & LAND USE	1
INDUSTRY COUPLED	2
GEOSCIENCES TECHNOLOGY	2
TOTAL	7

MSE-049

IMPACT OF FEDERAL PROGRAM
on
RESERVOIR RISK PERCEPTION

ELEMENT	IMPACT
	PERCEIVED RISK WILL DECREASE__%
FEDERAL STREAMLINING	5
STATE LAW	5
INDUSTRY COUPLED	5
GEOSCIENCES TECHNOLOGY	5
TOTAL	20

MSE-050

IMPACT OF FEDERAL PROGRAM
on
WELL LIFE

ELEMENT	IMPACT WELL LIFE WILL LENGTHEN__% PER YEAR MORE THAN NO PROGRAM
INDUSTRY COUPLED	2
GEOSCIENCES TECHNOLOGY	10
TOTAL	12

MSE-051

IMPACT OF FEDERAL PROGRAM
on
EXPLORATORY DRY WELL FRACTION

ELEMENT	IMPACT FRACTION WILL IMPROVE__% PER YEAR MORE THAN NO PROGRAM
INDUSTRY COUPLED	5
GEOSCIENCES TECHNOLOGY	10
TOTAL	15

MSE/052

IMPACT OF FEDERAL PROGRAM
on
DEVELOPMENT DRY WELL FRACTION

ELEMENT	IMPACT FRACTION WILL IMPROVE—% PER YEAR MORE THAN NO PROGRAM
INDUSTRY COUPLED	5
GEOSCIENCES TECHNOLOGY	10
TOTAL	15

MSE/053

on

ECONOMIC MODEL PARAMETERS

GEOSCIENCE ASPECTS

FEDERAL PROGRAM ELEMENTS	Economic Model Parameters						
	Timing of Discoveries	Well Capital Cost	Well Field Investment at Risk	Reservoir Risk Percept.	Well Life	Expl. Dry Well Fract.	Dev. Dry Well Fract.
USGS Resource Assess.	X	-	-	-	-	-	-
State Coupled Res. Program	XX	-	X	X	-	-	-
State Commerc. Program	XX	-	X	X	-	-	-
State Law Proj.	XX	X	X	X	-	-	-
Regulat. Barrier Mitig.	XX	X	X	X	-	-	-
Geosciences Tech. Devel.	XX	X	XX	XX	XX	XX	XX
User Coupled Drilling	XX	XX	XX	XX	X	XX	XX

XX = Very Significant Impact
X = Significant Impact
- = No Significant Impact

MSE/054

IMPACT OF FEDERAL PROGRAM
on
TIMING OF DISCOVERIES

ELEMENT	IMPACT DISCOVERY RATE WILL IMPROVE__%
USGS ASSESSMENT	10
STATE COUPLED	30
STATE COMMERCIALIZATION	30
STATE LAW	20
BARRIER MITIGATION	30
GEOSCIENCES TECHNOLOGY	30
USER COUPLED DRILLING	300
TOTAL	450

MSE/055

IMPACT OF FEDERAL PROGRAM
on
WELL CAPITAL COSTS

ELEMENT	IMPACT WELL COSTS WILL BE REDUCED BY__% BY 1987
STATE LAW	5
BARRIER MITIGATION	5
GEOSCIENCES TECHNOLOGY	10
USER COUPLED DRILLING	10
TOTAL	30

MSE/056

IMPACT OF FEDERAL PROGRAM
on
WELL FIELD INVESTMENT AT RISK

ELEMENT	IMPACT INVESTMENT WILL DECREASE BY__% BY 1987
STATE COUPLED	2
STATE COMMERCIALIZATION	2
STATE LAW	3
BARRIER MITIGATION	3
GEOSCIENCES TECHNOLOGY	4
USER COUPLED DRILLING	8
TOTAL	22

M8E/057

IMPACT OF FEDERAL PROGRAM
on
WELL LIFE

ELEMENT	IMPACT WELL LIFE WILL LENGTHEN_% FASTER
GEOSCIENCES TECHNOLOGY	10
USER COUPLED DRILLING	10
TOTAL	20

MSE/068

IMPACT OF FEDERAL PROGRAM
on
RESERVOIR RISK PERCEPTION

ELEMENT	IMPACT PERCEIVED RISK WILL DECREASE BY__% BY 1987
STATE COUPLED	5
STATE COMMERCIALIZATION	5
STATE LAW	5
BARRIER MITIGATION	5
GEOSCIENCES TECHNOLOGY	10
USER COUPLED DRILLING	10
TOTAL	40

