MINERAL RESOURCE ANALYSIS OF THE PROPOSED SITE FOR UNDERGROUND STORAGE OF HIGH-LEVEL COMMERCIAL NUCLEAR WASTE, HANFORD, WASHINGTON

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ABSTRACT

Evaluation of known and potential mineral resources of the Hanford Site and vicinity, Washington State, was undertaken as part of a larger program being conducted by the United States Department of Energy to evaluate the suitability of candidate sites for construction of terminal repositories for high-level nuclear waste.

Current mining within 100 km of the Hanford Site is limited to surface-mined diatomaceous earth, sand and gravel, and stone. Occurrences of relatively low-unit-value minerals within 100 km of the candidate site consist of peat, diatomaceous earth, pumicite, quarry rock, and sand and gravel. Such resources are surficial in occurrence and are not concentrated within the Pasco Basin relative to the remainder of the Columbia Plateau. A small, low-pressure natural gas field, in production from 1929 to 1941, is present at the southern edge of the Hanford Site. No other commercial production of fossil fuels has occurred in the area. With the exception of small, low grade gold placers along the Columbia River, no high-unit-value mineral resources are known to occur within 100 km of the candidate site.

Economic analysis of the area within 100 km of the candidate site indicates that gross value of known mineral resources and potential, undiscovered natural gas within Columbia River basalts is $470.5 million. Subtraction of estimated exploration, development, production, and wholesale marketing costs from gross value leaves a net value of $33.3 million. Projected net value per area and per capita averages $569/km^2 and $62/current inhabitant. For the remainder of the Columbia Plateau, respective values are $1,195/km^2 or $98/inhabitant. For a mineral-rich state such as New Mexico, comparable net value per area is $17,600/km^2.

Mineral resource value potential of the candidate site area, based on its geologic environment and mineral production, is likely to remain an insignificant component of employment, personal income, and tax revenues derived from all sources. Within Columbia River basalts, the area is unattractive for future subsurface mineral exploration and development relative to other areas of the Columbia Plateau and United States.

INTRODUCTION

The purpose of this analysis is to provide information on the nature, value, and importance of known and potential mineral resources within the Hanford, Washington, nuclear site and vicinity. The work is part of a larger program being conducted by the U.S. Department of Energy (DOE) to evaluate suitability of various areas within the conterminous United States as sites for construction of repositories for terminal storage of high-level commercial nuclear-reactor waste. Geologic data supporting this work were collected and interpreted by Rockwell Hanford Operations (Rockwell), Richland, Washington, and the U.S. Geological Survey (USGS), Oil and Gas Resources Branch, Denver, Colorado. Economic data were collected and analyzed by George Leaming Associates, Marana, Arizona.

Current and past mineral resource production data was compiled and projected to the year 2005 for an area within 100 km of the candidate site and for the remainder of the Columbia Plateau. The 25-yr projection is considered to be the maximum foreseeable forecast period for analysis of economic data. A study area was chosen within 100 km of the candidate repository location to provide a better, more representative basis of analysis than that provided by the Hanford Site, which has been closed to mineral exploration and development for nearly 40 yr. In addition, estimates were made of production that reasonably could be expected from presently undiscovered resources in the immediate vicinity of the candidate site from elsewhere in the Columbia Plateau. Economic evaluation was confined to resources known to exist or whose existence is geologically feasible in potentially commercial quantities. These commodities are clay, diatomaceous earth, geothermal energy, gold, natural gas, oil, peat, perlite, pumice, saline compounds, and sand and gravel (Fig. 1 and 2). Minerals that might occur beneath Columbia River flood basalts in the Pasco Basin were not considered.

Areas of economic analysis are shown in Fig. 3. The immediate vicinity study area is the area within 100 km of the candidate repository location within the Hanford Site. The adjacent counties study area is the area, defined by county lines, which most closely approximates the immediate vicinity study area. The Columbia Plateau study area, defined by county lines, encompasses the greater portion of outcrop area of the Columbia River Basalt Group. County boundaries are utilized to define the above areas because most economic data are available only on a county-wide basis.

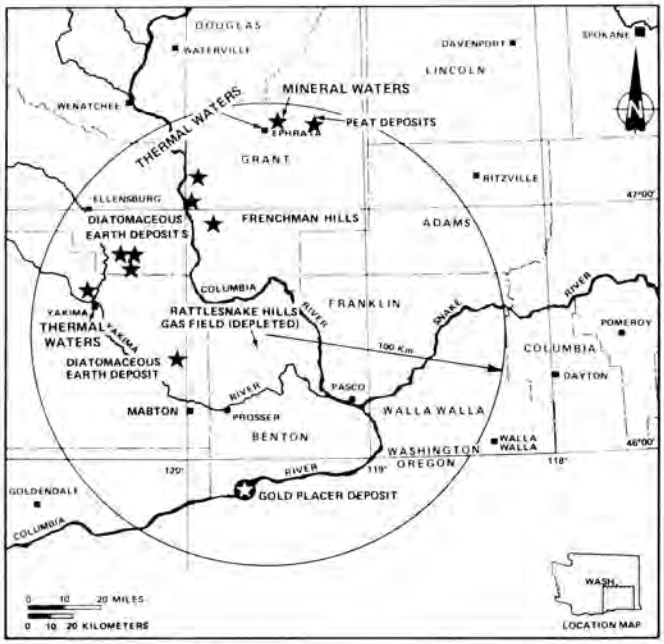

Fig. 1. Significant Mineral Resources Other than Sand and Gravel in the Immediate Vicinity Study Area.

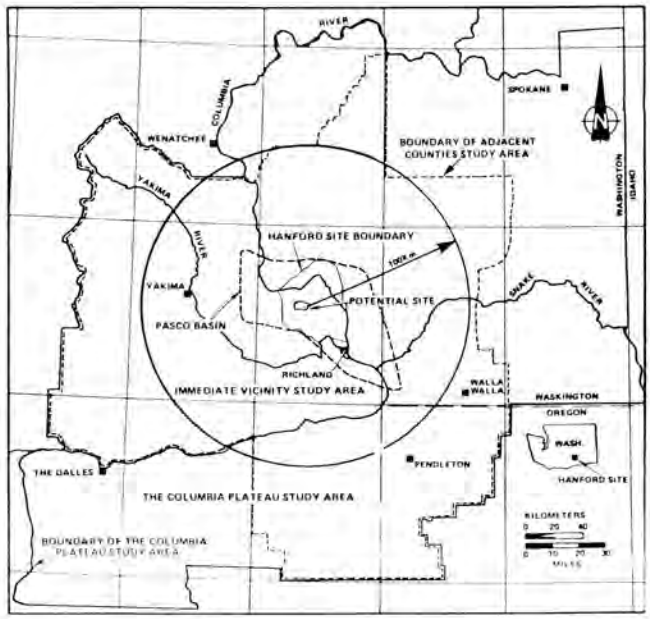

Fig. 3. Locations of the Pasco Basin, and the Immediate Vicinity, Adjacent Counties, and Columbia Plateau Study Areas.

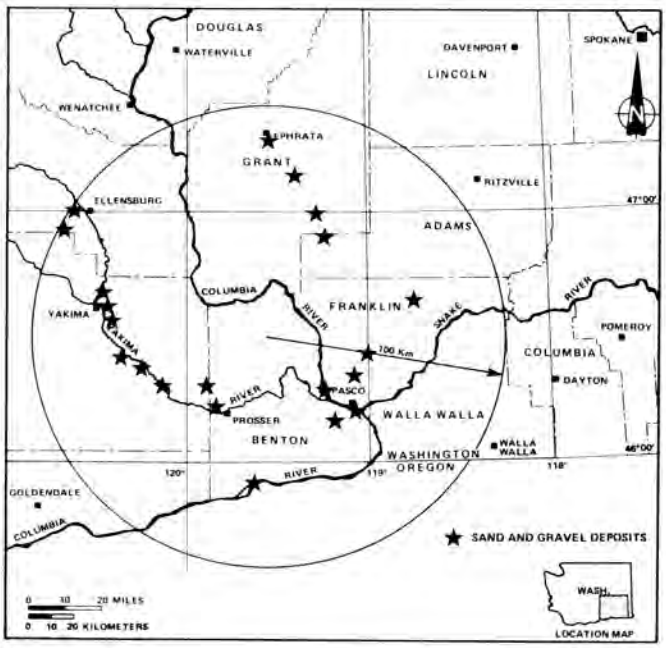

Fig. 2. General Distribution of Sand and Gravel Deposits Currently Exploited in the Immediate Vicinity Study Area, Washington.