MSE/059

IMPACT OF FEDERAL PROGRAM
on
EXPLORATORY DRY WELL FRACTION

ELEMENT	IMPACT DRY WELL FRACTION WILL IMPROVE__% PER YEAR FASTER
GEOSCIENCES TECHNOLOGY	10
USER COUPLED DRILLING	5
TOTAL	15

MSE/060

IMPACT OF FEDERAL PROGRAM
on
DEVELOPMENT DRY WELL FRACTION

ELEMENT	IMPACT DRY WELL FRACTION WILL IMPROVE__% PER YEAR FASTER
GEOSCIENCES TECHNOLOGY	10
USER COUPLED DRILLING	5
TOTAL	15

MSE/061

POSTULATED NUMBER OF ELECTRIC-QUALITY DISCOVERIES BY REGION TO YEAR 2000

REGION NUMBER	STATE(S)	NUMBER OF DISCOVERIES
1	California	15
2	California	14
3	Oregon	17
4	Nevada	25
5	Utah	10
6	Arizona	8
7	Montana	12
8	Colorado	4
9	New Mexico	10
10	Texas	1
19	Alaska	7
20	Hawaii	11
		134

MSE/062

RESOURCE CHARACTERIZATION AND ESTIMATED DISCOVERY RATE 1980-2000

ESL/UURI

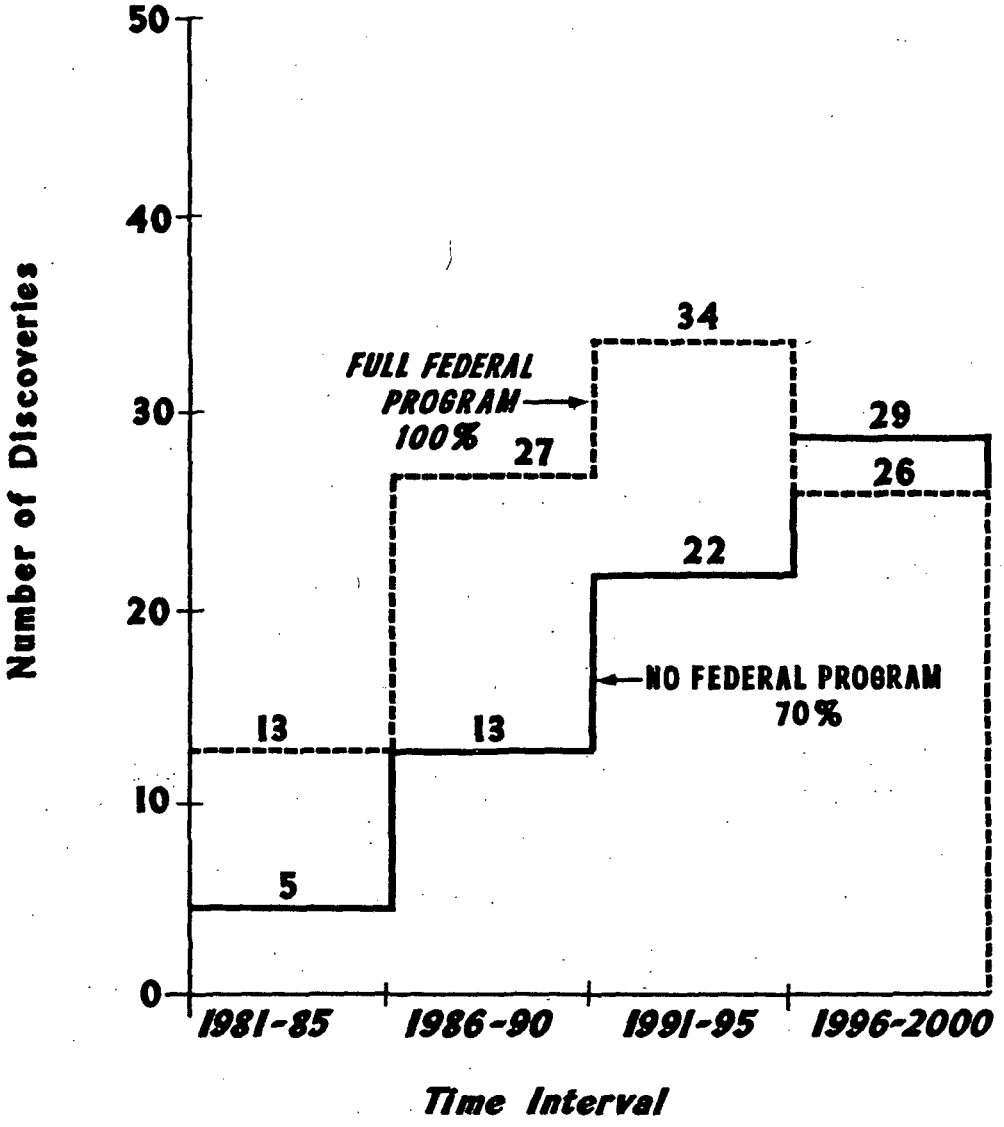
AUGUST 25, 1980

MSE/063

ESTIMATED FREQUENCY of DISCOVERIES

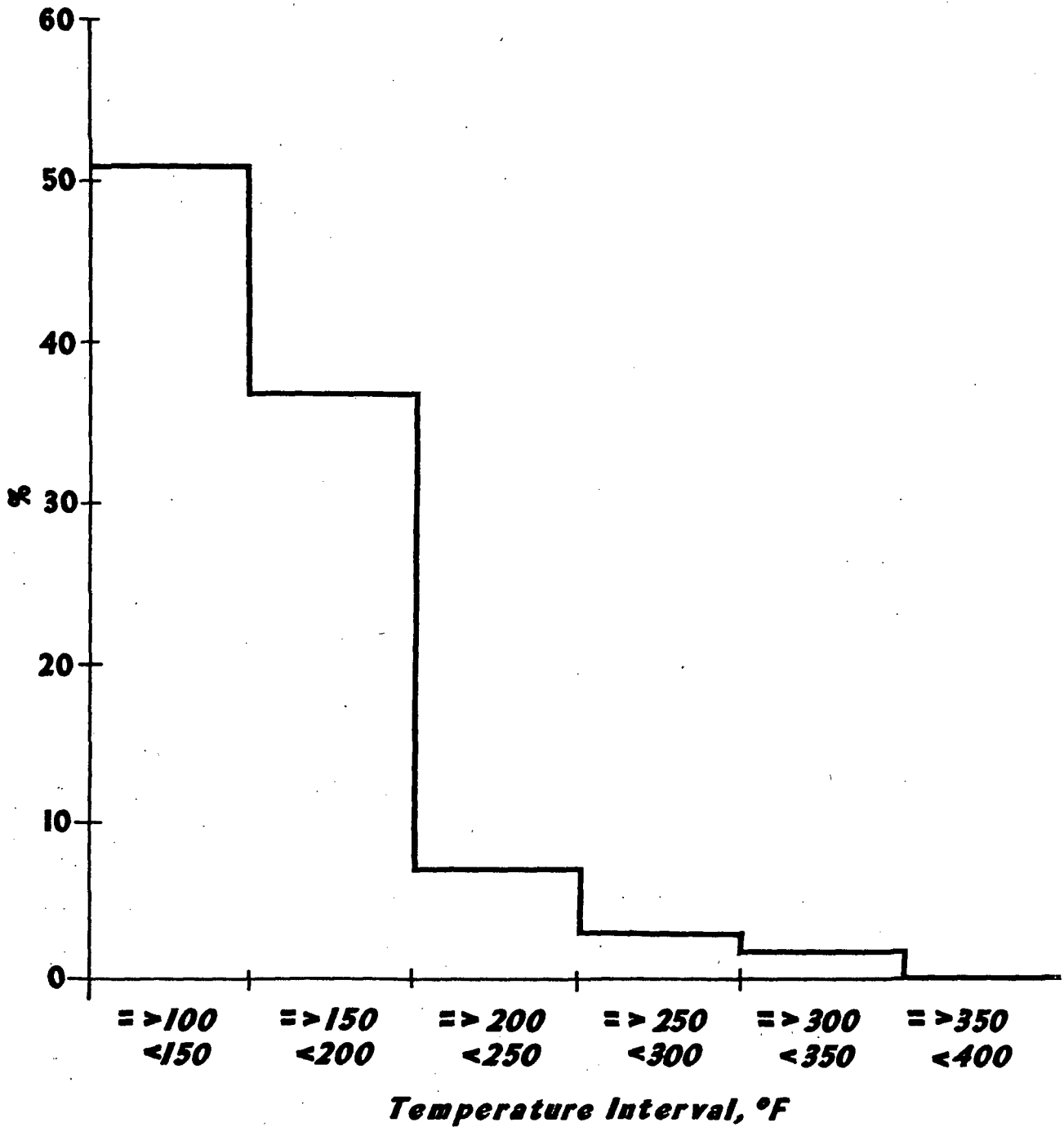
DIRECT HEAT RESOURCES

FULL FEDERAL PROGRAM



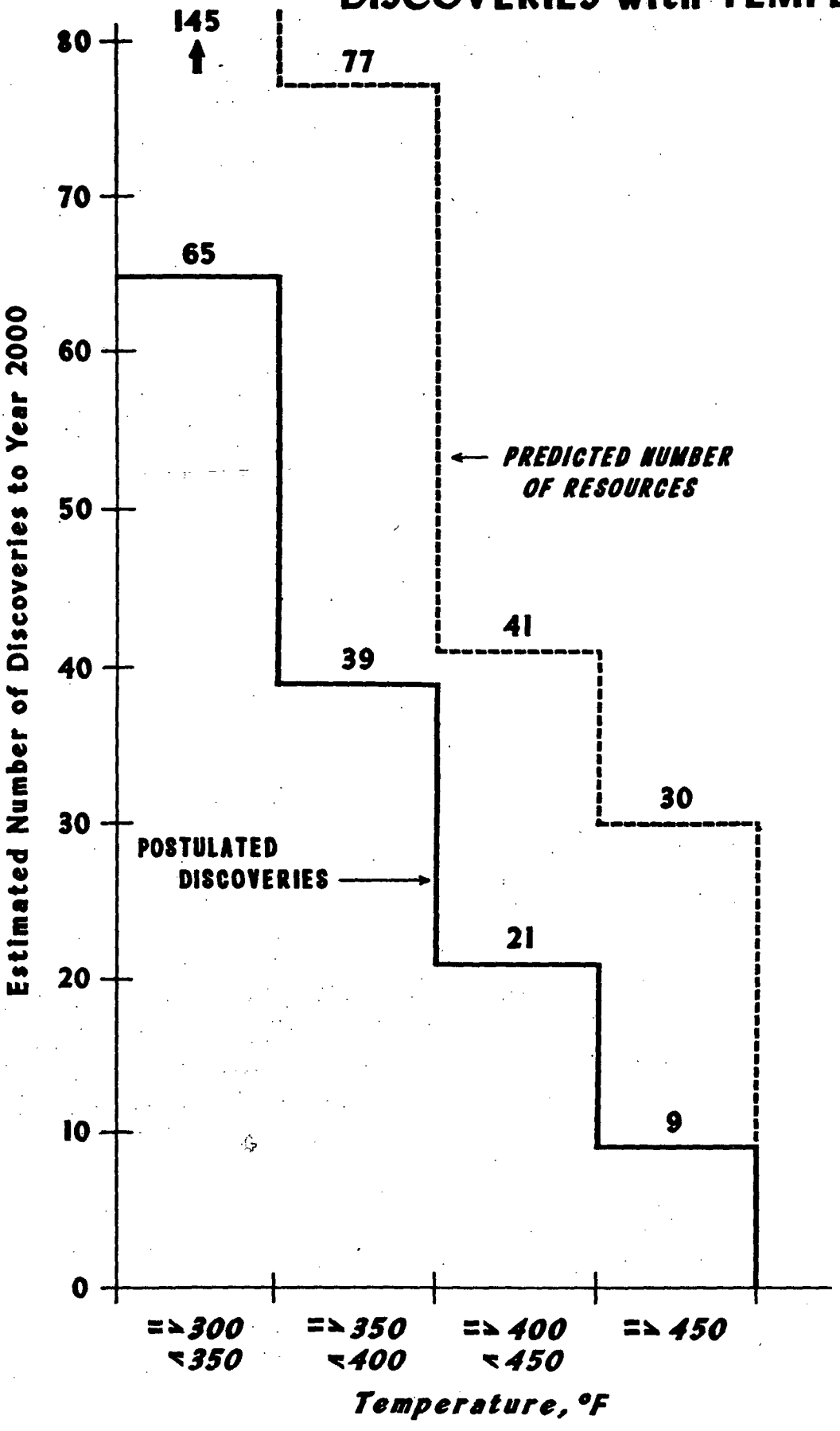
MSE/064

DISTRIBUTION of DISCOVERIES with TEMPERATURE



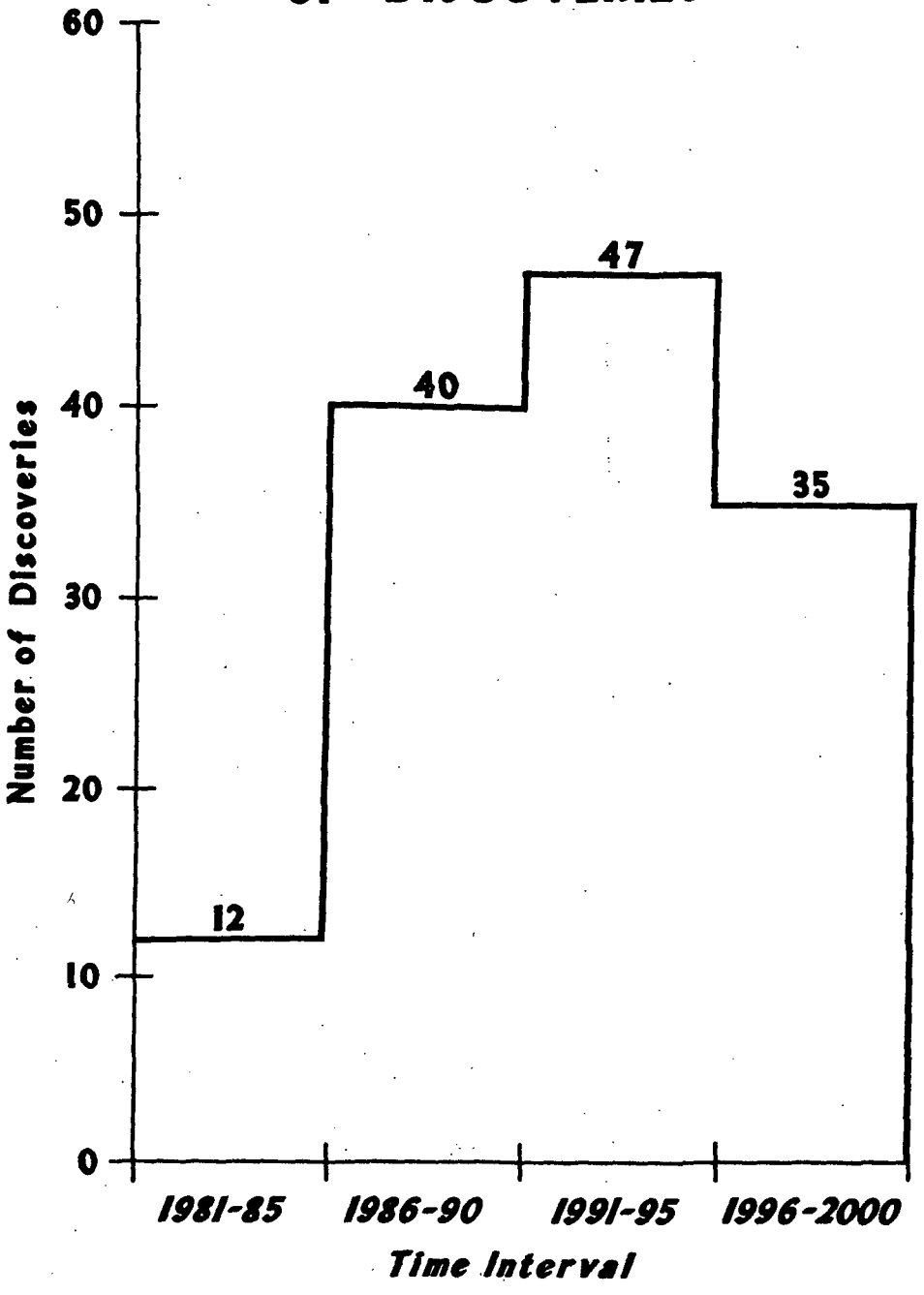
MSE/065

DISTRIBUTION of POSTULATED DISCOVERIES with TEMPERATURE