GROSS VALUE OF MINERAL RESOURCES - ADJACENT COUNTIES STUDY AREA

Active producers of mineral resources within the immediate vicinity study area are listed in Table I; known mineral resources within the same area are described in Table II.

Mineral Fuels: Natural Gas

The Rattlesnake Hills gas field (Fig. 1) has been depleted. Currently there is no gas production within 100 km of the candidate site. Based on occurrence of geologic environment similar to that of the Rattlesnake Hills gas field and known drilling results to date, it is estimated that future production of natural gas within the Columbia River Basalt Group could come from (1) westward or southeasterly extension of the Rattlesnake Hills gas field, Benton County; (2) the Mabton area, Yakima County; and (3) the Frenchman Hills area of Grant County (Fig. 1).

For economic evaluation, potential new gas fields that may be discovered within Columbia River basalts in the adjacent counties study area are assumed to be comparable in size to the Rattlesnake Hills gas field (i.e., to contain ~1.3 billion ft^3 of commercial natural gas). A second assumption is that future exploration for natural gas in the area would have a success rate similar to that for the Rattlesnake Hills gas field. In that effort, 37% of wells drilled were productive. Using these assumptions, three new gas fields similar in size to the Rattlesnake Hills field would yield 3.9 billion ft^3 of natural gas over 25 yr. At an expected value (in 1980 dollars) of \$5/1000 ft^3, such resources would have a gross value (market price times total quantity available at that price) of \$19.5 million, with 0.37 probability of realization (Table III).

TABLE I. Active Mineral Producers - Immediate Vicinity Study Area, 1979.

Commodity	Producer; Owner	Location
Basalt	Fewel-Ennis Quarry; F. D. Fewel and E. Ennis	Naches; T15N, R16E
Basalt	Johnson Quarry; F. G. Johnson	Prosser; T8N, R24E
Basalt	Yakima Sites; Native Stone Works	Yakima; T13N, R18E
Crushed shale	Summit View Quarry; Buck-Edinger Trucking Co.	Yakima; T13N, R17E
Diatomite	George Pit, Witco Chemical Corp.	George; T17N, R24E
Diatomite	Quincy Pit, Witco Chemical Corp.	George; T17N, R23E
Gravel	Grandview Pit, Asphalt & Gravel Products, Inc.	Grandview; T9N, R23E
Gravel	Hefron Pit, Grace Hefron	Sunnyside; T10N, R22E
Gravel	Johnson Pit, Superior Asphalt & Concrete Co.	Wiley City; T12N, R16E
Gravel	Richland Pits, Midland Rock Products	Richland; T9N, R28E
Gravel	Wightman Pit, Superior Asphalt & Concrete Co.	Union Gap; T13N, R19E
Sand and gravel	Anderson Pit, Sunnyside Asphalt Paving Co.	Sunnyside; T10N, R24E
Sand and gravel	Cascade Valley Pit, AAA Readymix, Inc.	Moses Lake; T19N, R28E
Sand and gravel	Dolman Pit, C. E. Dolman	Ellensburg; T17N, R17E
Sand and gravel	East Selah Pit, Yakima Cement Products Co.	Selah; T13N, R18E
Sand and gravel	Emerald Pit, Valley Ready Mix Concrete, Inc.	Sunnyside; T9N, R22E
Sand and gravel	Ephrata Pit, Columbia Concrete Products, Inc.	Ephrata; T21N, R26E
Sand and gravel	Holt Pit, Three Rivers Sand & Gravel Co.	Kennewick; T8N, R30E
Sand and gravel	Hull Farms Pit, Snipes Mountain Gravel	Sunnyside; T10N, R23E
Sand and gravel	Kennewick Pit, Matheson Sand & Gravel Co.	Kennewick; T8N, R30E
Sand and gravel	Kennewick Pit, Midland Rock Products	Kennewick; T8N, R30E
Sand and gravel	Luther Pit, D. L. Luther Co.	Granger; T10N, R22E
Sand and gravel	Merke Pit, E. Lewis	Yakima; T12N, R16E
Sand and gravel	Moses Lake Pit, Columbia Sand & Gravel, Inc.	Moses Lake; T19N, R28E
Sand and gravel	Newland Property, Peter Kiewit & Sons	Yakima; T13N, R19E
Sand and gravel	Pasco Pit, Central Premix Concrete Co.	Pasco; T9N, R28E
Sand and gravel	Potholes Pit, Sampson Sand & Gravel	Moses Lake; T17N, R28E
Sand and gravel	Richland Pit, Acme Concrete Co.	Richland; T9N, R28E
Sand and gravel	Sanders & Young Pit, Young Rock Products	Kennewick; T8N, R30E
Sand and gravel	Sulfur Pit, Connell Sand & Gravel, Inc.	Connell; T13N, R33E
Sand and gravel	Wachsmith Pit, Triangle Sand & Gravel Co., Inc.	Yakima; T13N, R18E
Sand and gravel	Wapato Pit, Columbia Asphalt	Parker; T12N, R19E
Sand and gravel	West Ellensburg Pit, Ellensburg Cement Products, Inc.	Ellensburg; T18N, R18E
Sand and gravel	Woodworth Pit, Snipes Mountain Gravel	Outlook; T10N, R22E
Sand and gravel	Yakima Pit, Central Premix Concrete Co.	Yakima; T13N, R19E
Sand and gravel	1147 Pit, Midland Rock Products	Pasco; T9N, R30E
Sand and gravel	10158 Pit, Midland Rock Products	Kennewick; T8N, R29E
Sand	E-20 Pit, Valley Ready Mix Concrete, Inc.	Granger; T10N, R21E

NOTE: Private-sector producers only.
SOURCE: McFarland et al., 1980.

TABLE II. Mineral Resources of the Immediate Vicinity Study Area.

Commodity	Location(s)	Description	References
Energy			
Lignite	Intercepts in borehole RSH-1.	Carbonaceous Ellensburg Formation sediment. Maximum rank-lignite. Beds less than two-thirds m thick at depths in excess of 1,000 m and therefore not exploitable with current or foreseeable technology. No past exploitation.	1,2,3,4
Peat	Crab Lake, near Ephrata, WA. See Fig. 1.	As much as 21 x 10^6 m^3 of relatively poor quality. No past exploitation.	2,5
Natural gas	Rattlesnake Hills gas field, central Benton County. Shows of gas in water wells near Sunnyside, Mabton, and Wenatchee. See Fig. 1.	Rattlesnake Hills field discovered in 1911; in commercial production from 1929-1941. Now depleted, the field yielded 37 million m^3 of low-pressure, high-methane gas. Isotopic analyses[2] suggest that the gas originated from organic matter trapped in volcaniclastic sediments interbedded with Columbia River Basalt Group flows. No associated oil reported. Assessment of oil and gas potential of sediments postulated to underlie the plateau flood basalts requires their penetration by drilling. No current commercial production from Columbia Plateau. Potential undiscovered resources in immediate vicinity study area estimated at 3 times that produced in the past from within the basalt group.	2,6,7
Geothermal	City of Yakima. See Fig. 1.	One low-temperature (35°C) artesian well utilized for recreational purposes. No production for purposes of energy utilization.	8,9,10
	City of Ephrata. See Fig. 1.	Low temperature resources being explored for space-heating.	
Metallic Minerals			
Gold	Placer deposits along the Columbia River. See Fig. 1. Mouth of Artesian Coulee, Berrian Island, and Blalock Island, Benton County; north of Vantage and east of Priest Rapids, Grant County.	Only placer of potential commercial interest is Blalock Island. Estimated as 13.3 x 10^6 yd^3 of sand and gravel containing 1/600 oz Au/yd^3.	11
Industrial Rocks and Minerals			
Clays	See Fig. 8 in reference 2.	Small, scattered occurrences sporatically worked in the past. No current production.	12
Diatomaceous earth	Mostly in Grant County. Scattered occurrences in Yakima, Kittitas, Klickitat, Adams, and Benton Counties. See Fig. 1; Table 1.	Currently mined in Grant County by Witco Chemical Co., at a rate of ~60,000 short tons/yr from shallow surface pits. Small, scattered occurrences elsewhere not currently being worked.	13
Mineral waters	See Fig. 1. Moses Lake and Soap Lake, Grant County.	Lakes containing dilute sodium sulfate, sodium chloride, and carbonates of sodium, magnesium, and calcium. No past production. Recreational use only.	12
Perlite, pumice, pumicite	Near Beverly, Grant County. Near Roza, S.E. Kittitas County, and Hanford, Benton County.	Scattered, sporadic past production. No current utilization.	12
Sand, gravel, and stone	See Fig. 2; Table 1. Near urbanized areas adjacent to river beds.	From 1977 through 1979, production has averaged 3.2 x 10^6 short tons/yr.	14,15