MSE/066

ESTIMATED FREQUENCY of DISCOVERIES



MSE/067

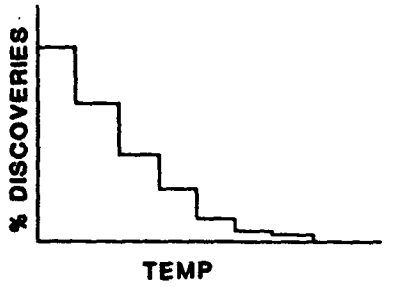
GEOLOGIC ASSUMPTIONS

-DATA FROM KNOWN RESOURCES CAN BE EXTRAPOLATED

-MOST DISCOVERIES 1980-2000 FROM KNOWN GEOLOGIC ENVIRONMENTS

-PYRAMIDING EFFECT TAKEN INTO ACCOUNT

-LOGNORMAL TEMPERATURE DISTRIBUTION W/EMPHASIS ON HIGHER TEMPERATURES



-T > 300°F FOR ELECTRIC POWER GENERATION

M8E/088

INSTITUTIONAL AND PROGRAMMATIC ASSUMPTIONS

- FAVORABLE CHANGES IN FEDERAL AND STATE LAWS AND LEASING
- CONTINUATION OF DOE RESERVOIR CONFIRMATION INCENTIVES