TABLE III. Projected Gross and Net Values and Estimated Present Values of Mineral Resources in the Adjacent Counties Study Area[a]--1981-2005. (Figured in thousands of dollars.)

Mineral commodity	Gross value[b]	Production cost[b]	Net value[b]	Present net value[b]	
				At 12%	At 18%
Mineral Fuels					
Natural gas[c]	$19,500	$16,100	$3,400	$1,070	$740
Peat	800	600	200	60	40
Metallic Minerals					
Gold (placer)	11,100	8,700	2,400	750	520
Nonmetallic Minerals					
Diatomaceous earth	185,200	172,600	12,600	3,950	2,760
Sand, gravel, and stone	263,900	239,200	14,700	4,610	3,210
			$33,300	$10,440	$7,270

[a]Values calculated for the adjacent counties study area in approximation of the immediate vicinity study area because of the availability of economic data only on a county basis. See Fig. 3.

[b]Values are expressed in 1980 dollars. Present value at the beginning of 1981 of a stream of 25 annual payments equal to 1/25 of the total net value.

[c]Natural gas values expected from presently undiscovered deposits within the Columbia River Basalt Group. The subjective probability of realization is estimated at 0.37. All other values are for currently known deposits, rounded to the nearest hundred thousand.

SOURCE: Reference 2.

Mineral Fuels: Peat

Peat is not now commercially exploited in the adjacent counties study area, but the Crab Lake deposit (Fig. 1) could have potential economic value. Crab Lake peat production over the next 25 yr, if any, is assumed to be about 2,200 short tons/yr using a scale comparable to current individual peat operations in the state. At this rate, only ~55,000 short tons of Crab Lake peat have present economic value. At the recent price of $13.70/ton, this production is assigned a gross value of $754,000 (Table III).

Metallic Minerals: Gold

Gold of Blalock Island (Fig. 1) is likely to be produced in the foreseeable future if the price of gold becomes sufficiently high, demand for coproduct sand and gravel increases, and environmental and political considerations can be accommodated. The Washington Department of Natural Resources estimates that the placer contains 13.3 million yd^3 of sand and gravel containing ~1/600 oz Au/yd^3. At a gold price of $500/oz, the deposit has a gross gold value of $11.1 million (Table III).

Nonmetallic Minerals: Diatomaceous Earth

Diatomaceous earth likely to be produced in the adjacent counties study area (Fig. 1) over the next 25 yr is projected to have a gross value of $185.2 million if current production levels and prices are maintained (Table III). It is unlikely that additional future production will come from *deposits not* now known because of the surficial nature of such deposits.

Nonmetallic Minerals: Sand, Gravel, and Stone

Only sand, gravel, and stone for which there is *a market have economic* value. Sand, gravel, and stone production in the adjacent counties study area (Fig. 2) from 1981 to 2005 will probably increase in proportion to population. Based on change from 1970 to 1980, population is projected to increase 53% by 2005 and production of sand, gravel, and stone should increase commensurately. Such increase would result in production over the next 25 yr of 100.7 million short tons. At the recent price of $2.50/ton, a gross value of $253.9 million is assigned (Table III).

DEVELOPMENT, PRODUCTION, AND MARKETING COSTS - ADJACENT COUNTIES STUDY AREA

Development, production, and marketing costs of known or undiscovered mineral resources of the adjacent counties study area are given in Table IV. The costs given are based on historical costs of exploration, development, distribution, and marketing for each commodity, and are the same as costs for the Columbia Plateau study area as a whole. (Ref. 2)

TABLE IV. Development, Production, and Marketing Costs of Known or Potential Mineral Resources of the Adjacent Counties Study Area and the Remainder of the Columbia Plateau. Costs are estimated in terms of costs per dollar of gross value, 1980.

Mineral commodity	Estimated cost					
	Per unit of output			Per dollar of gross unit value		
	Development, production	Wholesale marketing	Total	Development, production	Wholesale marketing	Total
Mineral Fuels						
Natural gas	$3.26/10^3 ft^3	$0.86/10^3 ft^3	$4.12/10^3 ft^3	$0.652	$0.172	$0.824
Peat[a]	6.22/ton	4.36/ton	10.58/ton	0.454	0.318	0.772
Metallic Minerals						
Gold (placer)[b,c]	390/oz	-0-	390/oz	0.785	-0-	0.785
Nonmetallic Minerals						
Diatomaceous earth[c]	145/ton	-0-	145/ton	0.932	-0-	0.932
Sand, gravel, stone[d,c]	2.40/ton	-0-	2.40/ton	0.942	-0-	0.942

NOTE: All estimates exclude federal and state income taxes.

[a]Estimates assume commercial production. Current total costs are apparently estimated by prospective investors at more than $13.70/ton, the current market price. Thus, at current market prices, production from the deposits is not economically feasible.

[b]Estimates assume production of gold as a by-product or co-product of sand and gravel production. Assumes 1/600 oz/yd^3 gold content and a processing cost of gold of $0.65/$yd^3$.

[c]Current approximate production cost. Transportation and marketing costs are considered to be negligible relative to production cost.

[d]Based on recent U.S. Department of Commerce and U.S. Bureau of Mines data.

SOURCE: Reference 2

NET VALUE AND PRESENT VALUE OF NET - MINERAL RESOURCES OF THE ADJACENT-COUNTIES STUDY AREA

Net values (gross values minus costs) of mineral resources that might be found and produced in the adjacent counties study area over the next 25 yr are given in Table III. For purposes of calculating present value of net value (value at the beginning of a series of periodic payments) of potential undiscovered resources of natural gas within Columbia River basalts, it is assumed that the $3.4 million of net value would be distributed evenly during the forecast period. This, in effect, maximizes present value by assuming that currently undiscovered resources will be discovered in the first year of the 25-yr period and will be produced at a uniform rate over the next 25 yr. In reality, such resources may be discovered after 1981 and may be produced for less than 25 yr. In calculating present value of a series of 25 equal net-value payments, two interest rates were used. Twelve percent was (1981) the approximate interest rate that could be received from a "safe" alternate investment (e.g., tax-free municipal bonds or certificates of deposit in insured financial institutions). Eighteen percent was the approximate current cost of money to invest in mineral resource development, as of the beginning of the forecast period.

The present value of potential natural gas resources within the study area, (net value of $3.4 million over 25 yr) is $1.1 million (at a 12% discount rate) or $0.7 million (at an 18% discount rate). These values have a subjective probability of realization of 0.37 (Table III), and do not include natural gas, if any, that may be found beneath the Columbia River basalts.

The same assumptions, methods, and discount rates used to calculate the present value of undiscovered natural gas have been used to calculate the present value of known deposits of diatomaceous earth, peat, placer gold, sand, gravel, and stone (Table III).

COMPARISON WITH THE REMAINDER OF THE COLUMBIA PLATEAU

Table V summarizes projected (25-yr basis) gross, net, and present values of mineral resources of the Columbia Plateau study area (as defined by county-line boundaries, Fig. 3). Costs used to compute net values are the same as reported in Table IV for the adjacent counties study area. Discount rates used to compute present value are the same as in Table III.

TABLE V. Projected Gross and Net Values and Estimated Present Values of Mineral Resources in the Columbia Plateau Study Area[a]--1981-2005. (Figured in thousands of dollars.)