- BETTER EXPLORATION, CONFIRMATION, AND ENGINEERING TECHNIQUES
- IMPROVED HARDWARE
- SUCCESSFUL DEMONSTRATION PROJECTS
- SUCCESSFUL USGS GEOTHERMAL PROGRAMS

PRESENTLY DISCOVERED RESOURCES BY REGION

REGION NUMBER	STATES	RESOURCE NAMES
1	N. California	None (The Geysers is excluded).
2	S. California	Brawley East Mesa - 2 Heber Salton Sea - 2
4	Nevada	None.
5	Utah	Roosevelt Hot Springs
7	Idaho	Raft River
9	New Mexico	Valles Caldera/Baca

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AREAS HAVING HIGHEST OF PROBABILITY FOR DISCOVERY

REGION NUMBER	STATES	GENERAL AREAS OF DISCOVERY
1	N. California	-The Geysers -Mono-Long Valley -Cascades
2	S. California	-Imperial Valley -Coso
3	Oregon Washington	-Cascades -Alvord Desert -Brothers Fault Zone
4	Nevada	-NE trending Battle Mountain heat flow high from Steamboat to NE corner of Nevada.
5	Utah	-SW Utah geothermal district -Tintic-Fish Springs trend
6	Arizona	-Safford-Morenci area -San Francisco volcanic field
7	Idaho	-Snake River Plain -Island Park -Overthrust Belt
8	Colorado	-Mt. Princeton
9	New Mexico	-Rio Grande Rift
10	Texas	-Trans Pecos Trend
19	Alaska	-Aleutian Islands
20	Hawaii	-Rift Zones on Big Island

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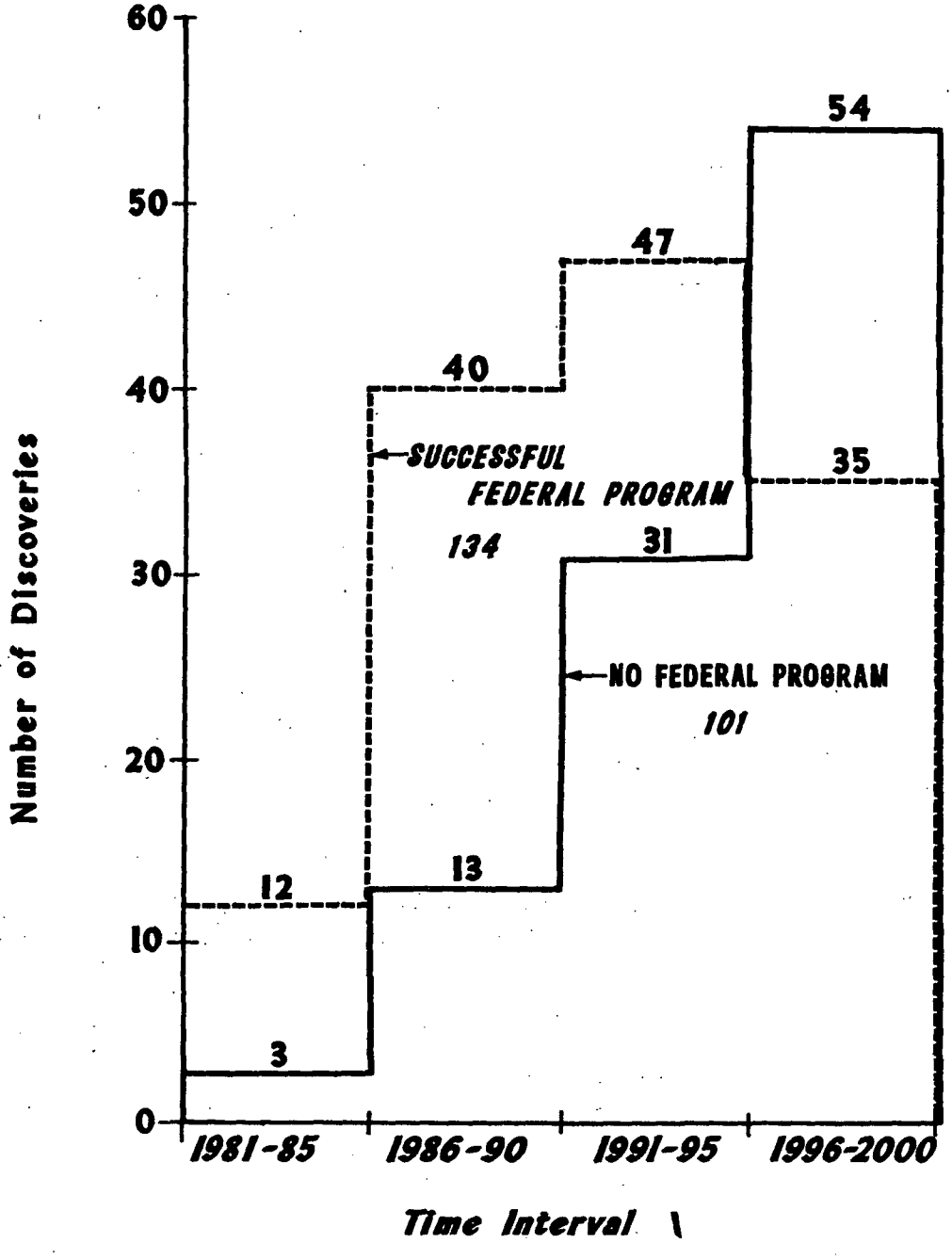
IMPACT OF FEDERAL PROGRAMS

- FEDERAL PROGRAMS ACCELERATE DISCOVERY RATE
- IT MAY BE 10 YEARS BEFORE AN AGGRESSIVE INDUSTRY WOULD DEVELOP BY ITSELF
- DOE PROGRAMS NEED MORE TIME FOR SUCCESS

PROGRAM ELEMENT	ADDITIONAL TIME (yrs)
REGULATORY STREAMLINING	5
RESOURCE CONFIRMATION	0
POWER PLANT INCENTIVES	3
TECHNOLOGY DEVELOPMENT	3
TECHNOLOGY DEMONSTRATION	3

- DOE PROGRAMS MAY SPEED DEVELOPMENT BY 7 YEARS

ESTIMATED FREQUENCY of DISCOVERIES



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FOOTNOTES FOR APPENDIX II

[1]The Generic Category Number is determined by listing in order the Range Number for the following resource characteristics as shown in the table: Temperature, Unpumped Flow Rate, Brine Contamination Index, Well Costs and Pumped Flow Rate.