Mineral commodity	Gross value[b]	Production cost[b]	Net value[b]	Present net value[b]	
				At 12%	At 18%
Mineral Fuels					
Natural gas[c]	$19,500	$16,100	$3,400	$1,070	$740
Peat	1,500	1,200	300	90	70
Metallic Minerals					
Gold (placer)	19,400	15,200	4,200	1,320	920
Nonmetallic Minerals					
Diatomaceous earth	185,200	172,600	12,600	3,950	2,760
Sand, gravel, and stone	457,000	430,500	26,500	8,310	5,790
	$682,600		$47,000	$14,740	$10,280

[a]As defined on a county-line boundary basis. See Fig. 3.

[b]Values are expressed in 1980 dollars. Present value at the beginning of 1981 of a stream of 25 annual payments equal to 1/25 of the total net value.

[c]Natural gas values expected from presently undiscovered deposits within the Columbia River Basalt Group. The subjective probability of realization is estimated at 0.37. All other values are for currently known deposits, rounded to the nearest hundred thousand.

SOURCE: Reference 2.

Net Resource Values

Projected net value of mineral resources with potential for production in the adjacent counties study area over the next 25 yr is $33.3 million (Table VI), or 41% of net value of such mineral resources in the Columbia Plateau study area. The portion of the Columbia Plateau outside of the adjacent counties study area is thus estimated to contain more than one-half (59%) of the net value of mineral resources in the Columbia Plateau. Estimates of net value per unit area and per inhabitant indicate that mineral resources are much more important in the portion of the Columbia Plateau outside of the adjacent-counties study area than would be indicated by the 59:41 ratio of net resource values. For the adjacent-counties study area, projected net mineral value averages $569/km^2 (Table VI) and $62/inhabitant. For the remainder of the Columbia Plateau, projected value averages $1,195/km^2 and $98/inhabitant. On a per-inhabitant basis, net value in the adjacent-counties study area is less than two-thirds of what it is in the remainder of the Columbia Plateau. In both areas, net value per square kilometer is relatively low. For the entire state of Washington, the net value of sand, gravel, and stone is ~$700/km^2 and net value of all of the state's mineral resources is estimated at over $1,700/km^2, or more than three times the ratio in the immediate vicinity of the candidate site. For a mineral-rich state such as New Mexico, the comparable figure is $17,600/km^2, or over 30 times the ratio for counties adjacent to, and including, the candidate site.

TABLE VI. Economic Comparisons of Mineral Resource Values--The Candidate Site Area Versus the Remainder of the Columbia Plateau.

Variable factor	Immediate vicinity study area[a]	Remainder of Columbia Plateau[b]
Area (km^2)	58,500	97,830
Population (1980)	533,241	478,793
Total employment (1980)	231,050	189,180
Net resource value[c]	$33,300,000	$47,000,000
Per km^2	569	1,195
Per inhabitant	62	98
Mining personal income[d]	$4,479,000	$4,945,000
Per km^2	77	126
Per inhabitant	8.40	10.33
Jobs in mining (1980)	280	340
Per 1,000 km^2	4.8	8.6
Per 1,000 inhabitants	0.5	0.7
Government revenues[e]	$192,400	$77,000
Per km^2	3.29	1.96
Per inhabitant	0.36	0.16

[a]Closest approximation of a 100-km radius from the reference repository location achievable on the basis of county boundaries.

[b]Closest approximation of main area of Columbia River Basalt Group outcrop, less the immediate vicinity study area, achievable on the basis of county boundaries.

[c]Net resource value is the projected value, in 1980 dollars, of minerals that could be produced from 1981 to 2005. In each of the two areas considered, net values are only for those minerals found within 100 km of the potential site and exclude values for other minerals, even though they may be found and produced elsewhere on the Columbia Plateau.

[d]Mining personal income is personal income derived directly from mining in 1978 as reported by the U.S. Department of Commerce, Bureau of Economic Analysis.

[e]Government revenues are defined as state and local tax revenues contributed by mining enterprises. Relative values reflect the fact that the state of Washington taxes natural gas production at a higher rate than other minerals.

SOURCE: Reference 2.

Personal Income

In 1978, personal income derived directly from mining and minerals processing in the adjacent counties study area was ~$4.5 million, or ~48% of personal income derived from minerals production in the Columbia Plateau study area. Mining and minerals processing in the vicinity of the candidate site yielded average personal income of $77/km^2 or $8.40/inhabitant (Table VI). In the remainder of the Columbia Plateau, personal income from minerals averaged $126/km^2, or $10.33/inhabitant. Mining and minerals processing in the adjacent counties study area is thus much less important in terms of dollars of personal income per square kilometer and inhabitant than in the remainder of the Columbia Plateau. In both areas, mining is a minor source of personal income.

Employment

Likewise, mining and minerals processing is a minor source of jobs. In the adjacent counties study area in 1980, mining and minerals processing provided 280 jobs; an average of 4.8 jobs/1,000 km^2, or 0.5 jobs/1,000 inhabitants. In the remainder of

the Columbia Plateau in 1980, analogous figures were 8.6 jobs/1,000 km^2, or 0.7 jobs/1,000 inhabitants (Table VI).

Minerals industry employment in the Columbia Plateau study area is exceptionally low compared to most other areas of the western United States. For the entire state of Washington in 1980, mining provided an average of 17 jobs/1,000 km^2, or 0.7 jobs/1,000 inhabitants. In mineral-rich New Mexico in 1980, the minerals industry provided an average of 88 jobs/1,000 km^2 or nearly 23 jobs/1,000 inhabitants.

Tax Revenues

Based on projection of current tax rates and revenues, annual tax revenues from mining in the adjacent counties study area are expected to average \$3.29/km^2 from 1980 to 2005, (Table VI). In the remainder of the Columbia Plateau, mining's annual contribution to state and local tax revenues is expected to average \$1.96/km^2 (Table VI). By comparison, in 1980 Washington State business and occupation tax receipts averaged \$2,334/km^2, or \$97/inhabitant. In New Mexico in 1978, where mining is considerably more significant, direct mineral severance taxes were \$528/km^2, or \$137/inhabitant. As a source of governmental revenue, mining and mineral processing in the adjacent counties study area is likely to be more important than in the remainder of the Columbia Plateau because the state levies higher gross income tax on natural gas than on other natural resources.

CONCLUSIONS -- IMPACT OF A WASTE REPOSITORY ON POTENTIAL MINERALS PRODUCTION

Current mining activity or activity that reasonably can be expected over the next 25 yr within 100 km of the candidate site would not be affected by the presence of a nuclear waste repository located at the depth that has been proposed (~1 km). Extraction of potential natural gas from within the Columbia River Basalt Group is a possible exception.

Loss of Value

Estimated gross value of mineral production lost by potential prohibitions on exploration and development of presently unknown natural gas resources in the immediate vicinity of the candidate site is \$19.5 million. No potential loss of gross value of other projected mineral production is likely. Potential net value of mineral resources lost to the economy is estimated at \$3.4 million. The probability that such resources actually exist, however, is only 0.37. Over a 25-yr period, the potential loss of net mineral resource value resulting from construction of a repository is ~\$136,000/yr. Present value at the beginning of 1981 potentially lost by precluding utilization of undiscovered natural gas resources in the immediate vicinity study area is \$743,500 (at an 18% discount rate) or ~\$1,067,000 (at a 12% discount rate). These values, considering the 0.37 probability of discovery of the resources, are considered *maximal*.

Personal Income, Employment, and Tax Revenue Loss

Because no natural gas is being produced within 100 km of the candidate site, the preclusion of such production in the future would not reduce present levels of employment or personal income derived from such activity. The prohibition of such activity could cause employment and personal income from mining to increase less rapidly than it otherwise would, but the differential is estimated to be only ~\$164,000/yr in personal income and 10 mineral industry jobs. Potential loss of state and local tax revenues because of the inability to seek, develop, and use undiscovered natural gas within 100 km of the candidate site is \$47,000 annually over the 25-yr forecast period. The loss would be composed of unrealized property, and business and occupation taxes.

Net Effect on Local Economies

Geologic assessment of the candidate site area and vicinity suggests that the area is relatively unattractive for future subsurface mineral exploration and development in conflict with construction of a high-level nuclear waste repository. The net economic effect on local and regional economies within the adjacent-counties study area resulting from preclusion of exploration, development, and production of as-yet-undiscovered natural gas resources is expected to be virtually nil. Construction of the waste repository facility would probably utilize quantities of local sand and gravel sufficient to more than offset economic loss resulting from loss of potential natural gas resources.

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