VARIABLE GENERIC RESOURCE CHARACTERISTICS AND THEIR RANGES

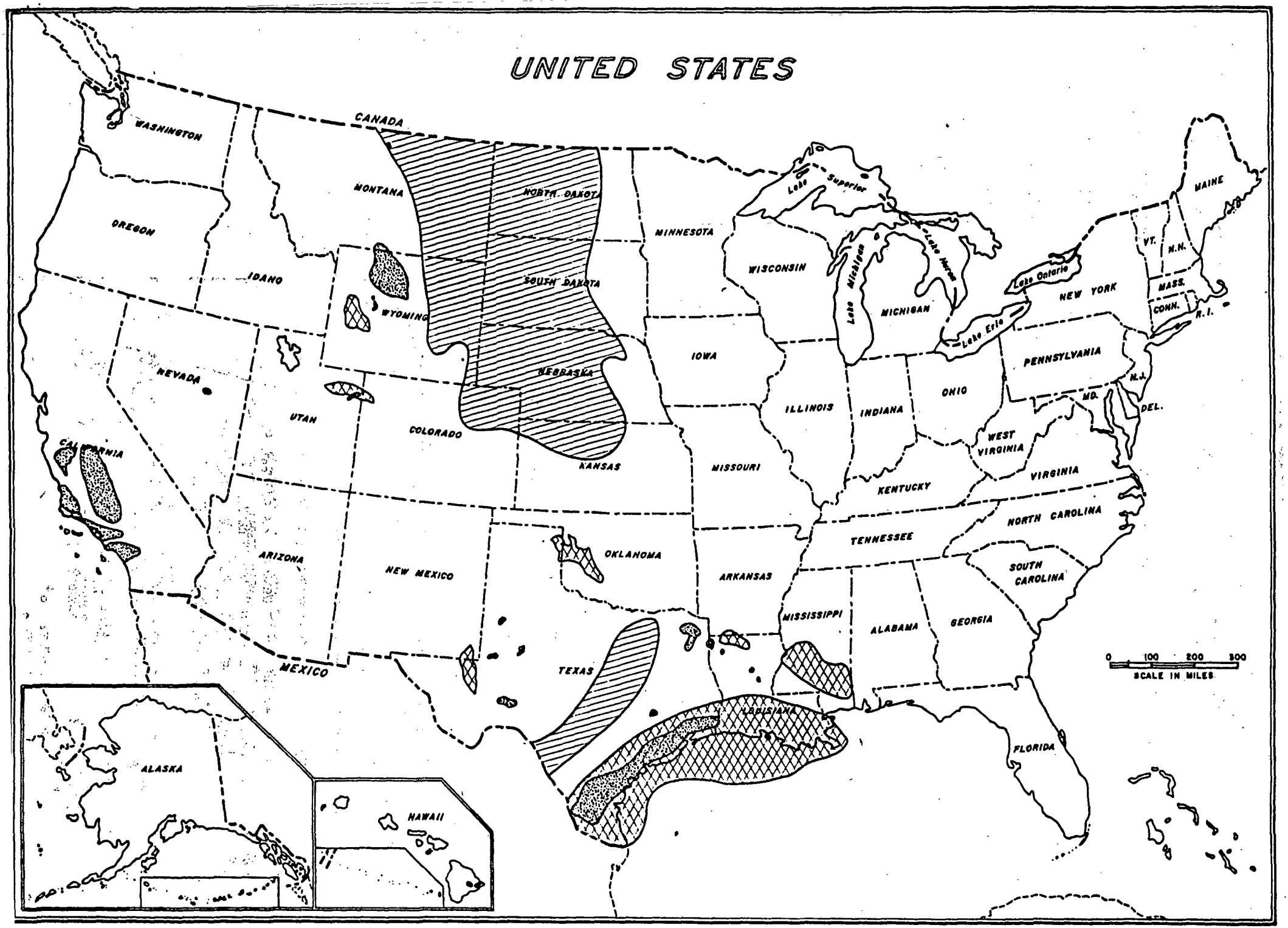
PARAMETER	RANGES							
Range No.	1	2	3	4	5	6	7	8
Temperature (^{o}F)	=>100 <150	=>150 <200	=>200 <250	=>250 <300	=>300 <350	=>350 <400	=>400 <450	=>450
Unpumped Flow Rate (10^3 lbs/hr)	<50	=>50 <100	=>100 <200	=>200 <400	=>400 <600	=>600 <800	=>800	
Brine Contamination Index (TDS)	0 (<2000)	1 (2000-100,000)	2 (>100,000)					
Well Costs ($M)	>2	<2 =>1	<1 =>0.5	<0.5				
Pumped Flow Rate (10^3 lbs/hr)	<50	=>50 <100	=>100 <200	=>200 <400	=>400 <600	=>600 <800	=>800	
Max. Produc. Acreage	Small	Large						

[2]These values represent the perception of the resource area at the time of discovery. "Discovery", as used here, denotes that point in time when a successful production well has been drilled and tested. These perceptions are likely to change as production experience is gained.

[3]In cases where temperature and well flow rate are expected to draw down over time, the expected mean values over the life of the resource are given.

[4]A marginal "0", or "1" with high noncondensible gas content is classified as a "1" or "2", respectively.

[5]Well costs include drilling, casing, completion and well heat equipment, excluding pumps.


UNITED STATES
CANADA
WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
KANSAS
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
MEXICO
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
MD.
DEL.
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
ALASKA
HAWAII
0 100 200 300
SCALE IN MILES

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GEOTHERMAL RESOURCES